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The Use of Role Playing in Engineering Curricula: a Case Study in Human-Automation Systems*

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This communication presents a collaborative experience between four Spanish centers: the School of Engineering (ETSE) and the Sports Services Area (SAF) both from the Universitat Autònoma de Barcelona (UAB) jointly with two centers of the Technical University of Catalonia, the Technical school from Vilanova i la Geltru (EPSEVG) and the Technical school in Terrassa (ETSEIAT). The idea behind this collaboration is to explore the possibility of role playing in engineering education and project development for engineering students. The basic principle of such projects is the identification of the corresponding roles associated with the different parts that can be found on current social/industrial activity. In this paper the role playing model is presented: the first part, the role of the partners, and the second part the students' role developing applied projects in human-automation systems.

Keywords: role-playing; project-based learning; human-automation interaction and satisfaction metrics

1. Introduction

There is a growing emphasis in higher education institutions on students developing professional skills that can be directly applied in industry. Important areas such as the development of teamwork skills, problem solving skills, decision-making skills, communication skills and information literacy skills have been given greater priority in response to industry requirements and greater reliance on teamwork within organizations [1, 2]. According to Luca and Tarricone, the essential skills are commitment to team success and shared goals, interdependence, interpersonal skills, open communication and positive feedback [3]. Team members need to be fully aware of their specific team role and understand what is expected of them in terms of their contribution to the team and the project. 'Teamwork skills and team member participation can often be enhanced through role-playing' as it allows for hypothetical situations to be approached in an authentic setting [4]. This is corroborated by research that concludes that situated learning allows learners to construct their own meaning and improves outcomes. Students perceive role-playing as one of the most important techniques for learning communication skills, after discussion. Role-playing scores the highest for the most enjoyable learning environment and since learning is improved if a student is motivated and engaged this is important to their learning outcomes.

Role may be defined as the way one behaves in a given position and situation. Role playing as a teaching methodology is the conscious acting out and discussion of the role in a group. In the classroom a problem situation is briefly acted out so that the individual student can identify with the characters. Role playing allows people to make mistakes in a nonthreatening environment. They can test several solutions to very realistic problems, and the application is immediate. It also fulfills some of the very basic principles of the teaching-learning process such as learner involvement and intrinsic motivation.

What is a role-play and how does it fit into the engineering education? Role-play or simulation techniques are a way of deliberately constructing an approximation of aspects of a 'real life' episode or experience, but under 'controlled' conditions where much of the episode is initiated and/or defined by the teacher [5].

Throughout the years different kinds of role-play have been popular and role-play has been used in lots of different contents. Role-play was especially popular during the 1960s and the 1970s where role-play was used in social and clinical psychology, an also in instructional and didactical theory [5]. But the use of role-play in educational research has a somewhat sparse history and especially the documented use of role-play in the engineering education is nearly none existing [6]. An educational program containing both a role-play and a preparation for

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the role-play can be used to develop all of the scientific competences. But the role-play itself favors development of the social, the communicative and the ethical competence. The interaction between the students as they play their roles in the role-play develops the students' social competence as the students become an active part of a social scenario that is different from their usual social context. Playing a role and arguing with the other students develops the students' communicative competence as they need to express themselves in a precise manner to get their arguments accepted by the other students. And finally the plot taking place in the role-play can be of ethical nature offering the students an opportunity to discuss ethical issues thereby developing their ethical competence. Some other advantages to be gained from using role-play in the science teaching is that the students actively engage themselves in the teaching and that they during the role-play reflect critically upon the subject in the role-play.

The Role Playing is used in our work as a methodological tool to provide students an appreciation of the range of issues and problems associated with engineering requirements in real settings [7]. The Role Playing strategy is a successful tool used, for example, in software engineering education [8]. Some researchers are using the game play method in engineering education: dynamic simulators combined with educational games have a positive learning effect on students in engineering curricula [9]. In order to develop an integrated framework, it's possible to improve the relationship between the Role Playing strategies inside the educational theory of Technological Pedagogical Content Knowledge [10]. One interesting approach is to establish a relationship between the use of the role playing tool and the realization of an engineering project. As an example of this, some researchers of the Carnegie Mellon University have been developing a practical Design Projects course and use a industry-based project management and product realization process approaches [11].

