

An Investigation into the Relevance of Documentation for Problem Solving in Equipment Controlled by Programmable Logic Controllers (PLCs)

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The Programmable Controller (PLC)

- The programmable controller is a very reliable industrial computer designed to survive in harsh environments
- Controlled by IEC 6-1131 defined languages
The most common being Ladder Logic

PLC Controlled Production Equipment



The Stages of Program Design

- 1 Requirements Analysis**
To elicit and document a detailed description of what the proposed project must achieve
- 2 The Design Stage**
Use tools such as Flow Charts
- 3 Implementation Stage**
Writing & documenting the Program
- 4 The Testing Stage**
Design and document the tests
- 5 The Maintenance Stage**
 - Software Update
 - Perfective
 - Corrective

PLC Program Support Documentation

- **Requirements Document**
What the system must do
- **Design tools:**
Flowcharts;
Input / Output List.
- **Hard copy of Program with:**
Labels;
Comments.
- **Documented Test Results**
Test cases

PLC Program Design

In the field of PLC programming the documented structured approach followed in computer software projects seems not to be generally applied (authors survey) .

- PLC programming is very "ad hoc"
- Documentation is poor
- Every PLC programmer has their own version of the correct way to write programs.

The Results of “Ad-hoc” Development

- Hardware & Software maintenance problems
- Increased machine downtime.
- Poor Overall Equipment Effectiveness (OEE) Figures

Experimentation

Controlled experiments were carried out by the authors to attempt to quantify the effects of quality as against poor documentation in terms of their usefulness in hardware and software maintenance.

Experiment 1 (Fault Finding)

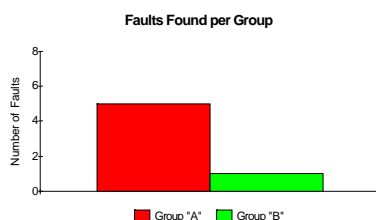
Purpose:

Examine the hypothesis that a poorly documented PLC program makes hardware fault finding more difficult than a well documented one.

The Experiment Subjects

- 16 Recently qualified electricians
- Divided into two Groups, “A” and “B”.
- **Group “A”** are given:
 - Requirements document;
 - A flow chart;
 - The I/O Assignment list;
 - A printout of the PLC program with detailed natural language comments and labels.
- **Group “B”** are given:
 - The I/O Assignment list ;
 - A printout of the PLC program with sparse comments and labels.

Results of Experiment 1



Experiment 2 (Software Maintenance)

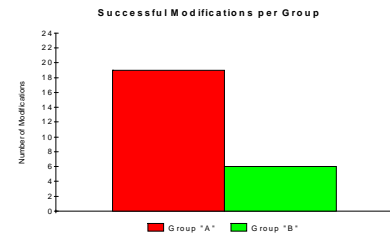
Purpose:

Examine the hypothesis that a poorly documented PLC program makes Software Maintenance more difficult than a well documented one.

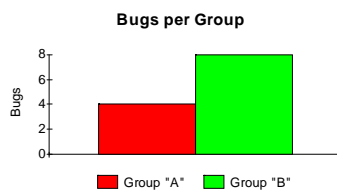
The Experiment Subjects

- 16 Recently qualified Industrial Automation Technicians divided into two Groups, "A" and "B".
- **Group "A"** are given:
 - Requirements document;
 - A flow chart;
 - The I/O Assignment list;
 - A Program Function Chart;
 - A printout of the PLC program with detailed natural language comments and labels.
- **Group "B"** are given:
 - The I/O Assignment list ;
 - A printout of the PLC program with sparse comments and labels.

Results of Experiment 2



Results of Experiment 2



Conclusion

- The experiments provide clear evidence of the advantages to be gained from using concise documentation for problem solving.
- Training in the use of such documentation has the potential to facilitate more effective problem solving resulting in more efficient utilisation of production equipment.