XVI IMEKO World Congress
Measurement - Supports Science - Improves Technology - Protects Environment ... and Provides Employment - Now and in the Future
Vienna, AUSTRIA, 2000, September 25-28

INTERACTIVE QUALITY EVALUATION FOR LABORATORY SESSIONS

B. Andò, G. Giuffrida and N. Pitrone
Dipartimento Elettrico, Elettronico e Sistemistico Università di Catania, Italy

Abstract: A tool for educational purposes to be used during laboratory sessions on electrical and electronic measurement courses is proposed. It represents an interactive environment for performing measurements and writing technical reports at the same time, using an user-friendly dialogue system. It should be emphasised that the implemented tool is quite different from an automatic measurement system, due to its interactive features. It improves the Quality Management of the educational services provided by electronic measurement laboratories by increasing the quality of typical laboratory interactions, such as theory-practice, laboratory instruments-users and teacher-students. A particularisation of the more general Deming quality theories has been adopted.
Keywords: Interactive tool, Quality evaluation, Laboratory sessions

1 INTRODUCTION

Laboratory sessions are significantly important throughout engineering courses, so great effort is needed to realise an adequate didactic experimental apparatus for performing the required training and a lot of time must be spend for writing the technical report. On the other hand, driven measurement systems can reduce attention and interest of the undergraduates, becoming inadequate for educational tasks.

By using advanced technologies a new interactive environment has been developed: it is based on a commonly used word processor for writing the technical reports while performing measurements [1] and has been adopted for educational purposes during laboratory sessions on electrical and electronic measurement courses.

Quality constraints must be met in order to offer a good service to the service customers, in this case represented by university students. How the evaluation of Quality can be performed? A good solution to this problem would be obtained by using a suitable index to be optimised on the basis of customer feedback: Customer Satisfaction (C.S.) [2].

In the past Quality tasks were accomplished by means of Quality Control (Q.C.), a statistical procedure based on goods analysis performed by the factory team during the production phase. Subsequently the Quality Assurance service was introduced. It was regulated by external bodies assuring that production was in agreement with regulations (e.g. ISO 9000).

Nowadays, the Total Quality Management approach is adopted. The main feature of this approach is related to the possibility of taking user satisfaction into account. This task is accomplished by measuring the Quality of a service using the C.S. index [2]. This is what the American Society for Quality Control highlights. This evolution is shown in scheme form in Figure 1.

In this work the Deming approach has been adopted to optimise the quality of the educational service provided by a measurement laboratory. Indeed, the proposed system has been planned and the quality evaluation has been performed by the Deming cycle theory, according to the steps described in the next section.

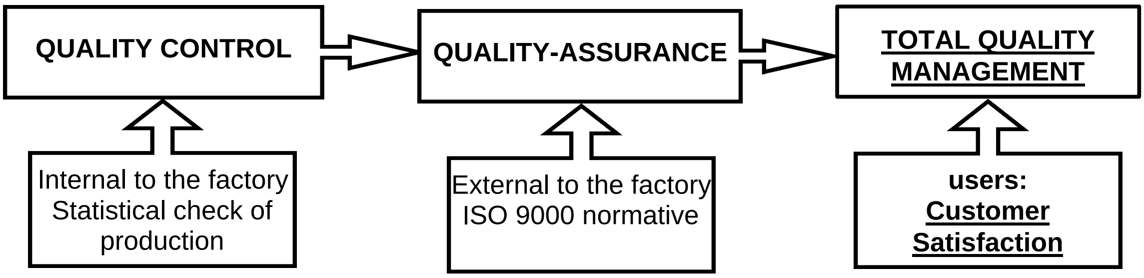

Figure 1. Evolution of Quality approaches.

2 THE DEMING APPROACH

Figure 2 shows the fundamental steps of the Deming approach.

The first step in the Deming approach is the so-called **Plan** Phase. During this phase user expectations must be taken into account. To perform this task and to fix the project constraints, useful meetings were held with the users and suitable investigations were carried out. In this case the undergraduated expectations were investigated.

