2nd IFAC Workshop on Advanced Maintenance Engineering,
Services and Technology
Universidad de Sevilla, Sevilla, Spain. November 22-23, 2012

Training in RAMS in Collaboration with Industrial Companies and Institutions

J. Marcos [*], M. J. Fernández [**], J. Sánchez [***], M. Suárez [****], A. M. Mariblanca [*****]

[*] *Dept. of Electronic Technology, University of Vigo, Spain (email: acevedo@uvigo.es)*
[**] *Dept. of Translation and Linguistics, University of Vigo, Spain (email: mjpintelos@uvigo.es)*
[***] *Dept. of Electronic Technology, University of Vigo, Spain (email: jreal@uvigo.es)*
[****] *Central Technical Office. SA Peugeot Citroen Group, Vigo, Spain (email: manuel.suarez1@mpsa.com)*
[*****] *Spanish Association for Standardization and Certification (AENOR), Madrid, Spain (email: amariblanca@aenor.es)*

Abstract: This paper presents two activities carried out by Engineering students from the Telecommunication Engineering School of the University of Vigo. The activities described have been organized within the subject "Reliability of Electronic Systems", which covers the four aspects of RAMS (Reliability, Availability, Maintainability, Safety).

The activities focus on collaboration with local companies and institutions, so that the students can undertake real tasks related to the content of the subject as part of the subject assessment system. The first activity gets the students to work with real problems inside a local company. The second one is carried out by Engineering students in collaboration with Translation students from the Faculty of Philology and Translation of the University of Vigo and the Spanish Association for Standardization and Certification. This collaboration implies joint efforts of students from different degrees and active involvement in their own training.

The methodology of both activities stimulates active and collaborative learning and introduces the students to professional activity and interdisciplinary group work. The results achieved clearly demonstrate the interest of encouraging interdisciplinary teamwork competences and involving local companies and institutions in the training of university students.

Keywords: Reliability, Availability, Maintainability, Safety, Dependability, RAMS, Active learning, Cooperative learning

1. INTRODUCTION

Two activities have been organized by the Department of Electronic Technology of the University of Vigo in order to develop new tools and methodologies to improve the effectiveness of training during the last few years (Marcos et al. 2001, 2004, 2005, 2006). These activities have been included in a subject focused on RAMS technologies in devices, circuits and electronic systems.

RAMS technologies define Reliability, Availability, Maintainability and Safety (P. Kales, 1998). RAMS specifications are part of any design project for aerospace, aeronautics, or military applications, among others, and they are more and more usual in other fields such as people transportation in general and railway in particular. Engineering students are trained to design technological systems, but they receive little training about how, when and why their designs fail. For these reasons, training in RAMS is essential for students of Engineering schools (Mayers et al., 2000; Kececioglu, 1998; Kapur, 2002; Evans, 1998; Álvarez et al., 2003; Álvarez et al., 2004; Lalli, 1998; Denson, 1998).

Subjects dealing with RAMS have been taught in different countries for decades, but they are much more recent in Spain. In the particular case of the University of Vigo, these concepts were approached for the first time in 1998-99 through the subject "Reliability of Electronic Systems". This subject is offered by the Department of Electronic Technology of the Telecommunication Engineering School during the fifth year of the Electronics specialty of the degree in Telecommunication Engineering.

If students are given the chance to face real problems directly related with the content of any technological subject their training will be more efficient and their learning more thorough. This improvement will be especially significant during the last years of their degree, no matter the field. In addition, if these problems are to be solved by working in groups, the students will use active and cooperative learning techniques that will lead to better results (Gil et al., 2006; Marcos et al. 2009; Kagan, Spencer, 1994; Slavin, 1987; Panitz, 1999). This kind of activity builds teamwork specific competences that are really interesting for the future professional life of the students. Furthermore, if the work groups are interdisciplinary (i.e. comprised of students from different degrees), their working conditions will be even more similar to those in their future professional environment.

