Digital Life Stories: Semi-Automatic (Auto)Biographies within Lifelog Collections

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy is entirely my own work, that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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Abstract

Our life stories enable us to reflect upon and share our personal histories. Through emerging digital technologies the possibility of collecting life experiences digitally is increasingly feasible; consequently so is the potential to create a digital counterpart to our personal narratives. In this work, lifelogging tools are used to collect digital artifacts continuously and passively throughout our day. These include images, documents, emails and webpages accessed; texts messages and mobile activity. This range of data when brought together is known as a lifelog. Given the complexity, volume and multimodal nature of such collections, it is clear that there are significant challenges to be addressed in order to achieve coherent and meaningful digital narratives of our events from our life histories.

This work investigates the construction of personal digital narratives from lifelog collections. It examines the underlying questions, issues and challenges relating to construction of personal digital narratives from lifelogs. Fundamentally, it addresses how to organize and transform data sampled from an individual's day-to-day activities into a coherent narrative account.

This enquiry is enabled by three 20-month long-term lifelogs collected by participants and produces a narrative system which enables the semi-automatic construction of digital stories from lifelog content. Inspired by probative studies conducted into current practices of curation, from which a set of fundamental requirements are established, this solution employs a 2-dimensional spatial framework for storytelling. It delivers integrated support for the structuring of lifelog content and its distillation into storyform through information retrieval approaches. We describe and contribute flexible algorithmic approaches to achieve both. Finally, this research inquiry yields qualitative and quantitative insights into such digital narratives and their generation, composition and construction. The opportunities for such personal narrative accounts to enable recollection, reminiscence and reflection with the collection owners are established and its benefit in sharing past personal experience experiences is outlined. Finally, in a novel investigation with motivated third parties we demonstrate the opportunities such narrative accounts may have beyond the scope of the collection owner in: personal, societal and cultural explorations, artistic endeavours and as a generational heirloom.

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Table of Contents

Chapter 1

Introduction

1.1 Overview

"Telling stories is as basic to human beings as eating. More so, in fact, for while food makes us live, stories are what makes our lives worth living. They are what make our condition human."

- Kearney, 2002

From recounting an interesting weekend excursion or a recent holiday to our colleagues over lunch, to a lifetimes worth of memories from parent to child, our life stories are used to communicate our meaningful experiences to one another. We share our life memories readily in this form. So important are stories to our memories that Tulving (1984) suggests our memories are stored as 'episodes', or in a manner which closely resembles story-form. Not only do our life stories allow us to share and communicate our experiences with those that matter to us, they also offer us the opportunity for reminiscence and reflection. The review of past experiences in the light of present circumstances often allows unseen solutions to present problems to be uncovered. The reflection on our personal stories, and perhaps on those of others, allows us to grow, develop and progress in our lives. Stories and storytelling are integral in our day-to-day lives.

While paintings, books and diaries are ubiquitous modes by which memory and experience are preserved, within the last century we have seen incredible technological advances which have opened the door to new modes of capture and new possibilities for the expression of life experiences. For example, digital photography is now so ubiquitously available through digital cameras and mobile telephones that it is rare one is not available to us. As a result, we can, and do, snapshot any moment from our lives with ease. Similarly digital video enables us to preserve a visual recording of meaningful events, which can later be edited into personal stories through software. Blogging and social networks allow us to chronicle

our lives using a range of rich, digital, multimedia artifacts and then share it with not only our family and friends, but potentially with millions of others. These technologies currently only offer explicit capture of personal memories. A user must intervene in the event and actively decide to preserve it through a photo or video. The stories we can tell digitally are therefore limited by the artifacts we have decided to capture. Imagine, however, if all of our life experiences were passively captured and stored without the need for intervention. Then the opportunities for telling and sharing life stories would be greatly increased. This is the promise of 'lifelogging' technology, which is making the total capture of a life's experiences through digital means increasingly feasible.

As technology has advanced we have been continually offered new media through which we can both capture and express our meaningful life experiences in new and exciting ways. Lifelogging is one such development that offers just that – a world of new possibilities for reminiscing, retelling and sharing our personal histories.

1.2 Motivation

The goal of a lifelog is to capture and preserve a record of the activities and life of an individual through digital means. This is enabled through a range of complimentary technologies where each captured modality contributes a perspective on these past actions. When brought into confluence, they form a rich and detailed store formed from a variety of digital artefacts, each of which embody and represent aspects(s) of past experience. These artefacts may include not only the digital content encountered, captured and created in our day-to-day lives but through context sensing, proximal digital signals may sample the environment around the individual and its state. Lifelogs are rich, voluminous and multimodal (Byrne, Lee, Jones, & Smeaton, 2008), and their potential to empower reminiscence, reflection and exchange of personal life stories through digital technologies is exciting. However, until now this has been unexplored as a research theme largely due to the infancy of the technologies and the unavailability of such collections.

Moreover, in empowering these opportunities, mere capture of digital data is not enough. Appropriate solutions are required to transform a lifelog's content into a more usable, experiential form, aligned with the recollected account. Storytelling is a platform through which this can be achieved. Stories have been used throughout the ages as a transformative technique to weave experiences into an expressive form, thereby enabling them to be recounted, re-experienced and recollected. We must now

seek new digital solutions to enable this within lifelog collections. This is the focus of this work.

Traditionally, we only capture our most meaningful experiences in depth. Significant life events such as births, marriages, travels and other milestones are chronicled in detail through photos, mementos, and written records. Our current media archives reflect this, containing only short reasonably isolated episodes amounting to just snippet's of a life lived. Lifelogging seeks to move beyond this and capture a life broadly and in detail by continuously and passively sampling experiences as they occur. Sampled continuously and with the habitual and significant comingled, the development of patterns, themes and trends in daily life can emerge. This can provide new understandings about the life lived by the collection owner (Harper et al., 2009, Lindley et al., 2009). These collections enable exploration and narration of past personal experience placed within the context of the whole-life, rather than as a set of disconnected isolated episodes. This broader framing of life experiences has not been previously explored in personal narrative and is unique avenue for exploration.

By leveraging the power of lifelogging technology to digitise and externalise our personal life histories in the long term, we can explore wholly new concepts in personal life narratives. This will be the primary theme of this research: to explore the new possibilities for preservation, authoring, review and sharing of our personal life histories.

In summary the major goals and motivations of this research will be to:

1. Explore the competency with which narrative construction can be enabled with computational techniques for long-term collections of digitally-captured past personal experience.
2. Investigate the extent to which we can achieve meaningful, coherent narration of personal life histories from a diverse set of media fragments captured from a range of modalities.
3. Examine if it is feasible to move beyond retelling of everyday stories with digital technologies and if life stories may be placed in context of the greater life experiences using intelligent reasoning;
4. Finally, establish the functions and utility a life story generated from digital lifelog might offer to a collection owner or other motivated individuals.

1.3 Problem Definition

A lifelog offers the potential for a permanent account of our personal life history to be maintained, preserved and recounted. The opportunities for a lifelog to be an invaluable aid in recollection and reminiscence has been noted in many recent studies (Hodges et al., 2006; Harper et al., 2008; Lee & Dey, 2008b; Kalnikaite et al., 2010); this potential however has yet to be realized.

The domain of lifelogging and its associated technologies are extremely nascent and as a consequence many of the investigations to date have explored the development of capture technology or the management of the large volumes of content it such technology creates. Studies exploring the utility lifelogging may offer, or the applications it may enable, have for the most part been probative and cursory. Moreover, both the limited availability of capture technology and the effort required to amass these collections have constrained the number of studies that can be performed. To date, the vast majority of studies with lifelogging technology have employed short-term corpora that have focused on, if not a single modality, a narrow set of modalities. There is, as yet, no widespread availability of long-term collections to facilitate research investigations and to our knowledge no other research group is actively engaged in amassing such collections. However, ecologically valid, long-term and operationally realistic collections are required to design, develop and prove technologies for this domain. Their volume and complexity pose greater challenges than the short-term multimedia corpora typically employed in similar investigations. Lifelogs, as the name suggests, are long-term stores of life histories and are unlike traditional media archives given their multimodal and continuously sampled nature. It is consequently important that new technologies within this space validate their applicability with appropriate datasets and demonstrate that they address the many challenges stemming from these collections' richness, complexity and volume.

In order to explore the potential of lifelogs, we must not only have tools which support the capture and management of the content, but which deliver functionality in support of to key activities such as reminiscence, reflection and sharing. Only with appropriate tool support can the potential of these novel collections in this regard be established. Storytelling has been explored by some initial exploratory studies as a means by which many of the envisioned functions of lifelogs can be enabled. These include for example recollection, remembering and re-experiencing past personal experiences (Gemmell, Aris, & Lueder, 2005; Harper et al., 2007; Lee & Dey, 2007; Lee & Dey,

2008.) Given lifelogging's relative novelty, such exploratory investigation has only been conducted at a high level, typically suggesting techniques rather than delivering a tool to support such narrative creation. Moreover, computational techniques by which these collections can be transformed into experiential accounts have not as yet been explored.

While the domain of digital narrative may offer computational techniques, models and structures which may have utility within lifelog collections, this too presents challenges. Emphasis within current research is placed on formal structures for fictive narrative accounts or game-based storytelling (Ryan, 2004). As a result, the techniques employed by these systems may not be applicable or may require significant adaptation in order to be employed with such personal collections. Appan, Sundaram and Birchfield (2004) even recommend that such formal structures are unsuited to the retelling of past personal experience. In this study and within others of the domain (Landry & Guzdial, 2006; Landry, 2008), short term collections of traditionally captured media are employed and do not approach the volume, complexity or richness of content in a lifelog. They additionally consider only narration of everyday experiences rather than life stories of broad themes or periods in a life. More importantly, and to the best of our knowledge, there are no comparable systems for the long-term narration of past personal experience present in this domain.

As such there is currently no single approach which is capable of combining the advantages of digital narratives with the potential of lifelogs. More specifically there is no single approach which:

1. Provides a narrative structure and/or model for the construction of personal life stories from such collections;
2. Based on this model, automatically organizes the contents of a long-term lifelog collection to facilitate not only storytelling about short episodes from a life, but also enable the construction of narratives about broad periods across a life;
3. Automatically generates life stories, based on a theme or focus provided by a user, using a set of related multimodal episodes and representational knowledge which describes both the events and the life-store;
4. Provides an authoring environment suited to the construction of narrative accounts of past personal experience using digital media captured in the long term.

1.4 Hypotheses

The hypotheses for this doctoral work are now outlined.

1. *We propose that by utilising state-of-the-art multimodal information retrieval techniques in combination with narrative principles, we can successfully produce coherent and meaningful digital narratives from lifelog collections.*
2. *Furthermore, we hypothesise that the resulting narratives will support reminscence and self-reflective practices and will not only have resonance for the author, but will enable personal experiences to be shared with, communicated to and understood by motivated third parties.*

1.6 Research Questions

Brooks previously outlined three components for computed narratives: namely the structural, representation and presentational (Brooks, 1996). We focus the research questions for this research effort around these layers of digital narrative. The first question concerns structuring a lifelog collection to appropriately enable storytelling. The second and third questions explore the generation process, specifically examining the format the story should take and its presentation to an audience. Finally, the utility of the output story is an important component of this investigation. The last research question is evaluates the system's outputs, the quality of the narrative produced as well as the functions it may offer to an author, audience and other engaged individuals.

1.6.1 Structural Form

RESEARCH QUESTION 1 (Structural) What components of a lifelog should be used in the composition of digital life stories and how should they be structured to enable retelling?

Narrative structures are used to ensure a story 'flows' from beginning to end. The manner in which this occurs depends on the view and definition of story and plot. However, a common approach to achieving this, is to organise a collection into "*small related story pieces designed to be arranged in many different ways, to tell many different linear stories from different points of view with the aid of a story engine to sequence the story pieces*" (Brooks, 1999). These story pieces aggregate the data within the collection into units suitable for storytelling. Many approaches to such

formal structures for computational narrative have been suggested for use in digital storytelling engines, and include those employed by Brooks (1996). However these narrative structures commonly apply to fictive, cinematic or game-based narratives and may not suitably translate to experiential accounts of past personal experiences. This research question addresses this challenge by exploring suitable organizational structures to enable storytelling and the computational strategies for deploying them within lifelog collections.

One approach with merit is that recommended by Appan, Sundaram and Birchfield (2004), who advocate event-centric structures for personal digital narratives. Research has already been conducted into organising lifelogs in this way, albeit from a collection management and retrieval perspective. Doherty and Smeaton (2008) offer an algorithmic solution for the segmentation of lifelog content into events. However, the work to date focuses often on one modality in isolation, predominantly the Microsoft SenseCam (Hodges et al, 2006). A lifelog will in practice be composed of a variety of multimodal content and context sources, which may be non-continuous and unevenly distributed. Moreover, different components of the lifelog may have varying affordances in communicating past personal experiences and the structures employed must provide access to the most appropriate content for a retelling. This presents a significant challenge which this research question is designed to consider.

Furthermore, we must determine if Appan et al.'s event-centric approach is best suited to the organization of the lifelog content in support of storytelling. This is the subject of discussion in Chapter 4. Following which a computational strategy for the alignment and organization of multi-modal lifelog content must be devised. This is explored in Chapter 6. Such a structure must not only support the organization of the content into units sensible for storytelling, but must also support the development of a representational layer where relationships between these units are described so that narrative paths through the collection can be discerned. The structure must be suited to both to the production of narrative and be appropriate to the experiential nature of the personal content.

1.6.2 Representational Form

RESEARCH QUESTION 2 (Representation) What information should be captured about the relationships between the various story elements in order to facilitate the reasoning required to build the end narrative such that:

- *The author can specify a point of view, the subject, theme or focus of the story;*
- *The collection owner can collect information continually without the need to specify how it should later be assembled into a story;*
- *The contents of their collection can be distilled to achieve a coherent sensible story?*

Structuring of the collection provides all of the pieces which can be used to form a narrative about past personal experiences. As Brooks (1999) describing these units structured to support storytelling, explains "*these narrative pieces on their own do not constitute a single narrative or plotline … but instead act as building blocks for constructing many different narratives.*" The representational narrative layer seeks to capture the relationships between the various story units in order to facilitate the reasoning required to build the end narrative. Brooks explains that the better the representation, the more choices that will be present in the narrative paths a story can take. Consequently a better representation should lead to improved possibilities for and quality of the end narrative. Using this representational information, narrative paths through a collection can be identified and the plot of the story formed. Being formed from a number of distinct and potentially unrelated modalities, discerning appropriate descriptive information to achieve this knowledge representation automatically within lifelogs presents obvious challenges which we seek to address within this work.

The goal of the representational layer will be to identify the relationships between story elements and perform reasoning to determine the most suitable path through the content to form the narrative's plot. In order to form a coherent and meaningful life story, sufficient understanding both of the story and the content relevant to it must be available to the system. Despite being challenging, we believe that lifelogs possess both the volume and richness of context and content to extract such understanding and enable intelligent semi-automatic narration of its past biographical events. Through knowledge extracted from the content and context of each episode (be it semantic, thematic, or social), computational understanding of the story elements can be achieved. This knowledge, and the associations and relationships between the story elements it describes, can be used to represent the potential narrative paths that a story may follow. While achieving this knowledge representation automatically within lifelogs is challenging owing to the volume and complexity of the content, it is nonetheless vital to the success of the resulting narratives and so must be addressed. This research question is addressed in Chapter 6 which describes how the relationships between the story units may be described and in Chapter 7 which

outlines how the narrative paths may be uncovered and plot formed. The quality of the narrative is strongly tied to the completeness of the representational layer. Brooks (1996) comments that "*better the representation, in that the more authored choices which can be made among well defined elements, the better the resulting narrative.*" As such, we can evaluate the effectiveness of the representational layer by establishing the quality of the computed narrative. This is the subject of investigation in Chapter 8.

1.6.3 Presentational Form

RESEARCH QUESTION 3 (Presentational) How should a life story be composed and presented to its audience by an author in such a way that:

- *The author can specify a point of view, the subject, theme or focus of the story;*
- *The author and audience have opportunity to feedback into the presentation process;*
- *The end story is consistent with presentational forms commonly used to share, express and retell personal experiences from curated content.*
- *The end story produced is both coherent and meaningful to the audience?*

To form and present a digital narrative, a digital storytelling environment uses the structural and representational knowledge in order to choose and sequence story elements through reasoning, arranged with a sense of aesthetic style. This is perhaps the most challenging component of a digital lifelog narrative: how should retellings from multimodal lifelog collections be best presented, composed and communicated? This research question presents a number of complex interrelated areas for exploration.

First, we must consider the form that the presentation may take. Personal digital narratives may be represented in a variety of different ways. Biographical accounts may be orally retold or formally authored in written accounts or may employ compositional arrangements such as collage and scrapbooks to visually present fragments which embody the experience. Given the content within a lifelog collection, it is sensible that a visual form would be adopted to present the content, and this research question explores suitable approaches to the visual arrangement of digital content. To do this, we consult current practice and explore frameworks for the composition of personal narrative (see Section 4.2).

As a lifelog contains a wealth of content and context from a range of modalities, we must next consider how content appropriate to the story can be selected for inclusion into the end narrative. This involves both the identification of content relative to a story under construction and the reduction of voluminous, even repetitious and redundant content. This is focus of exploration in Section 4.3. The range of multimedia content requires us to additionally contemplate the *fluency, or its efficacy in communicating an aspect of the experience,* of each of the media modalities and how this may impact on the end retelling. We therefore explore how this multimodal content may be integrated into a coherent and aesthetic presentation in order to satisfy this research question.

While many presentational forms are possible, in Chapter 4 we indentify and select an expressive visual approach to presenting multimodal content which is highly suited to communicating past personal experiences. This is integrated into a digital system in Chapter 5 and this research question is subsequently addressed in Chapter 7 which outlines a computational strategy for the reduction of lifelog content into an aesthetically pleasing and coherent digital layout. This approach seeks to provision sufficient authorial control to enable flexible story creation, while provisioning authorial control by affording the author opportunities to feedback into the narrative under generation.

1.6.4 Functional Form Of Output

RESEARCH QUESTION 4 (Functional) What potential utility does a digital life story offer the author, audience or other motivated parties?

With a digital narrative tool implemented for lifelog collections, the efficacy of its narrative output should be established. Assuming the narrative output is of sufficient quality, potential opportunities that the resulting digital stories may afford can also be explored. This is the final research question we address.

Personal narratives retold through oral traditional or preserved in written accounts such as in diaries fulfill a number of functions. Personal storytelling and the retelling of past experiences provides us with the opportunity to examine a set of related events, framed from the perspective of our current self and within the context of our larger life experiences, motivations, goals and ambitions. This provides three main functions: first it allows purposeful reflection our life events and their development in order to affect or determine future actions (*directive*); second it enables us to share aspects of our lives with others, often as a means to develop social bonds, intimacy and/or

empathy (*social*); or finally, it affords a review of life experiences to search for meaning in them (*self*) (Bluck & Habermas, 2000). In short, the life story, formed in mind from our memories, provides meaning, continuity and identity to our lives and offers us the ability to recollect, reflect upon or share a coherent personal self-history of our entire life or a portion of it.

We maintain that a digital counterpart to our personal stories can promote, encourage and foster many of these functions and this is the subject of exploration in Chapter 8. We anticipate that the use of narrative to retell digital life experiences will make those artifacts from a lifelog collection wholly more engaging and meaningful to not only their owners but to others. We expect this will facilitate and encourage reminiscence, recollection and reflection on past personal actions. Furthermore, we maintain that they offer not only utility to the collection owner themselves but novel opportunities for engagement with the content to motivated individuals known or unknown by the collection owner. These functions of personal narratives are explored through a qualitative framework eliciting qualitative feedback from participants designed to probe these features (see Chapter 8).

1.8 Approach, Methodology and Outline of Thesis

This research focuses on telling stories about past personal experiences which have been captured automatically through digital means. The approach to achieving this is multifaceted and encompasses probative study to explore requirements; interactive system design and development; and algorithmic implementation to support narrative construction. The process followed by this doctoral work is now outlined.

First a thorough review of relevant literature within the domains of lifelogging and digital narrative is conducted. Within Chapter 2 the domain of lifelogging is thoroughly reviewed. This explores the motivations for lifelogging and the current state of the art of the technologies. It presents many of the challenges presented by these rich multimedia collections to this research investigation and highlights the opportunities that the application of storytelling techniques offers. Within Chapter 3, the literature relating to narrative techniques and digital storytelling is examined. Here the fundamental requirements for narrative are discussed, the traditions and practices of biographical narration of past personal experience are reviewed and related digital techniques, tools and models for narrative are explored.

The first methodological step within this investigation is to explore how a tool to support story construction might be best delivered. This is the focus of Chapter 4. Prior to implementing a tool based solution it is important to establish how novel, multimodal and voluminous collections of life histories might be transformed into an experiential account of past personal action. Additionally a variety of storytelling frameworks and narrative forms may be applied to multimedia content. In order to establish the underlying requirements and gather an understanding of how narrative might be constructed from personal content, **probative explorations** will be required. We conducted probative interviews to explore current practices in personal experience archival, curation and narration. This is juxtaposed against a card sorting exercise designed to explore how multimodal lifelog content could be reduced and arranged into a sensible storyform. These studies in combination with the review of literature are used to elicit a set of design requirements for the storytelling system.

With these requirements established, a digital storytelling **authoring environment** was implemented. This is informed by the current practices probed but oriented towards the novel lifelog collections we seek to employ and is the subject of discussion in Chapter 5. The tool enables an author to bring together media fragments from the lifelog into a coherent and aesthetically pleasant manner. This can be performed as a manual operation if the author so chooses. Given the volume of content contained within a lifelog collection, we cannot expect a user to manually locate and construct individual stories from its contents. As such we must make the process of constructing a narrative retelling as automatic as possible. Rather than propose a full-automatic generation solution, we instead favour a semi-automatic approach. This provides the author opportunity to feedback into the generation of the narrative, either by manipulating the output or its inputs. This gives opportunity to overcome and correct and shortcomings of computational approaches and a more coherent and meaningful story should be produced as result.

To construct a narrative, the tool must allow an author to quickly identify content for inclusion. The author must specify their focus, and the consequent content for inclusion, by selecting either a topic, theme or period within their life of interest to them. Using this information, the system determines the episodes of most relevance to this story and chains them appropriately into a related sequence. This can be achieved by allowing the user to leverage the associative networks that bind the episodes in lifelog, and enable browsing and identification of related material. At this point, users are provided the opportunity to correct any errors in the sequencing,

inclusion or omission of episodes. Once satisfied with the selected episodes, it is assembled into a presentational form. Users are also offered the ability to choose from a finite number of style and/or plot options. Following this, generation of the end narrative is carried out and the multimodal media items from each episode is assembled into story-form. The resulting multimedia narrative presents the richness of experience, affect and meaning of the life story by leveraging colour, animation, transitions and audio to convey these concepts during presentation.

In order to provide such a system we must first have **structuring and annotation processes**. Both of these processes will be elaborated upon in Chapters 6 and 7. We cannot expect a user to exhaustively annotate the content contained within that collection, so the knowledge and understanding required to represent and compose a narrative for a given life experience should be gained by automatic means. First the collection must be structured into a set of episodes and then knowledge must be extracted from the digital artifacts within those episodes to enrich their description (Research Question I). These descriptions enable intelligent reasoning about the lifelog content to occur and allow a representational layer of narrative paths to be formed within the collection (Research Question II). These annotations will allow the **generation process** to interpret the episodes in a number of ways. These annotations would enable: first the episodes to be placed in the greater context of the amassed life experiences; second the intelligent assembly of the episodes and their constituent artifacts into a story; and finally the end presentation to be constructed based on the expectations of the user. This contributes to answering Research Question III and more generally to the first hypothesis within this work.

Chapter 6 examines the structuring processes implemented within the system. The system provisions manual support for time alignment of the modalities, but the remainder of the structures are automatic. The system first extracts a set of descriptive ‘themes’ from the content and context based sources within the collection. Their distribution within the collection, and in particular their temporal distribution, is used to create indexes which will be used in the generation step. The content is then automatically organised into ‘episodes’ which aggregate the lifelog content into higher-level narrative units. In Chapter 7, the generation techniques are described. These include the provision of weights to the content and modalities employed to represent their fluency in storytelling, the detection and selection of episodes relevant to the story under construction and the selection of content from each episode suited to the focus of the story.

With a life narrative system developed, in Chapter 8 we evaluate its outputs to be coherent, comprehensive and meaningful. As such narratives have not been previously evaluated, we develop an **evaluation frame** by which their utility, meaning and affective qualities can be assessed. Given that stories are highly experiential and affective, this will incorporate both qualitative and quantitative measures. Quantitative measures for example are employed to ascertain the coverage and completeness the story over the intended topics and episodes, while qualitative measures are reserved for the determination of the experiential impact and resonance with the end audience. The evaluation is conducted with the lifelog collection owners a series of story construction exercises. The manual construction of personal stories is contrasted against the generative processes and structures employed. The utility of narrative output from lifelog collections in reminiscence, reflection and sharing of content then discussed.

Departing from evaluations framed on the collection owners, in Chapter 9, we explore what utility the collection may offer beyond these individuals to motivated third parties. The investigation presented in Chapter 9 demonstrates that lifelog content can establish meaning with motivated third parties unknown to the collection owner, and more importantly that it can offer them novel rewards. While sometimes conflicted about having access to such a personal collection, the third parties were excited by the potential to explore a life through a digital collection and enthusiastically engaged with the task. The third parties were able to intelligently intuit, appraise and distill the collection into coherent representations of the owner and thereby demonstrate the exciting possibilities might be empowered through mediated accounts. It also notes the potential for novel applications such as artistic explorations of lifelog content.

The evaluations outlined in Chapters 8 and 9 point to the functions personal digital narrative developed from a lifelog collection may offer both the individual who massed the content and motivated third parties. The findings from this address Research Question IV and the second hypothesis of this work.

Finally, the future directions and conclusions from this work are presented in Chapter 10. These outline a set of targeted deployments to specific application domains and communities of practice which might be considered, as well as possible enhancements to the tool and alternative computational strategies which might be evaluated for their efficacy.

To facilitate this research investigation, three participants massed multimodal long-term lifelog collection spanning in excess of 20 months. As the majority of participants are involved in research activities, one such example of a significant life story within the period of collection might include their PhD process; their travel to a conference; or work on a particular project. The nature of these collections and the experiences they contain is explored in detail in Appendix IV. These novel collections enable the evaluation of the storytelling system.

Given the highly personal nature of the lifelog collections employed, a key consideration during both data capture and evaluations was ethical best practice. Prior to commencing the data collection effort, guidelines for the collection and the use of personal digital content was prepared, in consultation with all investigators and stakeholders. These were adhered to throughout the capture period and during all evaluations conducted described within this work. The considerations included the storage of the collections, the use of sensitive data within experimental evaluation and suitable evaluation protocols, the instructions to participants, maintaining personal & social privacy, and ethical obligations while engaged in continuous capture. These are described further in Appendix IV.6, in Section 8.4 and in Section 9,3,5.

1.9 Research Contributions

This research makes a contributions to both the digital storytelling and the lifelogging communities. Current work within the digital narrative community emphasizes formal approaches to narrative generation and fictive narrative rather than the storytelling of past personal experiences. Those studies which examine the application of digital narrative to multimedia corpora of personal histories have only explored this at a high-level using single modality, constrained or temporally short collections. In contrast, we explore narrative techniques with using an extended collection of life history data recorded over a two-year period from a variety of voluminous multimodal sources. Furthermore, many investigations in the lifelogging community highlight the importance of retelling. By constrast, how this can be achieved in practice has not been rigourously examined.

The findings uncovered from constructing life stories from such collections will therefore have much worth and novelty, and provide valuable insights to both communities. The major expected contributions can be summarised as follows:

1. Large scale and long-term lifelog collections are amassed from a variety of modalities by a number of individuals.
2. Using relevant literature in combination with probative investigation, a set of high-level requirements for the digital narration of life experiences in the long-term are formulated
3. A structuring and annotation process for lifelogs which satisfies the set of high-level requirements is defined and appropriate information retrieval techniques are explored.
4. A generation process for composing digital life stories is delivered and algorithmic solutions and story models to achieve this are proposed, implemented and evaluated.
5. An evaluation framework to assess life stories is developed and enables examination of the semi-automatic narrative generation and its efficacy.
6. Finally, the utility of personal digital narratives produced from lifelog content is probed and a number of future directions, of interest to both domains, for further exploration are proposed.

Chapter 2

Lifelogging

Overview

As technology has advanced we have been continually offered new media through which we can both capture and express our meaningful life experiences in new and exciting ways. Lifelogging is one such development that is sure to offer just that – a world of new possibilities for reminiscing, retelling and sharing our personal histories. In this chapter we explore the origins of lifelogging in Vanevar Bush's MEMEX as well as the current realization of this vision. The goal of a lifelog, to capture as much information as possible, are outlined and framed within literature on experiential systems design. We outline the technologies which can be used to enable capture for lifelogging across a variety of modal channels including visual, audio, content, context and other sources. The current research strands namely capture, management, recollection and reminding, reflection, sharing and support, are then explored. Finally the nature of lifelogs as well as their affordances and constraints are used to frame the opportunities that such collections present. This motivates our exploration of digital narrative.

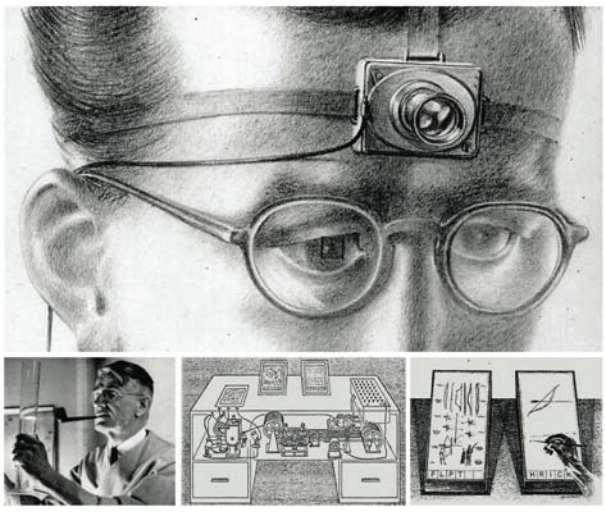


Figure 2.1 Illustrations of Bush's MEMEX

2.1 The Memex Vision

The notion of ‘lifelogging’ or digitally recording our life experiences may seem more at home in the realm of science fiction than reality, however, of late and owing to increasing interest from research, it has been gaining both popularity and prevalence. Despite its relative novelty, it is far from a new concept. In fact it was originally envisaged in the 1940's by Vannevar Bush who proposed the notion of a MEMEX or a life encyclopedia in "As We May Think" (Bush, 1945). In his vision, the MEMEX was a large desktop "*device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility.*" He saw this desktop as having cameras by which to capture documents, screens to display information and controls and levers by which to manipulate the information and follow associative trails (see Figure 2.1). An individual would sit in front of the device and scan in their important documents, photographs or books, enter text via a typewriter or even enter information or communications by speaking to the device. Bush was even so bold as to propose the capture of biological recordings, suggesting, for example, that the electrical impulses of the eye might even be captured to preserve an image of what a person sees. Once entered into the MEMEX, a person should be able to call upon and review any item within it with ease and efficiency by manipulating the levers, entering a relevant reference or pushing a sequence of buttons. Once added, the information would give rise to "*wholly new forms of encyclopedias... with a mesh of associative trails running through them*" and he saw the collection of all sorts of information from a person's life in one central repository as the means by which to create "*an enlarged intimate supplement to [a person’s] memory.*"

2.2 Emergence of Lifelogging

While this vision must have appeared to many as if of a world born of H.G. Wells, it nevertheless inspired some to work towards such a memory aid and Vannevar's dream for the future (Bush, 1945).

Steve Mann became one of the earliest individuals to work towards Bush’s vision. Beginning in the 1970’s, Mann began experimenting with wearable image capture technology or WearComp (see Figure 2.2). Beginning with experimental photographic applications which were bulky and cumbersome, these were iteratively refined into more lightweight forms and to enable continuous capture (Mann, 1997), eventually

becoming unobtrusively embedded within eyeglasses (Mann, 2004b; Mann et al., 2005). Between 1994 and 1996, Mann used this wearable infrastructure to begin continuously broadcasting his life[1]. His seminal work in this area has provoked much discussion and he has interrogated many of the issues and challenges relating to continuous capture of a life (Mann, 2004a; Mann, 2004b). He describes his work not as lifelogging but as cyborglogging or *sousveillance (Mann, 2004b)*. A term coined by Mann, sousveillance describes the digital capture of an activity from the perspective of the person who is engaged in it.

Figure 2.2 The Evolution of Mann's WearComp

During the period when Mann was conducting his WearComp explorations, the use of personal computers saw a significant rise in popularity. The desktop computer and the digital documents it contains was recognized as a valuable resource in achieving the MEMEX vision. Freeman & Gelernter (1995) explored the Lifestreams model through which a "*diary of your electronic life*" could be maintained as a "*time-ordered stream of documents*". Much as in Bush's MEMEX, a record of every document created, or sent by other people, would be preserved in the Lifestream. They envisioned this starting with an electronic birth record and moving towards the documents of present interest, and then extending into the future to highlight information and resources soon to be relevant such as reminders and to-do items (Freeman & Gelernter, 1996). The LifeStream interace is presented in Figure 2.3.

Despite these early explorations, the notion of lifelogging has only recently become to emerge as a contemporary trend. Its popularization can in many ways be attributed to two research efforts within Microsoft Research, the MyLifeBits Project (Gemmell, Lueder & Bell, 2003) and the SenseCam (Hodges et al., 2006). MyLifeBits has been

[1] http://wearcam.org/myview.html

directly inspired by the MEMEX vision and seeks to provide a lifetime store for all digital content encountered. It automatically records and preserves interactions on the desktop such as emails, document content and their accesses, but also provides support for other media to be added such as photos, audio or video records. Its goal is to offer a single repository through which all of a person's digital media might be managed, maintained and associated. To compliment this archive, the Microsoft SenseCam offers the ability to maintain a visual record of what the user 'sees' as they go about their daily activities. It is a small wearable camera that uses a number of internal sensors to detect changes in the environment of the wearer and trigger photo capture. The SenseCam in particular has fueled the appeal of and interest in lifelogging as recent research suggests its utility in stimulating recall of memories, having the potential to be extremely beneficial to those with cognitive impairments (Berry et al, 2007).

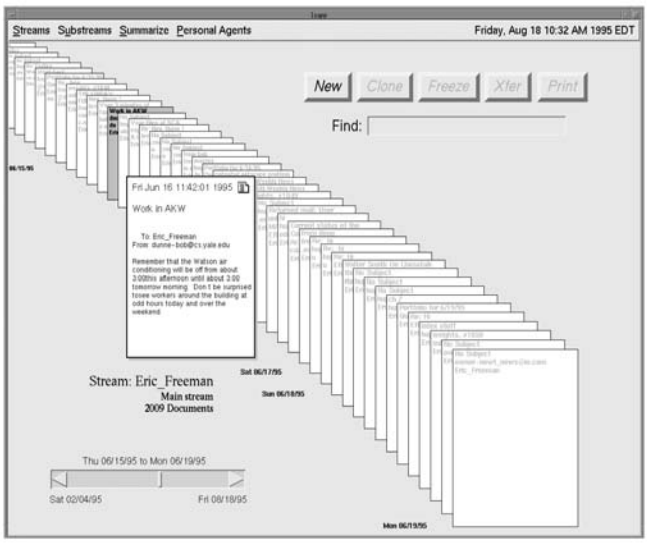


Figure 2.3 Lifestreams preserves a time-ordered record of digital documents

As O'Hara (2010) notes there are many important pioneers like Steve Mann within the domain of lifelogging, however "*perhaps the most committed is Microsoft executive Gordon Bell, who has developed a suite of technologies and practices to deal with the giant quantities of information one can generate in a normal life, and who has written about the potentially transformative effects of such technologies for work, health and learning, as well as in everyday life (Bell & Gemmell, 2009)*." Gordon Bell is a major proponent of the lifelogging and MEMEX visions. Since 2001, he has become a guinea pig for both of the major lifelogging technologies developed at Microsoft Research. He has attempted to record all of his "*communications with other people and machines, as well as the images he sees, the sounds he hears and the Web sites he visits--*

storing everything in a personal digital archive that is both searchable and secure" (Bell & Gemmell, 2007). He has digitized his paper notes and records, his telephone conversations, and has extensively chronicled his life through MyLifeBits and SenseCam.

While the efforts of individuals like Bell and Mann may seem extreme or eccentric to many, they highlight the increasing feasibility with which a life may be recorded digitally. With the rise in popularity of social networking sites, many today are streaming their lives through commentary or media shared online. With the expense of data storage dramatically reducing in the past number of years, long-term storage is ever-more affordable. With widespread availability of high fidelity digital capture technologies such as digital cameras and smart-phones, day-to-day activities can be captured with relative ease. With the recent commercial availability of novel life capture technology[2], like the SenseCam, lifelogging may increasingly becoming a part of everyday life.

2.3 Definition, Goals and Motivations

The goal of lifelogging is to capture and preserve a digital record of the day-to-day activities of an individual. This record seeks to be as both detailed and complete as possible, by broadly surveying as many of the activities of an individual through digital means. Building over time, it should form a replete repository of past personal experience across the lifetime of the individual.

Truong, Abowd & Brotherton (2001) discuss capture and access for MEMEX stores from the perspective of ubiquitous computing. They "*define capture and access as the task of preserving a record of some live experience that is then reviewed at some point in the future. Capture occurs when a tool generates an artifact that documents the history of what happened. The artifacts, or captured data, are recorded as streams of information that flow through time. The tools that record experiences are the capture devices; and the tools used to review captured experiences are the access devices.*"

To stimulate understandings as to why an individual might be motivated to engage in lifelogging, Caprani, Gurrin & O'Connor (2010) conducted a survey which explored the media, mementos and artifacts individuals currently preserve about their lives. They

[2] http://www.viconrevue.com/

note the wide variety of media people capture already about their lives, and how the types of items recorded and maintained shifted as the individual aged. They conclude that individuals already are motivated to maintain a great deal about their lives and lifelogging technology could compliment and enhance these documentary practices. In subsequent work, Caprani, Gurrin & O'Connor (2010) comment that lifelogged collections may be a potentially valuable resource, particularly in later life.

A major motivation for using this technology is to off-load the burden in preserving memories. Rather than a record of a life being a process of active and explicit capture, lifelogging technology periodically and passively samples the activities a user engages in without the need for intervention on the part of the individual. Such technology ideally is designed to operate unobtrusively, ensuring that no moment goes missed.

2.4 Applications & Domains

Lifelogging is becoming an increasingly pervasive technology and its utility has already been examined in a variety of contexts, use cases, applications and domains. While many of these investigations represent probative or early stage research, they nevertheless demonstrate the potential of this technology to be far-reaching.

In capturing a record of past personal experiences, lifelogging has become synonymous with augmenting and enhancing memory. Its potential as a memory aid (Hodges et al., 2006) has become its most prevalent avenue of current research. The preliminary findings of a study between Microsoft Research and Addenbrooke's hospital in Cambridge, U.K indicates that SenseCam may offer significant benefits to individuals with neurodegenerative memory problems (Hodges et al.,2006, Berry et al. 2007). Berry et al. (2007) demonstrated its potential in the rehabilitation of patients with limbic encephalitis while Bowen (2008) investigates the therapeutic efficacy of SenseCam as an autobiographical memory aid in a patient with temporal lobe amnesia. Lee & Dey (2007, 2008) previously developed a memory aid tool, 'MemeXerciser', to support recall for persons with Alzheimers and other memory impairments. The MemoryLane project leverages lifelogging to provide technology interventions such as reminiscence therapy and other interventions in the care of persons with Alzheimers (Kikhia et al 2009; Hallberg et al., 2009).

Utility within other medical and care scenarios has also been demonstrated for lifelogging technology. This includes its use as an assistive technology to aid individuals with impairments or the elderly. It may be used to allow individuals with

aphasia to communicate about their past personal experiences (Al Mahmud, Aliakseyeu, & Martens, 2008; Burke & Franklin in Berry et al., 2010). It can additionally be employed to assist the blind (Tjoa, Andjomshoaa & Karim, 2006) or as a reminiscence tool for the elderly (Caprani et al., 2010; Caprani, Gurrin & O'Connor, 2011).

Many of the current lifelogging applications are focused on the medical domain given their enormous potential within this space. However, its applications are not limited to this area. Already, the SenseCam has been deployed in variety of other contexts such as tourism (Wood, Fleck & Williams, 2004; Blighe et al., 2007), education (Barreau et al., 2007; Yang et al., 2006; Fleck & Fitzpatrick, 2006) and business (Tjoa, Andjomshoaa & Karim, 2006). Wood, Fleck and Williams (2004) have previously discussed the potential range of applications of the SenseCam: in particular they highlight its promise in the area of tourism. Further to this Blighe et al. (2007) have explored enhancing the experience of museum visitors with take-home SenseCam images and related content. Lifelogging devices have also been used to record and observe dietary habits (Reddy et al., 2007). The opportunities for such technology to benefit and contribute to family life have also been demonstrated (Lindley et al., 2009b, Harper et al., 2008).

The previous applications spaces outlined all emphasis the benefits these collections might offer the individual who amasses them. However, there is much scope for motivated third parties to benefit from the access to the personal data gathered by a lifelogger. This proposition is starting to be recognized within the domain and there are already early stage, small scale and probative studies which explore this offering. Byrne et al. (2008) show that the SenseCam may also be used as an ethnographic tool within user-centred design practices to enable researchers to gather data remotely about user behaviour and work practices. Its utility in this regard has lead to its use in qualitative market research (Cook in Berry et al, 2010). Lifelogging technology is currently being employed by the University of Oxford to monitor large sections of the population remotely for sedentary behaviour (Kelly et al., 2011). By instrumenting an individual with such recording apparatus, the shortcomings of self-reporting can be overcome, enabling population monitoring to yield more accurate outcomes. Lifelogged content may be repurposed by artists to develop "*alternative and creative new applications*" such as in the work of Deborah Aschheim (Ascheim & Keller in Berry et al, 2010). Finally, lifelogging technologies may be used to record the shared

perspectives of multiple individuals so they may document a single event (Lindley, Calvillo Gámez, Gámez Leija, 2010).

Lifelogging technology offers a range of exciting applications ranging in scope from those with personal, social and societal benefits.

2.5 Technologies Supporting Lifelogging

Today's realisation of the MEMEX is far from the unified solution originally proposed by Bush (1945). Lifelogging, as previously discussed, provides in-the-moment capture of personal experiences. The goal of which is to amass a detailed collection of past personal experience not only to create an archive of each action but a rich picture of that individuals day-to-day actions and their life as a whole. There are many ways in which a lifelog may be amassed and is often dependent the end goal, deployment or domain of use.

Lifelogging technology may either passively sample the activities of the user and require minimal intervention and interaction on the part of the user or leverage digital content the author already produces to form the collection. Typically, the former is favoured with special-purpose tools, like SenseCam (Hodges et al, 2006) or MyLifeBits (Gemmell, Lueder & Bell, 2003), being employed. These custom engineered devices are often engineered towards a specific requirement of the lifelogging vision, serving to preserve a single aspect or component of the overall activity, such as the visual. These special purpose devices therefore only provide part of the overall picture. More accessible and everyday tools and platforms can then be employed to add further richness and capture other components of daily experience. As O'Hara (2010) notes "*mobile phones, Web browsers, email programs, social networking sites and medical sensors all generate information that is of potential interest to the lifelogger.*" In order for a lifelogger to capture a complete account of their activities currently they must employ a slew of complimentary devices, tools, applications and recording apparatus.

Typically each intervention is suited to digitally recording a single modality, or aspect of the individual's day-to-day activities, in isolation. These modalities may range from the visual, recording a stream of that the individual sees around them during their day; content captured from a mobile, computing or peripheral device such as the digital documents encountered, created, consumed or exchanged; audio which provides a record of ambient sounds encountered or conversations held; presence or contextual

cues of the number and location of people within the vicinity of the individual; environmental to provide an indication as to status of the area around the wearer which might include light levels or weather conditions; and finally information on affective or biological cues may be gathered to provide an indication as to the status of the individual themselves. The data captured by these tools and techniques can then be brought together to form an extremely rich multimodal collection of digital life experiences for an individual. Some of these tools are now explored in more detail.

2.5.1 Visual

Visual lifelogging aims to record digitally all that a user 'sees' as they go about their day-to-day activities and provide a rich visual stream through which the wearer can remember and reconstruct their past personal action. The visual information captured by and contained within this record can provide powerful cues to help recover and access personal memories (Hodges et al, 2006; Berry et al. 2007) and can be extremely useful in helping to describe and communicate past personal experiences (Lee & Dey, 2007; Harper et al., 2008). There is however a range of technological solutions which can be employed to capture such visual records. The most detailed way in which to achieve this is to employ full and continuous video capture using devices like Steve Mann's EyeTap (Mann et al., 2005; Mann, 2004b) or a head mounted wearable camera (Hori & Aizawa, 2003, Tano et al, 2005). Being headmounted, such approaches offer the advantage of capturing "*images exactly as they were originally seen by the user*" (Mann, 2004b). While this provides an extremely detailed and rich picture of the individual's activities, it often proves impractical, requiring an additional capture, processing and storage device (such as a laptop) contained within a backpack. It may also require a great deal of power to operate over the course of a whole day requiring additional battery packs or external power sources and have additional cables running from the recording apparatus to the external storage devices and power sources (Hori & Aizawa, 2003; Tano et al, 2005). This makes such solutions currently cumbersome for the individual involved, intrusive into the naturalness of interaction, with their overt and bulky nature making them impractical for use in the longer term.

Given the current limitations of continuous video capture, an alternative often employed is to use intermittent or periodic image capture. While this captures the individual's day in less detail, it is often more than sufficiently rich to allow reminiscence (Lindley et al., 2009b) while its demands are low enough to allow passive capture to operate continuously throughout the day from a single

consolidated device without need for external or alternative connected resources. Given the pervasive nature of mobile phones and that many now include high resolution digital cameras and are programmable, these devices can be employed in a lifelogging context. These multifunction devices are worn typically around the neck of the lifelogger via a lanyard cable and programmed to take photos after a given time. Mobile camera-phone based alternatives to visual lifelogging have been employed in UCLA's DietSense project (Reddy et al., 2007) and York University's WayMarkr (Bukhin & DelGaudio, 2006). Mobile phones are often used in these scenarios as they have the added ability to gather other contextual sources simultaneously with the visual data (se Section 2.5.3).

Figure 2.4 The Microsoft SenseCam

Finally, and of much interest of late, is the research prototype developed by Microsoft Research Cambridge, UK to record a visual account of a person's experiences (Hodges et al., 2006). As a purpose built solution it offers a number of advantages, particularly as it has sufficient power to last an entire day, is small, unobtrusive, lightweight and wearable. Photos are captured from the perspective of the owner as the device is worn around the neck (as illustrated in Figure 1), and is oriented towards the majority of activities which the user is engaged in. It employs a fisheye lens allowing a broader and more comprehensive view of the wearer's activities to be captured as compared with traditional camera lenses. At a minimum the SenseCam will take a new image approximately every 50 seconds, but sudden changes in the environment of the wearer as detected by onboard sensors, can trigger more frequent photo capture. The device requires no manual intervention by the user as its sensors detect and record changes in light levels, motion and ambient temperature and then determine when is appropriate to take a photo. For example, when the wearer moves from indoors to outdoors a distinct change in light levels will be registered and photo capture will be triggered. The SenseCam takes images quite frequently (approximately once every 20 seconds) and as such collects in excess of 2,500 images in a typical day. As a result a wearer can very quickly build a large and rich, extensive visual diary

of their day. The battery is sufficient to allow the camera to run all day, and can be fully recharged overnight, allowing uninterrupted recording during the day. While this type of device offers notable advantages over video recording, head mounted displays and the use of programmed smart-phones, there are some differences in the resulting stream from traditional visual media (Gurrin et al., 2008). For example, these images tend to be of lower quality, often having undesirable artefacts such as noise, blurring or grain. Additionally, by employing only intermitted or periodic image some potentially important moments may be missed making it difficult to fully recognise the context of some activities. However, in practice, this tends not to be overly problematic.

SenseCam is not the only purpose built passive photo capture tool available to lifeloggers. The StartleCam (Healey & Picard, 1998) is similar in many respects to the SenseCam. Instead of using sensors which monitor changes in the external environment of the wearer, the physiological state of the wearer is monitored to trigger photo capture. While a novel approach to passive capture, the apparatus is considerably more cumbersome than SenseCam requiring several skin conductivity sensors to be connected to the wearer's fingers and connection to a portable computer in a backpack. Helmes, Hummels & Sellen (2009) present 'The Other Brother' a novel tangible design for augmented capture of experiences. Unlike the SenseCam it is designed to be situated in a social or domestic space, where it can be used to both capture and "*re-experience the ambience of a moment*."

2.5.2 Audio

While "*sounds are rich and evocative*" (Dib, Petrelli & Whittaker, 2010), they are largely unexploited within current lifelogs. The value that such content might add to a lifelog has not however gone unnoticed. Oleksik & Brown (2008) explore sentimental memory capture through audio and "*reveal the potential of sound as a form of sentimental memory capture*." In particular they note the impact that these audio samples have on their participants and this indicates the "*significant potential of sound as a form of sentimental memory capture."*

The audio a lifelog might contain could range from ambient sounds collected from the environment, noises familiar in or specific to a particular location, spoken phrases or conversations, music, everyday noises such as cars, or pets (Oleksik & Brown, 2008; Dib, Petrelli & Whittaker, 2010). The capture of these so called '*sonic gems*', or memorable moments preserved via audio, may be facilitated through a range of

technologies; the simplest of which is a digital dictaphone style recording device. Kalnikaité & Whittaker (2007; 2008) explore the use of spoken audio notes recorded with a dictaphone and how they may support "*memory for conversation using temporal co-indexing of handwritten notes and speech*" through an interface dubbed 'ChittyChatty'. The Personal Audio Loop (Hayes, et al., 2004; Patel, et al., 2008) modifies a standard mobile phone to provide a "*ubiquitous service to recover audio content from a person's recent past*." The PAL application allowed recent audio to be temporarily maintained in order to recover interrupted conversations. Gordon Bell (2009) digitally records all of his telephone conversations (Bell & Gemmell, 2007; Gordon & Gemmell, 2009) while Maisonneuve et al. (2009) use smartphones to monitor continuously ambient noise levels rather than spoken word. Ellis & Lee (2004a; 2004b) create audio lifelogs by continuously sampling with commercially available MP3 recording devices. They then 'scavenge' other content and context sources to provide additional richness to the sampled audio. Building on this work and in collaboration with Doherty, they explore the use of continuously sampled audio a channel for discerning events of interest within SenseCam visual diaries (Doherty et al. 2007).

Many of the audio lifelogging explorations to date have employed commonly available solutions, in cases albeit with augmentation or enhancement. However, Oleksik et al. (2008) suggest purpose built devices may offer advantages, much as the SenseCam does in capturing experiences visually. They advocate "*opportunistic and unobtrusive sound recording*" to preserve audio records of important moments and present a concept device for this. Dib, Petrelli & Whittaker (2010) share this sentiment; commenting that "*passive recording technologies suggests how such veridical examples can serve as evocative proxies for everyday activities.*"

Audio is clearly an important modality to capture, given that "*sounds can evoke vivid recollection of past experience*" (Dib & Kalnikaité, 2008.) Unfortunately, while this may be the case, the passive sampling or continuous recording of audio content raises many practical concerns. Ellis & Lee (2004a; 2004b) note many of these issues, most of which relate to personal privacy. Where they attempted to capture spoken conversations through continuous recording they "*frequently encountered shock and resistance from acquaintances.*" Furthermore, they observe that there may be legal ramifications to recording audio without the explicit permission of all parties involved. Owing to these complexities, audio is exceedingly difficult to incorporate into modern lifelogs, especially where capture in the long-term is desired.

2.5.3 Personal Content

Not only can the sights and sounds encountered by an individual be recorded, but using digital tools lifelogging may preserve a record of interactions with digital content. Our personal computers house our digital life: maintaining our correspondence by email, the documents and reports we generate, and the multimedia we may have captured or exchanged. They are a rich resource for the creation of a personal life archive (Gemmell, Bell & Lueder, 2006.) Gemmell, Bell & Lueder note that it is not just the digital documents that our computer contain which may describe our lives but also the patterns with which we access them. For example, repeated visits to a webpage may signify its significance or its use in conjunction with other digital content may be emblematic of a task we are engaged in (Gemmell, Bell, Lueder, 2006; Oliver et al., 2006).

To enable the capture of computer activity there are a number of software suites available to lifeloggers, such as Microsoft Research's MyLifeBits (Gemmell, Lueder, & Bell, 2003) and SLife (2008). These applications continually monitor the operating system to determine what application is currently in use, retrieve details about that application and capture the content from the current window in focus. Not only does this provide the content the user is currently working with but it also provides an indication as to their current mode of activity, i.e. am I writing a research paper or surfing the web during my lunch break? The SWISH desktop system captures this such activity information and mines it to discern discrete tasks (Oliver et al., 2006) Stuff I've Seen does not monitor the desktop activity but maps all content on a desktop computer so it can be more easily accessed (Dumais et al., 2006). Phlat, similarly indexes the contents of a harddrive while incorporating contextual and associative cues (Cutrell et al., 2006).

Not all digital content is maintained on a user's personal computer. Increasingly, content is accessed, created and maintained on mobile devices and it is important that lifelogs encompass these devices. ContextPhone allows a record of mobile phone application use, call histories and SMS messages to be collected (Raento, Oulasvirta, Petit & Toivonen, 2005). Nokia's Lifelog software offers similar opportunities by creating a chronology of personal content maintained on the mobile device which can then be archived (Myka, 2005).

2.5.4 Personal Context

Visual and audio records offer rich and expressive means to preserve a record of past action. However, it may also be important to be able to proxide contextual understanding of those actions. In order to provide description of the circumstances, conditions, situation and factors relating to the activity lifelogging often seeks to sample the environs of the individual though digital means. Given that access to memories is mediated by cues, capturing this contextual information may also have benefit in stimulating later recall of activities (Kalnikaité et al, 2010.) In a study which compares and contrasts visual stimuli captured with a SenseCam to location information gathered with a GPS unit, Kalnikaité et al. (2010) assert that contextual cues support inference about habits, routines and past action, while more visceral modalities like images promote detailed recall.

A common approach to gathering contextual cues about a user's activities is to embed sampling software on the mobile phone of the individual. This is advantageous as sampling can be conducted on already ubiquitous personal devices, which in the majority of instances, are carried with their owner throughout the day. There are many examples of this approach. The Campaignr platform (Reddy et al., 2007) runs in the background of a Nokia mobile phone and can be used to periodically sample GSM information, copresent Bluetooth devices and proximal WiFi signals. ContextPhone provides a similar mobile phone based logging tool (Raento, et al, 2005). By sensing the co-present Bluetooth devices around a mobile device a determination of 'who' is present can be made, while sensing GPS or GSM location data and proximal wireless signals 'where' the individual is can similarly be uncovered. This information can then be used to mine interesting locations and travel sequences (Lee & Cho, 2007; Zheng, 2009); to derive a users real world social networks (Eagle & Pentland, 2005; Lavelle et al., 2007), to determine and predict behaviours (Eagle & Pentland, 2005; Eagle, 2010); to determine life patterns and routines (Eagle & Pentland, 2005; Rekimoto, Miyaki, Ishizawa, 2007) or to create text-based descriptions of the activities in which the user engaged in (Costabello & Goix, 2008; Costabello, Rocha & Goix, 2008.) It has also been suggested that appending other complimentary sources and metadata can further enrich the sampled contextual information. This might include the addition of the time of day, season, or day of the week, as well as weather, nearby places or amenities derived using the location. (Fuller, Kelly & Jones, 2008; Lee & Cho, 2007.) In doing so, the potential to cue recall with context information can be further enhanced (Fuller, Kelly & Jones, 2008).

Figure 2.5 A biometric devices as worn by a user – the BodyMedia Armband is fitted to the arm.

2.5.5 Biometrics

Contextual sampling allows a description of the environment of the individual to be garnered, however, through technology the physiological state of the individual can also be examined. This can provide cues as to their emotional and affective state, levels of alertness, and to moments of interest for later reexamination (Kelly & Jones, 2010). Potential sources of this data include for example: Accelerometer information to provide movement and activity; and Galvanic Skin Response (GSR), Heat Flux, Skin Temperature and movement heart rate which can be indicative of emotional state, excitement and alertness.

Kelly & Jones (2009, 2010a, 2010b) have used two commonly available biometric monitoring devices the Polar Heart Rate band and BodyMedia armband (see Figure 2.5) to collect biometric information for lifelogging applications. They have explored how these devices might be used in combination with other lifelog content to discern personally significant items within the collection. The Affective Diary (see Figure 2.6) uses similar biometric monitoring to create a record of the emotional state of an individual along with other personal content (Stahl et al., 2009). Participants wore an armband which monitored them throughout their day and through a visual interface the information gathered was visualized to present transitions in their affective state over the course of their day and to encourage self-reflection. Other commercially available products which can be used to monitor physiological state and which could be incorporated into lifelogs include, FitBit[3] which enables sleep and fitness to be tracked, and NikePlus[4] an in-shoe Bluetooth enabled transmitter which can be used to track activity and movement.

While biometrics is a theme of emerging interest for lifelogs, in our experience and as documented in Byrne, Kelly and Jones (2010), the nature of these devices are too

[3] http://www.fitbit.com/
[4] www.nikeplus.com/

intrusive and cumbersome for practical use over long periods of time. Many of the devices require contact with the skin, making them inconvenient to wear as they catch on clothing and become a source of irritation. Consequently, the wearer is often very aware of their presence, making them unsuited to long-term use.

Figure 2.6 The Affective Diary.

2.5.6 Other Sources

Sellen & Whittaker (2010) note that constructing a digital archive of life experiences requires a diverse range of capture technologies. Outlined above are a number of the core technologies employed by contemporary lifeloggers. As Sellen and Whittaker (2010) elucidate that these collections include "*the paper and digital documents we work on or look at; email, paper mail, and instant messages sent and received; content of telephone conversations; Web sites visited; and charge-card transactions. Also included are data from other everyday activities (such as still images, video, ambient sound and location data). Finally, these personal archives might also be supplemented with environmental measures (such as light intensity and temperature variation) and even internal, biosensor data (such as heart rate and galvanic skin-response measures) reflecting our physical and emotional state.*" However, a lifelog is not limited to or bounded by these sources. As access to digital information increases and as new technologies become available, they bring with them new sources of content that can be incorporated into a lifelog. One such example is the rise in Web 2.0 applications. These online sources now commonly provide programmatic access to personal information which has been distributed online. This enables lifelogs to for example incorporate banking information (Schwarz, Mankoff, Matthews, 2009) without the need to digitize statements; or to leverage content within social networks to provide social commentary to the events and activities depicted through its content (O'Hara, Tuffield, & Shadbolt, 2009; O'Hara, 2010).

2.6 Current Research Stands

Creating capture technology to support the MEMEX vision was an early focus within lifelogging research. The focus has moved to the technical challenges of building such collections and particularly in their organization, management and in enabling refinding of the contents within these long-term personal archives. Sellen & Whittaker (2010) remark that this overt focus on the technical challenges has been to the detriment to the benefits of the technology, namely: reminiscence, recollection, reflection and self-examination as well as opportunities for sharing of experience. They advocate the need to explicitly consider the value of lifelogs to the specific users, applications and domains which are being targeted by the technology and to prove and substantiate any such benefits with thorough investigation (Sellen et al., 2007; Sellen & Whittaker 2010). Many now are responding to this challenge (Berry et al, 2010).

2.6.1 Capture

In Section 2.5, we described how today's realisation of the MEMEX is far from the unified solution originally proposed. From this is it clear that considerable effort has been placed on the development of technology to support lifelogging and there are many examples of this (Mann, 1997; Mann, 2004b; Reddy et al., 2007; Hodges et al., 2006; Gemmell, Lueder & Bell, 2003). For these devices practical issues such as ergonomics, portability, reliability, robustness, battery life and performance are been key considerations and the devices are often redesigned and refined for practical use. One notable example is the iteration and miniaturization of Mann's WearComp (1997; 2004b). While there are outstanding challenges in the capture technology, particularly in using them in confluence (Byrne, Kelly & Jones, 2011), several of the major tools are now sufficiently mature to have been released as commercial products[5][6]. While such technology does not as yet have mass-market appeal, with more widespread availability, they now enjoy use in real-world contexts, beyond research applications.

2.6.2 Management And Retrieval

The creation of a lifetime store creates poses many challenges to the management of that information (Marshall, 2007). These include the organization, access to, re-finding

[5] www.slife.com

[6] www.viconrevue.com

and distillation of content from such voluminous repositories (Gurrin et al., 2008b). Considerable research emphasis is now directed towards taming these collections.

Appropriate structures to support the organization of the content have been explored by several recent studies. Doherty & Smeaton (2008) propose the use of an event-centric structure for lifelog, suggesting that the contents of a lifelog should be aggregated into higher-level units or 'events', which broadly align with a discrete activity the user engaged in. In their work, they leverage multimedia information processing techniques to provide an automatic solution to the segmentation of SenseCam visual diaries using visual features and sensor readings (Doherty et al, 2007; Doherty & Smeaton, 2008.) Smith, O'Hara & Lewis (2011) explore the use of ontological approaches in organizing a lifelog's contents. Unlike the work of Doherty & Smeaton (2008) which is engineered specifically to corpora of SenseCam frames, their solution supports the integration of multiple modalities including visual, content and context sources. They suggest that the use of an ontology has much merit as it allows relationships to be established between the collection's multimodal content. While sensible, the overhead of such deeply linked data in combination with long-term capture may present significant complexity. Kang et al. (2008) favour a more flexible structure for organization of a lifelog. In their approach, metadata describing each digital object in the lifelog is extracted, for example, EXIF information, and used to index it for later retrieval.

There is a recognised need for low cost annotation to support access to the content (Smith, O'Hara & Lewis, 2011). This may be achieved through automatic means so that only minimal effort is required on the part of the collection owner. Detailed descriptive information can often be automatically extracted from the content and context information contained within a lifelog and this can be used to label and classify its contents (Smith, O'Hara & Lewis, 2011, Kang et al., 2008; Gurrin et al., 2008b). Byrne et al. (2008) describe the use of semantic concept detection as a means by which SenseCam collections may be automatically annotated. This enables the probability of a semantic concept (e.g. general locations such as outdoors or indoors, the presence of a person or objects; and high level activities such as meetings or discussion) to be computationally determined based on the visual features of each image. The reliability of such approaches has been demonstrated with large SenseCam collections, albeit with a constrained set of generic detectors. The use of context information such as sampled Bluetooth and GPS signals has also proven use in labeling the contents of a lifelog for later retrieval (Byrne et al, 2007;

Smith, O'Hara & Lewis, 2011). Context data additionally allows a lifelog's contents to be annotated and related by social semantics (Lavelle et al., 2007). Document content and text-based information can also be mined for semantic terms and keywords which can be used to classify the contents and facilitate retrieval (Kelly, 2008). Using several of these approaches in combination serves to add further richness to the structure of the collection and empower more flexible retrieval scenarios through content- and context-based querying (Fuller et al., 2007; Kelly & Jones, 2007; Kelly & Jones, 2008).

Increasingly, attention is being directed towards the challenge of locating relevant content within the vast and diverse personal collection. Retrieval strategies are therefore increasingly important research direction for the lifelogging domain. The work of Kelly & Jones (2007, 2008; 2009; 2010a; 2010b) focuses on this challenge and they explore retrieval strategies and algorithms which may enable refinding from long term archives. While they employ long-term multimodal collections, the explorations are more oriented towards retrieval of desktop content, rather than visual modalities which are typically emphasized within lifelogging. Kelly and Jones (2007) propose the use of context and content techniques, noting the important role context information plays within many personal retrieval scenarios (Kelly et al. 2008). Kelly & Jones (2009, 2010a, 2010b) additionally explore the use of biometric information to locate content of significance within a lifelog and present retrieval algorithms suited to identifying relevant lifelog content based on marked biometric response. Much of this work is complimented by subsequent exploration by Chen (Chen, 2009; Chen & Jones, 2009; Chen, Kelly & Jones, 2010) which explores the provision of appropriate cues to the retrieval process and how the outputs of retrieval may be used to cue recall.

2.6.3 Access and Presentation

An important challenge, especially in multimodal lifelog collections, is identifying the right content to present to the user in response to their information need. Additionally, given the volume of these archives, gaining overview and understanding of its content is crucial. Several recent investigations explore this problem (Lee & Dey, 2007; Doherty et al., 2008; Chen, 2009). Lee & Dey (2007) discuss the challenges of presenting good cues to aid the recall and remembrance of past personal experiences from SenseCam content. They note that visual cues need to be recognisable, distinct and personally significant and that these three complex criteria pose significant challenges to the selection of cues through computational strategies. Similarly, Chen (2009) considers these issues but explores the difficulties posed by multimodal

content. Doherty et al. (2008) present computational approaches to the automatic selection of visual cues from SenseCam footage. A number of algorithmic approaches which use the visual features to detect salient frames were evaluated. Given the variable quality of the images (Gurrin et al., 2008), the incorporation of image quality measures was demonstrated to have much utility in avoiding undesirable frames.

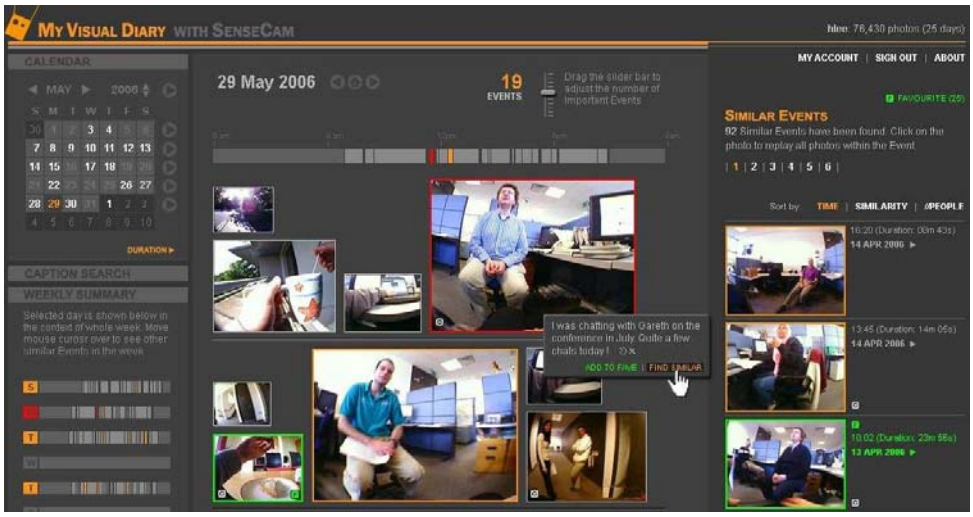


Figure 2.7 Lee et al's (2006; 2008) SenseCam Browser

Byrne et al. (2008) suggest that exploration of and access to lifelog content should be centred on three key axes (people, place and time). It is also recommended that a lifelog should be aggregated into events, or higher-level abstractions, which encapsulate a continuous activity and enable more convenient overview of its contents. This view has been incorporated into many of the software tools which enable exploration and review of lifelog corpora. A SenseCam browser described by Lee et al. (2006, 2008) presents an event-oriented view of a lifelog collection. In their browser, the size of the event corresponds with a measure of visual distinctiveness from other recent events. This allows important or novel events to be quickly distinguished. Caprani et al. (2010) created a similar SenseCam content browser designed specifically for the needs of an older population. Finally, Chen & Jones (2009) present an event-oriented interface which is intended to provide more flexible access to lifelog content. Unlike the previous efforts of Lee et al (2006; 2008) and Caprani et al. (2010), it supports both a variety of multimodal sources and the retrieval of content in response to a range of cues and criteria. The user interface allows complex directed searches to be issued by enabling time-, content- and context-based queries.

Beyond the collection browsing tools outlined above, several visual strategies for presenting lifelog content have also been suggested. Pousmann, Stasko & Mateas (2007) review a variety of relevant visual approaches and strategies which may be used to present digital data amassed about daily life and everyday experience. While not focused on lifelogging, their resulting design considerations are also very relevant. Baur et al. (2010) detail an information visualization of past access to music history. The 'LastHistory' interface provides a powerful tool for overviewing temporal patterns (see Figure 2.8). As the authors suggest, this visualization approach is suited to exploring other personal histories, explicitly referencing its applicability to lifelog collections. DataPrism (Fouse & Holland, 2010) presents an interactive visualization for the analysis of multimodal activity data. It is designed to support a wide range of multimodal time-based data including location-based, context, photo, and video sources; and its suitability in exploring lifelog corpora is explicitly mentioned by the authors. Finally, Kelly et al. (2010) present the visualization of colours present within a visual corpus of SenseCam content as a novel way to interrogate and discern patterns within the life of the collection owner.

2.6.4 Reminiscence, Reminding and Recollection

Lalanne & van den Hoven (2007) discuss the important role interactive systems may play supporting human memory. Given the promise of lifelogging technology as a memory aid, especially for those with cognitive impairments (Berry et al, 2007) this research area has become increasingly important. Sellen & Whittaker (2010) suggest that lifelogging could aid in supporting memory in a range of ways. This includes helping "*us mentally 're-live' specific life experiences, thinking back in detail to past personal experiences (often called 'episodic' memories). Remembering aspects of a past experience can serve many practical purposes; examples include locating lost physical objects by mentally retracing our steps, recollecting faces and names by recalling when and where we met someone, or remembering the details of what was discussed in a meeting*." Functions in support of remembrance and recollection are already offers within many software tools and packages that support the access to and review of lifelog content (Hodges et al, 2006; Gemmell, Lueder & Bell, 2003; Kalnikaite & Whittaker, 2008; Lee & Dey, 2008; Baur et al, 2010; Caprani et al., 2010; Chen, Kelly & Jones, 2010; Dib, Petrelli & Whittaker, 2010).

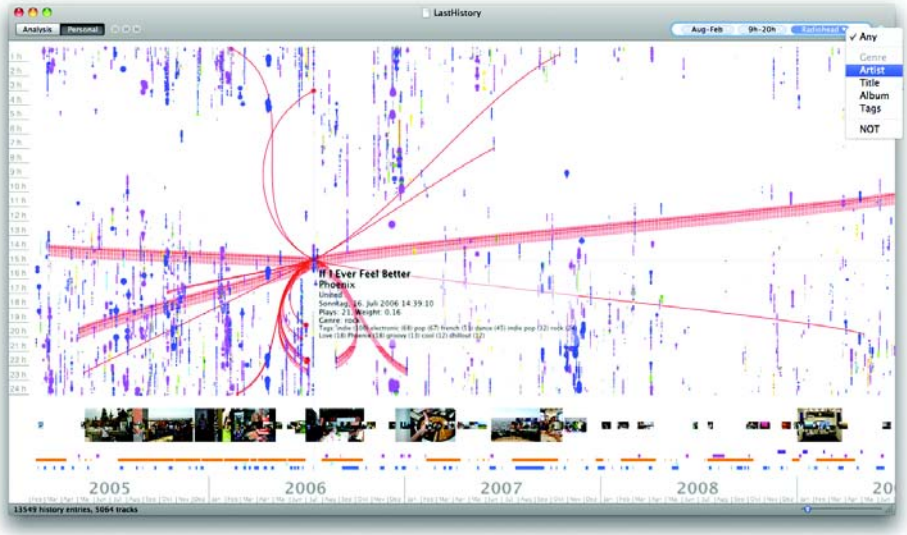


Figure 2.8 The LastHistory visualization of Baur et al. (2010)

Reminiscence may be regarded as a special case of recollection, in which lifelogs and their contents would "*help users re-live past experiences for emotional or sentimental reasons* (Sellen & Whittaker, 2010)." Users can be encouraged to reminisce by presenting them with past content, and given that a lifelog has a wealth of personal data, provides a rich resource for such activities (Cosley et al., 2008). As Cosley et al. (2008) goes on to explain, enabling reminscence is not without its own challenges, which include encouraging users to adopt reminiscence systems, engagement, and presenting the right content, Some of these challenges are being explored in a variety of work (Lee & Dey, 2007, Chen, Kelly & Jones, 2010). They also remark that reminiscence technology would have special utility for those with special needs in particular the elderly or those with cognitive impairments such as Alzheimers. Recognising this, Caprani et al (2010) are developing review software to support reminiscence for older adults while Hallberg et al. (2009) explore reminiscence technology targeted at those with Alzheimers. Hallberg et al. (2009) seek to provide a structured process for this activity. Within their software, users are invited to reminiscence through the frame of a 'Life Review'. The life review is a specific form of reminiscence therapy which is "*one of the most popular psychosocial interventions in dementia care, and is highly rated by staff and participants* (Hallberg et al., 2009)." Their reminiscence software presents the patient with prompts and cues formed from lifelogged content and context information in order to facilitate discussion of past activities and events with other persons.

Lindley et al. (2009a) have also explored the opportunities from reminiscence with lifeogs within the context of everyday family life. The review of SenseCam footage "*led*

participants to romanticise the mundane and find sentimentality in unexpected places, and was particularly effective at portraying personality and play." The SenseCam footage was found to be very evocative and review of the media was both engaging and rewarding for the participants. Lindley et al. (2009a) highlight how during reminscence the lifelog media "*supported recognition of character and the expression of sentiment, and made the portrayal of mundane elements of one's own life somehow refreshing*"

2.6.5 Reflection

Lifelogs offer a vast store of personal content and therein create new opportunities for the examination of past experience and of oneself. As Sellen and Whittaker (2010) state "*lifelogs might support a more abstract representation of personal data to facilitate reflection."* They elaborate that this "*might include examining patterns of past experiences (such as about one's behavior over time). Such patterns might provide useful information about our general level of physical activity or emotional states in different situations, allowing us to relate it to other data about, say, our health. Alternatively, reflection might involve looking at one's past experiences from different angles or perspectives. Here, the value is not in reliving past events (as in recollecting) but in seeing things anew and framing the past differently. The value is less about memory per se than it is about learning and self-identity.*" (Sellen and Whittaker, 2010)

Harper et al. (2008) demonstrate the SenseCam's utility in this regard. They explore how SenseCam, and by proxy lifelogged media, may be used a trigger for introspection. They found that the peculiar perspective that SenseCam provided on lived experience encouraged analytic thought. In particular, the detailed account of everyday experiences it captures, afforded the participants new appreciations of the mundane, allowing the 'extraordinary in the ordinary' to be discovered. Lindley et al. (2009b) building on this work, conducted a study where SenseCams were provided to six households. The capture of family life through SenseCam mainly stimulated opportunities for retrospective review but also afforded opportunities for new appreciatations and examination of the everyday. An interesting finding of the work was that the "*mere presence of a SenseCam, either round one's own neck or around that of another*" was seen to induce reflective, analytic examination of experience.

Fleck and Fitzpatrick (2006) examined the practices by which reflective behaviour could be fostered and encouraged through lifelogged accounts. They explore, in depth, the use of SenseCam in an educational context where teachers and tutors

were instrumented with a SenseCam for a number of days. The participants were invited to review their media to support reflection and learning's about their day-to-day practice. This investigation (Fleck 2009) realized an operationalised framework for recognising and evaluating reflection behaviour and analytic thought supported by SenseCam. Their findings highlight the many opportunities that lifelogs enable for reflection and introspection on the past, the self and on experience.

2.6.6 Sharing and Support

As Olsson, Soronen & Väänänen-Vainio-Mattila (2008) comment: "*People collect numerous immaterial and material things throughout their lives to remind themselves of the past. Some of these things are shared with others.*" While a lifelog collection is fundamentally a personal archive containing digital reminders of the past, this content can offer additional benefits through meaningful exchange of content. There are numerous potential avenues for exploration in this regard. Current research strands emphasise the utilities offered soley to the collection owner and explorations which shared, supported or mediated use of the content have not been investigated in depth.

Caprani, Gurrin and O'Connor (2011) suggest the importance of such investigation noting that reminiscence is often not limited to the individuals themselves but is often a shared activity, which involves the whole family. Lindley et al. (2009c) in a small scale exploration into the use of SenseCam media within a family context note the potential for SenseCam and other lifelogged media to be used in constructing representations of the self and how this may have utility in presenting oneself to others. Lee, Kim & Lee (2008) also explore a number of conceptual prototypes to speculate how lifelog content might be automatically shared with the individuals captured and depicted within the archive. The sharing of lifelog content with individuals of significance to the content owner is an increasingly important avenue for exploration.

Lifelogged content may have much utility beyond simply sharing the content with individual's known to the collection owner. Lifelog content may enable new documentary forms to emerge. Lindley, Calvillo Gámez & Gámez Leija, (2010) propose the use of SenseCam to capture multiple complimentary perspectives of significant cultural events. This would allow a record of the event to be preserved from the lens of the lived experience of multiple individuals and later authored into a mediated account. This may have social, societal or cultural applications for remembrance.

Similar opportunities for creative professionals and artists are highlighted by Ascheim & Keller (in Berry et al, 2010).

A lifelog may also allow third parties to support groups of individuals or particular populations. Lee & Dey (2008) outline how caregivers can use lifelog content to support those with Alzheimer's in remembrance activities. Alternatively, lifelogging technology has also been proposed to enable the monitoring of entire populations (Kelly et al., 2011). The goal of which would be to stimulate greater understanding of general health indicators and performance factors, but is not limited to these applications.

2.7 Nature of Lifelog Collections

Within this section we present some of the fundamental properties of lifelog collections which make them distinct from traditional desktop stores. Furthermore, we outline a number of challenges relating to these components of lifelogs. These issues and factors are described to illustrate some of the complexities of working with such novel collections. These challenges are, however, largely beyond the scope of this work.