Among all possible different engineering curricula that can be found around (see [12] for a few examples) it is recognized the value of handsome experiments and realization of project courses. Effectively, the realization of a project, usually during the last year of the degree, allows the student to face with a somewhat large problem where he/she has to be able to tackle the analysis and design stages as well as considerations on technology for implementation. However, it is necessary to improve the relationship between university professors and industrial mentors. At the Stanford University, some researchers have been using the P^5BL framework, Problem-, Project-, Product-, Process-, People-based learning. This methodology is a project-organized activity that generates a product for a client [13].

The motivation for this communication is to show how opportunities for real world control and automation applications can be found on the immediate environment. In fact, is necessary to reduce the gap between academically practices in the classroom and the professional career of the future engineers.

This paper presents the application of the Role Playing method in engineering from the point of view of an industrial automation case study. The paper is structured as follows. First, the industrial-academic cooperation at the authors Universities is presented. Second, the engineering students' practical experiences in the role of human operators are reported. Next, a framework for metrics evaluation in human tasks and satisfaction measures are showed. The paper ends with a discussion and some conclusions.

2. Industrial-academic cooperation

The Universitat Autónoma of Barcelona 'UAB' is a Spanish campus based university with more than 40.000 inhabitants (students, academics, staff, etc). In fact, this makes the University campus to behave like a city with some sort of facilities offered for their inhabitants. Among them, the Sports Service Area (SAF) is one of the largest and with more complex installations.

Due to the evidence for the need of introducing new control elements and to integrate the different subsystems to help the SAF management staff the collaboration between both entities (SAF and the Automation and Systems Engineering Group from the ETSE School) has emerged (see Fig. 1). The interesting point is that we decided to develop the collaboration under the form of engineering projects for undergraduate students [14].

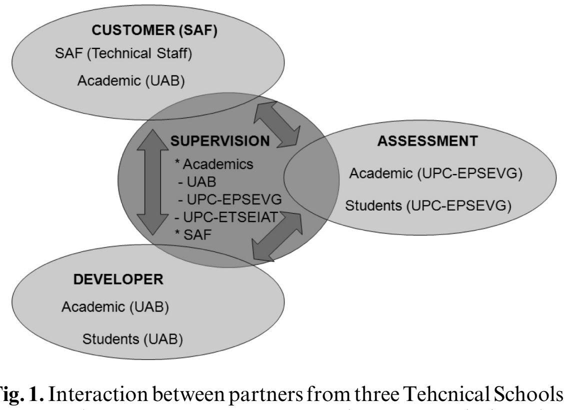

Fig. 1. Interaction between partners from three Tehcnical Schools (ETSE-UAB, EPSEVG-UPC, ETSEIAT-UPC and the SAF industrial mentor.

Each academic year, before summer, it is time to prepare the engineering projects to be developed during the next year. This way the students can look at the different offers and apply for one. From the SAF management a list of automation and control problems is first elaborated. From this list, jointly elaborated with the academic staff, a subset of problems that fit as an undergraduate project is identified and offered to the students. From this point students should apply for one project by presenting their curriculum vitae and explaining the motivation and reasons for doing such project. Once the selection is done, a first joint meeting between the customer (SAF management), Project Direction (Academic staff) and Project Developers (the students) is done.

From this point each student has a calendar of meetings (usually every 15 days) between him, the SAF management and the academic associated with the project. If any of the projects needs to collaborate with the work being developed on another project, there is a joint meeting where each one exposes their needs in order to find a joint solution.

From the described framework, the experience is now driven one step forward and a third element is introduced: the external assessment role (members from the Technical University of Catalonia 'UPC': EPSEVG technical school and ETSEIAT technical school). The motivation for the introduction of this factor and force it to be developed at a different university (therefore geographically distributed and from a different educational framework/environment) is to create an atmosphere as similar as possible to the one the students will face within their professional life. The total interacting group is therefore constituted of three teams. Each team has a leading academic and a group of students. In addition, each team has associated specific roles corresponding to the professional activity they have to play.

