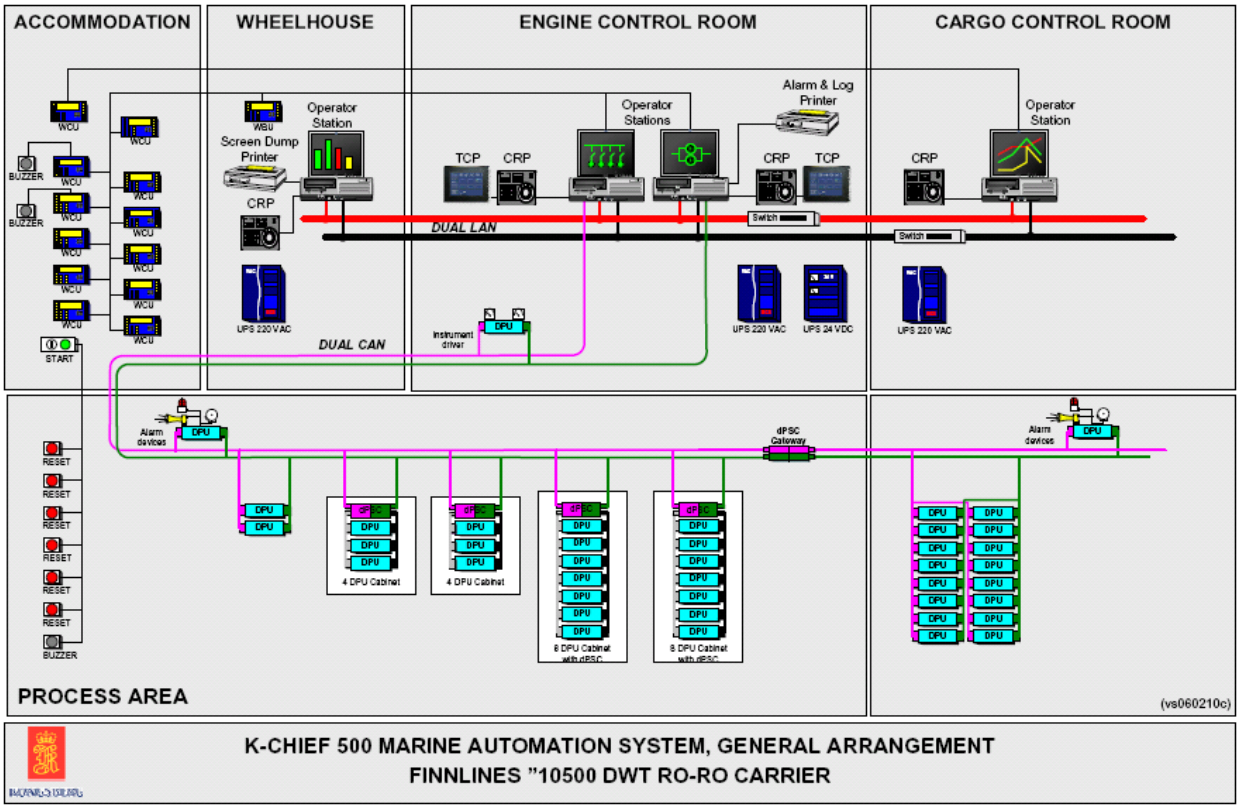
Automation is the new challenge for education of ship officers

Author Name: C.W. Jensen (Lecturer -Marine engineer , SIMAC)



How should the education institutes deal with the new challenge of educating future ship officers to deal with the increasing amount of automation and IT technology onboard? This paper puts forth some thoughts and practices designed to deal with that challenge at SIMAC (Svendborg International Maritime Academy) in Denmark.

KEY WORDS
SIMAC; Education; Automation; Control; Network; Topology;

INTRODUCTION
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, such as TCP/IP, PROFIBUS, and Modbus etc., 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).

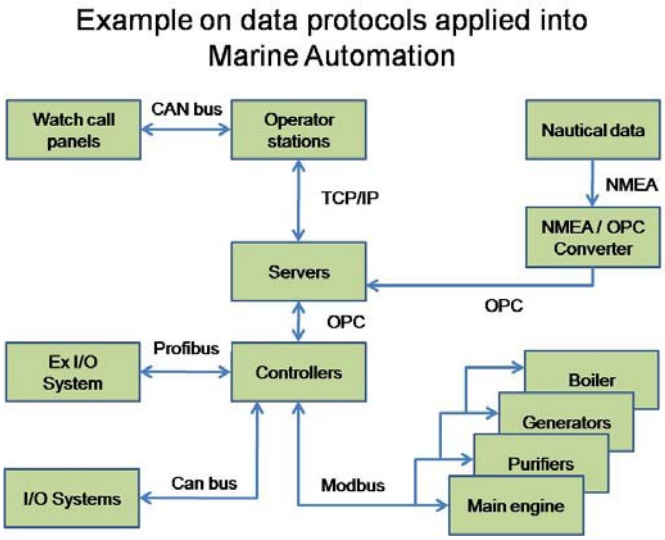


Fig. 1 Data protocols in Marine Automation

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 etc. All this can make it difficult for the faultfinding crewmembers to get an overview of a fault situation (Fig.2).