2.7.1 Passively Sampled Record of Experience

A key feature of a lifelog is the use of passive capture technology. This is designed to be minimally intrusive, requiring no intervention from the user to document their life histories. As Abowd, Mynatt & Rodden (2002) notes "t*ools that support automated capture of and access to life experiences can remove the burden of doing something at which humans struggle (such as recording), so they can focus attention on activities at which they succeed (indicating relationships, summarizing, and interpreting).*" In sampling passively, lifelogging technologies not only amass a rich and detailed record of past action, but the create collections which are markedly different from traditional corpora. Gurrin et al. (2008) examine a large set of 1 million SenseCam frames gathered by a single user over the course of a year. They note the differences in volume, visual quality, viewpoint and perspective within these collections. These distinctions may be in some respects advantageous to facilitating many of the functions outlined previously. Harper et al. (2008) assert that while these collections are amassed by sampling experiences they are not an analogue for it, but data representing aspects of that experience. The visual frames of the SenseCam are "*discontinuous yet empirically bound to*" the experience (Harper et al, 2008). This

discontinuity affords a novel perspective on the experience through which it can be examined in a new light and encourages reminscence and reflection. Lindley et al (2009a) describes that the lifelog content is "*not seen as an absolute record of what happened, but as something that offers a different perspective on the events of the day, with the potential to serve as a reminder of those events. Participants did not need to preserve every detail of every event, and accepted that there would be discontinuities between the photographs and their experience as remembered. Recording an essence of what had happened was sufficient for them*."

The passive capture is indiscriminate of the activity a user is engaged in. This means that ordinary and significant happenings are captured with equal regard by the technology. Sellen and Whittaker (2010) view this as a major limitation of the technology as the significant moments may become subsumed by the large volume of the habitual, making them more difficult to identify and discern. However, Lindley et al (2009a) highlights this as an opportunity. They remark upon the new appreciations of the ordinary and how the extraordinary can be found in the ordinary (Lindley et al., 2009a; Lindley et al., 2009b). Irrespective of these opportunities, Sellen & Whittaker are not alone in their views, with many others harshly regarding the 'keep everything' goal of lifelogging (Marshall, 2007).

2.7.2 Personal Archives

Lifelogs are clearly deeply personal collections. They archive all past action relating to a individual and the goal is to collect significant and mundane, intimate and ordinary, private and social moments alike. By archiving continuously through passive sampling, a very detailed picture of day-to-day actions can be established. From this, and over time, life patterns, routines and rhythms may emerge from the data and be discerned, as well, as any deviations, changes or irregularities from the norm. Being deeply personal it enables the past to be interrogated through a digital lens and enables long-term recall, recollection and reminiscence to be complimented and supplemented through digital technology. However, being a deeply personal archive and in attempting to not only digital record, but preserve in the long term, a life's experiences, a range of issues are presented.

Most notable are those relating to ethics and privacy. As lifelogging capture technology becomes more ubiquitous and commonplace, many new challenges in this area become a paramount concern (Scott, 2008). The issues faced range from personal privacy, the ethics of capture, social and societial implications to the legal

ramifications of continuous capture. As Scott (2008) notes, there is no panacea for these challenges and they must be carefully considered. Bannon (2006) comments on the need to delete content to maintain personal privacy and to digitally 'forget'. O'Hara, Tuffield & Shadbolt (2009) discuss the privacy implications of the lifelogging vision, while Mann (2004) presents case studies and practical examples of experiences and challenges encountered while attempting to continuously record his life. A common concern voiced relates to the notion of personal surveillance and the maintenance of this record in the long term. O'Hara (2010) notes that many of these concerns do not apply when the technology is used for medical applications, however, more generally it is often criticised as having the potential for "*deleterious effects on society, or because it will be a frivolous misuse of resources*." Mayer-Schönberger strongly contends that a "*comprehensive digital memory represents an even more pernicious version of the digital panopticon.*" Nguyen et al (2009) presents how this may indeed be a concern. They surveyed individuals' perceptions of captured with lifelogging technology. They confirmed '*that people would tolerate potential incursions from SenseCam for particular purposes*' such as medical applications. Of concern, they found that while people would prefer to be informed about and consent to capture, but that regardless of their preference or potential unease with being captured, they were unlikely to request deletion of content. Lifelogging must as such be very sensitive to privacy concerns.

Besides personal privacy, legal considerations may also be required. For example, Mann (2004a) illustrates how an individual engaged in continuous capture may inadvertently encounter, capture and duplicate copyrighted material. The "*conflicting interests of protection and long-term maintenance*" raised as another complexity by Marshall (2007) who also discusses a range of issues for a long-term personal store. For example, it is commented that in some circumstances it "*may even be legally mandated in some situations (for example, personal information that belongs to an employer).*" While it is important to be aware of the privacy, ethical and legal issues when conducting any long-term capture activity, they are beyond the scope of this work.

2.7.3 Long-term Stores

Lifelogs ultimately wish to provide a single repository of all personal information which can both be made available and contributed to across the lifetime of the individual. In ensuring access to data in the longer term, practical storage and management factors need to be considered. These include technology obsolescence; shifts in file formats,

operating system, software platforms, supporting technologies or technical infrastructures; the reliability of storage media in the long-term; and backup and maintenance (Marshall, 2007). While maintaining access to the content across decades presents new issues, others voice concern about the value of lifelogged data in the long term (Marshall, 2007; O'Hara; 2010; Sellen & Whittaker, 2010.)

Sellen and Whittaker (2010) remark that there is some concern that "*digital archives may be generally less valuable than people would hope.*" O'Hara (2010) similarly notes that some or all of the data may in the long term be largely useless. "*We store all sorts of pieces of 'useless' information, precisely because we do not know at storage time what will be useful in the future. The guesses we make about what memories are likely to be important in the future are unlikely to be right all the time, so the more raw material that is present in our records of the past, the more likely we are to have everything that is useful (Bell and Gemmell 2009). ... No doubt most of what is stored will actually be, as anticipated, completely useless; data tends to have a long-tailed structure, where some pieces of information are used all the time, while most of the rest is hardly ever consulted. The cheapness and ease of digital information storage make it possible to preserve records without the need to consult them* (O'Hara; 2010)."

2.7.4 Rich and Detailed, But Voluminous

Lifelogs typically employ passive capture as the primary method of recording experience. This samples daily activities with regularity to provide a rich and detailed account of past action. In doing so, large amount of large amounts of data can be very quickly gathered. For example, the SenseCam alone will capture in excess of 2,500 images in a typical data. This volume of data can be particularly problematic when dealing with long-term collections. The complexities of volume is a clear challenge and one which current research strands have placed emphasis on by exploring suitable data management techniques (see Section 2.6.2) Outcomes of this work, such as the segmentation approach of Doherty & Smeaton (2008), do help to mitigate some of these concerns. However as Gemmell et al. (2004) discuss in the context of SenseCam and MyLifeBits, this increased volume not only creates a problem for management of a long-term collection but also in refinding, retrieving, browsing and access to these collections. In particular, users may have difficulty '*homing in on the interesting items*'. Sellen & Whittaker similarly note this challenge stating that "*Capturing vast arrays of data might over-whelm end users maintaining and retrieving*

valuable information from large archives; it also ignores the burden huge amounts of data impose on system designers and developers" (Sellen & Whittaker, 2010).

2.7.5 Coverage of Life Experiences

Again, as mentioned above, a lifelog will seek to broadly survey a life's experiences. However, it is not practically possible to survey every experience that occurs. Completeness may be encumbered for a variety of technical or human factors considerations. This, nevertheless, may impact on the utility of the collections massed especially if moments salient to recollection, reminiscence or reflection have not been captured. Technical limitations, such as battery life of the devices employed, may be responsible for loss of capture (Byrne, Kelly & Jones, 2010). Human factors issues may also play a part, for example a user forgetting to put on the device in the morning or to remove its lens cap (Byrne et al, 2008). Capture may also be disabled during times where there is a personal need for privacy, but, may also be socially mediated if an encountered individual objects to being recorded (Byrne, Kelly & Jones, 2010). Finally there may be ethical or legal precedents which mandate the cessation of recording (see Section 2.7.2).

While broad coverage of an entire life is the envisioned goal, in practical application this is unrealistic. Some of these issues relating to coverage may be mediated and minimized by incorporating overlap and redundancy within the modalities employed. By employing complimentary channels, such as the use of digital photo capture in confluence with SenseCam, in the circumstances where one modality is not captured the other source may to some extent help reconstruct the experience. Another important contribution of incorporating multiple modalities is to enable context to be maintained in the long term. The advantages of doing so is that each digital object is not therefore standalone but contributes characteristics that makes it part of the whole (Marshall, 2007). Lindley et al. (2009b) supports this position noting that the use of a single modality alone may mean that insufficient context is provided to the overall experience. The inclusion of multiple modalities is consequently important to ensure broad coverage of contextual signals and capture of the life experiences.

2.8 Open Issues and Opportunities

Lifelogging is extremely nascent. Much of the effort to date in the domain has focused on these technical challenges (Kalnikaite, 2009) and in particular on iteratively

improving the research prototypes which currently support life capture. As has now been realized (Sellen et al., 2007; Sellen & Whittaker), equal emphasis must be placed on ascertaining the benefits that such technology offers and substantiating any claims about the technology, in particular in its potential as a memory aid, through rigorous evaluation and longitudinal trials. Sellen et al. (2007) importantly asserts that "*systematic experiments […] can help us make more informed decisions based on a deeper understanding of the relationship between life-logging technology and human memory.*"

There are of course a number of technical challenges which must be first be addressed in order to enable this. It is important that fully rounded technical infrastructures are established to support life capture (Truong, Abowd & Brotherton, 2001). They must cater for issues such as obsolescence and access to data in the longer term (Marshall, 2002). Furthermore there is much need to provide software and tools which support management, organization and access to archives. Sellen & Whittaker (2010) note that much of the research in this area has only yielded proof of concept demonstrators and not software which is practically deployable for either real world use or within long-term studies. However, the key challenge is the creation of and access to long-term lifelog collections which would support the systematic evaluation which Sellen & Whittaker (2010) calls for. To date, evaluations within the domain have been conducted with short-term, often single modality, collections and this is insufficient to prove the utility or benefit of lifelogs. As Gemmell et al (2004) similarly point out "*simple and short user tests are inadequate because until one has a large volume of truly personal data the benefits and shortcomings cannot be evaluated.*"

Much of the interest in lifelogging has centered on one particular benefit; a lifelog as a memory aid (Hodges et al, 2006; Berry et al., 2007; Sellen et al., 2007; Kalnikaite & Whittaker, 2007; Bowen et al., 2008; Gurrin et al., 2008; Kalnikaite & Whittaker, 2008; Lee & Dey, 2008; Chen, 2009; Chen, Kelly & Jones, 2010; Kalnikaite et al., 2010). Harper et al. (2008) suggest that this focus on memory may be an overly constrained view of a lifelog's potential. They propose a reframing of the currently held perspectives on the technology and recommend that lifelogs not be regarded as capturing "*digital analogues for [a] memory, but as devices that would provide resources for action.*" They elaborate that "*this view can provide a different framework and hence a different trajectory for the use and development for devices that support, enable, enrich or help document human action.*" A lifelog should not be a qualifier,

supplement or surrogate for the lived memory, being "*distinct from what was experienced*" but instead should offer a complementary account which can enable exploration of the past and of the self, seen through a novel lens. In viewing a lifelog not as an analogue for, but as documentary effort of our experiences, which produces a complimentary record to lived experience, new opportunities emerge.

Narration of the past becomes an important element of this reframing. Lifelogged content in evoking the past create "*new values, new resources for narrative and self-understanding*". Narrative produced from its content provide "*vehicles to convey memory, insofar as memory is an action (*Harper et al., 2008)". Stories produced with lifelogged content would enable a rich means through which the past histories maintain in these collections could be accessed. Narrative provides a framework for sensemaking and understanding (Bruner, 1990; Kearney, 2002) which would allow these complex and voluminous collections to be tamed into an intelligible and intuitive form. Furthermore, narrative accounts underlie many of the envisioned functional spaces of lifelogs: narrative enables the past to be accessed in a meaningful, rich and expressive manner; stories are vehicles for reminiscence and recollection; interpreting past actions supports reflection and the process of constructing narrative is an inherently analytical process; and storied interpretations are a common mechanism for sharing past personal experiences (Barrett, 2006; Bruner, 1990; Kearney, 2002; Li, Forlizzi & Dey, 2010). By enabling the historical narrative accounts captured within a lifelog to emerge and through the construction of storied interpretations of its content many of the opportunities latent within the domain of lifelogging can be realized. This is the focus of this work.

Chapter 3

Personal Storytelling and Lifelogs

Narrative is highly appropriate form though which the experiences amassed within a lifelog can be communicated. With opportunities created by applying narrative to lifelog collections outlined, we explore the nature and components of personal narrative. We introduce the oral tradition of personal storytelling as well as the forms that personal narratives might take. We discuss the components and properties of narrative, as well as outlining how digital techniques has been applied for personal storytelling and communicate experience.

Personal storytelling can concern conversational stories – single isolated episodes retold in isolation of the larger life experiences – or life stories which concern broad themes or periods from an individual's life and must be framed in larger life experiences to be understood. The function that life stories facilitate are additionally outlined to include the support of reminiscence and reflection, as well as the sharing of experience. We describe how narrative operates across several key dimensions namely the spatial, temporal, mental, formal and pragmatic. Within digital narrative we must consider the structure or organization of content to support storytelling, the representation or the form the narrative plot takes and the presentation or aesthetic representation of the story on screen.

3.1 Storytelling and Narrative

"The universe is made of stories, not atoms."

—Muriel Rukeyser

Storytelling is an instinctual process and one which has endured throughout the history of human culture. From cave drawings, stained glass windows, to comics, scrapbooks, films and infographics, storytelling provides a commonly-understood and compelling framework through which experience can be shared and expressed in a meaningful, coherent and powerful representation. Not only has storytelling endured as a tradition, but it has readily adapted to the availability and emergence of new media and technologies. Cinema and television have provided a new vehicle for

stories, like books and printing presses before them. This is no less true with digital and multimedia technologies.

A narrative may take many forms, however, given its instinctual nature, narrative can be implicit, intangible, concealed. It is arguably hard to define. To facilitate a clearer understanding of what may be considered to be a narrative or narrative form, below is a fuzzy set definition of narrative as provided by Marie Laurie Ryan (2005; also: 2003, 2007):

- *The mental representation of story involves the construction of the mental image of a world populated with individuated agents (characters) and objects. (Spatial dimension.)*

- *This world must undergo not fully predictable changes of state that are caused by non-habitual physical events: either accidents ('happenings') or deliberate actions by intelligent agents. (Temporal dimension.)*

- *In addition to being linked to physical states by causal relations, the physical events must be associated with mental states and events (goals, plans, emotions). This network of connections gives events coherence, motivation, closure, and intelligibility and turns them into a plot. (Logical, mental and formal dimension; causality; story schemata and causal structure.)*

Bal (1997) provides a complimentary view of narrative suggesting that it is composed of three primary levels:

- The *fabula* or the set of raw chronological events which will be depicted.

- The *story* is the subset of events which will be included in the end form. The story may restructure those events into a new sequence to achieve a particular effect or goal. This re-sequencing forms plot.

- The *narrative* 'is the story given form'. Any given story many have a number of narrative forms which may include oral retelling, the printed word, cinematic, visual or graphic depictions, games, or other multimedia expressions.

As suggested by both Bal and Ryan, achieving a good narrative is dependent on a complex interplay between a variety of interrelated factors. For example, Barthes (1977) observes not all of the events in the story will be of the same importance to the

plot and will contain both *cardinal* units, which can be seen as the core moments in narrative on which the plot is hinged, and *catalysers* or the surrounding relevant moments which fill the space between them.

Narrative and storytelling may take a variety of forms and may create fictive or creative accounts often developed for entertainment or the exchange of ideas or as vehicles for the communication of personal experience. The latter is of concern within this work and is now explored in more detail.

3.2 Personal Narratives

"*Stories are the creative conversion of life itself into a more powerful, clearer, more meaningful experience. They are the currency of human contact*."

-Robert McKee

McDrury and Alterio (2003) describe storytelling to be *"uniquely a human experience that enables us to convey, through the language of words, aspects of ourselves and others, and the worlds, real or imagined, that we inhabit. Stories enable us to come to know these worlds and our place in them given that we are all, to some degree, constituted by stories: Stories about ourselves, our families, friends and colleagues, our communities, our cultures, our place in history.*" Stories enable us to share our meaningful experiences about all aspects of our lives. Personal stories are used equally to share deeply intimate details of ourselves and provide engaging retellings of a recent events. Regardless of their significance, meaning or intimate nature, it is only by transforming experience into story that it is "*made memorable over time, [and] that we become full agents of our history (Kearney, 2002).*" The process of crafting experience into a personal story is inherently analytical. Through this act of individual sensemaking "*the complex and unordered world of experience can be tamed by crafting story lines*" *(Bruner, 1990 as cited in Shank, 2006).* The outputs of this process yield engaging, coherent and meaningful expressions which can communicate these experiences and facilitate exchange. Theses narratives about past personal histories are "*always told from the temporal perspective of the present. Narrators linguistically shape their tellings to accommodate circumstances such as the setting as well as the knowledge, stance, and status of those in their midst (Ochs & Capps, 1996).*"

3.2.1 Mediums of Personal Narratives

Personal narratives may be found in a variety of media. Diaries can be used to preserve a written account. Where previously paintings and art may chronicle a life through a visual record, now personal photographs and video are commonly employed. Television, radio and film can be used to present documentary accounts of lived experiences, viewpoints and perspectives. The internet, weblogs and social networks are modern forms for communicating these personal accounts (Ryan, 2005; Ryan, 2004). Irrespective of the form, all of the mediums require an act of mimesis in which the lived experiences are reflected upon and involves both "*a free-play of fiction and a responsibility to real life (Kearney, 2002).*" This considered, reflective and transformative process underlies the creation of personal narratives, regardless of medium or form.

3.2.2 Types of Personal Narratives

The three major types of personal narratives are now briefly outlined. These are: the everyday experiences communicated through conversational accounts; more involved and intimate retellings of personal history deeply rooted in identity and self or life stories; and finally those accounts which have been mediated on our behalves.

3.2.2.1 Everyday & Conversational Stories

Throughout our daily lives we discuss, exchange and recount our experiences to others (Brooks, 2003). As Norrick (2007) describes "*storytelling is a common part of conversation between friends and family members. We tell stories to make a point, to catch up on each other's lives, to report news, and to entertain each other. And one story opens the floor to other participants for stories of their own."* We readily exchange our experiences on a daily basis as part of social discourse. These social communicative acts typically recount short snippets of our lived lives from the recent past. They do not require a deep understanding of our background or identity to be appreciated, being digestible and comprehensible without a need for detailed exposition. Conversation is an accessible form in which they are conveniently exchanged. These *"conversational stories are embedded in their local contexts, their forms and functions developing from and reflecting these contexts. Conversational storytelling is not simply oral storytelling." (Norrick, 2007).*

While these stories are formed from short isolated episodes of experience, their retelling is by no means a simple process. "*Genuine conversational storytelling is*

always interactive, negotiated, and not simply designed for a particular audience by a single teller (Norrick, 2007)". Brooks (2002) describes the complexities of these everyday exchanges in more detail:

"*Many audiences for oral storytelling just sit and listen to a story presented to them in a linear way. It appears to them that the storyteller begins the story, recounts the events, embodies the characters, and then simply ends the story in a meaningful fashion. Actually, from the storyteller's point of view, oral storytelling is a much more fluid and flexible process, suggestive of a metalinear structure. As the storyteller begins, and often even before they begin, they must tune–in to the audience's attitude and responses, what many storytellers refer to as the audience's energy. Based on this energy, the storyteller will adjust their timing, their posture, their characterizations, and sometimes even the events of the story. There is a dialog between audience and storyteller. Oral storytelling involves a shared task, different from the physically separated tasks of the writer and reader of the printed story. The audience and teller negotiate a story into being in a highly dynamic interactive process.*"

3.2.2.2 Life Stories

Each and everyday, we communicate in story-form narrating the interesting and meaningful parts of our lives to colleagues over lunch, friends over coffee or family over the phone. While these memories are often shared in isolation through everyday storytelling, that is not how they are maintained in the mind. Autobiographical memory bridges the episodic memory, which contains individual everyday stories of our day's events, with the semantic memory, which stores and maintains our knowledge of the world we live in (Tulving & Donaldson, 1972). The combination of both within autobiographical memory allows complex relationships between the individual events to be formed, binding them together in a network of temporal, causal and thematic relationships (Burt, Kemp & Conway, 2003). These relationships, shaped by autobiographical reason, form sets of coherent meaningful '*life stories*' which reflect the current goals, ambitions and values of the self (McAdams, 2001). The life story evolves as we do; integrating significant or emotional events and updating retrospectively to account for changes in our perception and remembrance of past events, values and beliefs.

Unlike everyday stories, the 'life story' provides us with the opportunity to examine a set of causally related events, framed from the perspective of our current self and within the context of our larger life experiences, motivations, goals and ambitions. It

provides three main utilities to us: first it allows purposeful reflection on your life events and its development in order to affect or determine future actions (*directive*); second it enables us to share aspects of our lives with others, often as a means to develop social bonds, intimacy and/or empathy (*social*); or finally, it affords a review of life experiences to search for meaning in them (*self*) (Bluck & Habermas, 2000).

Causality is essential to telling a meaningful life story as it is in essence the glue which binds a series of events together to form a meaningful coherence structure (Onega & Landa, 1996). As Bluck and Habermas (2000) explain: *"Causal coherence may be the most significant type of coherence in the life story. Events, life periods, and the self are linked in terms of motivations, causes, or explanations. The speaker describes why certain events occurred and how those led to what happened next. They may use logic but may also rely on implicit theories of what motivates people, how emotional events should be coped with, and how development across the lifespan occurs. That is, when interpreting life, the individual refers to culturally shared views of personal continuity and development."* Bluck and Habermas (2000) explain that life story narratives are organised through *thematic coherence.* Life stories, they explain, contain themes which are either present throughout or emerge as the story progresses. These themes are often closely related to life lessons or truths and are correlated with the audiences' understanding of the flow of the events (*plot*) contained within the story.

As Kearney (2002) describes "*when someone asks who you are, you tell your story. That is, you recount, your present condition in the light of past memories and future anticipations. You interpret where you are now in terms of where you have come from and where you are going to. And so doing you give a sense of yourself as a narrative identity that perdures and coheres over a lifetime…. In this way storytelling may be said to humanize time by transforming it from an impersonal passing of fragmented moments into a pattern, a plot, a mythos."*

In short, the life story provides meaning, continuity and identity to our lives and offers us the ability to recollect, reflect upon or share a coherent personal self-history of our entire life or a portion of it.

3.2.2.3 Mediated Accounts

Personal experiences are not always transformed into narrated accounts by the individual alone. We are often supported in these efforts. Motivated third parties like biographers, journalists, psychiatrists, detectives, negotiators, lawyers, artists and many others help us negotiate and narrate the past (Kelliher & Davenport, 2007). They

help us to better understand our past by mediating our personal histories. Ethnographers, anthropologists and documentary makers perform this role at a broader cultural level, identifying and clarifying moments of meaningful societal significance. Genealogists help us to uncover and recover family heritage and stories relating to ancestry. This can provide new meaning to the present by better understanding those that went before you (Hadis, 2002). In therapeutic settings, mediating narratives of the past can play a crucial and cathartic role. Kearney (2002) outlines this to be found in "*encouraging [patients] to de-program their old histories, to divest themselves of the habitual plot-lines which have determined their behaviour up to now.*" Kearney, using the example of the Holocaust to illustrate the importance of documenting the past through personal testimony, describes how by combining first hand accounts with historical records or documentary footage documentary makers may *"invite contemporary witnesses to retell the untellable journey they made*." Through this documentary effort, others may bear witness to the reality of incredible past histories, challenging them confront the harsh truths which may be found within the past.

3.2.3 Role and Utilities of Personal Narratives

Combs and Beach (1994) state "*the stories that are part of the fabric of our lives are personal narratives.*" This thereby makes personal stories highly important to in every facets of our lived lives. Rosenbluth (1997) affirms the significance of personal narrative, noting in particular the meaning it attributes, to our lives: "*just as an amnesiac who has no memory of his past has lost the sense of who he is, so do we need stories from our past to give us a sense of our own identity.*"

Storytelling is often a communicative act and it extends benefit to both the narrator and their audience. As Hadis (2002) describes "*the act of listening and learning from stories bestows the benefits of identity, guidance and enrichment upon the audience; the act of storytelling casts the benefits of coherence, generativity and resulting human connections upon the teller.*" To the narrator, the process of retelling affords the "*ability to recall and identify with our own past [which] gives existence meaning, purpose and value.* (Lowenthal, 1985)." Retelling and, in so doing, reminiscing about the past can provide enormous therapeutic value (Rosenbluth, 1997). McAdams (1993) demonstrates in reporting on life story interviews, in which individuals recount their past through structured discourse, that the act of recounting intimate life histories can be enormously rewarding for the narrator:

"*Most people report that the experience of their telling their stories was profoundly satisfying and enjoyable, even if they had shed tears in the telling. They often ask not to receive payment for the interview, for they feel if they had shed tears in the telling. They often ask not to receive payment for the interview, for they feel that they have already*"

The narrator by introducing their past to an audience also extends them benefit. Narrators "*offer their listeners an invitation to intimacy. They expect their listeners to listen because both they and their listeners know that this is one very effective (and acceptable) way to create and enjoy a sense of intimacy* (Stahl, 1989)". By retelling their life histories, empathetic bonds may form, understandings may deepen and intimacy may be fostered between these individuals. By sharing their personal histories the narrator exposes a facet of their self and identity allowing new understandings and appreciations to develop. When sharing a common past, such as in family storytelling, this may additionally help to foster not just intimacy but a sense of connection and community (Hadis, 2002). Finally the sharing of experience with an audience may provide an opportunity for learning. In narrating the past, wisdom, advice and guidance may be provided to the audience implicitly or explicitly. Rosenbluth explains "*although we make our own choices and choose our own paths, those paths can be illuminated by the wisdom – and sometimes folly - of those who have been in similar situations before* (Rosenbluth 1997)"

Finally, stories not only have utility in exchanging about current lives lives but learnings and understandings may be imparted through heritage accounts. Spierling (2002) describes how "*stories have been used to transfer not only historic knowledge among the generations, but also to transfer cultural and social values and to provoke emotions. Humans use narrative for understanding intentional behavior.*"

3.3 Digital Storytelling

"Digital Storytelling is the modern expression of the ancient art of storytelling. Digital stories derive their power by weaving images, music, narrative and voice together, thereby giving deep dimension and vivid color to characters, situations, experiences, and insights. Tell your story now digitally."

- Leslie Rule, Center for Digital Storytelling

Through digital technologies, narrative can take a modern form (*Meadows 2003)*. Through digital tools, multimedia content, animation, and interaction, narrative has found new expressive forms as a result of the emergence of new technologies, tools and techniques (*Sandley, 2003)*. For example Spierling (2002) notes that "*virtual reality and graphical game engines are maturing as storytelling media.*" The Digital Storytelling Association (2002) describes digital storytelling as: "*[a] modern expression of the ancient art of storytelling. Throughout history, storytelling has been used to share knowledge, wisdom, and values. Stories have taken many different forms. Stories have been adapted to each successive medium that has emerged, from the circle of the campfire to the silver screen, and now the computer screen.*" Digital storytelling *"encapsulates aural, visual and sensory elements*" in a flexible and dynamic manner (Lynch & Fleming, 2007).

Digital narrative may be found in games (Mateas & Stern, 2002) and virtual environments (Magerko, 2005; Magerko & Laird, 2003; Braun et al, 2003), agent based approaches (Mateas & Stern, 2002; Brooks, 1996), as digital cinema (Brooks, 1996; Brooks, 1999), personal storytelling (Kelliher, 2007l Landry, Guzdial, 2006; Landry 2009), enabled through mobile devices (Nack et al, 2010), through the experience of interactive system use (Quesenbery & Brooks, 2010; Gonçalves & Jorge, 2004; Gonçalves & Jorge, 2008), through social networks (Sack, 1999), through social media (Kelliher, 2007) and through digital photographs (Ames & Manguy, 2003; Landry, Guzdial, 2006; Landry 2009); through the visualisation and presentation of data (Cheong et al., 2008) and even storytelling through programming of computer systems (Kelleher & Pausch, 2007)

In essence, digital storytelling aims to present multimedia content in an aesthetically presented form. This presentation '*serves to extract and highlight those events, outcomes and conclusions which the presenter and observer find "interesting"*' (Tomai & Forbus, 2007). A digital story like any other must be coherent and meaningful in its form, plot, composition and presentation. However, there are many challenges to achieving this in practice through computation. Brooks (2002) notes that while systems are good in supporting the author, an author is often still required:

"While the computer can accommodate many voices through its massive digital storage and search capabilities, it cannot automatically make sense of those voices. This is the job of the author. Yet how does the author, trained to see uni-linear stories,

shape these many narrative elements into a coherent form? Through the use of intelligent tools." *(*Brooks, 2002)

The role of the computer is often to support the author by providing intelligence in reasoning about plot. Brooks (2003) states that a "*metric of intelligence is the ability to understand enough about the world to recount it in a story"*. In support of the author digital narrative will take often take a plot-based approach to authoring multimedia into storyform: "*Instead of focusing on characters and point of view, the author focuses on plot, and structures the story as an interconnected branching network of plot lines (Brooks, 2002).*" A vital component of the digital narrative which must also be provided by the computer is agency. Janet Murray (1997) defines this as *"the satisfying power to take meaningful action and see the results of our decisions and choices."* This agency is often provisioned by interaction with the story form, for example, as in Mateas & Stern (2005) and in Appan et al (2004). By enabling the author or audience to interact and adjust the outcome, engagement and immersion is fostered. Interactive storytelling solutions facilitate the emergence of the narrative through user interaction. Emergent narrative enables continuing but different digital narratives to be generated in a manner akin to improvisational drama (Louchart & Aylett, 2004). In support of these interactive, generative and emergent narratives, Brooks (1996) describes three layers in which such intelligent tools commonly operate:

"1) The Structural Environment, in which the structure of the narrative is described in simple abstract terms;

2) The Representational Environment, in which knowledge of the various story elements is captured in the form of relationships between story events;

3) The Presentational Environment, in which software agents work as text/video editors, intelligently sequencing and orchestrating the different story elements according to an agent's individual stylistic preferences."

3.4 Digital Storytelling and Life Stories

"*I know only one thing about the technologies that await us in the future: We will find ways to tell stories with them*"

- Jason Ohler

Using digital media artefacts to recount, retell and reflect upon personal life experiences is not limited to our work and storytelling has additionally been explored within lifelog collections previously in a number of small-scale studies. Images from the SenseCam along with associated GPS location information is presented as a means to recount a 'trip-based' experience as a lightweight story in the form of an animated slideshow composed of SenseCam images (Gemmell, Aris & Lueder, 2005). While this work is relevant, the approach doesn't employ any intelligent assembly or reasoning of the story other than the location at which activities occurred and does not take advantage of the full range of context that is potentially available within a future lifelog. Harper *et al.* (2007) conducted a study with six participants into user-created digital narratives composed from SenseCam captured images. As Harper et al. suggests with the SenseCam (2008), Berger and Bach similarly describe the roles of photos in providing meaning and opportunity for narrative: "*Photos in themselves do not narrate. It is the meaning that is given, the voice behind the photograph, that allows for memories to be triggered, the place and time, and that in turn brings the photography to life*" (Lemon 2006; Berger, 1980; Bach, 2001). The work of both Harper et al. (2008) and Lindley et al. (2009) is particularly interesting, highlighting the usefulness of such images in reflection and reminiscing over life experiences, it does not offer insight into the composition of such narratives, but rather the perception of them. Additionally, given the rate at which such a collection might grow, the applicability of manual composition of such narratives is questionable.

Of most relevance, but perhaps not within the domain of lifelogs, is the work of Appan *et al.* (2004). They explore the composition of digital narratives for everyday experiences using media such as photos, gathered during the user's day-to-day activities. They highlight several noteworthy points. First they found that more traditional narrative models, such as those used in cinema or in the Agent Stories framework (Brooks, 1996), appear unsuited to the communication of everyday experiences. The cinematic model contains elements such as '*introduction, diversion, conflict, resolution and ending.'* While such a meta-linear model is easily applied to fictional narratives, it is difficult to categorise them or for a user to perceive them as 'resolution' or 'conflict'. Furthermore, constructing casual relationships to supporting or opposing events through such a model is extremely difficult whereas, they find, that causality in life stories emerges from the temporal and spatial relationships which bind the daily events. Secondly, they assert that users do not want to spend time editing or authoring their stories. As a result in the case of 'everyday narratives', they favour the use of an emergent story framework in which the story evolves through feedback and

interaction from the user. Interestingly they also advocate the use of low-sample capture of media within their narratives, citing the complexities of volume, data management and convenience. While in some ways we tend to agree, we feel that prior work in the domain of lifelogging, such as Doherty & Smeaton (2007), overcomes many of the data management concerns. Additionally, low sample rates or low volume collections cannot offer the richness of content and context by which to understand the patterns and subtleties of a person's life or to garner reliable semantic knowledge. We believe that this is highly important to ensuring the meaningfulness of autobiographical narratives.

Al Mahmud, Aliakseyeu & Martens (2008) are also exploring the use of passive capture technology in aiding those with aphasia to express themselves. Aphasia is an 'acquired communication disorder' that affects language comprehension and generation. Those suffering from the condition often use pictograph-based lexicons or tools in order to overcome their language barrier and this motivated Al Mahmud et al. to explore the use of passively captured photos as a way to enable conversational storytelling for such patients. The patients use the photos taken from cameras in their home, with the aid of a family member, to reconstruct their day from the captured artifacts. Additionally, they manually annotate their collection with text descriptions or emotional states. A major critique of the system is that it is a highly manual process. There is a huge overhead placed on both the sufferer and their family to regularly annotate and review the collection. Secondly, the 'story' produced is more akin to a summary of the patient's daily activities rather than a true narrative of his/her life.

Like Al Mahmud et al (2008), McCarthy, Sayers & McKevitt (2007) have been exploring the retelling of personal life experiences through digital technologies in a focused domain. They are developing a tool dubbed 'MemoryLane' which is designed as a reminiscence tool for the elderly. Within their system, various artifacts from the subject's life (e.g. photos, audio, video) are manually scanned or entered into a database, from which they are indexed and transmitted to a portal PDA device from which the owner can review their materials. While the project must account for the usability challenges of an elderly user working with small portable devices, the ultimate goal of this system to allow them to review their personal life history in story form. The goal of this work is as such similar to that of the proposed work in that a user will be able to review a life story from a period or based on a theme of interest, however there are notable differences. First as the system is contingent upon digitized personal artifacts manually collected by the individual, consequently the

quality and coherence of stories created through this system is wholly dependent on the physical mementos amassed and preserved by the individual. It is highly probable that periods, which are significant in their life, may not be represented by an artifact or may be sparsely populated. The solution proposed within this work seeks to automatically collect such mementos and as such would not be prone to such challenges. The system also differs in the approach to storytelling, their approach is to govern the process by complex rule- and case-based reasoning for wholly automatic storytelling (McCarthy et al., 2008) while ours advocates association and intelligent retrieval to enable semi-automatic narratives. However, the work of McCarthy et al. has one advantage, in that it amasses digital representation for significant events over a *whole life* rather than just a subset of several years. This enables it to tell stories for a much more diverse and complete set of life periods.

3.5 Further Discussion

This chapter serves to provide an initial overview of storytelling. Each subsequent chapter gives further review of relevant background material and prior work in digital storytelling. Situated in the appropriate chapter, this places the discussion in context with the relevant material. The following additional discussion will be presented:

- Within Chapter 4 discusses the value of storytelling and methods of constructing a story from personal histories, mementos and keepsakes. This is situated within the exploration of three domains of personal and mediated storytelling: the family practice of memento capture; genealogical practice; and scrapbooking. This furthers the discussion of the role and utility of personal narratives introduced in Section 3.2.3.
- Within Chapter 5 relevant storytelling systems, software and platforms are presented to situate discussion of the tool produced within this research effort.
- Chapter 6 presents a variety of existing algorithmic approaches to the structuring of a multimodal corpus and introduces the methods we employ in to support storytelling in lifelog collections.
- Chapter 7 outlines prior work in story generation and discusses models to achieve this. Formal approaches such as story grammars, planning structures as well as state-based, graph-based, thematic and emergent approaches are all reviewed.

- Chapter 8 explores the evaluation of digital narrative and reviews prior work within the domain to elaborate suitable methodologies. The major dimensions by which narrative output should be evaluated are additionally outlined.

3.6 Summary

Storytelling is an extremely powerful platform for sensemaking and sharing of past personal experiences. Stories help us to recall and intuit our past action, to deliberate future directions and to search for meaning in our lives. They are enormously useful to help understand others and ourselves, to empathise and to introspect. It is not just our personal stories which are powerful but digital counterparts conveying our personal experiences have enormous potential to facilitate such functions, to enable reminiscence, reflection and sharing of past personal experience.

Lifelogs present a rich resource for storytelling and sensemaking about our past personal experience. As discussed in Chapter 2 and as proposed by Harper (2008) in evoking the past lifelog's create "*new values, new resources for narrative and self-understanding*." However, as we have illustrated above, the potential for them to do so has not as yet been capitalized upon. Lifelogging is nascent and while the application of storytelling to these collections has not gone ignored, the studies to date have been probative, early-stage and exploratory. Moreover, they have focused on exploiting only short term collections, missing the opportunity for life stories and narratives of the self to emerge and not capitalizing on the full potential of these long term life stores. There is as such need for deeper exploration.

Christian and Young (2004) note that there has been little effort to verify that the computational approaches for narrative generation align with the expectations of audience and their mental models. For this reason, we next explore how users, their expectations and current storytelling practices might inform our digital tool for storytelling.

Chapter 4

Design Requirements for the Digital Storytelling Tool

Overview

The background literature surveyed notes that traditional approaches and models of narrative often do not lend themselves well to the narration of personal experiences. Moreover, lifelogging is a novel technology and narrative techniques have not as yet been applied to such corpora. It is consequently important to establish how best to facilitate the production of narrative from such multimodal content and how a tool might support this effort.

To establish suitable approaches, we undertook a number of human-centred investigations designed to elicit the requirements for our narrative solution. We present a design case study which identifies the underlying needs for a storytelling tool by probing the current family practices of memento management, the exploration of family history and the authoring of family stories through scrapbooks and albums. Subsequently, we explore through card sorting how narrative might be formed from voluminous and multimodal lifelog content. The results of these two investigations are used in confluence to elicit a set of requirements and recommendations for our storytelling tool.

4.1 Introduction

One of the goals of lifelogs is to allow access to past personal experience to enable reminiscence and reflection. We have explained that such functions can be enabled through storytelling and this is the premise of this work. We seek to provide tool support, or story-ware which would allow a user to author narrative accounts of past personal experiences from the multimodal content contained within their lifelog. Noting the challenges and complexities inherent within lifelogs (see Chapter 2.6), this is by no means a simple task. Moreover, Appan et al (2004) note that commonly employed narrative techniques including models and rhetorical structures, do not apply to the narration of past personal experiences. Consequently, in seeking to

provide such story-ware we first must consider a number of complex questions. These include, for example: What functionality should such a tool offer and what types of stories should it support?; How should a range of lifelog content be brought together to form a story?; What form should this take?; What support should the user interface offer to the creation and ideation process?; and how should the tool support the user in manually and in semi-automatically composing a story?

In order to address these questions and to ensure appropriate solutions for them are provided within our storytelling tool, we sought to elicit a set of design requirements for lifelog-based storytelling and for the tool which would support this narration. In order to expose these requirements, we employed a number of human-centred approaches: we *conducted evaluations* with nine users to explore how lifelog content might be reduced and arranged into storyform; and we additionally *probed current practices* of three 'personas' in the management, organisation and storytelling with personal media. In the previous chapters we have explored the literature relevant to both the digital narrative (Chapter 3) and lifelogging domains (Chapter 2). Within this chapter we build upon this work and draw the background material together with several probative studies we conducted. Each of these methods is discussed and major outcomes presented. Finally and based on the findings from each study, we discuss how they contribute to the identification of functionality, workflows and structures which would facilitate narration in a fitting manner. This Is presented as a set of design requirements and recommendations for a storytelling solutions appropriate to lifelog collections.

4.2 Probing Current Practice

We understand that lifelogs are novel collection and with novel collections a lot of the requirements and domain knowledge is new. This can make intuiting these requirements challenging (Lee & Smeaton, 2009). The discipline of human computer interaction recommends that when faced which such challenges to seek insights from real world users on how that system should be built. By probing practices and methods of task operation, they can provide cues as to how the digital system should operate and the strategies, functions and metaphors it might employ to deliver its functionality. By doing so this ensures the system is relevant and appropriate to the needs of users who might use it.

While lifelogging and the collections it produces are in many ways distinct from traditional media archives, there are many commonalities. By drawing upon communities of practice around current media types we can seek to uncover new understandings and inform the development of a storytelling solution for lifelogs. Exploring the family use of mementos has proved an invaluable aid in designing novel interactive systems owing to the rich insights it can produce (Bowen & Petrelli, 2011; Kirk & Sellen, 2010). We felt this would be similarly the case with our tool. Traditional media archives are used extensively within the context of family life to capture, curate and preserve experiences for reminiscences, reflection and sharing. This clearly overlaps with the three major functions we seek to deliver through lifelogged storytelling.

Families curate a range of personal content to preserve a record of family life. They often have established methods for this. By probing their motivations and practices, powerful insights and deep understanding can be gained. These can then be used to inform the design of digital systems. The work of Daneilla Petrilli exemplifies this (Petrelli, Whittaker & Brockmeier, 2008; Petrelli et al., 2010; Bowen & Petrelli, 2011). Her studies highlight the utility of working with families and the rich understandings that such endeavours may provide. She has explored the in-home use and collection of personal mementos, digital artefacts and physical objects and emphasised how digital systems can leverage this knowledge to produce systems that fully realize the needs of families and typical users.

These explorations can take many forms. Focus groups or participatory design with may be employed in which ideas are presented, discussed and refined (Stevens et al., 2003). Alternatively, the researchers may go out to the home to observe families in the processes of managing and maintaining their personal content as well as reminiscence and retelling tasks (Stevens et al., 2003; Kirk & Sellen, 2010). Observing ‘photo-work’ through ethnographic practice allows behavioural insights and instinctual techniques to be uncovered and identified (Lillios, 1999; Kirk, et al., 2006). Cultural probes (Gaver, Dunne & Pacenti,1999) offer an alternative to direct observation where accessing that environment may be difficult. They often contain a range of recording apparatus which encourages the user to self-report and reflect on aspects of daily life. Novel tasks may also be employed to encourage analytic reflection on the use of media and stimulate new understandings, for example Petreilli, Van Den Hoven & Whittacker (2009) asked family participants to select mementos for inclusion within a time capsule that would at a much later date be explored by their future selves. This

method helped to explore the meaning and significance attributed to many mementos preserved by a family. These probative practices have been used to successful inform the design of several novel interactive systems. These include digital memory systems like FM Radio (Petrelli et al, 2010), Sonic Gems (Oleksik & Brown, 2008), MemoryLane (Kalnikaite & Whittaker, 2011) and Frohlich's Memory Box (Frohlich & Murphy, 2000.)

Explorations into family practice do not offer insights only when working with traditional media formats. The potential to uncover equally rich insights for lifelogs has been unpinned by Harper & Lindley (Harper et al., 2007 Harper et al, 2008; Lindley et al., 2009). Motivated by their explorations, we examined how current family practices could inform the design of our storytelling solution. To do this, three perspectives on momentos and life histories were surveyed. Interviews were conducted as probative exploration within each of these three contexts.

We explored how and why media is captured within the family context. To do this we interviewed a young family. We specifically examined how they chronicled the lives of their young children through a variety of records, mementos, objects and physical artefacts. The preservation of a development record of a young child is a common practice within young families (Kientz, Arriaga & Abowd, 2009) and this, albeit mediated by the parent on behalf of the child, has strong parallels with the lifelogging, as both seek to capture a detailed account of the experiences of an individual.

Next, in order to understand how and why life histories may be explored in the long term, genealogical practice was examined. The heritage-based practices of a genealogist are employed in response to a family's desire to explore the personal histories of their ancestors. They will uncover the artefacts and records they have left behind and distill from these an experiential account of their life. This again has parallels with the goals of our system.

Finally, we conducted extensive interviews with several members of the scrapbooking community. The craft based practices of a 'scrapbooker' seek to narrate experiences from a life through an aesthetically presented album. This transformation of personal artefacts into narrated account and the methods, goals and motivations of the community were deemed extremely interesting to explore in light of the commonalities to this research effort.

Each of these explorations is outlined from a qualitative perspective and the findings are supported with discussion of relevant prior work. Following each case study, we

summarise the findings. Finally the case studies are drawn together coherently into four key strands that will be key to successfully delivering a storytelling tool for lifelogs and the retelling of personal experiences.

4.2.1 Family

The work of Petrelli (Bowen & Petrelli, 2011) notes the importance of exploring mementos in the home context. The home is "*a space created and cultivated as a container of the owners intimate self, beliefs and aspirations* (Petrelli, Whittaker, Brockmeier, 2008)" making it a rich resource for exploration when designing for personal memories. Young families are generally highly active in the process of curating their children's mementos and personal artefacts (Bowen & Petrelli, 2011). This, as such, forms the basis for our initial probe.

We conducted an in-situ interview with the mother of two young children. The mother was asked about the practices of managing and maintaining keepsakes from the family's life. In particular, the parents had enthusiastically and meticulously recorded memories for their first daughter and discussion consequently gave precedence to this child's curated memories.

4.2.1.1 Mementos Preserved

"[We] have her first lock of hair, her first tooth, we have her first pair of shoes from her first ballet... and [...] we have her first readers, we have that, we have that put away, her first drawing, her first painting - which was really kinda good we have that framed ... from school… Her first handprint, and her first footprint. We've that done in clay... we've that done."

The family clearly preserved a great many keepsakes about their daughter's early life. They were very motivated and kept a wide variety of items, objects and records to ensure they had documented both "*little every day things and all of the milestones."* The mementos not only included many of the expected keepsakes traditionally maintained for a young child such as "*loads of photos and videos*", craftwork and ephemera but also included many idiosyncratic objects, such as clay handprints and footprints. Petrelli, Whittaker & Brockmeier (2008) had similar observations and further explores how physical mementos are selected, displayed and managed (Petrelli & Whittaker, 2010). They similarly found a wide variety of objects were collected attributing this to Csikszentmihalyi & Rochberg-Halton's (1981) finding that there is "*an enormous flexibility with which people can attach meanings to objects… Almost*

anything can be made to represent a set of meanings." The range of expressive artefacts gathered by the family can be used to infer a great deal about the early years of their children, and their progress and development. As suggested by Glos & Cassell (1997), these keepsakes represent the whole narrative of that child while Petrelli & Whittaker (2010) note that such keepsakes embody a range of aspects of this developmental narrative. These are maintained as reminders of an important event, signifiers of a relationship, to motivate personal reminiscence, to reference specific elements of identity, or achievements and accolades awarded.

Not only were tokens and objects kept and maintained by the family, but early memories of the children were also chronicled through written records documenting and journaling these experiences in diaries and log books. The father, who stayed at home for a year after their daughter was born, had extensively journalled about the first year of their daughter's life. The mother had also preserved many of the milestone events (first food, first words, first tooth, etc.) in a baby book. The baby book is a structured approach to capturing many of the milestone events, development records and sentimental tokens relating to a child. It a common means of capture these experiences for young family (Kientz, Arriaga & Abowd, 2009). The baby book was ascribed enormous value in revisiting these past memories. Our family commented that the baby book was regularly examined and provided a rich resource for recounting early memories. The children particularly engaged with it, as it was an opportunity for them to see how they were as a young child.

"We have her book, a book a book we did when she was born. On the day they were born, […] who was the president of America, what song was number one, what price was it for a pint of milk, and that sort of stuff, we did that book all out ... what her first word was. She loves taking that out and looking at that."

For the family, this book was a focus for remembering and reminiscence. Discussion of the contents of this book, observed that the family does not just preserve keepsakes directly associated with the experiences of the family. They may opt to include tokens which contextualise those experiences through current affairs, (a newspaper on the day of a milestone event) or which provide cues to the world they lived in at that time (shopping bills or references to popular culture) . This again echoes findings from the work of Petrilli (Petrilli, van den Hoven,& Whittaker, 2009). As Petrilli, van den Hoven,& Whittaker (2009) describe, families will often try to represent the world and society at that moment to provide a deeper insight into the experience

and allow comparison between the moments of the milestone events and the future point when it is reexamined.

4.2.1.2 Storage and Display

The mementos within the family space were preserved in three main ways: archived into a box or store; placed in an area for short-term display; or placed in a fixed location for long-term display.

Within this family most of the child's early histories had been archived into a box and this was placed securely within an upstairs storage space. As the mother described, *"[Its] all put away ... in a box. It's all kept together."* These possessions, keepsakes and objects were stored in a special location; a common practice within family homes (Petrelli, Whittaker & Brockmeier, 2008.) This box house prized artefacts and ensured they were kept safe from damage, decay or loss for their future selves. It also consolidated many of the important tokens of their childrens' experiences into one central repository, making them easier to later refind and locate.

Prized possessions often did not make it immediately into this store but transitioned from use or display in another space within the home. This transition from other spaces allowed their significance to be considered and distilled over time. Within the home, the daughter was given a specific space for to display her objects of current value. "*Her door*", one of the double-doors separating the kitchen and living room, was a dedicated space for that child's craftwork to be displayed. It is typically "*full of her stuff and she'll put it up herself. Art and drawing and painting. She loves making things."* These midway spaces in the home allowed for objects of current significance to be displayed temporarily before deciding if they should transition to archival within the 'memory box', to permanent display on a wall within the home. This is further discussed in Section 4.2.1.3.

Items in permanent or long-term display were mainly framed photos which represented significant events from the family's history and included for example the marriage of the parents, and birthdays of the children. These were primarily displayed prominently within the living room of the home. Being displayed here, they provide opportunity to cue discussion of family histories with visitors to the home. Framed photos were mainly placed on the mantelpiece but were also found on window ledges and side tables within the living room. When attention was called to the framed photos, we noticed that they prompted exuberant discourse about the events and discussion of the narratives behind them. While the living room was a primary display area, other

rooms within the home served different display purposes. As noted in the work of Petrelli, Whittaker, Brockmeier (2008) spaces within the home can range in functional display purposes, with private but significant tokens being displayed only in personal spaces such as bedrooms or rooms not commonly accessed by visitors. Digital displays were present but were far less common that their physical counterparts. They were also less visible and in this case only found within a private space – a study. The family computer was used to display photos through the screensaver. As this was within an adjoining room only accessed by members of the family, it did not serve as a prompt for sharing or discussion unlike with the framed photos.

4.2.1.3 Memento Management and Shifting Roles

"If it was up to me I'd probably keep everything"

There was a real desire to preserve as much as possible. Early on the subject declared "*everything is kept.*" Later it became clear that this aspiration was not practical in application. The amount of storage afforded was limited, particularly in the midway display spaces and this precipitated the regular management and refinement of the family's mementos. This process of periodic spring-cleaning of the mementos is a common activity and is central to their utility (Petrelli & Whittacker, 2010). Petrilli, Whittaker & Brockmeier (2008) call this process *distillation* suggesting that having a compact collection is crucial as a large box is off-putting. Honing the family collections into small compact groups can also make them more emotionally powerful.

No one member was solely responsible for the archiving and preservation of family memories Members of the family assumed different roles within the management and decisions surrounding this distillation. For example, both parents were involved in pruning the contents of the box when it was required. However, the mother has assumed responsibility for the management of craft display areas (midway spaces) and mediated display and refresh of this spaces with the children; while it was the father's "*job to manage the stuff on the computer.*" As the memory box was placed in the an upstairs storage space, it was also his role to facilitate access to it. Being akward to access this space, he ensured that it was safely taken out when needed and put back safely and securely. As a result he mediated access to this memory store.

Surprisingly, the management of the family's mementos and keepsakes was not solely the preserve of the parents. As the children had become older they had become more

aware of the practices and had taken an active stance in the curation of their own content. The children would often cast the deciding vote in the decisions relating to what content would be kept, in particular those relating to their artwork. The door was used to temporarily display for artwork. After a time new artwork would be produced and the old content would need to be either archived or discarded. The mother was conscious that not all artwork could be kept with many pieces often being quite similar. With limited space in the children's boxes, the children would often be consulted to determine what they wanted kept from their school artwork. However, the daughter had recently become much more active in the archival process and was remarked to *"be very kind of hordish like that. She keeps everything and would look for things."* It is interesting that beyond consultation on archival decisions, the young child was actually maintaining objects and keepsakes for possible archival. Even at a young age she was preserving her future memories by identifiying mementos like photos, toys, and personal objects that she wanted to retain.

4.2.1.4 Effortful but Rewarding

Overall, the family felt a strong desire to preserve the early moments of their children's histories in as much detail as was possible. While this endeavour was very rewarding by virtue of the opportunities for recollection it affords, it can demand significant effort and time from the parents in order to do so. An example of this was seen in a diary captured by the father, who at the time stayed home to mind his young daughter. He "*kept a diary of her first year ... every single day... every single day*" for the first year of her life. In it, he noted all of the small occurrences and minor developments in the baby's early months. As this journal was loaded with rich descriptive details of their youngest daughter's early life, it was viewed as extremely meaningful. Recorded in it was a daily account of the behaviours, actions, noises, likes and dislikes and how they changed and progressed over the course of that year. Subsequent to being recorded, it continued to be regularly examined by the family (every few months) and had become a focal vehicle for remembering and reminiscing about that time. There seemed to be some minor regret that it only captured the first year of her life but nevertheless was "*great to have*" and the mother described this as a really valuable account:

"I love going back over that... its very funny, you know, the gurgles and when she starting eating solids, what programmes she loved, and what she didn't like, and what foods she liked and what foods she spat out"

The rediscovery and recollection facilitated by these mementos is '*loaded with emotions*' and opens a '*world of nostalgia, when brought to light'* as Bowen & Petrilli (2011). The statement above very much echoes this sentiment. However, it not only demonstrates how such accounts may be vehicles for engaging recollection but exemplify the efforts a parent is willing to exert to preserve such accounts. After all, the capture of such a detailed chronicle of the child's early life requires thorough, methodical action on the part of the parent. It also highlights the value that they now attribute to this endeavour. Through a continuous record of the child's first year, a life narrative emerged. This described the progression of the daily activities over time and formed patterned expressions of the child's early development. For them, the worth was not in the standout moments preserved in the account but how the moments, the gurgles and the minutiae were connected over time. The value attributed to this record is particularly encouraging for our investigation; both in how lifelogging may help preserve such a record and how our work may help distill such connected experiences into a narrated form.

4.2.1.5 Summary

This interview with the mother of a young family highlights several interesting elements. These findings are further typified in current family practice through supporting evidence from related work. This case study represents a family highly motivated to curate their children's early lives. While the detail with which they did so may be atypical, we believe them to be representative of many of the motivations, activities and practices a young family has in maintaining their family's history. The major findings of this study are now reviewed.

First, we note that within the family not only was it seen as valuable to preserve a detailed account of their lives, particularly those of their young children, but also that they were willing to extert considerable effort to do so. Furthermore, they found value not just in capturing the milestone events but also the day-to-day habitual moments which allowed them to track developments over time. This effortful, detailed and persistent capture aligns with the lifelogging vision and motivates our endeavour to capture a life digitally.

To chronicle their children's lives the family employ a wide variety of methods and modalities. They capture photos and videos along with physical tokens, keepsakes and objects. They also preserve personally created objects, such as the children's craftwork. Content not directly associated with the family may be curated and this

may help contextualise the present for future comparison and understanding. These might include such as newspapers or shopping costs. The plethora of sources employed indicate that our efforts must seek to encompass a wide variety of materials; in order to be successful it could not focus solely on one modality or digital content source. We saw that the members of a family may contribute to the store of personal mementos – in this case the children provided artwork while the father provided a journalled diary of the daughter's first year. Each of the members also contributed to the maintenance of this store. While a single user may be the primary recipient or owner of those mementos, many individuals may contribute to them and maintain a stake in their upkeep and management. This may be a feature worth supporting in a digital environment.

The family's display of content serves to highlight that keepsakes and tokens of personal experiences may have changing value over time. Like the artwork that had present significance, but may be later dispensed as new content is created. A keepsake's value may diminish over time unless it has a unique element or embodies an important milestone. On the other hand, we saw how items like the baby book appreciated in value becoming important objects for recollection and reminiscence. The notion that mementos, and the experiences they embody, may change in value and significance over time is an important factor for digital storytelling and for the digital systems which support such memento management. Finally, this probe notes the importance of making the content accessible and discoverable. Important objects are prominently displayed around the home to invite opportunities for discourse around them. The memory boxes are managed to prevent them becoming unwieldy and allowing their contents to be easily revisited. The ability to quickly access and discover content is essential to recollection around these tokens and sharing the experiences they represent.

4.2.2 Genealogist

As Bell and Gemmell (2007) note, one of the major goals of a lifelog is to "*digitally chronicle every aspect of a person's life*". Their availability in the long term means creates "*opportunity to reflect on what we must remember to be who we are now… But it emphasizes also the issue of how we might be in the future*" (Giaccardi, 2010). Petrelli, van den Hoven, & Whittaker (2009) highlight some of this potential in exploring the intentional capture of future memories and the opportunities that this creates for the family unit to revisit and examine their past. Both Sandhaus et al (2010) and Kirk & Banks (2008) note that this re-visitation of the past is a common cultural trend towards

end of life where physical ephemera may be distilled and organized in preparation for death. Sandhaus et al (2010) explains:

"When we get older, naturally we start looking back on our lifetime, on the important events, the good and the bad days, the many people we met and share our life with. Telling stories is the way we deliver the remembrance to our relatives and friends."

Lifelogs, capturing a life in the long term, also create the possibility for these stores to endure far beyond the individual (Bell & Gray, 2001). These collections could outlive their owner by being bequeathed as heirlooms becoming generational archives of experience. It would be sensible to consider lifelogs as having the potential to become a 'digital heirloom' as it carries with it a strong '*impression of the previous owner* (Kirk & Banks, 2008)." In doing so they would move beyond their original owner and open up opportunities for motivated individuals, most likely family. Such digital heirlooms have the ability to become "*a memorial for the person passing it on and a means by which others might reflect on the life of or relate to the original owner*." (Kirk & Banks, 2008)

With use in the long-term and the possibility to operate as an heirloom, heritage practices for lifelogs are important to explore. One major element of family heritage is genealogical practice. According to Hadis (2002) geneology is "*the kinship relationships that go to form the lineages and pedigrees of families, and the associated data that support their organization, display and maintenance.*" Geneology is centered on the *stories* of family and it is for this reason we choose to probe it to provide further cues for the design of the storytelling system under construction. We conducted a detailed interview with a single geneologist working at an internationally recognized firm in Dublin. The interview enquired into the process involved in uncovering family histories, the methods, records and archives employed as well as the significance of its findings and the gravitas for the individuals who commission the exploration.

4.2.2.1 Process

Many people poorly understand their own past. In such circumstances, they may enlist the services of a genealogist to explore and uncover the details of their family's past, origins and seminal moments. It is the role of the genealogists to help them uncover and recover this information by drawing together a variety of records and sources to create a coherent picture of that family and its progression through the ages. Within the first segment of the interview we explored the methods and practices employed in helping to identify relevant records and details.

There are variety of resources are available to the genealogist including, for example, online databases, historical records, census information, tax records and registers of births, deaths and marriage. While there is a large amount of information available, the subject noted that "*an awful lot of whether you can take someone back or not depends almost entirely on an accident. An historical accident of actually what records survive.*" In essence the genealogical process may require an element of luck. However, to guide the search for information they will apply a number of *"rules of thumb, and that's what you start with to try and work it out. They're very good rules of thumb as well."*

At each stage of the process the genealogist will try to identify an ancestor of the individual. This process often iterates backwards establishing the family lineage further and further back through time, one step at a time. The element which contributes most to the success of this progressive exploration, is the initial information provided to the team. Records can be very sparse the further you go backwards and it is extremely important that the genealogist has as much information as possible to both focus the search and to distinguish the client's person of interest from others. The search "*needs as much corroborative information as possible so you can pick out your [client's ancestor] from the 20 children of the same name who were born in a five year timeframe in the same county."*

Accessing the information can in some cases be problematic if the person is overseas. Where possible, they "*will actually go to the oldest person in the family - 'the repository'."* By doing so, they can get direct access to first-hand accounts which are invaluable to the success of the search. Alternatively, they often try to encourage the client to recount "*the stories that a grandmother might have told a child"* as they can often hold the kinds of details (people, places, timeframes and significant events) to initiate the search from. It was commented with access to these stories or to the oldest member of the family, the past was not too distant and much of the information needed could be gathered in this way.

With the required information established, the relevant resources would be consulted. This is a time consuming and often manual process. Where physical records need to be consulted there may be a long lead-time on access to a required resource. Often only a small number of relevant resources would be found and the information would then need to be pieced together in a coherent way. This occurs *"almost in a Sherlock Holmes sense ... you're applying this kind of rigorous logic and your deducing what you can from the evidence that you can squeeze out of three or four documents and*

working with that." The past is distilled from a large search space into a small number of facts about the ancestor in question, and then these are weaved into a coherent picture of what this individual's life might have been like. This is discussed in more detail later. Yet, even with a good starting point and access to what would be the right resources, this does not always mean success. As explained *"people are individual's you can always have someone who completely confounds the whole thing."*

4.2.2.2 Motivations for Accessing the Past

"For most of our clients they're doing it for a form of entertainment or they're doing it because they've just had a death in the family. But also sometimes a birth within a family, and have become grandparents or great grandparents, then its about building that sense of family."

There are a variety of reasons that an individual may contract a genealogist to explore their family history. The genealogist in question has first had experience of many of these; having worked with a broad range of clients, both domestic and international. For some, it was, as noted above, for entertainment or a frivolous exploration of their own past. They might be motivated to explore it for themselves or perhaps as a gift to another member of their family. They also had much engagement with descendents of emigrants overseas, looking to connect with and understand their own origins and lineage. As Hadis (2002) explains, understanding family histories and the stories passed from generation to generation helps to "*solidify everyone's sense of belonging.*"

For a small number of individuals, this process can be far more impactful. Several clients contracted by the firm were disconnected from their own identities and family histories through tragedy, emigration and distressing circumstances encountered as a young age. A number of such cases were discussed during the interview. Now in late adulthood, these individuals sought to uncover their own identities and reconnect with not only with their origins but often members of family they have never met. As the interviewee, commented:

"…But for people like this who were [separated from their family] its something very very different. It's actually extremely difficult; they're trying to find out about who they are, where they come from they're often dealing with issues of abandonment. They're dealing with issues of feeling loved, feeling wanted, and it goes to the very core of... the person's being."

4.2.2.3 Stories as Key

The motivations for accessing family histories may often be varied, however, in most cases the individual uncovering the past will want to do so in as much detail, depth and richness as possible. They will want to uncover as many generations as possible and as much information about them as they can. In short, the genealogist noted *"people often just want everything… everything that you can give them... and they want you to take [their lineage] back as far as you can possibly go."* This desire for details may motivate the use of a lifelog in such historical and heritage contexts as it would offer the much desired details and an insightful account of the past. However, they also noted that it was not just about the records and data, but also that "*they're looking for any interesting stories."*

Central to the genealogical practice is "*the elicitation, collection, indexing and visualization of stories that are specifically produced by a family (Hadis, 2002).*" The stories that it uncovers are a key component of its output and are extremely important to the clients who have contracted such discovery. For them "*family history is more than just birth, marriage, and death dates, it is the story of individuals' interaction with the community and other individuals*" (Central New York Library Resources Council, 1997).

The genealogist commented on how these stories made family histories more exciting and accessible to those involved. With an eventful past or colourful elements, the family history becomes more much engaging. As she explained, people "*almost want a little bit of a frisson of a scandal. It just kind of makes the whole thing more interesting.*" These stories were not necessarily of pleasant experiences and in fact scandalous occurrences would often be relished. This is discussed further below.

4.2.2.4 Transforming the Past

As noted above genealogical practice, its findings and the family histories it uncovers "*is more than just birth, marriage, and death dates"* (Central New York Library Resources Council, 1997.) In order to produce these stories which are so desired by the clients, the records and data uncovered about the past must be weaved into a narrative. Hadis (2002) states that "*genealogy provides the essential scaffolding*" for this but "*family history fleshes out these facts into a narrative*."

Our subject was painfully aware of this, commenting that "*not just the bald facts of births, marriages and deaths"* could be presented back to the clients in the report. Instead it was important to "*interpret the information*" for the client and provide a "*kind*

of social history" in which the facts of the past and ancestry were transformed into a narrative account. In this account the details of a person's abode, its location and particulars obtained from census information or tax records might be reported as a narrated account to provide a more visceral understanding of things past. Such an account is presented in Figure 4.1. We can see that while it is based on the facts obtained from documents and records such as the members of family who live at the residence, as well as its size, quality and environs, it goes beyond the facts to present a richer interpreted account which is more accessible and humanized. This helps to give *"a much more concrete sense"* of the past by describing what life might have been like for that family.

"Although there were 9 people in the extended Allen family, they also occupied only two rooms in the house, which must have been very crowded. It would also not have been possible to keep separate living, cooking and sleeping quarters. This must have been particularly hard on Elizabeth Boyle and her infant daughter."

"The Allen family themselves lived in a single room. This would have meant that neither Elizabeth nor her 3 sons would have enjoyed any privacy. Similarly, Elizabeth would have had to cook in the same room that the family lived, ate and slept, so there must always have been cooking smells. This exhibits the conditions for ordinary people in Dublin living in tenements. Tenement dwellers lived at the mercy of slum landlords who tried to fit as many as possible into their houses, to maximise their profits."

Figure 4.1 An Example of a Passage from a Genealogical Client Report.

4.2.2.5 Integrity of the Account and Duty to Report

While it is important to transform, interpret and intuit the data into a narrative account, it should be an honest representation of what occurred. Our subject was very explicit on this point. She noted "*you can never go beyond what the record actually says. We're not in the business of building castles in the air."* Simply put, the integrity of the account must be maintained.

While this is a key concern in the presentation of findings, it can be a difficult one. Should painful or upsetting information be uncovered, they could often be torn between this integrity and the upset and hurt it may cause the client to find out. In one particular case, particularly traumatic information came to light and a palpable sense of duty was felt to report this important but distressing information. As our subject explains: "*we can't go beyond the records but in the same way we can't change what happened…and I was the person who actually told [the client] what happened and to say that [the client] was devastated ... but once we had found it we simply couldn't not [report it]."* The past our genealogist maintained cannot and should

not be ignored even if it is painful to acknowledge it. Moreover, the past may be intuited and interpreted but it is of paramount importance that it be an undistorted, unembellished and representative account of the family history.

4.2.2.6 Importance And Affective

"I think its very affective. It gives people a chance of actually find out about ... their past relatives. For most of us you see most of us […] the furthest you know is your granny or granddad, you might have heard stories from your granny about her parents or grandparents. Beyond that nothing is known. You don't know names, you don't really know… "

"I think its really interesting for people when they engage in family history to find enough records that they can begin to understand what the conditions were like and what their ancestors , what the difficult decisions they faced ... and may be it helps them to understand why they made those decisions, why they chose to move abroad, sometimes why they chose to stay."

"In a way maybe they think oh that's why my father was so strict about this or that. Suddenly they might start understanding things about their family…. It gives people a chance to understand where certain ideas or traditions began within their family."

Petrelli & Whittaker (2010) note that often our relationship to our ancestors make a contribution to our sense of self and identity. This relationship is formed through stories handed down, heirlooms or ephemeral objects representing the family histories or the individuals themselves. As the genealogist notes and further supported by Rosenbluth (1997), besides this sense of connectedness, the family histories evidence traits we may have inherited or aspects of the family life which may have been engendered by them. They can aid understandings of where important elements in our life are rooted such as ties to places in the world, activities that have special meaning or actions which have special significance. Hadis (2002) remarks that these family stories "*bestows the benefits of identity, guidance and enrichment.*" As a result, these stories can be extremely meaningful and significant to the individual. The genealogist commented on how rewarding their discovery can be and *"what it means to families. It means a hell of a lot to them. […] They feel... certainly where a case has been successful... they'll feel that you've done something really special for them. "*

4.2.2.7 Past is not always Pleasant

"I often think that sometimes maybe its almost better to have a nice stable family who maybe nothing much happens but you don't have like huge number of deaths in the family or you don't have an early death of a parent or bankruptcy or suicide or any of these things. But people do like to have stories about their family."

As discussed above and as Sandhaus et al (2010) note the family histories are made from both "*the good and the bad days*" and it is important to be mindful of this when exploring the past. The reality of the past often breaks perceptions and preconceptions. "*Often [clients] will get a very different picture. [They'll realise its] not this sort of pleasant, nice olde worlde.*" In both the recent and distant past, families often suffered enormous burdens, Many of the cases encountered by the firm tackled these harsh realities, uncovering the emigration and separation of families, poverty, famine and many other challenges of bygone times. To be confronted with this stark reality can shatter illusions held of a charming world of days gone by.

The reality however can help the individual to better intuit their own past and give a more concrete sense of who and where they came from. Stone (1988) comments that even in these tough tales of harsh times, or incidents of ill-repute, scandal or suffering can often "*offer coping strategies as well as stories that make everyone feel better."* Even though theses stories will concern enormous hardships and obstacles, the ancestors involved will often have overcome them, and these family histories can be viewed as stories of courage, survival and hope (Rosenbluth, 1997). They can serve to offer inspiration, encourage and guidance to their decedents.

This is not true of all circumstances. Sometimes the disgrace or disaster can be too scandalous or uncomfortable. In some circumstances deeply unsettling or taboo elements of family history can be uncovered. This had occurred only in a very number of a small number of cases the firm had taken on, the details of which will not be discussed for obvious reasons. The impact, however, was discussed at some length. *"The other side of it is this where you have those really really difficult family stories and no amount of passage of time is going to ease that."* In such circumstances the discovery of this information can have devastating impact on the individual. Even if it is in the distant past, bringing it to light may force the individual to challenge and confront elements of their own and their family's identity. This can, as our genealogist remarked from first hand experience of its impact, be "*devastating*" to those concerned.

While such incidents will be a rarity, nevertheless, the possibility for them to occur must be acknowledged and when exploring the past we should be mindful of the potential for such discoveries. A tension between the desire to have intrigue and scandal and the nature of those incidents is therefore struck.

4.2.2.8 Summary

“I really enjoy what I do but I'm very aware that these are real people's lives. Just because they're in the past it doesn't mean that people don't exist in any lesser sense just because they're not alive. I think it’s very important to be able to interpret why things happened maybe why hard decisions were made but to give the family's who are now looking to understand what happened in the past and to kind of make connections with their family. I think it’s very important that they have as full of a story as you can give them.“

Within this section we have outlined the probative exploration of genealogy and its significance in the context of family stories. The focus has not overtly been on the heritage practices for discovery but instead on the meaning and significance of these personal histories resulting from their uncovery. Importantly, we note that despite the impact it may have on identity and sense of belonging, many people poorly understand their past. Histories and stories are often not maintained by the family themselves for a variety of reasons. A genealogist will help them recover and access these ancestral histories by consulting records about those individuals and the times they lived in.

An important component of this process is the transformative element of converting the uncovered data from documents, annuals and records into meaningful accounts that resonate with the client. The genealogist will provide a narrative account which richly describes the life and times of the individual to try and provide a greater sense of what daily life entailed. They interpret the data but are mindful to never go beyond the facts themselves.

These uncovered histories and family narratives have gravitas. They help the individuals better connect with their own past and help them form new understandings about their family, its behaviour and its values. It also helps them place their own identity within the context of the family’s lineage, giving them a much greater sense of who they are as a person.

Finally, this probe highlights that it is important to remember that peoples lives are not all pleasantries. Serious, scandalous or undesirable elements may be uncovered and there are consequences to exploring them. We must be respectful of these components of the family narrative and be mindful that they might be present, as if encountered could be highly upsetting and distressing. This underpins that lives long since lived can have massive gravitas for individuals living today.

4.2.3 Scrapbooking

Our physical mementos are often poorly labeled and their meaning and significance may be lost over time, and with them the stories they embody. This is no less true, and in many cases worse, for digital media (Rodden & Wood, 2003; Whittacker, Bergman, Clough, 2010). Curation of this content helps, as Petrilli notes, to 'distill' out the important elements and create mediated accounts of the significant experiences. One such curational practice often seen within families is the creation of scrapbooks or photo albums to preserve meaningful objects, keepsakes, trinkets and media within a single resource which can be revisited later to recollect and share memories (West, Quigley & Kay, 2007).

The creation of these physical scrapbooks has however has '*evolved beyond the basic hobby of pasting newspaper clippings, magazine articles and photographs in books*' (West, Quigley & Kay, 2007). Scrapbooking has grown in prevalence and is now steeped in artistry and craft. As Demos (2006) describes scrapbooks are "*carefully put together using archival quality materials, sophisticated layouts and polished graphics. Scrapbooks today usually include photographs, memorabilia, patterned papers, embellishments, and journaling either handwritten or computer generated to tell a story. In these new scrapbooks, pages represent not only a life event, but also a considerable collection of solid and patterned chapters and an assortment of unique decorative embellishments.*"

Medley-Rath (2010) acknowledges scrapbooking as "*a modern narrative form used to commemorate the lives of individual people and families.*" Members of the community chronicle their family's lives through the patterned expressions they create. To do this, they intermingle the preservation and management of family memories with discovery and heritage practices around family histories. For this reason, in our final probe, we explore the creative practices of the scrapbooking community in curating, discovering and authoring their family histories.

We conducted an interview with an owner of a scrapbooking store within Ireland and a leader in the community who regularly organized and lead scrapbooking workshops. Subsequent to the interview, we conducted informal observation at an instructor-led workshop and interviewed several attendees who were members of the community. This community is overwhelmingly comprised of middle-aged females and according to the scrapbooking fact-sheet: "*98% female, 85% Caucasian, and 63% are married with children living at home*" (Reid, 2008). The workshop attended was similar to the 'crop sessions' described by Demos (2006) who conducted ethnographic observation with this community. At the crop sessions, she saw "*women gathered to work on individual memory albums for several hours and shared ideas and conversations about special occasions and everyday life*". This was very much the case in the workshop which we attended. It was a gathering as much about learning new techniques and layouts as it was as forum for sharing, discourse and socializing.

4.2.3.1 Community

There was a palpable sense of community among those who attended the workshop. Scrapbooking not only offers them a personal and recreational pursuit but a sense of belonging within this wider community: "*Obviously you work on your own but that's the thing about scrapbooking, it's a really sociable kind of a hobby."* Members of the community regularly return to the workshops viewing it as a social opportunity as much as forum for learning and creativity: *"you meet the same people and they love to come along. Its really very much about people and meeting people."* Through the workshops they were able to meet like-minded individuals and form friendships. A sense of kinship was felt between the members of the community through their shared hobby, with one participant noting that they "*tend to have something more in common."* Many of the community commented that prior to scrapbooking they had no other social outlet having focused on raising their family. The social element of the workshops was therefore viewed as enormously rewarding and enabling.

"I got married I had kids and there was nothing someone of my age could do to meet people socially. It's a way of getting out of the house, coming to meet women of our own age and have a craft that we all have in common"

It is important to note that it is not about time away or escaping from the family, but rather a rewarding and personal endeavour which is firmly grounded in the family. Demos (2006) notes that scrapbookers have a clear passion for preserving family memories and during the workshops often "*eagerly showed their endless enthusiasm*

*and pride as we poured over scrapbook pages during interviews (*Demos, 2006)." This was similarly the case in the scrapbooking workshop we attended with one describing how they "*love to come together and tell their stories...They will create things at home but the whole thing is that you would bring that stuff with you the next time you meet up."* Scrapbookers will use the opportunity of the workshop to showcase their latest creations. They are very open to discussing not only the compositions but also relished the opportunity to share, retell and discuss the stories behind the creative endeavours. The kinship felt between the members of the community is fostered by this exchange of family stories. Through the narrated accounts, it invites them to gain deeper insights, form empathetic understandings and strengthen social bonds between each other. This dialogue also facilitates the sharing of ideas. By inviting others to view and discuss a created work, it enables other members of the community to observe the creative strategies and visual approaches have been employed and seek inspiration for their own compositions: *"I might look at other peoples' [albums] and think 'that's fabulous I'm going to copy that idea."*" Visual strategies that have been employed with success by others may then be emulated or adapted within their own compositions. Regardless of the quality of the albums created or stature within the community, there was enormous pride felt by the novices and leaders alike about the family memories they had curated and the members of the community were respectful of the meaning and significance these compositions had: *"It doesn't matter [what you might think of the layout] they're proud to show them and they're delighted and that's all that matters."*

Figure 4.1. An Example of a Heritage Layout

4.2.3.2 Motivations Steeped In Family Heritage

"A lot of people get into it because of birthdays somebody's having. It might be a once off and they'll never do it again some people get into it because maybe somebody's died and maybe they want to remember them. They want to get all their history together. It's really a celebration of somebody's life for whatever reason you do it."

There are a variety of reasons that individuals might take to scrapbooking and this was the subject of early discussions with many of those surveyed. The motivations might be as simple as "*you just want to do something different with their photos*" or could be more deeply rooted in the loss of a loved one that they seek to commemorate. Regardless of the motivations, scrapbooking had become a highly rewarding and "*very therapeutic*" leisure activity for almost all involved. As one individual proclaimed "*I find it very relaxing just to be left sit with my photos and think about my stories. It's my way of relaxing.*" It was viewed as a way to unwind, take stock and reflect: "*You're using a part of your brain that you let go idle five days of the week, you can be thinking about all sorts of things*."

While scrapbooking may be motivated for a variety of reasons, several of the more active members of the community all mentioned a common stimulus – a desire to curate their own heritage. Several scrapbookers mentioned having inherited photographs and content from their family following their death. After examining these heirlooms and mementos, they noticed they contained no information as to their significance and no descriptive labels to discern who or what they were about. Having inherited these mementos disenfranchised from their past, they were struck with the importance of maintaining their family history and managing their own mementos with inheritance in mind. This not only motivated them chronicle their own lives more richly but, where possible to uncover and preserve the family histories so they would not be lost.

