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EXPECTED ENHANCEMENT OF THE SHIP MONITORING AND CONTROL SYSTEM

SUMMARY

The international legislation places strict requirements on the safety of navigation and the marine environment. One of the solutions to the problem is to enhance the ship navigation control and maintenance with extensive use of information technology, which has largely contributed to the growth of communication technology. On the basis of an analysis of ship systems automation in the past, this paper deals with the developments and improvements to be expected in the near future. Four generations of shipboard automation are presented, including the characteristics and requirements that the automation of ship control and monitoring systems must fulfill in order to be classified under a particular generation. Fields of further enhancement are considered as these will be decisive in increasing the efficiency of business operations and ship safety. For the purpose of supporting the claims above, actual trends in the development of standards, equipment and systems have been analysed as well as their impact on the ship owner and the crew.

KEY WORDS

automation of ship control, efficiency of business operation, ship safety

1. INTRODUCTION

One of the areas that may be decisive for increasing the efficiency of business operations and ship safety is the development of new systems of management and monitoring connected to communication systems on land (shipping companies, equipment manufacturers, classification societies and maritime authorities). The ideal system of management and monitoring has to be a reliable and readily manageable system as well as a high display quality of the operator-mechanism relationship that enables the user "to see what is happening", i.e. all important information has to be unambiguously indicated, and handling has to be simple and effective. In addition, the management and monitoring system does not only simplify the maintenance work but also controls the maintenance and thereby takes part in adjusting the maintenance interval. This paper demonstrates a decrease in the scope of operations through use of ship automation systems from the first to the fourth generation. The requirements that the systems of management and control have to satisfy in order to be classified into one of the generations are pointed out. Furthermore, what other improvements may be expected in the future on the system of management and control. In order to support these considerations the authors demonstrate the current trends in the development of standards, equipment and the system itself. They also indicate the influences of these trends on the shipowner and the crew.

2. DEVELOPMENTS UP TO NOW

In the first generation of shipboard automation (~ 1960-1980) the automation of electric power production and remote control of the main engine were introduced, as well as:

- Automated regulation of circuits of temperature, pressure, levels and other dimensions;
- Automated monitoring and reacting in case of breakdown (automatic replacement of defective by correct mechanism);
- Automated introduction of standards into the engine room log;
- Performance of the main engine manoeuvres according to the demands from the bridge.

This phase is characterised by relay management and analogue regulation, there is no possibility to monitor the entire system of the engine room from a single control room, since it is not possible to transfer such a large number of readings (pressure, level, etc.) on the existing installations (copper tubes). Sensors were used and their measuring was depicted on the gauges in the control room as electric current and voltage values. That was the first step in remote reading. For the crew, this meant much more comfort at duty, which was now carried out in the usually air-conditioned control room. Though the first generation of shipboard automation brought about a certain decrease and simplification of job procedures, the high display quality of the operator-engine relationship was still not on a suitable level. There was no insight into the processes since the operator-mechanism display consisted of a large number of switches, indicators, etc.

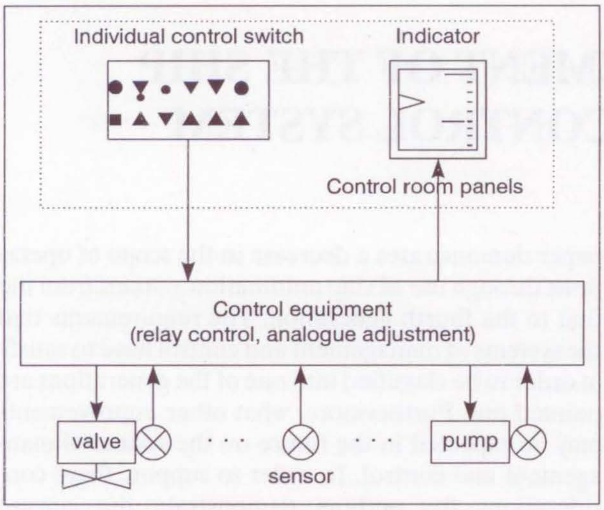

Figure 1 - First generation

The utilisation of the microprocessor further simplified the work procedure making work easier, and this resulted in the appearance of the second generation of shipboard automation (~ 1980-1990). Relay management continues, but the novelty is in digital regulation. The features of these innovations are better handling and simpler changing of parameters and function sequences, more rational utilisation of the ship power plant system and greater reliability during handling. The next step and special advantage of this new technology is the analysis of conditions. This characteristic is of importance, for example, for engine parts that are subjected to wear and pollution.