In this context, the SAF entity acts (and in fact it is) the customer (maintenance functions), the ETSE member is the software development group (monitoring and control interface), the ETSEIAT member provide us with the project-based learning approach and the EPSEVG member give us the human-centred automation approach. Previously existing collaboration between the ETSEIAT and EPSEVG Technical Schools provide us a framework in order to introduce active methodologies in engineering curricula [15].

The control engineering students from EPSEVG school have the following roles: software developers (in order to build new supervisory control interfaces), designers (in order to apply ergonomics recommendations for display design), project management and usability engineers (in order to prepare usability testing and measure efficiency, effectiveness and satisfaction of the SAF human supervisors).

Table 1. Competencies Required For a Control Room Operator

Potential competencies
Have a good knowledge of drills and procedures
Be able to operate control equipment accurately
Understand the theory andd application of the control process
Understand the safety aspects of control room operations
Be able to make appropiate decisions
Be able to assess a situation accurately
Be able to deal with stress and time pressure
Ensure that team goals, roles and responsibilities are understood
Be able to anticipate colleagues' requirements
Be able to pass the correct information to colleagues at the right time
Be able to notice overloaded colleagues and support them appropriately
Be able to think ahead and develop cintingencies
Ensure that colleagues maintains a shared understanding

The development of such roles is mainly based on scientific and technological skills [16]. These skills will be supervised and evaluated by the corresponding leading academic. In addition, other cooperation and interpersonal skills are to be considered. These skills will be considered by a team constituted by the leading academic members of each team and correspondingly evaluated. It's very important the relevance of effective teamwork in the successful operation of control room environments. According to this idea it's necessary to define a set of competencies, see Table 1, that a control room operator needs to accomplish.

Next section details the engineering students' activities in the role of human operators in the SAF control centers.

3. Engineering Students in the Role of Human operators

The research in team training has been focused on training the members of a team together as a composite unit. The control engineering students from EPSEVG school have the following active learners roles: software developers (in order to build new supervisory control interfaces), designers (in order to apply ergonomics recommendations for display design), and usability engineers (in order to prepare usability testing and measure efficiency, effectiveness and satisfaction of the SAF human supervisors). At the technical EPSEVG School we are trying to apply active methodologies as part of the engineering curricula. Within the MsC Engineering in Automation and Industrial Electronics, the first author of this paper is the head teacher of the Integrated Production Systems IPS subject. The internal structure of the teaching/learning process as an active cycle design with four phases: reflection,

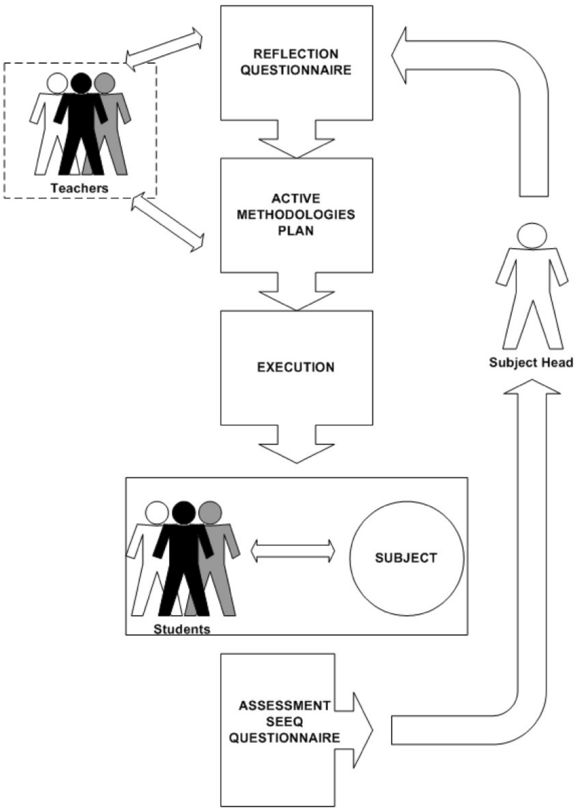

Fig. 2. Internal learning structure in a subject in the EPSEVG school. The aim is a cycle design in order to introduce a quality model in class.

active methodologies plan, execution phase and finally the assessment phase (see Fig 2). In our current situation we are trying to improve the relationship between project-based learning and the role-playing model.