"My granny never left notes on her photographs ... I found a bunch of photographs going back to the turn of the century… They're in very good condition but there's no indication of when they were taken or who they were of... That's what started me off: Why didn't someone write it down even a simple note on the back [to let] you know what date it was taken or why ... That for me is what scrapbooking is all about; putting snapshots of your life down on paper."

They commented that "*if you've lost somebody like your parents or something like that, you want to be able to sit down and immerse yourself in their life. You go find out the stories about them and then sit with a pile of photos and walk through them. Immerse yourself in them completely.*" Those who had inherited unlabelled photos and mementos from their ancestors were motivated to uncover these lost histories. They were inquisitive and asked their living relatives about this past and actively sought out the stories about the photos or content they had been bequeathed. They felt a duty to

ensure anything they discovered was preserved and often dedicated an album to heritage activities. This album allowed them to revisit and connect with the distant past. Scrapbooks enable this immersion by creating highly expressive and affective accounts of past personal histories, events and happening. They offer "*a way of bringing people back to life*" By giving "*a voice to your ancestors. They walked the streets before you did. You think you're important now but they were just as important. For me, there is a certain amount of that - telling their story."*

As Medley-Rath (2010) asserts a scrapbook is a modern narrative form used to commemorate the lives of individual people and their families. As with the histories uncovered through genealogy, they can be equally impactful, hugely meaningful and inspiring.

4.2.3.3 Heirloom and Inheritance

Scrapbooking emphasize the curation of past memories and family histories, but often the scrapbookers equally cast an eye to the future use of their albums and creative works. They are aware that the albums they create form a "*heritage gift [they will] pass on"* to their children. Cognizant of this, they may regularly prospect about its future use, creating the albums with this in mind and preserving memories which may be significant to those that will inherit the albums. This has overlap with many of the ideas of intentional capture of future memories discussed by Petrelli, van den Hoven & Whittaker (2009). The scrapbookers felt it was important, especially given the heritage concerns they had encountered themselves, that they leave a clear record of the family history for their children so that they would not face similar problems.

The scrapbooks were viewed as a way to communicate the past to their loved ones in a way that can be accessed even after they were gone. *"A lot of people [make scrapbooks] of themselves because they want to leave something behind so that their kids will remember the person that they were."* Doing so in a scrapbook was described as *"better than just writing it all in a diary"* as the photos, flourishes, labels and annotations served to provide a more meaningful, expressive and enjoyable form with which to communicate their experiences. Not only was a means to preserve the memories of importance that might otherwise be forgotten, but it was also seen as a way to speak to their loved ones even after they were gone. The layouts created could be crafted to offer advice or learnings from the past and they were hopeful that it would be impactful: *"I guess scrapbooking is my way of…telling [my children] the stories and giving them advice."*

Albums were also often created with an intended recipient in mind. For example, a common trend was to have one album per child: "*I have one for both my girls. I have one for each of them.… My kids will have this."* They were hopeful that the heirloom would be valuable to their children. Some commented that they would enjoy it if their children continued the curational process: *"So when I give it to her, she can add to it if she ever gets to the stage where its something that she enjoys doing, she can add to it or not or she can just have it."*

4.2.3.4 Treasuring the Past (Chronicling and Collecting Stories)

Motivated both by a desire to chronicle and understand their own family's past and to leave a clear record as an heirloom, many of the scrapbookers had become much more active in capturing and preserving a record of daily life. This active stance in capturing and preserving a record of family life stemmed from a new appreciation of the everyday as well as a deepened awareness of what value the day-to-day experiences may have. Medley-Rath (2010) comments this awareness leads some to consider the day-to-day experience in terms of its 'scrapworthy' appeal.

As scrapbookers immerse themselves in their craft, they "*start to treasure the everyday stuff more" as it "makes you look at your everyday life and see that it's just as special as the special occasions. That's what it's done for me."* In a sense, scrapbooking can begin to structure their lives (Medley-Rath, 2010). It encourages them to more actively and more regularly capture records of their family's memories and everyday experiences, and may come to structure their lives. Reid (2008) discusses how the process of keeping scrapbooks motivated some to take pictures of their family *"so that none of the sections 'lagged behind' the others."* Medley-Rath notes that some will no longer leave the house without a camera being very reticent to miss one of these moments. One participant affirmed this commenting that *"I find myself shouting and roaring '*Get the camera quick*' because these are the moments that are going to be special."* They feel a desire to record their lives whenever possible, even in the most innocuous of moments: *"You're can be standing looking at something really simple and you say to yourself 'I have to write this down'"* In preserving the families past, they collect vast quantities memorabilia, mementos and supplies, with one exclaiming: "*I've go so much. I've got rooms of it. I've got pages of it. It's ridiculous." While another commented "I have boxes of ticket stubs for layouts that I've planned to do."*

With a new appreciation many will "*scrapbook on a kind of an everyday basis*." One individual noted that "*everyday [her family] are doing stuff*" and she keen to

incorporate as much of this as possible into her scrapbook. To coordinate this, moments of importance were often immediately noted as well as the ideas for potential layouts around them: "*I try and have a piece of paper on the fridge [ready to note] a one liner if the kids say something funny or whatever.*" In addition to noting the scrapworthy moments as the occurred, the scrapbooker often consulted the family about elements to identify elements which might be incorporated. For example, one scrapbooker regularly asked her children what their favourite things at the time were, favourite subjects at school or best friends of the time. She felt that this was important to the curation process as it gives cues to *"who they were at that stage of their life… I like to ask them every now and again what it is that they like" … "Each year you'll watch it changing.*"

Scrapbookers treasure these simple stories about the past. They will actively collect such stories so that they might like to be retold in the future. They also weigh and consider the items that people value should they revisit those experiences in the future. They draw out the underlying stories, probing the salient details, in order to draw together a richly woven account. Much of this is supported by a curious and inquisitive nature. As part of their process, they incorporate much of the genealogical 'detective work' of discovering and uncovering the past. In particular when exploring their heritage, they adopt many of the practices seen with the genealogist. They would go to the members of the family and actively ask questions about the past, gathering not only mementos and facts but the stories behind those events. One individual explained that *"it's really important for me not just to find out when and where it was, but to ask something funny they remember about that day. That's when you come out with the stories that are important."* Their inquisitive nature was complimented by a sense of duty to the past. In uncovering the family history, they felt obliged to preserve them. *"You can find out a lot about people but then its up to you to remember it. For me, I do I try and remember what they've told me so I can put it down [in a scrapbook]."*

Scrapbookers actively curate the past. This in many ways echoes the desire of lifelogging to capture a detailed and complete record of past personal action. Their lives can become structured around scrapbooking and in the cases where it does '*nearly every aspect of their life becomes either scrapworthy or not scrapworthy*' (Medley-Rath, 2010). They gather the stories, supplies and mementos in support of this and intermingle a family's memento management with the discovery processes of a genealogist. They treasure the scrapworthy experiences, be they significant moments in their families lives, the everyday experiences, or their ancestry and

heritage. This preservation empowers their possibilities for creative endeavour, giving them content with which albums may be created on a variety of family memories and histories.

Figure 4.2. A Layout produced using a kit of papers and embellishments for 'Back to School'

4.2.3.5 Scrapbooked Albums

Scrapbooks are albums which contain a series of compositions arranged as pages in a book. Each scrapbook, or album, maybe be organized around the family as a whole, dedicated to an individual or centered around non-linear themes such as vacations, birthdays and other events. The layouts each album contains may concern a variety of accounts. They may retell everyday experiences such as a day spent in the park; capture the significant life events like a births, birthdays, weddings; or personal milestones such as a first day at school or notable achievements. In this way the scrapbook is not any different from the traditional family album, which constructs an idealized account of family life (Demos 2006, Downs 2007.) It is however distinct in the craft-based and creative nature of the compositions and the effort exerted in their creation.

Albums are often focused on a theme or individual so the layouts they contain are often purposefully crafted to suit that central theme. When complete is it simply added to the appropriate album: "*I have an album for heritage so whenever I do a heritage thing it goes into this album.... you just keep adding to the right album."* A story of a

significant event or happening may in cases span several pages within an album. Each page contains a distinct focus and each contributes to the whole. Typically a story will not span more than two layouts so that they it be organized as facing pages (see Figure 4.3.) In the following subsections, we discuss the composition and arrangement of a scrapbooked album in greater detail.

4.2.3.5.1 Templates and Themes

The workshops were instructor led and showcased approaches which might be taken in composing layouts for their albums. The instructor would provide all of the required scrapbooking materials including papers and embellishments and the participants at the workshop would apply them to their own personal content. This was seen as way for the participants to get through a year's worth of content facilitated through the layouts taught by an instructor. As a result of the workshop many stylistically similar layouts might appear across albums of the attendees. Moreover, scrapbooking supply stores provide kits with seasonal papers and embellishments. These may be bought by many within the community and applied to their content suggested ways. Templates and reuse are consequently important components of scrapbooked layouts.

Although it sacrifices creativity and personality, the templates are of high quality and general provide expressive embellishments and papers to create a rich layout. Additionally, templating is as an efficient way to create layouts. *"Its very quick as well you could take a box of photos and you could have them done in a week if you did a template. If you're constantly changing the layout each time and trying to come up with a new layout... it could take you forever."* Novices to scrapbooking will typically use templates to help them create compositions until such time as they are confident enough to trial their own approaches. Even skilled scrapbookers will follow the template demonstrated in the class, however they will normally adapt and customize it to suit their own tastes.

While proficient scrapbookers will favour adding their own personality and creative flair, it was acknowledged that the use of templates may have advantages when dealing with certain projects, particularly family history projects. The instructor of the class opined, "*if I was doing a family history class I would recommend that people do a template. Because very often you're dealing with large amounts of information large amounts of photographs,*" It would be too time consuming to create tailored layouts given this volume of content.

4.2.3.5.2 Composition & Aesthetics

While templating will provide a guide to achieving good balance and aesthetics most will want to apply their own approaches. The aesthetic chosen is designed to suit the topic of the story – for example a heritage story of great grandparents might adopt browns and sepia tones, while a layout concerning a young child might adopt a bright, colourful and playful aesthetic (see Figure 4.3). Design and photograph concepts were seen as invaluable guides to achieving a good aesthetic composition. The rule of thirds, the golden ratio and grid layouts, many of which are described by McCloud (1994), were all noted to be key strategies for scrapbooked compositions. Templates may, of course, be used to remove the need for such considerations. Emulatation of successful layouts found in other media was seen as a useful way to guide the creation of scrapbook layouts: "*Like how people layout a magazine is very similar to how people layout a scrapbook. I'll often look at ads in the paper I've seen and go how did they come up with that layout you know or I could copy that now."*

"Sometimes I take a picture out and I go 'Oh I've got a piece of paper that would go perfectly with that.'"

When commencing a layout, a scrapbooker would often identify a photo or memento of interest and use this as the focusing element for the aesthetic. A desired aesthetic, colour and mood would be established to compliment the item and then appropriate papers, typefaces and embellishments will be chosen to support that appearance. By "*matching the paper to the colour, the font*" the visual appearance becomes coherent to the focus of the story and helps communicate the experience. To achieve their creative vision, they will often spend a great deal of time sourcing the right materials and adjusting the media to suit the desired scheme. Photos may be painstakingly restored through tools like Photoshop, may be cropped, resized and adjusted. Lettering may be hand cut for inclusion in the layout and notes may be carefully handwritten. This effort adds to the reward and the more laborious tasks such as cutting out lettering can contribute to the therapeutic quality of the hobby.

As illustrated in Figure 4.3, the colour, paper, patterns and embellishments employed may not be limited to a single layout. Related experiences are often located near, if not opposite one another, and the visual style applied to both layouts is often used to establish coherence between them. While the layout does not necessarily need to employ identical flourishes or papers, the use of similar colours or patterns helps to underpin their relatedness. Figure 4.4 shows a small custom crafted album about a

European trip. It integrates a variety of mementos, photos and memorabilia as well as patterns and background elements coherently. It does this by employing a clear visual aesthetic consistently across all pages of the album.

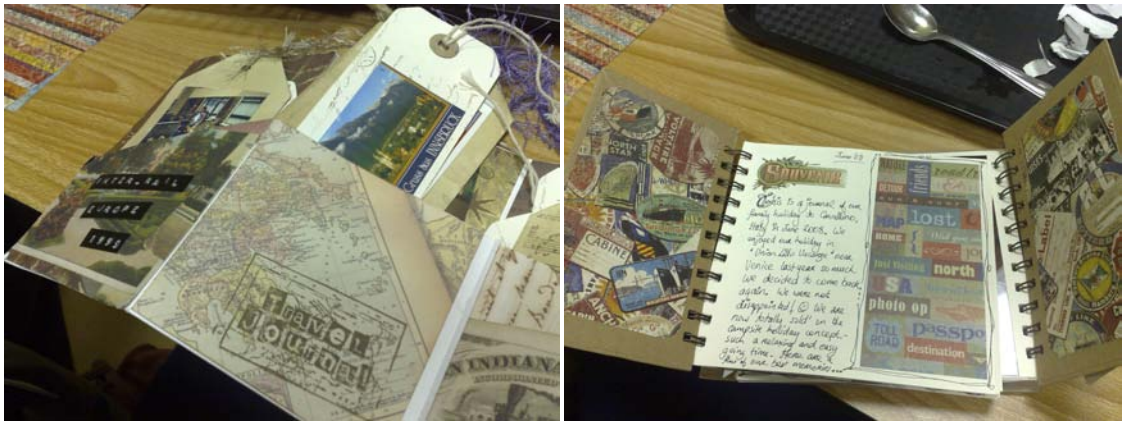


Figure 4.4. A custom album for a European trip, containing 'private stories' as well as expositional labels.

4.2.3.5.3 Well Considered Layouts

The preservation of family memories through scrapbooks is a carefully organized, planned and prepared activity (Demos, 2010). This corresponds with the effortful distillation and management seen in family practice. All elements of the creative composition were carefully considered by the scrapbookers, from content to positioning, alignment and aesthetics. They layouts were sometimes painstakingly trialed prior to committing to a final arrangement: *"I like moving things around…I wouldn't stick anything down until I was absolutely sure it was exactly where it should be."* In particular, they emphasize the visual arrangement of the content for form and aesthetic balance: *"I spend a lot of time thinking about what way I want it. I like it to be balanced… I'd have an eye for photos and stuff and how they're balanced. I take that to my pages."*

4.2.3.5.4 Captions and Labels

As many of the scrapbookers had inherited photos and content from their family without any other information, they were painfully aware of the need to label and describe the layouts and the content they contained. They do this to provide exposition to many of the people, places and activities illustrated by the layout. Captions can be included through printed labels, handwritten labels or handcut letterings applied as embellishments. These captions might not always be authored but meaningful content such as lyrics, poems or songs might be employed: *"You'll find a quote to match you layout if you want. Or some people use words of songs that*

are special to them. Or poems that are special to them as well. Songs are nice.“ Examples of descriptive elements can be seen in Figures 4.1, 4.2, 4.3 and 4.4, and their adoption within most layouts highlights their importance in retelling and communicating the experience visually.

The descriptive labels applied were not however always designed for general consumption and could be applied at a variety of granularities. Private messages and stories were common in one of the scrapbookers layouts. She describes these as “*secret stories*” designed to hide “*private stuff I won't let people know is there.”* These “secret stories” may be included as captions on the reverse of images, pullable strips used to reveal something or integrated pockets which house mementos, keepsakes or further content (see Figure 4.3). They are designed to give extra and more personally significant details on a particular aspect of the story. They can be targeted towards a future self to provide reminders of personal components of the experience that they would prefer not to reveal to all and sundry or they be used in a heritage capacity to articulate details of the experience to those who might inherit the scrapbook. This allows the stories contained within the layout to operate on a variety of levels. To the casual viewer, it gives a sense of the experiences but for those afforded by the author, the hidden captions enable much deeper exploration and a more personal retelling of the experience to be recounted.

Figure 4.3. Examples of how the aesthetic may be used to not only emphasise the experience, but also to create coherence and unify several related layouts.

4.2.3.5.5 Staging And Signposting the Experience

Scrapbooking comes to structure their lives (Medley-Rath, 2010). They spend large volumes of time thinking about the compositions they may create and this has impact on how they negotiate the world they live in. They consider how the everyday may be composed and may visit places purely for scrapbooking purposes. They regularly contemplate as to what may be scrapworthy about their experiences (Medley-Rath, 2010).

While engaged in significant moments, they actively consider how they may represent and compose that experience within their albums. Knowing that they will curate an experience may influence how they live it. One member discussed how they might wish to capture content they would not other wise to ensure they could "*signpost the experience*" in their layouts. They explained why they might stage some of the content:

"When I go on holidays... I would take the build up photos to pad out the story, so people can actually understand. Like in a book or a movie, it doesn't just start with the photo of the thing itself, it starts with the build up photo - a photo of the road signs... like [destination] this way, the plane or the note before that says 'taking off in an airplane'. Rather than me writing down 'we went off on holidays on Tuesday', they can actually see and experience it."

4.2.3.5.6 A Work in Progress

Most of the albums were seen to be "*a work in progress, always on-going*." While they might have a central focus, often layouts were added to the albums ad-hoc. Being a creative pastime, layouts may not have been planned for inclusion and impromptu creation may be spurred by happening upon media of interest. These layouts are added to the most relevant album even if they are not premeditated. As a result the albums and the stories they contain continue to evolve and reshape overtime as each new composition is completed and added.

The continual addition to an album may lead to the emergence of related sub-themes. As the content grows over time, these sub-themes may solidify into coherent groups and may precipitate the need to establish an album on its own for this topic. One attendee at the workshop, who reasonably new to the hobby, explained how she now had two albums; one for her family and one about her daughter. As her collection of compositions had expanded, she noticed a large number of layouts related to her daughter and moved these from the original album about her family to a dedicated

album. She also commented that by removing the content about her daughter from the first album it had unintentionally left a number of blank spaces throughout which needed to be revisited and filled. For a variety of reasons, the ordering, organization and layouts contained within an album may be significantly pruned and adjusted as time goes on.

Layouts may be revisited to ensure they are sensibly organized and positioned relative to related layouts. This helps to maintain coherence with the other adjacent layouts. They are not only revisited to adjust their order and sequence within an album but the compositions themselves may also be modified to ensure completeness. This may occur where the scrapbooker realizes a an important element or description may have been omitted at the time: "*If you didn't put something down at the time, you might just go back … add it later on when you remember.*" Revision is also an opportunity for improvement of the layout too. Layouts are seen as very malleable and could be reshaped and re-envisioned as time progressed; either as a result of a new perspective on the experience or as a new suitable creative approach has been devised.

The only obstacle to rework was time and as one scrapbooker commented: "*You don't always get time to indulge yourself in all this stuff but when you do you come up with a million things you want to do.*" Many aspired to revisit their layouts to revise and improve the aesthetics or arrangements employed; however with many new experiences and memories preserved they favoured creating new compositions of experiences not yet curated in a layout: "*Maybe I'll never get around to it but you hope you will eventually. Maybe in my retirement.*"

4.2.3.6 Summary

Scrapbooking is a modern narrative form which at its core seeks to commemorate and celebrate the lives of family members. It can be motivated by the passing of parents or grandparents, who bequeath a plethora of mementos, unlabelled. This stimulates a desire to preserve and curate not only the heritage of family histories but also to record and chronically the present. Many saw the albums they created as a generational artefact that would be inherited by their loved ones. Albums might also focus on curating the lives of the individuals who will inherit them.

The albums may contain a variety of experiences including the significant milestone events of a life, through to everyday moments. The albums are expressive forms through which these stories may be retold. They incorporate patterns and papers,

decorative embellishments, mementos, keepsakes and media fragments labeled to richly describe the experience which tool place. The aesthetics and arrangements are informed by design and photograph principles. These are carefully considered; often trialed for long periods before they are committed to an album. To expedite the curation of family histories through scrapbooked compositions, templates may be employed. Templates and approaches are learnt through instructor-led workshops but the community often share and discuss compositions amongst themselves thereby disseminating ideas. Inspiration for layout approaches may be found outside the scrapbook community in printed adverts or online.

The hobbyist activity is normally conducted at home where they will have their own private room or workspace dedicated to their hobby. The completed layouts will then be brought to the workshops as an opportunity to share. In the home, and on a daily basis, the scrapbooker will actively curate the ongoing past by taking note of memories they would like to scrapbook; photographing and recording everyday and significant moments; and by seeking out and discovering their heritage from extended members of the family.

Scrapbooking memorializes the lives within a family and in so doing combines both preservation and heritage practices to curate those experiences through creative, craft-based compositions.

4.2.4 Summary of Findings

Within this section we have presented three probative studies conducted within the frame of family mementos and histories. We explored the memento management practices of a young family, the exploration of ancestry and family history through genealogical accounts; and the craft based practices of hobbyist scrapbookers who transform mementos into authored, creative and expressive accounts. Across these three practices there has been a great degree of commonality.

The family and the scrapbookers both seek to *preserve* a record of the past so that it can be later revisited for recollection and reminiscence. This desire to actively record both the seminal and everyday motivates the use of lifelogging technologies to passively record life experiences for later reuse.

The genealogist and the scrapbookers endeavour to *uncover* the past and to expose hidden histories so that they may be remembered and preserved. Family history can

be impactful and rewarding. It can provide many learnings and help to understand ones identity. This *discovery* of family and past action means that important stories can pass to generation, be curated and maintained. Discovery within a lifelog and the content relevant to them will be important to facilitating narrative composition.

With the family, the genealogist and scrapbookers, *narration* is central to enabling explorations of the past. The family context demonstrates that this should occur as a *curational* process where content is distilled to the mementos of most significance, so that such narratives may be more easily accessed. The genealogical perspective underpinned the importance of transforming facts and information into experiential accounts. Finally the scrapbookers, showed how mementos and media can be curated as aesthetically-pleasing compositions which transform the media fragments into something expressive and meaningful.

Finally, all of these practices were seen to be effortful. Despite being labourious, the curation offers many *rewards*. The family highlights how it empowers recollection and reminiscence. The genealogist underpins the impactful understandings on self and identity which can be facilitated. The scrapbooker demonstrates the opportunities for retelling, social exchange and discourse these stories may create.

These four elements (preservation, discovery, curation, reward) are key to the provision of narrative from a lifelog collection.

4.3 Examination With Experimentation

A deeper understanding of current practices around physical storytelling and memento management afford us some insight into the considerations present in the development of digital tool for lifelog-based storytelling. However, it is clear from Chapter 2 that lifelog collections are distinct from traditional media archives. They are voluminous. They provide a very detailed account of experiences through data. They not only incorporate traditional multimedia sources but have a range of content and contextual sources. Most importantly these collections tend to be unmanaged by the owner. As a result of these distinctions it was deemed important to establish how lifelog content may be managed and narrated in practice.

Given that a lifelog contains a wealth of content and context from a range of modalities, it is important to consider how to select the most appropriate content to the story and how to integrate this multimodal content into a coherent, aesthetically

pleasing presentation. This is a particularly challenging task and to explore it, a card sorting activity was conducted with nine lifelog collection owners. This card sorting activity in many respects emulates the compositional style employed by scrapbookers to curate and narrate accounts of past experience. Card sorting therefore lends itself well to investigating how lifelog content might be similarly authored. Participants were asked to arrange, select and reduce physical representations of 'artefacts' from an extended lifelog collection to produce a multimodal story. The goal of which was to observe the behaviours and practices employed by the participants in this effort and to establish if the methods observed in current practices extended to these more novel collections. Conversely it also provided opportunity to explore how practices around lifelog content might diverge and what new considerations and factors were present when employing such collections. It was also used to exemplify how a large corpus of information might successfully organised in physical practice and thereby how it might be performed computationally.

4.3.1 Background

The approach taken was based on the work of Lee at al. (2007) who examined the reduction of image based lifelog content. Their goal however was not the provision of a narrative form for such content, but rather the provision of good memory cues to a person suffering from Alzheimer's disease. Within this study, they utilised the Microsoft SenseCam, as a passive photo capture device (Gemmel et al, 2005). Their participants were instrumented with the device for a short period, following which they were asked to engage in a card sorting activity in which they iteratively reduced the content to the item which provided the best cue. While the goals are not identical to ours, their evaluation method - card sorting (Fincher & Tenenberg, 2005) - was effective and as such is one we have adopted to investigate the reduction of lifelog content in order to best present a personal story, although in our case it is adapted to include the full range of content and context which might be present within a lifelog.

4.3.2 Participants

Nine individuals (7 male, 2 female; age range 20-50) engage in the card sorting activity (Fincher & Tenenberg, 2005) in which they arranged, selected and reduced physical representations of 'artifacts' from an extended lifelog collection to produce a multimodal story). All were members of the research group and had previously created a SenseCam archive of at least one day's experiences, as it was the only component of an extended lifelog that could not be easily simulated.

4.3.3 Method, And Aims

Prior to the experiment, participants selected up to five stories relating to an interesting activity from their SenseCam collections. Several participants had extensive collections however others were more constrained and two could only provide content relating to a single activity. Examples included: attending and presenting at conferences; personal holiday or site-seeing; and socialising with friends/colleagues. In order to simulate a full lifelog collection, participants were requested to provide both their SenseCam images, and any related digital content created, reviewed or accessed within the time frame of the activity, for example web page(s) related to the conference they attended; emails sent to a friend; digital photos or videos taken; etc. On average 1687.5 images were provided to author each story, which were temporally skimmed to between 75 and 150 images. Only 6 stories had digital photo content (on average 37 photos per story.) Most stories had some digital document content available, mainly emails; this was in low volumes (average 6 emails per story.) A breakdown of the stories provided by each participant as well as the types of digital content available for the construction of each story can be seen in Table 4.1.

These were then printed and assembled into card format (Fincher & Tenenberg, 2005). To more fully simulate an extended lifelog, contextual (location, people, relationship), emotional and thematic information, were provided through an oral retelling of the experience by the participant. This was supported by a high-speed playback based review of the SenseCam footage during which missed items were noted. This served to ensure that the contextual items as complete as possible and not wholly contingent upon the person's recollection of the activity.

Participants were presented with the artifacts as a set of small lightweight cards. They were instructed to use them to create a multimodal representation of their chosen story by first reducing the content to the 50 items following which they iteratively reduced the content from 50 to 25, 25 to 10, 10 to 5 and 5 to one single item. Participants were also asked to 'think-aloud' (van Someren, Barnard & Sandberg, 1994), paying particular attention to their reasons for including or removing items, thereby providing insight into their decision-making and content reduction practices. The session with participants was video taped to preserve a record for later analysis. Figure 4.1a & 4.1b illustrate the card sorting activity and content reduction.

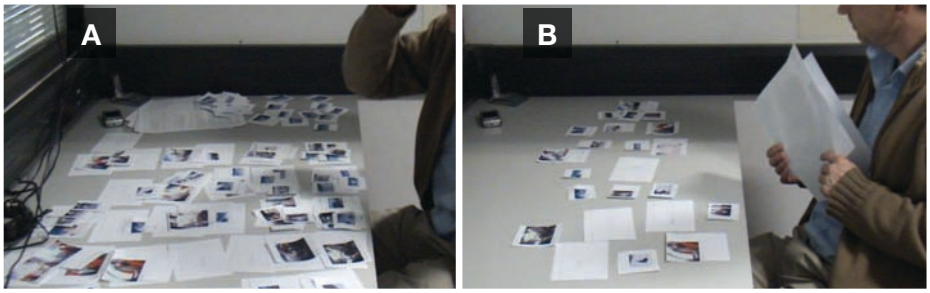


Fig. 4.2 (a) & (b): A participant engages in the card sorting activity iteratively reducing the content to that most important to the narrative.

4.3.4 Results and Discussion

The card-sorting activity gave insights both into the cognitive processes by which lifelog content may be converted to story-form and the possible ways in which this might be implemented within a supporting tool. The major findings from this study are now outlined.

Expensive To Review: The expensive nature of conducting a review of lifelog materials was highlighted throughout the sessions with all participants. A typical mode for re-experiencing SenseCam images is high-speed playback, however, this proved time consuming to review even stories spanning only short timeframes. User 1 had a 6-hour story consisting of 1,630 frames taking 2:43 minutes to review. Users 5 had a story spanning a day and a half and took over 8 minutes to review in this format and the user became visibly disinterested by the end of the review. Even with the reasonably short and isolated episodes employed it was impractical to use this review format to re-experience, and it is clear that it would not scale to large collections. The process of card sorting was also time-consuming highlighting the onerous nature of manually reviewing and managing lifelog content. Participants spent considerable time appraising the content items and took between 20 minutes and one hour per story, depending on the complexity and volume of content. The voluminous nature of a lifelog is prohibitive to manual story composition, discouraging personal review. This finding, albeit obvious, qualifies the need for tool support in lifelog storytelling.

Engaging and Enjoyable: Despite its expensive nature, the study highlighted the potential for reminiscence and introspection. The users delighted in the examination of the artefacts, with users 1, 3, 5 and 7 particularly engaging with their material. While reviewing their artefacts, these participants often paused to reflect upon artefacts of significance. When 'thinking aloud' about experiences, the participants tended to do so with exuberance, using highly emotive language reflecting the affective quality of

the experiences. It is encouraging that the lifelog content is compelling – there was risk that due to the high frequency of capture it may have been spurious, capturing incidental or mundane experiences which did not display any significance to the user.

Record vs. Experience: Stories are not factual accounts. However, a lifelog and its artefacts amount to an unbiased highly chronological account and this has implications. The participants noted that the detailed account recorded by passively capturing devices is skewed from the remembered experience. User 1 noted a marked disjoint in their first story - an overseas site-seeing trip. Due to the time required to get from site-to-site, the SenseCam's visual record contained a large number of 'walking' images and thereby prominence was given to this action. However the action of walking featured neither in the conversational retelling or the digital story composed; but instead favoured landmarks visited by the individual. The landmarks however featured in a comparatively low number of frames within the SenseCam recording. This disconnect supports Harper et al's (2007) position that the SenseCam, and perhaps more generally lifelogs, are not an analogue for the experience. This creates a challenge to storytelling.

Composition Observations: The composition of the story can be broadly defined by the types of artifact chosen and the aspects of that story which an artifact communicates. Table 4.2 illustrates this for a subset of the stories, while Tables 4.3 and 4.4 provide further breakdowns. As the author's intended meaning and the nature of the story will have a significant bearing on its final representation, both the selected artifacts and the aspects of the story embodied by them vary widely. For example, user 5's story 1 pertains to a party and so the chosen artifacts predominantly embody people present, while user 8's story 1 is of a site-seeing trip, large reflecting those places visited. While the end representation may vary, we found overall that the strategies and methods users employed in assembling a multimodal story from lifelog content tended to be largely consistent.

Content Fluency: The range of available multimedia content required the participant to contemplate the affordances of each of the media modalities in communicating the story or its *fluency* and how this might impact on the end retelling. Tables 4.2 and 4.4 illustrate that users employed different modalities to communicate specific aspects of the story, suggesting that the modalities may have very different fluencies within the retelling. Almost 50% of a typical story is composed from SenseCam images (see Table 4.3.) making it the dominant modality. However, this is more likely to be a result

of the volume available. In the 6 stories with digital photos, this photo media becomes the preferred modality. While preferred, users repeatedly expressed that it was desirable to include SenseCam content to support the photo-media, to provide a secondary viewpoint on that moment or to narrate something not otherwise captured by the available photos. As capture is often 'staged', the explicitly captured photos tend not to embody a particular *action,* however the SenseCam provides 'in the moment' capture of activities such as walking, presenting, eating, etc. Text-based or document content was less frequently employed and typically in an expository capacity. For example, user 1 employed Twitter messages succinctly summarising their site seeing; and users 3, 5, and 8 included an agenda, itinerary or programme.

Themes as Focusing Elements: The participants' initial action with the cards was to identify the salient themes and elements of their story. By reviewing these cards, the participant quickly identified which of the themes (and by consequence) aspects of the story are important to its plot. Once a user had identified the focal aspects of the story, they then cycled through the remaining content, iteratively associating relevant content to related theme (Fig 4.1a.) By doing so, they confirm that there is appropriate content to support representation of each aspect of the story, establish sufficient coverage of the plot as a whole and ensure the story's coherence to its themes. A story consisted on average of 3.38 explicitly mentioned thematic or contextual elements (see Table 4.3), highlighting their importance to lifelog-based storytelling. The most central components were people present and actions undertaken, e.g. giving a presentation. (see Table 4.4.) Only in a minority of cases was specific reference to time information made. While often mentioned during the oral retelling, emotional/mental reactions were not typically utilized. In one case, weather (it being cold) was also mentioned.

Core and Anecdotal Elements: In creating a story, it was anticipated that the participants would emphasise the selection of artifacts core to communicating the overall activity, however, often elements which expressed peripheral or anecdotal encounters were preserved. These moments while not core to the plot, were noted by the users to be important to the overall experience. By preserving such elements, the narrative becomes more personal, exemplifying the unique experience of the individual. This aligns well with Barthes's (1977) *cardinal* and *catalysing* narrative units.

Content Reduction, Filtering and Removal: Users were presented with a large number of multimodal content (minimum 75 items) which they iteratively reduced. The

processes by which the available content was reduced were largely consistent across all users. Users first conducted a quick review of the stack of cards, from which they identified the key themes and/or artifacts. After which, they sampled the available cards categorizing the content based on utility in retelling their desired story. Items that were relevant but redundant, due to repetition, were typically removed unless they provided an alternative or salient viewpoint on the activity e.g. a SenseCam image which might compliment an explicitly captured photo. Finally, poor quality or irrelevant content was immediately discarded.

Table 4.1. Participant stories provided and the amount of digital content for each.

Participant	Story	SenseCam (skimmed)	Photos	Email	Document	Web	Video	Other
1	1	1630 (78)		1				27
1	2	939 (79)		12	1	5		20
2	1	234 (79)		13				
2	2	379 (77)						
2	3	311 (80)		1				
2	4	193 (98)						
3	1	2109 (102)	97	8	1		1	
4	1	12805 (103)		7	1	1		
4	2	2902 (102)	7					
4	3	5398 (102)	7	25	4			
4	4	3493 (102)	11	1				
5	1	955 (81)	68					
5	2	4893 (76)	42	2		1	2	
5	3	329 (85)		2				
6	1	297 (75)		1	1			
6	2	87 (87)		2				
6	3	686 (87)		3				
7	1	2411 (77)		19	3			
7	2	916 (154)	30					
7	3	27 (27)		7		1		
7	4	270 (92)		1				
7	5	525 (77)		1				
8	1	741 (94)		4				
9	1	135 (135)		1				
9	2	400 (82)		4				
9	3	811 (83)		4		1		

Content retained from this review was clustered around the major themes of the story ensuring that they were appropriately covered by the available content. Content was then reduced to meet the upper-bound in one of two ways: by removing an entire cluster or by examining the artifact clusters and removing relevant but overlapping

content e.g. visually similar photos, or items made redundant by another artifact. This content reduction process was consistently applied across the iterative reductions. Expositional content – the artifacts used to explain or provide context to the story - was most likely to be removed as the upper-bound was lowered. Participants stated that these factors were implicit based on the presence of other content and could consequently be assumed or inferred. For example, explicit labeling of a person's presence would not be required if it was obvious from a photo that they were present.

Redundancy may operate within and across content modalities. For example, two SenseCam photos captured at a similar time may contain extremely similar visual depictions of an activity, or a theme or text message may explicitly label an activity which may be well described by a photo alone. In most cases, redundancy was a primary reason for removal of content, however, one user demonstrated that redundancy across modalities could be beneficial. The participant was attending a party and enjoyed the complimentary perspectives that a photograph and the SenseCam offered to proceedings; one provided a first person perspective while the other surveyed the event more broadly. It is worthwhile considering that while similar modalities may overlap in the content being presented they may afford complimentary perspectives which afford alternative viewpoints on the activity.

Table 4.2. Example of lifelog artifacts selected by users to embody a chosen story within 5 items.

User	Story	Item 1	Item 2	Item 3	Item 4	Item 5
1	1	Twitter	SenseCam	SenseCam	SenseCam	IM Transcript
		Exposition	*Place*	*Place*	*Person*	*Exposition*
3	1	Photo	SenseCam	Photo	SenseCam	Document
		Person	*Person/Place*	*Person*	*Action*	*Exposition/Place*
4	2	Photo	SenseCam	SenseCam	Theme	Theme
		People/Place/ Object	*People/Action*	*People*	*Object/Place*	*Object*
4	4	Photo	SenseCam	SenseCam	Photo	Theme
		People/Object	*People/Action*	*Action*	*Object*	*Time*
5	1	Photo	Photo	SenseCam	SenseCam	Photo
		Person	*Object*	*Action/Person*	*Action/Person*	*Person*
5	2	Photo	Photo	SenseCam	SenseCam	SenseCam
		People/Place	*Place*	*Action*	*Action*	*Action/Place*
7	2	Photo	Photo	Theme	Theme	Theme
		Place/Object	*Person*	*Emotion*	*Place/Object*	*Person*
8	1	Email	Sensecam	Sensecam	Sensecam	Sensecam
		Exposition	*Place*	*Place*	*Place*	*Place/Object*

This reductive step also aligns well with Whittaker, Bergman & Clough's (2000) discussion of negative selection. Within negative selection, people will desire to remove content of poor quality from their photo collection. They will regularly engage in pruning content that they perceive as unsuitable to retain within a media archive. Prior work has demonstrated users to be very reliable at making such judgments about their personal media (Rodden, 1999).

Table 4.3. Summary of Content Types Employed (Displays average number in the Top 10 media artifacts selected to embody a story.)

Media Type	Totals	Stories with available photos	Stories with available text media
SenseCam	4.63	3.33	4.62
Photo	1.08	4.33	0.77
Theme	3.38	2.00	2.92
Document	0.08	0.17	0.15
Email	0.54	0.17	1.00
Web	0.17	0.00	0.31
Other	0.17	0.00	0.31
Number of Stories	24	6	13

Layout and Presentation: Two major arrangements of the content were observed during the card sorting activity. In a minority of cases, where the stories could be considered more 'habitual', content was arranged as a chronological account. This was seen in particular with user's 4, 8 and 9. Within the experiment typically participants employed a theme-oriented montage-style layout in which items were placed concentrically around the most important items (Fig 4.1b.) This has parallels with the work of Ames & Manguy (2006) and Appan, Sundaram & Birchfield (2004.)

Table 4.4. The aspects of a story embodied by the modalities a percentage of the total items (Note that a single artifact may embody one or more aspect of the story e.g. might simultaneously represent a person and an action.).

Aspect	All	Photo	Document	Context/Themes
Person	0.47	0.62	0.04	0.36
Place	0.19	0.38	0.04	0.19
Time	0.03	0.00	0.00	0.10
Action	0.32	0.08	0.04	0.06
Object	0.25	0.23	0.22	0.26
Emotion	0.03	0.00	0.00	0.08
Exposition	0.07	0.00	0.65	0.03
Other	0.00	0.00	0.00	0.01
Number of Items	240	26	23	78

4.4 Design Requirements for A Lifelog Storytelling Tool

Within this chapter, two probative explorations have been outlined. Using this information in concert with the knowledge elicited from prior work and relevant literature, we establish a number of design requirements. These recommendations inform and guide the development and implementation of the storytelling tool for digital lifelog collections. They belong to five broad categories: general requirements, storytelling requirements, structural, representational and presentational requirements. They are now outlined.

REQUIREMENTS I (GENERAL):

1. **COLLECTION**: The goal of lifelogging is to passively and continuously record a life through digital means and preserve as detailed and uninterrupted a record as possible (see Section 2.2). In order to support this goal, the user must be able to continuously collect information about their day-to-day activities without the need to specify how it should later be assembled into a story, regardless of how abundant the collection may become.

2. **CURATION**: Lifelogging helps to collect a life, and may contain masses of information but as noted in Section 4.3.1 it is important that this information be distilled. Family practice employed this distillation to manage mementos and ensure they were accessible (see 4.2.1.2). Scrapbookers carefully formed ideas for narrated accounts and distill out relevant keepsakes for inclusion in these albums (see 4.2.3.3). In lifelogs, the reduction of content was an essential part to their curation in storyform (see 4.3.4). A reductive curatorial process will be indispensible in making sense of in gaining value from the collection in the long-term. This curation can be supported through the crafting of content into stories.

3. **DISCOVERY**: Identifying the 'stand-out' content is an essential part of curating memories (Petrilli, Whittaker & Brockmeier (2008). To do this the individual must be able to discern the emotionally powerful, significant and meaningful keepsakes, media or tokens from other content they may have preserved, so that it may be distilled out. Opportunities for discovery and rediscovery of this content must be afforded to the user.

4. **REWARD**: Although it may be effortful (see Section 4.2.1.4) the curation of content is a rewarding practice (see 4.2.1.4, 4.2.2.6, 4.3.4). The distillation of abundant

stores of personal information offers many benefits such as new opportunities to explore personal identity, to share the experience and to reminisce. It is important that a digital system delivers similar rewards to the individual.

REQUIREMENTS II (STORY):

1. ***EXPERIENTAL***: It is essential that the story represent an expertiental account. As noted in Section 4.3.4, the data a lifelog contains does not always align well with the experience. The process of creating a story must be transformative (see Section 4.2.2.4), converting the content and data into a suitable experimental form.

2. **INTEGRITY**: While transformation and interpretation may be required to author the story, we should not go beyond what the data depicts that account to be. Integrity in providing an representative account of the experience is a key component of narrating life histories (see Section 4.2.2.5)

3. ***MALLEABLE***: Life stories evolve over time as the current sense of self. They change to be focused from the perspective of current identity (see Chapter 3.3). Much like this, scrapbookers revisit, adapt, reform and refine their layouts over time perhaps in response to new perspectives or the availability of new media for inclusion (see 4.2.3.5). As personal and physical stories adapt over time, so too must a digital equivalent have the ability to be edited and refined.

4. ***SUPPORTED:*** Section 4.3.4 highlights the expensive nature of review and distillation for such voluminous collections. The process of authoring even short narratives took much time. An author must be supported through computational approaches and strategies to offset the burden and time-consuming nature of review and composition.

5. ***AUTHORIAL CONTROL***: While support is required, the author should retain control over the outputs of any computational process. These processes should guide the user towards an endpoint rather than simply deliver it. Under such authorial control, the author must be able to not only specify the goals of the story (by providing a point of view, theme or focus for the story) but should be able influence its outcomes to match their desired or expected outputs. This ensures the correct elements have been distilled and that the author has considered and reflected on the media to be included in the story. This supports I.1 and I.2 above.

REQUIREMENTS V (STRUCTURAL):

1. ***PRESERVATION***: The family expressed the desire to capture and keep all moments in the development of their children (see 4.2.1.3). Scrapbookers became enraptured with the preservation of moments from their family's life (see 4.2.3.2). There is a desire to capture a life in great detail and the lifelog amassed should support this. The content and structures employed should be as replete as possible and cover both seminal events and everyday moments with equal opportunity. In doing so, it increases narrative possibilities.

2. **BROAD**: The family and scrapbookers preserved a wide variety of objects, media and ephemera as mementos. In supporting curational endeavours through storytelling, the digital system should enable a disparate set of digital sources, channels and modalities to be brought together. The structures should be flexible enough to broadly support their inclusion and curation in story-form.

3. ***TEMPORAL***: An essential component of narrative is time (see Chapter 3.1) and this much be preserved. Be it an entire family history (see 4.2.2.3), the seminal events and their connections (see 4.2.1.1) or just moments (see 4.2.3.3), a clear representation of time is key. Life narratives are linear progressions through time, often focusing on broad periods (see Chapter 3.3). Time must be central to the structure of life narratives and it must be accurately and appropriately represented.

4. ***THEMATIC***: Themes are focusing elements within the creation and arrangement of experiential accounts (see 4.3.1). Moreover, themes are key components of narrative and should describe the actors (people), settings (places) and happenings (actions) (see Chapter 3.1). Thematics are the backbone of personal narratives. They are the focal element of the story. In combination with the temporal they highlight changes, developments and progressions and this is key to the formation of plot. Life narratives are hinged on these thematic elements and so must be a key component through which a digital collection should be organised.

5. ***EPISODIC***: Personal stories concern episodes of experience. These episodes represent a single happening over a short period of time. An episode encompasses all of the sensory elements which contribute to that experience: the sights, sounds, observations, mental reactions, etc. Likewise, a digital system should structure its content around these units of experience, drawing together

'sensed' and sampled information to embody the aspects of that experience. Related episodes may often be brought together and these episodes may have different competencies within a retelling (see 4.3.4).

6. ***OWNERSHIP***: Mementos and content from multiple individuals may be held together. Within the family often many members of the family will have mementos displayed together or stored together (see 4.2.1.2). Elements from across the family may be drawn together to contributed to curated accounts (see 4.2.3.3) of personal or family history. It is important that the digital system supports the contribution from a variety of individuals while maintaining attribution to its original owner.

7. ***MEDIATED MANAGEMENT***: Life experiences may contain both good and bad moments. In collecting a lifetime of experience, we must acknowledge that some of the content may be unpleasant. However, the past – good and bad – must not be ignored and we should still endeavour to preserve a record of all experiences. Even unpleasant experiences can be central to identity and reviewed after long periods of time can be cast in a new light and potentially offer cathartic benefits (see 4.2.2.7). Where content may be removed, the potential for narrative is reduced and potential benefits that experience may offer in the long term disappear. Removal and management of content must be well-considered, much as was observed with the family (see 4.2.1.2). In physical practices, the pruning of an archive is reflected upon and often negotiated between members of the family. The digital system should encourage this reflection over management and support several individuals in this practice (see 4.2.1.3).

REQUIREMENTS V (REPRESENTATION):

1. ***CONNECTIONS***: Life stories are formed between sets of related episodes chained together. Geneologists string together significant happenings through records to tell the story of a life. Families mark the seminal moments and developmental progression of a child. Scrapbookers organize their albums to place related episodes in proximity. The representational layer should identify and map these relationships so that they can be exploited in the formation of narrative.

2. ***ADAPTIVE***: The meaning and significance of momentos and the experiences they embody will change over time. As a result, the representational layer of the

narrative system must be sensitive to this and adapt to reflect changes in importance.

3. ***REDUNDANCY***: Redundancy and repetition are undesirable and in narrative authoring the human author will seek to minimize this overlap between content elements (see 4.3.4). In representing the narrative, it should be possible to identify and remove redundant, repetitious or spurious elements. If redundant elements are retained the coherence of the plot may be negatively impacted.

4. ***FLUENCY***: Different modalities have various efficacies in communicating components of the narrative and may embody different aspects of the experience (see Section 4.3.4). In combining the media fragments from a lifelog collection, the storytelling tool should be sensitive to each modality's *fluency* in the retelling. Modalities should be employed based on both their suitability to the narrative and its affordances in communicating that narrative.

REQUIREMENTS V (PRESENTATION):

In drawing together a number of disparate media fragments to retell past personal experience the following must be considered.

1. ***TRANSFORMATIVE***: There is a disjoint between data contained within an archive and the manner in which that should be retold. The presentation process could appropriately convert units within a lifelog into an experiential account. This supports II.1 above.

2. ***COHERENCE***: In bringing together a variety of media fragments to represent and communicate an experience, this must be done in a sensible manner. The elements chosen should communicate the narrative in a concrete way, be relevant to the focus of the narrative and should aid understanding of the message or experience being communicated. They should operate coherently together.

3. ***PERSONAL***: The stories under construction will be about past personal action and may be related to aspects of identity. The narratives produced should be meaningful to their owner, be affective and have resonance for them.

4. ***EXCHANGE***: The stories produced should have the ability to be shared in some form. They must support social exchange and discourse around them and have the ability to be exchanged between individuals (see Section 4.2.3.1).

RECOMMENDATIONS:

In addition to the requirements outlined above, the scrapbooking practices aligns well with the goals of our investigation. Their practices can be used to further inform the design of our system.

1. ***COMPOSITION***: Scrapbookers employ patterned chapters decorated with carefully positioned media, decorative backgrounds and an assortment of embellishments. They coherently integrate a range of personal and experiential fragments to produce a narrated account of an experience by creating compelling, aesthetically pleasing layout-based compositions. The organizational strategies they employ are sensible as a frame for digital storytelling.

2. ***FLEXIBILITY:*** The spatial composition employed is not only successful at integrating various disparate media fragments but it is highly flexible. Not only is it flexible in allowing a variety of content to be used in confluence, but in the ways in which that content may be represented and presented. For example, the spatial approach can be used to simulate timelines, illustrate associations or exemplify focal elements. Being unconstrained, a variety of illustrative techniques can be employed to highlight the underlying narrative. Its flexibility in lends itself to creating a diverse set of interpretations and to creative endeavours. A digital system should seek to integrate this unconstrained approach and provide flexibility in the composition of personal narratives from multimedia.

3. ***WORKING SPACE***: Although it might be revisited and adjusted, the scrapbookers viewed their albums as a store for completed compositions. Prior to inclusion in an album, layouts were often carefully considered before the final arrangement was committed to. A working space in which these arrangements can be tested and trialed would be beneficial to include In order to support such practice.

4. ***CAPTIONING:*** An essential component of the creation of scrapbooked layouts was the annotation of the contents with descriptive labels. This included the use of quotes, short snippets, short phrases or single words. These were used to either describe the focus of the layout or the significance of an element within the layout. It would be important to provide for such description. Descriptive captions could operate at various granularities. More personal or private captions might hidden or placed behind elements for example. This enabled the layout to address a variety of audiences, through exploration at different depths. It is additionally an effect

mechanism for the provision of agency to the audience. These concepts could be useful within the digital environment, particularly when sharing or presenting the narratives.

5. ***REUSE***: Scrapbookers acknowledged that often the same layout or style of patterned expression was repeated across layouts and perhaps across an entire album. This allowed for rapidity of layout creation and the coherence of layouts to a particular aesthetic approach. Reuse was additionally seen across members of the community where styles and approaches were either shared or emulated. This reuse of styles and layout conventions would be important to support within a digital environment.

Chapter 5

Storytelling Tool Implementation

Overview

Within this chapter, we present a storytelling solution engineered to support an author in the construction of personal digital narratives from lifelog collections. In designing the tool, we leveraged the understandings garnered through the probative studies and sought to satisfy the requirements elicited. A key requirement is the need to support the author through automation and computational processes. This is motivated based on the volume, complexity and detail of the lifelog collections employed within this research investigation. While authorial support is a key component of the system, a wholly automatic solution is not favoured as it might overly constrain the creative outputs. The devised tool, Orison, optionally offers the authorial support through narrative generation. This allows an author to create a personal narrative from a lifelog corpus entirely manually should they so desire. Even if an author elects to employ the generative support, the flexible authoring support provided by the tool enables them to edit and refine the outputs. A semi-automatic approach is central to the operation of the tool. This recognizes that the user must have the ability to coordinate, control and craft the stories produced within the system.

The functions the tool offers an author, in the support of story creation are presented within this chapter. First the architecture, technical infrastructure, data structures and media sources employed by the implemented storytelling solution are described. Subsequently we explore the storytelling framework employed. Finally the functions offered by the system in support of story creation are elaborated. Creation is catered for through four main steps: the system supports the user in locating content relevant to the story under construction; it allows them to arrange and fashion the identified media fragments into story-based compositions; it allows these compositions to be placed and situated within the main story to form a plot; and the story may then be presented and shared with others. The tool also provides a number of features which

enable an author to consolidate their media for use within storytelling and for that content to be structured and organized to support storytelling.

The user interface and functionality provided to an author is the focus of discussion within this chapter. It explores how an author may use the system, and the process of manually composing and refining narrative produced. The automatic computation elements, which provide authorial support in the structuring of content to support storytelling and in the generation of narrative output are discussed in the subsequent chapters of this work.

5.1 Introduction

Based on the design recommendations and requirements elaborated, we developed a lifelog storytelling tool to support the construction of personal narratives from lifelog content. Its development was informed by the design requirements garnered from the probative investigations. While several domains of current practice were considered in the elicitation of these requirements, the goal was to create a flexible tool for storytelling which could be deployed to a diverse sets of users and to meet a variety of needs. Many of these requirements were carefully incorporated into the final system and are evident in the metaphors and concepts adopted, the storytelling workflows and practices and patterns of management and organization of personal media. In doing so it translates these real-world concepts and practices into the digital system while providing sensible and familiar functionality in support of the creation of personal narratives from lifelog content.

The tool, named Orison after an orb like repository of human experience featured in David Mitchell's Cloud Atlas, was designed to provide a fully implemented and feature complete tool for the creation of digital narratives from personal content. The system has all of the expected behaviours and functionality of a media-editing tool from single click installation, to export and import which facilitates sharing of completed stories. The application additionally runs cross-platform from the user's desktop environment.

While oriented towards lifelog collections, the tool is designed to be flexible in its support for personal content and can equally allow the construction of digital narrative from traditional media collections and social sources. The method of digital storytelling enabled closely resemble that observed with the scrapbooking communties: album based two-dimensional layouts. The tool's workflow is designed to serve as a digital analogue to scrapbooking and is intended to parallel their

observed patterns and creative practices, albeit in a digital environment. Four primary actions were identified: locating information for inclusion in a layout (*browsing*); the arrangement of content into a working layout (*composition*); committing that layout to an album and situating it appropriately (*placing*). . Finally, an important component of the story's creation is its potential to be shared with those important to the author (*presentation*). There is a section within the application relating to each one of these functions. The system provides support to import, organise and structure a variety of content and contextual sources. The structuring processes organise the available lifelog content and aligns the modalities to facilitate storytelling (see Chapter 6). The system then supports the user in the creation of a personal digital narrative about their past life experience in one of two ways. First they may opt to compose the story manually by browsing, composing, and arranging the content within albums and chapters as 2-dimensional spatial layouts. Alternatively, they may choose a guided approach in which they specify the nature of the story under construction (see Chapter 7). The system will then identify content appropriate to the user's query and begin selecting and visually arranging the content for them. The user may later intervene to adjust and tweak the output as required. The system also supports extensive customisation and styling of the final layouts.

The studies of current practice indicated that personal mementos and any compositions created would not only have personal significance but serve a social function also (see Section 4.3.2.1). As such it is important that the tool supports this aspect of storytelling. To this end, it incorporates a presentation mode allowing created works to be narrated and shared. This operates similarly to slideshows in photo management software. The chosen album is presented fullscreen with background audio and the elements transition on screen progressively. Agency is provided through interaction which allows individual elements to be more deeply interrogated, to expose captions and related content.

The functions of the tool in story creation as outlined above are explored in more depth in the following sections. The novelty of the tool in story authoring and in the collections it employs are next outlined, after which a description of the technical implementation, structures and content employed is elaborated upon. Finally each of the major functional areas within the user experience are explored and the process of story construction outlined.

5.2 Comparison to Similar Tools

There are a number of comparable storytelling tools within the space of personal digital narratives. Two examples are Appan, Sundaram & Birchfield's everyday storytelling tool (2004) and iTell a photo-based storytelling system produced by Landry & Guzdial (2006). Appan, Sundaram & Birchfield (2004) explored the use of personal media captured at regular intervals for storytelling. Through interaction with a viewpoint, an event-centred visualization of everyday media, users can construct a non-linear narrative. This narrative emerged as a result of interaction, and this interaction affords a high-degree of agency to the author/audience. Unlike Appan, Sundaram & Birchfield (2004), Landry (2009) favours an authored approach to story construction with personal media. The 'iTell' system provides a structured framework for authoring narratives with personal photographs that guides the author at each stage of construction. The process is rigid to ensure the narrative's completeness and that all aspects of the story are considered. This guided approach had demonstrated utility with novices, who might otherwise be challenged by the creative undertaking of storytelling. iTell was later iterated into Landry's (2009) Storytellr tool which encouraged deeper reflection and analytical thinking on past experience during story construction.

The most closely comparable storytelling system is that of the Confectionary authoring-environment (Kelliher & Davenport, 2007). This system enables construction of everyday rich-media narratives from content co-opted from a variety of personal sources. These sources allow video, photo and text based content to be weaved into a two-dimensional spatial layout. Two-dimensional space provides a familiar and instinctual story composition fabric, and is a well-established form of digital narrative (Kearney, 2002; Ryan, 2004). Confectionary, like our tool, exemplifies this approach by providing a spatial canvas for creating patterned stories from aesthetically-presented media fragments.

Our approach, however, diverges from that of Kelliher & Davenport in a number of significant ways. Notably, the Orison tool attempts to assist the author in the construction of personal digital narratives through computational components. Confectionary comparatively lacks automation requiring authorial decisions to be made entirely by the user. Our system does allow completely unassisted authoring of narrative. Given the volume and scope of the lifelog collections employed, however, the story generation functionality it makes available to an author is a key offering and

contribution of our authoring environment. While the Orison tool employs a similar compositional framework, the decision to provide authorial support through the automatic generation, means the underlying implementation is very distinct from that of Confectionary. First, to support the more voluminous lifelog collections it not only caters for content-based sources but contextual information. The content sources supported are additionally wider. The local repositories created from these sources are structured and organized to support the semi-automatic generation of digital stories (see Chapter 6). By automatically structuring the collection into units appropriate to storytelling, the effort on the part of the author is substantially reduced. Other systems require much of this organizational effort to be conducted by the author prior to story construction adding substantial overhead to the process (Landry, 2009). Finally, significant computational logic is in-built to identify narrative paths and to both retrieve the content relevant to that narrative and to visually arrange the chosen content in an appropriate 2-dimensional composition.

5.3 Architecture

Within this section, the architecture of the Orison tool is explored and elements such as the technical implementation, its data model, the content and contextual sources support and the collections it employs are outlined.

5.3.1 Technical Implementation

The system was developed with Adobe Flex 3.5 and delivered as a cross-platform desktop environment with Adobe AIR 2.0. The user interface connects with a SQLite database which contains information on the content and context available for use within compositions, the organizational structures and indexes employed, as well as stories created by the user. This database can be optionally secured using a one-way hash encrypted password preventing direct access to the database itself. Personal content, such as photos, imported into the application is cached in a local directory, stored within the user's documents folder. This directory provides a unified repository which ensures that the content is available to the Orison application. This avoids access issues which might result from modification, movement or removal of the original media file. The store also contains the SQLite database, which maps its artefacts to the media content within this store. This unified local cache, additionally contains information on the indexes and keywords used. Finally, the user interface integrates with web delivered services for a number of key features. These include: the

provision of critical updates to the application and to the underlying data structures; the central logging of application errors; and to deliver complex content processing services that could not reliably be provided across platforms e.g. image processing and natural language processing. These remote processing services are discussed in more detail in Chapter 6. An overview of the architecture is provided in Figure 5.1

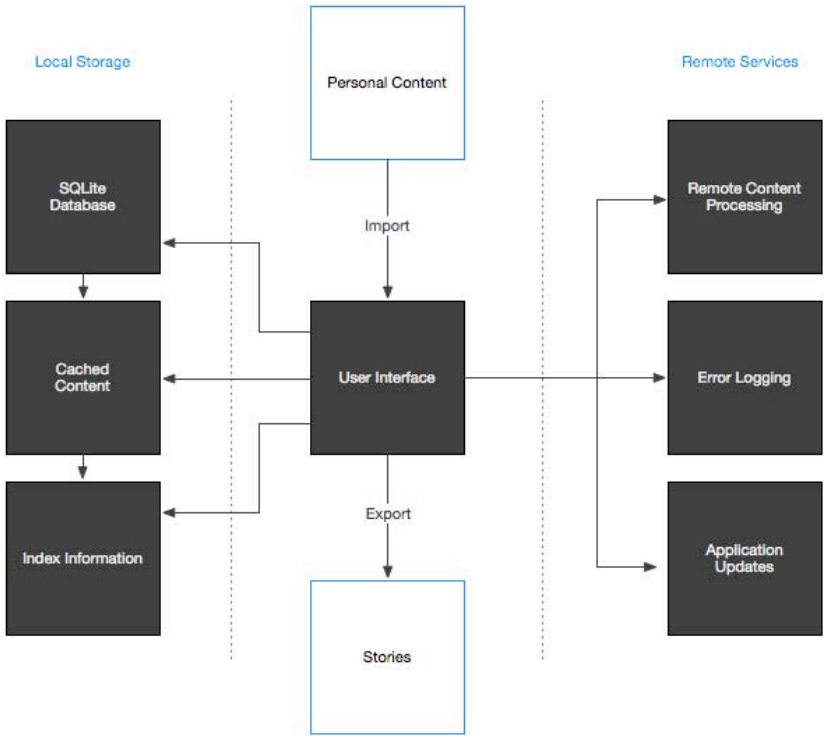


Figure 5.1 Architecture of the Orison System

5.3.2 Data Store Structure

The SQLite data store houses all of the application data. It contains the information on the content which has been imported by the user. These elements are known as personal *artefacts.* Each of the artefacts is described with a type, a timestamp and a unique identifier. An artefact must belong to a person, the *collection owner.* The owner may further describe each artefact with a caption or may attribute significance to it by 'bookmarking' it. Depending on the type of artefact, additional metadata specific to that content-type may be maintained within the database.

The artefacts may be aggregated into higher-level units which describe an activity or reasonably short period. These are known as *episodes*. The aggregation of high-frequency person content, and in particular lifelog content, in this manner is typically recommended to reduce its complexity and to coherently associate related content in a more digestible form (Doherty & Smeaton, 2008; Byrne et al, 2008). The additional

benefit is that an episodic structure more closely resembles the way memories are encoded and makes them a more familiar and sensible form for exploration of past experience (Tulving & Donaldson, 1972; Tulving, 1984). An episodic structure has also been recommended when working with the narration of personal experience (Appan, Sundaram & Birchfield, 2004; Ho & Dautenhahn, 2008) and was adopted for this reason. The structuring of content into episodes is explored in Section 6.4

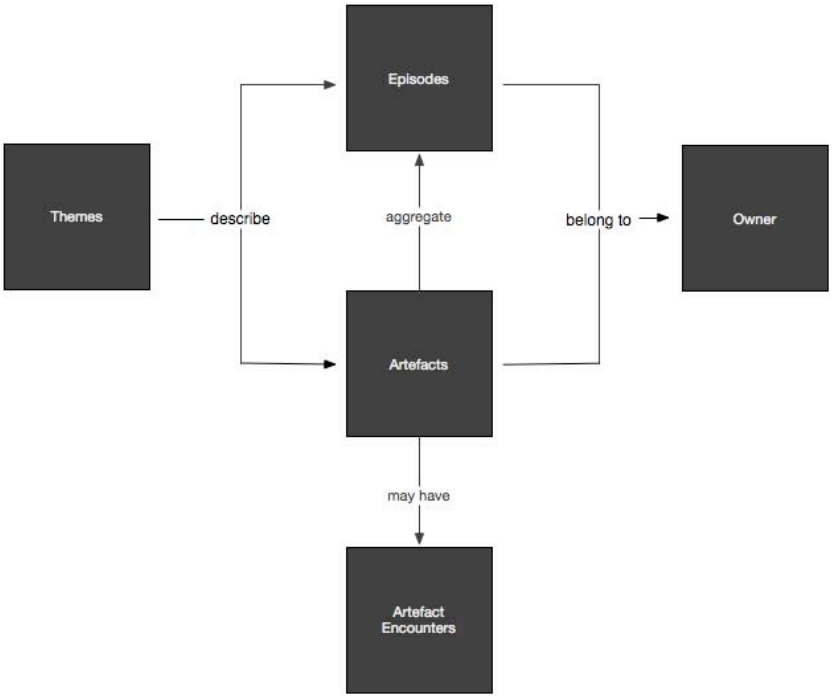


Figure 5.2 Overview of the Data Structure for Orison, which is both thematic and episodic.

As the collection incorporates contextual elements, provision for this must be supported within the data structures Orison employs. Contextual factors relate to time spent at a particular place, in proximity to a person or in a particular internal (biometric, emotional) or external (weather, temperature, etc.) state. Each unique contextual factor is considered to be the artefact, while the instances at which a contextual factor is detected are *encounters* with the artefact. For example, a Bluetooth device may be considered an artefact that is encountered at various points within the day. This allows contextual factors and the points at which they are encountered to be distinguished.

Finally, both *artefacts,* and the *episodes* they are aggregated into, can be related to one another by the *themes* which describe them. The content within the Orison data store is organized in a thematic fashion which is the primary method of identifying related content. The thematic structure is flexible and behaves much akin to a

folksonomy where content can be tagged with keywords or keyphrases (Gruber, 2007). Within Orison, themes take one of three major types: a person, a place or a description. Users may contribute these themes but they may also be automatically derived based on the terms in text-based content or contextual elements of an artefact. These automatic processes are outlined in Section 6.2, A unique feature of the way in which the themes operate within the Orison structure, is that they may be organized based on their relationships. For example, the theme 'Dublin' may be described as belonging to 'Ireland'. While this does not incorporate full ontological or semantic classification, it allows for richer categorization and sensible organization of content, which can enable query expansion and novel exploration. The work of Hargood, Millard, & Weal (2008, 2009, 2010) highlights the utility in employing a thematic approach to narrative structuring and generation. Their system uses images retrieved from the online photo sharing service, Flickr, as *natoms* (narrative atoms) for storytelling. The tags become features, which in turn denote a motif and connotes particular themes. Their approach is influenced by Tomashevsky (1965) and Barthes (1957, 1975) and takes a structuralist approach within their thematic model. While there are clear parallels with our work, we apply themes less formally to our corpus.

In summary, the data structure employed allows for multiuser support as many owners may have content within a single collection. These owners import *artefacts* which may be aggregated into *episodes*. These can then be described, organized and related to one another by applying *themes* to them. This structure is overviewed in Figure 5.2

5.3.3 Supported Artefact Types

Within the Orison application, support for both content and contextual sources is provided. These are as follows:

- SenseCam – Passively captured photos recorded using a SenseCam can be imported into Orison. Using the sensor file readings, each photo is matched to a reading taken from the onboard accelerometer, passive infrared and ambient temperature sensors. Files manually captured by the user, by pressing the appropriate button are automatically bookmarked.

- Photos – Personal Digital Photos can be imported into the system. A copy of the image is stored in the application's storage directory and a thumbnail image

created for viewing. The artefact's timestamp is assumed to be the creation date of the file.

- Videos – Digital video captured by the collection owner can be imported. The video is copied to the application directory and the artefact date is assumed to be the creation date.

- Campaignr – Context information from the mobile logging software, Campaignr, can be used within the software. This allows GPS and associated address information as well as encountered Bluetooth and WiFi signals to be incorporated into the structure and resulting stories. Each unique contextual factor is seen to be an artefact while each context data point is viewed as an encounter with that artefact.

- SLife – Desktop content such as webpages visited and files accessed can be included within the data store. A document artefact is created for each unique file path or URL imported, and a document access is then viewed as an encounter with that document.

- SMS – Short Text Messages can be imported into the system. These must be first exported from the device into a format supported by Orison. At import, the sent and received items are associated with one another and threaded to show conversations between individuals.

- Twitter – Short messages from Twitter are parsed from the user's timeline. Orison imports status updates created by the user, messages which mention them and any replies to their messages. These status updates are also threaded for conversations following import.

- Metadata – Text labels, captions and descriptions may be applied to the content to further describe it. These additional descriptions further enrich the media artefacts.

5.3.4 Collection Information

Three long-term lifelog collections were collected for use with the storytelling tool and to facilitate an exploration into story construction from personal collections. Three participants captured their day-to-day experiences extensively for a period in excess of 20 months; the author of this work is among them. Data collection for this work

commenced in May 2008. The initial month of capture saw many teething issues while participants familiarised themselves with the recording apparatus, technologies and considerations of capture. All other months of capture are considered to be complete. However in some circumstances and owing to device or technology failure, content from some periods may be incomplete or missing for one or more modalities of capture.

To capture the participants' daily activities a variety of multimodal and mobile sources, were employed and sampled at high frequency. Passive capture technology was employed to continually sample the environs of the participant as they went about their daily activities (e.g. SenseCam visual frames, location information, computer activity). This information was complimented and augmented a range of content sources that were explicitly captured by the individual (e.g. SMS messages, Twitter content, personal photos). The modalities employed balance many considerations both for the user and the end goal; and ensure there is sufficient richness, completeness and computational understanding within the end lifelog in order to facilitate the generation of life narratives.

To perform the collection, participants were provided with a number of hardware and software solutions. A Nokia N95 mobile became the primary mobile phone for all participants. It was used to maintain a record of mobile content including SMSs, call history, photos and with an in-built five megapixel capture was used as their main photo capture device. The Campaignr was additionally installed on the phone and was capture the participant's personal context every 30 seconds. This provided a record of GSM cell tower information, proximal WiFi and Bluetooth signal sources, and GPS location information. A Microsoft SenseCam was also worn by the participants on a daily basis to capture their daily activities as a series of photos and sensor readings, unless requested not to do so by another individual in proximity to them or if there were restrictions on recording in a particular space e.g. within a hospital or school. On average, the device yielded between 2,000 and 3,000 images per day. SLife was installed on the participants' desktop and laptop computers. This activity logging software recorded all application use and file access. Finally, each of the participants was asked to setup and maintain a twitter account. They were instructed to post regular status updates using the online social network about the activities they were engaged in. These were used to provide text-based annotations of activities, thoughts or items of interest.

The content and context contained within the long-term collections are illustrated in Table 5.1. The passive capture effort (Mobile Context, Desktop Activity and SenseCam) commenced in May 2008 for all users. Users 2 and 3 ceased passive capture in December 2009, however, User 1 continued until May 2010. This gives Users 2 and 3 a 20-month passively sampled lifelog and User 1 a 24-month collection for use within this evaluation. User 1 provided digital photo, SMS and Twitter content until May 2011, giving a total span to the collection of 3 years. User 2 provided digital photos until May 2010 and SMS content until August 2010, giving a total span of 2.333 years. User 3 provided digital photo content until December 2009 (in line with cessation of passive capture), SMS content until February 2010 and Twitter status updates until June 2010, although the number of items contained this modality were very limited. In practical terms, the collection can be seen to span only until February 2010, providing a 22 months of data.

Type	Sub Type	User 1	User 2	User 3
Document Activity	Desktop	134,215	9,836	12,997
Document Activity	Laptop	26,091	18,893	767
Document Activity	*Total*	*160,306*	*28,729*	*13,764*
Mobile Context	Mobile	1,203,844	732,557	358,416
SenseCam	SenseCam	1,156,697	732,848	459,530
Digital Photos	Photos	1,396	1,592	2,002
Text	SMS Received	7,943	3,023	539
Text	SMS Sent	8,970	3,026	166
Text	Twitter	838	476	106
Text	*Total*	*17,751*	*6,525*	*811*
Total		**2,539,994**	**1,502,251**	**834,523**

Table 5.1: A per user breakdown of the lifelog collections.

This represents a rich and highly detailed account of the participant's experiences in the long term. A major novelty of this work is the use of long-term multimodal lifelog collections. With the exception of Gordon Bell (Bell & Gemmell, 2007), such collections do not exist nor are they available from a number of users to facilitate research investigations.

While the resulting collections are extremely novel, some considerations of their use need to be born in mind. In particular, is the limited number of participants involved, each of which had a vested interest in the collection of data employing the data in their own doctoral research. The limited number of participants stems from the highly personal nature of the archives which makes it difficult to recruit participants willing to so broadly and intimately capture their life experiences and make that data available for use in research efforts. Additionally given the personal nature of the content, it was agreed that each of the collections would be maintained by the individual themselves and the investigators would not have access to other participants collections. Therefore the evaluations, organization, etc. of the collection had to be performed on the users own computer without intervention and without the ability to directly access the data. While there are practical and ethical limitations, it should be remembered that the collections are extremely novel and enable a first of its kind research.

The development of these collections is described in greater detail in Appendix IV. Further discussion with the analysis of a representative month is provided in Appendix V. This serves to illustrate the nature of collections and modalities they contain as well as their affordances, constrains and complexities.

5.4 User Interface Design

The Orison tool was designed to be user-friendly and a well-rounded professional and compelling product for storytelling personal experiences. A number of design decisions were taken in its development and are now outlined. We discuss the design decisions made in its development, the rationale and reasoning behind the user interface and narrative generation workflow.

5.4.1 General Layout and Main Sections

Within the tool the menu appears on the left hand side and provides access to the main sections of the application (see Fig 5.3.) These are *overview* screen, access to *browse* and review the artefacts and episodes, a section for the composition of *stories*, the playback and *presentation* of completed stories, *import* of new content, *management* of imported content and general application *settings*. Each functional space within the tool is given a large amount of screen space with other application elements such as status bars, being kept to a minimum. They behave as if stacked over one another and slide into view from top to bottom following selection. This animated transition helps to visually reinforce the vertical menu employed.

At the bottom of the screen two indicators are available in the status bar to provide visibility of the system state. These indicators provide information on current database operations and if an internet connection is available.

5.4.2 Metaphors Adopted

Metaphors aim to introduce recognizable and familiar concepts into computing systems. Their introduction allows a user to draw upon their real-world knowledge to derive expectations as to how the digital system might operate in practice. Concepts from the real world that have a strong relationship to the digital function are often consequently co-opted in the user interface. The most notable example of this is the desktop metaphor. Leveraging familiar metaphorical concepts has instructional value, enabling a user to quickly orient to and familiarize themselves with the digital environment by applying established mental models and understandings (Carroll & Thomas, 1982).

In the explorations into current practice outlined in Chapter 4, we identified a number of archetypal patterns in the management and organisation of personal physical media and in crafting story-based compositions. We incorporated a number of these patterns as ‘metaphors’ which translate the real-world concepts and practices into our digital system. By doing so, we aimed to providing sensible and familiar support and controls during the creation of personal narratives from lifelog content.

Many of these were based on observations from scrapbookers, and included for example the addition of a ‘scratchpad’ or temporary working space and the use of albums and chapters to organise the stories.

Two main metaphors are adopted within the user interface and are integral to the storytelling framework of the application. These metaphors build on concepts encountered with the scrapbooking community, translated into a digital equivalent. These are as follows:

- *Albums:* Scrapbookers compose craft based layouts which represent an episode from their lives. These layouts are assembled into albums. Within these albums, the placement and ordering of layouts has significance. For example, a series of layouts might describe the progression through a period of a person’s life with each layout iteratively developing the story. While scrapbooked albums were seen as well defined stories, they are not viewed as fixed constructs. Layouts can be

reordered or moved between albums. This concept of an album, and in particular its opportunity for refinement was important to the scrapbooker's process of storytelling and one which is deemed important to emulate in our work. Within Orison we incorporated these concepts. Each layout composed is placed within a virtual album. The album is represented by a book-style icon to visually represent the concept. Layouts contained within the digital story album can be reordered, refined and organized as they can be within their physical counterparts.

- *Scratchpad*: Another observed practice of the scrapbooking community is to carefully consider the layouts being composed before committing them to an album. Scrapbookers often have a working space in which a possible arrangement is trialed and then left in place in case any adjustments are required. Once satisfied with the layout it is then fixed in place and added to an album. They also often identify elements they would like to use to create a composition, but do not have all of the required components and preserve these items for later use. As such the concept of a working space, or scratchpad, was important to integrate within the system. It provides a space within the tool where layouts could be experiments with and content of interest to the author can be preserved for later use within a story, While exploring a media collection, a user may discover elements of interest and may save these to the scatchpad. The scratchpad can then be used as a compositional space to experiment with their layout and styling prior to placing them within an album. Once the author is satisfied with the arrangement, the elements may be converted to a layout within an album.

In addition to this, each section of the user interface is given a unique aesthetic 'flavour' which aims to reinforce its goal and the functional concepts it encapsulates. For example, the working space in which compositions are arranged, called the *scratchpad*, has a rough worn background while the album placement area has a more clean and finished appearance. This visually signifies the differences in the nature of the compositional spaces (see Fig 5.5 & 5.7.) The settings screen employs a background grille. The import header features a progress bar style header. The management section contains a folio style background and uses sketched-style icons. Many of the implicit metaphors and functional aspects of the application are subtly underlined in this way.

5.4.3 Storytelling Framework

As discussed in Chapter 3, the use of 2-dimensional spatial layouts is a familiar and intuitive fabric for the composition and understanding of narrative. It is a tried and tested format seen throughout the ages in cave paintings, comics and collage (Kearney, 2002.) Throughout this work, we have also introduced and discussed both the current practices of the scrapbooking community and other digital narrative tools as proponents for this approach. Consequently, and as mentioned in Section 5.2, within the Orison tool, stories are composed in this manner.

Layouts are formed from aesthetically presented media fragments carefully arranged on a single spatial canvas. These multimedia collages are formed from interweaving visual and text-based elements. Each layout may be a story in itself but typically forms part of a larger narrative contained within an album. Within an album, a layout is a unit of the story, while plot is represented by the order in which the layouts have been arranged. The process of authoring a narrative within the Orison tool is explored in more detail in Section 5.5

5.5 Story Creation

The story creation process closely emulates that observed within the scrap-booking community. These key activities are facilitated within the tool to successfully enable the authoring of personal narrative: locating information for inclusion in a layout (*browsing*); the arrangement of content into a working layout (*composition*); committing that layout to an album and situating it appropriately (*placing*). Finally, an important component of the story's creation is its potential to be shared with those important to the author (*presentation*). There are several major sections within the application, each relating to one of these functions.

The system further supports the author in creating their stories by providing functionality to automatically generate layouts from content of interest. The flexible authorial support embedded within the system allows a user to specify the nature of the story under construction by identifying exemplar content. The system will then retrieves related content from the corpus, filters to the most appropriate items and visually arranges it into a chapter or album. The user may intervene to adjust and tweak the output as required.

This automatic assistance supported within the user interface is the subject of discussion in later chapters. Within this section we consider the manual processes available to a user in the construction of a personal story without any computational processes. Later we consider how the author can be supported in this construction effort. The contribution of the generative steps is discussed in detail in Chapters 6 and 7.

Figure 5.3 The browsing and search screens within Orison.

