HANDS-ON EDUCATION WITH MARITIME IT & AUTOMATION

Lars Lindegaard Mikkelsen,
Senior Lecturer, SIMAC
Claus Walther Jensen,
Senior Lecturer, SIMAC
E-mail: cwj@simac.dk, askholm@simak.dk

Abstract. This paper describes considerations and actions taken at SIMAC to meet the pedagogical, didactic, and logistic challenges of training the ship officer students in advanced automation and (technical) maritime IT systems. At SIMAC we have been working for several years to improve the teaching areas of IT and Automation. We know from experience that studying the theory books is not always enough, and theory does not appeal to all students.

We find a project oriented model that combines theory with practice is the most effective teaching method for this area. But getting hands on in automation gives some logistic and economic problems. This well proven model is now being further developed in combination with E-learning.

SIMAC has a lot of experience with E-learning from educating technicians for the offshore industry. When we combine this experience with teaching results in automation for maritime studies, we take the best of both to form a new concept.

With background in these considerations we will work towards combined automation training based on a flexible and mobile training kit together with with a Learning Management System, containing the theoretical lessons that support the students' work with their problem based education.

INTRODUCTION

This paper is a continuation of the paper "Automation is the new challenge in education of ship officers" presented at WMTC 2009 in Mumbai by author Mr. Claus Walther Jensen. Part 1 of this paper is mainly taken from the aforementioned paper, and part 2 is a result of thoughts and further development done by the authors as follow-up research after the many positive responses from the WMTC conference.

PART 1. AUTOMATION IS THE NEW CHALLENGE IN EDUCATION OF SHIP OFFICERS

Part 1 of this paper describes the actions taken at SIMAC to meet the pedagogical challenge of training the students in automation and technical IT systems, systems that ship officers embarking modern ships will be expected to use and maintain with advanced fault-finding included.

SIMAC is a Danish education institute preparing ship officers primarily for the Danish merchant marine. SIMAC also has a department for supplementary training, where full mission simulators and well-equipped automation laboratories are part of the training of ship officers and offshore technicians.

This paper is not based on academic research, but is based on teaching experience and participation in several training projects for new-building crews, especially projects that focus on training the crew in the new IT based control and monitoring system onboard.

Automation today

Traditionally, institutes educating marine officers all over the world have trained their students in subjects like propulsion plants, navigation, safety, maintenance, management – but have not always put enough focus on Automation and IT.

Automation and IT are now part of all new-buildings, from small ships with simple alarm systems that communicate via CANbus, to sophisticated LNG carriers, which are just as complicated as a

petrochemical process installation ashore, so the process control system onboard covers several different network types, among them TCP/IP, PROFIBUS and Modbus, all communicating the process parameters between the process instruments, auxiliary units, controllers, alarm panels and the operator stations.

It is also normal to see vendors of specific maritime process equipment supply their complete units with an isolated local control system, which must then be interfaced towards the ship's main control system via defined protocols and network communication (Fig. 1).