At the EPSEVG School, we have a production systems laboratory that incorporates a Flexible Manufacturing System (FMS). The control engineering students works in 2-people groups. Each group plays a role within the operation of the Flexible Manufacturing System FMS and receives training on display design and systems maintenance.

The application of the Role Playing method in engineering room from the point of view of an industrial automation case study is presented in this paper in the following terms:

- One engineering student (Msc Automatic Control and Robotics from the Technical University of Catalonia) playing the role of control room designer and developing a new SAF management building offices layout in order to identify all the tasks (supervisory control, maintenance, display design and usability testing). This student made a meeting and a questionnaire with the SAF staff in order to obtain information about the physical and mental workload (see subsection A below).
- Other engineering students (MsC Engineering in Automation and Industrial Electronics from EPSEVG and ETSEIAT schools) have been using the GEDIS display design ergonomics guideline in order to improve the interface quality [17]. In these moments, one student is programming these changes in order to improve the quality of the SAF monitoring interface (see subsection B).

Finally we will present the feedback of the SAF staff and the effectiveness of this method with the aid of well defined usability metrics as well as future steps. See References [18], [19] for a more detailed presentation on display design and usability evaluation in human-automation systems.

3.1 Supervisory control task in the SAF project

After a meeting with the SAF manager staff and the external assessment in December 2008, it is necessary to indicate the SAF manager staff a set of important recommendations along the following ones:

- To train maintenance operators in supervisory control tasks (monitoring and alarm systems)
- Improvement of the feedback between the manager, the maintenance operators and the software developers
- Re-design the control center layout in order to define a control room (see Fig. 3). It is necessary to establish a single functionality for each office and translate the meetings to a meetings room.

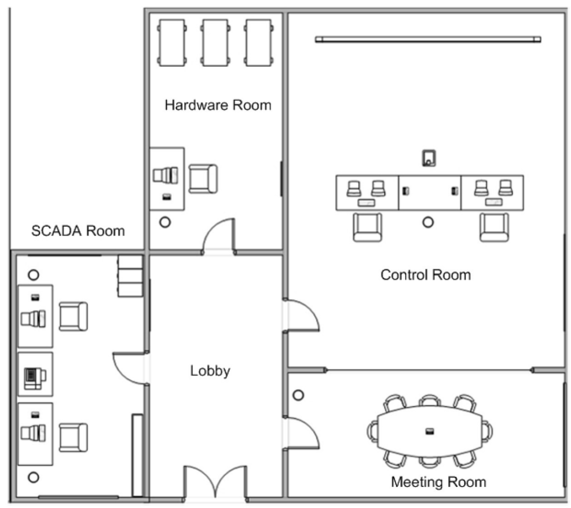

Fig. 3. An engineering student (MsC Automatic Control and Robotics) in the role of control room designer: after a meeting and a questionnaire with the SAF staff, this is a possible SAF layout in order to differenciate all the tasks (supervisory control, maintenance, display design, usability testing).

- Improve the display design quality, by using, for example, an ergonomic guideline

The current SAF center layout was constituted by a set of rooms (hardware room, meeting room and main room). In the main room, many people with different tasks were sharing the room: management, maintenance, supervisory control interface designers). The problem in this layout is the difficulty to obtain an effectiveness performance. One new solution is the re-design of the SAF centre in order to assign one function in one room (the supervisory control task inside the control room, the interface design inside the SCADA room, the collaboration between staff and stakeholders inside the meeting room, etcetera).