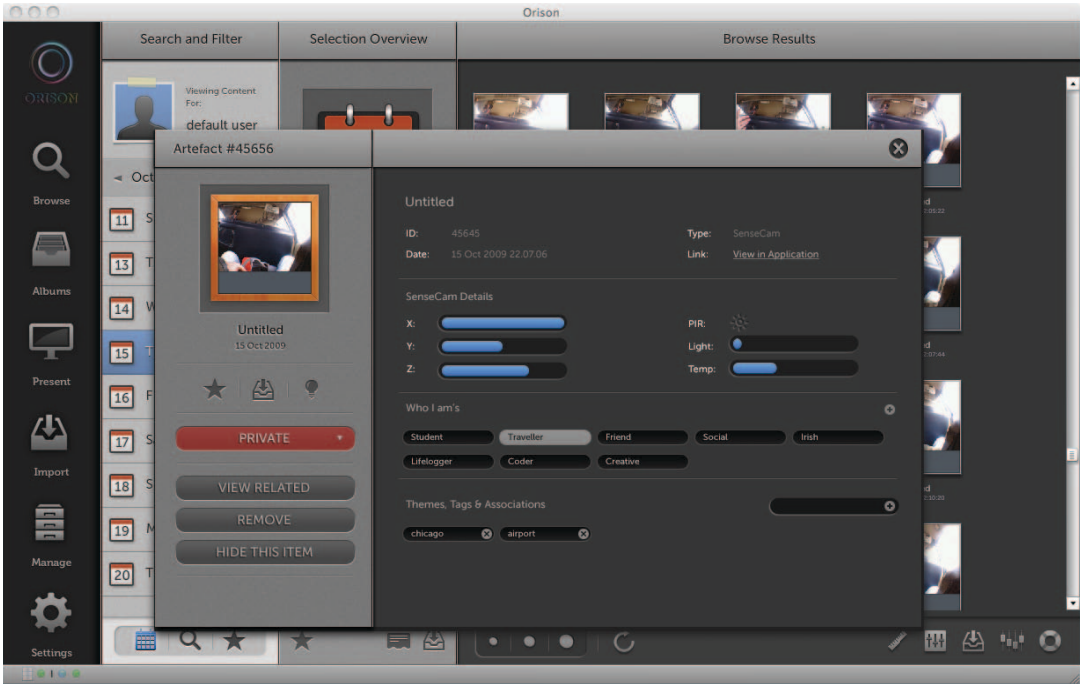


Figure 5.4 The Details Panel for a Selected Content Item

5.5.1 Browsing

In order for the user to begin creating a story they must first identify content relevant to the story they wish to create. This in itself presents a challenge with many in the personal information management community noting the difficulty that users have in refinding personal content in modern computer systems (Barreau & Nardi, 1995, Jones, Bruce & Dumais, 2001.) Refinding effectiveness hinges upon the efficacy of memory and its ability to recall appropriate cues to retrieving the target information. This is a confounding point in the retrieval process and often may hinder successful access to desired information (Elsweiler, Baillie & Ruthven, 2008; Elsweiler, Ruthven & Ma, 2006). In particular, temporal information about the media may be poorly recalled, making it difficult to locate through time based search (Elsweiler, Baillie & Ruthven, 2009). More flexible access to information and explorative search which leverages associations between related items is recommended as a favourable approach, particularly when dealing with long term collections (Elsweiler, Ruthven & Jones, 2007). Within Orison, many of these recommendations have been incorporated into the mechanisms for information access. The browsing screen, see Figure 5.3, allows a user to search by date where they can specify the year, month and day for relevant content to search for. Alternatively, they may retrieve content based on the themes that describe them. Wayfinding within the result set is aided by indications of the amount of content found per day and the volume of content for each media-type found. This can be used to filter the content quickly. Items of interest can be explored further to determine their suitability using the details panel, which additionally allows the user to view the themes applied to the content and contribute additional themes or descriptions to the content (see Figure 5.4). From this overlaid panel, the user can explore elements associated with and related to an item of interest. They can, additionally, browse for elements related to a particular theme or topic by searching for them from the main browsing window. The ability to browse by connections to other elements is an important feature as its closely resembles how memories are encoded and associated with one another (Anderson & Bower, 1980). This provides more familiar methods for exploring and investigating long-term personal archives. Once content of interest has been identified, it can be added to a story and the process of composition can commence. This is discussed in the next section.

5.5.2 Composition and Placing

The storytelling frame used within the Orison tool is a two-dimensional spatial canvas which allows media fragments to be arranged in storyform. Three important compositional spaces exist within the tool these are:

- *ScratchPad*: With relevant content identified it is initially placed into the working space or scratchpad. The scratchpad provides a layout space in which arrangements can be trialed and elements of the layout can be arranged and styled. When satisfied with their layout, the user can move it from the working space of the scratchpad into an album, where it becomes a chapter. This compositional space is illustrated in Figures 5.5 and 5.8.

- *Album*s: An album contains a number of authored layouts and is considered to encapsulate one story, which typically narrate a central coherent theme or topic. Each layout within the album will tend to develop and advance the plot of the story and contribute in some way to the central premise of the narrative. Albums can be accessed and created from the 'Album List' view shown in Figure 5.6 and each album can be given a title to describe it.

- Chapters: Each album can contain one or more chapters, which can be re-ordered as desired to convey the appropriate plot. A chapter is distinct only from the scratchpad in that this layout has been committed to an album. A title can be specified for each chapter in an album and the layout and arrangement of its story elements can be adjusted at any point. See Figure 5.7.

Within the scratchpad and chapter editing layout spaces the author is given options to manipulate the content in order to create a desired layout. They may, for example, move and reorder content, adjust its size, transparency and rotation, apply a caption to the content, and style its appearance. The tool affords a large degree of control over the presentation of content, allowing any text to be resized or displayed in one of over 20 typefaces, and content to be bounded with either a customizable simple solid border or a predefined frame. To simplify the process of applying these styles, predefined style patterns can be quickly applied to an entire chapter or to an element within the layout. Text and frame styles can be saved and reused across components. Background images can be applied to the layouts. The author can employ these to rapidly style all elements within a layout. These style and arrangement options are provided in overlay panels, as shown in Figure 5.9. Captions can also be applied to

the media fragments contained within a layout. These are positioned directly below the media fragment and move with it. Captions can also be placed independent of the content as illustrated in Figure 5.10. These captions can be moved independently of content they might provide commentary upon.

Figure 5.5 The ScratchPad provides a compositional space where layouts can be trialed before committing them to an album

Figure 5.6 The album selection screen.

Figure 5.7 The Album Layout View provides a list of chapters within the album and the ability to edit layouts.

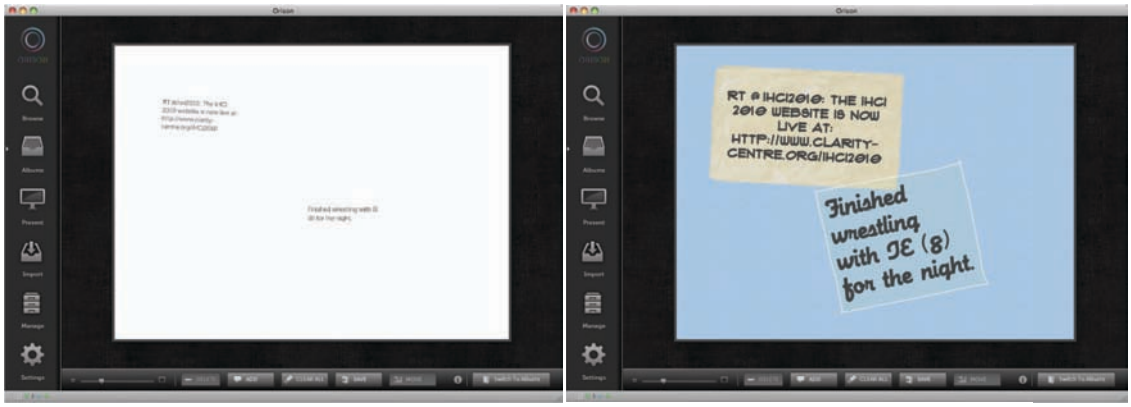


Figure 5.8 The ScratchPad as a working space: Left: Content initially placed in the scratchpad has no style information Right: The same content after styling and layout.

The ability to rapidly layout content as a chapter is available. Rather than adding content to the working space of the scratchpad, an author may select a number of relevant artefacts when browsing for content. These items may then be automatically arranged into a layout using one of several predefined layout patterns (see Section 7.6). The patterns represent common approaches to 2-d spatial arrangements and should have general utility. They include grid, circle, spiral, scatter, path, stacked and vertical and horizontal layouts. This assistive function allows a user to quickly create a chapter and arrange and style its elements to provide a usable composition that could then be refined into their envisaged creation.

Figure 5.9 A number of story composition panels. From Left to Right: Background Options for a layout; Positioning and captioning of a story element; Custom styling control; Predefined Style selection.

5.5.3 Sharing and Presenting

Enabling communication and exchange of stories is an important component of narrative's social function (Bluck & Habermas, 2000). Support for meaningful exchange around the authored work was incorporated into the application with two mechanisms: it provides the ability to export and share created compositions across computers; and it delivers an interactive playback mode in which the albums can be explored in an engaging, immersive manner.

From the album list, an option to export is provided. This packages the album, its layout and all of the content it employs into a distributable bundle that can be shared with others. Once exported the file can be moved across systems and imported onto another system with all of the media seamless migrated. Albums imported onto another system not only preserve the content required by the story but also maintains descriptive information including ownership and associations across systems. This provides an easy means to share created works.

Within the application, a presentation option is available on the main menu. This contains the ability to select an album for presentation as well as a series of configurable options. These options provide authorial control over playback, presentation and pacing. Presentation options include the order in which the elements appear on screen, the transition between chapters, and the appearance animations for story elements. The pacing of playback can be controlled by adjusting the duration each chapter is presented for and the time each story element takes to transition into appearance. Pacing can be complimented by the selection of a suitable audio track to

accompany playback. 15 ambient tracks are available and loop for the duration of playback. The inclusion of complimentary audio is designed to give a more immersive retelling experience (Ferrington, 1994).

Once configured, the story is then presented in a full-screen window. Controls are hidden until user activity is detected. This places emphasis on the playback and encourages immersion. Agency is a key component of successful digital narrative, as noted by Brooks (1999). Within the system agency is provided through interaction with the on-screen elements. When hovered over, interactive elements are highlighted with a pulsing glow. Elements containing hidden captions can be flipped over to reveal the message. Elements with related content, such as threads of conversation for an SMS message, can be brought into view. These interactive elements afford the audience some degree of control over playback while preserving the fidelity of the authored account. This provides opportunities for deeper exploration of and engagement with the content.

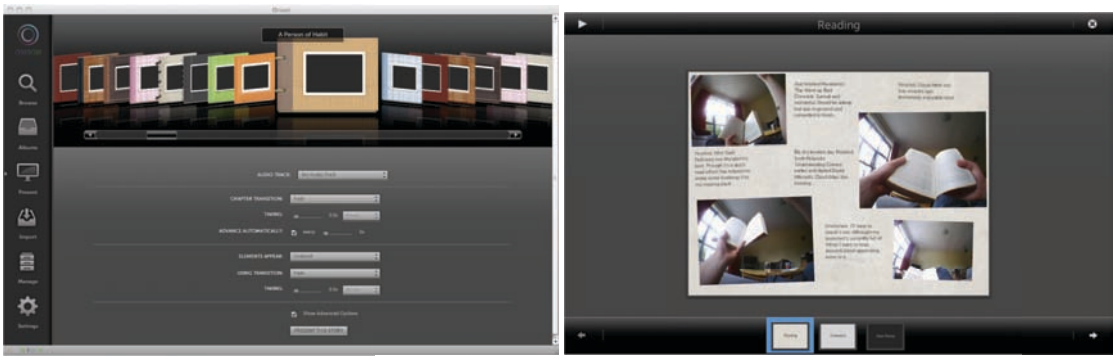


Figure 5.9 Left: The story presentation screen provides configurable options for playback. Right: The fullscreen presentation mode gives an immersive playback of the story.

5.6 Managing Content

While the Orison tool is focused on features related to storytelling, an important component of its system is the provisioning and organization of content to support that storytelling.

5.6.1 Content Import

In section 5.3.3, the content and context types supported by Orison were outlined. The tool provides support to import content from each of these sources (see Fig. 5.10.) To import content the user simply selects the appropriate icon and provides any required information (e.g authentication details for online services, or file system

information for local content). Each import also provides an advanced option to adjust the timestamps of the content. This ensures that all of the content sources can be aligned with one another. Multiple imports may be performed concurrently, with imports in progress displayed in the right hand sidebar.

The import process converts digital media on the file system into ‘artefacts’. Where possible the content of the imported elements is employed to extract and apply themes to the content (see Section 6.2), which is then segmented into episodes (see Section 6.4). Essentially, the process will perform all necessary steps to organize the imported content into structures suitable for storytelling.

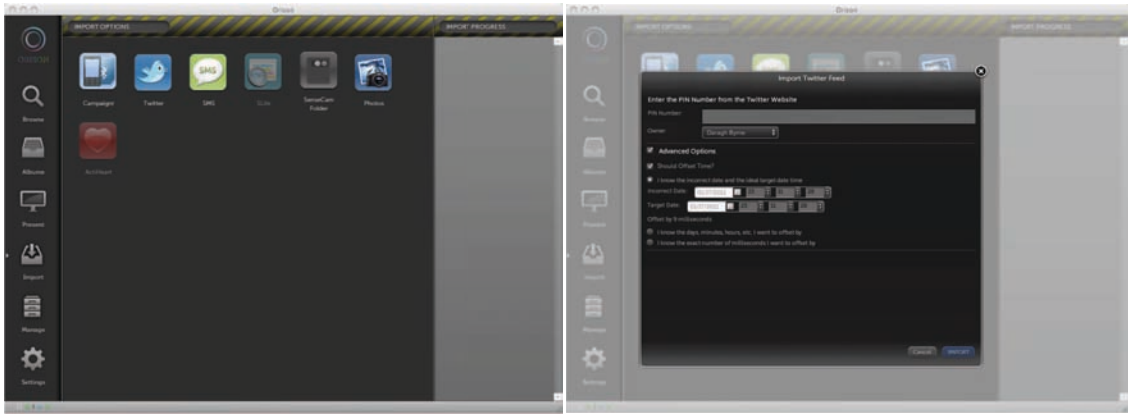


Figure 5.10 Left: The Default Import Screen Provides a variety of import options. Right: The Import Panel for Twitter Content with Advanced Options displayed.

5.6.2 Time Alignment

Within the lifetime of lifelog collection, devices are likely to crash, reset or ‘loose power’ and as a result loose their time information. Upon restoration, a new, perhaps erroneous, time will be applied to the device and this may not only conflict with previous recordings from the device, but may move it out of alignment with other devices capturing in parallel. As a number of high-frequency capture devices were employed (the SenseCam, Slife and Campaignr software) devices can easily move out of sync with one another and create complexity in unifying the sources into the central repository employed by Orison. A further complication is travel; as devices move between timezones, some devices, like mobile phones may automatically update, while others may handle this change less gracefully.

These time issues cause complications when attempting to align a variety of multimodal sources into a single unified repository. As noted in Byrne et al. (2011),

synchronisation of data from diverse mobile sources is a time-consuming and tedious process. Time is an essential dimension within personal narratives and as a result, and despite the effort required, the content must be reliably aligned. As there is no means that this can be reliably achieved to a high degree of precision using algorithmic approaches, this task must be undertaken by the collection owner. Although this is a substantial effort on their part, it is necessary to ensure it is completed reliably. This is not a wholly manual process and the software supports bulk adjustments of temporal information. This may be achieved by applying a time offset to content at import or through the management panel following an import. By integrating alignment into the import process, this manual alignment step is conducted as early as possible.

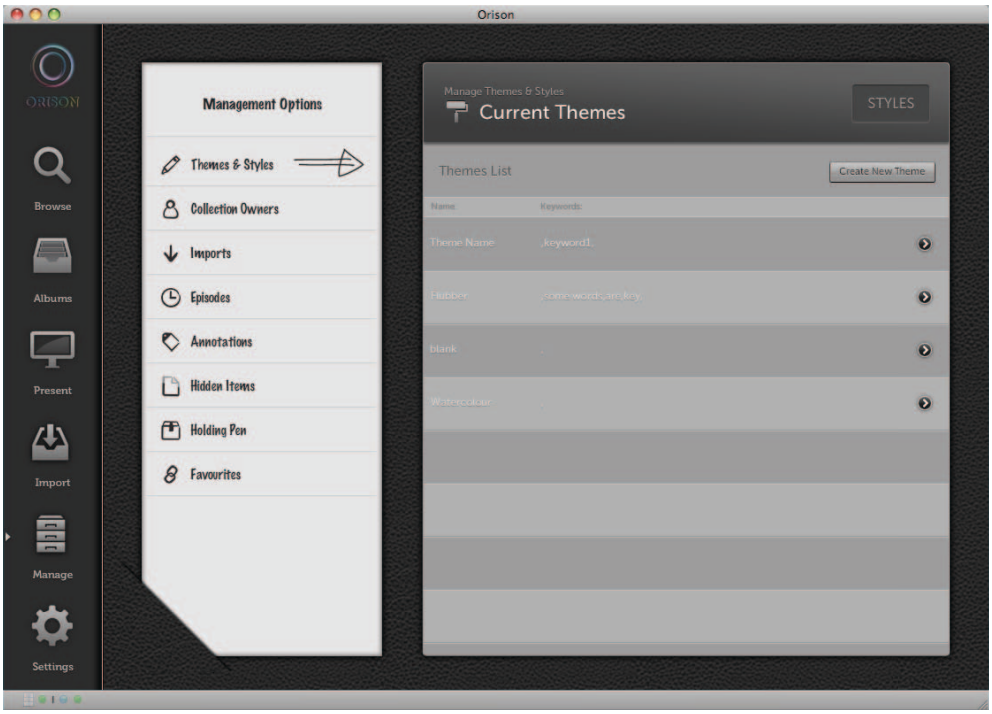


Figure 5.11 The management screen provides a number of options to manage content, collection owners and styles.

5.6.3 General Content Management

The user interface also provides a number of options to manage the stored content. Many of these are informed by the family practices of media management. In particular we note that numerous individuals may be involved in maintaining and contributing to personal archives (see Section 4.2.1.3). The tool supports multiple content owners and the management panel provides options to create, modify and remove collection owners who have access to the tool, its content and its stories. Styles and themes created from the story composition panels can be adjusted, refined or removed as required also. The option to adjust or remove entire imports is also

available in this section of the application. Not only does the tool provide these standard application and media editing functions, but it also incorporates some novel elements for managing personal content in the long term.

When dealing with personal digital content in the long term, many seemingly innocuous human factors issues may become very pertinent (see Section 2.7). As time progresses perception of content may change. Some of the content captured, particularly by passive technologies like the SenseCam, may be embarrassing, compromising or unflattering (Byrne et al. 2008; Kalnikaite et al., 2010.) Some of the content may be upsetting or emotionally distressing as it may reflect or cue traumatic experiences (see Section 4.2.2.7). The potential for this increases as the longevity of the collection increases (McCarthy et al, 2009. O'Hara, 2010) Finally, content may not be seen to align with the current sense of self and may require removal, revision or pruning (O'Hara, Tuffield, & Shadbolt, 2008). A common suggestion to handle these complexities is for the computer system to emulate the way in which memory handles these cases (Bannon, 2006; Dodge & Kitchin, 2007; Mayer-Schönberger, 2009.) This creates a tension between the lifelogging objective (to preserve as much personal information as possible) and the human objective (to forget what is not needed). Whittaker et al (2011) argue against making a personal archive partial and to attempt to maintain as complete a record as possible and rely on search. However, this does mean that a user may be presented with potentially undesirable or upsetting content. While the occasions on which this may occur are likely to be very limited, we consider it important to cater for such occurrences. Within the Orison system we engineered a novel approach to the problem, in which "forgetting" can be mediated in two ways. First, the system allows content to be temporarily forgotten. Any item within the system can be hidden whereby it will not be presented in the user interface or within any search results. The content still resides within the repository and can be restored at any point. Even with the ability to hide content, it was felt that permanent removal was still an important feature to provide. Particularly if content depicting the user in a particularly unflattering light was inadvertently captured, e.g. a SenseCam photo of the individual in the bathroom. Instead of instant removal of content as is normally provided in multimedia systems, it was decided to instead to make the process more considered. Should the user identify content that they wish to remove, they move it to the 'holding pen'. Content in the holding pen behaves like a hidden item and will not be displayed in search results thereby avoiding the user accidentally stumbling upon it. After a period of 1 month, the user can then opt to permanently delete the item. By encoding a lead-time on content removal, we hope to make the process more

considered and reflective, and remove the possibility for reactionary removal of content that could prove useful at a later point.

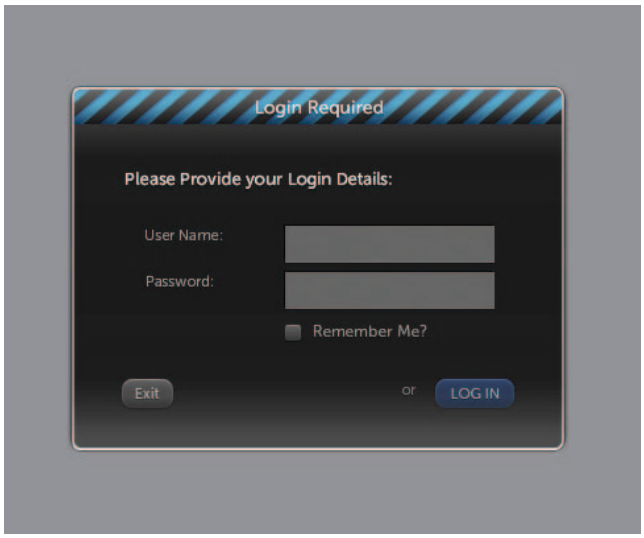


Figure 5.12 The authentication screen

5.7 Other Features

Beyond the content and storytelling features the system supports some basic features which are not discussed in detail here as they are common to many similar systems. The tool for example requires authentication prior to access of the system (see Fig 5.12). If it is the first use of the system, a welcome screen which is used to create the first collection owner is presented, following which a tutorial introducing the system is made available. The system logs errors and transmits them back to a central server to help in their later diagnosis and employs an automatic update framework that enables changes to both the application and to the underlying data structures to be seamlessly rolled down. This means that the system can be easily distributed to personal computers without the need for direct access to enhance, correct or adjust either its functionality or underlying data repository. This was an important consideration given the personal nature of the archives it employs and this is discussed in more depth in Appendix IV. Finally, the settings screen allows the user to control and adjust many of the configurable elements of the system and its functionality as required. This, for example, allows a user to change the file system location where the data repository is stored, to permanently clear the scratchpad and provide parameters to the story generation processes.

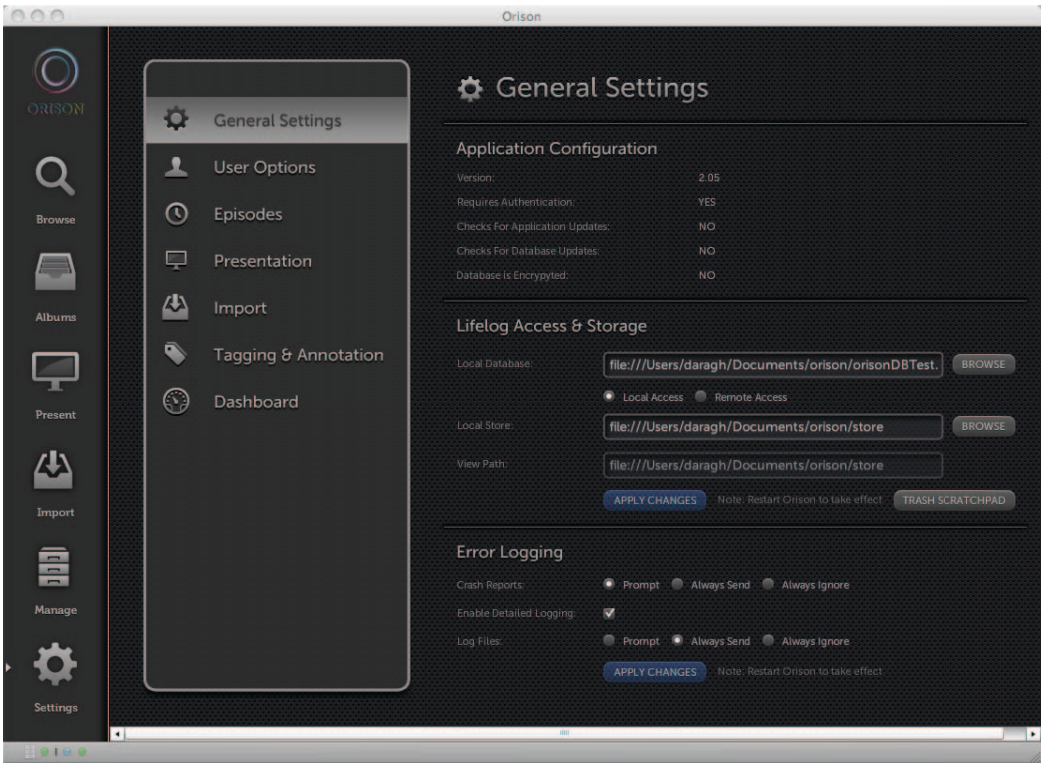


Figure 5.13 The Settings screen provides a number of configurable options to the user.

Summary

Previous chapters have explored the requirements for storytelling of lifelog collections. Within this chapter, we introduced our solution, the Orison tool which provides a storytelling platform for the construction of personal digital narratives from multimodal lifelog content. It has been informed by many of the practices observed within the physical storytelling methods of scrapbookers and by the memento management strategies within family scenarios. Consequently, the storytelling framework employed is 2-dimensional spatial narratives. This novel storytelling tool provides flexible support for a range of content and context sources typically found within multimodal lifelog collections and specifically oriented towards lifelog collections we have developed to support this research investigation. Content imported with the system is housed in a unified repository that organizes content in structures which support storytelling where artefacts are encapsulated into episodes and associated through themes.

The tool also supports an author in the construction of narrative first by providing overview and search of the collection. This allows a user to browse, discover and make sense of a large, long-term lifelog collection. It enables an author to identify the stories they wish to compose and the content relevant to a story under construction.

Media can then be organized and arranged into story-based layouts which are placed into albums. Their order forms the plot of the story with each story comprising a unit of the overall narrative. Once created the tool enables an author to share their story with others either by exporting and exchanging it or by presenting it within the tool itself. The system aims to provide all of the expected behaviours and functionality of a professional media-editing tool.

Within this chapter the major functionality of the tool has been outlined. This description has particularly emphasized the features for manual construction of a story within the tool The automated structuring and generation features included within the tool are discussed within the next two chapters respectively. Chapter 7 additionally evaluates the Orison system, elicits feedback from users and explores the quality of the narrative output it produces.

Chapter 6

Structuring the Collections

Overview

The volume of information amassed within a lifelog is considerable and as a result it cannot be expected that a user would manually manage this content or structure it appropriately for storytelling. We need to support the user in this endeavour through automatic techniques. The structure is associative and each item of content needs to be first related to other content within the collection and then organised into appropriate story units. We describe the extraction of 'themes' or descriptive tags of past action from the variety of available multimodal content sources. These are then used to arrange the collection into a folksonomy. We also draw out importance measures derived from a themes presence and distribution within the collection; this is an important step required to support the generation processes. The structuring process then aggregates the multimodal content into distinct story units or *episodes* of experience as recommended in the requirements of Chapter 4. These episodes are automatically detected using clustering and segmentation strategies. With the content structured, automatic generation of personal narrative can be facilitated.

6.1 Introduction

Throughout this work, the volume of lifelog collections has been noted. Within very short spaces of time, the passive capture technologies employed, such as the SenseCam or mobile context sampling can amass large quantities of data. SenseCam can produce upwards of 2500 images in an average day while mobile context garners approximately 1,500 sampled records. As the goal of lifelogging is to sample a life's experiences continuously and passively, this collection is constantly increasing both in size and complexity. Manual annotation, organization and structuring of the resulting collection would place a significant burden on the user to both regularly and reliably perform this activity. As a user has the task of monitoring and retrieving data from these devices on a regular occasion, coupled with the potentially invasive nature of the capture, they are already overly encumbered. It is important that we seek

automatic methods which can be employed to offset their workload and achieve the desired storytelling structure.

In Chapter 5, we introduced the digital narrative system and its user interface. The system architecture is centred around artefacts. An artefact is an individual media fragment stored by the system and can be used to express a facet of an experience from the collection owner's past. For example, a SenseCam image gives the visual dimension, a tweet may provide exposition or description of the activity, while Campaignr information provides the perspective of context, place and environment. The architecture sees these artefacts aggregated into episodes and related to one another through a thematic structure. An episode represents a short temporal sequence and broadly aligns with a single activity the user engaged in. Each episode is a container for all of the artefacts captured during that time. By bringing together these media fragments within the episode, more complete digital view of the experience is built. Other works commonly describe this unit as an 'event', however, this name implies the happening is of significance, where often the activity may be relatively mundane. As such we favour the use of episode in describing this concept, however, both terms may be used interchangably. Finally, a theme is used to describe both the artefacts and episodes stored with the system. It represents the 'knowledge' the system has about past experiences by providing the set of concepts which describe the dimensions of the experience. For example a theme may label where the activity took place, who was in it, and its nature. Episodes and artefacts can then be compared and contrasted based on the themes which label them.

This structure designed to enable storytelling of personal experiences. In this chapter, we outline the automatic computational processes, overviewed in Figure 6.1, through which the lifelog can be organised to achieve this.

As we cannot expect a user to annotate the content contained within a lifelog collection exhaustively, the knowledge and understanding required to represent and compose a narrative for a particular life experience should be gained by automatic means. There are several steps which occur within the structuring process. These are now briefly outlined. First, themes are extracted from suitable content and context sources and applied to the media within the collection (see Section 6.2). As Marie Laurie Ryan (2004) notes a story must be about people (actors) and places (settings) and the happenings (actions) at a particular moment in time. Themes are used to label and describe aspects of an experience so these element of narrative can be labeled and identified. Themes reflect the social, semantic or topical classes that belong to an

experience. By describing an artefact in terms of these aspects, it can be classified, and its relationship to other artefacts within the corpus established. Furthermore, a themes importance globally within the collection can be determined based on the number of occurrences found and the progression of that theme over time. Themes are applied to artefacts much akin to tags within a folksonomy. To achieve this contextual signals may be transformed to classify the social elements of experiences while natural language processing methods such as named entity detection and keyphrase extraction can help uncover the topical and semantic classifications. Following the extraction step, indexes for each theme are created (see Section 6.3.2). These indexes describe the distribution and relative importance of the themes within the corpus. This indexing step is an important component of the story generation process to be outlined in Chapter 7. For media without easily processable text or contextual information, themes can be applied by cross annotating these artefacts with themes in close temporal proximity (see Section 6.3.1). Finally, the media fragments are aggregated into high level units or *episodes* which are used to represent a single experience that might be retold (see Section 6.4). These episodes become the primary unit of storytelling. Clustering methods applied to the passively and continuously sampled modalities facilitate this. The user has the ability to adjust the outputs of this automatic process at any point, or indeed to augment the annotations and structures applied should they deem there to be any deficiencies.

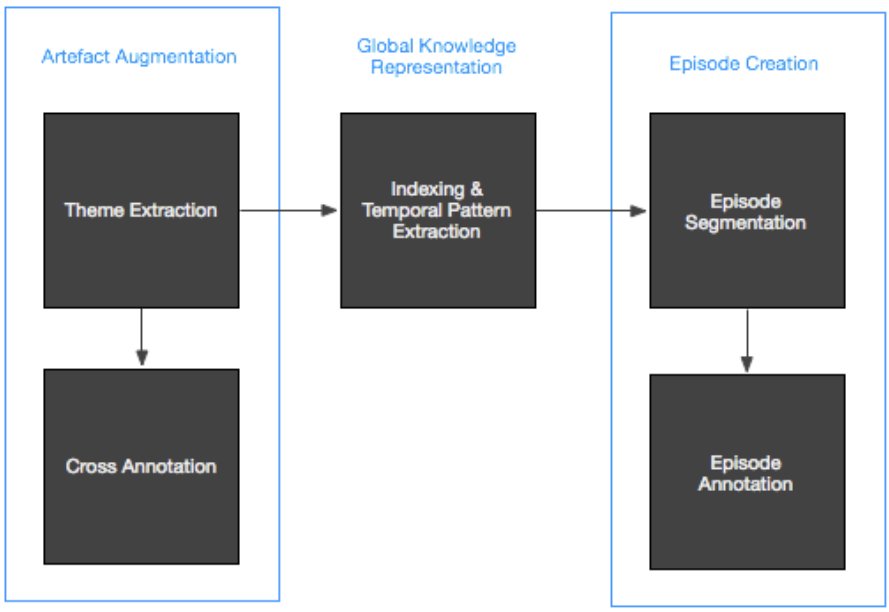


Figure 6.1. High Level Overview of the Structuring Processes

6.2 Theme Extraction

The content and contextual information contained within a lifelog can enrich our understanding of the digital recordings of past personal experiences it contains. From its contents, topics, themes, and descriptive labels, can be obtained to enrich the representation of the artefacts and episodes and to form and navigate their relationships within a lifelog collection. Thematic extraction is essential to both the formation of a structure suitable for storytelling and in the representation of narrative for the lifelog. Themes are the primary way in which media artefacts and episodes within the Orison system are described and can be related to one another. As described in Section 5.3.2, themes are a descriptive label and behave much like much like a tag in a folksonomy, with the exception that they can have a type, they may be related to one another in simple ontological arrangements, and their association to an element of content may be weighted in the range of 0..1. While users may contribute and apply themes to the content manually, the system automatically examines the content it contains and extracts these descriptors from suitable content and context sources. With this section we describe, how this structuring process is achieved.

6.2.1. Overview and Background

Bluck and Habermas (2000) explain that life narratives are organised through *thematic coherence.* Life stories, they explain, contain themes which are either present throughout or emerge as the story progresses. These themes are often closely related to life lessons or truths and are correlated with the audiences' understanding of the flow of the events (plot) contained within the story. This motivates our approach to describing experiences within the collection. Further to this and as illustrated in Chapter 4.3.2, themes are important focusing elements within the construction of lifelog based narratives, helping to filter, organize and arrange the content within a story. Themes as a result are highly important features of the storytelling framework we employ and the structure must support their discovery, detection and extraction from the content within a lifelog. We can achieve this in two primary ways: first through social semantics contained within the mobile context data; or through salient words and phrases found in text or document-based content.

The mobile context data gathered allows us to infer contextual themes. The Campaignr software senses Bluetooth, Wireless and GSM location every 30 seconds. The detected Bluetooth devices can be mapped to a person or actor within the story while wireless and GSM signals provide the setting in which the user was or is. As

such at any given point in time we have an understanding of the social context of the collection owner. These social themes can be extracted and used to create an associative network linking related points in time by the people and places.

Themes of a person's life are not limited to the contextual characteristics of their activities but also by the semantics of those activities. Digital artefacts accessed, created or reviewed during these activities may be semantically related to the subject of the activity. The content of these text-based items may describe the activities they are currently engaged in. An effective way to mine such themes is by examining the text-based content of these artefacts. Emails, instant message conversations, text messages and documents or webpages accessed contain a wealth of information and may provide useful content-based annotations to help classify and describe the content within the lifelog. There are complex and sophisticated approaches to extracting themes from document content (Morinaga & Yamanishi, 2004; Mei & Zhai, 2005; Mei et al, 2006). We instead favour a number of readily available and well-established information retrieval and natural language processing techniques used in combination with a preprocessing step suited to provisioning for the dirty nature of the short message content contained within the corpus. These computational strategies include named entity recognition (Nadeau & Sekine, 2007) and part of speech tagging (Voutilainen, 2003).

6.2.2. Theme Extraction

The theme extraction module automatically extracts thematic descriptors from the mobile context data and from the text-based content. While the mobile context is relatively straightforward to discern social thematics from, classifying the collection with semantic descriptions from text-based content poses more of a challenge. These processes are now outlined below and illustrated in Figure 6.2.

6.2.2.1 Mobile Context Extraction

Each Campaignr record is processed using the Google Maps API to reverse geocode the packet using the GSM and WiFi information. This enables GPS coordinates as well as a street address for the signal to be derived. For the time at which the record was sampled, a theme is then applied to the collection for each unique signal source. Each Bluetooth device id and its 'friendly name' are applied and mapped as related. Similarly each WiFi signal and its mapped SSID are applied. For GPS and address information they are applied hierarchically, starting with the lowest level GPS point, and iterating from street address, city, region to country. Relationships are additionally

established between these elements to enable associative refinding. In this structure a country theme thus is related many regions, cities and address themes, but a city belongs to just one country. This enables a point in time to be described at a variety of spatial granularities.

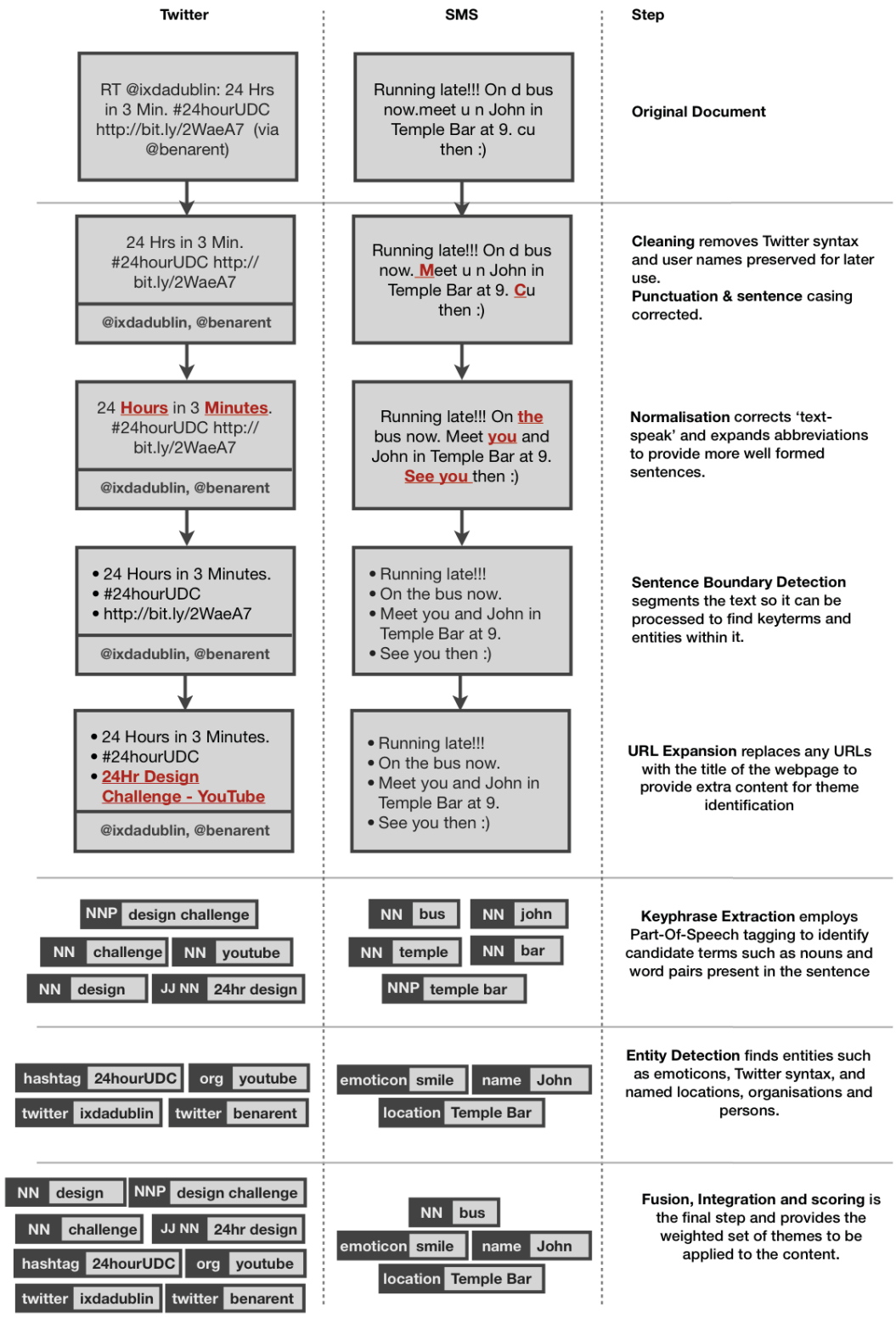


Figure 6.2. An illustrated example of the Theme Extraction Process for Twitter & SMS content.

6.2.2.2 Text Context Extraction

Keywords and keyphrases provide semantic information which can be used to describe a document by its contents and subject matter. In keyphrase extraction, single or multiple terms are chosen from the contents of an input document without a predefined list of phrases (Turney, 1997; Turney, 1999). The document is interpreted computationally and a set of representative keyphrases assigned to categorize that document. We take such a keyphrase extraction-based approach to the selection of themes to describe the text based content within a lifelog.

The theme extraction step runs as an online component which the Orison tool connects to. In order to invoke the service it passes an XML representation of each artefact under annotation and any directly related content, such as within thread of conversation for an SMS message. Each document is analysed by the extraction service in the following consecutive steps: Document Cleaning and Preprocessing, Keyphrase Extraction, Entity Recognition, fusion and weighting. This process seeks to address challenges such as noise, poor grammar, punctuation, the presence of contractions and text speak as well as limitations of the bag of words model when dealing with succinct text forms.

Document Cleaning and Preprocessing: Short message forms are noisy owing to the regular use of abbreviations and contractions or 'text-speak'; suffer from poor punctuation and casing as a result of constrained input modalities; and have other artefacts which make them difficult to readily process (see Appendix V). We perform preprocessing to clean and normalize each document. This is intended to create a more syntactically correct document thereby improving the efficacy and precision of the subsequent steps. The steps in this process are outlined below. This document cleaning step will afford the later processes the best possible chance at accurate detection and classification of relevant items within the short message content. The steps to clean the documents are outlined in the following subsections.

- *Cleaning:* In the case of a document activity item, the application name and title are passed. The title of the document often contains path information, extension information, and potentially much spurious information. This is extensively preprocessed to remove any undesirable elements. For Twitter documents any message syntax denoting a retweet or mention is stripped as this prefixes the message content itself. No initial cleaning is preformed on the SMS Messages.

- *Punctuation and Casing Correction:* Malformed punctuation and spacing regularly occurs in both SMS messages and Twitter content (e.g. "Or get takeout.Or eat in town.", “this on a bank hol sun..sorry") and may be present in document titles where title terms are conjoined by delimiters (e.g. “Report-April2008”). These irregularities may impact performance of the later steps negatively and in particular that of the sentence boundary detection. This step ensures spacing is applied correctly and that all sentences begin with an uppercased character.
- *Normalisation:* Short message forms frequently contain contractions and 'text speak'. Owing to such syntactic complexities, they are often difficult to directly process thereby requiring normalisation. There are several well-documented approaches to this and they range in complexity. Solutions to normalization often seek to translate the contracted form into proper English text and these include dictionary based approaches, natural language processing and machine translation methods (Aw et al., 2006; Kobus, Yvon, Damnati, 2008; Henriquez & Hernández, 2009’ Cook & Stevenson, 2009). Some of the challenges faced in short message normalization are well overviewed by Aw et al. (2006). Raghunathan & Krawczyk (2009) previously compared dictionary based approaches and statistical methods. They find that a dictionary-based substitution approach for translation will yield reasonably good performance. They indicate that a native dictionary - a dictionary for abbreviations and contractions which has been established on the corpus under translation – will in most cases offer comparable performance to machine translation approaches. Based on this, we trained a dictionary on a representative sample from the available lifelog collections. 375 SMS messages and 400 twitter messages were randomly sampled from two lifelog collections and were manually annotated. These annotations identified contractions, abbreviations, common misspellings or phrases were identified and a translation specified for each. This was used to establish a substitution dictionary. Annotations were parsed into a dictionary containing the entry and its appropriate translation. This provided 243 entries in total. The frequency with which each entry was encountered in the annotated short messages was also included. Where an entry had more than one possible translation, the most frequently encountered, and thereby most probable, translation is selected as the replacement string.
- *Sentence Boundary Detection:* Within traditional document corpora, sentences are bounded with the use of standard punctuation such as a fullstop (‘.’); an exclamation point (!) or a question mark (‘?’). Short message documents often employ emoticons, such as a smiley face “:)”, to add qualifiers for tone or emotion

to the text content. These typically represent sentence bounds also. Identification of emoticons and traditional bounds will be performed to decompose the document into its component sentences. The is achieved by using the OpenNLP7 toolkit's machine learning approach to detect sentence boundaries.

- *URL Expansion:* Some short message forms, e.g. Twitter messages, may contain embedded hyperlinks. These provide an additional source through which content, and by proxy descriptive semantic information, may be garnered. In cases where a message contains a link, that link is extracted, followed, and the title of the webpage is determined. The link is then replaced with the title in order to enrich the possible keyphrases that mihgt be extracted.

Keyphrase Extraction: Part of Speech (POS) tagging (Voutilainen, 2003) was employed to identify the grammatical structure of the short message, as overviewed in Figure 6.3. This should be performed a single sentence at a time, necessitating the previous sentence boundary detection step. This process can first classify the tokens within the sentence into, for example, verbs, prepositions, adjectives, and nouns. The full set of typed dependencies which may describe the syntax of a sentence is documented by de Marneffe & Manning (2008). Further to this it can be used to then aggregate these grammatical elements into word pairs. Using this classification result, candidate keyterms and keyphrases can be extracted using pattern matching to a set of predefined rules. These rules describe noun phrases and word pairs that are desirable. Matching phrase sets were extracted and passed to the fusion and integration step.

```
1.  (ROOT
2.   (S
3.     (VP (VBG Heading)
4.       (PP (TO to)
5.         (NP
6.           (NP (DT the) (NNP Science) (NNP Gallery))
7.           (PP (IN for)
8.             (NP (DT the) (NNP TEDxDublin) (NN event)))))
9.       (NP (NN tonight)))
10.    (. .)))
```

Figure 6.3. Part of Speech Tagging Result for Twitter Message: "Heading to the Science Gallery for the TEDxDublin event tonight"

[7] http://incubator.apache.org/opennlp/

Phrase Type	Pattern
Unigram	NN
	NNS
	NNP
	NNPS
Bi-gram	NNS + NN
	NNP + NN
	NNPS + NN
	NN + NN
	JJ + NN
	JJR + NN
	JJS + NN
Tri-gram	NNS + CC + NN
	NNP + IN + NN
	JJ + CC + NN
Four-gram	NNS + CC + DT + NN

Table 6.1. Example of Candidate Selection Rules for Part-of-Speech output.

Entity Recognition: The theme extraction next seeks to identify entities contained within the text as follows:

- *Emoticon Entities: E*moticons which are descriptors of tone, used to convey the authors intended meaning in place of other cues. They commonly occur within short message forms and can be mined to infer sentiment or further content about the message content. A dictionary of emoticons was established and this was used to detect their presence in the text-content. Encountered elements were extracted and labeled.
- *Twitter Entities:* Twitter status updates contain a variety of domain specific syntactic elements which can be used to further describe and classify the content. Within Twitter documents the author can optionally prefix a term with a hash symbol ('#'), thereby explicitly marking it as tagged. Given that the user has explicitly tagged that term it has been denoted as a significant or focal element of the text. It should therefore be retained as a descriptor for the document when automatically annotating. In addition to this, tweets may also include references to other Twitter usernames. This includes directing a message at a person, mentioning them within the body of the message or as attribution when reposting or 'retweeting' another person's update. Twitter usernames are prefixed by an @ symbol in the text making them identifiable. Being explicitly labeled by the author, the Twitter-specific hashtags and username types are extracted and employed to annotate the document.

- *SMS Entities: M*obile SMS messages contain elements specific to mobile devices which may include phone numbers and contact names or records. Using the recipient information further content to the message can be established. For a SMS message, the content is examined as well as the recipient information and any phone numbers or contact details available are extracted and used to further annotate the message with descriptive classifiers.
- *Named Entity Recognition:* Named Entity Recognition (NER) provides a computational step through which elements such as cities, places, person names, and organisations, can be detected within text-content (Nadeau & Sekine, 2007). This process provides not only the position of the entity within the text but also classifies the element to a specific type. For named entity recognition, we employ two sources. First, the OpenNPL[8] tooltil offers entity recognition for dates, locations, organisations, persons and time. To augment this, and provide an extended set of entities we additionally employ the online NER tool, OpenCalais[9]. OpenCalais offers a web service through which up to 400,000 classifications can be performed per day. It was previously the commercial product ClearForest but was purchased by Reuters and made available online. ClearForest has been previously shown to outperform other NER frameworks (Marrero, 2009). The named entity process assumes English text and the outputs are passed, along with all previous to the final fusion step.

Fusion, Integration and Scoring: As a final step the outputs of the keyphrase and entity recognition steps are integrated. First, each of the terms and phrases extracted by both phrases are validated. Any trailing whitespace or punctuation is removed. Stopwording is performed and all keyphrases are ensured to be a minimum of three characters and non-numeric. As each sentence is examined independently in the keyphrase extraction phase, the same term may be detected repeatedly. These are aggregated and where repeated encounters are found, the aggregated element is scored to represent total number of encounters in the document. The various approaches may overlap and detect the same key-term or phrase. For example, a noun phrase may also be determined to be a person name or a city. Where overlap from any of the entity recognition or keyphrase extraction steps occurs, these are integrated by selecting the preferred descriptive type. The preferential type is determined by ordering the duplicate phrases based on a set of predefined and

[8] http://incubator.apache.org/opennlp/

[9] http://www.opencalais.com

heuristically established priorities. The scores from duplicates will be summed into this single representation. Finally, temporal entities are removed as they do not hold information value. Following this, the scored output is returned and the detected entities and phrases are applied as themes to describe the original message.

6.3.2.5 Limitations

While the approach addresses many of the challenges presented by noisy short message documents in keyphrase extraction, it does not address all concerns. As noted in the discussion of these text types, spelling errors are common. Addressing this by provisioning support for spelling error detection and correction within the cleaning phase could contribute to greater reliability in the later steps. Furthermore, extracted keyterms and phrases may have multiple representations. For example, a twitter hashtag #CHI may be synonomous in many cases with the more specific hashtag #CHI2011. Alternatively, this tag may be represented in the more terse form of #CHI11 or may be included in the body of the text in a variety of forms including 'CHI 2011', 'CHI 11' or 'ACM CHI Conference on Human Factors in Computing Systems'. This could however be addressed by examining similarity to other keyterms within the corpus and mapping related terms. Acronyms could be identified and mapped to their expanded forms using computational approaches such as that of Schwartz & Hearst (2003) or Okazaki & Ananiadou (2006). Finally, a message may not reference present events but instead discusses past action, or planned future actions. As a result, extracting descriptive content may inaccurately label that moment with descriptors which would be better applied to another timeframe. This is not addressed within the theme extraction module. Temporal references within the text content could be detected and used to apply these terms forwards and backwards to other timeframes within the collection. This would help to overcome problems of temporality and mislabeling.

6.3 Indexing and Cross Annotation

With the themes extracted for suitable content and contextual sources, these are further mined to first to apply the themes to temporally adjacent media for which themes cannot be obtained. Following which indexes that will be used by the generation processes and describe the distribution of the themes within the collection are created.

6.3.1. Cross annotation

The extraction process determines representative themes which can be obtained from the text-based and contextual sources within the lifelog. A large volume of the content is composed from visual modalities (digital photos and SenseCam content) and we must consider how these elements can be annotated with suitable themes to describe them. We exploit the temporal nature of lifelogs in order to achieve this and apply labels from temporally adjacent content in other modalities.

6.3.2 Indexing

Not all themes will be of equal importance within the collection. For example, frequently occurring themes will be less useful in identifying interesting or relevant artefacts as they are likely to apply to a large number of items. As a result it is important to establish the distribution of each theme within the corpus in order to establish its utility in searching the corpus. This will be a key factor in the selection and generation process.

The continuous sampling and temporal nature of these collections is a unique component that can be capitalized upon in deriving weights for the themes and content. The temporal distribution of the themes can provide cues as to when they might be expected to occur and therefore if an encounter with that theme may be unusual, interesting and important to include within a retelling. The indexing step gathers information on the distribution of themes and this facilitates ranking of episodes and artefacts within the generation phase.

The index contains information on the encounters with that theme, their duration and cumulative weight as well as its general distribution within the collection. Finally a ‘typical’ pattern of encounters is derived. This is yielded by assigning each encounter to a summed bin. There are 168 bins each of which represents a distinct hour in each day of the week. Once all encounters have been assigned to the bins, they are normalized by values in the maximal bin. This then provides an expectation of that themes occurrence within a typical week and can be used to score an encounter’s novelty. The particulars of the weighting and selection methods which employ these indexes are discussed in more detail in Chapter 7.

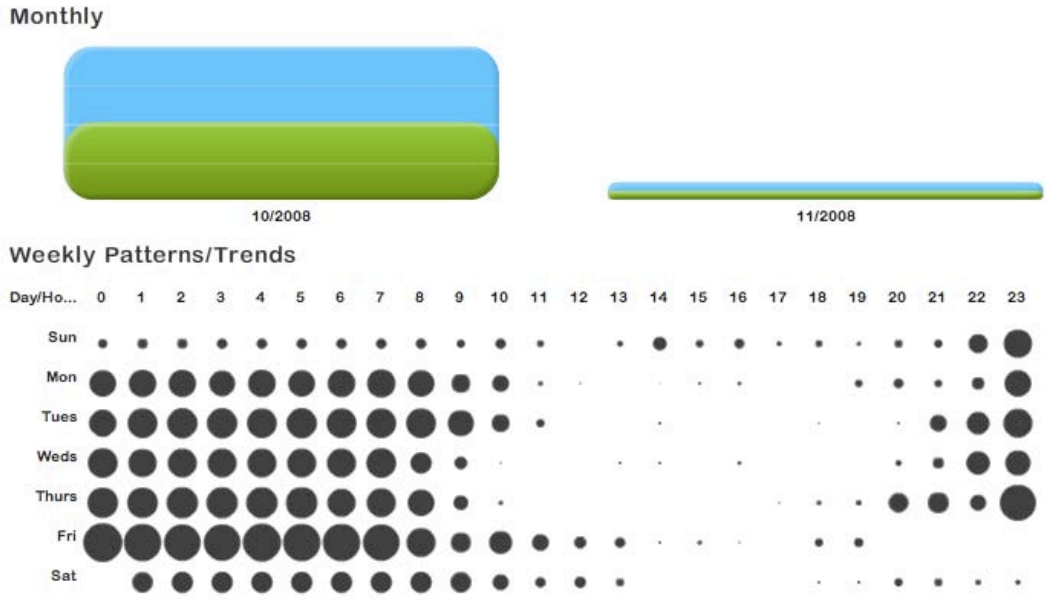


Figure 6.5. An illustration of the information captured within the Index.

6.4 Episode Segmentation and Aggregation into Story Units

The artefacts must be aggregated into a unit which aligns with the manner in which personal stories are constructed. Appan et al. (2004) make clear recommendations on such units. They advocate the use of an event-based model as the structure which should be employed within personal narratives and this aligns well with requirement elicited within Chapter 4. The aggregation into story-units is not only important to enable storytelling but sensible. It reduces the complexity of the collection by aggregating related content, allows redundancy in the artefacts to be identified and better aligns with the experience to be retold.

Approaches to episodic structuring in lifelog collections already exist. Doherty and Smeaton (Doherty et al., 2007; Doherty & Smeaton, 2008) have proposed a segmentation solution for visual lifelog content captured by the SenseCam. Using the visual features of the images and the sensor values recorded by the device, the SenseCam's images can be aggregated into a higher level unit, which they term an 'event', given that it tends to encapsulate a single activity engaged in by a user. This approach aggregates several thousand visually images into approximately 20 events per day. The authors report reasonably high performance of their algorithm (62.17% recall and 62.57% precision for boundaries with an overall F-Measure of 0.6237). O'Conaire et al. (2007) additionally explored the organisation of a visual lifelog but

instead of a segmentation approach they applied clustering techniques to group visually similar images from a day.

Similar approaches to event detection have been applied to mobile context data (Costabello et al (Costabello & Goix, 2008, Costabello, Rocha & Goix, 2008). They too favour the use of clustering algorithms to aggregate Bluetooth and GSM context data into groups of related content. They exploit the 'temporal distance' of such data in order to aggregate it into a set of temporary clusters. The temporary clusters are then further clustered using a MultiLevel Sliding window approach in order to 'smooth' the clusters and account for issues inherent with mobile context data, such as frequently jumping cell tower ID's in highly populated areas. A recent study conducted by Blighe et al. (2008) has shown that the use of GSM context information can also be applied to the segmentation of visual lifelog content and identification of unique settings in collections of such images.

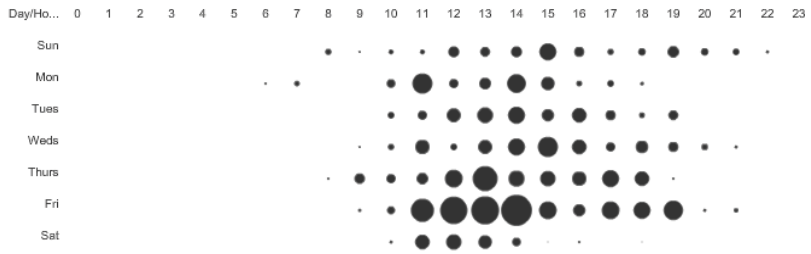


Figure 6.6. The pattern of SenseCam frames captured by User 3

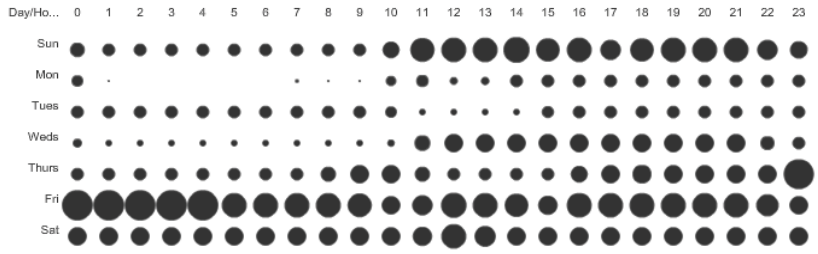


Figure 6.7. The pattern of Context Polls captured by User 3

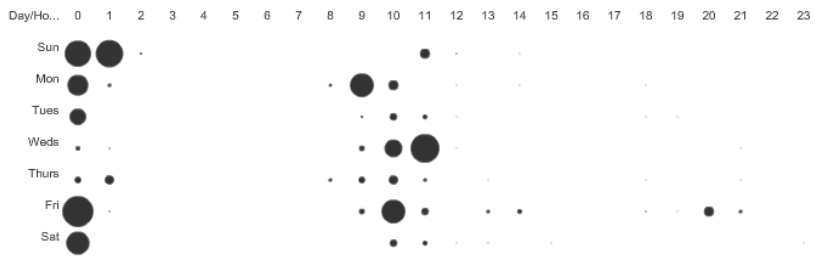


Figure 6.8. The pattern of Laptop Document Activity captured by User 3

Given the variety of content and context sources available within our lifelog collections, many of these approaches could be suited to our lifelog collections. Furthermore, it seems sensible to employ a segmentation approach which is applied to the passively sampled modalities. These modalities are sampled at regular intervals and provide detailed continuous records that can be used to identify changes in the user's environment. The detection of change can then be used to mark and detect likely boundaries between discrete activities the individual engaged in. However, using one modality in isolation to establish these boundaries is suboptimal owing to variances in coverage across the passive modalities. The coverage and compositions of the collections is discussed in more detail in Appendix V, however Figures 6.6, 6.7 and 6.8 serve to illustrate this point. Here we notice that for a sample month, no one modality offers continual coverage of all activities. Capture may be interrupted by the user removing or powering off a device, perhaps temporalily for personally or socially motivated reasons or may fail to record for a period due to problems with hardware or software. As a result, there are gaps in the collection's coverage where one or more modalities may not be available. In the below example, a distinction between midweek and weekend is clear, where the weekend days have been better sampled. The SenseCam was recorded typically throughout the working day but does not pervade early morning or late evening activities. Laptop use primarily occurred at the home where neither SenseCam nor context information was well covered. This variance in passive sampling overviews some of the complexities present in combining the passively sampled content into discrete episodes. The challenge is to identify the method to detect episodes which best applies to this lifelog archive given the multimodal activity channels available. In the next section, we detail our approach, multilevel clustering, which is designed to recover from these breaks in coverage.

6.4.1 Clustering Approach Overview

In seeking an appropriate method for the segmentation of multimodal lifelog content into discrete episodes, an flexible algorithm was sought that could be adapted both to the nature of the corpus and to the available passively sampled modalities. An additional requirement was that the approach should not require any a-priori information on the number of clusters, such as in K-Means clustering.

We identified the clustering approach of Kang et al (2004) as suitable for our purposes. They employ a time-based clustering (TBC) algorithm applied to location trace logs in order to derive significant places that a user encounters during a journey. A new place is found when the distance between the location of the previous place

and the new input location is beyond a threshold value, and when the total duration spent at a location is greater than a time threshold. Importantly the algorithm does not aggregate repeated visits to a location. While other approaches consider this a deficit (Zhou et al, 2007), it means that independent temporal sequences are kept distinct from one another allowing distinct episodes to be discerned. Hu and Wang (2007) extended this algorithm into the i-Cluster location extraction algorithm. They enhanced the algorithm to cater for repeated visits within a very short duration (for example a window of 10 locations.)

In adopting this algorithm we address two limitations to its use in episode detection. First, the TBC Algorithm requires continuous location data in order to reliably perform clustering and temporary breaks in coverage are not supported. Secondly, both the TBC and iCluster approaches consider only locations that have a long duration at which they are visited and ignore the transition intervals. In creating episodes, it is important that we consider both the times at which the individual was stationary or engaged in a single activity and those where they transition between stationary activities, i.e. traveling. We extend the clustering method to cater for these.

As illustrated in Figures 6.6, 6.7 and 6.8 the mobile context information typically has most coverage within the collections, thereby making it the dominant modality with the collection. Consequently, precedence is given to it in clustering for episode detection. Subsequently, any gaps in coverage are identified and episodes are detected for these periods using an alternative source, if one is available. The contextual samples may yield a long-duration episode where a person is stationary at one location, but within this location may engage in a number of different activities. For example, a person may be ‘stationary’ within a building containing their workplace but while there may engage in a number of sub-episodes such as walking through corridors, meetings, working at a computer, taking a short break, etc. To cater for this where long duration episodes are found, they are then further decomposed by passing them to a lower level clustering applied using another modal channel. This helps to better encapsulate and reflect the activities the user was engaged in. Document activity records describes the computer-based activities of an individual and are given priority in the decompositional step next. This is followed by the SenseCam content. Finally, if no passively captured sources are available, explicitly created media such as twitter content, SMS messages or photo capture are used to indicate an timeframe of interest.

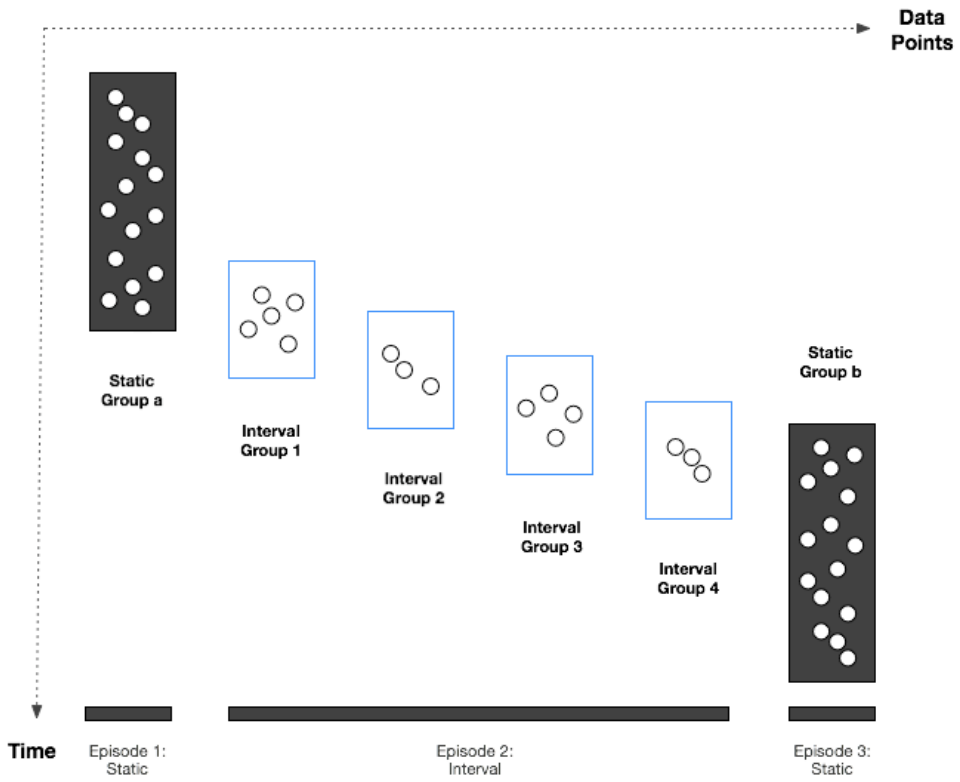


FIgure 6.9. A visual overview of the clustering method for episode detection

6.4.2 Description of the Cluster Method

We now outline the clustering method and the adaptations to the TBC method of Zang et al (2004). They explain its operation as follows:

"As a new location measurement is reported, the new location is compared with previous locations. If the new location is moving away from previous locations, the new location is considered to belong to a different cluster than the one for the previous locations… Suppose that the user moves from place A to place B. While the user is at place A, the location measurements are all close together (within a certain distance of each other – a parameter of our algorithm) and considered to belong to one cluster, namely, cluster a. As the user moves toward place B, the location measurements move away from cluster a. On the way to place B, a few small intermediate clusters are generated. And, when the user gets to place B and stays there for a while, a new cluster (cluster b) is formed. If a cluster's time duration is longer than a threshold (the second parameter of our algorithm), the cluster is considered to be a significant place."

6.4.2.1 Level 1: Contextual Clustering

As the first stage in the clustering step, context information is used to discern unique episodes existent within the event. The Campaignr software embedded on a mobile device is used to capture contextual information for use within the lifelog collections we amass. It does so highly regularly (every 30 seconds) and captures a variety of signal sources. These include copresent Bluetooth signals, WiFi signals and the local GSM cell tower the device is connected to. Using the WiFi and GSM information, each packet can be geocoded to optain a GPS position and street address. We use this derived location information in the first clustering stage.

Mobile context information can be reasonably noisy (Costabello & Goix, 2008, Costabello, Rocha & Goix, 2008) with, for example, frequently jumping cell tower ID's in highly populated areas. As such it is important to smooth the data prior to its use to account for such rapid transitions. An agglomerative approach to smoothing is taken. For each context packet i, the derived GPS position is compared to the i+1 packet. If the i+1 packet is identical, these two packets are aggregated and the process continues. If the i+1 packet does not contain the same GPS point, packet i compared to packet i+2, and aggregated if contains the same point. Each point in the series is compared to two subsequent items and aggregated if similar. A second pass over the data points is made. This examines each group and determines if another overlaps it and encompasses it based on the start and end time of the packets contained by each group. If a packet is determined to be a temporal subset, it is enveloped by the larger group. In so doing this seeks to remove short temporary jumps as a result of noise in the contextual samples. This is performed for each continuous sequence as a preprocessing step prior to clustering. This step is illustrated in Fig 6.10

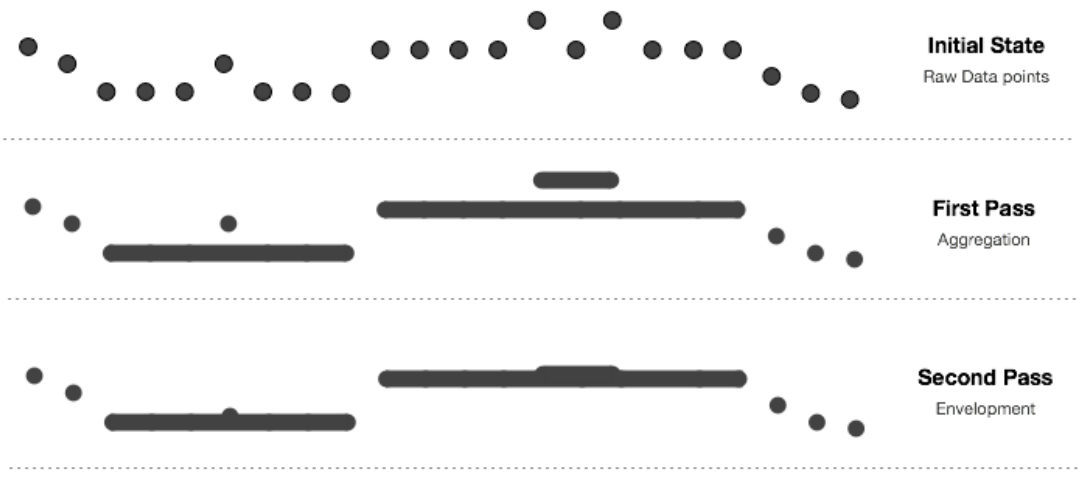


FIgure 6.10. An overview of smoothing contextually derived locations.

With the smoothing complete, the clustering is applied with an adjusted version of the TBC method. This algorithm is outlined in Table 6.3. As a the next location in the sequence is passed to the clustering algorithm, it is first checked against the previous one. If the difference in time between the previous location and the current item is more than a boundary threshold (set to be 3 minutes), then a new clustering sequence is commenced. This ensures that only continuous series are clustered. Any intervals from the previous series are checked and added to the set of episodes if they meet certain criteria.

	Algorithm 2: Adaptation of Kang et al. Method for Episode Detection in Context Data
	cluster(*loc*) input: measured location *loc* state: current cluster *cl*, pending location *ploc,* episodes Episodes *pending transition intervals pIntervals* previous location *prevLoc*
1	If timeBetween(loc *prevLoc) > boundary then*
2	addCurrentClusterToEpisodes( )
3	clear cl
4	add loc to cl
5	prevLoc = loc
6	else
7	If pLoc != null then
8	addCurrentClusterToEpisodes( )
9	clear cl
10	add ploc to cl
11	if distance(cl, loc) < d then
12	add loc to cl
13	ploc = null
14	else
15	ploc = loc
16	else
17	ploc = loc
18	
19	**addCurrentClusterToEpisodes()**:
20	if duration(cl) > t then
21	add cl to Episodes
22	If *pIntervals.length > 0*
23	If duration(merge(pIntervals)) > t then
24	Add merge(pIntervals) to Episodes
25	clear pIntervals
26	add ploc to cl
27	Else
28	add cl to pIntervals

Table 6.2. The Time Based *Context* Clustering Algorithm

Within the main clustering function, several variables are maintained across iterations of the algorithm as new locations are passed to the clustering function. The current cluster *cl* contains a set of nearby locations, the pending location *ploc* is employed to help reduce outlier entries. The ploc variable allows comparison between previous points to see if the user is actually moving from the location or if this is a spurious reading. As a new location in a temporal sequence is encountered, its distance to the mean position of the current cluster is compared to see if it is within threshold distance d (set at 30 metres). If it is within this threshold amount, the new location is added to the current cluster and the pending location is cleared. Alternatively, it will next check if there is a pending location from a previous iteration. If there is, the current cluster will be closed and its duration checked to see if it is greater than the time threshold t (set at 10 minutes). If the cluster is above the time threshold, it is added to the set of episodes along with a merged set of all the previous transition intervals between this cluster and the previous one added. This means that the stationary event at a place for great than time *t* and the transition event traveling to the stationary place are maintained as episodes. Following which the algorithm will clear the set of interval clusters, start a new cluster, adding the pending location to it, and check if the new location should be in this cluster based on their distance. If the new location is added, the pending location is cleared. If not or if there is no pending location, the new location is assigned to the pending location variable for the next iteration. In Zang et al's method, if the current cluster is found to be below the time threshold it is discarded, instead, we maintain a list of these discarded clusters in the pending intervals set. This set can then be used to generate the interval episode when a cluster of sufficient duration has been found.

Once the clustering is complete, the episodes detected by the algorithm are post processed. First the episodes are sorted chronologically and the n^{th} and $n^{th}+1$ episodes are compared. If there is a large gap in duration between them (greater than t/3, or approximately 3 minutes), a new episode is created and added between these two episodes. If there is a gap, but it is reasonably small, the respective start and end times of the two episodes are adjusted to close the gap accordingly. Next each of the detected episodes, including those which represent gaps in the continuous series, are examined for their duration. Episodes with long durations may embody more than one unique activity and may require further decomposition. This occurs if the duration is greater than 3t (or thirty minutes). This decomposition helps to validate, by using the sensed sources from another modality, if the episode is under-segmented. Decomposition is performed as follows: first SenseCam sensor readings are

employed; then or if no other modalities are available, any explicitly captured or authored media is used to create short episodes which encapsulate these media fragments. The steps involved are outlined in each of the following subsections.

6.4.2.2 Level 2: SenseCam Clustering

As noted in the work of Doherty & Smeaton (2008) the sensor channels gathered by the SenseCam offer an efficient means by which the content can be segmented. It additionally offers performance comparable to that of more intensive image analysis techniques. The 3-axis accelerometer readings offer a means by which low-level changes in activity can be detected with reasonable performance. Doherty et al (2007) note that sensor source is particularly effective in recognising setting and room changes. The readings from each axis are combined into a motion value by using the square root of the sum of the squares. The values are then smoothed using a simple moving average employing a window size of 7 items. The adjusted algorithm outlined above is instantiated with a time threshold of 5 minutes and a temporal gap of 3 minutes. The distance measure in this case is set to a tolerable level of change between the motion values, and established as a 5% difference.

6.4.2.3 Level 3: Explicitly Captured Content Aggregation

If no other content source is available the episode segmentation relies on the timestamps of any explicitly created media. This includes the capture of digital photographs, the authoring and receipt of text messages, and Twitter status updates. Being created rather than passively sampled, these may denote points of interest within the collection. For each item, where no other episodes have been created, a short episode of 5 minutes is created, centered around the media item. If authored media has been created within short burst, for example a sequence of photos captured, these are aggregated into a single episode using a window of 30 minutes, providing this window does not extend to overlap with other previously detected episodes.

6.4.3 Application of Themes to Episodes

With the episode detection complete, events are annotated and enriched with the details of concepts, people and places relevant to them. This is an important component of the representation layer within the narrative system as it defines the relationship between the story units (episodes) and the content they encapsulate. It also enables the episodes to be related to one another and recurrent patterns and thematic progressions to be discovered computationally. To achieve this, themes

encountered within the timeframe of the episode are retrieved. For each unique theme which occurs during this timeframe, the total duration of those encounters are found and the sum of the weights of the encounters calculated. The summed weights are then normalized by the duration in minutes and the resulting value assigned as the episodes affinity for that theme. A mapping between the theme and the episode is then established within the collection's structure.

6.5 Manual Augmentation of the Structure

While the goal is to automate much of this process, the collection owner, may at any point, augment, adjust or correct this structure as they see fit. They can contribute new themes, adjust the episodes or correct inaccuracies that may be present thereby bringing the collection into better alignment with the experience they engaged in.

Summary

The volume and richness of a lifelog collection motivates the need to automatically establish a structured collection. This structure must be appropriate and suited to storytelling and establish both the units of narrative and the relationships between these units. This low level structure is essential to support the representational and presentational layers for narrative generation.

As suggested by Appan et al (2004) and based on the findings of our probative studies, we adopt a thematic episodic structure. In this the artefacts are classifed and labeled by tags which describe the actors, settings and happenings of that experience. The importance of these themes are established to provide an understanding of their relative importance within narrative generation. Finally these artefacts are aggregated into episodes, the units of storytelling applied within the lifelogs.

To achieve this a range of computational processes are applied. The thematic extraction module enables the extraction of representative, descriptive tags from the mobile context and text-based documents within the collection. To achieve this it must in particular overcome the noisy and dirty nature of the short message forms a lifelog contains. The documents are cleaned and normalized and then entities which describe the social and semantic focus of these messages are extracted using pattern matching applied to the part of speech tagged document in combination with named

entity recognition. These themes are then cross-polinated across the modalities to ensure all artefacts are well labeled.

Episode detection employs a clustering based approach which operates on a number of modal levels. Starting with the mobile context information, the best covered modality, the collection is structured using location information into discrete units where the collection owner was traveling or stationary at a particular place. Where large timeframes are spent in a single activity, they may be further decomposed using another lower level modality. These episodes are designed to align and represent reasonably discrete experiences that the collection owner engaged in.

Through these computational processes in concert with user augmentation, the collection is organized sufficiently to support the generation process which is described in the following chapter.

Chapter 7

Semi-Automatic Narrative Generation

Overview

With the information appropriately structured and organised, generation of a narrative form can then be undertaken. The generation process begins with the user identifying a theme, topic or timeframe of interest. To facilitate the generation step, first the system will seek to identify a representation for the narrative by elaborating a suitable narrative path through the episodes contained within the collection. Relevant episodes are retrieved and ranked based on a combination of their overall relevance and in combination with a temporal weight for the themes. This assigns a relevance score to each of the chosen episodes and can be used to indicate a suitable number of artefacts which should next be chosen from each episode. The selected elements form a linear narrative path through the collection and this order forms the narrative's plot. Artefacts must now be chosen from each episode. For each episode, the artefacts are retrieved and ranked both based on relevance to the themes of the story and based on the fluency of the modality in retelling experiences. Artefact selection then proceeds by iterating through the ranked list and passing the top item to the coherency checking module. This inspects the item relative to those already chosen and ensures a minimum amount of redundancy and repetition occurs. The item will either be accepted or rejected and iteration will continue until all elements have been exhausted or the target number of items for inclusion has been reached.

The final step in this process is to visually present the chosen episodes and artefacts within album-based layouts. Each episode is considered to be a distinct chapter, with the spatial composition formed using the chosen artefacts. Based on the characteristics of the episode, the presentation processes automatically define a suitable layout algorithm as well as a visual aesthetic. This is then used to arrange and present the content within a 2-d spatial layout. The final output can be adjusted by the author to arrive at their envisioned narrative.