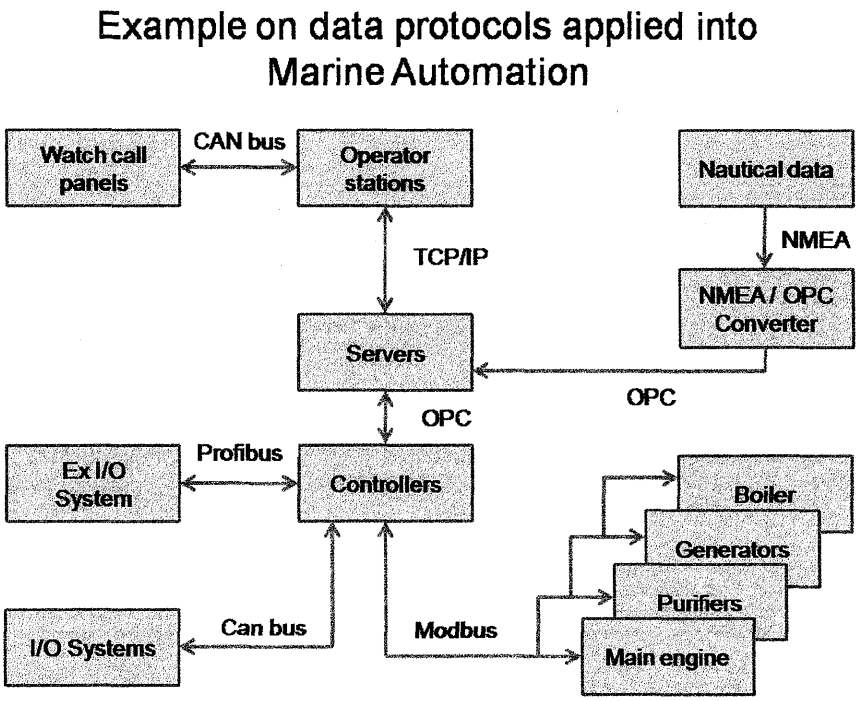

Fig. 1. Data protocols in Marine Automation

Thus a ship's network topology can be very complicated and the different technologies used for communication all have their own specific protocols; setting standards for electrical signal levels, cabling, connectors and termination. All this can make it difficult for the faultfinding crewmembers to get an overview of a fault situation (Fig. 2).

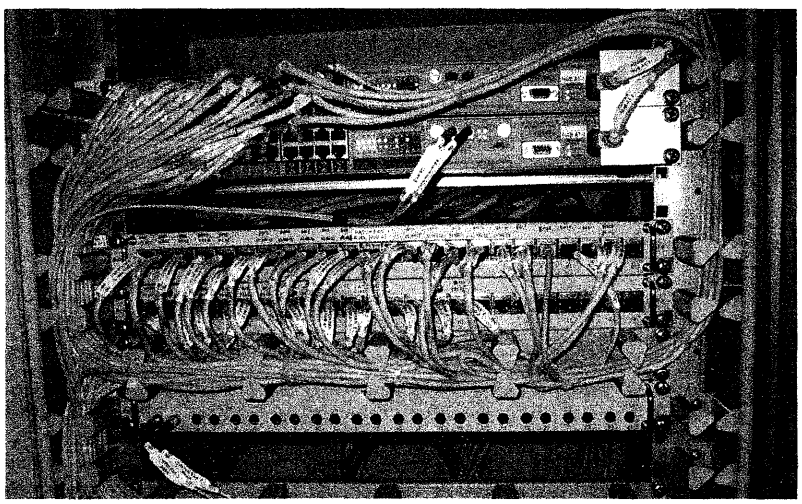

Fig. 2. Ethernet switch in the typical Control Network on a ship

The education institutes have an obligation toward their graduates, the future ship officers. The education institutes must ensure that the officers have a basic knowledge of the Automation and IT onboard and can solve basic problems on their own. At the same time, the institutes must prepare the ship officers to go into project groups concerning new-buildings and be able to discuss the level of automation and the selection of technology, and finally be able to approve the documentation supplied by the vendors, and participate in making plans for additional specific education.

Educational problem

SIMAC and other maritime academies use simulators to train students to operate advanced ship control systems. A simulator is still a very successful tool for training the operation part of the machinery installations. Simulators familiarize the students with graphic user interfaces, alarm management systems and more.

Our participation in new-building projects has shown us the need for more specific knowledge about advanced control systems. The crewmembers are nervous about taking over a new ship with highly sophisticated control systems based on advanced network technology. They complain that they are not able to fault-find in network problems since they don't have the necessary knowledge about the main components and their functions.

At SIMAC we have been teaching about the main components of control systems for a couple of years, so the students have learned about PLC (Programmable Logic Controllers), Graphic user interface, Network components and Internet technology, but always as independent topics. Because of these small-scale laboratory exercises the students have not seen the components in the right context, and do not have a complete overview of a ship's control system.

STCW and automation

The international convention on Standards of Training, Certification and Watchkeeping for Seafarers, STCW, is the main guide for all those involved in educating seafarers. The STCW is not very specific in its requirements for competences within control system objectives. The STCW code is a rather static document, while the areas of IT and automation are developing rapidly in the marine sector, so it is important that the objectives in STCW are accepted as "*The minimum standard of competences*", as stated in STCW Table A-III/2. The competences concerning control systems in STCW are specified as follows:

"Theoretical knowledge: Marine electrotechnology, electronics and electrical equipment. Fundamentals of automation, instrumentation and control systems."