Inside the meeting room it is possible to develop a training program. The use of simulators to train operators is common in the nuclear industry and the sugar production factories [20], [21], [22]. In some cases the plant operator does not know enough about the process he/she is supervising or actuating upon, so operation is inappropriate. A way to help prevent these problems is to use advanced monitoring and control techniques and an effectiveness training program. The EPSEVG members are working in the development of a training program in order to reduce the distance between a control engineering student and a human operator in supervisory control tasks.

Finally, the engineering student playing the role of control room designer has learned how to work in a real industrial project and allow us reduce the gap between the University and the professional life.

3.2 SAF display evaluation

The experimental study is the evaluation of the SAF interface with the collaboration of control engineering students from EPSEVG School. Twenty five students monitored the SAF interface for around three weeks. The students define a numeric value for each indicator of the GEDIS guideline and propose interface improvement.

The GEDIS starts from the initial point of view of strategies for effective human-computer interaction applied to supervision tasks in industrial control room and constitutes a method that seeks to cover all the aspects of the interface design [17, 23, 24].

The GEDIS guide allows to elaborate design recommendations at the moment of creation of the interface as well as recommendations of improvement for already created interfaces. The GEDIS guide is composed of two parts: description of ten indicators and measure of ten indicators. The indicators have been defined from extracted concepts of other generic human factors guidelines, and for aspects of human interface design in human computer interaction. As an example, included indicators are: architecture, navigation, alarm design, use of color and text, human operator inputs, etc. The method for the use of the GEDIS guide is: to

Table 2. GEDISs Guide Indicators (Part I)

Indicator name and Subindicator name	**Numeric/qualitative range and SAF numeric value**
Architecture	**1,7**
Map existence	[YES, NO] [5,0] 0
Number of levels le	[le < 4, le > 4] [5,0] 0
Division: plant, area, subarea, team	[a, m. na] [5,3,0] 5
Distribution	**3**
Model comparison	[a, m. na] [5,3,0] 3
Flow process	[clear, medium, no clear] [5.3,0] 3
Density	[a, m. na] [5,3,0] 3
Navigation	**3**
Relationship with architecture	[a, m. na] [5,3,0] 3
Navig. between screens	[a, m. na] [5,3,0] 3
Color	**5**
Absence of non appropriate combinations	[YES, NO] [5,0] 5
Color number c	[4 < c < 7, c > 7] [5,0] 5
Blink absence (no alarm situation)	[YES, NO] [5,0] 5
Contrast screen versus graphical objects	[a, m. na] [5,3,0] 5
Relationship with text	[a, m. na] [5,3,0] 5
Text font	**3,2**
Font number f	[f < 4, f > 4] 5
Absence of small font (smaller 8)	[YES, NO] [5,0] 0
Absence of non appropriate combinations	[YES, NO] [5,0] 5
Abbreviation use	[a, m. na] [5,3,0] 3

Table 3. GEDIS Guide Indicators (Part II)

Indicator name and Subindicator name	**Numeric/qualitative range and SAF numeric value**
Status of the devices	**4**
Uniform icons and symbols	[a, m. na] [5,3,0] 3
Status team representativeness	[YES, NO] [5,0] 5
Process values	**3**
Visibility	[a, m. na] [5,3,0] 3
Location	[a, m. na] [5,3,0] 3
Graphs and tables	**4**
Format	[a, m. na] [5,3,0] 3
Visibility	[a, m. na] [5,3,0] 3
Location	[a, m. na] [5,3,0] 5
Grouping	[a, m. na] [5,3,0] 5
Data-entry commands	**3**
Visibility	[a, m. na] [5,3,0] 3
Usability	[a, m. na] [5,3,0] 3
Feedback	[a, m. na] [5,3,0] 3
Alarms	**3,8**
Visibility of alarm window	[a, m. na] [5,3,0] 3
Location	[a, m. na] [5,3,0] 3
Situation awareness	[YES, NO] [5,0] 5
Alarms grouping	[a, m. na] [5,3,0] 5
Information to the operator	[a, m. na] [5,3,0] 3

Where a = appropriate, m = medium, na = no appropriate.

analyze the indicator, to measure the indicator, obtain the global evaluation index and finally elaborate the recommendations for improvement. The computation of the GEDIS guide global evaluation index is done according to the following formula:

$$Global\_evaluation = \frac{\sum_{i=1}^{10} p_i ind_i}{\sum_{i=1}^{10} p_i} \qquad (1)$$

In a first approach it has been considered the mean value among the indicators expressed in (1). That is to say, to each indicator it is assigned an identical weight ($p_1 = p_2 \ldots = p_{10} = 1$) although it will allow in future studies to weight the importance of some indicators above others. The global evaluation is expressed in a scale from 0 to 5.