7.1 Introduction

In order to produce a narrative, we must first organize the collection into a suitable structure to facilitate storytelling. In this structure, artefacts are aggregated into story units of episodes and the relationships between these units are represented through the themes they are labeled with. The thematic knowledge further enriches this representation and the understanding of the importance of these themes within the narratives we might produce by mapping their distributions and typically observed patterns of occurrence within the collection. The previous chapter discussed how the organization of a lifelog into this storytelling structure could be achieved automatically.

These thematic annotations of the episodes will allow the generation process to interpret and understand the set of related episodes to be constructed into a personal digital narrative. These annotation enable: first the episodes to be placed in the greater context of the amassed life experiences; second the intelligent assembly of the episodes and their constituent artifacts into a story; and finally the end presentation to be constructed based on the expectations of the user.

Within this chapter we discuss how the narrative generation can occur using the structured information within our lifelog collections. We first outline a number of relevant approaches to modeling and generating narrative within digital systems. This places our approach within a broader context. The process of story distillation is overviewed subsequently. It requires three main stages: episode selection, artefact selection; and content presentation. The computational processes behind each of these stages are described in detail. This chapter serves to outline each of the representation and presentation steps used within the narrative generation process. This will be illustrated to explain the algorithmic approaches and how the functionality satisfies the requirements previously outlined.

7.2 Story Models for Narrative Generation

As outlined previously, Brooks (2003) states that a "*metric of intelligence is the ability to understand enough about the world to recount it in a story"*. This 'narrative intelligence' is the ability to organize experience into narrative (Riedl & Young, 2006). This organisation can be achieved through computational processes and Min et al. (2008) note there are two major approaches to this: linear and branching narratives.

A linear narrative, according to Riedl & Young (2006) is a "*traditional form of narrative in which a sequence of events is narrated from beginning to ending without variation or possibility of a user altering the way in which the story unfolds or ends."*
Alternatively, a branching narrative offers a more varied approach to story generation. The branching narrative is represented as a story graph, which consists of a series of nodes connected by conditional branches. The graph is often directed and acyclic and the nodes are typically linear, scripted scenes. After each scene, the conditional branches offer decision points for the user and describe the transition from one possible state in the story to another (Riedl & Young, 2006). Branching techniques are typically plan-based and require preconditions and goals to be carefully established by the author for all units of the story. This story generation method is recognized as an effective means to create coherent well-formed interactive story content (Iurgel, 2004; Hill et al. 2001).

While there are many approaches to modeling and generating narrative, the model must seek to provide a well-formed narrative. Magerko (2005) describes several aspects that are key to any successful storytelling model. These include:

- *Expressivity*: The author should be able to express and control the dimensions of the narrative and its plot, such as pacing and staging.
- *Coherency*: The author must be able to associate content within the context of the overall narrative to ensure logically unfolding stories.
- *Variability*: The narrative output should not be constrained to a single outcome. Multiple paths through the story units should be supported. The more possible orderings which are present the better the representation should be.
- *Fully structured*: The model should allow the author to 'explicitly define the space of stories' such that it fulfills the author's artistic vision for the narrative.

Magerko (2005) additionally notes that within interactive story generation the author should be able to provide a logical representation for the story as an input to the storytelling mechanism. The input required should allow the author to be as specific or abstract as he desires in terms of plot content and the presentation of that content. Smith & Hancox (2001) further contribute a set of desirable properties for a computed representation of a narrative. They assert this representation should "

– Include important events: A representation is only useful to the extent that it includes the 'important' events in a story. The most important events can be defined as those that are retained in the most abstract version of the representation;

– Be coherent: A representation should 'hold together and make sense' (Alterman and Bookman, 1990). While this is easy to say, it is much harder to specify. One of the main ways in which coherence is established is by linking event sequences together via various kinds of relation, of which causal relations seem to be the most important. Another way is extraction of the 'gist(s)' of a story, by finding one or more macro-events that summarise it;

– 'Cover' the content: The representation should include, either explicitly or implicitly, all of the events in the story. Any of the explicit events of the story that are left out of the representation should be recoverable from it, via further inference processes."

Prior work that has analysed structure of fairytales, folklore and popular narratives (Bal, 1997; Chatmann, 1978; Propp, 1968) is a common foundation for many computational story models. For example, Lawakami et al. (2003) developed a structural model for language generation based on motif networks inspired by such work. Many formal approaches to modeling digital narrative have employed such structures, and in particular story grammars. Grammars provide a templating language for narrative generation and define rules for the composition of that narrative (Tuffield, Millard & Shadbolt, 2006). Correira (1985) previously employed them with hierarchically organized units of text where the relationships between the text content were described with rule-based grammars. Story grammars are however viewed as having notable deficiencies and are widely regards as inflexible (Black & Wilensky, 1979, Lang, 1999; Tuffield, Millard & Shadbolt, 2006).

An alternative to story grammars is to employ a planning structures. Planning structures are often employed within branching narratives and use a story graph to represent the potential decisions leading to narrative's plot. The representation is formed from a set of nodes or plot points within the graph that are connected through directed edges in a partial order. Planning models require a language which defines how the story graph should be traversed, with each node having a set of preconditions defined. To reach a node those preconditions must be satisfied and often an error checking step is required. Plan-based structures are a popular approach within interactive drama. Façade (Mateas & Stern, 2002), Mimesis (Young et al, 2004), Tail-Spin (Meehan, 1977) and Universe (Lebowitz, 1985) are all examples of planning based approaches to modeling and generating narrative. Universe provides text-based narrative generation through a plan-based activity. It employs a library of plot fragments for which goals and plans are specified (Lebowitz, 1985). Mimesis employs partial order plans to fully structure the plot and relies on a STRIPS-style

planning representation to support replanning (Young et al. 2004.) Façade is a game-based environment which responds to a players interaction. The story is represented as a set of 'story-beats' selected based on the interactions with the user and sequenced for dramatic plot. A beat is selected where it fulfills a set of preconditions. Magerko (2005) also combines both branching and story planning approaches. Overall this approach is seen as "*advantageous because a narrative plan lays out the entire sequence of actions that will be performed during a storytelling session* (Riedl & Young, 2006.)" However a limitation of this approach is that it requires a formalized language where a large number of preconditions and constrains must be specified in advance of generation.

Magerko & Laird (2003) suggest a state based model for narrative as an alternative to plan based approaches. The major difference is that the representation of plot becomes a graph of desired states to be reached. In order to create the plot, the author specifies and describes the initial and final goal states. "*A state is marked with a transition from one state to another, which provides the relative ordering of how states should flow temporally*". Where more complex plots are required additional goals for the story which must be achieved. They demonstrate this approach through the Haunt environment (Magerko & Laird, 2003).

Another method for generating narrative using a graph-based structure is that of spreading activation. Smith & Hancox (2001) describe this to be "*one of the most influential paradigms for story comprehension*", and builds on "*psychological work on semantic networks (also called associative networks).*" The process operates through marker passing. A graph is iteratively traversed, adding incremental weight to the nodes within it each time they are encountered. Once a stopping condition has been achieved, "*the results of the spreading activation process are 'pruned' to obtain the most likely interpretation for a story. (Smith & Hancox, 2001)".* The ConTour application employs spreading activation in this manner to dynamically determine the relationships between story elements contained in a multimedia repository and enable emergent narratives to be formed from user interaction (Davenport & Murtaugh, 1997.)

Emergent narrative enables continuing but different narratives to be generated in a manner akin to improvisational drama (Louchart, Aylett, 2004a). As Louchard & Alylett (2004a) note the generation of narrative in response to interaction is distinct from the widespread use of authored accounts. Emergent narrative is commonly employed for real-time narrative environments. In such systems, the authoring and presentation stages are simultaneous, often with limited authorial control required. While the initial

state of the story may be defined, there will be no final state or goal defined, allowing the narrative to emerge over time as the author or agents interact. This approach is often suited to dynamic storytelling solutions such as role-playing games and virtual environments such as in the multiagent Virtual Storyteller system (Theune et al, 2003). Louchart & Aylett (2004b) suggests an multilayered narrative model, architecture and requirements for such interactive story generation. These emergent approaches, however, do not align well with the storytelling requirements for our system. Authored accounts are central to both the physical (see Section 4.2.3) and digitial (see Section 5.4) storytelling practices we employ.

Discussed in Section 5.2, Hargood, Millard & Weal (2009) employ a thematic approach in which digital narratives are built using an approach informed by the work of Tomashevsky (1965). Tomashevsky introduces a formal structure for narrative which narratives are built from natoms (narrative atoms), contain features and denote motifs. Hargood et al. (2009) structure a corpus of tagged Flickr images to adopt this thematic structure and generate photo compositions using this model. Initial evaluation showed promise with this approach but more rigourous investigation is required to prove it in the generation of narrative. Like the folksonomy approach of Hargood et al, Tuffield, Millard & Shadbolt (2006) suggest an ontological approach to narrative building which might be well suited to personal narratives. They note, however, that while ontologies capture a clear representation of the knowledge between events and items - a key element of coherent storytelling - it does not do so in a succinct or flexible way.

Brooks (1997) comments that many of the Propp (1968) based formalisms do not lend themselves to computationally authored accounts, as they require rigid sequencing. He suggests instead the use of a set of narrative elements to provide a structuring framework. These are based on the schema elements of Brannigan (1992) and incorporated into the AgentStories environment for meta-linear cinematic narratives. Appan, Sundaram & Birchfield (2004) subsequently examined this framework and its applicability to experiential accounts rather than fictive generative narrative. They discovered that the resulting narratives “seemed disjoint” and were “not very meaningful.” They cite these problems as stemming from the difficulty of labeling personal and experiential content with narrative categories; and forming and establishing causal relationships between everyday events may be difficult with the narrative structures often ignoring temporal and spatial relationships between everyday events. As a consequence of this finding, Appan et al (2004) posit that

formal models offer little utility within experiential storytelling and favour emergent and interactive approaches. Emergent approaches are open-ended and dynamically created, potentially yielding wildly different output each time an experience is explored. Our work has indicated, and in particular that with the scrapbookers, accounts should be authored. Authored approaches can, as the studies in Chapter 4 suggest, equally manage to avoid being disjoint and ensure meaningfulness. As such their finding runs somewhat contrary to the requirements we have established. While, as Appan suggest, traditional and formalized approaches to story generation may not be suitable for use with experiential accounts, we advocate, in light of the probative studies conducted, the use of a computation model for assisted authoring, rather than emergent, narrative.

We employ an approach which leverages concepts from Cheong et al (2008), more specifically their 'Kernel Extractor'. Cheong et al (2008) adopt a summarization-based method for story generation applied to story based visualisations of game log data. This has a relationship to multimedia content summarization, as noted by the authors, but goes beyond summarization by identifying and preserving narrative structures within the content. Underlying their method are plan-based formal structures for mapping the story graph. The story graph and plan based structures are not a component of our approach to narrative generation given the effort required on the part of the author to supply necessary preconditions and states for the narrative in advance of generation. Given the number of experiences and episodes within a lifelog this would be an enormous undertaking. Instead, we employ a more flexible approach suited to the story units we have constructed. This is outlined in more detail in the subsequent section.

Within the Cheong et al's summarizer (2008), two main tasks are performed: kernel extraction and coherency checking. "*Kernels refer to essential story events that cannot be eliminated from a potential summary without harming the reader's story understanding (Chatman, 1978).*" The summarizer has three main steps. First the *kernel extractor* identifies the kernels required for inclusion within the story by assessing their weight within the story. Next, the *coherency evaluator* examines the kernels selected to ensure that they are coherent and sensible for inclusion. This step ensures that both the narrative and its plot are well formed. Finally, the viewer model characterizes the viewing preferences. After summarization the selected log content, organized into a narrative representation, is passed to the visualization step where it is presented. This summarization oriented approach aligns well with the reductive

process observed in Section 4.3.2 when transforming lifelog content into storyform and with the ‘distillation’ of personal content for management and curation (see Section 4.2.1,5).

7.3 Approach to Story Distillation

In our approach we integrate learning’s from Chapter 4 with complimentary research into narrative generation and past prior work. As noted above, many of the story generation models are highly oriented towards the generation of fictive accounts or towards emergent story creation. These methods do not extend to authored narratives of past personal experience. We instead employ multimedia summarization strategies to reduce the content in tandem with narrative techniques to facilitate the transformation of lifelog content into a storied interpretation. This operates in a largely reductive manner seeking to ‘distill’ out the episodes and artefacts relevant to the narrative being authored.

The first step in this process is to identify the appropriate story units or episodes for inclusion within the narrative. This requires the narrative to be formed through the representational layer. The representation of potential narrative paths through the lifelog content is mapped through the associative relationships between themes and episodes. The significance of the elements can be established by looking at the global importance of that theme and its affinity to a given episode within the collection. This information is used to establish which episodes should be included within the narrative.

To form a coherent plot from these episodes, they are pruned to a sensible set which represents the salient elements of the story. To ensure coherence, the episodes are checked as part of a post-selection step to minimize redundancy and overlap. Plot is established by ordering the selected elements not by importance or relevance to the focus of the story but by positioning each episode in temporal order.

With the plot established, the content to represent the experiences encapsulated within each episode must be chosen. The various modalities contained within a lifelog have different affordances or *fluencies* in communicating the end story and this is accounted for within our method. Content is prioritized according to the fluency of each modality and this helps to ensure the right distribution of content is selected from the modalities to appropriately retell the story. Each modal channel is then examined and content relevant to the focal themes of the story are selected. These,

like the episodes, are checked for coherence which seeks to minimize overlap and redundancy. Finally, the chosen content is arranged in a 2-dimensional spatial canvas and, for impact and expressiveness, is visually styled.

In order to initiate the generation process, the author must first indicate the topic for their story. They may optionally limit the episodes and artefacts included to a period of particular interest. They must also specify the number of layouts, or chapters, that their story, or album, should ideally contain and the average number of elements that each chapter should be composed using.

The subsequent sections outline the computation approach to each of the major steps in the generation process. Finally discussion of how an author may feedback into this generation process to control, adapt and adjust the outputs is outlined.

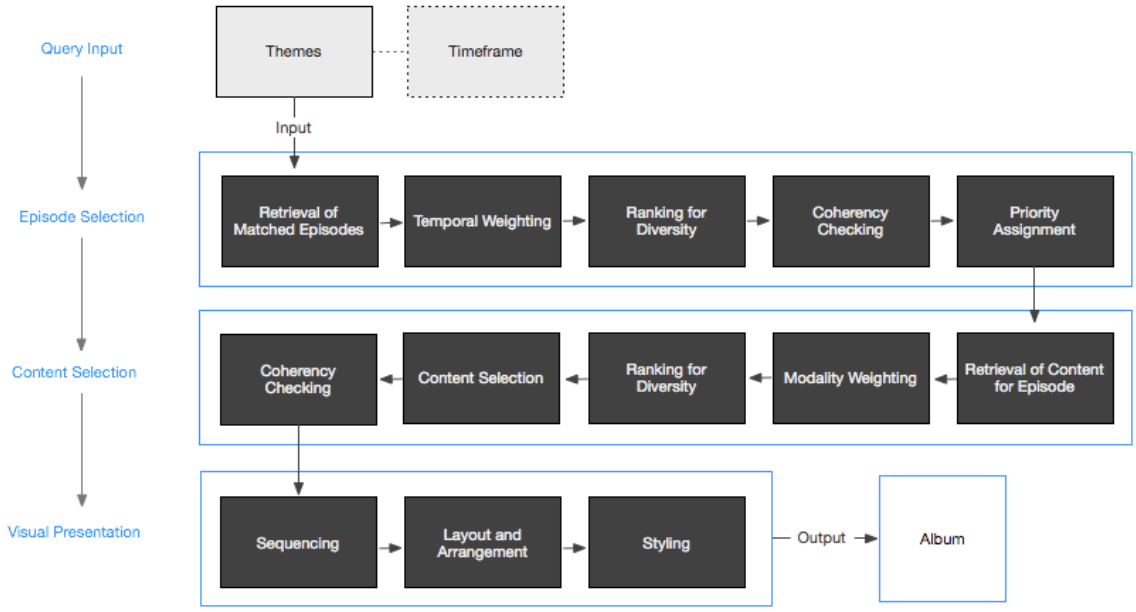


Figure 7.1. High Level Overview of the Generation Processes

7.4 Episode Selection

7.4.1. Retrieval

The first step in the generation process is to identify episodes relevant to the story under construction. This step is initiated by the user providing either a set of one or more themes which defines the focus of the story. They may optionally provide a date range to focus the retrieval of relevant episodes. The author must also provide a maximum number of episodes to be selected as well as the desired average number of artefacts to be chosen per episode. Once initiated, the generation step will consult

the corpus. Each theme input in combination with a date range if specified will seed a query to the collection. This will retrieve up to 100 episodes labeled with that theme along with the association score assigned. In addition to this, the temporal indexes for each theme will be loaded into memory in preparation for the weighting step.

7.4.2. Relevance and Temporal Weighting

The results for each theme are then scored independently. They will be fused and integrated in the next step.

Within document retrieval systems, TF-IDF is a straightforward and efficient algorithm which can be used to return documents that are highly relevant to a particular query (Ramos, 2003). It produces a composite weight for each term in a document which diminishes the overall importance of frequently occurring terms. Robertson (2004) notes this to be a "*heuristic implementation*" of the implicit knowledge that "*a query term which occurs in many documents is not a good discriminator*", however, despite being a heuristic approach it has "*proved extraordinarily robust."* To ensure themes that occur widely within the lifelog are given less weight in determining the relevant episodes, we employ a mildly adjusted version of the standard TF-IDF approach.

Within this measure, we employ the total unique encounters with themes in combination with the unique encounters for the particular theme being weighted as the 'inverse theme frequency' component where the 'theme frequency' is formed from association strength between the theme and the episode normalized using the duration of the episode to avoid bias towards longer episodes (see Section 6.4.3). This can be expressed as:

Theme Weight = $$w_{ti} = tfi \quad \times \quad \log\left(\frac{E}{ef_i}\right)$$, where

- tf_i = theme frequency or the associational strength between theme *i and the episode.*
- ef_i = encounter frequency or unique temporal encounters where theme *i* was present
- E = number of unique temporal encounters in the collection.

The term frequency approach enables us to temper the ranking of results based on the general features of the collection. It incorporates the relative importance of a theme within the collection as a whole. However, the lifelog is, unlike most document corpora, highly temporal in nature and we can leverage the linearity of the collection as a feature within the ranking of results. Heuristically speaking, if a theme regularly occurs within a given hour of the day or day of the week, we can assume that this represents a more habitual occurrence. Conversely, if a theme occurs infrequently at a particular time, relative to its other encounters, we could deem this to be a more interesting occurrence, as it is not of the norm. We can exploit the temporal features of the collection, and use the general pattern of encounters established during the indexing step (see Section 6.3.2), to further weight the episode for its expected level of interest. This temporal weighting also contributes towards narrative development. It enables the generation step to incorporate Ryan's (2005) temporal dimension for narrative by reducing the weighting for likely mundane happenings and promoting "*not fully predictable changes of state" and "non-habitual physical events."*

The temporal weight is created as follows. Using the temporal pattern established (see Section 6.3.2), each of the scores within the 168 bins (each bin corresponds to a distinct hour within a given day of the week) are normalized into the range of 0…1. The bin corresponding to the episode is identified. Where the episode overlaps multiple bins, the scores from those bins are aggregated in the appropriate ratio. This provides the expectation of encountering the theme at this point and is equivalent to a score of habitually. The temporal weight is the measure of expected novelty, and can be calculated as one minus the score of habitually.

The overall score for each theme within an episode is then calculated by summing the theme and temporal weights. This is as follows:

Theme Score = $$S_{ti} = w_{ti} \times \left(1 - w_{hi}\right)$$, where

- wt_i = TF-IDF weight for theme *i*
- wh_i = habitually weight for theme *i*

7.4.3 Ranking and Encouragement of Diversity

Scores for each theme and each episode were calculated in the previous step. In order to rank the set of returned results, the scores for each theme must first be

integrated. The set of episodes returned for each theme is aggregated and a score of the similarity to query *q* (the input set of themes) is calculated for each episode. This is calculated using the Fast Cosine Scoring algorithm as outlined in Manning, Raghavan, Schütze (2008). Scores are then cached for each episode.

In the selection of episodes for inclusion it would be advantageous to minimize the amount of overlap and redundancy. Moreover, it would be advantageous to avoid highly similar episodes being included in the end retelling. As such within the selection step we incorporate a measure of dissimilarity to encourage diversity within the episodes chosen for inclusion. By encouraging diversity, it should thereby include a wider range of options and increase the overall richness of the representation. To achieve this we employ an approach similar to as outlined by Halvey et al (2009).

A greedy algorithm is employed. Prior to initiating this algorithm the highest ranked episode is selected to start the process. This is added to a set of selected episodes, S. The set of themes applied to this episode is then compared to each remaining episode and a score of dissimilarity (1-similarity) is calculated. The remaining episodes are then re-ranked using the weighted harmonic mean below. The benefit of this approach is that it *"improves the diversity in the result set while still maintaining the similarity to the original query (Halvey et al, 2009*) ."

$$\mathrm{Re}\,lDiversity(e,S) = \frac{\sum_{i=1}^{n}(1 - Similarity(e,S_i))}{n}$$

$$RANK(q,e,S) = 2/\left(\frac{1}{Similarity(q,e)} + \frac{1}{\mathrm{Re}\,lDiversity(e,S)}\right)$$ where,

- q is the input query
- e is the episode being examined
- S is the set of selected episodes.

Each iteration of the greedy algorithm proceeds as follows. The remaining episodes are reranked using the formula above using the set of selected episodes. Following reranking, the top ranked episode is removed and passed to coherency checking (see Section 7.4.4.) If accepted, it is added to the selected set, otherwise the next item is iteratively checked until one is accepted. The algorithm will then iterate again. This will continue until all episodes have been exhausted or the upper bound for the desired number of episodes is reached.

7.4.4 Coherency Checking

The coherency checking aims to remove redundancy, repetition and overlap which may occur within the selected results. It aims to further augment the diversity encouragement within the selection step by ensuring a set of heuristics is met. In this, each candidate episode is further compared to the current set of selections. Two aspects are inspected: *temporal adjacency* and *thematic coherence*.

Episodes which immediately precede or succeed each other are more likely to overlap in the content, and in particular its visual content. In order to minimize repetition which may occur as a result, a threshold for acceptable temporal distance is established (at least 5 minutes apart). The candidate episode is checked against each previously selected episode to ensure this minimum temporal distance is maintained.

Episodes which present very similar thematic labels may embody very similar activities. Unless there is sufficient distinction between the two episodes only the best-ranked episode should be retained. The set of themes applied to the candidate as well as the association strength for each are compared against each episode in the selected set to ensure a thematic distinction is maintained (not more than 80% similarity).

Using these two features the following rules are applied:

1. If the temporal distance and thematic similarity are within the acceptable threshold for all items, the candidate episode is added to the set of selected items
2. If both the temporal distance and thematic similarity are unacceptable i.e. it is proximal and very similar, the candidate is rejected.
3. If either the temporal distance or the thematic similarity is unacceptable, the acceptable value must be significantly different. Otherwise it is rejected

7.4.5 Priority Assignment

Finally, for the set of selected episodes a priority is assigned. This is used to represent each episodes relative importance in retelling the experience. To calculate this priority, the score of similarity to the input query q is employed. The scores are examined and applied as a ratio relative to the other episodes.

7.5 Artefact Selection

For each selected episode, next a set of representative artefacts will be chosen to embody that experience within the end retelling. Using the priority assigned, the target number of artefacts per episode is established. This is calculated by multiplying the desired total number of artefacts for the story as a whole with the priority value. This affords those episodes calculated to be more central to the focus of the story opportunity to be overviewed in greater depth and detail. This approach places emphasis on the *cardinal* units while only briefly outlining those that are expository or *catalysers* for the main narrative (see Section 4.3.2.). With a target number of artefacts established, selection of episodes proceeds similarly to episode selection.

7.5.1. Retrieval and Channel Organisation

All artefacts aggregated within the episode are retrieved from the corpus and arranged by modality. This enables visual, text, contextual and thematic elements to be distinguished within the selection process.

7.5.2. Relevance Weighting, Ranking & Diversity

An episode represents a short continuous timeframe and as such the temporal weight applied within ranking the episodes will have little utility at this granularity. The IDF weighting is still applied to ensure precedence is not given to frequently occurring themes within the ranking of results. Ranking is performed as outlined in Section 7.5.3, however, each modality is ranked independently. Diversity is again desirable in the content selected.

7.5.3 Modality Weighting and Content Selection

Within artefact selection it is important to ensure that the experience is covered with content appropriate to its retelling. As described in Section 4.3.2 each of the modalities employed has a variety of affordances in retelling and may help to embody different aspects of the experience. This is described as their *fluencies* in retelling. Modality weights were established using the outputs of the evaluation in Section 4.3.2. This ascribes a relative importance to each channel in determining the content for inclusion in the end retelling. This weight is applied to each modality.

Not all modalities will be available within each episode and we must account for this. For the available modal channels, the weight is transformed into a proportional

representation – a ratio derived from the modality weight for the available modalities. This proportional score is then combined with the total number of artefacts to be selected. This produces a distribution for the artefacts across the available channels. Each channel is then organized in order of highest priority.

Selection proceeds using a greedy algorithm as follows. The modality with the highest priority is examined. For that modality, the most highly ranked artefact is removed from the queue and passed to coherency checking. If accepted, it is added to the set of selected artefacts, otherwise it is permanently removed from the selection step. The artefacts within that modality are iteratively examined until one has been selected or the modality is exhausted. When an artefact is selected, the modality's priority score is decremented. The artefacts in each modality's queue are next reranked against the set of selected artefacts to ensure diversity in the output and finally the modalities are reordered based on the new modality score. This places the modality with the greatest priority, and number of artefacts remaining to be selected, at the top ensuring it is the next to be examined. The algorithm then iterates. This will continue either until the upper bound for the number of artefacts to be selected has been reached, or all modal channels and artefact queues have been examined and exhausted.

7.5.4 Coherency Checking

The coherency-checking step is designed to ensure redundancy, repetition and overlap is kept to a minimum. This is particularly important within artefact selection. Visual content, in particular, the SenseCam content may often be very similar to frames which are near neighbours. Temporally proximal text content may discuss similar elements or there may be accidental repetition by sending the same message twice for example. The passive modalities may overlap with the explicit, for example with SenseCam content featuring the authoring of a text message or the capture of a photo.

As a candidate artefact is passed to the coherency-checking step the following is examined:

- If the artefact is a passively sampled visual frame, it is checked to see if it overlaps with explicitly authored content (Twitter, SMS, Photo) which has already been selected. If such content exists within a narrow timeframe of the candidate, it is rejected.

- If the artefact is thematic, it is checked to ensure it is not one of the input query themes. This avoids redundancy.
- If the artefact is text-based, the content of the message is examined with all other selected text-content using edit-distance. If the text content is largely similar it is rejected.

7.5.5 Priority Assignment

Content selection continues until all content has been examined or the upper bound is reached. Once all content has been selected a priority is assigned to the content elements. This priority is derived from the relevance score assigned to the content item multiplied by the modality weight. The scores are then transformed into a relative representation as in Section 7.4.5. This artefact priority can then be used within presentation to determine focal elements for the compositions to be created.

7.6 Content Presentation, Layout and Arrangement

Following the selection of episodes and content from each episode, the content must be arranged into a visual analogue of the story. As described in Section 5.5, the Orison tool composes stories with a 2-dimensional spatial narrative. An album encapsulates a single story; the chapters it contains each represent a unit of the overall story and their ordering forms its plot. Chapters contain compositional layouts produced from aesthetically presented media fragments which have been sensibly arranged. In Section 6.4, we outlined that within the lifelog structure, the lifelog content or artefact is aggregated into episodes and that these episodes represent story units. As such, chapters align with the organizational unit of episodes. Within the layout and presentation step, each episode which has been selected for inclusion within the story becomes a chapter. The artefacts selected to represent an episode, each become an element within the chapter's spatial composition. To translate each episode into a chapter-based layout, two steps occur: first the artefacts are visually arranged, and next the content is aesthetically presented.

7.6.1 Layout

To layout the artefacts for an episode into a chapter-based composition, the system employs a set of computational layout algorithms. These algorithms emulate commonly observed layout strategies within scrapbooked layouts. These are briefly outlined below and illustrated in Figures 7.2 and 7.3

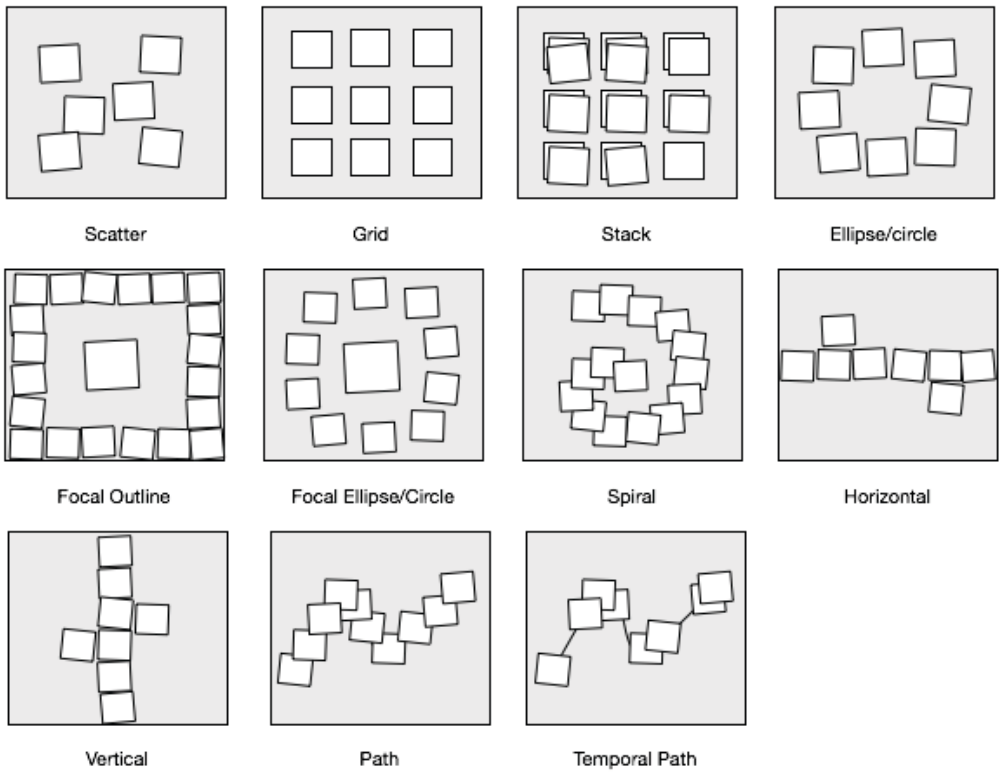


Figure 7.2. Illustrations of the layout algorithms

- *Scatter:* Elements are placed randomly within the confines of the layout. The vertical, horizontal, and rotation are all elements which may be varied. This placement may be used to give a collage type effect where media fragments overlap one another.
- *Grid:* Elements are placed in sequence in a series of columns and rows. Columns and rows can be spaced for clearance between the elements. A jitter parameter may also be specified to give a more natural placement and feel to the grid. This specifies an allowable range of variance the object may be placed from the centre of its target cell. Elements may be ordered chronologically, by media source or by the score assigned to them during the selection step. The placement within the grid may also be started from any of the four corners.
- *Stack*: Elements are laid out similarly to the grid-based approach, however, the elements can be grouped. Grouped elements appear progressively stacked, one on top of the other. Elements may be grouped by time, themes or by modality. Grouping is performed for time and themes by K-means clustering and this is initialized with the target number of cells.
- *Ellipse / Circle*: Elements are arranged in a circle. Ordering can be specified as with the grid arrangement as well as specifying an angle at which the layout

should commence from. It can be specified if the elements should form an ellipse or a perfect circle.

- *Focal Outline*: A single focal element is displayed centrally in the layout. The remaining elements are arranged around the edge of the layout and frame the focal item. The focal element is chosen as the best scoring artefact from the selection step.
- *Focal Ellipse/Circle*: A single focal element is displayed at the centre of an ellipse or circle. The remaining content is placed around the central item. Focal element is chosen as the best scoring artefact from the selection step.
- *Spiral*: Elements are arranged as part of a spiral starting from the centre of the layout. Each element increases the distance from the centre, gradually moving along the path of the spiral.
- *Horizontal*: Elements are arranged horizontally across the layout and aligned to the vertical centre. Elements may be ordered from left to right by score, modality or time. If grouping is applied, elements within the group are stacked vertically and aligned to the vertical midpoint.
- *Vertical:* Elements are arranged from top-to-bottom in much the same manner as the horizontal approach.
- *Path*: Elements are placed along a curved path starting from the left hand side of the screen and moving left. Elements may be ordered and are evenly spaced along the path.
- *Temporal Path:* Elements are placed along a curved path, however the distance between them corresponds to the temporal distance between the elements. This helps to create a timeline of artefacts as the time between the components of the experience can be visually overviewed.

For an episode, one of the above layout patterns is applied using a set of heuristic rules to determine which is most appropriate. Minimum and maximum sizes for the artefacts to be added to the layout are specified depending on the number of elements and layout approach applied. Alternatively, the author may provide parameters to the layout algorithms to configure how they are applied and make them better suit their own preferences.

Figure 7.3. Layouts produced by applying the scatter, grid, ellipse and path layouts to the same content.

7.6.2 Styling

With the elements included in the visual layout, a set of styles is applied to the media fragment. All elements may have a border or frame applied. Text content will be styled with a suitable typeface, font size and colour. Similarly any captions on the media item will be styled. Finally, a background image will be applied to the chapter.

7.7 Authorial Control

The author is afforded a great degree of control over the episode and content selection process as well as the visual arrangement of element on screen. The user can not only specific the focus of the story by providing a set of themes relevant to the focus of the story and a timeframe to which the selected lifelog content should be filtered, but they may also feedback on and adjust the outputs of the selection process.

Once the generation process has been completed and prior to the created album being commited to the user's library of stories, the user can preview the outputs. The previous provides an overview of the episodes and chapters selected as well as the visual composition for each chapter. The author may then adjust any of these elements.

First they may review the episodes selected for inclusion. As required, they may optionally remove an episode from inclusion. They may also review the set of matched episodes for the set of themes specified and opt to include alternatives to those the system selected. This can help overcome computational shortcomings in either the structure of the lifelog or in the computational components of the generation step.

Next, for each episode included in the story, they may 'tweak' how it is translated into a chapter-based layout. The author may review and manually adjust the episodes or artefacts selected for inclusion. They may also manually specify the theme to be applied or the layout approach to be adopted. When satisfied with the generated album, they then save it to their library. Once in their library, they may revisit it any point to freely adjust the layout, styles or arrangement for any of elements within a chapter. These edits are unconstrained and may be performed as outlined in Section 5.5.2.

Summary

The generation step is designed to support an author in distilling the lifelog content into an expressive representation for an experience of interest. The step seeks to identify the episodes and artefacts from the lifelog which satisfies the author's envisaged story, enabling them to quickly compose their envisioned creation.

Rather than taking a formal approach to narrative generation, such a plan-, schema- or grammar-based methods commonly employed within digital narrative techniques, we adopt a summarization-oriented technique. This is informed by Appan et al. (2004) who note that such formal strategies do not lend well to narrating accounts of past personal experience and that of Cheong et al's (2008) who show the potential of a narrative 'summarizer' in creating storied interpretations of large datasets.

The units of storytelling within the lifelog collections we have amassed are 'episodes' and as a first step in the generation process we identify episodes relevant to the story under construction. The selection of non-habitual content is encouraged by incorporating a temporal component to the weighting of results, while diversity is promoted through the use greedy algorithm to re-rank results after each selection. Finally, coherence is ensured by attempting to minimize the overlap or repetition between selected episodes. These three components attempt to ensure that the narrative broadly satisfies the information and narrative needs of the author. Each

selected episode then becomes a chapter within an album-based layout and the plot is represented as temporal sequence from first to last.

With the plot and episodes established, the content that will be displayed in each chapter must be identified. For each selected episode, its content is examined computationally. The fluency of each modal channel is considered so that the content selected may best communicate the experience being retold. The selection of content is mindful to ensure that content is suitably distributed across these channels. Coherency checking ensures that the chosen artefacts are clear, consistent and repetition is kept to a minimum. Once selected, the artefacts are visually composed into a chapter-based layout using a set of presentation algorithms. Finally, the media fragments are styled to be aesthetically pleasing and to create an expressive representation of the experience.

While the generation step reduces the burden on the author in creating an authored account, it affords a great degree of control to the author. They may provide feedback on the selection process at any point, to ‘tweak’ adjust or refine its outputs. Alternatively, they may revisit the albums and chapters produced to manually adjust, edit or refine the layout.

Chapter 8

Evaluation: Collection Owners

Overview

With the generation and presentation system outlined and the various components of the system independently evaluation, we now explore the efficacy of story creation as a whole end-to-end process. Three collection owners engaged in narrative construction tasks. They identified a number of stories present within the collection: both short-term episodic stories and broader life narratives. We evaluate the system in composing both story types as well as in manual, guided (or semi-automatic) and automatic construction. The participants composed 5 stories per condition or a total of 30 stories each. For each task the participant provided qualitative and quantitative feedback on the systems efficacy in generating narrative. This was facilitated through a rubric-based evaluation framework designed to be suited to the personal narratives being authored and to provide a measure of quality for the created works. A questionnaire additionally probed the narrative output constructed, any problems encountered, the process of construction, how they felt about revisiting the content, and recollections and new appreciations as a result of constructing the story. The systems' usability and appropriateness to story construction is examined, after which the quality of the narrated output produced for each condition is examined.

The freeform feedback on each of the stories is examined and we compare and contrast the various conditions to see which promotes reflective thought and new appreciations.

8.1 Introduction

The previous three chapters have outlined the system's core functions in manually composing, in automatically structuring and in supporting the author in creating narrative accounts through generative processes. Within this chapter, we investigate the efficacy of these processes by examining the narrative output the system can deliver. We engaged the lifelog collection owners, involved in creating long-term

multimodal lifelog collections as part of this research effort, in a series of narrative construction tasks. The outcomes of this were examined in order to investigate the efficacy of the system and its approach in supporting an author in personal story construction. We also explore its utility in empowering functional offerings of that narrative such as in reflection, reminiscence and sharing of experience.

8.2 Participants

Three long-term lifelog collection owners form the study participants (1 male, 2 female) and took part in the evaluation. Participants all had amassed a lifelog in excess of 20 months containing a wide variety of personal multimedia and context information (see Appendix IV). These collections contained in excess of a million data points (see Chapter 5.2) and widely sampled the day-to-day activities of the individual through SenseCam, mobile content and document activity capture.

All of the participants were postgraduate students within the faculty and had good computing experience. The participants did not have prior exposure to the user interface, though some familiarity with the concepts and technologies could be expected as all were involved in the research effort to amass lifelog collections and had been involved or attended prior discussion of the work at research meetings. All users had some previous experience with the use interactive multimedia systems. No incentive to participation was provided. It should additionally be noted that Participant 1 is the main investigator within this work and as a result has knowledge of the desired outcomes for this work and must be treated as a special case within reporting. This is discussed further Appendix IV.6.

8.3 Method

Prior to introducing the tool and in order to evaluate the storytelling system fully, participants were asked to identify suitable story creation tasks. This is described in detail in Appendix VI. A task generation framework was employed to support the user in eliciting sufficient number of interesting stories from their personal lifelog collection. The goal of the framework is to ensure that the tasks employed within the evaluation of the system broadly survey the range of personal narratives a user might want to create. Furthermore, it encouraged the participants to consider what experiences were captured within the lifelog and available for storytelling. This was conducted as a free recall phase which provided a series of usable stories which were subsequently

re-described as story generation tasks. This elicited 45 tasks in total per participant, of which 25 task represented everyday stories about short episodes while 20 represented more intimate life stories about either aspects of identity or broad periods and themes within their life.

Participants were provided with the software, Orison, required to complete the evaluation. The participants were instructed on the use of the system and its features, and were also provided a user manual that outlined its major functionality and explained its operation and installation. Once installed, participants were instructed on how to import and time align their multimodal lifelog content. After which, the collections were processed to identify themes and was then segmented into discrete episodes. Given the volume of the collections involved, this process took a number of weeks to complete. Participants did not annotate the collections manually prior to the evaluation in order to determine the efficacy of the automatic steps without additional correction or improvement by human augmentation of the labels or structures applied.

Tasks within the evaluation were performed as follows. Each participant created stories: *manually* without any computational assistance; *guided* where the author selected an episode from a set of recommended episodes and iterated in this process until it was completed; or automatic whereby the author specified the desired parameters and the system generated the narrative without further input. For each method of story generation, the user was asked to complete 5 tasks categorized as everyday stories and 5 tasks as life stories.

Participants were asked to familiarize themselves with the system and the process of story authoring prior to commencing the evaluation. Once familiar with the system, they were asked to complete a series of tasks selected from the set they had generated. The participants were asked to complete 90 story construction tasks, 30 for each generation mode and 45 for each type of story. The story construction exercise was completed over a 2-week period.

A questionnaire was administered across various stages of the evaluation. After each narrative construction task, the users were asked to review the created story using the full screen presentation mode (see Section 5.5.3). Once the playback had completed, the users were asked to provide subjective ratings both on the systems performance and in the quality of the narrative produced using the system. To do this a rubric was employed and this is described more deeply in the next section. Additionally, they were asked to comment on the process of constructing the story, their motivations for

creating the narrative, their approach to its construction with personal media; and any significant considerations they may have encountered either while constructing or during review. Finally, after completing all assigned topics, the participants were asked to provide general feedback on their experiences with the user interface and completed the System Usability Scale (Brooke, 1996) to provide a standard measure of the usability of the system. This questionnaire is presented in full in Appendix VII.

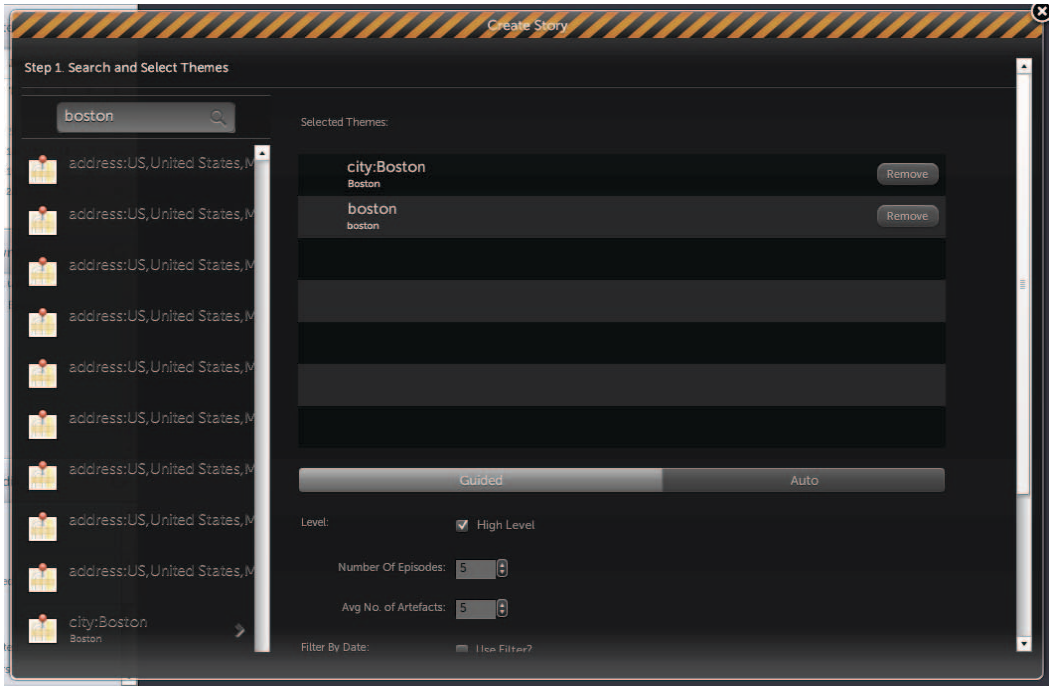


Figure 8.1: The Story Generation Panel

8.4 Evaluation Framework

With the authoring system implemented, we evaluated the digital narratives it produces along the following dimensions: the presentation and narrative form; the ability to enable reflection and reflective practice; and the potential utility for communicating and sharing of personal experiences. However, at present there are no formal methods or frameworks for the evaluation of digital narratives and as part of this doctoral work we also investigated how best to evaluate the outputs of such a narrative system.

There is no consensus on how a digital narrative should be evaluated or the criteria for their evaluation. As such, many working in the area fail to report their evaluation strategy with sufficient depth for it to be useful to others or repeatable (Appan, Sundaram & Birchfield, 2004); opt for a highly qualitative or informal approach to

evaluation (Brooks, 1999; Harper et al., 2007); or omit evaluation (from reporting) altogether (Sack, 1999; Szilas, 1999; Tanenbaum & Tomizu, 2007).

One means to the quantitative evaluation of digital narrative output within lifelog content would be to adopt the approaches taken with the summarisation of Rushes Content (Over, Smeaton & Kelly, 2007). Within the TRECVID summarisation evaluation, participating sites seek to compress raw unedited footage, with high numbers of retakes and large amount of consequent repetition, to within 2% of its original using a variety of techniques. The resulting video content is then evaluated using a standard set of benchmark measures including coverage and flow or usability of the summary. Coverage of the narrative of the original content is a sensible metric to be included in narrative evaluation, however, it should be noted that narrative is not just summarisation. In fact there are clear distinctions between the goals of the two. A good narrative is to be emotive, expressive and most importantly engaging, while a summary attempts to communicate as much information is as compact a space as possible. As such other measures must be considered to temper the notion of coverage and more fully appraise the goals of a narrative. We believe that there are four major dimensions by which a narrative should be evaluated:

1. **Form and content:** The choices of what to show and how to show it are fundamental to a good digital narrative according to Tanenbaum and Tomizu (2007). Within lifelog narratives multimodal content will be presented to the audience and as such both the fluency of the media chosen and the mode in which it is presented will have significant impact on the communication of the meaning and focus of the story. We must as such consider how to appropriately measure and compare such factors.
2. **Coherence:** Coherence is integral to a good story. The quality of the end narrative is determined by how well organised and well paced the content is presented and the pace at which the plot unfolds. McAdams notes the complexities of coherence in organic personal stories (McAdams, 2006) and indicates that while important it is subject to a large number of influencing factors. Furthermore within interactive and digital narrative according to Bruckman (1990), there is a careful balancing act to be maintained between the provision of control and freedom to the audience over the story and the story's coherence. Coherence can likely be metricated through the level of control provided, the perception of distortions or 'jumps' in the story and/or attempting to ascertain the overall flow of the story.

3. **Expressiveness and affect:** Our life stories are experiential and often are highly bound to our emotional (or affective) state. As such, the resulting stories must sufficiently express these affective and experiential components. There are many ways in which the affect may be represented within narratives, one example is the use of colour to represent mood or emotional state (Tanenbaum & Tomizu, 2007). The evaluation of expressiveness should not focus on the mode of presentation however but how successfully the narrative conveys and communicates these experiential aspects. These can be assessed through metrics and heuristics as suggested by de Lera & Garreta-Domingo (2007).
4. **Engagement, Impact and feedback:** Brooks asserts that an audience should actively desire to know the outcomes of a story, and with a better narrative, the experience becomes much more engaging; achieving just that (Brooks, 1996). This engagement is a vital component for any story not just lifelog-based stories and as such we must carefully consider it within any evaluation. Although likely difficult to accurately and reliably elicit such metrics, we assert that evidence of personal engagement with the story should be recorded and reported in some manner.
5. **Integrity:** In addition to these general components of good quality narrative, within personal storytelling, we also consider integrity a key component. We maintain that a persona story of past experience generated by a system should report, present and describe that experience with reliability. It is important that the experience, through transformation into a narrated account, not be distorted or overly embellished, such that it might misrepresent the happenings which occurred. This requirement was highlighted in Chapter 4 in particular within discussion of genealogical practice (see Section 4.2.2.5).

To evaluate the quality of the narrative, and by proxy the efficacy of the underlying computational approach, we employ a rubric. Rubrics are frequently used to evaluate storytelling, however, mostly within educational contexts (Barrett, 2006; Sadik, 2008). Several examples have been developed specifically to rate the outputs of digital storytelling exercises, as a means of reflective learning (Sanders, 2009; Sadik, 2008; Barrett, 2006). Rubrics as Goodrich (1997) explains are "*is a scoring tool that lists the criteria for a piece of work, or 'what counts' … it also articulates gradations of quality for each criterion, from excellent to poor*." A rubric is a scored scale that can be used to enlighten understanding of a set of criteria within creative undertakings (Allen & Tanner, 2006). As Sadik (2008) notes, it emphasises the overall quality of the work by providing extensive description and definition. Further motivating rubrics as a suitable evaluation mechanism, is their previous use in assessing the capabilities of lifelogged

media in other studies. Fleck (2009) provides a rubric framework for the establishing the quality of reflective thought provoked through review of SenseCam accounts. An additional advantage offered by rubrics is that they are effective for use by others without the need to be administered (Sadik, 2008; Goodrich, 1997). This is a key factor within our evaluation. As the narrative output produced by the participants reflects deeply personal aspects of their life, many ethical and privacy concerns (outlined briefly in Appendix IV, more deeply in Byrne, Kelly and Jones, 2010) place constraints on this evaluation. As a result of this, direct access to either the participants collections, outputs or created work was not permitted as part of the ethical procedures put in place within this research effort. The rubric, enabling independent evaluation to occur, was very suitable to these needs.

To compose the rubric for this evaluation, a number of widely available rubrics for digital storytelling, most oriented toward use in educational exercises, were reviewed and evaluated (Sadik, 2008; Goodrich, 1997; Sanders, 2009; ITS Digital Storytelling Rubrics; UMass Digital Storytelling Rubric Assessment). Suitable criteria within each were noted, compiled and integrated. These were validated against the five criteria outlined above to ensure completeness with the addition of an element relating to integrity. The criteria were finally checked for relevance and appropriateness to our storytelling tool, its spatial storyform, and its functionality. Each criteria in the rubric is scored between three to zero points from best to worst case. The final rubric is presented in Table 8.1 and its placing with the story creation questionnaire is presented in Appendix VII.

8.5 Results and Discussion

Within this section, the outcomes of the end-to-end user evaluation are discussed. We present the findings in terms of the system's usability, its efficacy in generating narrative accounts; and finally in the functions that this may empower.

8.5.1 System Usability

Overall, all of the participants expressed favourable opinions of the user interface. One participant (P3) noted it to be "*very powerful*" while P2 commented that they "*liked the way you have one easy place to view lifelog [with the tool] and that can easily browse through it*."

Focus			
The focus of the story is established early on and maintains focus throughout	The focus of the story is established early on and is maintained for most of the story	The focus is generally clear, but there are lapses in places	It is difficult to discern the focus of the story
Style - General			
The style is original, fresh and compelling	The style is clear	The style is basic	The style is missing or weak
Style - Appropriateness			
Overall design has aesthetic appeal/ease of use consistent with purpose/audience. Style is highly engaging and well suited to message of the story	Overall design has good appeal and is reasonably consistent with the purpose and to the intended audience	Overall design has adequate appeal but shows some inconsistencies with purpose/audience.	Overall design is unappealing and inappropriate for purpose/audience Style is more distracting than helpful
Creativity			
Complete originality in composition and delivery, strong evidence of critical thinking skills	Creative, striking theme maintained consistently – extending value and meaning to the message	Theme appropriate for topic and audience	Theme(s) used inconsistently or inappropriately for topic and audience.
Content			
Content is clearly relevant to story and its focus, message is distinctly clear.	Content has some relevance to the story and its focus, message is clear with some confusing points	Content has little relevance to the story and theme, message is not clear	Content has no relevance to story and theme, there is no evident message.
Fluency			
The content chosen is highly fluent, expressive, detailed and original. The content helps to express the meaning of the story in an inventive way	Fluent with some details	Reasonably fluent but unclear in places.	Lacking fluency, details or originality
Layout Organisation & Sequencing			
Graphics & story content are organized in a clear, logical way within the layouts. This makes the story easy to follow.	Most information is organized in a clear, logical way. One picture or media fragements seems to be out of place.	Two or more media fragments seem to be out of place making the story difficult to follow.	There is no clear story. Story elements seem to be sequenced randomly.

Chapter Organisation & Sequencing			
Story chapters are organized in a clear, logical way. The order in which they are presented is sensible and helps convey the meaning of the story	Most of the chapters are organized in a clear logical way. One chapter appears out of place.	Two or more chapters seem to be out of place making the story difficult to follow.	There is no clear story. Story chapters seem to be sequenced randomly.
Presentation			
Transitions, effects and audio are appropriate to the subject manner, add to the flow of the story and do not detract	Most transitions, effects and audio are appropriate to the subject manner, add to the flow of the story and do not detract	Some transitions, effects and audio are appropriate to the subject manner, add to the flow of the story and do not detract	Little to none of the transitions, effects and audio are appropriate to the subject manner, do not add to the flow of the story and do detract
Economy			
The story is told with exactly the right amount of detail throughout. It does not seem too short nor does it seem too long.	The story composition is typically good, though it seems to drag somewhat OR need slightly more detail in one or two sections.	The story seems to need more editing. It is noticeably too long or too short in more than one section.	The story needs extensive editing. It is too long or too short to be interesting.
Coverage and Completeness			
Biography covers full story of the subject. All significant points included	Biography covers story of subject with most major points included	Biography covers only part of story of subject. There were many significant points missing	Biography does not cover the subject
Coherence			
The story was easy to understand and the elements it contained were sensibly chosen and clearly related.	The story was reasonably easy to understand as most of the elements were clearly related	It was difficult to see the relationship between the story elements and this made the story hard to follow	It was difficult to understand what was being retold and the elements of the story did not appear related
Integrity			
Truthful and appropriate account of the experiences.	The story is largely truthful and appropriate with only one or two minor inconsistencies	The story presents a somewhat realistic account but with several inaccuracies	The story does not present a realistic account of what occurred

Table 8.1: The Personal Storytelling Rubric employed.

All participants agreed they liked both the user interface and the experience of working with it. They additionally considered the organization of the user interface to be clear and consistent throughout, and this validates the design effort outlined in Chapter 5. While favourably disposed to the user interface, there was some difficulty expressed with navigating between its views, in particular between the album and scratchpad views. These views were nested within a single section in the navigation hierarchy and accessed from the 'Albums' option in the menu. Once inside this section, two compositional spaces could be switched between by toggling a button in the bottom right of the screen (see Section 5.5.2). Conceptually this seems to have created difficulty for all users. P1 illustrated this by commenting: "*Sometimes I found myself getting a bit lost. The album, scratchpad and chapter edit view is a bit complicated and maybe they should be separated.*" Additionally, P3 comments "*I found switching between the scratchpad and albums and edit view sometimes confusing - I didn't think to click bottom right.*"

To further demonstrate the general usability of the system, it scored highly on the SUS questionnaire. The three participants reported a 77.5% usability rating. All agreed the system was easy to use and that the functions of the system were well integrated (1 strong, 2 agree) and disagreed that the system was cumbersome (2 disagree, 1 strongly disagree). All users disagreed with the statement the system was unnecessarily complex. When asked about using the system regularly ("I think that I would like to use this system frequently") responses were in agreement. However, the learnability of the system was less commended by the responses. Given the level and scope of functionality within the system this is to be expected and would be an area for future improvement by the inclusion of interactive training resources and help features.

8.5.1.1 Browsing

The user interface and functionality provided in support of browsing, identifying and filtering content was agreed by all participants to be easy to use (2 very easy, 1 easy). However, despite the success of options and user interface elements in supporting browsing, participants reported difficulty in finding the content they wished to locate. Two participants expressed the views that it was difficult to locate the content in support of their stories. There are two compounding factors which may explain this. First, the volume of the collections makes identifying content difficult, as there may be large volumes of content present within each day. Second, to identify content the user will often need to know a date upfront. In many cases, the exact timeframe of an

activity may be difficult to discern. A comment from P2 supports this, as they stated: "*I couldn't remember the dates for items, so I randomly browsed through dates to find stuff.*" An alternative strategy was employed by P1 who "*normally started by trying to find the right timeframe. Then I'd browse by the SMS or Photos or Twitter messages to see if there what was interesting or relevant.*" The participants also indicated that the general performance of the user interface in retrieving and displaying items was an issue. Owing to the very large collections, in some cases it could take a noticeable period of time (more than 30 seconds) to return results. P3 commented that "*the volume of content means it can be pretty slow to load sometimes. You just have to sit and wait for it."*

8.5.1.2 Composition And Layout

When composing layouts manually, all of the participants agreed that the scratchpad was useful, however two of the participant's indicated some difficulty in achieving their desired layouts with ease. In particular, they found the resizing and positioning of elements posed challenges and constrained the layouts they might otherwise have created. P3 noted: *"Its not very easy to resize items when editing an album, but of course it can be done by editing the numbers in [the overlay] window."* P3 also acknowledged that they had not become fully accustomed to the story editing intereface, while P2 mentioned that they found it to be a "*nice system…once they had gotten used to it.*" These comments indicate that better training and support for early users may be required, particularly for the authoring steps.

In composing their layouts, the users noted some of the constraints of the editing functionality. This included not being able to copy elements from one chapter to another (*"Sometimes, I wanted to use the same items for more than one chapter. It would be great if there was a copy function");* that manual story composition always required to be placed in the scratchpad initially ("*It would be great to be able to add a chapter too without having to go through the scratchpad all the time*") and that only one story element at a time could be manipulated within the editing view (***"****multiple selection for items in the scratchpad and album would make it easier to move them around.").* Not all of the feedback critiqued the functionality, with one participant noting that the provision of a set of themes and styles was an excellent feature. They commented that *"the styles and themes are really nice, they help you to get started on a layout fast."* The display of content within the story was also well received with another participant commenting that they "*love the little location maps and that you can include the Bluetooth names*" within a composition.

8.5.2 Performance in Generation

As outlined above, and in order to evaluate the narrative output for quality, we developed a rubric framework. For each created composition, completed the rubric and reported. This assessed 13 criteria scoring each with a maximum of 3 points, giving a total possible score of 39 points for each narrative. Using the feedback garnered from the participants, the rubric feedback was analysed and aggregated. The rubric score is presented as a percentage of total in reporting and the performance for the story types and authoring modes is presented in Figure 8.2 and in Table 8.2.

It is important to note that the manually composed stories may be considered a benchmark for the system. The manual stories require content to be identified from the collection without any system support. It also requires the author to manually layout, present and style all elements within the compositions. It is very effortful, but carefully crafted. As a result of this effort, the manual narrative produced by the participants may be considered the 'high bar' for the system to reach. However, in examining Figure 8.2 and Table 8.2 we can see that despite this effortful composition and creation, the manually composed narratives only score 62% for quality. This highlights the complexities involved in achieving ideal or 'perfect' narrative forms. While some of this may be attributable to the current limitations of the system and its user interface, as outlined above in Section 8.5.1, in practice and with effort many of these limitations could be overcome. Given that these manually compositions scored to have only fair quality, we must set reasonable expectations for the performance of the computational elements.

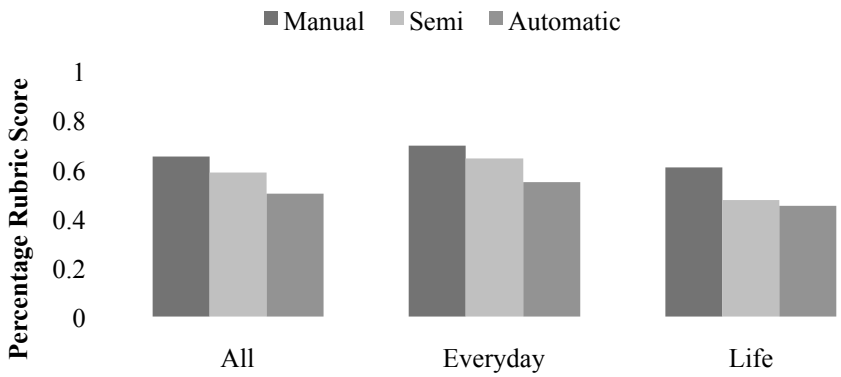


Figure 8.2 A Breakdown of the Scores Reported

In examining, Figure 8.2 we notice that producing a coherent and high quality narrative for life stories is more challenging. This is not unexpected as they span far larger periods and have higher demands on the computational processes. However, it is encouraging that the everyday stories were produced to a similar standard with the guided approach (64% quality) as in manual (69% quality).

The rubric output is further decomposed and the average scores for each criteria overviewed in Table 8.3. For all criteria, the manually composed narratives outperform the system authored approached. Interestingly, the manually composed narrative is viewed as having considerably more integrity than either of the automatic approaches. There is also a marked difference between the performance of the automatic system in producing focused and coherent narratives, in layout organization and sequencing, and in chapter organization and sequencing. This indicates that the automatic layout algorithms, as well as the construction of plot through the generative processes may require further refinement. Overall, the guided approach provides a middle ground between the effortful compositions of the manual process versus the less coherent but minimal effort automatic generation. This is likely due to the continual feedback into the guided generation step that the author provides. This compliments the position of Brooks (2002) where he asserts the role of the author is important to help shape narrative elements into a coherent form.

In addition to the rubric-scoring, the questionnaire administered to the participants explored their perceived satisfaction with each composition they had authored. This was scored on a 5 point Likert scale in the range 0-4. To validate the reliability of the rubric framework in assessing the narrative quality we examined both scores to see if they were correlated. As illustrated in Figure 8.3, there is a strong positive correlation between the subjective measure of satisfaction and the scores produced using the rubric framework. This finding supports the efficacy of the rubric framework developed.

Rubric Criteria	**Everyday**	**Life Story**	**Total**
Manual	0.69	0.61	0.65
Guided	0.64	0.47	0.59
Automatic	0.55	0.45	0.5
Total	0.62	0.51	0.57

Table 8.2 Rubric Scores Reported each variable within the evaluation

Rubric Criteria	All	Manual	Guided	Automatic
Focus	1.54	2.09	1.50	1.16
Style - General	1.68	1.45	1.80	1.80
Style - Appropriateness	1.76	1.91	1.75	1.68
Creativity	1.35	1.27	1.30	1.48
Content	2.04	2.50	2.00	1.72
Fluency	1.59	1.73	1.65	1.44
Layout Organisation & Sequencing	1.91	2.41	1.85	1.56
Chapter Organisation & Sequencing	1.91	2.36	2.10	1.40
Presentation	1.56	1.23	1.80	1.68
Economy	1.63	1.91	1.80	1.28
Coverage and Completeness	1.51	1.73	1.60	1.32
Coherence	1.87	2.32	1.95	1.44
Integrity	1.88	2.45	1.75	1.56
Total	**22.25**	**25.36**	**22.85**	**19.52**
Min	8.00	16.00	12.00	8.00
Max	37.00	37.00	35.00	37.00
StDev	7.52	5.44	6.94	8.41

Table 8.3 Scores Reported for each Criteria within the Rubric Analysis

8.5.3 Analysis

Examining the participant's feedback, the complexities of creating a complete narrative is highlighted. In many cases, particularly, with the automatic processes the participants regarded the stories as somewhat incomplete. Their feedback noted the compositions to be "*Definitely elements missing. Definitely" and "it does not tell all aspects, its not very complete.*" A perception of incompleteness stemmed particularly in the automatically generated narratives from two elements: desired content or modalities missing from a layout or entire episodes missing from a story. One participant commented on a life story concerning a friend, that it was "*great that [the automatic generation] got SMSs for the events. They reminded me of these events and my relationship with the person. But I would have liked some pictures. The pictures it included depicted other people.*"

However, the notion of completeness was more complicated than it might at first appear. Completeness in practice is difficult to achieve even for the manual storytelling tasks. When composing the life stories, and in particular for those which

concern personal relationships, the number of experiences, episodes and events which could be involved are normally plentiful. Even if a story was well composed and reasonably well regarded it may be still be considered incomplete: "*it isn't complete as it doesn't tell all aspect of the relationships but I couldn't find more images*"; "*the story isn't complete but it has a number of nice points in it*." A lack of coverage or completeness did not mean that the narrative was considered a failure. Often those which only surveyed a number of the experiences were perceived to be very valuable. For example, comments to this effect included: "*it doesn't cover the whole event, but it gives a nice snap shot of the conference"; "it doesn't tell all aspects of the weekend, but gives a nice little overview through in the available photos"; "its not fully complete, as it doesn't tell all elements. That being said it is a nice summary, with some of most important parts shown. Yeah, I like this summary.*"

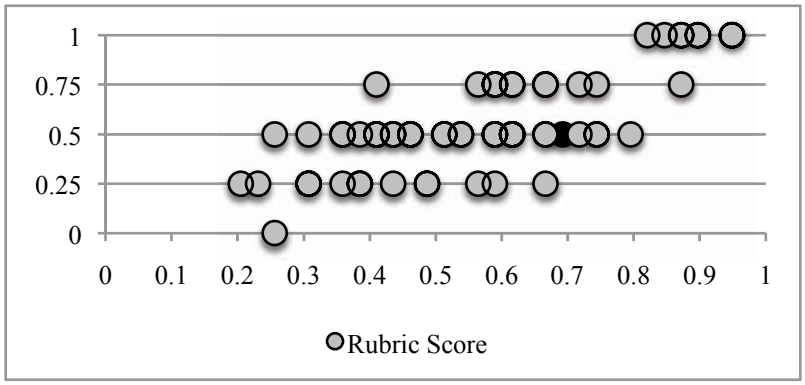


Figure 8.3 A comparison between the subjective measure of satisfaction with the Rubric outcomes. We can see these are well correlated.

These examples additionally tease at the two key issues underlying the success of the end narrative. These are the ability to identity and include the content most appropriate and the presence of the desired content within the collection.

In many instances during the story generation tasks, poorer outcomes were attributed to the coverage of the collections. The participants often clearly envisioned what real world experiences they would like to include in their narrative regardless of if the content was preserved and available within the lifelog collection. This created significant expectations on the output. In a number of cases, the content the author desired simply was not present within the corpora due to capture issues, or coverage of the modalities.

Participant 2 noted one such instance in which *"two episodes for the story are not included as no relevant data was captured. SenseCam and Campaignr data was*

missing, and unfortunately, no digital photos were taken." In another instance, the story generation was unsuccessful again due to collection coverage: "the major interesting parts of the story are well covered and presented with digital photos, but still there are some important aspects of the story that were not captured …, and unfortunately, the SenseCam data seems to be missing for that entire period. This means some aspects of the story can not be presented." Participants also speculated about media which was not captured through the lifelogging technologies employed but that they would have liked to have included in the retelling: "*Also, the important information for this event was through conversation, I may have also took notes on my computer, and there were a series of emails related to this event which were not available in current data collection*". Participant 2 in particular expressed some regret where the collections did not fully cover the experience: "*There's a lot of content missing for the last year [for this story]. I'd have loved there to be more about this.... I wish I'd captured more photos about these bits*". Participant 1 desired to create a story relating to a personally significant wellbeing topic but much of the media required had not been captured as the events primarily occurred within a location where individuals had a reasonable right to privacy.

This issue of coverage constrained the potential narrative output in more ways that just the availability of content for retelling. Mobile context was an integral component of the structure not only in the segmentation of episodes within the collection, but it provided continuous labels of the locations, devices and places. This description with mobile context enabled episodes to be identified for inclusion within a generated narrative. However, if the mobile context was not available, then episodes were only sporadically labeled where text based content was present. This presents a challenge to the generation processes and indicates that automatic labeling alone is not sufficient to enable this generation to occur. As such, manual labeling by the collection owner will be important to help recover from these omissions.

The findings outlined are an encouraging first step, but it is clear there are many complexities inherent in the use of lifelog collections within the generation of narrative. Issues including the coverage and distribution of content across collections, and aligning the real-world experience with available content in the corpus require deeper consideration. Considering the volume of content and experience contained within these collections, it may also be helpful to attempt to try and manage users expectations by disambiguating between the perceived success, utility and value of

the narrative and its coverage of the major aspects of the experience. This will be particularly important within storytelling for broader experiences and life stories.

8.5.3 Functional Possibilities

8.5.3.1 Recollection and Remembering

The process of creating a narrative from the media within the lifelogs in several instances stimulated spontaneous recollection about that past experience: "*There was one tweet and I saw that and a flash of the day came back to me. I just remembered all about it. A long leisurely late lunch and just a really nice afternoon."* This is in keeping with findings from other studies such as Lindley et al (2009) and Harper et al (2007). Several of the storytelling tasks elicited feedback such as "*I had forgot all about that*" or "*I'd forgotten loads of details about this…"* One participant summarised this describing how the review of media in the manual storytelling tasks "*brought the event back to my mind and got me starting thinking about it again.*" Another described how "*seeing the stuff from my lifelog reminds me of the events and of my feelings at the time, and about my feelings about the people involved.*"

In many instances the review of the content triggered some recollection, "*on seeing the photos of the event, the event started coming back to me.*" However, recollection did not occur in all cases. For a large number of tasks, no recollection or reminiscence whatsoever was reported. Often the participant was motivated to do so, but could not access the particulars of the happening: "*there are many details and episodes I have forgotten, and there are some actions that I can not figure not even after viewing the images.*" Where poor quality media or unsuitable cues to the experience are available, an individual may struggle to identify the experience which is depicted. While the quality of the media and cues within the lifelog may be a component of this, given the number of activities captured within the lifelog, and the time which had passed since their capture, it is not surprising that many of the details and episodes which the system may present to a user may have been entirely forgotten. Furthermore as a lifelog will indiscriminately capture both everyday and unusual with equal regard, it may be difficult for an individual to distinguish some events with ease. In these circumstances, the participants often carefully reviewed the available media but without much success. "*There are some episodes that I have totally forgotten, and even after viewing all the SenseCam images from that episode, I was unable to recollect what was happening and why we did that.*"; "*There's lots of details and*

episodes I have forgotten, and there are some actions that I cannot figure not even after viewing the images."

Generally speaking, "*by reviewing the images, [they] did have a much better recollection of the details on that day*." Through the lifelog content participants could reconstruct and infer many of the details of the experience: "*I remembered details that I have almost forgotten, things like what exactly these people look like, what my friends were wearing, and things like that."*

"*I was in a fairly happy mood when creating one chapter of this story, as the images reminded me of the gorgeous weather on that day. And it was nice to see the images. I had actually forgotten one part of the visit but the images helped bring back some vivid memories. I actually forgot the exact name of the institute that I was visiting until I saw it's name on a WiFi label.*"

8.5.3.2 Reminscence and Examination of the Past

Some of these recollections were coupled with more emotive accesses into the past. The review sometimes brought out "*happy thoughts*" about the moments being depicted. Participants also reported enjoyment and engagement around the review: "*it's really nice to see it back.*"; "*I loved that it had included the trip up to the [place]. That was really memorable, so it was great to have that included. It was really nice to see that back from start to finish*." Many of the trip-based experiences were, in particular, catalysts for reminiscence. On participant comments on reviewing a holiday they had taken, that they were: "*very happy to review the photos, even happier than when I was actually there, as if the images brings sunshine and a feel of summer.*". Another participant described the engagement with the story which had been created about a trip to a conference:

"*It was really nice to see the [x] again... some great photos were included and the system created a really nice layout. I could remember from looking at the photos of the conference where I was and what I was doing. I remembered the particular track it was in. It was really clear what was going on and why I was there. There was also a sequence about going out for dinner with some of the other attendees. It was nice to have them featured prominently as they were such a big part of the whole experience. I could remember some of the jokes and even people who weren't in the images."*

This revisitation of the past in a very small number of cases afforded the individual an opportunity to look back and consider their value. A participant talking about

reviewing SMS exchanges and their nicety, remarked "*that person never really featured in the Sensecam footage, it was interesting to see the other parts of the relationship. It was a lot about the exchange of SMS messages and it was really interesting to see how much we texted when I was away.*" Discussing the ability to look back on the everyday another participant observed that "*it's nice to think back on all the little things. It makes you appreciate them all the more*." These new appreciations and understandings were prompted by the review of the everyday.

The review of the past occasionally prompted comparison with the present. One participant reviewed personal milestones as part of their life storytelling in the exercise. This activity seemed to, in particular, stimulate reflection on the past from the perspective of the present:

"It's strange to think how…how much has changed from year to year … how relationships have changed…It's also so strange to think how much can change in just a few years in all aspects of your life – your career and where you're living."

8.5.3.3 Sharing Experiences

Surprisingly, participants indicated they would share only a small number of personal stories composed. They expected that they would only share 38% of the stories. This was biased towards everyday, and shorter-term stories, (42%) while a smaller number of life stories would be shared (34%). Initially this may appear discouraging, but in examining the only the manual compositions, this figure increases significantly where 54.5% of stories would be shared. 63.5% of manually composed everyday stories would be shared, while only 45.5% of life stories would be shared. As the manual compositions can be considered the 'gold standard' within this evaluation and should be of higher compositional quality than the generated counterparts, this distinction indicates that the quality of the composition may be an important factor in the decision to share with others.

In particular, participants indicated a strong preference for sharing trip-based everyday stories. Friends and family were seen as the most likely recipients of any shared content, being explicitly referenced in the feedback on nine occasions. There was also a strong preference to share the created works with those who were present during the experience or depicted in the media. This was formally referenced on 6 occasions and informally in substantially more places. P1 commented that they would share created compositions with those involved, as they would "*get a kick out of seeing the footage of the event back.*" In a very small number of cases, the author was

happy to share these everyday stories widely: "*I'd be happy to share it with anyone*." Finally, a strong case for sharing a life story emerged if it concerned the development and progression of a relationship. In that circumstance, it was viewed as nice to exchange the story for shared understanding. Generally, however, the life stories were viewed as highly intimate, more so than the everyday: "*It's pretty personal though, so I'm not sure [who I'd share it with]. I'd need to know the person pretty well*"; "*I think I might share it with someone who knew me very well… but only if I really knew them*"; "*It's pretty personal in some places. But I might show it to someone close to me*." Despite a reluctance to share life stories there was some sparse reference to their utility in communicating personal development and growth, especially if it concerned a broad period. They might learn "*how things have changed a lot over the course of a few years. It might let them see who I was then and where I am now...*", while another indicated that the life stories would allow an audience to "*see what I'd done year to year*";

The content included within the story was often important to its perceived value in sharing experience. One participant commented of a composition "*It's a really interesting experience, and full of nice scenes, would be fun to share it with friends*." Another comment indicates they might, for example, share compositions "*for fun [as] some pictures are very interesting*".

As noted above, when the experience concerned a trip away, there was an indicated preference towards sharing. One participant (P3) indicated they were "*interested in talking about travel experiences*" with friends, to explaining what they did during the holiday for those "*who weren't there*", while another discussing a trip away said of the composition "*it would be nice to show [friends and family] the trip*" through the created work. Trips and holiday experience would not just be shared to facilitate discourse about personal experience but could also inform and share ideas. For example several comments on sharing such experiences indicated these stories could have much value for those planning to visit the location: "*For people who might like to visit that place, I would like to show them some images from it to give them some ideas.*"; "*There should be some nice pictures captured during this story and it would give them some ideas for their visit to the city.*"

Not all stories would be shared and there were a number of reasons why they might not be. First, and given the nature of the collections, the story may be too personal. An element of content contained within the story might also expose personal

information. One participant noted that if sharing they "*wouldn't include my SMS or emails*" as they were considered too personal for general consumption. Next, the author might have created an interesting composition but might not have an intended audience in mind: "*I would probably show it to others, but I have no potential audience in mind at the moment*." While a story might be personally significant, it may not be viewed as having meaning, relevance or interest for others. This was another reason for it not being shared: "*It's not that interesting a story to tell really, as I think few people would be interested to hear about this now.*" The later part of this comment indicates that some stories may also have a temporality - that the experience may be relevant for sharing for a time - and that should too much time elapse, its potential in this regard will diminish entirely. Finally personal preference also plays a factor. One participant in particular did not perceive there to be much utility in exchanging experiences in this way. They comment that "*to be honest, I do not think I am really the type of person who with sit down with others and show them digital stories of mine. maybe .. if I had more free time I would want to do it, who's to say*."

8.6 Conclusions

Within this chapter we have outlined a framework for the evaluation of personal digital narratives through the use of a scoring rubric for quantitative assessment of quality in combination with a questionnaire to garner qualitative feedback. We engaged the collection owners in 6 story generation tasks for two major types of story (everyday and life stories) across 3 modes of generation (manual, guided and automatic). The rubric established the quality of the narrative produced for each.

We note that while manual storytelling is effortful, achieving a 'perfect' narrative is difficult in practice. Even with the effort exerted in composing personal stories manually, there was still room for improvement within the reported quality. Creating narrative comparable to manually composed narrative is deemed to be the desirable goal for narrative generation. Comparing the guided and automatic approaches, we noted that the fully automatic generation of narrative had some deficiencies. However, a guided interactive approach to story construction works well. This approach bridges the affordances of both processes. It enables an author to feedback into the generation process and inform, shape and refine its outputs at each step in the selection, while it minimizes the effort required on the part of the author as they do not have to exhaustively browse, search and identify content suitable to the story under construction.

A number of challenges to the efficacy of generative approaches were identified. Firstly, the coverage of the collection may limit the experiences which may be retold and the lack of particular content may create a mismatch between the expectations of the user and the ability for the system to produce the desired outputs. Secondly, decreased coverage may negatively impact on the structures employed by the system to support the author in story construction. Manual augmentation of a lifelog corpus will as such be a vital component should such a solution be employed in practice. Furthermore, it may be advantageous to extend the modalities and thematic annotation processes to provide more redundancy across modalities in the classification of the corpus. It is currently overly contingent on the mobile context sources for success.

Finally, we highlighted the value of narrative to the author. We noted in particular its use in the sharing of experience. However the propensity to share may be constrained by the quality of the narrative. The quality of the narrative output is bound in many ways to the functions it may enable. Qualitative feedback indicated that the content selected, its arrangement and coherence is also important to facilitating retrospective recollection, reminiscence and reflection.

As final remark on the efficacy of the system, overall, we consider the performance to be reasonably good for a first of its kind implementation. The multimedia strategies employed may be refined, augmented and improved by extending and enhancing the multimedia approaches employed. Furthermore, the reasonable performance of the guided approach, further motivates our position that a semi-automatic approach to narrative generation is preferable. We would also recommend that any generation step encourage the manual refinement of compositions immediately following generation. This would afford an opportunity for any computational imperfections to be corrected and refined.