These lines are of course taken out of context. They are inexact and at the same time meant as minimum requirements, so fortunately we can use them as guidelines for a very thorough automation training for ship officers. It is up to the education institutions to closely follow the technical development within this area, and to make sure that course plans and competences in house are continuously adjusted to keep up with the business community.

"Project Ship" at SIMAC

At Svendborg International Maritime Academy, we recognize the need to combine the study of machinery and electrical technology with the IT and Automation part. We are therefore in the process of modernizing our laboratory facilities to meet this new challenge.

The first part of the project was the establishment of a control system, with economic support from the Danish Maritime Fund. The topology of the control system established in the SIMAC laboratory is very much inspired by real topology diagrams from advanced ships (Fig. 3).

The result of all this modernization will be a fully automated laboratory with the most important machinery installations found on a ship. The project has been given the name "Project Ship" to make it clear that study conditions are the same as onboard a real ship.

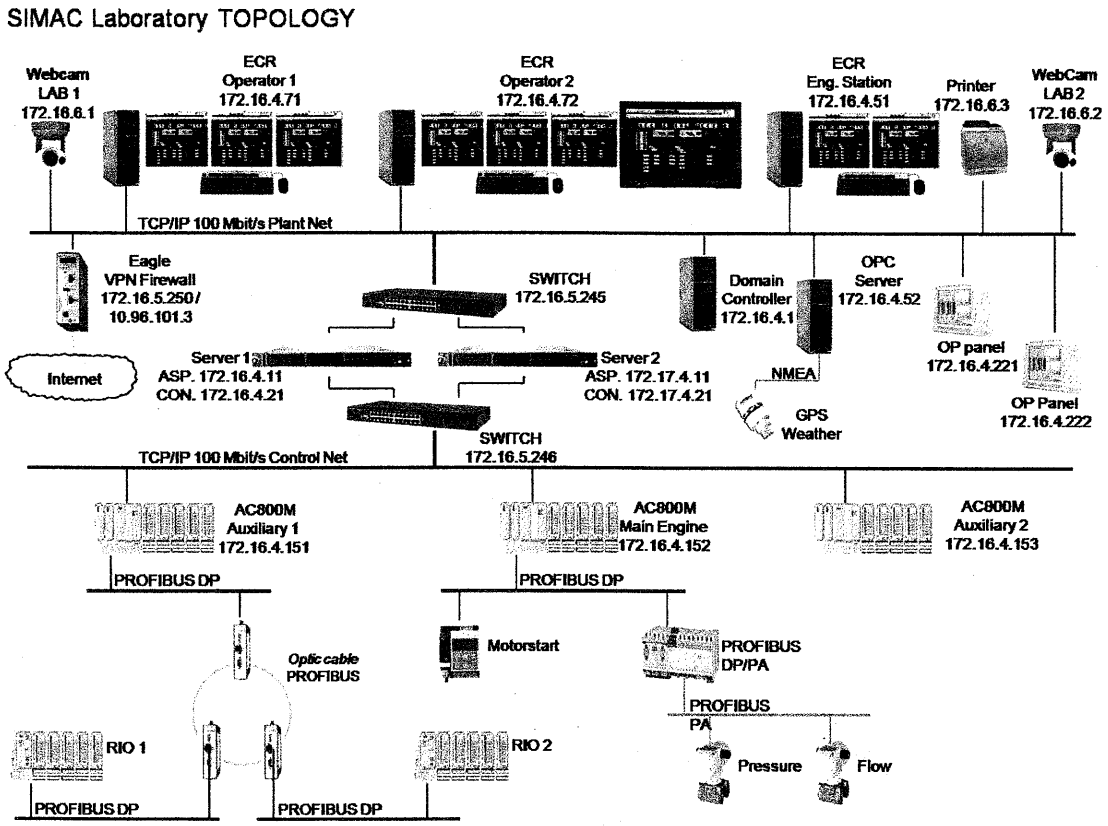

Fig. 3. Topology diagram for the control system in the laboratory

SIMAC started by establishing a distributed control system with control room and facilities for three groups of students to work at the same time.

In future we will connect all the necessary auxiliary systems to this infrastructure in the laboratories.