For the correct use of the GEDIS guide it is necessary the collaboration between the control room technical team and the human factors technician, since in some cases to analyze the indicator it is necessary to consider the expert's opinion.

The result of applying GEDIS to the SAF interface is a global evaluation GEDIS index of 3.4. So it is necessary to indicate the SAF designer a set of important recommendations. The ones obtained in this case are:

- Revise the relationship between architecture, distribution and navigation indicators.
- Improve the feedback between interface and human operator in data-entry commands indicator.
- Improve the location of alarm indicator.

With the GEDIS guide it is also possible to indicate to the SAF staff and the ETSE software development group a set of important recommendations about graphical screen improvements. For example, the *Piscina ACS* screen can be improved with a set of changes in color and text font indicators. Fig. 4 shows the original *Piscina ACS* screen and Fig. 5 shows the revisited *Piscina ACS* screen.

Finally, these engineering students playing the role of display designer have learned how improve the quality of a supervisory control graphical interface in a real industrial project.

4. Metrics for evaluating the human tasks

An example of methodological framework is the Process Model of the Usability Engineering and the Accessibility MPIu+a developed by Toni Granollers which gathers together all the cycle phases: requirements' analysis, design, implementation, launching, prototyping, evaluation and user, see [25] for a detailed presentation. The analysis of requirements is a necessary previous work in order to establish the best relationship among the human, the interface, and the task. For example, which is the user's profile? human in the role of maintenance staff or supervisory control operator or display designer. Another important aspect is the application of sustainable development principles through the entire design lifecycle in engineering education [26].

In the evaluation phase, and for the usability measure, it is necessary to have the contribution of the experimental studies carried out in the usability laboratories. The problem is how to define common metrics for human-automation interaction because each task and each automation system has singular properties (chemical control processes, flexible manufacturing systems, oil control processes, etc.) [27]. another problem is to determine which is the best interface, from the point of view of the user's

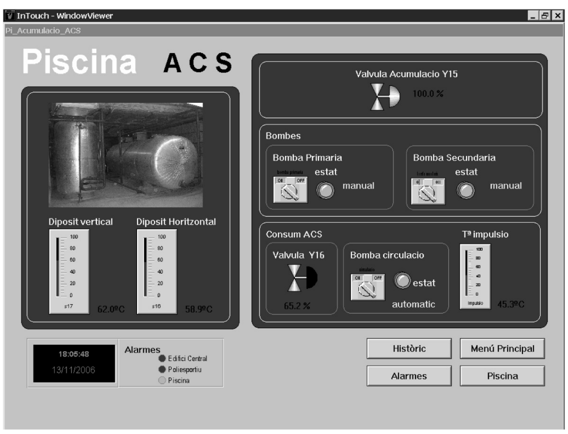

Fig. 4. Original Piscina ACS screen. The human operator can control the water quality of the SAF internal swimming pool.

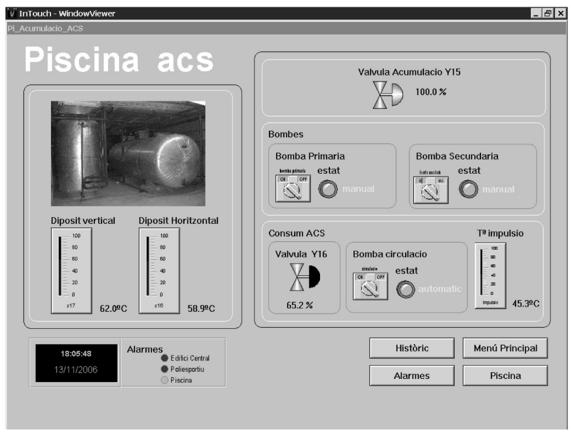

Fig. 5. Piscina ACS revisited with changes in color indicator. In Fig 4 there is a problem with the state of the device (active—green color) with the background color of the screen (green again), With the aim to facilty the human processing information is necessary a clear functionality on screen.

experience? Some interfaces are appropriate for a few users but not for all users.