Chapter 9

Evaluation: Motivated Third Parties

Overview

Within much of this work, emphasis is placed on the first person use of the narrative output and the system, however it was acknowledged in the requirements elicitation that often these stories move beyond the first person perspective. We saw how geneologists employ storytelling to explain the lives and times of individuals long since passed in order to make that data more assessable and comprehensible. We saw that often in oral traditions stories may be passed on and retold to disconnected individuals and may be shared beyond the immediate family. Here we explore this and the utility that narrative from lifelog collections might offer to third parties. We consider that the media may not be immediately comprehensible to a third party with no knowledge of the individual and that the collection owner may have an essential role in the meaning making and distillation of significance from a lifelog. This is explored by providing a nine-month subset of a lifelog collection to fifteen media editing students who had no prior knowledge of the collection owner or his environs. They were tasked with exploring the content through the storytelling tool and creating compositions about the collection owner.

9.1 Introduction

Within this work, Chapters 7 and 8 have explored in detail the potential for narrative construction from lifelogs to offer such opportunities to their collection owners. These collections clearly offer profound opportunities for insightful self-exploration through data (Li et al., 2010, Lindley et al., 2009; Fleck, 2009) and lifelog collections and applications have been employed in a variety of scenarios to offer the collection owner benefits in terms of self-examination, reflection, reminiscence, and sharing of past experiences (see Chapter 8; Hodges et al, 2006; Harper et al., 2008).

We are, however, often supported in these efforts. Motivated third parties like biographers, therapists, documentary makers, lawyers, artists and many others help

us negotiate and narrate the past. They help us to better understand our past by mediating our personal histories. In particular, we have highlighted the practices of geneologists in such undertakings. Chapter Four discusses, though examination of current genealogical practice, the potential for such personal archives to provide opportunity for learning, discovery and new societal understandings to third parties. Today, personal life data is often employed by third parties such as therapists, lawyers and biographers who help us piece together fragments of our existence into coherent narratives. Ethnographers, anthropologists and documentary makers perform this role at a broader cultural level, identifying and clarifying moments of meaningful societal significance. The availability and consideration of lifelog data might not only afford deep exploration at the level of the individual, but also at the wider level of society at large.

The value of these personal collections in supporting the individual, in mediating their life histories or in assisting their explorations of the past has not as yet been undertaken (see Section 2.4 & 2.6.6). We believe it is equally important to consider that lifelogs and their narrative capabilities may have significant value and utility to others besides the collection owner.

In considering the possibility to move beyond the collection owner and enable explorations by wholly unconnected third parties, we must first consider the practicalities of such a shift. In removing the collection owner as author, narrator and interpreter of the data, contextual understanding of the significance and nuances of the past experiences may be lost. Furthermore, there may be barriers of sense- and meaning-making posed by the volume of content to be explored and the degree to which the data is intelligible by a third party. We may additionally, through unbounded creative exercises explore the possible uses for narrated accounts authored by a third party using the Orison platform. Within this chapter, we therefore seek to explore the following:

- *The comprehensibility of the media*: There are a variety of media modalities available within a lifelog, and often they are voluminous. What aspects of the collection will be intelligible to a third party and what strategies might they employ for way-finding within and sense-making of the content?

- *The role of the collection owner*: What challenges are posed in terms of understanding and intuiting the content to a third party? Can a third party reliably

intuit and describe the individual despite a lack of contextual understanding of that person, their life and the events they have engaged in?

- *Opportunities Afforded:* What opportunities for discovery, new insights and understanding either at a personal, cultural or societal level might be afforded to a third party through narrative construction from personal lifelog collections?

This chapter will explore the potential of lifelog collections to provide reflection, insight and utility to motivated third parties. This exploration is framed within a storytelling exercise, where the primary method of investigation is the construction of a cogent story from the lifelog data of the author. As narrative construction requires both sense- and meaning-making on the part of the author, we can determination the comprehensibility of the data to a third party based on the coherence, intelligibility and integrity of the output.

This chapter is organised as follows. First, the method, participants and evaluation framework for the exploration is outlined. The task provided to participants is described, as well as as the tools, collection and apparatus employed. After which, the major findings of the study will be described. This discussion includes the examination of the content selection, story distillation, organization and construction. This discussion is supported with qualitative feedback provided by the participants. Finally, a number of case studies which represents a number of potential uses for lifelogged media in explorations of life histories mediated by third parties.

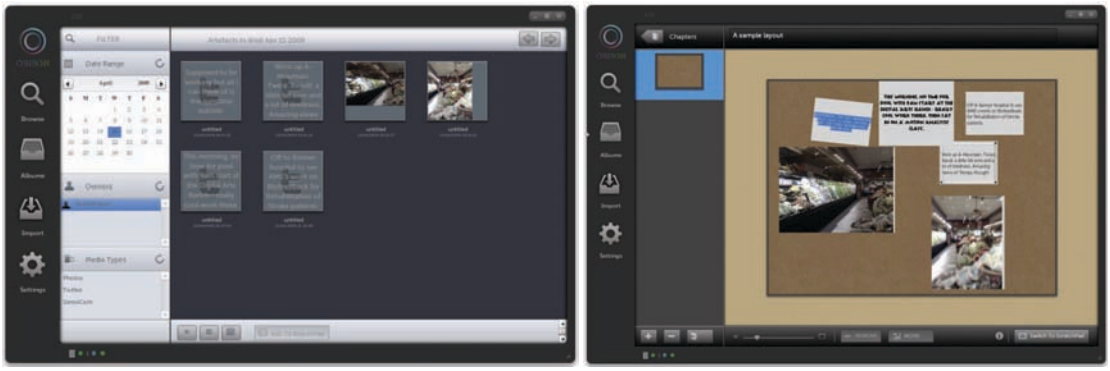


Figure 9.1. a) The browsing screen and b) the story chapter editing and layout screen.

9.2 Collection and Tools

The third party participants in this investigation were provided with access to both lifelog content from a collection owner, the author, and a variation of the personal narrative construction tool developed as part of this research investigation.

9.2.1 Lifelog Collection

A range of content and context from a 24-month lifelog multimodal collection was employed within this study and is as described in Section 5.3 and Appendix IV. While there were a number of content and contextual sources available for use within the project, it was decided best to constrain the amount and types of information provided to the participants. From a much broader collection, three main content streams were chosen for use within this work, namely: passively captured SenseCam images, explicitly captured digital photos, and Twitter status updates providing text based annotations of activities, thoughts or items of interest. The duration was fixed at 9 months and the modalities limited to those most critical as the students only had a limited amount of time to complete the assignment and it was felt providing the entirety of the collection would be excessively overwhelming.

The choice of modalities was further informed by ethical best practice. We also opted not to include modalities which contained communications with third parties (e.g. SMS or email) as this project moved beyond the original scope of capture for personal use and repurposing the content in this manner may have created privacy implications. This was a parameter of the ethical approval we received as including such communication might unnecessarily breach the privacy of the data owner and person's who corresponded with them.

The content from a single long-term lifelog collection owner was provided to the participants. The archive contained content between the 12th of March and the 21st of November 2009 inclusive, which breaks down as follows:

SenseCam images: A set of passively captured images (sampled approximately every 20-40 seconds) gave a rich visual diary of the individual's day-to-day activities. In this time-span, over half a million frames were available for use. To avoid overwhelming the participants with repetitious images [10], the dataset was temporally skimmed to only include every 10th image. In total 53,000 images were provided to the participants for constructing stories. It should be noted that due to recording issues

during the collection period, images were not available for much of August (5-24th incl.) and September (7th-23rd incl.). No explicit labeling of the image, its contents or associated information about the past action embodied by the image was provided to the participants.

Digital Photographs: To compliment the SenseCam images, a set of digital photographs taken by the collection owner were also provided. 301 images were included, with most of these being from April 2009 where the collection owner had been traveling for three weeks.

Twitter status updates: A set of tweets taken from the collection owner's public timeline were also provided to the participants. These 140-character text messages can be viewed as contextual annotations about items of interest or activities the collection owner engaged in.

The collection included some of the following activities: attendance at several conferences abroad; international research visits; tourist activities around cities; nights out with friends and colleagues; giving and watching presentations, attendance at local/national seminars and conferences. While these featured in the collection, it mainly contained typical days working in the university lab, evenings and weekends at home, personal time, and other general day-to-day past-times.

9.2.2 Storytelling tool

A variation of the storytelling tool described in Chapters 5 was provided to the students. This version of the software only allowed for manual construction of a story. No additional functionality or support for the automatic construction, composition, organization or layout was provided within this version of the software. This decision ensured that participants could not be assisted in negotiating the large collection, allowing evaluation of their ability to understand, intuit and make sense of the collection. The browsing options were kept straightforward and the users could opt to select a day of interest, and filter the content to display only a single type (SenseCam, Twitter or digital photos) (see Fig 9.1b.)

All of the participants were provided with storytelling software for use in the evaluation. Support was provided to them in setting up and configuring the software. Each of the students was provided with a database containing a list of the available media that they could use within the exercise. Unlike the previously described version,

they did not have direct access to the content; this instead resided on a remote server which the storytelling application connected too and retrieved on a per-item basis. As such, the participants required internet access to allow them to work with the tool and the available content. All other functions of the tool remained the same as described in Chapter 5.

9.3 Evaluation Method and Framework

The evaluation was conducted in collaboration with Arizona State University (ASU) and was integrated into a Media Editing course provided at ASU. The students enrolled on this course formed the cohort for this investigation. As the evaluation was conducted as the last component of their course, they had been versed in media editing techniques and skills making them highly suitable participants. While it may have been preferable to work directly with professionals already engaged in third party experience editing practices, we felt that the motivated student population, versed in media editing techniques, made suitable candidates for this initial and novel exploration. We acknowledge that further work with the professionals operating in suitable domains would be required to reliably and robustly confirm any observed utility or opportunities for third party exploration of lifelog content.

9.3.1 The Final Cut

The 2004 film, ‘The Final Cut’ served as inspiration for this work, exemplifying the task to be completed by participants. The film is set in the not-to-distant future where parents can opt to have their children implanted from birth with a ‘Zoe’ chip that captures a complete audiovisual record of their life experiences. This parallels the lifelogging effort undertaken within this research. The film depicts an impartial third party known as a 'cutter' who is charged with the task of reviewing and editing captured footage into a cogent movie summary upon an implantee’s death. This life summary is then screened as a eulogy for the friends and family of the deceased. The core concept of this film is the distillation of a whole life’s into a coherent narrative. This provided a suitable conceit for this evaluation; the goal of which is to provide a lifelog collection to third parties, who have no prior knowledge of the individual but must review, explore and edit the content of a provided lifelog to tell that person’s story.

9.3.2 Participants

15 participants (13 male, 2 female) from the media editing undergraduate course cohort agreed to participate in our study. Participation meant granting permission to the researchers to use their assignment content, descriptions of their work and analysis of such in external presentations. The participants represented students from all four years of undergraduate education and derived from a wide variety of disciplines including design (6), engineering (1), liberal arts (3), art (4) and film (1).

The participants had no prior knowledge of the collection owner's life, friends, colleagues and associates, or places in which he regularly spends time, making them excellent third party candidates for our study. In one case, a single participant had coincidentally attended a talk the collection owner had given a year previously at the study site and data collected at this talk was included in the collection.

The 'Experiential Editing' module assignment was used to evaluate our approach. The assignment was a required element for all students in the media editing class, regardless of their participation in the research study. All students were informed that their participation in the study was completely voluntary and had no impact on their final grade. Participants were free to opt out of the study at any time without penalty and incentives to participate (e.g. extra credit) were not offered.

9.3.3 Experiential Editing Module

This study was integrated into a new undergraduate course in media editing at ASU. The 200-level class is a core course in an interdisciplinary undergraduate digital culture curriculum, aimed at integrating aesthetic, practical and intellectual engagement across Design, Engineering and the Arts. The class explores the core concepts of media editing (e.g. form, composition, rhythm, pattern) through 6 integrated modules (graphics, audio, movies, networks, interfaces, experiential) of increasing complexity. Each module examines a particular media framework through exemplar works, theoretical readings, practical experimentation, and critique and discussion. This evaluation formed the final 'Experiential Editing' module and provided students with a unique opportunity to take on the role of *life editor*. Using the provided software and lifelog collection, they had to complete this exercise which formed an assessment within the media editing course.

At the beginning of the Experiential Editing Module, participants were introduced to the concept of 'life editing' in the form of a contemporary movie screening. The ideal

exemplar of ‘The Final Cut’ set the conceptual stage for the assignment, framing the task the students had to complete and challenging the students to think about the nature of exercise. Screening this movie for the participants served not only to introduce the concept of life capture and editing, but also highlighted many of the features, facets and considerations of life capture, such as being able to subvert lifelogging technology and the revision or re-conception of personal histories. Building on these ideas, participants were also assigned a variety of readings including Vannevar Bush’s ‘As We May Think”, a seminal article on lifelogging (Bush, 1945). Ideas expressed in the movie and assigned readings were used to seed discussion during a follow-up class seminar.

9.3.4 Methods

Participants were first instructed on the setup and use of the Orison software during an instructor led classroom session. During this session the process of creating a composition with the tool and the dataset was introduced to the participants. The instructor gave the participants a broad overview of the data collection, including how and when it was collected. General details about the collection owner were introduced including where he lived and the fact that he traveled.

The participants were given one week to complete the following assignment: “*You will be “The Cutter” of someone’s life experience. Using photos, SenseCam Images and Twitter data collected by an individual over a 9-month period, you will create an album(s) demonstrating insight into this person’s life. Who are they, what have they done, how can we interpret their everyday encounters, how might they be remembered?”*

In addition to submitting their edited works, the participants were asked to provide a written reflection of their experience completing the assignment noting in particular: the process of editing someone else’s life; the methods used for locating relevant content; the strategies employed for making sense of the data; the editing constructs adopted; and the overall experience of using the custom-designed software. The participants presented and discussed their work in a class critique session. The collection owner was present via projected Skype video throughout the session, offering feedback, clarification and answering questions.

9.3.5 Ethical Considerations and Practices

Given the highly personal nature of the content that the students were tasked with working with a number of considerations for ethical best practice were put in place within this study. Many of these considerations were directly embedded within the software the students employed during this study. The system was designed to provide secure access to the content, and users were required to authenticate for each session of use. Content resided on a remote server, accessible only through the tool provided, thereby preventing direct access. Within the tool there was also support to automatically roll out updates to correct software errors or to alter and adjust the provided data, should undesirable elements be found within the collection and require immediate removal. Furthermore, the software prevented local copies of the content being made the ability to directly copy-and-paste content or drag-and-drop it out of the application was disabled within this trial.

The participants were additionally required to comply with a non-disclosure agreement and formally agree not to publish or redistribute the content in any medium beyond the confines of the classroom, thereby protecting the content owner's content and privacy.

The ethical considerations and the highly personal nature of the content were reinforced during in-class discussions through which many of these issues were raised and openly examined. Additionally, the students were encouraged to be respectful of the content given that they were being afforded a unique opportunity to explore another individual's life through digital means.

9.4 Results and Discussion

"*How does one interpret the life on another? What are you supposed to see when you look through someone else's eyes? And how can you organize and present what you see in ways that only someone from the outside can? Will it be interesting? Will it tell a story? Will it tell the truth? Will it change the past?*

Or will a few pictures simply make you rethink some things? Like taking someone's life and shifting that perspective into a simple message, one that all can understand."

- Feedback from one of the participants

The stories created by the students ranged in number, type, composition, style and strategy, reflecting the variety of competencies, skills and background of the participants involved. The 15 students produced 27 chapter-based compositions in total, with an average of 1.8 albums submitted per student. One student submitted 5 albums. An album contained an average of 3.52 chapters and at minimum a story had to contain one chapter, with a maximum of 13 chapters in a single story. In total 95 compositions were created, of which 62 were given an explicitly title by the author and indicating that the students were actively considering and narrating the compositions they were creating. Within each chapter approximately 8.36 artifacts from the lifelog were employed, with a maximum of 32 items being used in a single layout. 66 photos (max 9, avg. 0.7), 672 SenseCam images (max 32, avg. 7.1), 56 tweets (max 10, avg. 0.6) were used, totaling 794 elements employed. 738 of those were unique, meaning only a small number of elements were chosen for use in more than one chapter-based layout.

Figure 9.2. The types of story created: a) *Time* – A chronology of a single day; b) *Biographical* - An exploration of observed eating habits; c) *Expressive* – A fiction layered on the real world content;d) *Investigative/Critical* - reflections on technology

9.4.1 General Findings

The system and its workflows were designed with the creative storytelling practices of scrapbookers in mind (see Section 5.4.2). We next discuss the types of stories created

and then present the findings of the evaluation in the same manner as the scrapbookers: we first explore *browsing*, discovery and exploration of the content; next the *ideation and composition* of a working layout; and finally the *placement* of a layout and framing within a story and the reflection on completed work.

9.4.1.1 Types of compositions created

The created stories varied widely in terms of the aspects of the collection owner's experiences chosen and the storytelling point of view adopted. Not only was there a variety in the execution but also in the types and topics of the created stories. These were broadly classified into 4 major groups:

Time: Several albums examined chronological or focused accounts of a specific day or isolated episodes within the lifelog. These included for example, a detailed exploration of a 'typical' day, traveling and sightseeing (see Fig. 9.2a).

Biographical: These higher-level accounts examined the collection owner's life broadly from psychological and social perspectives or through exploration of evident trends and recurrent themes. They often considered encounters with people, places, objects or technologies and typically included authorial narration through captioning which exposed reflections on the owner's lifestyle (see Figure 9.2b).

Expressive: These compositions and albums attempted to go beyond the life of the individual in some way. They considered the aesthetics of the captured content, playing on the colors and forms found in the lifelog content. In two cases, participants layered entirely new narratives on top of the existing content. In these cases the content and the real-world actors and settings were repurposed and re-conceived from the storyteller's perspective to tell a fictive account of an imagined happening. They also served as an allegorical reflection on some aspect of the collection owner's life (see Fig 9.2c).

Investigative/Critical: These highly analytical and reflective compositions provided commentary on either the nature of the medium, the data or experience-editing project. These accounts used captioning to present explicit narration of the author's position (see Fig 9.2d).

9.4.1.2 Exploration of the Content

In order to complete this task the students first had to familiarize themselves with the contents of the lifelog and we can investigate the degree to which students explored

the collection by examining the temporal information of the content employed within their compositions.

36% of all content used in the participant's compositions came from the first month within the collection (March 2009.) With 73% of all employed content being drawn from the first three months of the provided lifelog; 288, 176 and 121 artifacts originating in March, April and May 2009 respectively. This appears to indicate the collection was poorly explored with participants emphasizing the earlier portions of the collection, however, this is not necessarily the case. These months were particularly busy for the collection owner with a lot of travel in April. As a result these months contained more non-habitual, and perhaps more novel content for use within compositions. Given that October 2009 – a month with travel and large amount of non-habitual activity - was the next most employed month (111 artifacts), this seems to reinforce that content was being selected from non-habitual activities rather than on the basis of a shallow or narrow exploration of the collection. Additionally, while much of the content came from just a few months, the layouts were composed of artifacts spanning an average of 38.99 days. One composition contained artifacts from a period between 23rd March and 11th November; a spread of 234 days. 46.32% of layouts contained content from a period greater than a week, and 60% of layout spanned more than a single isolated day. This indicates that the participants were not just choosing easily assessable material, but carefully considering the media for inclusion, often surveying reasonably broad time-spans to identify the content appropriate to their story.

9.4.1.3 Observed Strategies for Way-finding and Sensemaking

It was clear that the participants perceived the volume of content to be a barrier to understanding and working with the collection. One participant commented that "*It was a little tough for me to get into because it was almost overwhelming to have such a wealth of information available to you and having to make sense of it and present it in a cohesive and logical way*", while another remarked "*Never before have I been given the opportunity to look at someone else's life in such detail. It was a bit staggering at first.*" While students often identified the topic of their story early on, they still had a challenge in terms of locating content relevant and appropriate for their story: "*the only real struggle I had with the project was meticulously scrolling through each day-trying to find the right images I wanted to use with the project.*"

Participants employed a variety of strategies to help them navigate the voluminous lifelog content and three predominant strategies emerged. First and most simply the participant constrained the task heavily by limiting the duration of exploration to a few days or a particular month. This focused the task making it easier to find content. By doing so however, they consequently constrained the story they could tell to simpler forms and chronological accounts. The second approach was to randomly or in a semi-guided fashion jump to a location in the collection, with one student commented that this strategy worked well for his particular compositions: "*...randomly looking through them did however help me stumble on the abstract images...*". Finally and the seemingly predominant approach to locating content, was to explore the lower frequency modalities first (tweets and photos), ignoring the voluminous SenseCam images. This allowed the participants to scaffold up an understanding of the events and identify the location of interesting items within the collection. One of the participants explains: "*I tried going to the dates of holidays in hope of finding something interesting without too much luck. I realized that by scanning through all the regular pictures, which were much fewer in numbers would be easier and most likely have more importance as they were actually chosen by the* '*cuttee*'*. This turned out very effective and spawned my ideas for my story. From there it was simply filling in the gaps and organizing the content.*" In effect, the tweets and photos - occurring relatively sparsely within the corpus - enabled the users to navigate to potential points of interest.

In addition, the Twitter text content not only allowed for way-finding but by providing a contextual annotation for the event, allowed the users to gather a deeper understanding of the activity, its significant and its context: "*Some of the data was immediately obvious as far as what it was communicating however in other instances it was helpful to have access to the tweets to make sense of what was happening.*"

9.4.1.4 Ideation and Composition

"Figuring out what to do with all of these images was the hardest part of this project by far."

Within this section we explore the participants creative processes for narrating the life of this individual and how they conceived the subjects and topics of their albums. Many of the participants took very different approaches in their compositions, arrangements and in the subjects and focus of the stories they produced and these are discussed.

Patterns and themes: Recurrent themes and patterns often formed the basis of the participant's stories. They examined the relationship of the collection owner to people, places and things encountered and the significance or bearing of them. Such stories were typically composed as an exploratory process, first identifying the major and salient themes within the archive and then identifying the most suitable elements for inclusion. The authors took care to minimise repetition and to carefully select the content on the basis of its aesthetics and appeal within the composition. One participant explains: "*As I was browsing through all the files on Orison, I found certain patterns...I decided to divide the albums into these three sections to make up the idea of this person.*"

On-the-fly Creation: While some of the participants conceived their story upfront, several of the students took a less rigid approach and ideated their story dynamically. The story was opportunistically crafted based on interesting items stumbled upon through exploration and the concept of the story iteratively evolving. One participant elaborates: "*I found it fairly difficult to do much planning because I honestly had little idea where I wanted to go with it. The challenge with this then was sifting through information as I went along and simultaneously determining what I wanted and how to build a narrative with it on the fly. However once I had gathered all of my objects, the project got a little easier as the rest was aesthetics*."

Aesthetics: The authors gave careful consideration to the attractiveness of the compositions, considering all visual aspects of the content they were adding to the layout: "*I tried to find the moments that 'looked the best' - images that captured smiles, or maybe interesting lighting, and also images that contained the most people in one shot.*" Many of the authors additionally spent a great deal of time applying background, frame and text styles to the content within a layout. This was often done to visually reinforce the narrative being communicated. For example, in Figure 9.2c, a comic-book style typeface and bordering has been applied to the content, representing the fictive nature of the story. This can also be seen in the examples of Figure 9.3.

Authorial Narration: 65.26% of the created chapters were given an explicit title and 13% of the artifacts were given a caption by the author. These allowed the participant to communicate their perspective on the narrative, its meaning and significance effectively: "*I used mostly [SenseCam] pictures, and then wrote my interpretation of how those aspects related to the lives of the person and why they might have been*

important to that person." In some cases, with the author considered what that individual might have said about their own life and placed these narrations in into a first-person voice thereby giving the narration much more weight. In some cases the existing twitter content, being authored directly by the collection owner, was used in place of captioning to achieve similar effect: "*Sometimes the tweets adequately framed what I wanted to express...Other times I did a little of my own interpretation of the provided images and added my own captions.*"

Integrity: For some of the participants the honesty, objectivity and integrity of the account was of paramount concern. They took on the mantle of the 'ombudsman of the audience' (Murch, 2005), desiring to create an undistorted, unembellished and representative account of the life experiences. This had bearing on the compositions created, limiting them in the scope of what they could create and compose from the content. One explained: "*I finally decided on telling a simpler story that was more conceptual in nature. It seemed like the best way to present the data in a way that wouldn't skew or misinterpret it at all. Keeping integrity in the truth of his life was a major motivation for me*"

9.4.1.5 Identification with and understanding of the collection owner

One of the goals of this work was to see how feasible it was for a third party to re-cut the captured personal experiences of an unknown individual. It was expected the high volume of content would create a barrier to this however, gaining an understanding of the individual solely through their content seems to have been very achievable. Several reported that they had a perceived understanding of who this individual was, with one of the participants correctly claiming to have a worked out the roles and interpersonal relationships with encountered individuals - so at least in that respect some level of understanding can be scaffolded through exposure to the content. One participant initially offered feedback indicating that a good sense of the individual could be achieved from the corpus: "*the sheer volume of SenseCam images picturing his desktop computer gives us a pretty good idea of how he spends the majority of his waking hours*". However, later the participant offered a conflicting perspective, "*there's no real way I'm going to know who this person is based solely on a few pictures, several tweets and a whole bunch of SenseCam images*". Indeed, a lifelog can offer an objective account of activity, but the question of its ability to accurately convey the nature of that person to a third party is debatable. We can quantify time spent in one activity or correctly identify settings, scenes or actors, but truly understanding the owner at a deep level is challenging. One participant argued that

"*at first I thought it was an incomplete sample of the information provided to us but the more I considered it the more I felt it captured a decent amount of who I perceived [the collection owner] to be.*"

There are clearly open questions about how fully a life can be understood through objective data alone, how complete that data must be to begin with, and how much it can truly and honestly reflects the life, personality and traits of the individual in question. We believe in order for the participants to creatively, competently and reflectively transform the information into a meaningful story, they must have demonstrated at least some holistic understanding and appreciation of that persons life.

Figure 9.3. Contextual Misunderstandings?

9.4.1.6 Contextual understanding

For the most part, the participants seemed very able to make sense of the data. For example, they were able to discern reliably the typical habits and routines present within the collection owner's daily life. From this they were able to establish what diverged from the norm and what was perhaps of interest to storytelling, e.g. trips, travel and nights out. They were additionally able to identify predominant themes and patterns within collection, including the relationship with technology; to others in his life; and the places and spaces frequented. These themes were explored in many of the compositions created by the participants. While this demonstrates that the students were certainly able to intuit and interpret the artefacts contained within the lifelog collection, the degree to which they achieved this is difficult to reliably ascertain. For example, while some events may appear mundane or habitual to the casual observer, it is likely that some hold special significance for the individual(s) involved. This may be difficult for a third party to ascertain from the available content alone. The question of significance is further explored in Case Study 1 (see 9.4.2).

Irrespective of the depth of understanding, with no direct connection to the collection owner, there is much room for misinterpretation. While major misinterpretations of the collection owner's life were not evident from the student's compositions, some minor examples of this were observed. For example, popcorn being mistaken for unhealthy potato chips, while one hand only appearing on the steering wheel while driving was viewed as potentially reckless rather than a requirement with manual drive cars. While these examples are incidental and overall do not introduce insurmountable error into the compositions created, it is important to note the potential for such errors to be introduced. As such, when interpreting the outputs of third parties, some prudence may be required.

9.4.2 Case Study 1: Scrapbooker

From the 15 students, we have chosen to highlight one of the participants in particular as we feel they exemplify many of the works, processes and considerations involved. The student in question was additionally selected, as they were themselves a scrapbooker. As the tool was oriented towards this community, this made them an ideal candidate for more detailed exploration. The participant was clearly intrigued and engaged by the task and produced 4 albums, containing a total of 16 chapter-based compositions. They employed 164 items from the lifelog (130 SenseCam images, 26 tweets, and 8 digital photos) spanning the full range of the collection, indicating it had been well explored.

9.4.2.1 Artistic Opportunities

"The opportunities for simply creating something artistic out of his experiences was intriguing." The participant was motivated by the opportunity to create aesthetically pleasing compositions which juxtaposed playful, experimental and artistic layouts with considered and reflective thoughts on the nature of the medium, the notion of life capture and the aspects of the collection owner's life communicated via the data (see Fig 9.4). This observation is similar to that of Harper et al. (2008) and Lindley et al. (2009) both noted the construction of 'creative views' and the potential for playfulness in the compositions.

9.4.2.2 The nature of the media

Within the album 'Obscure' the participant ruminates on lifelogged media. In particular the compositions reflect many of the unique aspects of SenseCam. Seemingly undesirable low-quality features of SenseCam are well documented and include blurring, noise, light lensing effects and poor capture in low light conditions. Many of

the students' compositions similarly noted this, but the participant does not just simply highlight but instead capitalises upon the 'strangeness' (Lindley et al., 2009) that can be seen in the SenseCam frames. These unusual artefacts of the capture technology facilitate creative compositions and were explored in chapters entitled '*Mystery*' (blurring), '*The Effects of Light*' and '*Colours in the Dark*' (see Fig 9.4.b).

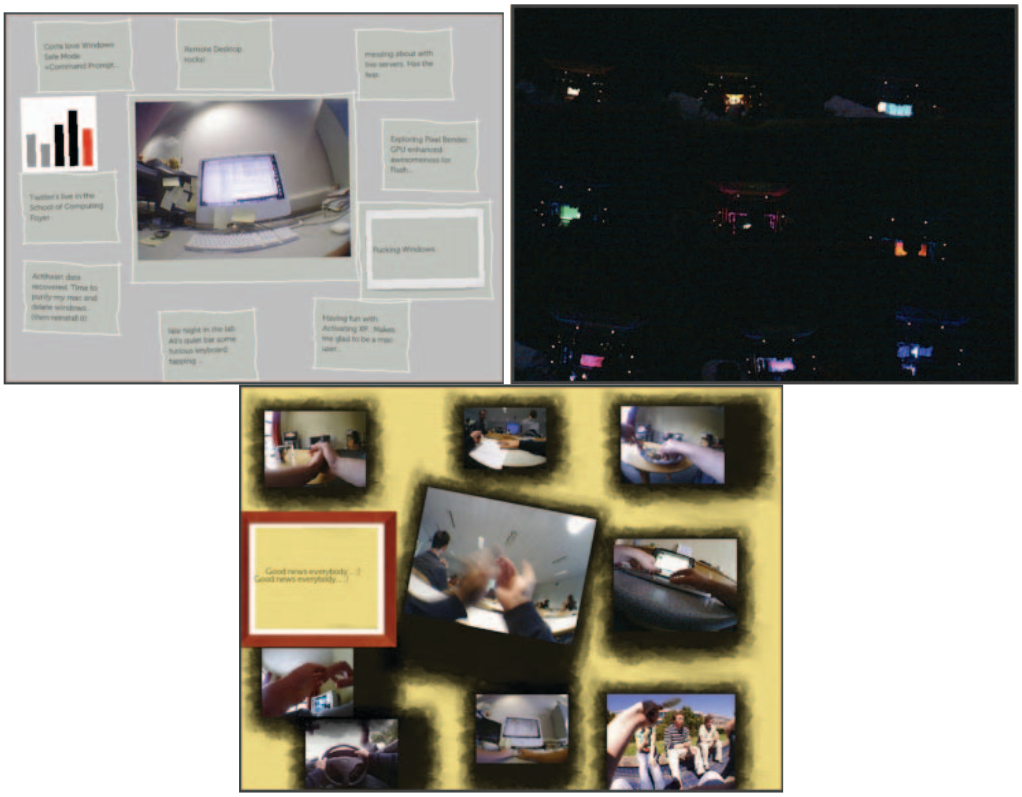


Figure 9.4. Samples from the case study participant a) What would we do without the web - *The center of the universe*; b) Obscure - *Colours In The Dark*; c) Awareness I Can See Myself - *Busy Hands*

The SenseCam may additionally highlight seemingly innocuous things making them more apparent. In the album '*Awareness: I Can See Myself!*' the participant explored this in great detail; choosing to focus on '*Busy Hands*' (see Fig 9.4.c). The position of the SenseCam means that conversational hand gestures can trigger image capture via the on-board infrared sensor, making them more pronounced. The participant dedicates an entire composition to the variety of gestures and hand actions that were captured and again this complements the findings of Harper et al. (2008) and Lindley et al. (2009) on the 'strangeness' in the capture medium which can allow new appreciations of the ordinary and the everyday. Not only is there opportunity for understanding of the individual from lifelogs but by leveraging the unusual aspects of the medium wholly creative exercises and studies can also be empowered and enabled.

9.4.2.3 Musings on Life Capture

"*I feel as though I have insight into a stranger's private existence and I'm conflicted as to whether or not that is ok. But I do feel like I know him after these hours I have spent with him in his car, office and house.*"

While the participant has good insight into the life of the collection owner and has carefully considered the nature of the technology and medium, they seem to have grappled with the moral and ethical implications of the technology. This dilemma is reflected to a degree in the compositions produced by the participant. Within the created works, the participant explores the, perhaps unwitting, capture of others in the space around the collection owner and the degree to which these individuals might be aware of the fact that they themselves and their interactions with the collection owner might have been captured within this archive. To further motivate this point, the compositions also emphasis the large number of people encountered and captured within the collection. Another aspect of life capture examined within the participant's compositions, is the question of what might be missed from the recordings and the chapter '*In the dark*' addresses questions of gaps in recording, missed experiences and what this might mean for the collection owner and unintentionally a third party who cannot decipher the actions during these periods.

9.4.2.4 Significant Happenings

"*It occurs to me that the reason for editing the events of one's life can be summed up in one word: significance. Different people will find different things about [the collection owners]'s life significant...*"

From the point of view of the third-party, it is not always about being faithful to an objective account of the individual's life, but the role of the ombudsman is to tease out what they perceive to be important and meaningful. The participant notes that this will undoubtedly change from person-to-person based on their values, perspectives and interests. It is interesting to juxtapose this position with that of the genealogist to the integrity of the authored accounts (see 4.2.2.5). The album '*Snipettes of a Life Well-lived*' is singularly focused on this idea, and the participant has distilled a number of events they perceive to be especially meaningful from their perspective. For example, the thoughtfully titled '*Only God Can Make a Tree*' appreciates the simple pleasure and beauty in a day spent in the park, '*Night Gems*' explores being indoors on a rainy day from an aesthetic standpoint, while '*We All Need Somebody to Lean On*' explores the importance of people in our lives and the regularity at which we encounter them.

9.4.3 Case Study 2: Narrated Accounts

Many of the created works produced by the students attempted to sum up what was perceived as characteristic traits of the collection owner. One participant's compositions stood out from the others for their ability to insightfully intuit the perspective of the collection owner. In this regard, the author of these works was not just the ombudsman for the audience but also for the owner. We examine in this case study the albums created by this student, two of which are featured in Figures 9.5 and 9.6.

Figure 9.5. Surrounded by Technology

9.4.3.1 Patterns and Reflections

"*As I was browsing through all the files on Orison, I found certain patterns. It seemed to me that this person used lots of technology in their life, traveled, and seemed to do a lot of social networking. I decided to divide the albums into these three sections to make up the idea of this person. I used mostly sense cam pictures, and then wrote my interpretation of how those aspects related to the lives of the person and why they might have been important to that person*."

The participant in question created three album-based compositions each with 2 or 3 chapters and focusing on a single theme identified from the contents of the lifelog

collection. The participant identified these to be predominant in the collection owner's life and central to how they lived their life. Each of the albums begins by introducing the theme with a caption voicing the position of the author and narrated in first person voice. The subsequent chapters serve to expand upon the concept as introduced; each exploring a further facet or subset of the central premise.

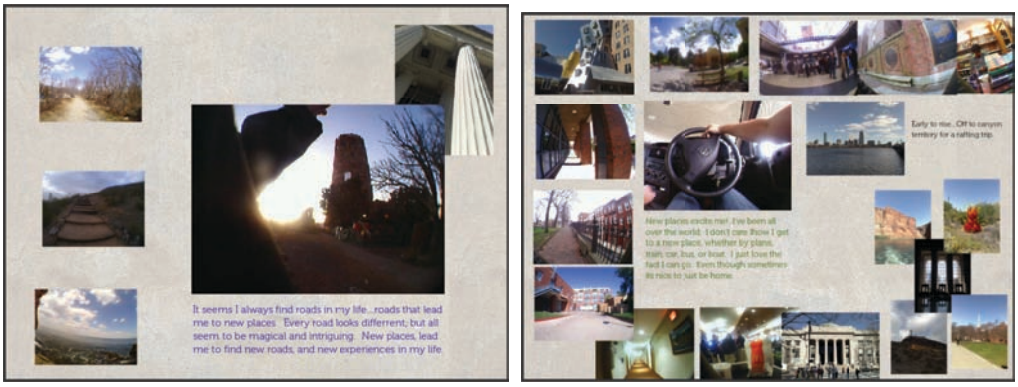


Figure 9.6. Oh the Places

9.4.3.2 Visual Strategies

The participant uses a single visual strategy effectively and repeatedly. The arrangements composed, while varied, focus on a single dominant image, often presented enlarged relative to the other content, which a detailed caption is associated with. The caption is used to convey the major sentiments within the stories and this is discussed in more detail below. This caption is used to convey a central thesis or position for the composition, or if the initial chapter, for the story as a whole. The dominant image and its caption are associated to set of images, which further support or illustrate the author's position. In each album the initial composition is subdued containing only a small number of on-screen items, thereby placing the emphasis firmly on the caption. The subsequently slides then contain a plethora of examples serving to emphasise, underpin and support the point being made by the narrator.

In addition to these visual strategies, each of the albums adopts a singular visual aesthetic, making each chapter coherent with one another. This helps in the communication of author's central premise as the visual style, like the point being made, runs through all of the chapters. The visual style is simple, relying only on a consistent background. None of the elements are bordered or framed, but are carefully arranged within the composition. While a different background and font styling are adopted across the albums, the layouts have a somewhat similar style

suggesting that these three stories are parts of a larger comment rather than independent, unconnected piece. Overall visually it is understated and restrained but aesthetically pleasing, and while simple in its approach seems to work well in supporting the arguments being made.

9.4.3.3 Captions, Narration and Authorial Reflections

"I used mostly sense cam pictures, and then wrote my interpretation of how those aspects related to the lives of the person and why they might have been important to that person."

The use of captions and the manner in which they narrate the story is of particular interest within this case study. The nature of the captions indicate the participant has not only explored the collection to identify salient themes and patterns within the collection but has clearly reflected upon them and their significance to the life of the collection owner. The captions not only attempt to communicate the proposition of the author but also to provide a voice to the collection owner.

The use of captions distinguishes these authored works from many of the other compositions produced by the participants. In the majority of the other albums and chapters are not clearly indicative of narration but simple labels ascribed to the actions within the associated content or the authors interpretation of them. Within these compositions, the captions clearly demonstrate attempts to both reflect upon the life of the collection owner and to narrate their life on their behalf. By placing the captions in a first person voice coupled with their nature, the captions seem to embody the inner monologue of the collection owner. The example below taken from the album '*Networking People*' illustrates this:

"In my world I am constantly connected to other people. I love that about my life. The career path I've chosen allows me to meet and talk to such interesting people. Oh how I love the connections and bonds I form with strangers and friends alike. I go to a new place and am excited to see who will be there."

The use of first person singular indicates that rather than the author trying to tell the story *for* the collection owner, they are trying to tell the story *of* the collection owner. This is an important and interesting distinction. Furthermore even though the story is being told from a third person perspective, the author has chosen to frame this from a first person narrative mode as indicated by the use of the first person singular rather

than third person. The below example comes from the album entitled ‘Surrounded by Technology’.

"I can't escape technology. I use it everyday, without even thinking about it. It is a part of my being. I live and breathe technology and I am always thirsty for more."

It is evident from these examples that the author has reflected upon these themes and beyond this has insightfully, incisively and succinctly narrated the collection owner’s perspective. The author uses captions to lend a voice to the collection owner, narrating their media on their behalf, with powerful effect.

9.4.4 Case Study 3: Fictive Accounts

While many of the students chose to produce authored accounts describing the individual, his activities, his life in general and or encountered aspects of his life, some chose to abstract away form the individual and use the media as the building blocks for an entirely new narrative. Two participants composed fictive narratives. In these accounts, fictional characters are represented by actual people depicted in the content, settings are recast to the newly imagined world and the activities the collection owner engaged are judiciously selected to fit into the plot of the creative interpretation. While these may present new narratives layered on top of real experiences, these narratives also served as an allegory for prominent aspects of the collection owners life. The narratives were based on prominent themes and features within the landscape of the collection owner’s experiences and discussed for example the prevalence of technology, television and devices. In addition to this, one student chose to use the content to express their own action vicariously through the eyes of the collection owner. This participant had previously visited a city, independently of the collection owner, and had not maintained a digital record of their sightseeing and excursions. They repurposed content from the collection owner’s visit to this city in order to recount their own experiences. By repurposing and reordering media in this way, they could reconstruct their discovery and exploration of the city. It is clear from these examples, that there are opportunities beyond negotiating just the life of the collection owner, and in fact a third party may use this content as a wholly new creative opportunities. This case study explores one of the fictive accounts created by the participants in detail (see Fig 9.4).

9.4.4.1 Fiction and Faction (or Recast rather than Recut)

"My thought process was to first pick out certain images that stood out and begin to tell a story with… With a little creativity after seeing shot after shot of a television screen/computer screen I had to pick a story surrounding those elements.

The participant set about repurposing media within the collection to tell a new story, layered on top of the lifelog content. The inspiration for this flight of fancy was the prevalence of screens, particularly televisions, within the visual frames of the SenseCam content. The author noted this and began to construct a new narrative entitled 'Too much bad TV' around relevant content (see Figure 9.4). To do this, the participant explored the collection and identified content that might be relevant to the story under construction. In doing so they opportunistically repurposed media to fit with the story contents and not necessarily based on the linearity of the collection. As the author had predefined the nature of the story, they had very specific requirements and this meant considerable effort was spent in locating suitable imagery and content. This saw them *"meticulously scrolling through each day-trying to find the right images [they] wanted to use with the project."*

Figure 9.4. 'Too Much Bad TV' A fictive account created from the lifelog.

9.4.4.2 Allegorical Commentary

While originally tasked with sensemaking from these collections, such compositions ignore the integrity of the account and its factual truths. This is very much in opposition to the position of the genealogist (see Section 4.2.2.4) and the requirement established that the creation of personal narrative should maintain the integrity of the experience and provide an honest retelling. These ficitive accounts layered ontop of personal experience do, however, offer new opportunities for associating meaning with the data.

The story created centres on the omnipresence of screens and digital technology within collection owner's life and as such is not completely fictive but has an allegorical component to the composed narrative. The story hints to the pervasive nature of television and technology and additionally alludes to the negative and perhaps unhealthy predominance of television within the landscape of this person's life. While settings, events and people have been recast to fit the goals of the narrator rather than provide an accurate reflection of who the collection owner might be, there is certainly an underlying commentary on their life. By layering reflections on the collection owner and their world within a figurative account, the narrator has explored an interesting and engaging mode through which that meaning can be embodied, represented, and expressed.

9.4.4.3 Nature of the Media

In many of the participants' compositions, unique aspects of the media and in particular the SenseCam photos were identified. Several of the students produced compositions which highlighted these elements, including the blurring, noise, poor lighting conditions, etc. and explored the artifacts of the capture technology through creative output. Within this students work, this was also the case. It was noted that "*the whole theme of this particular man's days seemed blurred and almost repetitious to a degree. While the blurriness and chaos seen in a lot of the photos can be attributed to shaky camera work, [the participant] took that idea and ran with it. It seemed almost like a bad hangover*"

The participant comments on the extreme blurring and light effects present in many of the visual frames and strangeness that this creates (see Fig 9.4). These images are employed throughout the fictive account to set an unsettling tone and to evoke a feeling of disharmony.

9.4.4.4 Narration and captioning

The use of narration and captioning within the created story is particularly interesting. All content within the compositions is captioned, as each frame of a graphic novel might be. The captions either provide a first person narration of the events, an inner monologue to the central character, dialogue with other actors in the story, or a description of the action represented by the visual frame.

The use of captioning within this work provides a coherent narration to the events, but the author uses subtle techniques within the appearance of the captions to denote or demark transitions in dialogue or the significance of a caption. For example, the author alternates the bolding of captions when two actors converse to help identify who is speaking in each frame or bolds particularly significant captions of the central characters dialogue if they are present in isolation. In the final sequence, the 'TV' begins to communicate directly with the central character, and to reinforce that there is something unusual about the communication; the author presents all of this dialogue in a new typeface. Here a sans-serif is employed unlike the handwritten script which is used in the previous 6 chapters.

9.4.4.5 Aesthetic Reinforcement

The visual style and aesthetic employed by the narrator not only help to reinforce the overall mood of the story but additionally help to confirm its fictive nature. As seen in Figure 9.4, the lifelog content used within the compositions are all enclosed in a solid white frame, each captioned using a script-styled font. This resembles the visual style of a graphic novel or comic book and echoes the sentiment that it is an imagined account. The background employed on all chapters is a worn, 'grunge' pattern and communicates a tone of discord and disharmony – a central theme of the story. The author additionally chooses uncomfortable disharmonious images to reinforce a feeling of discontent and uncertainty within the storyworld. Many blurred images are employed to give a visual sense of the central character in this narrative as feeling strange and unsettled. The last image is in particular very striking and contains a darkened room with an eerie figure featured on the television set seemingly communicating with and controlling the main character.

The use of narration and the visual style employed by the narrator help create a powerful tone for the narrative. The visual strategies employed support and strengthen the narrative arc and its progression, thereby creates a rich and engaging story.

9.5 Conclusions

This chapter explored the possibility of motivated third parties utilising lifelog content. To investigate this possibility, we provided a 9-month subset of a long-term lifelog collection to 15 students enrolled on a media-editing course. The students worked with the content to produce stories about the collection owner's life and the outcomes were framed with qualitative feedback garnered from the students during their assignments. We noted the ways in which the students worked with the content, scaffolding understanding by first exploring the lower frequency modalities and moving to those of higher frequency. The types of compositions used as well as the modalities employed were considered alongside the students motivations for their chosen stories. The participants very successfully constructed diverse, meaningful story compositions from a very large data collection and within a constrained time frame. This demonstrates the potential for lifelog content to be employed by motivated third parties and we surmise that given adequate time and an established task domain framework, third parties can develop rich socio-cultural understandings and insights about the human condition.

In addition to this the case studies presented in this chapter, illustrate three key findings. The first case study highlights the ability for a third party to uncover and reflect upon the major themes and patterns of an individuals life which might be embodied in the content contained within a lifelog. The second case study, indicates that a third party can conduct a precise examination of things past allowing the author to incisively and insightfully narrate these themes and activities on behalf of the collection owner. Finally, both the last and first case studies emphasise the opportunities to go beyond the personal perspective of life storytelling allowing new imagined accounts and artistic expressions to be created and to leverage the media in unexpected and novel ways.

As noted in the introduction, the use of digital lifelog content in combination with narrative editing techniques may additionally offer new modes of support to third parties. These professional practices may include lawyers, therapists, biographers, cultural anthropologists and historians, genealogists and documentary editors; all of whom already help us negotiate our past and imagine our futures. While each domain may have particular requirements, by demonstrating the potential for lifelog content to be successfully used by a third party, this opens the door to exciting new avenues for

individual, societal and cultural explorations of moments of significance captured within a lifelog from a third party perspective.

Chapter 10

Future Directions and Next Steps

10.1 Introduction

The tool outlined within this work represents a first of its kind application for the development of personal digital narratives from long-term multimodal lifelog collections. The Orison tool endeavours to deliver all of the expected functionality and behaviours of a complete media-editing tool, however, it still represents an early-stage research prototype. While it enabled this investigation successfully, there is still much room for improvement based on the findings of this work and from the lessons learned in its development and deployment. This is also much opportunity for further explorations examining deployments of the tool, perhaps to specific communities of practice and domains of relevance.

The user trials and evaluations conducted, highlight not only functional elements for improvement but opportunities for further investigation and the domains in which the tool may have particular utility. The previous chapter highlights that there are many such avenues for future exploration and that they extend beyond the confines of the first-person authored accounts. Within this chapter we explore the future work required to deliver an improved tool and explore consider the future directions for the Orison platform.

10.2 System Improvements

During the user evaluations, feedback was garnered from the participants on their perceptions of using the Orison tool. The feedback was generally favourable, however, did note several areas for improvement. It will be extremely important to consider these elements should any future deployments be undertaken. For example, the speed and performance of the tool might be improved. It was generally perceived that the browsing and search functions needed to provide more flexible and advanced

options. Participants also noted the importance of expert user functions such as the inclusion of keyboard shortcuts, improved drag-and-drop support and advanced layout controls. It would also be advantageous to evaluate the tool's usability and utility more rigourously through real-world deployments for longer periods. This is discussed further in Section 10.2. Scrapbookers would make an ideal candidate population as many of the concepts within the system have been oriented towards this domain.

Within this work, we have emphasized specific sources of content and context captured within the lifelogs we had amassed. The addition of other modalities and sources might benefit the possibility for the narration of past personal experiences. Sources such as passively sampled audio could offer more immersive experiences (Ferrington, 1994; Oleksik and Brown, 2008). Biometric or other context sources could also be leveraged.

Lifelogging technology can be intrusive, cumbersome and invasive, currently discouraging use in the long term (O'Hara, Tuffield, Shadbolt, 2008, Beauvisage, 2009; Byrne, Kelly and Jones, 2011). While we have shown the exciting opportunities for narration of past person experience that these long-term collections can enable, we must acknowledge the practical issues. To increase the audience the tool might reach, more prevalent forms of life-capture could also be incorporated. Online social media sources like Twitter (Java et al., 2007), Flickr (Mislove et al, 2008), Facebook (Joinson, 2008), and Foursquare[10] (Scellato, 2010) could offer contemporary compliments to lifelogged content, if not suitable alternatives. They are however sampled with far less regularity than the passive capture devices employed within this work and they will provide explicitly crafted, rather than passively captured, comment on activities the user has decided to note. Employing content from these online social sources offers immediately accessible archives for motivated parties to explore individual, societal and cultural understandings through the Orison tool.

Beyond improving the general usability and extending the sources employed, the structuring and generation processes could be further examined to explore the utility of alternative techniques. Many of the implementations currently employed could be enhanced for robustness, and performance.

[10] https://foursquare.com/

Within the thematic extraction there are a variety of techniques which may be incorporated to enhance the types of themes which may be extracted or augment the efficacy of this step (Aw et al, 2006; Wong, Liu, Bennamoun, 2007; Henriquez & Hernández, 2009;Tomokiyo, Hurst, 2003; Shehata et al, 2008; Byrne et al, 2009; Friedman, Geiger, Goldszmidt, 1997; Comaniciu & Meer,1997). As noted in Section 6.4, the episode detection opts for a clustering solution not overly fitted to any one modality. This could be compared against document clustering approaches (Oliver et al. 2006; Lokaiczyk & Goert, 2008), multimedia event mining methods (Xie, Sundaram, Campbell, 2008) and the application of emerging approaches designed for lifelog systems (Chen, Jones, Ganguly, 2011). Any improvements which can be gained the quality and precision of the structured corpus will have a positive effect on the efficacy of story generation.

Performance improvement in the automatic selection of content could also be gained by incorporating more advanced features for information retrieval, indexing and ranking. This might include novel weighting and ranking approaches (Qui et al, 2010); weighted relational hypergraphs and graph theory (Wilson, 1986; Ozdal & Aykanat, 2004); activation spreading (Troussov et al, 2008; Davenport & Murtaugh, 1997); query expansion techniques (Xu & Croft, 1996); keyframe selection techniques (Doherty et al, 2008) and multimedia and document summarization approaches (Salton et al, 1997; Money & Agius, 2008). Rhetorical Structure Theory (RST) also offers a framework for the explanation and analysis of coherence through the composition and relations between nuclear and satellite elements. RST has been adapted both to the analysis and summarisation of multimedia collections (Taboada & Mann, 2006) and could be adapted to use in the selection and representation of content from a lifelog.

10.3 Application Spaces

The Orison tool was developed to provide a general tool for media-editing and story contraction within lifelog collections. While informed by a number of studies with communities of current practice, it was not engineered towards the needs of any one group or domain. Rather than developing a system for a specific type of professional practice or evaluating our approach with a cohort of particular practitioners, we first wanted to determine the efficacy of the tool in supporting an author to create of stories from this unique dataset. Several opportunities for future exploration with specific domains have been highlighted. These are now outlined:

Family Contexts: The management of personal mementos in a family context was previously discussed (see Section 4.2.1). It was both observed and noted from literature that families have complex management process around mementos in the home. Displayed photos often represent significant moments in the family history, while logs, diaries or journals of children's experiences are often maintained. The Orison tool may offer a novel means by which the management processes could be simplified. As Whittaker (2010) suggests rather than pruning and maintaining digital personal mementos, automatic processes for retrieval could instead be employed, removing the ongoing organizational cost involved.

Hobbyist Use: The craft based practice around scrapbooking heavily informed many of the concepts within the Orison tool. It is typically focused on preserving and archiving family content and stories within albums using artistic layouts and styled with a variety flourishes. The compositions are painstakingly considered and the scrapbookers tend also to have an established process through which these compositions are crafted. It would be interesting to establish if the generative selection and compositional processes are seen as assistive within this content or if they are perceived as detracting from the artistry. Deploying within this community of practice would also serve to rigorously evaluate many of the workflows and processes incorporated into the tool in practice.

Therapeutic Practice: There is the possibility to use the generated narratives as a means by which to mediate and guide reflection in a therapeutic or clinical context. Kearney (2002) discusses the crucial role that narrative plays within therapy, as he puts it '*encouraging [suffers] to de-program their old histories, to divest themselves of the habitual plot-lines which have determined their behaviour up to now.*' The lifelog digitally captures an individual's behaviour and patterns. It is ignorant of favourable or undesired traits recording both indiscriminately and lends to a more factual account of things past, free of 'false memories', bias or other sins of memory. As such the narratives produced from it may have plentiful offerings within mediated narrative therapy. Furthermore, it may have utility in supplementing oft-used journaling practices in behavioural therapy allowing fresh insights to be garnered into the patterns of behaviour or situations affecting the sufferer (Howatt, 1999; Ullrich, Lutgendorf, 2002)

Memory Aid and Medical Care: Much of the recent work with lifelogs has emphasis the technology as a memory aid, particularly in light of some encouraging early results

investigating its benefits to persons with Alzheimer's disease (Hodges et al., 2006; Berry et al, 2007). Some of this work (Lee & Dey, 2008a,b; Smith et al, 2009) has explored how lifelog content could be transformed into an account of past personal experience in order to promote recall among such individuals. These projects typically require a caregiver or family member to author an account from the content manually. By allowing narrative accounts to be quickly authored on demand and in response to patient information needs, the burden on the carer could be reduced while providing a complete account of the activity. The utility of our semi-automatic approach to narrative generation may have significant benefits within this space. More generally the tool could be adapted for use as a reminiscence tool for older adults as described by McCarthy et al (2008).

Artist Explorations: The case studies outlined in Chapter 9 highlight the artistic opportunities latent within explorations of lifelog content. This was previously noted by Wood, Fleck and Williams (2004) as a playful space that the lifelogging tool SenseCam could operate within. Subsequent to this, work by Aschheim and Keller (2010) exemplify these possibilities. Unconstrained deployments of lifelog content and accompanied with the Orison tool could yield exciting possibilities in this regard.

Third Party Practice: The investigations in Section 4.2.2 and Chapter 9 emphasise that there are not only opportunities within lifelog collections for the content owner, but also for motivated third parties. There are many scenarios relating to third-party use of lifelog content that may be studied further as part of future work. These exciting possibilities include working with historians, archivists, genealogists and cultural anthropologists, who operate at a broader societal and cultural level, probing, identifying and preserving moments of significance from a third-party perspective.

In the modern digital age, there is much need for novel tools to support these practices. We believe that lifelogs, and the multifaceted data they produce, are a rich resource for understanding interactions between people (known and unknown), technologies and their environments (Holland and Hutchings, 2000). Its potential in this regard is of current interest to several motivated third parties, including FireFish a market research company (Cook, 2010), University of Oxford's BHF Health Promotion Research Group and creative artists (Kelly & Foster, 2010). The interest of these groups, along with along with that of cultural anthropologist Micheal Wesch, encourage this form of investigation. The acquisition of personal life histories and the arrangement as narrated accounts of personal histories has, as such, significant and novel applications within cultural anthropology and third party practice.

10.4 Novel Explorations

Lifelogging has only recently gained note and while discussed since Bush's MEMEX vision remains a very nascent domain. Most investigations to date have employed only reasonably short collections of lifelog content and the availability of long-term multimodal collections creates in itself exciting opportunities (see Chapter 2.) The Orison platform is uniquely positioned to explore previously unexplored aspects of what it might mean to author a narrative from personal digital content that surveys a life across broad periods. These include:

Shared Perspectives: Several of these collections might be brought into confluence to explore how the different accounts might offer alternative perspectives on real life events. The notion of shared perspectives is not new, and has been the focus of several compelling narrative experiences. Johnston (2008) explores the use of split screens to display concurrent perspectives from the actors within the narrative. The audience may then choose which thread of the story they wish to focus on allowing them to seamlessly switch between the competing viewpoints. This work was inspired by the splitscreen film, TimeCode (2000). Discussed by Bizzocchi (2009), it is a common technique employed in cinematography to illustrate activities happening in parallel. Rather than fictive, scripted accounts, the Orison tool and the collections available to it could be leveraged to explore the viewpoints of connected individuals on daily living.

Accounts Tailored to the Audience: The information contained within a long-term lifelog collection provides a detailed account not only of past personal experiences, but of the collection owner's association to the people and places they encounter, their affinity for them and their importance to them. Within the Orison platform we have demonstrated the utility of this information in automatically generating coherent and insightful narratives about that individual. These stories are often shared with another person and should the recipient have a similar collection the outputs of the generation could be tailored to their knowledge of the collection owners world. Familiar acquaintances or places would not need to be exposed, nor would experiences shared by both individuals need to be elaborated in detail. The potential to employ another individual's archive within the generation process and tailor the output to their needs, understanding and perspective is an innovative concept and could create far more compelling interpretations of past experiences for the audience.

Polarised Accounts: Memory is fallible, and people often forget important details, recall them incorrectly or colouring events based on current perspective. A lifelog, however, is a highly chronological, details and unbiased record of past action. This, as noted in Section 4.3.2, creates tensions. Several have commented that this tension may require the incorporation of functions which emulate how memory handles experience and a common concept introduced is the ability to forget digital information (see Section 5.6.3). Schacter, Chiao & Mitchell (2003) note that experiences may be more than just forgotten in mind. For example, they may be distorted by misattribution, suggestibility or bias. From a storytelling perspective it may be very interesting to explore how the objective accounts amassed using digital technology could be polarized or biased by the owner in the narrative creation process to present an account that does not remain entirely truthful to the actual happening. The notion of misattribution, a common occurrence with organic memory, would create interesting implications for trust, reliability. If as in Terminal Time (Domike, Mateas & Vanouse, 2002) and Vox Populi (Bocconi, Nack & Hardman, 2005), the storytelling system should begin to intermix related or potentially unrelated events in a convincing manner, what opportunity is there to distort the perception of what happened and influence the audience. The system could inflate the truth and create more compelling accounts from innocuous or mundane happenings but what would be the connotations of this for the author, audience, trust and reliability.

10.5 Summary

As part of this research effort a tool for the construction of digital narratives from lifelog content has been created. There are many opportunities for continued investigation with this tool. First, the usability of the tool can be explored in practice within an ecologically valid, and large-scale cohort of users. Further to this, the application of more sophisticated information retrieval strategies can be explored to enhance the performance and robustness of the narrative structuring and generation phases within the tool. The tool could also be extended to incorporate a number of new features most importantly an increased number of content and context sources. Alongside technical advancements of the tool itself, there is opportunity to explore its utility within a variety of communities of practice. Given that the tool was developed with many concepts observed within the scrap-booking community, it is sensible to pursue deployments within this cohort. There are a number of additional professional practices for which the tool may offer utility and exciting opportunities which could be exploited. These include working with cultural anthropologists, digital historians, with

artists and considering it as a tool for medical or therapeutic care. Several novel investigations are supported both by the availability of the storytelling platform and access to long-term multimodal lifelog collections and makes possible explorations into the significance and implications for authoring narrative accounts of a life in the long term.

Conclusions

In the afterlife you relive all your experiences, but this time with the events reshuffled into a new order: all the moments that share a quality are grouped together.

You spend two months driving the street in front of your house, seven months having sex. You sleep for thirty years without opening your eyes. For five months straight you flip through magazines while sitting on a toilet.

You take all your pain at once, all twenty-seven intense hours of it. Bones break, cars crash, skin is cut, babies are born. Once you make it through, it's agony-free for the rest of your afterlife.

But that doesn't mean it's always pleasant. You spend six days clipping your nails. Fifteen months looking for lost items. Eighteen months waiting in line. Two years of boredom: staring out a bus window, sitting in an airport terminal. One year reading books. Your eyes hurt, and you itch, because you can't take a shower until it's your time to take your marathon two-hundred-day shower. Two weeks wondering what happens when you die. One minute realizing your body is falling. Seventy-seven hours of confusion. One hour realizing you've forgotten someone's name. Three weeks realizing you are wrong. Two days lying. Six weeks waiting for a green light. Seven hours vomiting. Fourteen minutes experiencing pure joy. Three months doing laundry. Fifteen hours writing your signature. Two days tying shoelaces. Sixty-seven days of heartbreak. Five weeks driving lost. Three days calculating restaurant tips. Fifty-one days deciding what to wear. Nine days pretending you know what is being talked about. Two weeks counting money. Eighteen days staring into the refrigerator. Thirty-four days longing. Six months watching commercials. Four weeks sitting in thought, wondering if there is something better you could be doing with your time. Three years swallowing food. Five days working buttons and zippers. Four minutes wondering what your life would be like if you reshuffled the order of events. In this part of the afterlife, you imagine something analogous to your Earthly life, and the thought is blissful: a life where episodes are split into tiny swallowable pieces, where moments do not endure, where one experiences the joy of jumping from one event to the next like a child hopping from spot to spot on the burning sand.

- Excerpt from Sum, David Eagleman

Thesis Statement

Lifelogs are novel collections of past personal experience collected by sampling the everyday activities of an individual through digital means. These collections, containing a deeply personal record of lived experience, are a rich digital resource for narrating the past. It provides a detailed picture of everyday life and this can be used to retell experience in exciting ways. The core proposal of this work is the emergence of this technology empowers new possibilities in the narration of past personal experience.

By using information retrieval methods, in combination with narrative principles and techniques, we assert that these vast collections of past histories can be tamed and transformed into compelling, evocative, and coherent accounts. Secondary to the technical challenge of achieving this, we proposed that these accounts might enable many functions not only for the individual who amassed them but also for motivated third parties who might wish to mediate our past.

Work Undertaken

This work has taken a system-oriented approach to exploring and addressing the research questions within this work. This system enabled the exploration by delivering a fully functional tool for the editing and authoring of the life experiences, which may be contained in rich multimodal lifelog collections. To realize this tool and evaluate the research questions, we:

- Established requirements and appropriate narrative techniques through explorations into current practice and through probative user evaluations;

- Designed and implemented a tool which addressed these requirements and provided the support to an author to compose a narrative as a 2-d spatial composition from aesthetically presented media fragments. This tool enables an author to browse, compose, place, present and share stories from lifelog content;

- Incorporated automated computational processes to structure the collection into units appropriate for storytelling;

- Developed authorial support, provisioned through multimedia summarization approaches, to story authoring which enables lifelog content to be automatically

distilled into story form in response to the author providing the focus of the story to the computational processes;

- Evaluated the efficacy of the computed narrative with the collection owners; and finally explored the utility of narrative both with collection owners and with motivated third parties in order to establish the potential these collections may have both in reminiscence, reflection and in mediated authoring scenarios.

Hypothesis

The hypothesis underlying these research questions was that by employing computational techniques leveraged from information retrieval in combination with narrative principles, we could produce coherent and meaningful narratives from lifelogged archives. Moreover that the narratives produced would not only have meaning for the collection owner but could empower functions such as reminiscence and reflection. While the information retrieval, content summarization and collection structuring methods we employed were relatively naïve, they performed well. This is supported by the findings of Chapter 8 while illustrated that authorial support which relies on these methods and approaches may deliver satisfactory storied interpretations of incredibly complex, voluminous and detailed lifelog collections. We demonstrate that this content has opportunities for exchange and stimulated reminiscence and recollection of past experience. Furthermore, we demonstrated that third party authoring has much potential in creative and mediated endeavours for these collections.

In summary, we found the computational approaches employed and outlined in Chapters 6 & 7 to support the author in composing narrative from these collection and in gaining value from its vast contents. These findings support the hypotheses of this work.

Research Questions Addressed

In this section we review the research questions outlined in Chapter 1 and describe where within this thesis each element was discussed, interrogated and explored and how the question was satisfied.

RESEARCH QUESTION 1 *(Structural) What components of a lifelog should be used in the composition of digital life stories and how should they be structured to enable retelling?*

In Chapter 4, we motivate the capture of a multimodal lifelog collection which emulates the wide variety of keepsakes, objects and tokens families keep to preserve and curate a record of a life. In Section 5.3.3, we describe that developed storytelling solution supports a variety of multimodal sources including: SenseCam content which provides a visual diary; desktop activity which provides the digital content an individual interacts with; mobile context which describes the locations and people a person encounters; SMS and Twitter status updates as textual annotations of past action; and explicitly captured photos. Each modality can be used to describe an aspect of the experience and sometimes offer complimentary perspectives. In Section 5.3.2 we describe the general structures used to organize this content as being episodic and thematic. Episodes aggregate the content into story units while the themes describe the relationships between them allowing narrative paths to be identified. Given the volume of content contained within these archives we seek to automatically organize the content to support storytelling. This uses a variety of techniques which are outlined in detail in Chapter 6. The automatic structuring processes presented in this Chapter satisfies Research Question 1.

RESEARCH QUESTION 2 *(Representation) What information should be captured about the relationships between the various story elements in order to facilitate the reasoning required to build the end narrative such that:*

- *The author can specify a point of view, the subject, theme or focus of the story;*
- *The collection owner can continually collect information without the need to specify how it should later be assembled into a story;*
- *The contents of their collection can be distilled to achieve a coherent sensible story?*

Representation of narrative requires the relationships between the story units (episodes) to be identified. Within this structure, ‘themes’ are applied to classify and label the episodes. These themes describe aspects of the experience: the *actors* by identifying potential people of relevance through Bluetooth devices, twitter user names or contact information; the *settings* by identifying location through mobile content; and the *happening* by describing it through key terms and phrases extracted from text content. This information required to build this narrative is automatically extracted using the structuring processes described throughout Chapter 6, and

through the selection of relevant themes the author can indicate the focus of the story they wish to create.

RESEARCH QUESTION 3 (Presentational) How should a life story be composed and presented to its audience by an author in such a way that:

- The author can specify a point of view, the subject, theme or focus of the story;
- The author and audience have opportunity to feedback into the presentation process;
- The end story is consistent with presentational forms commonly used to share, express and retell personal experiences from curated content.
- The end story produced is both coherent and meaningful to the audience?

The use of spatial 2-dimensional layouts, in which aesthetically presented media fragments are arranged on a spatial canvas, is motivated as an appropriate narrative form for a personal digital storytelling. This approach is stimulated by the exploration of scrapbooking practice (see Section 4.2.3) and probative experimentation with lifelog content (see Section 4.3.3). In Chapter 7, we describe a generation process which caters for authorial control and feedback and ensures story coherence. Chapter 8 evaluates the generated narrative output and contrasts it with manually generated output, thereby validating our generative approach and fulfilling this research question.

RESEARCH QUESTION 4 (Functional) *What potential utility does a digital life story offer the author, audience or other motivated parties*

In Chapter 8, we explore the functions that the personal stories produced from lifelog content may offer to the owner of the content. The stories produced stimulated recollection and reminiscence, often prompting recall of forgotten elements and being deemed a rewarding experience. Some reflective thought was also observed and a willingness to share the content to provide insight into experiences and facilitate social exchange and discourse was noted. In Chapter 9, we explored the opportunities that storytelling with lifelog content may offer to motivated third parties. This highlighted the potential of these collections in cultural or societal explorations through digital accounts, in artistic endeavours, and in creating new fictive accounts. Lifelog content is traditionally the preserve of the collection owner and this serves to highlight the capabilities, functions and utility lifelogs offer to others beside the individual who captures them.

Final Remarks

I was once told that an average person opens the fridge 22 times a day. I checked my lifelog to see if this was true. For me, at least, it wasn't.

Reflecting on this, I thought about the value a lifelogs might offer. In this work we have emphasized the retelling of everyday or life stories – the types of stories we typically exchange in our real world discourses. Certainly the ability to retell experiences through this content is exciting. A lifelog is, as the research suggests, a rich and evocative resource for this.

The real contribution these collections will make is, in my opinion, in the ability to go beyond those experiential retellings and interrogate a life through narrative. We have teased at the potential for this within the latter stages of this work. Through annotation, association and understanding, the patterns of a life may be revealed. By doing so underlying relationships, perhaps even the more innocuous connections, between lived experiences may be made explicit. The average time spent brushing your teeth, the number of times a fridge was opened each day, all the instances of looking out a window; all these ignored, disregarded, abstruse and opaque associations, the minutiae of our daily lives, might all be uncovered through digital accounts.

What then if a lifelog was to be described fully with every action labeled, every association made, every pattern exposed and every trend identified, what might this empower when all the moments that share a quality are grouped together?

The possibility to review, retell and re-experience our life from this perspective is increasingly feasible.

Appendix I

Summary of Chapters

Chapter I: Overview

Within this work we present a digital tool for personal narration of past life experiences. This tool leverages novel personal digital collections known as lifelogs to enable this investigation. The tool has the following characteristics which are lacking in previous personal digital narrative approaches:

- Allows for large volumes of personal content to be structured and employed in narration of past personal experiences and provides flexible support for multimodal content to be employed.
- Supports the user in the semi-automatic construction of digital narratives in a flexible manner.
- Generates stories based on presentation forms observed in current practices and engineered with these practices, workflows and metaphors in mind.

Specifically the thesis addresses the following research questions:

RESEARCH QUESTION 1 (STRUCTURAL): What components of a lifelog should be used in the composition of digital life stories and how should they be structured to enable retelling?

RESEARCH QUESTION 2 (REPRESENATIONAL): What information should be captured about the relationships between the various story elements in order to facilitate the reasoning required to build the end narrative such that:

- The author can specify a point of view, the subject, theme or focus of the story;
- The collection owner can collect continually information without the need to specify how it should later be assembled into a story;
- The material can be causally related to achieve a coherent sensible story?

RESEARCH QUESTION 3 (PRESENTATIONAL): How should a life story be composed and presented to its audience by an author in such a way that:

- The author can specify a point of view, the subject, theme or focus of the story;
- The author and audience have opportunity to feedback into the presentation process;
- The end story is consistent with the presentation forms used by autobiographical memory
- It is both coherent and meaningful to the audience?

RESEARCH QUESTION 4 (FUNCTIONAL): What potential utility does a digital life story offer the author, audience or other motivated parties?

Chapter 2: Lifelogging

As technology has advanced we have been continually offered new media through which we can both capture and express our meaningful life experiences in new and exciting ways. Lifelogging is one such development that is sure to offer just that – a world of new possibilities for reminiscing, retelling and sharing our personal histories. In this chapter we explore the origins of lifelogging in Vanevar Bush's MEMEX as well as the current realization of this vision. The goals of a lifelog, to capture as much information as possible are outlined and framed within literature on experiential systems design. We outline the technologies which can be used to enable capture for lifelogging across a variety of modal channels including visual, audio, content, context and other sources. The current research strands namely capture, management, recollection and reminding, reflection, sharing ands upport, are then explored. Finally the nature of lifelogs as well as their affordances and constraints are used to frame the opportunities that such collections present. This motivates our exploration of digital narrative.

Chapter 3: Narrative and Personal Storytelling

Narrative is highly appropriate form though which the experiences amassed within a lifelog can be communicated. With the opportunities created by applying narrative to lifelog collections outlined, we next explore the nature and components of personal narrative. We introduce the oral tradition of personal storytelling as well as the forms that personal narratives might take. We discuss the components and properties of

narrative, as well as outlining how digital techniques has been applied for personal storytelling and communicate experience.

Personal storytelling can concern conversational stories – single isolated episodes retold in isolation of the larger life experiences – or life stories which concern broad themes or periods from an individual's life and must be framed in larger life experiences to be understood. The function that life stories facilitate are additionally outlined to include the support of reminiscence and reflection, as well as the sharing of experience. We describe how narrative operates across several key dimensions namely the spatial, temporal, mental, formal and pragmatic. Within digital narrative we must consider the structure or organization of content to support storytelling, the representation or the form the narrative plot takes and the presentation or aesthetic representation of the story on screen.

Chapter 4: Design Requirements for the Digital Storytelling Tool

The background literature surveyed notes that traditional approaches and models of narrative often do not lend themselves well to the narration of personal experiences. Moreover, lifelogging is a novel technology and narrative techniques have not as yet been applied to such corpii. It is consequently important to establish how best to facilitate the production of narrative from such multimodal content and how a tool might support this effort.

To establish suitable approaches, we undertook a number of human-centred investigations designed to elicit the requirements for our narrative solution. We present a design case study which identifies the underlying needs for a storytelling tool by probing the current family practices of memento management, the exploration of family history and the authoring of family stories through scrapbooks and albums. Subsequently, we explore through card sorting how narrative might be formed from voluminous and multimodal lifelog content. The results of these two investigations are used in confluence to elicit a set of requirements and recommendations for our storytelling tool. These requirements align with the research questions presented in Chapter 1. Broadly the identify that the solution must support the continuous capture of content from a variety of modalities without needing to specify how it is later assembled into storyform (*collection*); through storytelling the tool should support the distillation of content into meaningful representations (*curation*); to do this it must support the *discovery* of significant content within these large archives; and finally in

response to the effortful curation of this content it must offer some gain or benefit to the user for doing so (*reward*).

Chapter 5: Storytelling Tool Implementation

Within this chapter, we present a storytelling solution engineered to support an author in the construction of personal digital narratives from lifelog collections. In designing the tool, we leveraged the understandings garnered through the probative studies and sought to satisfy the requirements elicited. A key requirement is the need to support the author through automation and computational processes. This is motivated based on the volume, complexity and detail of the lifelog collections employed within this research investigation. While authorial support is a key component of the system, a wholly automatic solution is not favoured as it might overly constrain the creative outputs. The devised tool, Orison, optionally offers the authorial support through narrative generation. This allows an author to create a personal narrative from a lifelog corpus entirely manually should they so desire. Even if an author elects to employ the generative support, the flexible authoring support provided by the tool enables them to edit and refine the outputs. A semi-automatic approach is central to the operation of the tool. This recognizes that the user must have the ability to coordinate, control and craft the stories produced within the system.

The functions the tool offers an author in the support of story creation are presented within this chapter. First the architecture, technical infrastructure, data structures and media sources employed by the implemented storytelling solution are described. Subsequently we explore the storytelling framework employed. Finally the functions offered by the system in support of story creation are elaborated. Creation is catered for through four main steps: the system supports the user in locating content relevant to the story under construction; it allows them to arrange and fashion the identified media fragments into story-based compositions; it allows these compositions to be placed and situated within the main story to form a plot; and the story may then be presented and shared with others. The tool also provides a number of features which enabe an author to consolidate their media for use within storytelling and for that content to be structured and organized to support storytelling.

The user interface and functionality provided to an author is the focus of discussion within this chapter. It explores how an author may use the system, and the process of manually composing and refining narrative produced. The automatic computation

elements, which provide authorial support in the structuring of content to support storytelling and in the generation of narrative output are discussed in the subsequent chapters of this work.

Chapter 6: Structuring the Collections

The volume of information amassed within a lifelog is considerable and as a result it cannot be expected that a user would manually manage this content in order to structure it appropriately for storytelling. We need to support the user in this through automatic techniques. The structure is associative and each item of content needs to be first related to other content within the collection and then organised into appropriate units. We describe the extraction of 'themes' or descriptive tags from the variety of available multimodal content sources. These are then used to arrange the collection into a folksonomy. We also draw out importance measures derived from a themes presence and distribution within the collection; this is an important step required to support the generation processes. The structuring process also aggregates the multimodal content into distinct episodes as recommended in the requirements of Chapter 3. These episodes are automatically detected using clustering and segmentation strategies and are categorized based on user defined rules. With the content structured, automatic generation of personal narrative can be facilitated.

Chapter 7: Semi-Automatic Narrative Generation

With the information appropriately structured and organised, generation of a narrative form can then be undertaken. This is the focus of Chapter 7. We discuss the computational strategies to support an author in distilling the lifelog content into an expressive representation for an experience of interest. The step seeks to identify the episodes and artefacts from the lifelog which satisfies the author's envisaged story, enabling them to quickly compose their envisioned creation.

Rather than taking a formal approach to narrative generation, such a plan-, schema- or grammar-based methods commonly employed within digital narrative techniques, we adopt a summarization-oriented technique. This is informed by Appan et al. (2004) who note that such formal strategies do not lend well to narrating accounts of past personal experience and that of Cheong et al's (2008) who show the potential of a narrative 'summarizer' in creating storied interpretations of large datasets.

The generation process starts by identifying a suitable narrative path through the contents of the collection. Relevant episodes are retrieved and ranked both for similarity to the query and to encourage diversity in the selected episodes. Non-habitual episodes are favoured by incorporating a temporal component to the weighting of results, while diversity further encouraged through the use greedy algorithm to re-rank results after each selection. Finally, coherence is ensured by attempting to minimize the overlap or repetition between selected episodes.