These facilities make interdisciplinary training possible, so the same laboratory exercises combine the mechanical, electrical, automation and IT aspects. The setup also gives students a great opportunity to define their own exercises/projects and investigate problems from new angles, using the built-in data logging and trend curve function for all objects.

The new control system makes it possible to fault-find on network technology and bus communications in a real context. The students can study the documentation and try some faultfinding exercises among the components in a real control system.

Historical process data can be retrieved from the database as well as from event- and alarm logs, so different process data can be held up against different load conditions or a fault situation, often leading to a new understanding of the possibilities with automation.

This setup will give our students an excellent opportunity to study how communication in control systems works. We set up appropriate faults to train the students to track faults and familiarize them with the main components of a modern control system.

To give the students and guests an idea of how ships could be monitored from ashore, three web-cameras have been added to the laboratory. When these are included in the network VPN connection, we hope they will encourage the students to work with projects about distance monitoring of ship installations in the future.

Students as programmers

The control programs in the controllers will be programmed by some of our students and then checked by the lecturers.

We have already completed the first part of this "Project Ship" by adapting the control system onto the B&W main engine.

This first programming job was done by two students in cooperation with a senior officer from a Danish shipping company (Fig. 4), and resulted in a project to improve the operator interface (HMI) for manoeuvring the main engine.

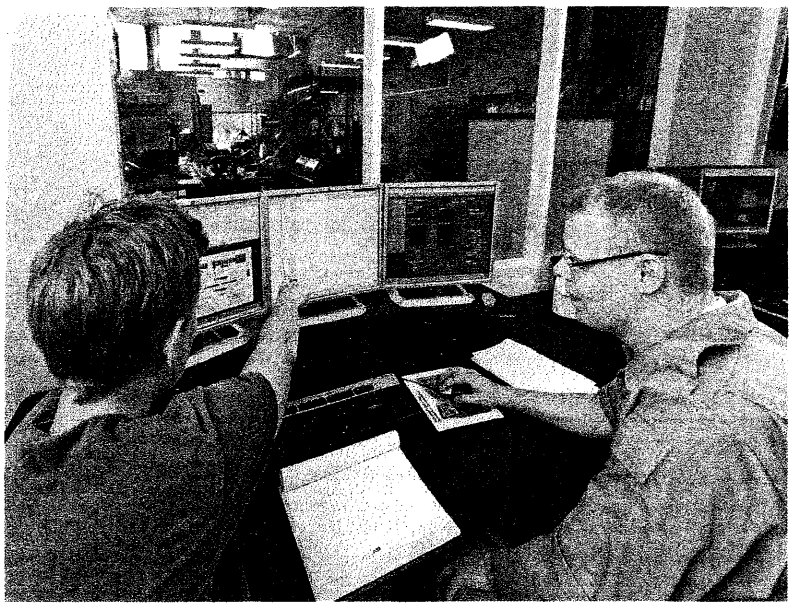

Fig. 4. SIMAC students as programmers

The start and stop program for the main engine was programmed in the programming language "Sequential Function Chart" in accordance with IEC 61131-3.

The traditional sequential process for starting the main engine is now visualized on the operator stations step by step, and each transition condition can also be seen on the screen (Fig.5).

As a result of this programming project, the 52-inch screen in the control room is now often used as a pedagogical tool to explain the necessary auxiliary systems, which must be started and monitored during the start up process.

The further phases of "Project Ship" at SIMAC consist of programming control programs for the machinery equipment and designing the user interface. These will be done by the students as part of their bachelor projects or other projects relevant to their education as ship officers. Letting the students be programmers has a positive side effect. They know much more about it, have accepted it and are now keen to get involved in the upcoming work within the project.