The collaboration of local companies and institutions is indispensable for the implementation of all these techniques. The following sections depict the content of the subject "Reliability of Electronic Systems", as well as the subject assessment criteria. The aforementioned techniques have been -and are being- assessed through the two particular activities described through this paper. They both count on the collaboration of local companies and institutions and one

of them is carried out by interdisciplinary groups, with Engineering and Translation students.

2. THE SUBJECT

The subject "Reliability of Electronic Systems" is allocated 60 teaching hours -45 of theory and 15 of lab work. The 45 hours of theory are used to explain the RAMS basic ideas, the most popular statistical functions, help tools like FMECA (Failure Mode, Effects and Criticality Analysis), FTA (Fault-Tree Analysis), Markov models, etc. This subject is focused on components, circuits and electronic systems, so the calculation of failure rates and the other parameters are related to this technology.

The students have two options to demonstrate subject matter competency:

- Final examination and the compulsory lab practices.
- Class attendance, the compulsory lab practices, and the corresponding reports.

This subject has been taught for fourteen academic years now and in that time no student has decided on the final examination, so this possibility will not be discussed in this paper. The second option shows the following determining factors:

1) The student must attend, at least, 80% of the theory classes and 100% of the lab sessions.
2) The student must present the lab reports, which are to be written in pairs.
3) The student must hand in five reports during the academic year, which are to be written individually.
4) The student must carry out two activities that must be related to the content of the subject and deal with two real situations in collaboration with local companies and institutions.

The following paragraphs will detail the fourth determinant, which is the object of this paper. As said above, the methodology used for these activities makes the student face real problems directly related to the content of the subject. The students have to identify a problem clearly, define a problem-solving procedure, find different solutions for that problem and classify those solutions according to their feasibility. The whole activity is developed in a real work environment, where the students have to use their abilities to work in a team with the means a company or an institution makes available for them, to report on their progress to the company and the instructor, etc.

Still, this kind of activity should be related to the content of each subject. It hence follows that organizing involves some extra effort on the part of the instructors; they have to find suitable entities for the collaboration, selecting activities, and monitoring and assessing them. This effort will change depending on the characteristics of the subject, the number of students or the industrial network of the area.

The methodology of the activities turns the students into a really active element in their own learning process. In this case, they have to solve real problems related to the content of the subject and therefore to maintenance – either preventive (PM), corrective, predictive (PdM) or Reliability Centered Maintenance (RCM), etc. Besides, the results of the activities depend on teamwork, so the student has to master cooperative learning techniques. As explained below -section4- for one of the activities the students have to work in groups with their classmates and also with students from degrees of a different field, specifically Translation. One of the objectives of this last activity is that the students acquire the competence to work in an interdisciplinary group.

These activities are not professional practices, as they are related to a specific subject, and not to a whole degree. An activity of this kind can be part of the professional practices of a degree, but not every activity in a professional practice can be used for the kind of initiative dealt with in this paper. It is not a professional practice for a subject either, where the lab is just replaced by the industrial facilities. This would not be designed by an instructor for the students to learn, but selected by the instructor and the company staff for the students to solve the problems in the facilities of the company.

Due to the very essence of the activities, the work of the students is closely monitored by both the instructor and the relevant staff of the company. This requires balancing the number of students involved in each activity with the number of instructors that teach the subject and with the size of the company that receives the students.

The two activities described in this paper have then a different nature. One of them has been developed with the collaboration of a company and the other one with a standardization entity. Both activities are analyzed during the following sections.

3. ACTIVITY ORGANIZED IN COLLABORATION WITH LOCAL COMPANIES

Two options are offered for the students who prefer the second assessment system of the subject "Reliability of Electronic Systems":

- The students themselves look for a company to work with and present their report proposals to the instructor. The reports have to be related to the content of the subject and meet some specific requirements regarding complexity, the time allotted to the activity, etc.
- The students write a report in collaboration with the Department of Maintenance and General Technical Services that the PSA Peugeot Citroen group has in Vigo.

As most of the students choose the second option, the following sections will focus on the activity resulted from the collaboration with the factory of the PSA group in Vigo.

The students have to solve a real RAMS problem that will be related either to electronic equipment or to facilities managed