The selected elements form a linear narrative path through the collection and this order forms the narrative's plot. For each episode, its artefacts are then examined and items relevant to the narrative under construction. The fluency of each modal channel is considered so that the content selected may best communicate the experience being retold. The selection of content is mindful to ensure that content is suitably distributed across these channels. Coherency checking ensures that the chosen artefacts are clear, consistent and repetition is kept to a minimum. Once selected, the artefacts are visually arranged into a 2-d spatial layout, a chapter, using a set of presentation algorithms. Finally the media fragments are styled to be aesthetically pleasing and to create an expressive representation of the experience.

Authorial control is afforded to the author by allowing them to feedback on the selection process at any point. Alternatively, they may revisit the albums and chapters produced to manually adjust, edit or refine the layout.

Chapter 8: Evaluation: Collection Owners

With the generation and presentation system outlined and the various components of the system independently evaluation, we now explore the efficacy of story creation as a whole end-to-end process. Three collection owners engaged in narrative construction tasks. They identified a number of stories present within the collection: both short-term episodic stories and broader life narratives. We evaluate the system in composing both story types as well as in manual, guided (or semi-automatic) and automatic construction. The participants composed 5 stories per condition or a total of 30 stories each. For each task the participant provided qualitative and quantitative feedback on the systems efficacy in generating narrative. This was facilitated through a rubric-based evaluation framework designed to be suited to the personal narratives being authored and to provide a measure of quality for the created works. A questionnaire additionally probed the narrative output constructed, any problems

encountered, the process of construction, how they felt about revisiting the content, and recollections and new appreciations as a result of constructing the story. The systems' usability and appropriateness to story construction is examined, after which the quality of the narrated output produced for each condition is examined.

Chapter 9: Evaluation: Third Person Perspectives

Within much of this work, emphasis is placed on the first person use of the narrative output and the system, however it was acknowledged in the requirements elicitation that often these stories move beyond the first person perspective. We saw how geneologists employ storytelling to explain the lives and times of individuals long since passed in order to make that data more assessable and comprehensible. We saw that often in oral traditions stories may be passed on and retold to disconnected individuals and may be shared beyond the immediate family. Here we explore this and the utility that narrative from lifelog collections might offer to third parties. We consider that the media may not be immediately comprehensible to a third party with no knowledge of the individual and that the collection owner may have an essential role in the meaning making and distillation of significance from a lifelog. This is explored by providing a nine-month subset of a lifelog collection to fifteen media editing students who had no prior knowledge of the collection owner or his environs. They were tasked with exploring the content through the storytelling tool and creating compositions about the collection owner.

Chapter 10: Future Directions

As part of this research effort a tool for the construction of digital narratives from lifelog content has been created. There are many opportunities for continued investigation with this tool. First, the usability of the tool can be explored in practice within an ecologically valid, and large-scale cohort of users. Further to this, the application of more sophisticated information retrieval strategies can be explored to enhance the performance and robustness of the narrative structuring and generation phases within the tool. The tool could also be extended to incorporate a number of new features most importantly an increased number of content and context sources. Alongside technical advancements of the tool itself, there is opportunity to explore its utility within a variety of communities of practice. Given that the tool was developed with many concepts observed within the scrap-booking community, it is sensible to pursue deployments within this cohort. There are a number of additional professional

practices for which the tool may offer utility and exciting opportunities which could be exploited. These include working with cultural anthropologists, digital historians, with artists and considering it as a tool for medical or therapeutic care. Several novel investigations are supported both by the availability of the storytelling platform and access to long-term multimodal lifelog collections and makes possible explorations into the significance and implications for authoring narrative accounts of a life in the long term.

Appendices:

I. Summary of Chapters

An overview of the chapter is provided, summarizing the salient points and finding from each.

II. Key Terms

The key terms for lifelogging, storytelling and story generation are provided

III. Research Questions and Requirements

Overview of all of the research questions identified and the requirements associated with them. Also overviews where in the thesis these research questions and requirements were addressed

IV. Building Long-term Lifelog Collections

Discussion of the collection effort is provided. This includes an overview of the tools employed to amass the long-term collections, the modalities and sources captured, an overview of the final collections employed and statistical break down across the three participants. Finally some considerations relating to their use are noted.

V. Exploring the Composition of the Collections

Using a sample month, the composition of the collection is further interrogated to give a better sense of its contents and the affordances, considerations and challenges that such long term multimodal collections pose.

VI. Task Generation for Lifelog Digital Storytelling

To facilitate the evaluation outlined in Chapter 8, the lifelog collection owners were asked to identify known item tasks for use in this investigation. We outline the framework employed to elicit these task descriptions. This additionally provides cues to the contents of the collection and the nature of the stories under composition.

VII. Storytelling Questionnaire & Rubric

Within the evaluation in Chapter 8, participants were asked to rate the efficacy both of the system and of the stories produced with the system. In order to achieve this, a rubric was devised to facilitate scoring of the narrative output. The questionnaire and rubric employed are provided for illustration purposes.

VIII. Example Compositions

Example compositions created using the Orison tool are provided in higher quality and larger format than placed within the discussion. These serve to illustrate the creative outputs produced by the participants within both the evaluations of Chapter 8 and Chapter 9.

Appendix II

Key Terms & Definitions

Lifelogging

Lifelog: Digital archive of personal information, containing for example desktop activity, mobile activity, passively captured photos, explicitly captured photos. A record of past personal actions recorded through digital means, primarily through passive capture to offer as detailed a record as possible.

Explicit Capture: A mode of media capture where the user must take overt action to preserve a moment in a digital record. In traditional media (photo, video, audio) explicit action from the user is often required in the form of button press or application access.

Passive Capture: A record of current actions is sampled without any explicit action from the user. The capture technology will be initially enabled by the user but will continue to operate in the background and without any need for intervention. Actions are sampled regularly to preserve a full account

Desktop activity: Items accessed on personal computer, for example word documents, emails, web pages etc, and the associated information relating to accesses, which includes, duration, frequency and time of access.

Explicit photo capture: Photographs explicitly taken by an individual using a multifunction mobile phone or digital camera.

Mobile activity: Activity performed on mobile phone, e.g. SMSs sent and received, phone calls made, received and missed, web browsing.

Mobile context: Understanding of an individual's current environment as captured by a technologies embedded on mobile devices, which may include geo-location, motion, light status, weather, people present.

Passive photo capture: Image capture which does not require explicit intervention by a user, i.e. is triggered by sensors (e.g. motion, infrared) or a preset time interval.

SenseCam: The SenseCam, Developed by Microsoft Research in Cambridge, UK, is a wearable passively capture device designed to record a person's day-to-day activities as a series of photographs. It is typically worn around the neck, and is oriented towards the majority of activities which the user are engaged in. At a minimum the SenseCam will automatically take a new image approximately every 30 seconds, but sudden changes in the environment of the wearer, detected by the onboard sensors can trigger more frequent photo capture.

Structure

Artefact: A data fragment contained within the lifelog collection. An artifact is any datapoint which can be used to embody an aspect of a personal experience. It may be used to describe visual (photos), contextual (locations, people) or expository elements (text, captions).

Episode: An episode is a higher-level unit within the lifelog designed to align with a single experience. It aggregates the elements of the experience, the artefacts, into a single unit that encapsulates the variety of ways it can be expressed. An episode will typically encompass a single discrete activity the individual has engaged in.

Theme: Themes describe the experiences encapsulated within an episode. They can belong to a variety of specific types but broadly relate to *people*, *places* or *happenings*. Themes are used to label and categorise the contents of a lifelog collection from an experiential perspective. They can be used to map relationships between the contents and to discern patterns within the collection. They are core to the representation of narrative paths through the lifelog collection.

Storytelling

(Personal) Story: A personal story is a experiential retelling of one or more episodes from past personal experience.

Life Narrative: A life narrative retells a set of related episodes focused on key theme of interest and related to a broad period in the individual’s life. It should be framed from

the perspective of the current self and placed within the context of the larger life experiences.

Author: The author is responsible for crafting or creating a storied interpretation. Within the context of the work, they will most often be the owner of the collection and will actively draw together the contents of a lifelog into an experiential account.

Audience: The individuals who will review the created works and narrative accounts. An audience may be the individuals who the story is crafted for or targeted towards or the individuals who the created work is actually reviewed with.

Layout or Chapter: A layout, or chapter, is a two dimensional composition in which artefacts from a lifelog collection are aesthetically presented. The media fragments presented within the compositional space will retell an aspect of an experience visually

Album or Story: An album or story contains one or more chapter-based compositional layouts. Each chapter is a unit of the narrative and their sequencing forms the plot and the progression of that story.

Narrative

Narrative Generation: The process of computationally creating storied output from a collection of digital content.

Narrative Representation: The representations defines the relationships between the story units within a digital collection. It helps to identify the possible narrative paths between all possible units of the story and is central to the identification of plot. A higher quality representation will mean that there are more possibilities for the plot of the narrative

Narrative Presentation: The presentation of a storied interpretation follows the identification of plot through the representational layer. The story units are transformed into a presentational form which can then be used to narrate that account to an audience.

Coherence: The coherence of a story describes how meaningful, sensible and well formed it is. In order for a narrative to be coherence, the relationships between the

elements of the story must be clear and the inclusion of elements within the story must be purposeful and advance the plot of the story.

Focus: The focus of the story concerns its major topics or what the story is about. This may be either a past action, theme, or timeframe that it is attempting to retell. The focus of the story should be easy to discern from the elements it includes and the progression in plot.

Completeness: A complete narrative will include all of the salient story units required to tell the story in a coherent way.

Plot: The plot is the units of storytelling employed by the narrative and the order in which they are sequenced. The ordering of these elements defines the progression of the overall narrative, with each unit of the story contributing a component over the story. Each element in sequence serves to develop and progress the narrative from a starting point through to an end point. This progression is known as the plot.

Pacing: Pacing is the speed at which the plot unfolds over time. The pacing of the plot, and the elaboration of the major happenings with the story, may vary throughout its retelling. The author typically controls this component of the narrative to deliver suspense or drama at key moments in the narrative's trajectory.

Fluency: Elements included within a story may have different competencies in communicating, expressing and representing the experiences and plot of the story. The affordances each element or type of element within a narrative in retelling is known as its fluency.

Appendix III

System Requirements Review

In this section we review the requirements developed for the system. We outline where in the thesis each element was discussed, interrogated and explored and how the requirement was satisfied.

REQUIREMENTS I (GENERAL):

5. ***COLLECTION****: The user must be able to continuously collect information about their day-to-day activities without the need to specify how it should later be assembled into a story, regardless of how abundant the collection may become.*

   We amassed three multimodal lifelog collections and through computational support minimized the need for the user to describe, structure or organize that content (see Section 5.3; Appendix IV.)

6. ***CURATION****: It is important that this information be distilled. Family practice employed this distillation to manage mementos and ensure they were accessible. A reductive curatorial process will be indispensible in making sense of in gaining value from the collection in the long-term.*

   This curation was supported through the crafting of lifelog content into digital stories. This can be performed manually where the user identifies content of interest and transforms it into story-form (see Section 5.5) or automatically whereby the system distills the content on behalf of the author (see Section 7.3).

7. **DISCOVERY**: Identifying the 'stand-out' content is an essential part of curating memories. Opportunities for discovery and rediscovery of this content must be afforded to the user.

   The user may discover content through the support of the digital tool. It enables a user to browse content of interest and opportunistically discover content through the awareness screen (see Section 5.5.1)

8. **REWARD**: Curation should benefits such as new opportunities to explore personal identity, to share the experience and to reminisce. It is important that a digital system delivers similar rewards to the individual.

   The rewards are noted discussed in Chapter 8. The reminscence and recollection with this material was seen in particular to be engaging and enjoyable. For motivated third parties, it was seen as an exciting and novel undertaking (see Chapter 9.)

REQUIREMENTS II (STORY):

6. ***EXPERIENTAL****: The process of creating a story must be transformative converting the content and data into a suitable experimental form.*

   The storytelling framework encourages evocative and expressive accounts to be created. It allows media fragments to be styled and presented in exciting arrangements (see 5.5.2). It is not just data which is presented but the visual aesthetic and immersive experience employed during presentation (see 5.5.3) creates a sense of the experience. Colour, texture and form can be associated with the content to typify the experience, add coherence and intonate meaning.

7. ***INTEGRITY****: Integrity in providing an representative account of the experience is a key component of narrating life histories*

   The automated processes of story generation provide reliable accounts of the experience as noted in the evaluation in Chapter 8. However, when manually composing a narrative, the system provides a degree of flexibility to the author. This allows them to create fictive accounts representing the media in new ways should they so chose (see Chapter 9, Case Study 3.)

8. ***MALLEABLE****: As personal and physical stories adapt over time, so too must a digital equivalent have the ability to be edited and refined.*

   The album-based narratives composed can be revisited at any time. At any point, an author may contribute new content to the layout, adjust or refine a composition or apply new labels and descriptions as required (see 5.5.2.)

9. ***SUPPORTED:*** *An author must be supported through computational approaches and strategies to offset the burden and time-consuming nature of review and composition.*

   In Chapters 6 and 7 we outline the computational processes the storytelling tool offers to support the author in their creative and curational endeavours.

10. ***AUTHORIAL CONTROL***: The author must be able to not only specify the goals of the story (by providing a point of view, theme or focus for the story) but should be able influence its outcomes to match their desired or expected outputs. This ensures the correct elements have been distilled and that the author has considered and reflected on the media to be included in the story.

    The author is central to the authoring process, even when it is computationally assisted. The author has the ability to feedback at any point into the generation of the narrative and adjust its outcomes as they see fit (see Section 7.7).

REQUIREMENTS V (STRUCTURAL):

8. ***PRESERVATION***: The content and structures employed should be as replete as possible and cover both seminal events and everyday moments with equal opportunity. In doing so it increases narrative possibilities.

   In our collection effort we sought to capture a wide variety of modalities to broadly survey the day-to-day activities of the individuals recorded (see Section 5.3, Appendix IV)

9. **BROAD**: The digital system should enable a disparate set of digital sources, channels and modalities to be brought together. The structures should be flexible enough to broadly support their inclusion and curation in story-form.

   The storytelling environment flexibly supports all media contained within our lifelog and allows it to be integrated into a narrative account (see Section 5.3).

10. ***TEMPORAL***: Time must be central to the structure of life narratives and it must be accurately and appropriately represented.

Time is a key consideration within the tool with appropriate support being provisioned to support the alignment of the various modalities employed (see Section 5.6.2)

11. ***THEMATIC***: Life narratives are hinged on these thematic elements and so must be a key component through which a digital collection should be organised.

    Themes are central to the structures of the storytelling environment (see 5.3.1). All Content and episodes are labeled with them (see Section 6.2).

12. ***EPISODIC***: Personal stories concern episodes of experience. These episodes represent a single happening over a short period of time. An episode encompasses all of the sensory elements which contribute to that experience: the sights, sounds, observations, mental reactions, etc.

    Episodes are the unit of storytelling within the storytelling system (see 5.3.1). We provide automatic processes to aggregate the content into these units and provide an algorithmic approach which is not fitted or reliant on a single modality (see 6.4.)

13. ***OWNERSHIP***: It is important that the digital system supports the contribution from a variety of individuals and attributes that content to its original owner.

    Support for content contribution by multiple collection owners is provisioned within the storytelling environment (see 5.3.2, 5.7.)

14. ***MEDIATED MANAGEMENT***: The digital system should encourage this reflection over management and support several individuals in this practice.

    The system encourages careful reflection particularly on the removal of content by requiring a ‘cooling off’ period before content can be permanently deleted. Content may be hidden to support ‘forgetting’ and multiple collection owners may manage the contents of the collection (See 5.6.3)

REQUIREMENTS V (REPRESENTATION):

5. ***CONNECTIONS***: Life stories are formed between sets of related episodes chained together. The representational layer should identify and map these relationships so that they can be exploited in the formation of narrative

Connections may be identified through the labeling of episodes with themes (see 7.4) This enables narrative paths through the collection to be identified in response to story generation by the author.

6. ***ADAPTIVE**: The representational layer of the narrative system must be sensitive to this and adapt to reflect changes in importance.*

   The temporal weights enable episodes and experiences houses within the lifelog collection to have shifting importance over time. This allows frequent themes to be reduced in importance and non-habitual experiences to be discerned (see 7.4.2.)

7. ***REDUNDANCY***: In representing the narrative, it should be possible to identify and remove redundant, repetitious or spurious elements. If redundant elements are retained the coherence of the plot may be negatively impacted.

   The encouragement of diversity in episode and artefact selection as well as the incorporation of a coherency checking step ensures redundancy is minimized (see 7.4.3, 7.4.4).

8. ***FLUENCY***: In combining the media fragments from a lifelog collection, the storytelling tool should be sensitive to each modality's *fluency* in the retelling.

   Modality weights (see 7.5.3) encourage the artefacts with the best communicative qualities to be included in the end narrative.

REQUIREMENTS V (PRESENTATION):

5. ***TRANSFORMATIVE**: The presentation process could appropriately convert units within a lifelog into an experiential account.*

   Presentation converts the data from a lifelog into an expressive aesthetically coherent form. It has support for styling and arranging the content as well as the automatic layout of content in a suitable form (see 5.5.2, 5.5.3, 7.6.)

6. ***COHERENCE***: In bringing together a variety of media fragments to represent and communicate an experience, this must be done in a sensible manner.

Artefacts are selected to be relevant to the goals of the story under construction (see 7.5.3). Coherency checking minimizes redundancy and repetition (see 7.5.4.) Content is then presented in a manner suited to the nature of the story (see 7.6).

7. ***PERSONAL***: The stories under construction will be about past personal action and may be related to aspects of identity. The narratives produced should be meaningful to their owner, be affective and have resonance for them.

   The narratives produced, being based on past personal experiences were seen as deeply meaningful to the collection owners. (see Chapter 8).

8. ***EXCHANGE***: The stories produced should have the ability to be shared in some form. They must support social exchange and discourse around them and have the ability to exchanged between individuals.

   The system provides support for the exchange of storied interpretations either by exporting the authored account to provide to a person of interest or by direct presentation through the tool itself (see Section 5.5.3).

RECOMMENDATIONS:

In addition to the requirements outlined above, the scrapbooking practices aligns well with the goals of our investigation. Their practices can be used to further inform the design of our system.

6. ***COMPOSITION****: The organizational strategies scrapbookers employ are sensible as a frame for digital storytelling.*

   We adopt such strategies as key metaphors within the workflow of the system (See Section 5.4)

7. ***FLEXIBILITY:*** *The spatial composition employed is not only successful at integrating various disparate media fragments but it is highly flexible. Being unconstrained, a variety of illustrative techniques can be employed to highlight the underlying narrative. Its flexibility in lends itself to creating a diverse set of interpretations and to creative endeavours.*

   We adopt the spatial layout and while we favour the inclusion of authorial support and computational assistance, the system enables the author to manually

compose narratives in a flexible manner too. The choice of compositional approach adopted is at the discretion of the author (see 5.4.)

8. ***WORKING SPACE****: A working space in which these arrangements can be tested and trialed would be beneficial to include In order to support such practice.*

   The scratchpad provides a working space in which authors can store content they want to include in a composition temporarily and trial layouts and aesthetic presentations before committing its contents to an album (see 5.4.)

9. ***CAPTIONING:*** *An essential component of the creation of scrapbooked layouts was the annotation of the contents with descriptive labels. These concepts could be useful within the digital environment, particularly when sharing or presenting the narratives.*

   Captions can be attributed to a media item included within a layout or flexibly included within the layout (see 5.5.2.) Captions can be hidden so as to only display during exploration (see 5.5.3) much like the ‘secret stories’ of the scrapbookers (see 4.2.3.5.)

10. ***REUSE***: This reuse of styles and layout conventions would be important to support within a digital environment.

    The system provides support for reuse within two major ways. Styles and themes maybe developed so that aesthetic patterns may be quickly applied to either an item of content or an entire composition (see 5.5.2). Computational layout patterns were also included within the system. These allowed compositions to be quickly created from commonly visual arrangements (see 5.5.2, 7.6) much as in the templating approaches of the scrapbookers (4.2.3.5.1).

Appendix IV

Building Long-term Lifelog Collections

Within this section we explore the long-term lifelog collections amassed for use within this work. We describe the technologies used to record the day-to-day activities of three individuals in the long-term, overview the size, scope and modalities available within the resulting collections and finally discuss the considerations and challenges of employing these novel personal collections.

IV.1 Participants and Duration

In order to facilitate the investigation proposed within this work, it was required to amass a number of long-term lifelog collections from several users. Given the intensive nature of the data collection combined with the extended duration of recording, this was prohibitive to the recruitment of participants. As a result, a small cohort of motivated individuals was employed within the investigation. In total, three participants agreed to capture their day-to-day activities in the long term using these technologies; the author of this work is among them. All of the participants were postgraduate students within the School of Computing at Dublin City University. While not directly incentivised through reimbursement, each had a vested interest in the capture of the lifelog collections; the collections formed the datasets for use within their doctoral research activities. Considerations ensuing from this are discussed later in Section IV.6.

Data collection for this work was conducted over a two-year period, commencing in May 2008 and ceased in 2010. The initial month of capture saw many teething issues while participants familiarised themselves with the recording apparatus, technologies and considerations of capture. All other months of capture are considered to be complete. However in some circumstances and owing to device or technology failure, content from some periods may be incomplete or missing for one or more modalities of capture. The implications of this are discussed in further in Appendix V which examines a one month sample of the collection in detail. Largely, gaps in recording coverage are not a major cause for concern; for the most part there were minor, and

brief. In one notable circumstance a data corruption on a recording device caused the loss of one modality's data for a period of one month. However, the availability of multiple modal sources meant that this information could be largely reconstructed through the other sources. Practical considerations for the collections, their coverage and other related issues is the subject of detailed discussion in Byrne, Kelly & Jones (2010).

IV.2 Modalities Captured

The use of a variety of multimodal and mobile sources, sampled at high frequency enables a rich picture of a person's life to be assembled. Through these multiple modalities and the detailed information amassed on an individual's past actions, storytelling applications can be enabled. However, each modality captured places additional burden on the user, encumbering them through the management and maintenance of recording apparatus and devices. As such it is desirable to reduce this onus on the user by employing only the most necessary modalities and those technologies which are passive requiring less intervention to operate. The passive modalities can then be supplemented and augmented with a range of content sources that would be commonly captured irrespective of this collection effort. It is important to note that each modality offers different affordances in terms of retelling and reconstructing stories of past personal experience. The modalities employed balance many considerations both for the user and the end goal; and ensure there is sufficient richness, completeness and computational understanding within the end lifelog in order to facilitate the generation of life narratives. These are now outlined.

IV.2.1 Passively Captured Media

Passively Captured Images: Within our lifelog collection, continuous passive image capture was enabled through the use of a small wearable device, the Microsoft Research SenseCam (Hodges et al., 2006). While these images are of reasonably low quality, and often contain many undesirable elements such as blurring, noise and light effects (Gurrin et al, 2008), as they are captured without intervention they offer an uninterrupted stream of images equivalent to a visual diary of day-to-day action. More importantly, as the camera is worn from the neck they appear to offer a first person view of the activity - or an image captured as the wearer might have seen. Capture can be trigged by changes in the environment of the wearer detected by a series of on-board sensors (accelerometer, light, passive infrared.) If no changes are detected,

a photo will be taken after a short interval. This results in a photo being recorded on average every 20-30 seconds. As passive photo capture continuously records without the need for user intervention, it offers the potential to capture events and activities that otherwise might not be captured or there might not be opportunity to capture. It also offers a more natural viewpoint of the event, with traditionally captured photo often being 'staged'. Lindley and Harper note many of the qualities of SenseCam images which make them highly suitable for re-appreciating past personal action (Harper et al., 2007; Harper et al. 2008; Lindley et al. 2009a; Lindley et al. 2009b).

Figure IV.1 The Microsoft SenseCam

Mobile Context: This provides digital cues to the user's location and the people who might be proximal to them at a given moment in time. The detection of GSM, GPS and wireless network information provides location, while co-present Bluetooth devices indicate the people who may be present (Lavelle et al. 2007; Kostakos, 2008). As mobile context information can be used to derive and describe the *who* and *where* of an activity, it extremely useful within the context of story construction. Using the information within this modality, the actors and settings for a story can be derived. More importantly, over time this information can be aggregated to understand the relationship of these people and places to the collection owner, as well as their importance within the landscape of their life (Eagle & Pentland, 2006). An understanding of these components as well as their overall importance, can help facilitate the reasoning required for story generation. Within the story, this understanding can be used to provide expositional content to the retelling.

Computer Activity: Desktop activity recording enables a record of interactions between an individual and their digital documents to be maintained. This allows not

only the access to documents, the viewing and sending of emails, and the review of webpages to be recorded but also the content associated with these digital document to be preserved, examined and mined (Gemmell, Lueder,& Bell, 2003.) As content being accessed or authored at a particular moment will often concern the focus of the user's activity either peripherally or directly, the collection of computer activity can enhance the richness of the collection and further facilitate the reasoning required for storytelling.

IV.2.2 Explicitly Captured/Created Media

Explicitly Captured Media: Media deliberately captured by a user represents a moment in time that they have explicitly decided to preserve. These items therefore have some significance implicitly ascribed to them making them important to include within the lifelog. Within the lifelog collections we augment the passively captured SenseCam photos with digital photographs taken by subjects. These images being of higher quality and with their deliberate nature of capture, offer an alternative, and perhaps preferable viewpoint on a past activity.

Short Message Content: This includes short text messages forms such as SMS messages or Twitter status updates, both of which can further augment and enhance the collection. SMS messages exchanged between mobile phones are text-based conversations between two individuals. Twitter is a micro-blogging format where a user is invited to describe the current activity they are engaged as a 140-character text-based message known as a tweet (Java et al., 2007). These message forms can provide very useful information on the user's activities, thoughts or interests and can be used to compliment the visual content from the SenseCam or traditional digital photos.

IV.3 Collection Method & Apparatus

A number of key hardware and software solutions were employed within the data gathering. Each of the participants were provided with the following apparatus in order to collect their life experiences digitally:

IV.3.1 Hardware:

Nokia N95 phone (Nokia, 2007): The N95 is a sophisticated mobile device which runs the Series 60 platform enabling mobile applications to be developed and deployed on

it as part of this investigation. It also includes a built-in 5-megapixel camera and large storage capabilities (up to 8GBs) making it ideal for use in the long-term collection of data. All of the participants used this device as their primary mobile phone and digital photo capture device and as such contained all of their mobile content including SMSs, call history, photos. It was additionally used to capture the participant's personal context.

Microsoft Research SenseCam (Gemmell, et al, 2004; Hodges et al, 2006): is a small lightweight, wearable device that passively captures a person's day-to-day activities as a series of photos and sensor readings. The device requires no manual intervention by the user as its sensors detect and record changes in light levels, motion and ambient temperature and then determine when is appropriate to take a photo. Each of the users wore this device on a daily basis to capture their day-to-day activities, unless requested not to do so by another individual in proximity to them or if there were restrictions on recording in a particular space e.g. within a hospital or school. On average, the device yields 3,000 images per day and the battery is sufficient to last a typical day.

IV.3.2 Software:

Desktop Activity Recording Software: Users were asked to run desktop activity logging software constantly on both their home and work computers. For those running Windows-based machines, they are provided with both the Microsoft MyLifeBits (Gemmell, Lueder, & Bell, 2003) and SLife (2008) software, while those running Macintosh OSX are only required to run SLife. These software suites record all application use and file access on a desktop or laptop computer. As a user switches between windows on their desktop, the software intercepts the operating system commands and creates a new desktop event. This event contains a start and end time equating to the duration with which the user spent within that window before switching to another. It is additionally described with the title of the active window, the application it belongs to, and a URL or path, if available. The desktop activity software does not maintain a record of the content of that window. On a nightly basis and using proprietary software, the accesses which had occurred during that day were then post-processed to align them with the relevant content contained in the related digital document.

Mobile Context Recording Software: The Campaignr software, provided to us by UCLA (USA) (Joki, Burke, Estrin, 2007) was deployed on the users' N95 devices.

Participants ran this software continuously to capture their contextual factors such as location through Wireless, GSM sniffing and the persons in proximity to them through Bluetooth device sniffing. The software was configured to capture these contextual factors every 30 seconds. This data was stored on the mobile device and at a juncture of the user's choosing could be uploaded to a central server. Once uploaded, the mobile context information was then processed. For each recorded poll, the captured GSM and WiFi information was then used to geocode the information using a Google Geolocation API [11] which returned the GPS information, including accuracy, and a street address for the location. This information was then appended to the record along with a set of reverse geocoded place names and toponyms retrieved from GeoNames[12].

Mobile Activity Recording Software: A proprietary piece of software enabled the logging of missed calls, made and received calls and sent and received text (SMS) messages. Participants ran this software on a monthly basis to capture a record of mobile content captured within that period.

Twitter: Each of the participants was asked to setup and maintain a twitter[13] account. They were instructed to post regular status updates using the online social network about the activities they were engaged in. These were used to provide text-based annotations of activities, thoughts or items of interest.

IV.4 Composition of the Collections

The content and context contained within the long-term collections are illustrated in Figure IV.1. The passive capture effort (Mobile Context, Desktop Activity and SenseCam) commenced in May 2008 for all users. Users 2 and 3 ceased passive capture in December 2009, however, User 1 continued until May 2010. This gives Users 2 and 3 a 20 month passively sampled lifelog and User 1 a 24 month collection for use within this evaluation. The users provided additional explicitly authored or captured media beyond this main timeframe for use within the evaluation. User 1 provided digital photo, SMS and Twitter content until May 2011, giving a total span to the collection of 3 years. User 2 provided digital photos until May 2010 and SMS content until August 2010, giving a total span of 2.333 years. User 3 provided digital

[11] http://code.google.com/apis/gears/geolocation_network_protocol.html
[12] http://www.geonames.org/
[13] http://www.twitter.com

photo content until December 2009 (in line with cessation of passive capture), SMS content until February 2010 and Twitter status updates until June 2010, although the number of items contained this modality were very limited. In practical terms, the collection can be seen to span only until February 2010, providing a 22 months of data.

		User 1	User 2	User 3
Type	**Sub Type**	**Count**	**Count**	**Count**
Document Activity	Desktop	134,215	9,836	12,997
Document Activity	Laptop	26,091	18,893	767
Document Activity	*Total*	*160,306*	*28,729*	*13,764*
Mobile Context	Mobile	1,203,844	732,557	358,416
SenseCam	SenseCam	1,156,697	732,848	459,530
Digital Photos	Photos	1,396	1,592	2,002
Text	SMS Received	7,943	3,023	539
Text	SMS Sent	8,970	3,026	166
Text	Twitter	838	476	106
Text	*Total*	*17,751*	*6,525*	*811*
Total		**2,539,994**	**1,502,251**	**834,523**

Table IV.1: A per user breakdown of the lifelog collections

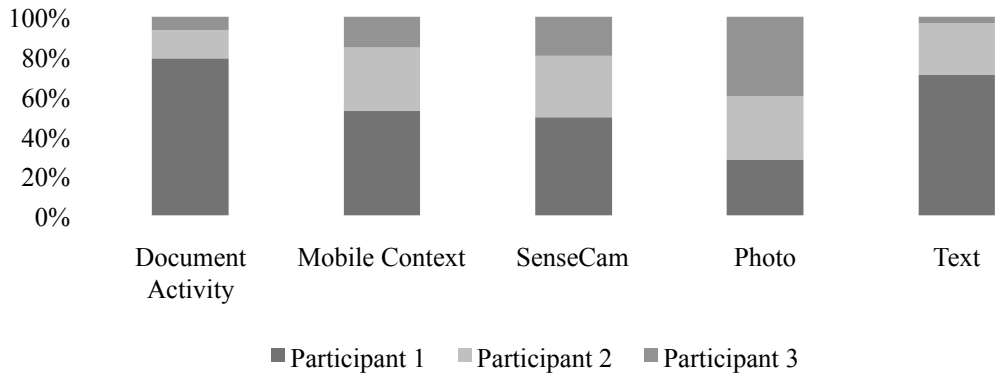


Table IV.2 Relative Distribution of the Modalities Across the Participants

	User 1	User 2	User 3
Type	**Count**	**Count**	**Count**
Mobile Context	*1,203,844*	*732,557*	*358,416*
Bluetooth MAC Address	*19,047*	*29,179*	*12,802*
Bluetooth Friendly name	*3,210*	*4,182*	*1,667*
WiFi Signal Mac Addres	*18,496*	*10,023*	*11,406*
Wifi Signal Name (/SSID)	*11,355*	*6,700*	*7,817*
GPS Position	*22,865*	*15,294*	*11,662*
Place (address)	*2,177*	*2,007*	*2,166*
Total	**112,969**	**71,929**	**49,280**

Table IV.3 Mobile Context Signals Detected

Noting the distributions of content across the collection owners, as overviewed in Table IV.2, we note that User 1's collection contains more data for almost all modalities. This is with the exception of explicitly captured photo content, for which User 3 is the most dominant source.

Finally, it is important to note that mobile context capture polls for proximal digital signals at a rate of every 30 seconds. Within each poll, there may be a number of co-present signals detected from a number of sources. Table IV.3 outlines the signal sources encountered by each user. Despite the general variance in Bluetooth devices, GPS points and WiFI signals encountered, it is interesting to note that all users largely visited the same number of distinct geographic places in the duration of the 20 month passive capture effort (apprxomitately 2,100).

The composition of the collections across the users is explored more deeply in Appendix V. This discussion probes a representative month selected by the participants from the larger collection amassed. This is designed to better illustrate the nature of the collections employed, their affordances, challenges and constraints as well as the coverage and distribution of each modality.

IV.5 Experiences in the collections

It is helpful to consider the nature of the items contained within the collection to better contextualise the data amassed as part of the lifelog More information on the events and activities contained within the participants' collection are described in the appendix material on developing task sets for the collection (See Appendix VI). Broadly the experiences contained within the related to five major categories: those

relating to career and/or work; relating to travel; personally significant experiences, often relating to the first or last instance of an activity; socially significant moments and events; and memorable moments concerning short episodes relating to activities and events of interest. These are described in more detail in Stage 1.B of the Groundtruthing exercise in Appendix Vi.

IV.6 Notes on the Collection

A major novelty of this work is the use of long-term multimodal lifelog collections. With the exception of Gordon Bell (Bell & Gemmell, 2007), such collections do not exist nor are they available from a number of users to facilitate research investigations. While their novelty adds to the contribution of this work, there are some considerations which must be born in mind.

Participants: Lifelogs are highly personal collections. As such, it can be difficult to recruit participants to amass such collections over the longer term. Added to this the burden imposed on participants to manage the many recording devices, and also to manage and review their data over a long period of capture may reduce the willingness or likeliness of potential candidates to participate. As such, and from our own experiences, we found it is best to recruit participants with an vested interest in amassing these collections, i.e. those directly or peripherally involved with the project - Microsoft's Gordon Bell is an excellent example of such an individual (Bell & Gemmell, 2007). Given that these people have a stake in the project they are also more likely to exert additional effort to ensure that their collections are correctly, properly and reliably captured. The practical constraints and overheads of managing any more than a small number of participants within such a collection activity must also be considered. Irrespective of the participants affiliation to the research project, plain language statements and informed consent agreements should be sought upfront. Additionally, given the personal nature of these collections, the individual's willingness to participate may change over time. As such provision to allow an individual to withdraw their participation and data without penalty should be made.

Collection Storage: Ethical consideration around the storage and aggregation of an individual's personal artefacts was a key consideration within the development of the lifelog collections. We have taken great efforts to ensure that all possible data protection steps have been ensured in our work. First and most importantly each participant's lifelog collections should be independent of all others and placed on

separate secured volumes. The only individual with access to create, maintain or review this content was the collection owner themself. Participants were tasked with the management and storage of their own collection to mitigate any individual being accidentally exposed to the personal content of another.

Instructions to Participants: In building, the lifelog collections participants were made aware of the situations in which they should not engage in recording practices. This included any circumstance where an individual has a reasonable right to privacy, for example within a doctor's surgery, hospital, school, etc., and where a given individual has specifically objected to recording taking place either generally or during a specific activity.

Experimental Design - Conducting Groundtruthing & Evaluations: Within all of our experimental evaluations and groundtruthing annotations, access to the collections was maintained only by the collection owners themselves. This constrained was designed to ensure sound ethical practice. As such all annotation, groundtruthing and experimental investigations were conducted on the individual's computer in isolation and independently. Any information extracted and used for evaluation could not contain specific identifiable details. Given the highly personal nature of these collections, it was important that participants were not required to provide personal or sensitive information. As a result, all evaluation frameworks employed ensured that those examining the groundtruths could not discern any private information about the participant. In any output provided for use within an evaluation, feedback was anonymized or obfuscated. This allowed models, algorithms and implementations to be developed and assessed without the need for the participant to provide personal data to the investigator.

Quantitative Output: While the low number of collections garnered in such studies may create a barrier to quantitative output, it should be borne in mind that these collections survey extremely broad periods in rich detail and contain many thousands if not millions of artefacts. While it may be difficult to achieve experimental results that are widely generalizable with the low numbers of participants involved in this work, the inferences which can be gained are extremely valuable. We therefore choose to suppliment quantitative output with qualitative feedback in order to better support any findings. This seeks to making them more applicable and generalisable. The utility of this approach is highlighted not only in our work but also by others in the domain, for example Elsweiler et al. (2007).

Bias & Subjectivity: It is worth providing a cautionary note on the low numbers of users and the use of qualitative measures for evaluation. In all qualitative work there is the potential for subjective feedback. While in other experimental approaches the use of sufficiently large numbers can weed out 'wild card' participants and spurious feedback, it may be extremely difficult to do so given the limited number of individuals involved in these trials. It is also important to consider as we use participants who have a direct stake in the success of a research project that they may be inherently subjective and/or biased towards specific outcomes of the evaluation. In our evaluations, we attempted to minimise the participants' exposure to goals and hypotheses of the evaluations to remove the potential for such issues. Furthermore, it must be noted that the main investigator of this work is one of the participants. We must acknowledge this participant to have more potential for bias and subjectivity given the knowledge of the desired outcomes. We acknowledge the findings from this participant to be a special case in reporting.

Personal & Social Privacy and Ethics of Continuous Capture: Lifelogs are by their nature extremely personal collections containing a wealth of rich fine-grained pictures of the activities an individual has been engaged in over extended periods of time. As such there are many places, spaces and situations in which for personal reasons a user will not wish to capture, for example, bathroom breaks, early mornings while getting dressed etc, or in the evening preparing for bed. The individual may also retrospectively wish to temporarily or permanently 'forget' particularly painful, upsetting or embarrassing moments contained within such collections (Bannon, 2006). There may in addition to the personal considerations for privacy be socially-mediated constraints placed upon recording and capture. For example, friends or family members may explicitly object to being captured (perhaps to any recording or just in specific situations). Further to both the social and personal limitations on recording, there may additionally be ethical, moral and legal implications imposed. In any situation where an individual (known or unknown) has a reasonable right to privacy, including hospitals, waiting rooms, schools, changing rooms, bathrooms, etc. the lifelogger should not record any material. The use of this technology raises many questions about privacy and ethics. While we considered many of these issues within this work they are not discussed in depth. We undertook to ensure best practice was applied in dealing with many of these factors and participants were encouraged to be sensitive to these complex considerations when engaging in recording. While we do not extensively outline the procedures we put in place within this work, prior to commencing the data gathering effort in May 2010, they were exhaustively

considered. Participants and investigators alike were mindful of these concerns throughout the collection effort. Further details of this can be found in Byrne, Kelly and Jones (2010) or and in other literature within the domain, primarily that of O'Hara, Tuffield & Shadbolt (2009.)

IV.7 Summary

For the purposes of this research, three participants (including the primary author) collected lifelog data which broadly represented their life experiences. Data collection commencing in May 2008 and continued for two years. The effort recorded personal information from a number of passive and active content streams. These included passively captured images from the Microsoft SenseCam, desktop activity and document access, mobile context information, digital photographs, mobile SMS (/text) messages and Twitter status updates.

While the resulting collections are extremely novel, some considerations of their use need to be born in mind. In particular, is the limited number of participants involved, each of which had a vested interest in the collection of data employing the data in their own doctoral research. The limited number of participants stems from the highly personal nature of the archives which makes it difficult to recruit participants willing to so broadly and intimately capture their life experiences *and* make that data available for use in research efforts. Additionally given the personal nature of the content, it was agreed that each of the collections would be maintained by the individual themselves and the investigators would not have access to other participants collections. Therefore the evaluations, organization etc of the collection had to be performed on the users own computer without intervention and without the ability to directly access the data.

While there are practical and ethical limitations, it should be remembered that the collections are extremely novel and enable a first of its kind research.

Appendix V

Exploring the Composition of the Collections

Within this section, we discuss the content contained within the lifelog collections amassed by the participants by illustrating their contents through a representative month. As the long-term multimodal lifelog collections we employ are extremely voluminous, intuiting its composition presents difficulties. We frame this discussion by examining a representative month of content from each of the participant's lifelog collections. Taking a representative month in isolation allows the content to be explored in a more assessable manner and for the contribution of the modalities to be better discerned. Within this section we will explore each of the modalities in turn looking at the amount of content collected, its nature and contribution to the collection. The information elicited in this section can also be employed to contextualise the experimental studies outlined in Chapters 8 and 9.

The variety of modalities captured seeks to provide an overview each of participant's day-to-day activities through digital means. While there are limitations to this, as outlined in Chapter 2, the modalities selected for use offer a broad and detailed picture of these activities painted by overlapping and complimentary modalities which expose the activity through data in a variety of ways. For example, a SenseCam frame may offer a visual depiction of an activity while mobile context may add a description of the location. Within the representative month the data displays the participant going about their daily activities. During the working week, this entails conducting research at an academic institution. This includes activities such as going for lunch, meeting colleagues, discussing and presenting their work, attending research meetings and symposia, writing research papers and engaging in computing activities. As a result, the majority of content Monday to Friday represents such activities. In the evenings, the participants would typically be expected to spend time in their homes and go about other normal household activities such as making dinner. At weekends and during the evenings, social activities such as meeting friends, nights out, dinners, short trips, and similar events can be encountered. During their selected month, some of the participants engaged in activities outside of their normal patterns or routines, specifically in the case of Users 1 and 3 overseas travel to attend conferences.

Personally significant events described within the collections were elicited as part of groundtruth development. A description of these is provided in detail in Appendix VI.

	User 1 - October 2009			User 2 - May 2009			User 3 - May 2009		
Type	**Count**	**Days**	**Avg.**	**Count**	**Day**	**Avg**	**Count**	**Days**	**Avg**
Desktop Activity	7147	26	274.88	663	31	21.38	6102	29	210.41
Laptop Activity	8115	26	312.12	6524	31	207.25	1839	29	63.41
Total Activity	*15262*	*26*	*293.50*	*7288*	*31*	*235.10*	*7941*	*29*	*136.91*
Mobile Context	49220	31	1587.74	51179	32	1599.34	50835	31	1639.84
SenseCam	77204	31	2490.45	46705	31	1506.61	30554	31	985.61
Digital Photos	14	14	1.00	0	0	0.00	18	31	0.58
SMS Received	110	31	3.55	121	30	4.03	3	1	3.00
SMS Sent	84	31	2.71	123	30	4.10	0	0	0.00
Twitter	48	30	1.60	49	12	4.08	0	0	0.00
Text	*242*	*31*	*7.81*	*293*	*30*	*9.77*	*3*	*1*	*3.00*
Total	**141942**	**52**	**2729.65**	**105202**	**32**	**3287.56**	**89351**	**58**	**1540.53**

Table VI.1: A per user breakdown of the lifelog collections from a representative month

V.1 General Overview of the Collection

Even with three collections from participants of similar age, working environment and education background we can see that there are significant differences in their lifelog collections. Table 1 illustrates many of these differences. For example, we can see that User 1 collects far more digital content than the two others in the cohort. The computer activity recorded is almost double that recorded by the other two participants. Examining the document activity alone we see that User 1 accesses a comparable amount of digital content both at the fixed desktop computer placed in the work environment and on the laptop, normally situated in the home environment. User 2 accesses content prevalently from their laptop while User 3 conversely does so from a desktop computer. This is indicative of a wide variance both in content access and in work practices. All users capture a comparable volume of mobile context, but SenseCam content is captured with some variance across the users. There is of course a marked difference between the volumes captured between passive and

explicit modalities. Photos may be indicative of socially interesting events and we can see that User 1 & 3 may have encountered such activities. SMS messages are sent and received in almost similar volumes for User 2 perhaps indicating 2 way communication. We also see that both Users 1 and 2 produce several of these messages per day while User 3 does not.

The variation in patterns of access and capture is unsurprising. Previous research in the domain of personal information management notes that similar users may employ diverse practices and strategies in amassing, managing and organizing their information (Barreau & Nardi, 1995; Teevan et al., 2004). Similarly the motivations to capture moments vary widely across individuals and the motivations for doing so can be wide-ranging (Whittaker, Bergman & Clough, 2010). Essentially, people despite apparent similarities are individuals. Their lifestyle, activities, interests and actions resultantly shape the contents, composition and makeup of the personal life stores they might amass. This is an essential consideration when exploring such collections.

V.2 Computer and Document Activity

Document activity recording creates a record of all interactions with digital documents on a user's computer. The monitoring software was installed both on the participants' home laptops and on their work desktop computer. Table 1 shows the details of the contents captured on their computers and the high volume of computer interactions can be noted. As a user transitions between individual application windows, a new computer activity event is created. This means that over the course of a working day hundreds, if not thousands, of these transition events can be captured. Obviously the number of 'activities' captured is dependent on the degree to which task (and window) switching occurs. This is dependent on the nature of the task being performed. For example, during an information foraging or (re-)finding exercise where the user tries to find content online or on their computer, they may visit several websites or directories and examine many documents in order to satisfy their information need. In contrast in a more involved task such as document editing or authoring, the user may spend long periods of time within a single window. A computer activity sequence is illustrated in Table 3. In the sequence, the user is preparing a presentation. It can be seen that the user rapidly switched between active windows seeking content relevant to the presentation. At 18:22, the user seeks an image of Vannevar Bush's MEMEX device and conducts a number of web searches. After locating the content of relevance, they return to the presentation and begin integrating it. At 18.32 the user then refers to

material in a previously prepared presentation and so on and so forth. These sequences highlight how related content is accessed by a user to perform daily computer tasks in complex patterns. It also indicates the intricate paths which maybe followed through desktop content even for apparently simple tasks. With rich information captured about the task, there is much opportunity to contextualise the activity.

Application	Title	Activity Count
18/10/2009 18:20	TextEdit	Untitled
18/10/2009 18:20	Keynote	ASU Lifelogging
18/10/2009 18:21	TextEdit	Outline of ASU talk
18/10/2009 18:21	Keynote	ASU Lifelogging
18/10/2009 18:21	Keynote	Untitled
18/10/2009 18:21	Safari	Top Sites
18/10/2009 18:21	Safari	Vannevar Bush - Wikipedia
18/10/2009 18:21	Safari	Vannevar_Bush_portrait.jpg 640?503 pixels
18/10/2009 18:21	Safari	Vannevar Bush - Wikipedia
18/10/2009 18:22	Safari	The Atlantic - Wikipedia
18/10/2009 18:22	Safari	As We May Think - Wikipedia
18/10/2009 18:22	Safari	Memex - Wikipedia
18/10/2009 18:22	Safari	memex - Google Search
18/10/2009 18:22	Safari	memex - Google Images
18/10/2009 18:22	Safari	Google Image Result for http://xenotex.com/lj/memex/MEMEX0L.jpg
18/10/2009 18:22	Safari	MEMEX0L.jpg 510?725 pixels
18/10/2009 18:23	Keynote	ASU Lifelogging
18/10/2009 18:23	Safari	memex - Google Images
18/10/2009 18:23	Safari	Vannevar_Bush_portrait.jpg 640?503 pixels
18/10/2009 18:23	Keynote	ASU Lifelogging
18/10/2009 18:24	Keynote	Text
18/10/2009 18:24	Keynote	ASU Lifelogging
18/10/2009 18:25	TextEdit	Outline of ASU talk
18/10/2009 18:25	TextEdit	Untitled
18/10/2009 18:25	Keynote	ASU Lifelogging
18/10/2009 18:25	TextEdit	Outline of ASU talk
18/10/2009 18:26	Keynote	ASU Lifelogging
18/10/2009 18:26	Keynote	Untitled
18/10/2009 18:32	Finder	Papers & Reports
18/10/2009 18:32	Keynote	ASU Design School Talk
18/10/2009 18:32	Keynote	ASU Lifelogging
18/10/2009 18:32	Keynote	ASU Design School Talk
18/10/2009 18:32	Finder	Papers & Reports
18/10/2009 18:33	Finder	Transfer Report
18/10/2009 18:33	Keynote	ASU Design School Talk
18/10/2009 18:33	Keynote	Untitled
18/10/2009 18:34	Finder	PhD Experiments & Evaluations
18/10/2009 18:34	Finder	Papers & Reports
18/10/2009 18:34	Finder	SRMC08
18/10/2009 18:34	Safari	Vannevar Bush - Wikipedia
18/10/2009 18:35	Safari	Gmail - Inbox (4) - daragh7@gmail.com
18/10/2009 18:35	Finder	H74
18/10/2009 18:35	Keynote	ASU Lifelogging
18/10/2009 18:36	Finder	Papers & Reports
18/10/2009 18:36	Finder	Handbook of Mobile Software Engineering
18/10/2009 18:36	Finder	Papers & Reports
18/10/2009 18:36	Finder	SRMC08
18/10/2009 18:36	Keynote	ASU Lifelogging
18/10/2009 18:37	Keynote	ASU Design School Talk
18/10/2009 18:37	Keynote	ASU Lifelogging
18/10/2009 18:37	Keynote	Metrics
18/10/2009 18:37	Keynote	ASU Lifelogging
18/10/2009 18:38	Keynote	Untitled

Table 3: A computer activity sequence captured for User 1. This represents the user preparing a presentation and consulting online material for graphics, and previous documents and presentations for relevant content.

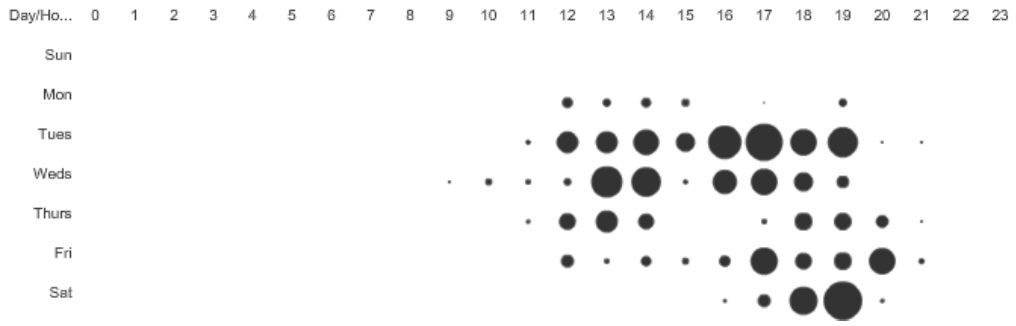


Figure 1. The temporal pattern of document activity on User 1's desktop / work computer

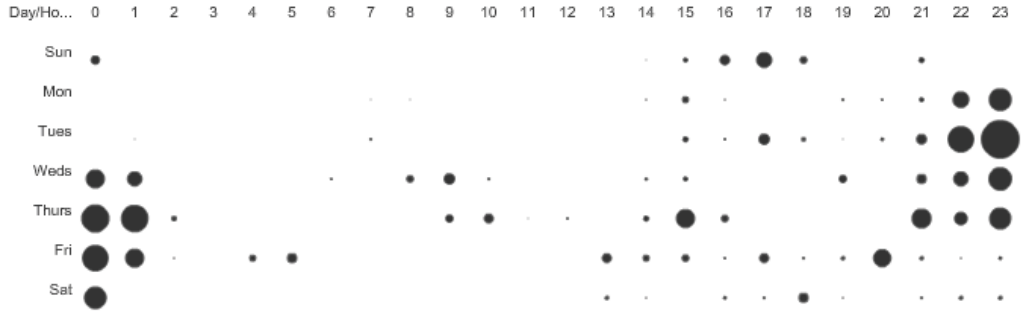


Figure 2. The temporal pattern of document activity on User 1's personal laptop

Application	Activity Count	Duration in Hours
Safari	6539	98.37
adl	478	26.14
Terminal	80	24.33
Flex Builder	1078	6.65
TextMate	999	4.94
Finder	1729	4.92
Adobe Illustrator CS4	451	4.04
Mail	627	2.95
Keynote	292	2.70
iChat	651	2.61
Total for Top 10	**12924**	**177.65**
Total for All	**15262**	**194.02**

Table 4. The top ten applications accessed by User 1 in the sample month.

Application	Title	Activity Count	Duration in Hours
Flex Builder	Flex Development - LifelogLightBox/src/LightBoxCon...	216	1.51
adl	LifelogLightBox	150	0.68
TweetDeck	TweetDeck	125	0.51
NewsFire	NewsFire	96	0.92
iChat	Chat with xxxxxx	91	0.25
adl	ShortMessageFormAnnotationTool	82	0.29
Tweetie	Tweetie	82	0.30
Keynote	ASU Lifelogging	77	0.76
iChat	Daragh Byrne	70	0.17
Flex Builder	Flex Debugging - ShortMessageFormAnnotationTool/sr...	65	0.36
Flex Builder	Flex Development - LifelogLightBox/src/LifelogLigh...	63	0.39
Flex Builder	Flex Development - ShortMessageFormAnnotationTool/...	55	0.54
Flex Builder	Flex Development - LifelogLightBox/src/LifelogItem...	50	0.30
Keynote	Transfer Preso 3.1	45	0.13
TextEdit	Outline of ASU talk	44	0.28
TextMate	screen.css Documents	44	0.06
Remote Desktop	Campaignr2.0	43	0.70
TextEdit	Untitled 2	41	0.27
TextEdit	Untitled 3	41	0.19
Finder	SenseCam Workshop	37	0.13
Flex Builder	Flex Development - LifelogLightBox/src/LightBoxEle...	36	0.27
Finder	CampaignrThemesViewer	32	0.46
iChat	Chat with xxxxxxxxx	32	0.14
Flex Builder	Flex Debugging - ShortMessageFormAnnotationTool/sr...	31	0.22
Xcode	LexiTweetTest - Debugger Console	31	0.23

Table 5. The top 25 documents accessed by User 1 in the sample month

It is important to note, therefore, that the variance in the level of computer activities recorded across the users (see Table 4) is not necessarily indicative of decreased computer use or lower capture. User 1 has a much larger amount of computer activity (15,262 computer actions, 7,147 desktop, 8,115 laptop) compared to users 2 and 3 (7,288 and 7,941 respectively.) This indicates that the user in particular performs a lot of context-shifting between windows and applications. It is also interesting to note the spread between desktop and laptop is quite even during this month since the user was travelling for approximately 2 weeks and away from their primary desktop computer. However, when we examine the temporal patterns of computer user indicated in Figures 1 and 2, we notice that the desktop, as you might expect, is used primarily within conventional business hours. However the times at which the laptop is used are far more varied but tend towards the late evening. In contrast to user 3, user

2 primarily worked from home during the month, and so most of the content was found to be on the laptop computer (663 desktop items, 6,524 laptop items). Finally, user 3 spending a typical working day in the office, saw the predominant source of computer activity from their desktop computer (6,102 versus 1,839 items.)

These simple overviews of computer activity already give a flavour for the rich insights such activity information might provide to a user to retrospectively examine aspects of their life. Table 4 illustrates the primary activities of the users within the representative month. Exploring the top applications used the participant we see that in this month, (besides the a large amount of time spent accessing content on the internet which might be expected for any individual nowadays, a large proportion of the time was spent in development related activities (adl –Debugging; Terminal – command line access, Flex Builder – coding environment, TextMate – code editor.) We can also see that some time was spent preparing a presentation (~3 hours in Keynote, a presentation management application). The type of application is indicative of the task the user is engaged in. This is more deeply explored in Table 5 which presents the unique documents accessed within the month (web pages are ignored). The titles of several documents and windows not only occur with some prevalence but they can further describe the computer activities which were undertaken, providing cues to their importance.

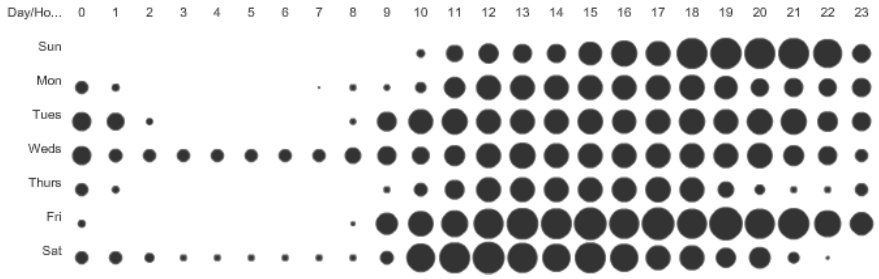


Figure 3. The temporal pattern of logged mobile context for User 2.

Mobile context

Mobile context offers the ability to capture the '*who*' and the '*where*' of day to day activities. This is achieved through the capture of digital signals co-present to an individual sensed via their mobile phone. Within our scenario we sampled the environment for a variety of contextual signals (GSM location, WiFi signals, and BT devices) at an interval of every 30 seconds. This yielded a huge amount of information on the movements and social encounters of the users. In the representative month,

user 1 captured 49,220 polls of contextual signals; user 2 had 51,179; and user 3 recorded 50,835 polls. Figure 3 highlights that this large volume of polls broadly covers the hours where a user might be engaged in their daily activities and thereby provides good coverage to describe those actions.

Campaignr software employed (see Appendix IV.2.1) however, was somewhat prone to crashing. The software was installed on the participants' mobile devices, a Nokia N95, and once started ran unobtrusively in the background. This had the benefit of allowing the device to be used normally while running the software, but, made the visibility of a crash very poor meaning that it could be some time before an fault was noted and corrected by the participants. This was more problematic in the cases of User 1 and 3's collections as they left the software running continuously (see Figures 4 & 6). Operating it in this manner meant that it was not only more prone to crashing due to extensive periods of operation, but it was more likely to go unnoticed for long periods. User 2, however, disabled Campaignr before bed and restarted capture in the morning (see Figures 5.) This meant that User 2 would typically only miss some hours of capture, whereas, it could be anywhere up to a couple of days before Users 1 and 3 noticed and corrected a failure in the software. This user behaviour and responsiveness to software failure is highlighted in the distribution of polls within the participants' collections (Figures 4,5,6).

Within each poll collected by Campaignr, information about a number of signal types is preserved. First, the details of the GSM cell tower that the mobile device is connected to is captured along with the relative signal strength. For each nearby WiFi signal, information on the name, unique identifier (MAC ID) and relative signal strength are provided. After the packet has been uploaded, it is further processed using this information to reverse geocode the packet and derive GPS coordinates as well as a street address for the signal. This is also used to append nearby place-names to the packet. Finally, co-present Bluetooth devices are sensed and their unique identifier (MAC ID) and friendly name (if available) are recorded. Additionally, the time of capture is recorded.

Discussion in this section has centred on individual polls of context information, however, each poll contains an enumeration of a variety of signal sources encountered. Each poll may contain one or more proximal WiFi signals or Bluetooth devices as well as a specific GPS coordinate and address and placename information for that location. The variety of signal sources encountered by the participants in their sample month is outlined in Table 3. These are indicative of both the personal patterns

and habits of the individual and the activities they were engaged in during that month. For example, User 1 was travelling during the month, and consequently encountered a far higher number of GPS points and unique street addresses. As they were travelling, they had a far higher opportunity to encounter social situations (Bluetooth devices), new places and associated contextual signals. This accounts for the marked contrast between this individual and the other users despite a comparable number of polls sampled. User 1 encountered a GPS point on average of 18.66 times, while Users 2 and 3 an average of 67.5 and 45 times respectively. While all of the users encounter a relatively similar number of unique places within the month, the average time spent in each again varies greatly. It is also interesting to note that unique places found within the collection are almost always half the number of GPS locations encountered – clearly and obviously a location may subsume several GPS points (Kelly, Byrne & Jones, 2009). Similarly, the same Bluetooth friendly name may be encountered on a variety of devices (Lavelle et al, 2007), as can the the WiFi signal name for a number of signal sources.

The contextual samples recorded will reflect in many ways the patterns and routines from our lives. This is highlighted again in Figure 7 which describes how there are a large number of Bluetooth Devices, WiFi Signals and GPS points are very infrequently encountered while only a comparatively small number will be encountered repeatedly. Only a minute fraction of all encountered devices are encountered with any regularity. In the case of the GPS encounters for User 1, they encountered within the month 1690 points only once, while just 8 points were encountered more than 1000 times. These 8 GPS points relate to the user's home (2), place of work (3), family residence (1), hotel during trip (1) and conference venue (1). Bluetooth and WiFi signals displayed a single encounter for a large number of devices (1,212 and 1,380 respectively) with only 17 Bluetooth and 20 WiFi sources being encountered more than 1000 times. The top encountered WiFi signals related to signals encountered at home (2), work (5), family residence (2), hotels stayed in (5), conference venue (5) and visited institution (2). The Bluetooth signals encountered related to the presence of the user's own computers (2), the mobile phones of work colleagues (4), the computers of colleagues (2), a stationary computer at a visited institution (1), known attendees at the conference (3), unknown or peripheral devices encountered (5). These highly encountered contextual signals correlate with the regular habits and predominant activities of the users, i.e. the place, people and digital signals they encounter in their workplace, their travel to work, and in and around their home.

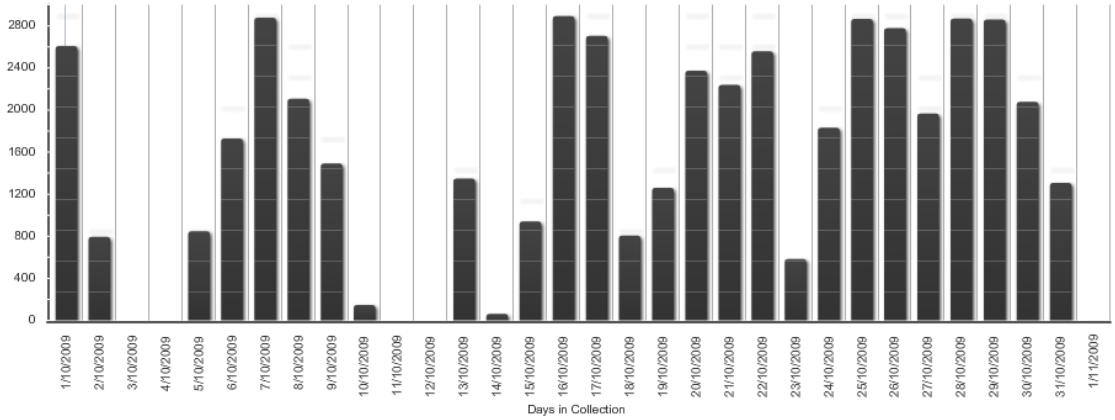


Figure 4. The distribution of Mobile Context Polls captured by *User 1* for the representative month.

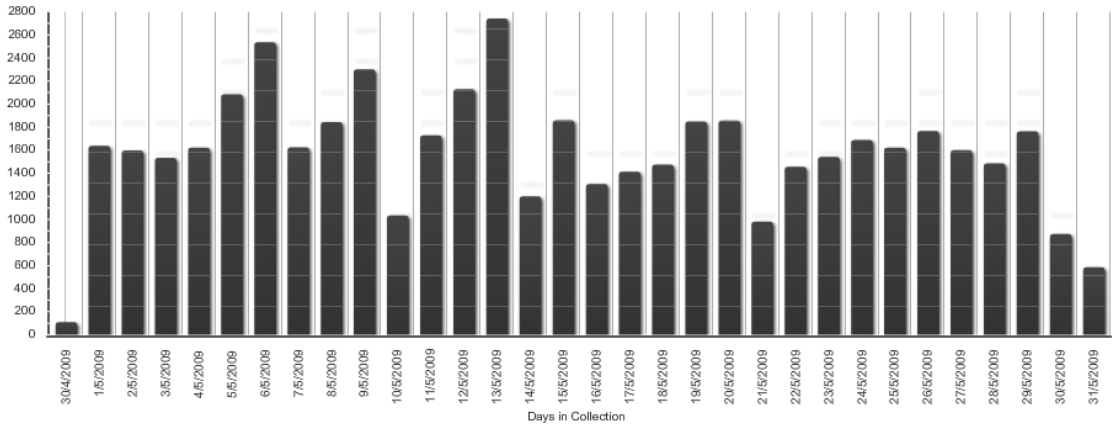


Figure 5. The distribution of Mobile Context Polls captured by *User 2* for the representative month.

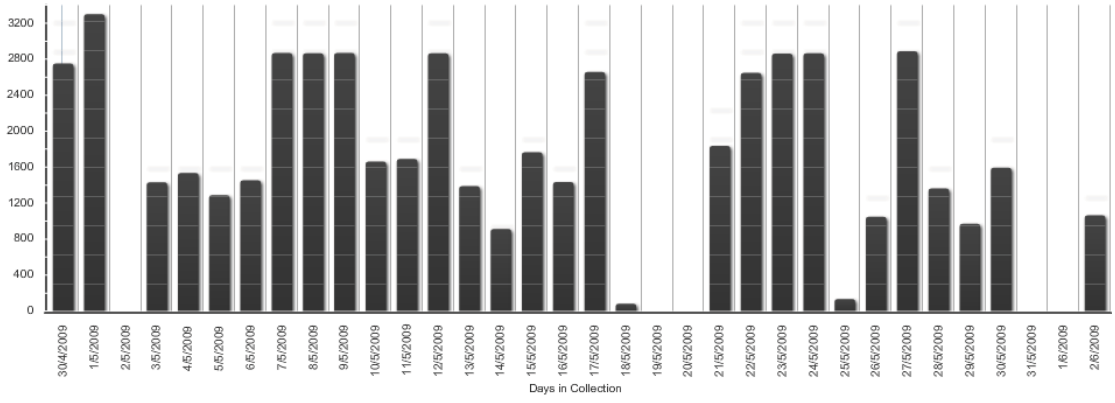


Figure 6. The distribution of Mobile Context Polls captured by *User 3* for the representative month.

Type	User 1		User 2		User 3	
	Count	Encounters	Count	Encounters	Count	Encounters
Bluetooth - Devices	2559	88335	1645	19815	1453	17748
Bluetooth - Names	546	66373	422	13446	225	12846
GPS Locations	2631	49102	773	52181	1153	51940
Unique Place/Area	1244	292443	350	294045	624	339175
WiFi Signal	2804	110869	790	192956	1629	141062
WiFi Signal Names	1568	110526	576	192615	1174	140803
Total	**11352**	**717648**	**4556**	**765058**	**6258**	**703574**

Table 3. Mobile Contextual Items Encountered by the Participants.

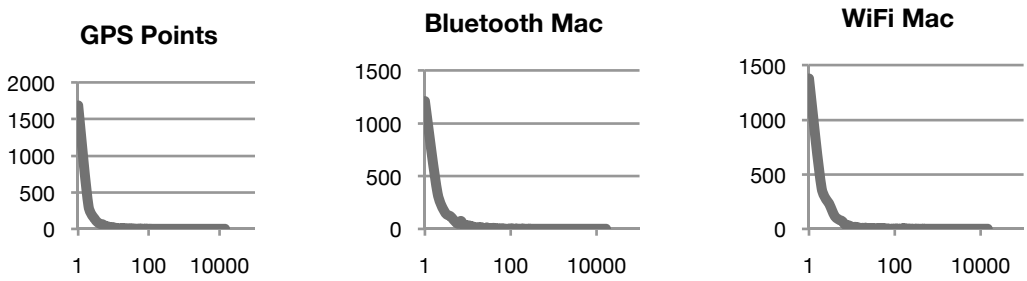


Figure 7. Logarithmic plot of signal encounters within User 1's collection. The y-axis presents the number of devices or signals against the number of times they were encountered on the x-axis.

Figure 7. A thumbnailled set of images from a user's day

SenseCam

The SenseCam is a main component of current lifelogging research and technology due to the rich and detailed view of past personal experience it can capture. The wearable camera, allows an individual to capture a rich account of their day-to-day activities as a series of low-resolution (640x480px) photographs. The resulting visual diary was an important component of the lifelogs we amassed. This is illustrated in Figure 7 which presents a thumbnail view of the photos captured for a single day. This gives a sense of the content captured and the potential insight and understanding which may be derived. For example distinct activities can be discerned as visually similar and contiguous blocks. Within Figure 8, the two major types of sequences found within the images are shown. The first is visually consistent sequences of images in which the visual composition of the frames tends to be consistent and stable from one to the other. This is typically where a user is engaged in a static activity such as working at a computer, or watching television and the visual frames are very similar to one another. The second type is visually varied; these result where the user has a burst of activity such as walking, running or traveling. Within these sequences there can be large and often noticeable variance in the visual composition of the frames. Colours, textures and orientation may change quickly in these sequences.

The media has some limitations, primarily it being low fidelity. The camera preserves a reasonably low resolution image and while sufficient for most purposes often contains undesirable artifacts such as blurring, noise or light lensing effects (Gurrin et al, 2008). It also operates poorly in low light conditions. Being worn, it is also subject to being obscured by clothing such as jackets (Byrne et al. 2008). Many of these features of the medium can be seen in the examples frames in Figure 14.

Being worn, it presents the images as if taken from a first person perspective, making the images appear more visceral. Unlike a traditional camera, which requires a user to step out of the moment to explicitly capture it, the SenseCam captures daily interactions passively and continuously without the need for user intervention. This offers opportunities to preserve a record of life experiences which otherwise might go undocumented and adds the potential to serendipitously capture meaningful and significant experiences. This is certainly true of the participants involved who informally reported capturing chance happenings such as bumping into old

acquaintances and preserving a record of nights out that might not have been otherwise captured.

At a minimum the SenseCam automatically takes a new image approximately every 30 seconds, but onboard sensors can trigger more frequent photo capture. Furthermore, the device captures the day indiscriminate of the nature of the activity, its habituality or interest, resulting in voluminous collections. The collections employed within this work exemplify the amount of information that may be captured even in short periods. In just one month, User 1 amassed 77,204 SenseCam frames or an average of almost 2,500 images per day, with Users 2 and 3 capturing 46,705 and 30,554 images respectively. As a consequence of the indiscriminate and frequent mode of capture, a large portion of the collection may relate to mundane activities. While seemingly problematic, this may offer opportunities. Both Harper et al (2008) and Lindley et al. (2009) note that its objective and chronological account of past action may afford new appreciations of the everyday and allow the extraordinary to be found in the ordinary. They also comment that due to its orientation and continuous mode of capture, it tends to offer a distinctive and unusual viewpoint on personal activities (Harper et al., 2008; Lindley et al. 2009).

The device is designed to operate in excess of 12 hours, thereby supporting the capture of the typical day. We can see however in Figures 10, 11, and 12 that all of the participants had some days of no capture or very low capture. This in part can be attributed to the battery performance. In particularly busy days the device's battery life may not support capture of the entire day. The problem can be compounded if the participant forgot to charge the device or if the device fails – sp crashing was an infrequent occurrence, but in cases where it did occur may have taken days to recover from and repair the device. Days without capture may additionally be indicative of the burden placed on capturing with the technology. The devices are worn and noticeable, thereby intrusive into social interactions and making the wearer cognizant of the device. At times, and given the onus the device placed on the wearer, particularly if continually capturing, the participants reported 'needing a break' from it on occasion. It is worth noting that as a result of these factors, the SenseCam may not provide a full visual diary for all aspects of the participants daily lives. Examining the temporal pattern of capture in Figures 13, 14, 15, we note that the capture of experiences with the SenseCam does not often extend beyond the early evening for users 2 and 3. This is in contrast to Figure 4 which indicates that mobile context is captured until reasonably late at night. As the capture is typically confined to

‘daylight’ hours, the ability to fully overview activities with SenseCam content may be hindered. As a result of these compounding factors, the visual record it preserves may not fully extend into the participants’ personal lives, social events and excursions and this has bearing on the scope and completeness of narrated accounts which might be generated from the collections. It is nevertheless an important modality for recounting the past personal experiences. The visual record it provides is a compelling means to convey those actions.

Figure 8. Temporally consistent vs. visually varied sequences.

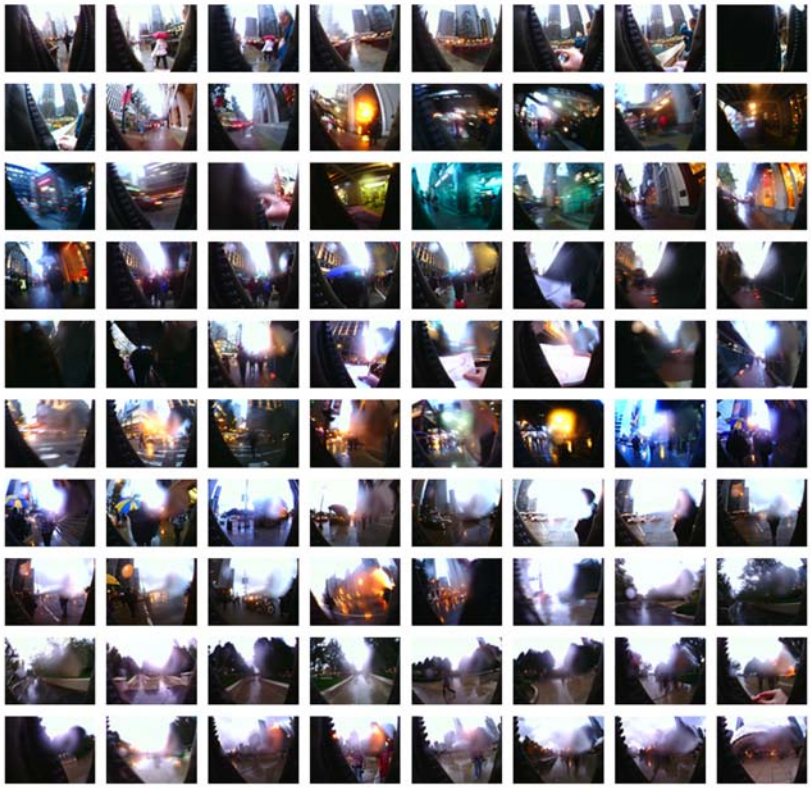


Figure 9. Sample images from User 1: A sequence of a city trip

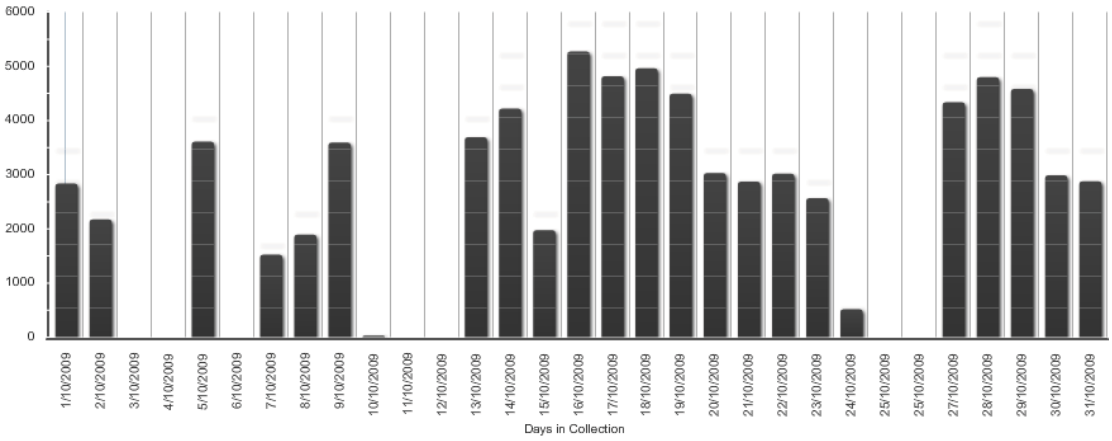


Figure 10. The total number of SenseCam frames passively captured for User 1

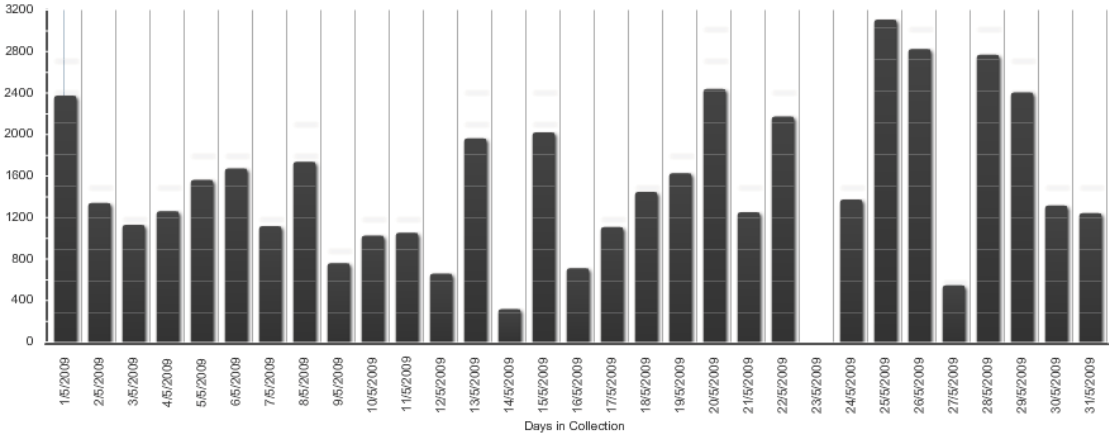


Figure 11. The total number of SenseCam frames passively captured for User 2

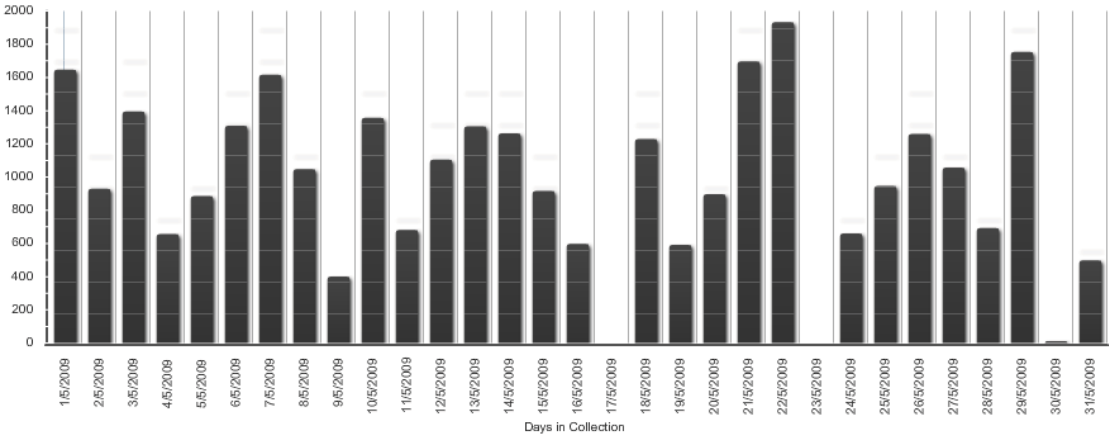


Figure 12. The total number of SenseCam frames passively captured for User 3

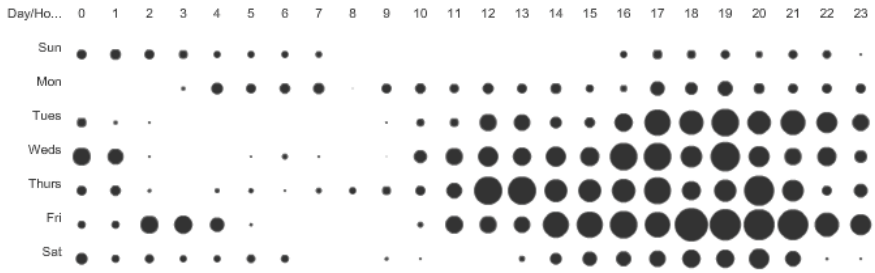


Figure 13. The pattern of SenseCam frames captured by User 1

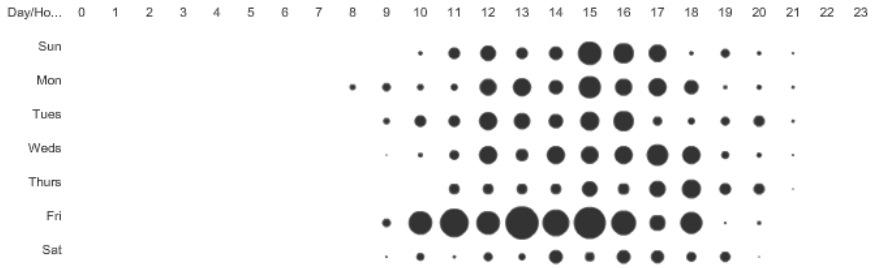


Figure 14. The pattern of SenseCam frames captured by User 2

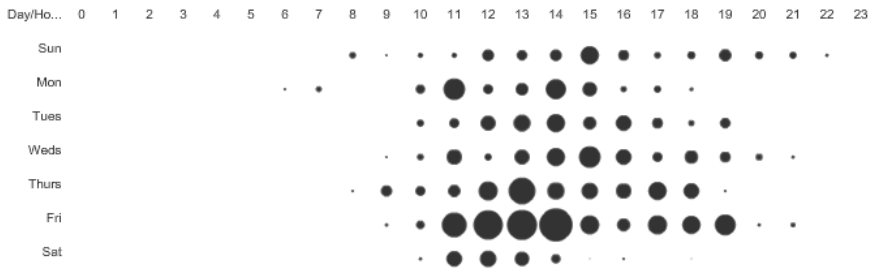


Figure 15. The pattern of SenseCam frames captured by User 3

Photos

Digital photos offer a visual record of a moment in time that the collection owner has explicitly decided to capture. In most instances the participants captured the photos in their lifelog collection using the 5-megapixel camera built in to the provided N95 device and, as a result, they are of much high quality than the SenseCam content.. Their explicit nature of capture means that they exist in very low volumes within the collection and are distributed disparately and intermittently throughout. Photos were captured either as a single isolated item or moment of interest or as a short burst of capture representing an episode of interest. Some examples are illustrated in Figure 16 where we can see increased frequency of capture motivated by the user being in a

novel location and documenting their sight-seeing in a city. We also note the distinctions from the SenseCam photo media in clarity, quality and viewpoint of the event. Comparing and contrasting Figure 16 to the same event as captured with the SenseCam footage in Figure 9, it is clear that complimentary perspective on the past action which photo content provides will be important for storytelling.