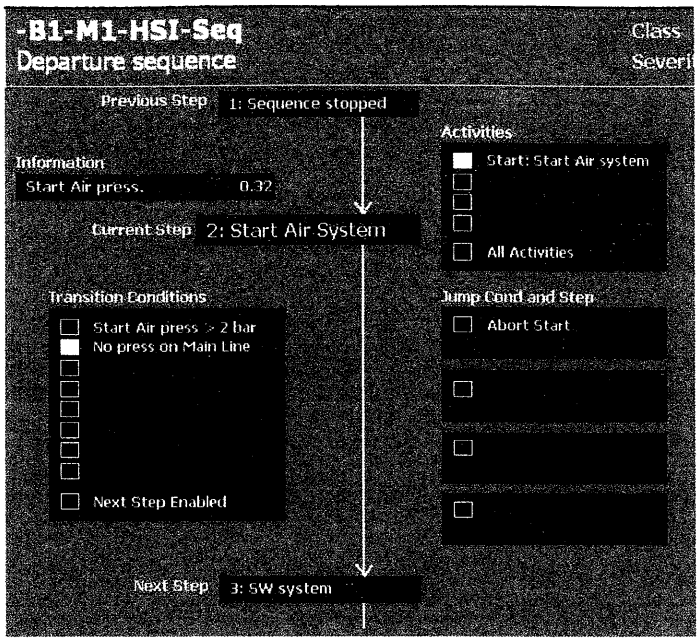

Fig. 5. Graphic presentation of sequential process

Joint venture with vendors

The modernization process in SIMAC laboratories will be a financial burden, which must be solved in partnership with maritime based companies. SIMAC offers the companies the opportunity to have their modern equipment on display in the laboratory for the maritime decision-makers of tomorrow. SIMAC offers the physical installation as well as the programming of the equipment so it will become part of the "Ship's" control system and can be used to train the new officers.

Vendors can also use the laboratory as a showroom for their customers and/or SIMAC students can participate in full-scale tests on new equipment, a clear advantage for both the students and the vendors.

Educating the lecturers

The new IT and Automation education challenge is not only a problem for the students. The lecturers at the education institutes must be educated in this technology as well, and at a relatively high level to ensure that the right methods will be used to train the ship officer students afterwards.

In Denmark there is an ongoing project set up by the "Danish Maritime Authority" to educate the majority of the lecturers at the maritime education institutes to the level of master's degree. This educational program has been a great opportunity for the lecturers to reach the necessary level in Automation and IT, ensuring that we can meet the Automation and IT education challenge.

PART 2. AUTOMATION EDUCATION SUPPORTED BY A FLEXIBLE MOBILE TRAINING KIT AND ONLINE LESSONS

At SIMAC we have been working for several years to improve the teaching area of IT and Automation. We know from experience that studying the theory books is not always enough, and theory does not appeal to all students. The majority of our students are more interested in practice. They want to dive into the technical and practical stuff and get hands on. We find a project oriented model that combines theory with practice is the most effective teaching method for this area. But getting hands on in automation gives some logistic and economic problems. The hardware and software are often very expensive. Our model starts with the teacher giving a class lesson and afterwards groups work hands on with a problem based on a case story. They configure hardware and program software, produce documentation, perform tests

and record their conclusions. They are inspired to pay attention and then work out their own solutions using marine automation.

This well proven model is now being further developed in combination with E-learning.

SIMAC has a lot of experience with E-learning from educating technicians for the offshore industry. When we combine this experience with teaching results in automation for maritime studies, we take the best of both to form a new concept. With background in these considerations we will work towards a new learning program based on a Learning Management System containing the theoretical lessons that support the students' work with their problem based education. A unique training kit that contains the necessary hardware to prove the theories provides further support. The teaching will be based on a new generic training model (Fig. 6) inspired by models from the area of software development.

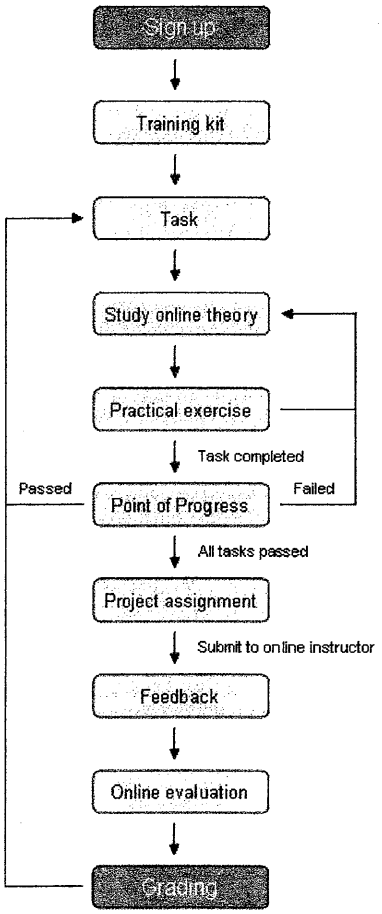

Fig. 6. Generic training model

The practical exercise will be at iterative process as a combination of theory and exercise.