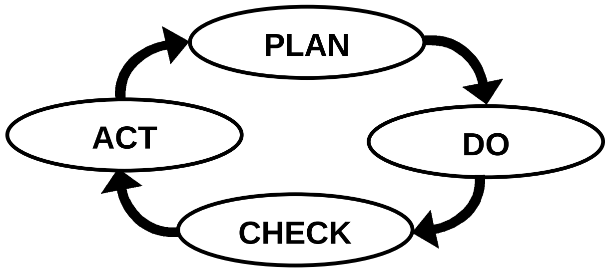

Figure 2. The Deming approach

Students generally spend a long time in experimental activity in the laboratory, because a relevant amount of data must be collected, circuit schemes must be drawn and so on. Many mistakes can occur during data processing. They are also required to write a detailed technical report on the performed measurements. A typical sequence for report writing is shown in Figure 3 Often it takes a long time to write this report, usually assigned as homework. Hence, an user-friendly interface, a suitable development environment and simple data exchange are features to be performed by the tool to be designed. Moreover, it will be very useful to choose a very common word processor, such as Microsoft Word.

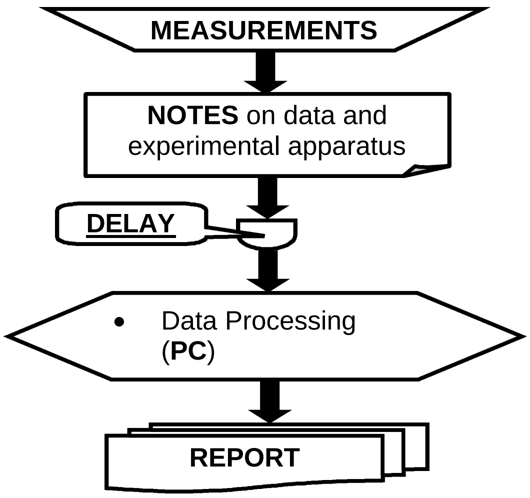

Figure 3. Typical sequence for report writing.

In detail, in the considered case typical electronic measurements are carried out by using a waveform generator and an oscilloscope, while writing the report. It is needed both to write down the Time and Voltage values in a desired position of the report and to capture the waveform image on the scope screen and transfer them into the report. Moreover, the emulation of the waveform generator front panel to be included in the word processor would be suitable in order to make the proposed environment more comfortable. This can be achieved by controlling the digital instruments by some dedicated menu, properly added to the word processor and by putting measurement results directly into the report. In an environment which includes these features the student can write the report and in the meanwhile can perform the measurement process.

The next step in the Deming approach consists in the **Do** phase and involves the realisation of the required instrument (product). The availability of laboratory instrumentation based on the HP-IB (Hewlett Packard Interface Bus) connected to a host computer enables developing an interactive instrument satisfying the constraints raised during the plan phase. An HP-IB measurement apparatus is shown in Fig.4.

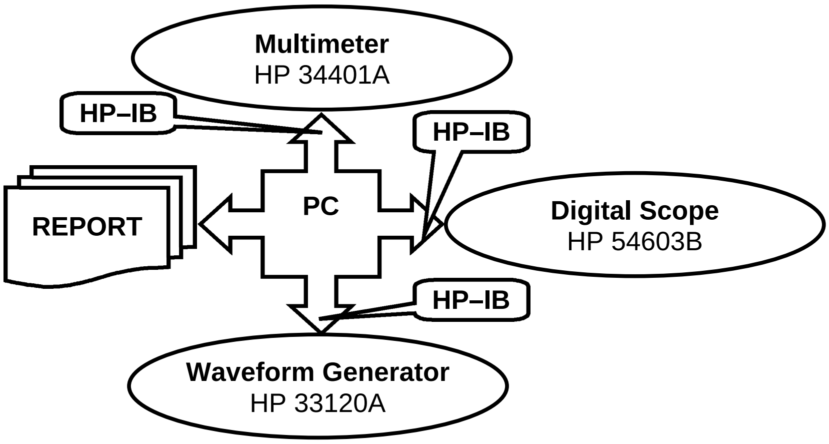

Figure 4. An HP-IB measurement apparatus.

In order to realise the physical layer of the dedicated network allowing communication between the digital instruments (e.g. waveform generator, digital scope, digital multimeter) and the PC, the HP-IB bus was used. As established by the HP-IB protocol, the digital instruments can assume either Talker or Listener role, while the Control task is performed by the PC. In order to develop suitable routines allowing the control of the digital instruments, the SCPI (Standard Command for Programmable Instruments) language was adopted. As an example, to perform a Voltage measurement the following string must be used
:MEASure:VOLTage: AC 20, 0.001, where
:MEASure:VOLTage is the keyword to obtain a voltage measurement;
AC is used to perform an AC measurement;
20 is the measurement range of the instrument;
0.01 is the required resolution.

In order to establish communication between the Windows environment and the instruments, a dedicated tool, «HP Interactive», developed by HP, was used. This tool uses the SCPI language to manage data flowing through the bus.