In human-computer studies it is necessary to define qualitative and quantitative performance rates. Following some ideas of the experts in usability studies and field studies, the tasks presented in the previous section demand a high level of activity planning that involves reasoning and decision making. It is possible to follow different approaches: the *individual differences* approach, the *case study* approach and the *system characteristics* approach. In this paper we follow the first approach. The studies of user's differences have diverse goals:

- To find ways of predicting performance.
- To find and characterize individual variability. To find not only differences in the degree to which users are able to reach the goals, but also differences in how they perform, i.e. decision making strategies and user satisfaction.

From the point of view of usability engineering the proposed performance method can be summarized in three steps [28], [29]:

- Effectiveness measure.
- Efficiency measure.
- Users' satisfaction measure.

Effectiveness is a measure of how well a human accomplishes the supervisory control task. For efficiency measures we find the ISO definition: 'resources expended in relation to the accuracy and completeness with which users achieve goals' [30]. Effectiveness and efficiency measures are objective measures. For satisfaction measures we find user's questionnaire in order to achieve attitudes towards the use of the interface (how difficult is to learn how to use the interface, user's discomfort feelings when using the interface, etc.) [31].

Finally it is possible to define a usability metrics. The number of attributes in usability engineering is three.

Attributes A = [Efficiency Effectiveness Satisfaction]

And in the case of objectives measures, it's possible to add these attributes inside (2), when m is the number of attributes

$$Usability = \frac{\sum_{i=1}^{m} A_i}{m} \quad (2)$$

In order to study the users' satisfaction the authors have been working in two approaches. The first one is the satisfaction measure of the SAF staff and the second one is the satisfaction measure of the EPSEVG engineering students obtained by application of the above presented role playing model.

The experimental session was carried out in the meeting room of the SAF at the UAB Universitat Autónoma of Barcelona in December 2008, the two SAF staff members (maintenance head and computer science engineer) participated in an interview with a control engineering student playing the role of usability expert, they used the SAF display in a brief session in order to detect a possible device fault, and finally they answered a questionnaire about user interface satisfaction.

The questionnaire on user interface satisfaction has been based on diverse classic references in this type of tools, for example the QUIS questionnaire [32]. The questionnaire has six questions related to the task where the user answers in concordance with the scale of Likert [33] with four answer options per question. Moreover, one more question has been added where the user assesses in a qualitative way the quality of the graphic display.

The six questions considered were:

- The task was difficult to understand.
- The task has been long.
- I have been confused, without having clear what it was necessary to do.
- I needed to be very concentrated to carry out the task efficiently.
- I have been pressured by the time.
- I think that my performance has been correct.

From the point of view of the SAF maintenance head, the task is easy because he has great experience in process control and in fualt tolerant control. From the point of view of the SAF computer science engineer the task is difficult to understand as a novice user in process control and it's necessary to change some functionalities inside the screens in order to improve the quality of the supervisory control application (for example, the creation of an alarm system).