Testing the training model

The combined training model has been tested by three Indian students from AMET University in Chennai, who visited SIMAC for eight weeks in spring 2009 to gain knowledge within marine automation to improve their bachelor project as marine engineers (Fig.7) Ram, Arun and Nithin followed several lessons and from there they worked on their own by following the online material on SIMAC's web server. They improved their skills by challenging each other against the tasks and the training kit.

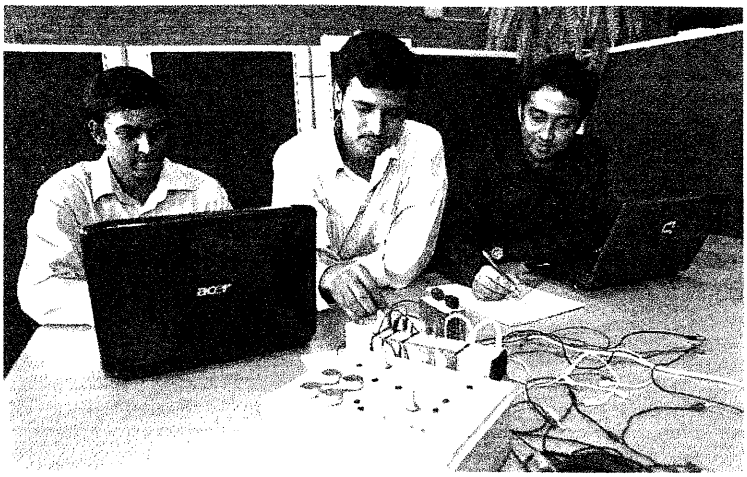

Fig. 7. AMET students working online with their training kit

The students from AMET University had a final assignment: to produce a complete automation system for a diesel driven emergency generator. Their presentation of this job for the lecturers at both AMET and SIMAC was to be done as a WEB demonstration of their work, specifically their automation system, including their WEB visualized user interface.

The demonstration took place on the 4th May 2009 (Fig. 8). The lecturers and students were ready in their auditoriums and the performance was a great success. Afterwards we had a very positive response from both students and staff of AMET University.

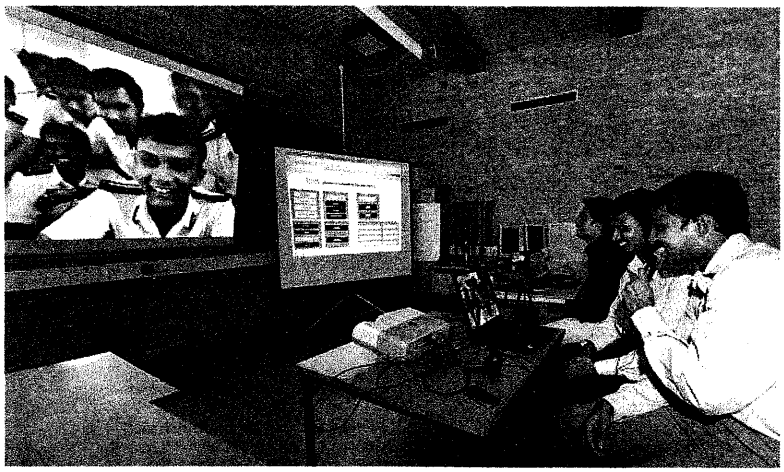

Fig. 8. AMET students presenting their work to their colleagues at AMET

CONCLUSION

Now that we have recognized the need for a thorough training in maritime automation for the students who will become ship officers, we also must face the fact that theoretical lessons are not always enough, and theory does not appeal to all students. The majority of our students are more interested in practice. They want to dive into the technical and practical stuff and get hands on. At SIMAC we have faced the facts and are working to develop the most beneficial way of improving our automation training so the students get the most out of it, but we must still consider a realistic economy. The combined learning method that supports class lessons with online lessons and the physical training kit has proven to be profitable, and will certainly be part of the education and training going on at SIMAC in the future.

The new combined training program can also be used by former students, now crewmembers, to train the skills needed in the new areas of advanced maritime IT and automation.