The last task is the communication between Microsoft Word and the interactive HP tool. The considered applications support the DDE (Dynamic Data Exchange) protocol for transferring data among Windows applications. On the basis of these considerations, a large number of macro procedures, written in Visual Basic (a programming language included in MW) were developed to control the instruments and import the measurement results in the technical report. Figure 5 gives a schematic representation of the realized interactive environment.

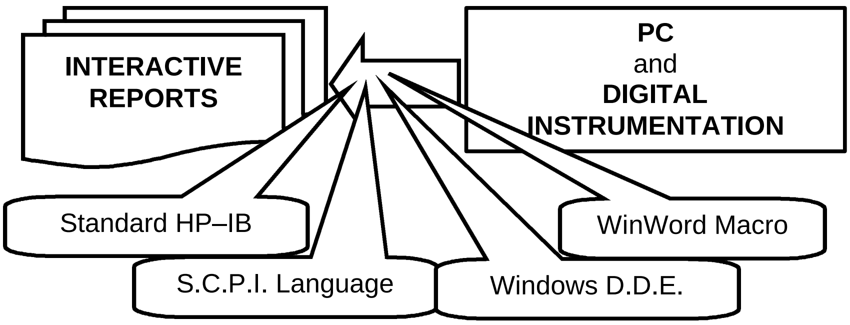

Figure 5. A schematic representation of the interactive environment.

In Section III a detailed description of the user interface of the tool will be presented.

The proposed tool has been used by students attending a measurement course in order to develop some of the laboratory exercises. The quality of the instrument was evaluated on the basis of student feedback. This represents the third part of the Deming cycle: the **Check** phase. To point out the differences between the two different laboratory approaches (with and without the interactive tool) some of the laboratory exercises were performed via traditional methods.

At the end of the course a suitable questionnaire (it looks like a **C.S. sensor**!) to evaluate the software was submitted to the students. The questionnaire consists of 28 questions (7 for each quality factor). For each question 5 possible answers with an increasing score (1 to 5) were planned. One more question for global evaluation and a section for notes and suggestions was also added. In Figure 6 a statistical analysis of the collected answers is presented.

QUALITY FACTORS	Importance	**Customer Satisfaction**
User interface	21.9	**71.2**
Execution time	12.0	**51.7**
Time consuming	23.9	**79.2**
Educational value	42.2	**67.9**
Global evaluation		**74.8**

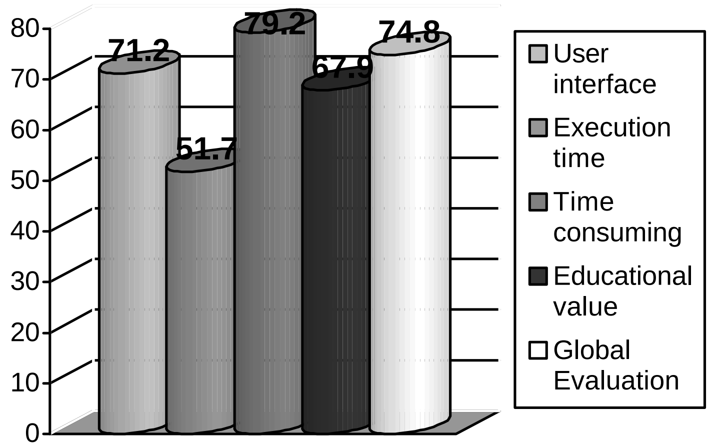

Figure 6. Statistical analysis of the collected answers (the values of the customer satisfaction represent the percentage of the maximum initial expectation, set to 100%).

The values reported in the two columns relate to user interest and a suitable C.S. index., which was computed by normalizing the sum related to the answers collected. The C.S. index is satisfactory for all quality factors except for the execution rate. Indeed, an execution time of 45 s to capture the waveform images from the digital scope screen was evaluated. It should be observed that this result can be ignored because the relative importance rate value is low. Nevertheless, an *improving action* has been undertaken in order to optimize the obtained quality factor. This task was carried out during the fourth step in the Deming cycle: the **Act** phase. The problem was solved by using a dedicated HP tool: the HP 34810A BenchLink/Scope. During the **Do** phase, this tool was initially discharged because it does not support DDE functions. A particular implementation in Visual Basic was proposed to overcome this difficulty and to link the tool with the instrument. By using this tool the execution time was drastically reduced to 4 s.