In order to evaluate the effectiveness of the venture from the educational perspective, at the end of course 2008-2009 the students from *Integrated Production Systems* subject (IPS subject from the technical school EPSEVG) answer a Spanish adaptation of the Student Evaluation of Educational Quality Questionnaire (SEEQ) [34]. Briefly, the main conclusions drawn by the student's answers are:

- The students prefer dynamism in the class: more practical problems and less theoretical lessons.
- The students prefer to increase the number of laboratory sessions.
- The students think that the workload of the Msc Engineering in Automation and Industrial Electronics is high. Usually, these students work and

Table 4. Comparison between some answers

SEEQ Category	2006 IPS Subject	2009 IPS Subject
Learning		
A4	75%	80%
Organization		
C4	55%	80%
Group Interaction		
D1	78.9%	70%
Examinations		
G2	26.3%	60%
Assignments		
H3	36.3%	80%

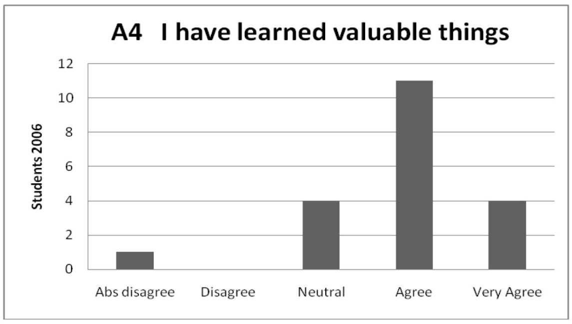

Fig. 6. The answers of the 2006 IPS students in the category Learning and subcatergory A4. The Agree and Very Agree answers are the 75% answers of the total answers.

don't have much time to do homework for their University Studies.
- The students are satisfied with the evaluation/ assessment of the subject.

The IPS subject is a 14 week course and the timetable includes the use of portfolio, oral presentation, interaction between groups, progress assessment and final technical rapport. In the IPS subject the chapters are: computer integrated manufacturing, advanced automation, human supervisory control tasks, and programming tasks with programmable logic controllers and human-machine interfaces. In the last three years the average number of students is 20. In order to evaluate the SEEQ categories (Learning, Organization, Group Interaction, Examinations, and Assignments) each category has a Likert scale: absolutely disagree, disagree neutral, agree and very agree. Table 4 shows the comparison between some answers (only Agree and Very Agree answers) between the year 2006 and the year 2009. The questions are:

- Learning: A4 You have learned and understood the subject materials in this course.
- Organization: C4 Practicum classes are useful and well prepared.
- Group Interaction: D1 The own team and the other teams are a good tool to share ideas and knowledge.
- Examinations: G2 Methods of evaluating student work are fair and appropriate.
- Assignments: H3 Practicum tasks in the laboratory, contribute to appreciation and understanding of the subject.

During the year 2006, we were trying to introduce active methodologies in the classroom (project based learning). The Fig. 6 shows a detailed answer of the learning question A4 'I have learned valuable things'. In the year 2009 we are trying to improve the relationship between project-based learning and role playing model. The Group Interaction assessment between the 2006 IPS Subject and the 2009 IPS Subject are similar (see Table 4). In the other categories of the SEEQ questionnaire (Learning, Organization, Examination, Assignment), we can observe the increase in the 2009 subject students' assessment.

5. Conclusions

This paper has presented an experience that introduces a collaborative framework for undergraduate engineering project development. The idea presented here is based on representing the existing roles present in a professional framework with the additional value of integrating players from different universities and an industrial partner that provides services to the community. It is shown, among other points, how (i) the university itself can provide the customer points of view, (ii) promote collaborative work between different individual student projects within a global large project and (iii) provide collaboration among different educational frameworks.

What should students learn in role playing projects? The students must understand the current situation of the industrial system; analyze the context and understand the students' role and the role of the other members, stakeholders, etcetera; develop an active problem-solver strategy and finally obtain a new design solution. All these objectives with the aim of improving the human-automation system.

We will continue this work with usability testing in order to measure effectiveness, efficiency and satisfaction metrics over SAF supervisory operators. From the point of view of the authors, it's possible to apply the Cognitive Walkthrough method in order to obtain an analysis' task.

The SAF staff and the ETSE computer science engineer are assessing the use of the GEDIS guide in order to introduce changes and improve the quality of the computing graphical interface.

With the aid of well defined metrics and data collection it's possible to begin a statistical analysis as a future step of our work.

Finally, it is necessary to extend our approach in order to apply these methods to other subjects of the engineering curricula, study multiple roles, such as engineer-manager and find methods that help students to move from novice to expert.

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