Within the collection, the photos exist sparsely. User 1 captured 14 photos in their representative month; User 2 captured none; while User 3 captured 18 photos. Despite their low volumes, their explicit nature of capture and their intermittent distribution make them highly indicative of interest points within the collection.

Oct 15 2009 23:19:00 Oct 15 2009 23:22:00 Oct 15 2009 23:36:00

Figure 16. Example Photos Captured by User 1 during a siteseeing Trip

Text Media – SMS & Twitter

Within the collection two sources of explicitly authored text content exist: SMS messages sent and received by the user; and Twitter status updates authored by the user. Within these message formats we only consider the text content and do not look at multimedia content which might be attachedMMS (multimedia) messages are not included within the corpus as they were not regularly employed by any of the participants. They presented a technical overhead in developing a solution to extract this content from an owner's device, but would have offered minimal contribution to the collections.

SMS messages are reasonably brief, near synchronous, text-based communications between mobile users. A single message has a limit of 160 characters, but in practice this upper bound does not always apply with longer messages automatically being spread across multiple packets. Authored using the relatively simple input of a 12 button keypad, text input can be cumbersome. Sending messages will in most cases

also cost the sender a small amount. Content is therefore expensive both to input and to deliver and these factors *"both permit and force people to express themselves consisely in mobile text messaging"* (Harper, Palen & Taylor, 2005.) The concise nature of the medium means that the content has unique unique linguistic features very distinct from traditionally authored desktop content (Hard af Segerstad, 2005.) Contractions or 'text speak' are commonplace, making the language of the communication terse and sometimes the intended meaning difficult to interpret. The messages are often grammatically incomplete and typographically erroneous, with intonations indicated through 'emoticons'. Examples of the messages can be seen in Table 4. They highlight many of the features of the language including the lack of proper punctuation, grammar, contractions, emoticons, spelling errors, conversational styling etc.

The messages sent can be of a variety of types. This includes question answering, planning future activities, discussing past action, advertisements, information sharing and notification (Ling, Julsrud, & Yttri, 2005). Despite the messages being brief, terse communications, they can be ascribed real value, significance by the recipient. Harper (2010) discusses this at length, citing 'text-gifts' exchanged by individuals to sustain, maintain and enrich their social bonds and interpersonal relationships. These messages in particular can hold much sentimental value and with their owners expressing a desire to curate such content.

It is important to remember that these messages represent two way communications. The distribution of sent and received messages roughly corresponds with one another (see Figure 15, 16) as does the temporal component of the messages (see Figures 17,18). This indicates that, as expected, the messages are highly reciprocal. SMS messages were sent and received frequently throughout the day by all users to a number of distinct individuals. While they are reciprocal in nature, they are small in volume meaning there are widely and intermittently dispersed throughout the collection. On average 78 messages were sent and 69 messages received in the month; typically these were exchanged with a small number of core contacts. The reciprocal nature of these messages means that the messages sent and received are often paired. As a message is received, the individual normally respond to it within a short timeframe, and likewise when the collection owner authors and sends a message to a recipient. This is illustrated through the timestamps in Table 4. As many of the messages authored by the collection owner form part of a wider

communications, these messages can be associated together to form threaded conversations.

As these are two way communications, exchanged with the collection owner and person's known to them, they are unlike other media formats within the collection. The photo content, mobile context, and document activity all describe what the collection owner is doing at a particular moment in time, however, SMS messages are often not so overtly focused on the present. Instead, they tend to be social conversations which discuss past actions, or planned future actions. Furthermore as many of the messages will originate from other individuals they may not necessarily relate to the habits and activities of the collection owner, instead describing their past actions, important encounters and notable moments which have been shared with the collection owner. Furthermore, even when discussing the life and actions of the collection owner, the content of the messages do not tend to be 'annotations' or descriptive accounts of the event, instead they relate to planning and coordination or reactions to the planned or past activity. Being social exchanges, the messages may contain multiple lines of conversation. For example, a single message may contain statements on past and future action "I have just arrived… I will go to", while simultaneously discussing current activities or observations and responding to the contents of the previous message "Sorry to hear/Glad things are well… I just/I am…etc." Finally, as the messages are exchanged, often between very well known individuals with already established social bonds, understandings and relationships, much of the information contained within the messages may be latent and implicit. In many of the messages, people, places or actions may be referred to in abstract ways without fully exposing the background, context or particulars. These have instead been established during the real-world and social interactions of the individuals and do not require explicit exposition within the exchanges for them to be interpreted. While this makes it difficult to employ the content in reasoning – due to their implicit nature and complexity of the content and the references they bear – it nevertheless offers opportunities within the storytelling frame under investigation. The content does contain emotional reactions, personal interpretations and mental reactions to past and future actions. This offers opportunity to present the user's intuited perspective on these activites which the other modalities do not afford. They also offer the potential to add value in contextualising the activities and decisions beyond objective data captured from the event. The SenseCam, document activity and mobile context content captured all only offer an objective account of a moment in time, this content in contrast offers exposition rather than overview and provides discussion around the activities which

took place. While there are many complexities in employing this content source, as mentioned above, the exposition and personal discussion, communication and exchange may offer utility in exposing the user's perspective within constructed stories.

Contact	Time	User 2
To: User 1	Oct 06 2009 08:11:04	Morning :). I just awake now so wont be in dcu before 11
To: User 1	Oct 15 2009 06:24:58	Just leaving now, will be bout 10. Will wait if you not ready
From: User 1	Oct 15 2009 06:26:54	Thats fine should be there aw then mm problem
To: User 1	Oct 15 2009 06:43:49	Just parked at the main entrance in Nissan
To: User 1	Oct 15 2009 18:40:40	Did you know that while you are abroad, you can now Top Up your phone credit using your Laser or Credit Card? Just dial freephone 1749 to top up! From O2.
To: User 1	Oct 19 15:52:54 2009	Running a bit late. Kirstin in our office will give u directions to Matthews center & I will meet u there. Sorry!
From: User 1	Oct 19 2009 16:04:44	Found it ! ;)
To: User 1	Oct 19 2009 16:15:39	Grand. Be there in 5
From: User 1	Oct 15 2009 19:15:38	…have just landed in chicago we're on route to the hotel now. Will head out siteseeing around 3.30 we guess
To: User 1	Oct 15 2009 21:12:44	..just saw your message. i will be back to the hotel in half an hour, and plan to go to the art institute museum at around 5pm.whats your plan?
From: User 1	Oct 15 2009 22:07:24	Think we're going to go to the millenium park. And have a wander. About to leave so could meet you briefly in reception if you want
To: User 1	Oct 15 2009 22:46:37	Sorry again. I think there's a delay of vodafone sms ü I guess you must be some where in town nowü I'm heading to art museum now, c u later or tomorrow.
From: User 1	Oct 23 2009 19:41:49	"I'm sure you'll be grand…I.ll try some other spots in the airport soon and see if i can get a network the works "

Table 4. Sample SMS Messages for User 1.

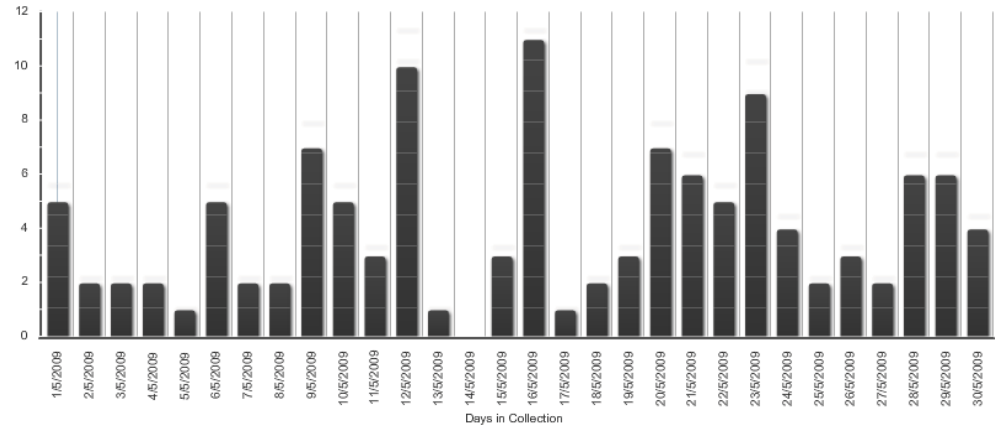


Figure 15. The distribution of received text messages within the month for User 2.

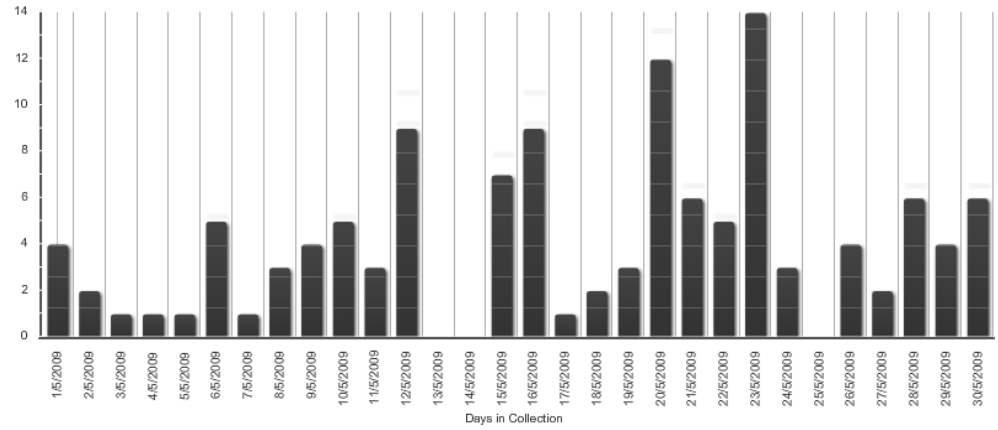


Figure 16. The distribution of sent text messages within the month for User 2.

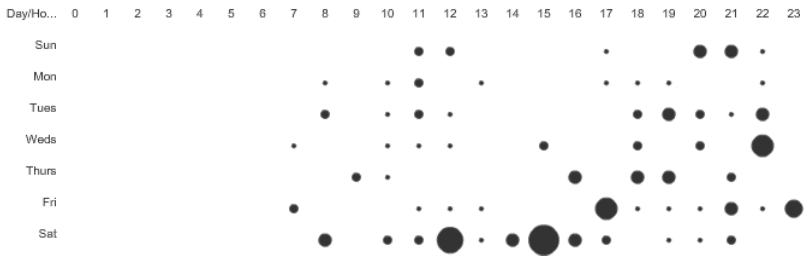


Figure 17. The temporal pattern of received text messages within the month for User 2.

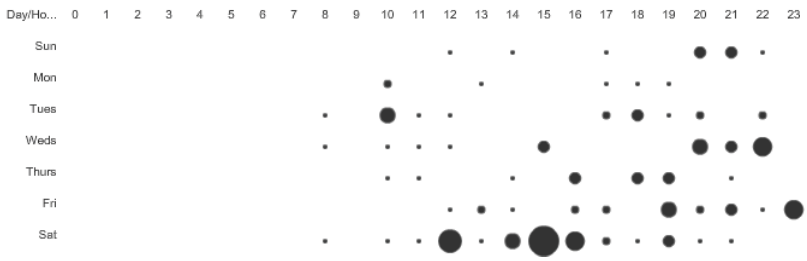


Figure 18. The temporal pattern of sent text messages within the month for User 2.

Twitter ‘status updates’ like SMS messages are brief and have a hard-upper bound of 140 characters. This places significant constraints on the text content and forces the author to be extremely succinct and terse. Like SMS messages, intonation or emotion is often denoted with ‘emoticons’ however it is distinguished both in input modes and unique syntax is can contain. Twitter messages may be authored via a variety of platforms – from desktop and laptop systems to mobile devices (Krishnamurthy, Gill & Arlitt, 2008). This means that the quality of the content (grammatically and typographically) may vary widely and may in instances display many linguistic characteristics of SMS messages. In addition to the variance in quality, the ‘tweets’ also contain domain specific terminology and syntax. Unlike SMS messages for example, they may contain URLs pointing to web content of relevance to the subject of the message. They may also contain an user contributed tag which is prefixed with a ‘#’ symbol and consequently known as a ‘hashtag’. Hashtags denote a keyterm or topic of particular relevance within the content that the author wants to explicitly draw attention to. Finally, a status message may be ‘retweeted’, akin to forwarding in email, allowing a status message authored by another user and of interest to be passed on to other users (typically a ‘RT @username’ indicates this action). Some examples of Twitter content can be found in Table 5 below.

The messages themselves are authored to serve a variety of purposes. These typically include sharing a personal perspective or insight; describing a current, past or planned future activity; information diffusions (sharing news or general interest items); and discussion or ‘chatter’ (Java, et al., 2007.) Some of these purposes overlap with those seen in SMS messages. However, unlike SMS messages which are two-way exchanges between well-known individuals, twitter content is directed at a much wider audience (Krishnamurthy, Gill, & Arlitt, 2008.) Typically anyone can ‘follow’ a user’s twitter update stream and so the content tends to be authored without assumption of implicit knowledge or understanding. As a result, the content tends to quite broadly overview the topic under discussion and be more self-explanatory. These succinct monologues should have clear affordances in story-construction. By offering clear and concise overviews of past personal action authored by the collection owners themselves, they can be used to caption and describe content from other modalities including, for example, the activities depicted by the SenseCam’s visual frames.

The Twitter status updates are authored explicitly by the user about specific moments, thoughts or information that the individual has decided to remark upon. SMS

messages however are exchanges between two individuals and a received message from another individual is a common catalysis for message authoring. In the case of ‘tweets’, the individual must be motivated to author a message without prompting from another individual. Table 1 shows that Users 1 and 2 only chose to author a small number of these messages (approximately 50 messages) within their sample month. These messages exist in relatively small numbers and are broadly and sparsely distributed throughout the collection (see Figure 19). Like photo content, this makes Twitter content indicative of interest points within the collection. We can expect that a user must find the subject of that message somewhat significant in order to be motivated to remark upon it and distribute that message to a broad audience.

Time	User 2
Oct 27 2009 13:35:00	Finding the 200+Emails & 401 RSS items daunting. Nothing like getting back after a week away to make you want another week away!
Oct 22 2009 18:20:00	Sipping "tea" in the airport and having a more detailed read of the media theory blog and the student's thoughts on lifelogging
Oct 21 2009 11:58:00	Flickr adds people tagging. Finally: http://tr.im/flickrpeople (via @Shiflett) (via @swissmiss)
Oct 19 15:05:00 2009	Heading to ASU to give a talk to the Media Theory class.

Table 5. Sample Twitter Status Updates for User 1.

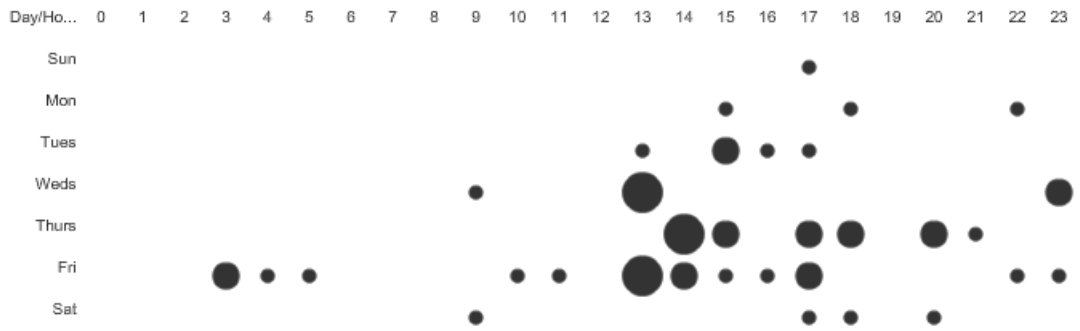


Figure 19. The temporal pattern of tweets within the month for User 1.

SMS messages and Twitter status updates serve different functions within the corpus and within storytelling. The Twitter content, often authored to remark on a moment in time, provides a contextual annotation about a moment in time or item of interest to the user, or their reactions to those items, while SMS messages reflect personal communications about daily actions and the planning of and discourse about past and future action. Even though they only contribute relatively low volumes of content to the collection, they offer much opportunity within reflection, remembrance and story construction. While both SMS and Twitter content present challenges

particularly in their linguistic features, they provide exposition of the activities captured in detail within the passive modalities and offer the users perspective from that time on those happenings. This is particularly useful in storytelling. Both modalities have differing affordances based on the nature of their input and exchange. Twitter content being authored by the owner and directed at a wide audience gives an annotation of past action which is typically well described and may be used to summarise, overview or describe that action in a general sense. SMS content, being a social discourse and exchange may offer some information on that activity and while the information may often be abstract and implicit within the exchanges, may provide further exposition of the activity and contextualise it further. The distinction between the two formats is highlighted by the exchanges on October 19th in Tables 4 and 5. Both relate to the user presenting a guest lecture to students at an overseas institution. The twitter content clearly describes and overviews the activity being undertaken and can be broadly understood by anyone reading the content. The SMS content exposes further information relating to the presentation, indicating it took place in the Matthew's Centre and the user made their own way there as the colleague was running late. While it doesn't explicitly mention the presentation (this is implicit within the exchange), it helps contextualise it further.

Appendix VI

Task Generation for Lifelog Digital Storytelling

In order to fully evaluate the storytelling system, participants were asked to identify suitable tasks. A task generation framework was devised to support the user in eliciting sufficient number of interesting stories from their personal lifelog collection. The goal of the framework is to ensure that the tasks employed within the evaluation of the system broadly survey the range of personal narratives a user might want to create.

Naturalistic approaches to evaluation are often suggested within the domain of personal information retrieval and management (Kelly et al, 2005). Within such approaches a tool is freely deployed and through either ethnographic observation or log file analysis the efficacy of the tool is established. A major limitation of this approach is that participants will use the system in an unconstrained way. This makes both the users interactions with that system and the outputs for its evaluation unpredictable. When deployed to a large cohort this issue is less problematic, however, in dealing with the very limited number of participants of our study group, this is a paramount concern. A naturalistic approach to evaluation is as a result unsuitable and it is therefore preferable to guide the users in performing the variety of tasks which are required to be performed as part of the evaluation.

We consequently adopt a task-based framework to evaluating our system. In evaluating a system with prescribed tasks many opt to use tasksets which contain generic descriptions that extend broadly to all of the participants. While this is possible with the small number of participants within the study, again it is unfavourable given the personal nature of these collections and the degree to which their contents vary. This *personal* issue is discussed in more depth in Jones et al. (2008). Moreover, should generic tasksets be employed, the subject of the narrative output would more likely be less personal. Prescribing a generic task could thereby greatly diminish the meaning and significance of the authored output and have bearing on its perceived utility. This is undesirable as it could negatively influence the outcome of the evaluation.

A challenge is therefore how to '*devise tasks that correspond to private collections without an understanding of the kinds of tasks people perform or jeopardising the privacy of study participants*' (Elsweiler & Ruthven, 2007). Elsweiler & Ruthven (2007) favour the use of a diary to enable the participants to record such tasks. Diakopoulos & Essa (2005) suggest the use of ethnographic records. However, both of these methods are impractical within the context of long-term capture. Relying on the participant's own memory, free-recall allows a user to retrospectively consider important experiences and these can be used to form the basis of a task set (Soules & Ganger, 2005; Soules 2006). Free recall has the added advantage of encouraging more memorable experiences to be included within the task set. This aligns well with the goals of the storytelling evaluation and is the basis of the framework we employ.

Free-recall presents two main challenges for use within task-generation. First, as memory is associative, there may be bias during recall towards 'clusters' of events which are related or proximal to one another. Their use as ad-hoc input into the generation of narrative is not preferable. Additionally, this limited free-recall approach needs to be constrained to enable large numbers of known-item tasks to be generated. To address this, we separate the recall and task description stages.

This separation seeks to ensure the full range of personal digital narratives, which the system could be used to generate, are identified and evaluated. This is facilitated through two phases: first participants are required to conduct a two-part free *recall* of experiences and personal facets contained within their collection; and next they are guided through the *selection* of stories from these recalled items. As noted in Chapter 3, personal stories can be episodic or narratives about an isolated experience from a short timeframe or the more intimate life stories which retell a set of related experiences relating a broad timeframe and centred on a particular theme or topic of interest. The user identifies suitably memorable stories from the free-recalled set of experiences and assigns them to one of the two major groups. The identified story may then also be further decomposed into a set of categorical subtypes.

The process of task generation was separated into two stages to decouple the recall of suitable tasks from the selection of suitable tasks. This was done as recalling an experience often acts as a cue to trigger the recall of neighbouring and related activities. So by separating the generation into two distinct steps, it reduced the possibility that the task set could converge around a small number of temporally or thematically related events contained within the collection. Additionally, by asking the users to perform a free-recall stage prior to task set development, the users could

freely produce a list of events within their collection without awareness of the upper-bound or constrains required for the task set – thereby avoiding less interesting or less 'story-like' items being selected by the users in an effort to 'fill up' the task list and achieve the quota for selected items.

The goal was to identify 45 tasks for use with the system evaluation. A detailed description of the stages employed within this framework for task generation now follows.

Stage 1: Recall of the contents of the collection

Within the recall-stage participants were asked to complete two components. They were asked to identify activities and events present within their collection that they might like to tell stories about; and they were also asked to identify a number of personal characteristics or aspects of self that would be broadly contained within the collection. Once completed these were then used for task elicitation.

Stage 1.A Free Recall of Events and Activities

Participants were asked to free-recall events and activities contained within their lifelog collection. They were instructed that the identified experiences should be of interest and of significance to them. They were further instructed that for any recalled experience, the participants must be confident that content relating to this experience was contained within their collections and therefore it could be used within a story generation task. This exercise was unconstrained with no upper-bound established for free-recall. The participants were encouraged to recall as many items as possible.

The participants were asked to first quickly note a set of recalled experiences from the span of their lifelog collection. For each, they were asked to provide a short descriptive label. After their recall was exhausted, they were asked to revisit each item and ascribe more detailed information to it.

First, they were asked to provide the indicate the type (or time span) of the activity. They could attribute it to one of the following three categories: a single isolated episode; belonging to a short time span; or relating to a broad period. A *single isolated episode* was described as a short activity which was reasonably unrelated to other events within the collection. These might include for example: an hour-long presentation; meeting; a night out with friends. A *short time span* denotes the

experience to being a small set of related episodes spanning a reasonably short period of time. Examples might include: a short trip away, a memorable weekend, a site-seeing tour, etc. Finally, the *broad-time span* indicates a set of causally related episodes which span a long period of time, and might include a set of seminal moments in work or personal life, a medium-to-long term work project, achievement of personal goals, or the development of personal and social relationships, etc.

Participants were also asked to rate the dimensions or aspects on which the activity was primarily focused. These dimensions included a person; a place; the time; an object, thing or happening; a particular emotional or mental reaction; or any other components. For each of these dimensions, the participant was asked to rate them on a scale from non-relevant to highly important (0-3 scale). These ratings were designed to provide useful information that would later aid in the selection of appropriate stories within the next stage of task generation.

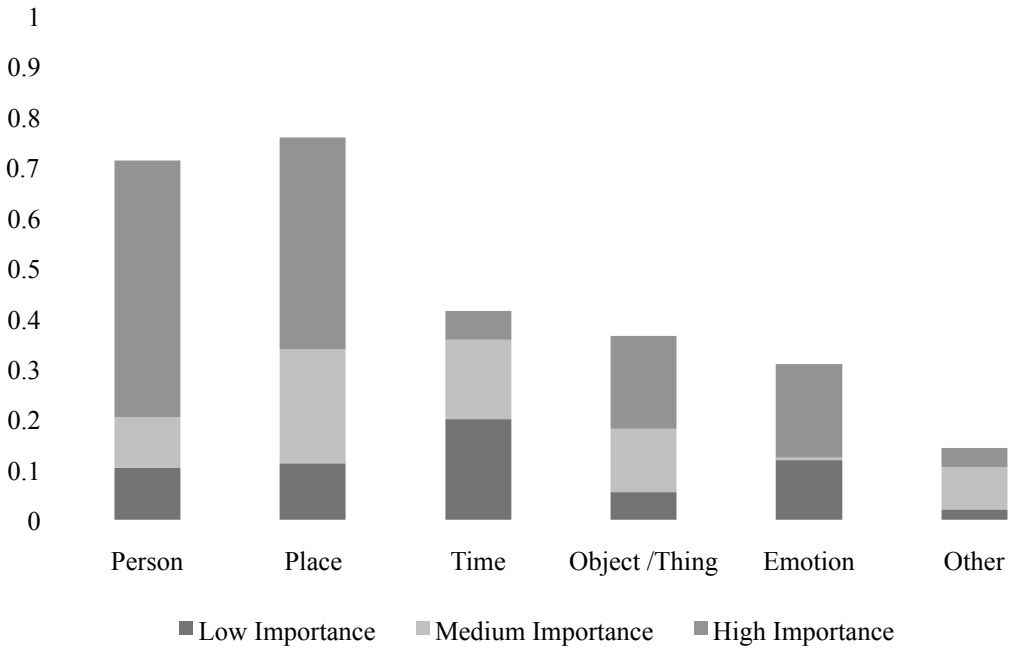


Figure II.1: Priority of Dimensions in the Free Recalled Items. The priority has been averaged against the total number of items recalled by each participant and across participants.

Stage 1.B Outcomes of the free recall exercise

The free-recall provided an indication of the nature of the experiences contained within the user's collection and of the types of past action the participants would want to create stories about. In total, 140 activities and items contained within the collection were recalled, of which participant 1,2 and 3 recalled 73, 36 and 31 items

respectively. Approximately 32% of these items related to a single isolated episode, while 39% related to a reasonably short period, and so the majority of items recalled (71%) related to short temporal periods. 28% of the items spanned a broader periods, and could be considered to be closer to life stories.

The participant's were additionally asked to rate the importance of a variety of dimensions for each of the recalled experiences. These included people, places, the temporality of the experience, objects or things which occurred or were encountered, emotions or mental reactions experienced and any other items. The distribution across these dimensions is illustrated in Figure II.1 and II.2. Of the 140 recalled experiences, 67.1% were rated as having a important association to or affinity with the people encountered. This component was predominantly considered to be highly important to the experience, with 65 of the 94 experiences having a person component being of high importance. Places were also considered to be an even more important component of the experience with 73.5% of all recalled experiences having some importance ascribed to place. Again, these were more likely to be considered central to the experience with 55 of the 103 items having places attributed as highly important. While important, the temporality of the item was considered to be more peripheral, with it being denoted as important to 40% of items but in half of these cases having only low importance to the overall experience. Objects, things or occurrences within the recalled experiences had some importance too with just under half of all recalled items ascribe some importance to them (44.2%). Emotions and other items had importance in 27.85% and 17.8% of cases respectively. While most priorities were relatively stable across participants, with the exception for the marked difference in references to emotions by participant 2 (see Figure II.2.)

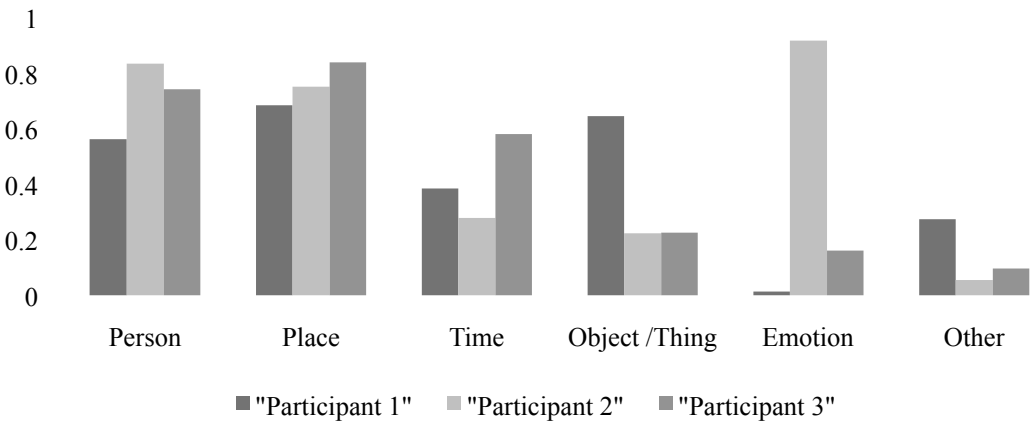


Figure II.1: Priority of Dimensions in the Free Recalled Items across participants, using a combined score of all importance's for each dimension.

Its helpful to consider the nature of the items recalled in order to provide context to the stories the participants elected to create in their task set. The 140 recalled items were examined and broadly classified into five categories. These were: experience relating to career and/or work; experiences relating to travel and holidays; personally significant experiences; socially significant moments; and memorable moments and events. Examples from each of these five categories are now provided.

1. *Relating to career and/or work*: As all of the participants were doctoral students within the research group, a number of the experiences recalled related to: significant meetings or discussions with colleagues and visiting researchers; attending conferences; visiting national and international research groups; attending and giving talks and presentations; preparing academic papers for publication; and important and/or tight deadlines. These often represented experiences which spanned short temporal periods, however the participant's noted much broader activities also. These included working on a particular project in the long term, and significant aspects of their doctoral studies or their doctoral work as a whole.
2. *Relating to travel*: As might be expected, these experiences pertained to local and overseas travel, typically personal holidays, trips and short-breaks, however, some overlapped with work-related travel. These were also considered to include friends visiting from overseas, novel excursions, sight-seeing trips and visiting exhibitions, etc. Given their nature, these were almost always short spans of time or isolated events, with the exception of a location being revisited after some time.
3. *Personally Significant Experiences*: These refer to items recalled which are of significance in the life of the individual and often relate to the first or last instance of an activity. Items belonging to this group recalled by the participants included for example: colleagues or friends leaving, giving a first lecture or talk, and moving house. More broad life experiences noted were the development or progression of friendships, living with (new) flatmate(s), and learning new skills or adopting new pursuits and activities, e.g. learning to drive, taking up painting or a new sport.
4. *Socially significant moments and events:* Unlike, the personally significant experiences, which tend to resonate with and be of most significance to the participant themselves, these experiences relate to social groups and significant moments encountered by them. Noted examples of this category

included: weddings and engagements, and to a lesser extent, house-warmings.

5. *Memorable moments:* As the category suggests, these items are short episodes relating to activities and events of interest to the collection owner. They may for example include moments in the home; significant dates in the person's calendar e.g. Christmas, Hallowe'en or a birthday; nights out, dinners, parties, a day spent in the park, or they may include a sporting, cultural or music event attended by the individual. Some of the recalled activities also related to simple 'everyday' moments that the individual cherished, for example a snowy day, baking, taking a train journey or waiting for a flight connection. Some of these could be considered more mundane and run-of-the-mill, but all of the noted items had some charm that the individual appreciated and prized.

Stage 1.B: Self-Concepts

The first component of the free-recall exercise placed emphasis on the happenings within the collection. However, and as described in Chapter 3, life stories are an important personal narrative form. These consider broad periods and the development of personally significant themes over time through a set of causally related events. They are also strongly connoted with personal identity and the sense of self.

In order to stimulate the identification of life stories, a second component of the free recall stage specifically explored aspects of self that the participants might narrate through their digital content. The aim of this was to encourage participants to think about the collection as a whole, how the content represented them as an individual and various aspects of their identity. To achieve this, the users were asked to enumerate a number of *self-concepts* that they believed to be present within the collection.

Identity "*is the way you see or define yourself, or the network of values and convictions that structure your life*" and it can additionally be viewed as a set of properties (Olsen, 2003) The way in which we view our identity can as such be sub-divided and categorized. In fact, we create many social and personal categories by which we describe ourselves. A self-concept is one of these properties or sub-divisions of identity which describes a component of our perceived self (Shavelson & Richard, 1982). These self-concepts tend to be relatively stable self-assessments which describe aspects of personality, individual skills, abilities or preferences, career,

occupation, hobbies and interests of the individuals, their physical attributes and characteristics and the individuals hopes, fears, goals, and standards. These often tend to be formed as statements expressing facts or opinions about the perceived self e.g. “I am tall”, “I am lazy”, etc. While these self-assessments may change over time, as ones personality, characteristics and identity does, they tend not to be transient or temporary but consistent for broad periods. These self-concepts may not only represent a view of an individual’s present sense of identity but may reflect future aspirations and desired behaviours allowing the current view of self to be compared and contrasted against an envisioned future self (Markus & Nurius, 1986). These self-concepts can additionally be quickly identified and elaborated by individuals in order to describe their sense of self and identity (Markus & Nurius, 1986) thereby making them very suitable within this task.

In this exercise, we asked the participants to enumerate a subset of approximately 20 self-concepts contained within their lifelog collection, thereby encouraging them to consider the content of their collection more broadly and framed from a high-level perspective. To provide a framework for this elaboration of aspects of self, the participants were asked to form twenty statements beginning “I am…”. Examples were provided to instill a sense of the task and these included “I am a PhD student”, “I am motivated”, etc. To further help the user frame the task and to help them more broadly consider the contents of their collection, they were advised to consider the following: “*if your lifelog was given to someone else might it say about you*”.

These elements will not be further discussed due to their inherently more personal nature, however, can be considered to belong to the following major types: items relating to career, friendships, places of residence, personal characteristics and traits, personal aspirations and goals, aspects under or desired for self-improvement, etc.

Stage 2: Task Set Generation.

The outputs elicited during the previous stage were then used to construct a set of personal story generation tasks. Participants were provided detailed instructions the types of stories which should be chosen and the criteria to determine if they were suitable. Broadly, participants were asked to identify tasks belonging to one of two categories. These categories correspond with the major story-types that would need to be evaluated within the narrative generation system. These were:

a. *Everyday stories:* Everyday stories communicate and share experiences from a reasonably short period in our lives, for example what you did last weekend, a recent holiday, trip or night out. Participants were asked to select 25 of these stories and the criteria for selection are outlined below.

b. *Life stories:* Unlike everyday stories which often communicate just a single episode, life stories present a set of causally related episodes centered around a single theme and are viewed in the context of broader life experiences. These tend to be much broader in scope and focus on longer periods and/or personal themes of interest. Participants were asked to select 20 of these more complex stories. The criteria for selection are outlined below.

For each of the chosen stories, the participants were asked to provide a succinct description, along with additional ancillary information which would aid them in completing the various story generation tasks. First they were asked to provide associated temporal information for the event, and this could be either specific (i.e complete dates and times) or general and broad (a particular month, week etc.). Keywords and phrases relating to the story were then elaborated and assigned to the appropriate dimension (person, place, etc.) Finally, the participants were asked to indicate the priority that should be allocated to the various components of the story. They were asked to distribute and assign a total of 100 points to either people (*who*), places (*where*), times (*when*) and things (*what*) as they saw fit. This distribution would be used to provide weighting information to the computational generation processes for the storytelling tasks.

Choosing Everyday Stories

Participants were asked to select 25 everyday stories using the items generated as part of the free recall activity. They were instructed that these should only include items noted to span short periods of time and that the selected items should be personally interesting, atypical from normal habitual activities in some way. Selected stories were additionally to be an activity, event or happening that they have previously retold to a friend, family member, etc, in a social capacity or that that they would have liked to share with them.

Participants were guided in their selection of everyday stories to ensure a diverse range of topics, themes and content was chosen and to ensure that the range of potential stories which can be generated were well covered. The participants were asked to review the events and activities elicited during the free recall phase and by using the ratings and additional information provided for each, select a number of

suitable everyday stories. This process was guided and they were advised to select 25 everyday stories as follows:

- Choose 5 stories about a specific (uncommon) place e.g. a trip to London;
- Choose 5 stories about a specific activity / action e.g giving an important presentation, preparing for a trip;
- Choose 5 stories about a particular day or short span of days of significance e.g. a birthday, a wedding, etc.
- Choose another 10 additional stories at their discretion.

Choosing Life Stories

Following the selection of everyday stories, participants were then asked to choose a number of life stories which represent more intimate and personal narratives about their life. This was achieved by using a combination of the elicited self-concepts and the free recalled activities which spanned temporally broad periods. Twenty life stories were required to be chosen. When making their selection participants were asked to consider the nature of a good life story based on a set of criteria (see section below) and ensure that it was well matched with them. It was hoped that by providing these criteria would encourage participants to reflect on their choices carefully.

Participants were prompted to choose a good cross-section of their life stories discussing a variety of topics. These topics could be a mix of specific stories focused on their relationship with a particular person, place or activity, to those which are more broad or intangible and which focused on high-level themes in their life. Illustrative examples of these themes and topics were provided and included items such as: their studies and/or career; living in a new location; relationships with family and friends; starting new activities and projects and their progression; new outlooks and attitudes they had developed over the course of collecting their lifelogs.

In order to further guide the process of life story selection and to ensure a mix of stories focused on broad activities, causally related events, and higher level self-conceptual stories, the participants were asked to choose their stories as follows:

1. From the free-recalled list of events, they should choose 10 items which span a broad period and which matches the criteria of a life story

2. From the list of self-concepts, 10 stories matching the criteria of a life story were to be chosen. They were also advised that these should not overlap with any story chosen in the previous step.

Criteria for selecting a life story

The following criteria were provided to the participants to aid them in their selection of appropriate life stories for inclusion in the story generation task set.

a) *Meaningful*: The story should be meaningful to the author. It should discuss something of importance and which resonates with the author. Furthermore it should say something about who the author is as a person.

b) *Personally significant:* The life stories should be personal and about who the author is. They shouldn't be overly focused on other people in a general way – unless, for example, it is about the author's relationship to them. The emphasis of the life story is about communicating aspects of self.

c) *Broad in scope:* Often a life story overviews quite broad periods in an individual's life – this can be as little as a month or encompass several years of a person's life. The life story is about significant times and themes in a life, so those items selected should not be overly focused on just one or two days of significance.

d) *Insight & Empathy:* A life story should give an insight into who the author is as a person - their identity; or at least some aspect of it. If the life story was to be retold to an individual known by the author it should give them a deeper insight into their life, who they are as a person and their sense of identity and personality. The goal of sharing a life story is simply to allow an individual to understand the author or narrator better by providing insights into their goals and motivations. Participants were advised that it might be helpful to frame the selection of a life story by reflecting on past personal conversations with intimate friends and family members and considering the personal topics that would have been discussed and the aspects of their life that had been shared in such situations.

Stories Selected

The final stories selected were maintained by the participants and were not shared to maintain good ethical practice. They instead used these selected tasks and their descriptions as a template for completing the story generation tasks during the evaluation of the system. Given the highly personal nature of these tasks and the topics under discussion within them, the final selected stories, chosen by the

participants, will not be presented here. We feel however that these stories are sufficiently overviewed by the examples provided in the free recall section and additionally by the exemplars outlined in the Self-Concepts section above. Some of the selected stories may be discussed in isolation, and with the permission of the participant, in the evaluations of this doctoral work, however, we feel it would be improper to expose all of this material given the personal nature of the tasks and limited number of subjects involved.

Examples of the worksheets provided to the participants, and the story selection workbook are provided for illustrative purposes in the following sections.

Appendix IV.2 – Free Recall Worksheet

	Duration				Important Aspects					
Description	**Is Single Isolated Episode**	**Spans Short Period**	**Spans Long Period**		**Person**	**Place**	**Time**	**Object /Thing**	**Emotion**	**Other**
	0	0	0		0	0	0	0	0	0

Appendix IV.3 – Story Generation Tasks Worksheet

		Time		Key Word / Phrases					Priorities (Must total 100%)			
ID	**Description**	**Start**	**End**	**Person**	**Place**	**Object / Thing**	**Keywords & phrases**	**Other**	**Person (Who)**	**Place (Where)**	**Time (When)**	**Things (What)**
	Examples											
1	Example1 (Everyday): Trip to Italy	13-Jan-10	14-Jan-10	Joe Bloggs, Jane Doe,	Italy, Rome, Vatican, Bascillica				20	50		30
2	Example2 (Life): My PhD	-	-	Gareth, Liadh, Yuki	Dublin		phd, lifelog, stories					100
3	Example3 (Life): My Friendship with Joe Bloggs	Nov-08	Dec-10	Joe Bloggs					80	10		10
	EveryDay Stories											
	Place											
1												
2												
3												
4												
5												

1			
2			
3			
4			
5			
Day or short span			
1			
2			
3			
4			
5			
Additional Stories			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Life Stories			
Spanning Long			
1			
2			
3			
4			
5			
6			

9			
10			
Who I ams			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Appendix VII

Storytelling Questionnaire & Rubric

Instructions to Participants:

Select a story from the ground-truth to construct. First do this manually, and then use the automatic components to create the story.

While creating the story, you should keep a note of any thoughts, obstacles or choices made. For example, this might include substituting the desired image with an alternative, as you couldn't find it, or a change in direction. When you have completed the storytelling task you should complete the questionnaire and rubric below.

Section 1 - Background

1. Please indicate the user

P1 P2 P3

2. Indicate the story type:

Everyday Story Life Story

3. Indicate the authoring mode

Manual Semi-automatic Automatic

Section 2 – Story Created

1. Describe the Story you created and why you choose to tell this story?

2. How satisfied are you with the story you have created? Very - Not Very

3. Describe the process took in composing the story. Consider the elements used, why you chose them, their overall look, arrangement, placement and your motivation for this.

4. How complete do you think the story is? Is there elements missing, does it tell all aspects of the story?

4. Is the story you created as you originally envisioned? If not describe why this is the case e.g. challenges you faced?

5. Describe any thoughts or recollections you might have had while composing this story? *This might include feelings or emotions felt, remembered items which were forgotten, new things you noticed, etc.*

6. Any other comments?

Section 3 – Possibilities for Sharing

In terms of the story you have just created. Consider if you would share this with someone and why would might do that.

1. Is this story something you might show to other people

   Yes No

•

2. Who would you share it with?

3. Why would you share it with them?

4. What do you think they might learn about you from this story?

Section 4 – Storytelling Rubric

Focus			
The focus of the story is established early on and maintains focus throughout	The focus of the story is established early on and is maintained for most of the story	The focus is generally clear, but there are lapses in places	It is difficult to discern the focus of the story
Style - General			
The style is original, fresh and compelling	The style is clear	The style is basic	The style is missing or weak
Style - Appropriateness			
Overall design has aesthetic appeal/ease of use consistent with purpose/audience. Style is highly engaging and well suited to message of the story	Overall design has good appeal and is reasonably consistent with the purpose and to the intended audience	Overall design has adequate appeal but shows some inconsistencies with purpose/audience.	Overall design is unappealing and inappropriate for purpose/audience Style is more distracting than helpful
Creativity			
Complete originality in composition and delivery, strong evidence of critical thinking skills	Creative, striking theme maintained consistently – extending value and meaning to the message	Theme appropriate for topic and audience	Theme(s) used inconsistently or inappropriately for topic and audience.
Content			
Content is clearly relevant to story and its focus, message is distinctly clear.	Content has some relevance to the story and its focus, message is clear with some confusing points	Content has little relevance to the story and theme, message is not clear	Content has no relevance to story and theme, there is no evident message.
Fluency			
The content chosen is highly fluent, expressive, detailed and original. The content helps to express the meaning of the story in an inventive way	Fluent with some details	Reasonably fluent but unclear in places.	Lacking fluency, details or originality
Layout Organisation & Sequencing			
Graphics & story content are organized in a clear, logical way within the layouts. This makes the story easy to	Most information is organized in a clear, logical way. One picture or media fragements seems to be out of	Two or more media fragments seem to be out of place making the story difficult to follow.	There is no clear story. Story elements seem to be sequenced randomly.

follow.	place.		
Chapter Organisation & Sequencing			
Story chapters are organized in a clear, logical way. The order in which they are presented is sensible and helps convey the meaning of the story	Most of the chapters are organized in a clear logical way. One chapter appears out of place.	Two or more chapters seem to be out of place making the story difficult to follow.	There is no clear story. Story chapters seem to be sequenced randomly.
Presentation			
Transitions, effects and audio are appropriate to the subject manner, add to the flow of the story and do not detract	Most transitions, effects and audio are appropriate to the subject manner, add to the flow of the story and do not detract	Some transitions, effects and audio are appropriate to the subject manner, add to the flow of the story and do not detract	Little to none of the transitions, effects and audio are appropriate to the subject manner, do not add to the flow of the story and do detract
Economy			
The story is told with exactly the right amount of detail throughout. It does not seem too short nor does it seem too long.	The story composition is typically good, though it seems to drag somewhat OR need slightly more detail in one or two sections.	The story seems to need more editing. It is noticeably too long or too short in more than one section.	The story needs extensive editing. It is too long or too short to be interesting.
Coverage and Completeness			
Biography covers full story of the subject. All significant points included	Biography covers story of subject with most major points included	Biography covers only part of story of subject. There were many significant points missing	Biography does not cover the subject
Coherence			
The story was easy to understand and the elements it contained were sensibly chosen and clearly related.	The story was reasonably easy to understand as most of the elements were clearly related	It was difficult to see the relationship between the story elements and this made the story hard to follow	It was difficult to understand what was being retold and the elements of the story did not appear related
Integrity			
Truthful and appropriate account of the experiences.	The story is largely truthful and appropriate with only one or two minor inconsistencies	The story presents a somewhat realistic account but with several inaccuracies	The story does not present a realistic account of what occurred

Storytelling Questionnaire

1. The Orison Tool

This section contains a few questions on the Orison tool you worked with during the evaluations

1. It was simple to use this system *

Strongly Agree Agree Undecided Disagree Strongly Disagree

2. I can effectively complete my work using this system *

Strongly Agree Agree Undecided Disagree Strongly Disagree

3. The system was responsive *

Strongly Agree Agree Undecided Disagree Strongly Disagree

4. The organization of information on the system screens is clear *

Strongly Agree Agree Undecided Disagree Strongly Disagree

5. I like using the interface of this system *

Strongly Agree Agree Undecided Disagree Strongly Disagree

6. Any comments on working with the tool:

2. Browsing the Collections

This section asks specific questions about how you went about browsing the collections using the tool and how the tool supported you in this task.

1. I was able to find the content I wanted with ease: *

Strongly Agree Agree Undecided Disagree Strongly Disagree

2. How would you rate the overall performance of the tool in retrieving the results *

Very Slow Slow Acceptable Fast Very Fast

3. I found the options for browsing and filtering results to be: *

Very Limited Complete

4. I found the options for browsing and filtering results to be: *

Easy to Use Complicated

5. Describe your strategies for finding content you wanted to use within your compositions i.e. how you browsed the content? *

3. Story Layout

This section asks specifically about how the tool supported you in creating the layouts and compositions you chose to create.

1. It was easy to create the layouts I wanted *

Strongly Agree Agree Undecided Disagree Strongly Disagree

2. The ScratchPad was useful *

Strongly Agree Agree Undecided Disagree Strongly Disagree

3. I was easily able to style chapters and elements *

Strongly Agree Agree Undecided Disagree Strongly Disagree

4. I found the themes helpful in creating layouts *

Strongly Agree Agree Undecided Disagree Strongly Disagree

5. I found it easy to create my own themes *

Strongly Agree Agree Undecided Disagree Strongly Disagree

6. Other comments on story layout controls (albums, chapters, scratchpad)

4. Story Composition

This section asks specifically about your strategies for creating, compositing and selecting the stories for your tasks

1. I mainly based my stories on (tick all that apply) *

Patterns or themes I found in the collection

A particular day or period of interest

People within the collection

Places within the collection

Things the owner did

Interesting pieces of content

Unusual content

Other

2. When creating my stories: *

I started with a clear picture of what I wanted to create, then explored the collection for the right content

I explored the collection to find interesting content, then started composing a story around that

I explored the collection to find a topic of interest, then went back to find content relating to it

I found interesting or unusual content and formed a story around that

Other

3. Composition *

I was able to create the compositions I wanted with ease

I was able to create the compositions I wanted but it took a lot of effort

I was unable to create the compositions I wanted

4. If not why?

5. Narration and Captioning - Tick all that apply *

I applied captions / titles to the chapters I created

I applied captions to the elements I added to my compositions

I added new captions to the compositions

I chose twitter / text content that provided a narration / explanation

6. I added a titles to a chapter: *

To explain what the chapter contained

To explain the significance of the chapter relevant to the others

To provide my viewpoint / perspective

I did not caption the chapters

Other

7. I added captions to the elements *

To explain why I used the element in my composition

To explain what was happening in the element

To add a narration to the composition

To provide my viewpoint / perspective

I did not caption the elements

Other

8. I added captions to the composition *

To add a title to the composition

To add supporting information to an element within the composition

To add a narration to the composition To provide my viewpoint / perspective

I did not add custom captions

Other

5. Usability

Please rate the system's usability in terms of the questions below.

- I think that I would like to use this system frequently

Strongly Disagree - Strongly agree

- I found the system unnecessarily complex

Strongly Disagree - Strongly agree

- I thought the system was easy to use

Strongly Disagree - Strongly agree

- I think that I would need the support of a technical person to be able to use this system Strongly Disagree - Strongly agree

- I found the various functions in this system were well integrated

Strongly Disagree - Strongly agree

- I thought there was too much inconsistency in this system

Strongly Disagree - Strongly agree

- I would imagine that most people would learn to use this system very quickly

Strongly Disagree - Strongly agree

- I found the system very cumbersome to use

    Strongly Disagree - Strongly agree

- I felt very confident using the system

    Strongly Disagree - Strongly agree

- I needed to learn a lot of things before I could get going with this system
    - Strongly Disagree - Strongly agree

6. General Feedback

The following section will ask some brief questions about your experiences with the tool and your suggestions for improving it.

1. What did you like about the system? *

2. What did you dislike about the system? *

3. What did you find CONFUSING or difficult to use? *

4. What IMPROVEMENTS would you suggest? *

Appendix VIII

Example Compositions

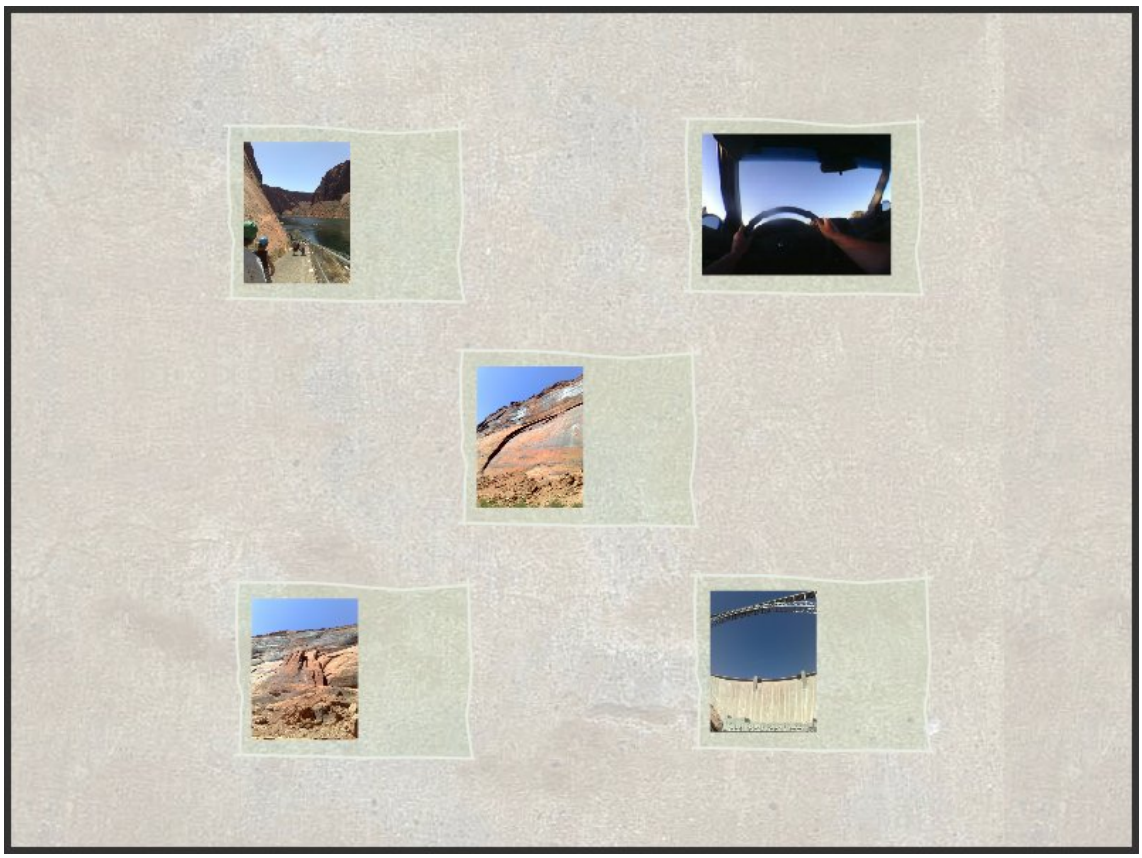
Example compositions created using the Orison tool are provided in higher quality and larger format than placed within the discussion. These serve to illustrate the creative outputs produced by the participants within both the evaluations of Chapter 8 & Chapter 9.

Manual


Went up A-Mountain. Twice. Result: a little bit sore and a lot of tiredness. Amazing views of Tempe though!

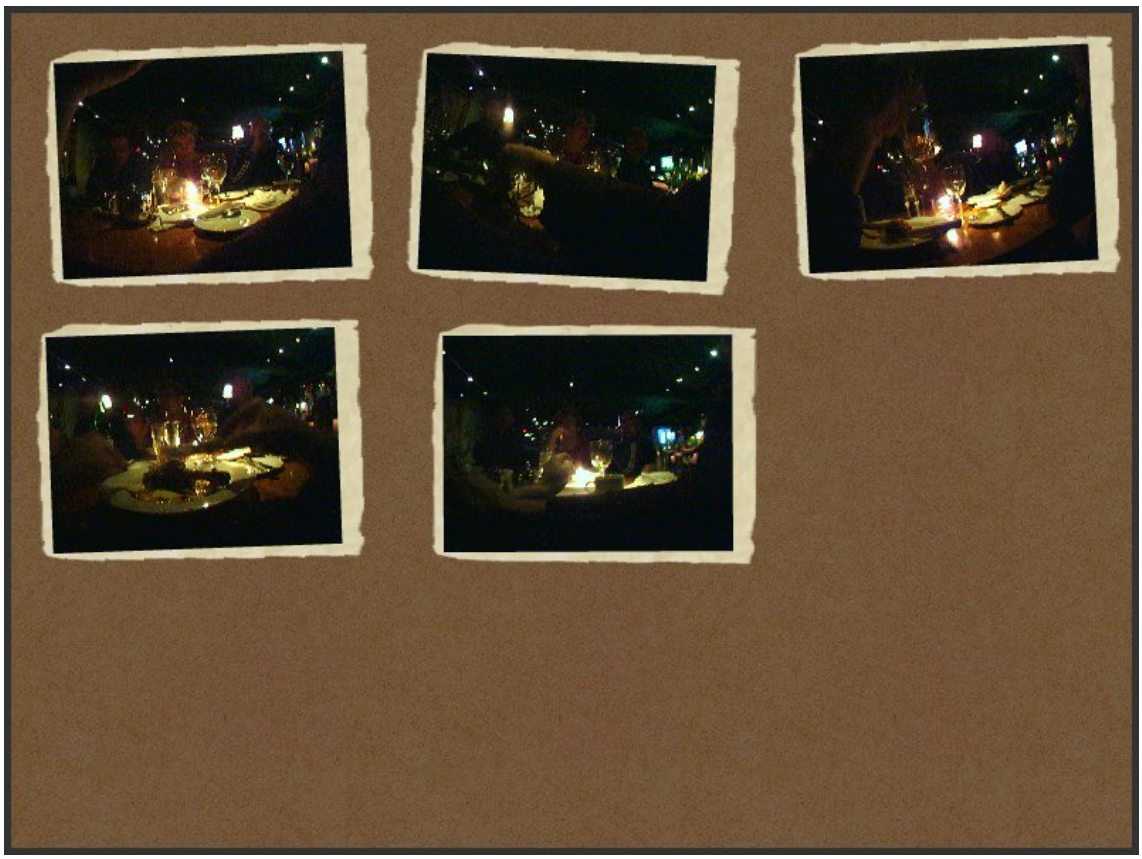

Arrival
whizzing around
lots of crock(ery)
green and leafy
being shellfish

System



Scorching day. been up the desert botanical gardens enjoyed chihuly exhibits. Car rental sorted also. Now time for a late lunch...

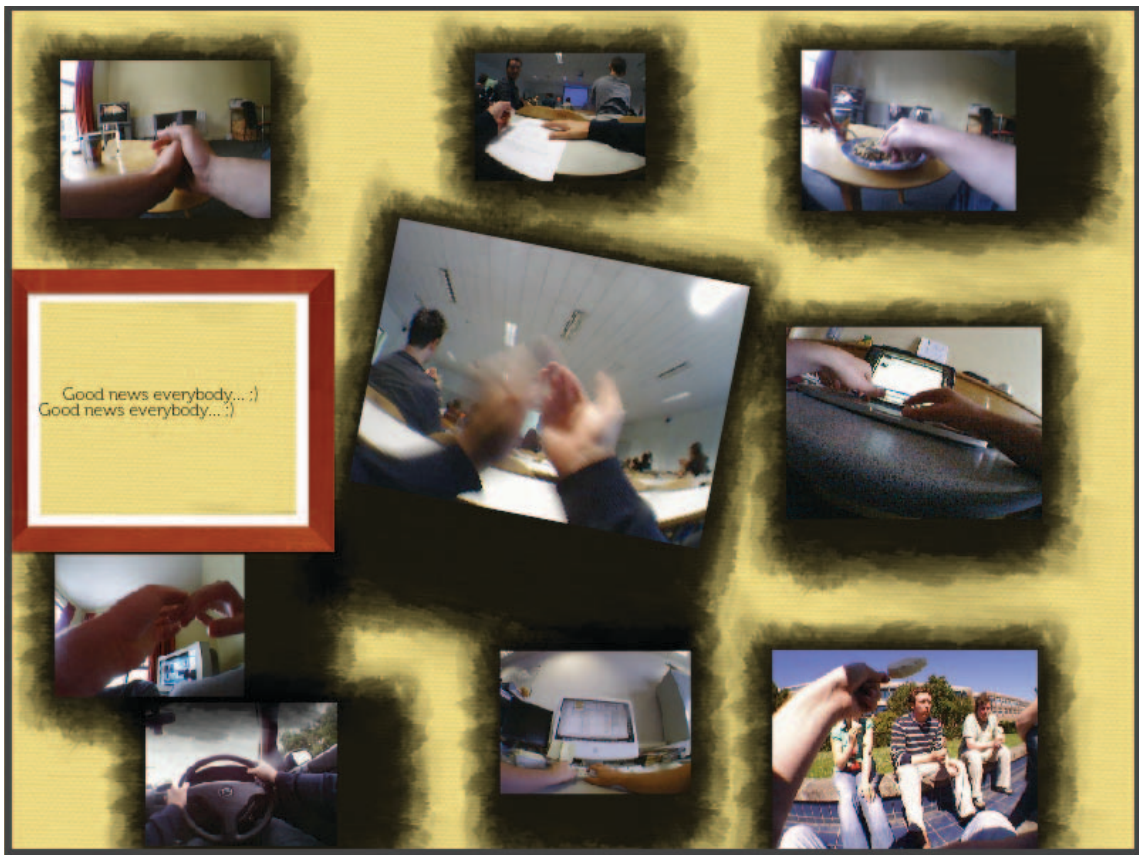
Early to bed... 4 and a half hour drive to the canyon tomorrow. So a suitably early start is required



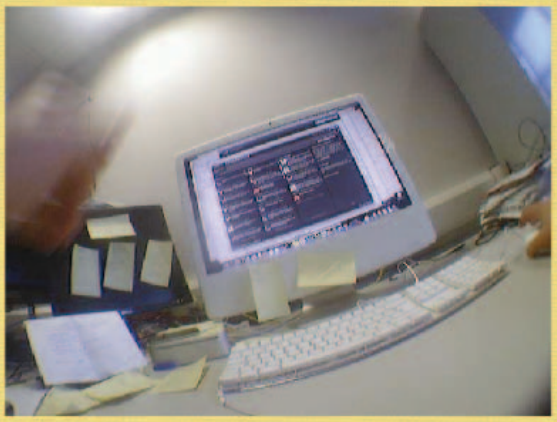

V6K

Third Party

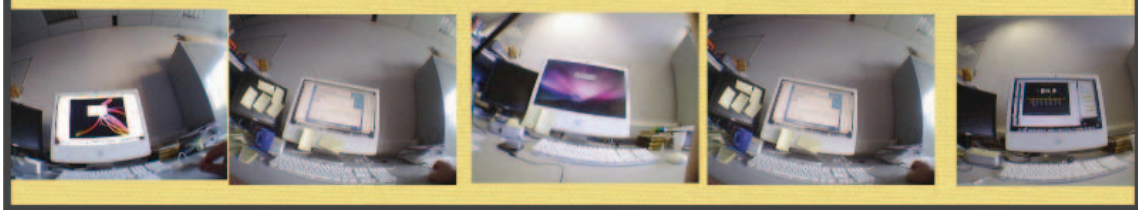

In spite of hangover, made it into town and spent a relaxing afternoon in the Iveagh Gardens.

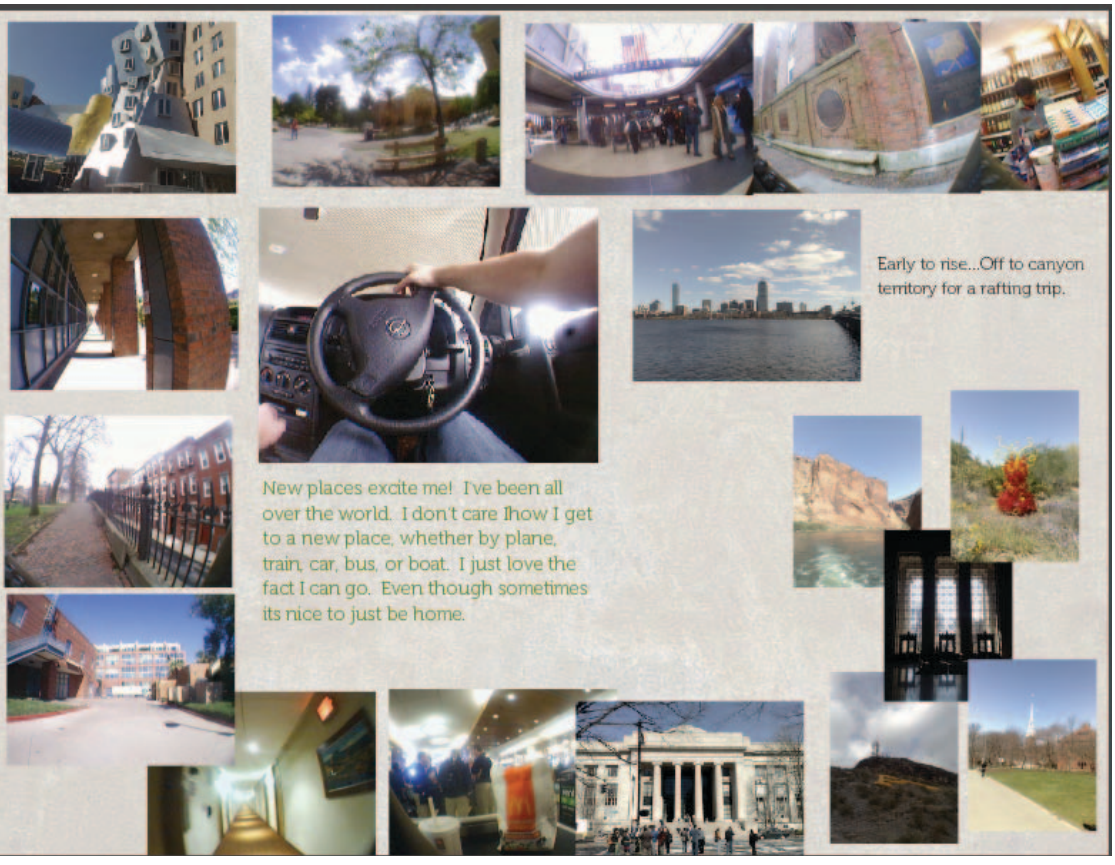

Good news everybody... :)
Good news everybody... :)


I can't escape tehnology. I use it everyday, without even thinking about it. It is a part of my being. I live and breathe technology and I am always thirsty for more.



This is where I spend most of my time, especially when completeing work. I seem to use this program often. I use stickies to help me remember thoughts, ideas, and events. It helps me keep my life in order and me on top of things.





Early to rise...Off to canyon territory for a rafting trip.

New places excite me! I've been all over the world. I don't care how I get to a new place, whether by plane, train, car, bus, or boat. I just love the fact I can go. Even though sometimes its nice to just be home.

Publications

There are a number of academic outputs which directly relate to this work. The motivations and ideas which were later developed into this doctoral thesis were initially presented at the 2008 Workshop on Story, Representation, Mechanism and Context (Byrne & Jones, 2008.) Subsequent to this the probative studies in Chapter 4 were conducted and the card sorting exercise. High level findings were presented at the 2009 Workshop on Designing for Reflection on Experience, while a deeper analysis of the materials used in story construction was discussed at ICIDS 2009. Finally, we would like to acknowledge that the evaluation in Chapter 9 was conducted in collaboration with Prof. Aisling Kelliher, Arizona State University and a substancial amount of the discussion presented in this chapter formed a publication presented at CHI 2011 (Byrne, Kelliher & Jones, 2011.) Finally, many of the issues relating to the development of long-term multimodal lifelog collections have been explored in depth within a chapter describing these efforts contained in the Handbook of Research on Mobile Software Engineering (Byrne, Kelly & Jones, 2010).

There are also a variety of peripheral publications which discuss a range of technical challenges, exploratory investigations, computational techniques for management and access, and visual strategies for lifelog content. Most of which focus on the use of the novel passive capture technology, SenseCam. While not directly related, these explorations have helped to inform the technical approaches to lifelog structuring and story distillation found within Chapters 6 and 7.

Journal Publications

1. **Byrne** D, Doherty A., Snoek C.G.M, Jones G.F., Smeaton A.F. 2009. Everyday Concept Detection in Visual Lifelogs: Validation, Relationships and Trends. *Multimedia Tools and Applications*, Special Issue on Semantic and Digital Media Technologies. Volume 49, Number 1, pp. 119-144.
2. Lee H, Smeaton A.F, O'Connor N, Jones G, Blighe M, **Byrne** D., Doherty A., Gurrin C. 2008. Constructing a SenseCam Visual Diary as a Media Process. *Multimedia Systems Journal*, Special

Issue on Canonical Processes of Media Production. Volume 14, Number 6, pp. 341-349.

Book Chapters

1. **Byrne** D., Kelly L., Jones G. 2010. Multiple Multimodal Mobile Devices: Lessons Learned from Engineering Lifelog Solutions. *Handbook of Research on Mobile Software Engineering*: Design, Implementation and Emergent Applications.

Edited Proceedings

1. Berry, E., **Byrne**, D., Doherty, A.R., Gurrin, C., Smeaton, A.F. 2010. *Proceedings of the second annual SenseCam symposium (SenseCam 2010).* Dublin, Ireland. 16-17 September 2010. ISBN 1872-327-915.
2. **Byrne**, D., Lee, H., Smeaton, A., Ciolfi, L. 2010. *Proceedings of the Fourth Irish Human Computer Interaction Conference, iHCI 2010.* Dublin, Ireland. 2-3 September 2010. ISBN 1872-327-885.

Conference Publications

1. **Byrne**, D, Kelliher, A., Jones G.J.F., 2011, Life editing: third-party perspectives on lifelog content, In *Proceedings of the 2011 annual conference on Human factors in computing systems (CHI '11)*. ACM, New York, NY, USA, 1501-1510.
2. Jones, G.J.F, **Byrne**, D., Hughes, M., O'Connor, N.E., Salway, A. 2010. Automatic Semantic Annotation of Landmark Images with Web Mining. 5th International Conference on Semantic and Digital Media Technologies, *SAMT 2010*. Saarbrücken, Germany. 1-3 Dec 2010.
3. **Byrne**, D., Jones, G.J.F. 2009. Exploring Narrative Presentation for Large Multimodal Lifelog Collections through Card Sorting. *ICIDS 09 - 2nd International Conference on Interactive Digital Storytelling*. Guimaraes, Portugal. 9-11 December 2009. LNCS Volume 5915/2009, pp. 92-97.
4. Wilkins P, Troncy R, Halvey M, **Byrne** D, Amin A, Punitha P, Smeaton A.F., Villa R. 2009. User Variance and its Impact on Video Retrieval Benchmarking. *ACM International Conference on Image and Video Retrieval - CIVR 2009*. Santorini, Greece. July 8-10 2009.
5. **Byrne** D., Doherty A.R., Snoek C.G.M., Jones G.J.F. & Smeaton A.F. 2008. Validating the Detection of Everyday Concepts in Visual Lifelogs. *SAMT 2008 - 3rd International Conference on Semantic and Digital Media Technologies*. Koblenz, Germany. 3-5 December 2008.
6. Dumont E., Merialdo B., Essid S., Bailer W., **Byrne** D., Bredin H., O'Connor N., Jones G., Haller M., Krutz A., Sikora T., Platrik T. 2008. Collaborative Approach to Video Summarization. *SAMT 2008 - 3rd International Conference on Semantic and Digital Media Technologies*. Koblenz, Germany. 3-5 December 2008.
7. **Byrne** D., Lee H., Jones G.J.F., Smeaton A.F. 2008. Guidelines for the Presentation and Visualisation of LifeLog Content. *Irish Human Computer Interaction Conference '08*. Cork, Ireland. September 19-20 2008.
8. **Byrne** D., Doherty A.R., Smeaton A.F., Jones G.. Kumpulainen S, Järvelin K. 2008. The SenseCam as a Tool for Task Observation. *HCI 2008 - The 22nd BCS HCI Group Conference*. Liverpool, UK. 1-5 Sept 2008.

9. Gurrin C, **Byrne** D, O'Connor N, Jones G and Smeaton A.F. 2008. Architecture and Challenges of Maintaining a Large-scale, Context-aware Human Digital Memory. VIE 2008 - The *5th IET Visual Information Engineering 2008 Conference*. Xi'An, China. 29 July - 1 August 2008.
10. **Byrne** D, Wilkins P, Jones G, Smeaton A.F and O'Connor N. 2008. Measuring the Impact of Temporal Context on Video Retrieval. *CIVR 2008 - ACM International Conference on Image and Video Retrieval*. Niagara Falls, Canada. 7-9 July 2008.
11. Doherty A., **Byrne** D., Smeaton A.F., Jones G.F., Hughes M. 2008. Investigating Keyframe Selection Methods in the Novel Domain of Passively Captured Visual Lifelogs. *CIVR 2008 - ACM International Conference on Image and Video Retrieval.* Niagara Falls, Canada. 7-9 July 2008.
12. Gurrin, C., Smeaton, A.F., **Byrne**, D., O'Hare, N., Jones, G.F. O'Connor, N.E. 2008. An Examination of a Large Visual Lifelog. *AIRS 2008 - Asia Information Retrieval Symposium*. Harbin, China. 16-18 January 2008.
13. **Byrne** D, Lavelle B, Jones G and Smeaton A.F. 2007. Visualising Bluetooth Interactions: Combining the Arc Diagram and DocuBurst Techniques. *HCI 2007 - Proceedings of the 21st BCS HCI Group Conference.* Lancaster, U.K.. 3-7 September 2007.
14. Lavelle B, **Byrne** D, Jones G and Smeaton A.F. 2007. Bluetooth Friendly Names: Bringing Classic HCI Questions into the Mobile Space. *HCI 2007 - Proceedings of the 21st BCS HCI Group Conference.* Lancaster, U.K.. 3-7 September 2007.
15. **Byrne** D, Lavelle B, Doherty A, Jones G and Smeaton A.F. 2007. Using Bluetooth and GPS Metadata to Measure Event Similarity in SenseCam Images. *IMAI'07 - 5th International Conference on Intelligent Multimedia and Ambient Intelligence.* Salt Lake City, Utah. 22-24 July 2007. pp1454-1460.
16. Lee, H., McGivney, S., **Byrne**, D., Smeaton A.F. 2007. Adaptive Information Cluster at Dublin City University. *iHCI 2007 - 1st Irish Human-Computer Interaction Conference.* Limerick, Ireland. 2 May 2007. pp15-19.

Workshop Publications

1. Kelly L, **Byrne**, D., Jones, G.J.F 2009. The Role of Places and Spaces in Lifelog Retrieval. *PIM 2009 - Proceedings of Personal Information Management*, Workshop at ASIST 2009. Vancouver, Canada. 7-8 November 2009.
2. **Byrne**, D., Jones, G.J.F 2009. Creating Stories for Reflection from Multimodal Lifelog Content: An Initial Investigation. *Designing for Reflection on Experience, Workshop at CHI 2009. Boston,* MA, USA. 4 Apr 2009.
3. Kumpulainen S., Jarvelin K., Serola S., Doherty A., **Byrne** D., Smeaton A.F., Jones G. 2009. Data Collection Methods for Analyzing Task-Based Information Access in Molecular Medicine. *MobiHealthInf 2009 - 1st International Workshop on Mobilizing Health Information to Support Healthcare-related Knowledge Work.* Porto, Portugal. 16 January 2009.
4. Freyne, J., Brennan, A.J., Smyth, B., **Byrne**, D., Smeaton A.F., Jones, G.J.F. 2009. Automated murmurs : the social mobile tourist application. Paper presented at *Social Mobile Web (SMW'09),* in conjunction with the Proceedings of the 12th IEEE International Conference on Computational Science and Engineering - CSE 2009. Vancouver, Canada. 29-31 August 2009. Volume 4.
5. Jones G.F., Gurrin C., Kelly L., **Byrne** D., Chen Y. 2008. Information Access Tasks and Evaluation from Personal Lifelogs. *EVIA 2008 - 2nd International Workshop on Evaluating Information Access,* A Satellite Workshop of NTCIR-7. Tokyo, Japan. 16 December 2008.
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