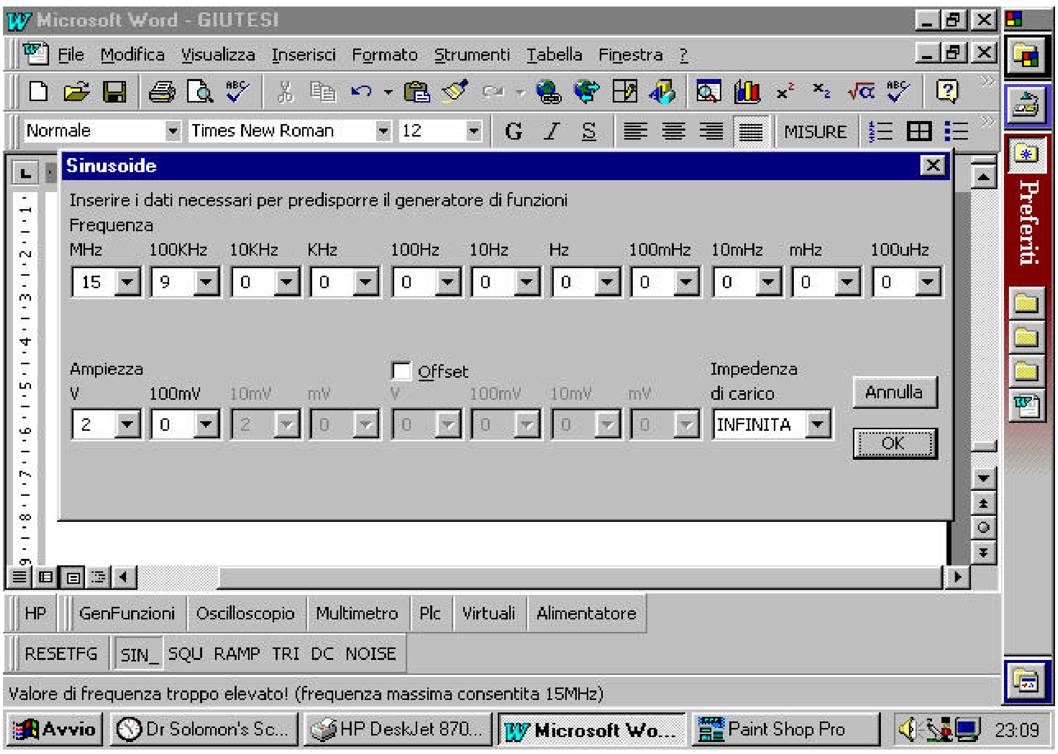

Figure 7. Dialog box to control the generation of a sinusoidal waveform

3 SOME DETAILS ABOUT THE EDUCATIONAL TOOL

The proposed tool has been developed as a subset of objects defined in a Microsoft Word model. Several macro instructions activated by selecting the corresponding function in a dedicated menu have been implemented. In particular, a menu bar is provided for each digital instrument. As an example, Figure 7 shows the menu bar controlling the generation of a sinusoidal waveform by the waveform generator. Amplitude, frequency, offset and all other signal parameters can be tuned directly from the word processor environment to obtain the desired waveform by the digital generator.

Dialog boxes were also used to assist the user with useful information about critical events. As an example, if out of range values are chosen for the waveform generator a message will appear and the procedure is interrupted. Such a message is shown at the bottom of Figure 7.

A student group using the proposed tool is shown in Figure 8.

4 CONCLUSION

An educational instrument supporting the student during the actual measurement session has been proposed. It should be emphasised that the environment developed is not an automatic measurement system but an educational tool helping the student during his activity. It should be recalled that one of the Quality aims is interaction with customers to develop an end product satisfying their expectations. This goal has been reached by means of the Deming approach. Due to student response one should be confident of the suitability of the proposed tool. Further effort could be made for improving the features of the product.

Figure 8. Students using the proposed tool

REFERENCES

[1] Salvatore Baglio, Salvatore Graziani, Nicola Pitrone «An interactive tool for writing the technical report on the laboratory of electrical measurement courses: *write it while measuring*», IASTED ‘97.
[2] Klaus j. Zink, «Total Quality Management as a holistic management concept. The European model for business excellence», Springer, 1998.

ACKNOWLEDGMENT

The authors would like to thank Eng. Antonio Barbagallo for providing guidance and for many useful discussions regarding Quality topics.

AUTHORS: Bruno ANDÒ, Giuseppe GIUFFRIDA and Nicola PITRONE, Dipartimento Elettrico, Elettronico e Sistemistico, Università di Catania, Viale A.Doria, 6 - 95125 Catania, Italy
Tel.+39-095-7382309, Fax+39-095-330793, E-mail: bando@dees.unict.it , Web: www.dees.unict.it