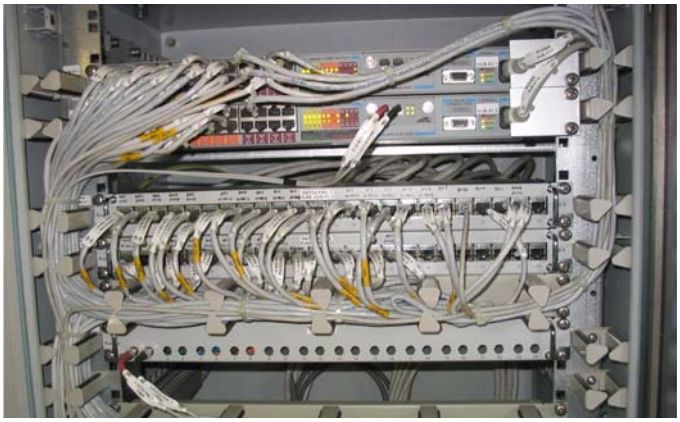


Fig. 2 Ethernet switch in the typical Control Network on a ship

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), Graphical 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 and the areas of IT and automation are, on the other hand, 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 education 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 together 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.

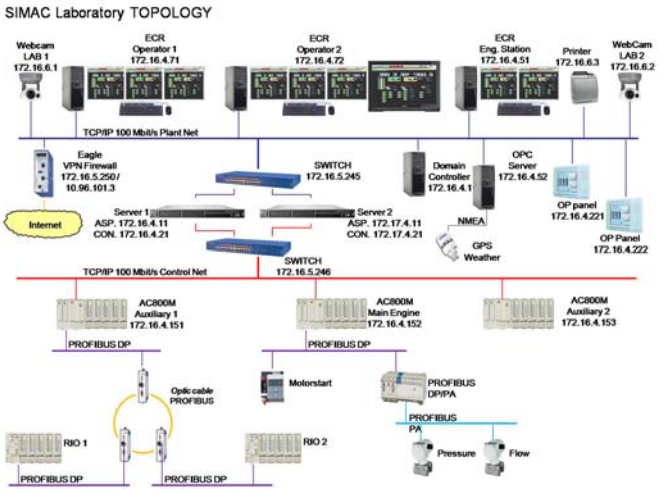


Fig. 3 Topology diagram for the control system in the laboratory

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 gives us the possibility to fault-find on network technology and bus communications in a real context. The students can study the documentation and try some fault-finding 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 pedagogic tool to explain the necessary auxiliary systems, which must be started and monitored during the start up process.

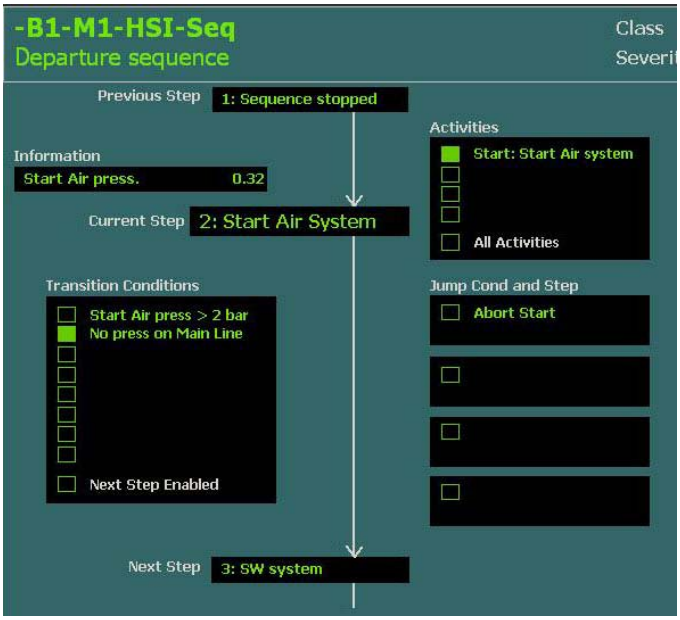


Fig. 5 Graphic presentation of sequential process

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.

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.

FUTURE

It is already possible to connect ships permanently to the Internet. The only limitations are the rates charged by the service providers and the policy of the ship-owners. The technology is here, and waiting to be applied to the operation and maintenance of a ship's technical installations.
What about having the performance data from a number of sister ships available at the ship-owners office, together with alarms and historical data concerning fuel consumption, bunkering, technical knowledge sharing etc.?
This will give new opportunities for research on the effects of initiatives to reduce costs and also on environmentally friendly activities.
We hope "Project Ship" at SIMAC will be considered when developing new methods to make use of the information that is often stored onboard the ship, but so far is never used as shared knowledge that could benefit an entire shipping company.

CONCLUSION

It seems that development in the field of Automation and IT for the maritime industry is just getting going. Shore based industries already use Internet technology in many areas and there is every reason to believe that this technology will play a major part on all ships in the future. Fuel economy, alarm response, monitoring installations, knowledge sharing and maintenance are only a few areas that will be improved by a higher degree of Automation and IT onboard. So to prepare the ship officer for the job of tomorrow, the education institutes have an obligation to train their students to operate and maintain Automation and IT installations, and also to ensure that they can take part in the decision-making process in this area of new technology, for the benefit of everyone who works in the maritime sector.