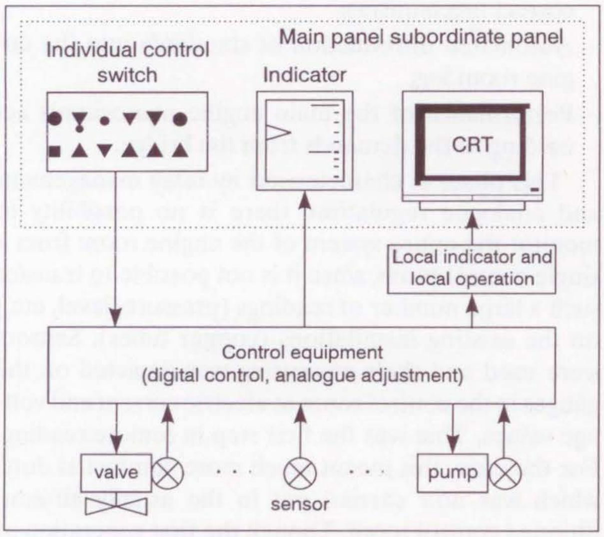

Figure 2 - Second generation

Computers are also used in monitoring systems for the purpose of working out estimates of economic efficacy and, for example, for the needs of analysis of conditions. They are also used for calculation of strength, stability, cargo loading plans, crew lists, etc.

The emergence of the third generation of shipboard automation (~ 1990-1995) comes with the use of modern work stations that brought about further significant advances:

- *Long-term data storage*. The possibility of obtaining data several days old and if necessary, data of several weeks or several months ago.
- *Expanded presentation of condition*. For the purpose of enabling proper assessment of recorded new and old data requires a modern presentation of the flow.
- *Maintenance functions*. Memorised parts of data (working hours, conditions and measuring...) and combinations of data may provide the user with precise information as to when and where maintenance is required.

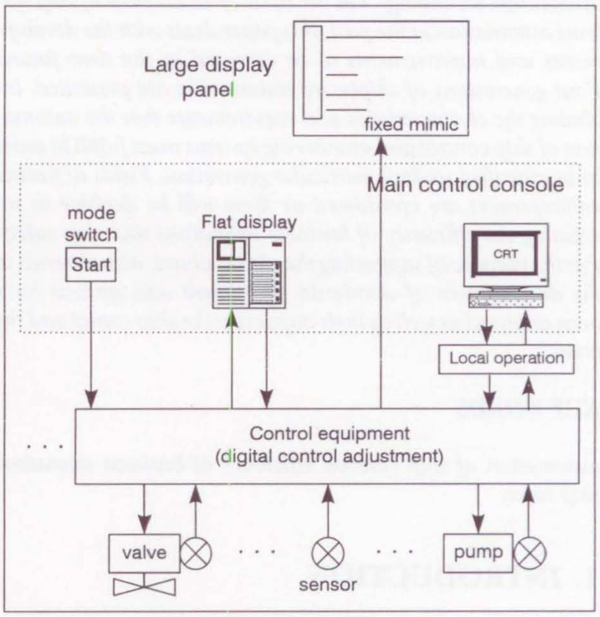

Figure 3 - Third generation

- *Improved high display quality of operator-mechanism relationship*. The first user graphic programs were more or less limited to presentation of a diagram, meaning that it was not easy to manage and quickly comprehend the processes. Workstations are also simple to use in integration and after that in exploitation. By means of a trackball and function keys based on windows and graphic high display quality, the user's work becomes simple. Visually well presented processes are easier to monitor and manage since the user sees precisely whatever is happening at a given moment. This improves work reliability. The work station should support an adjustable presentation of the diagram of such a process. The customarily selected data of the process can be inserted into the flowchart as values or symbols with a note or marked by a certain colour. With the possibility of direct intervention into the diagram, the entire process becomes by far easier to understand and manage. And since the whole hierarchy of the work concept is simply constructed, the user receives all the guidelines required for control of the process.

- *Integration of individual systems into the total system*. By means of serial attachments, individual systems such as separators, cargo, air conditioner, etc. are integrated into the total system so that they can also be remote-controlled and monitored from the workstation. The following advantage adds to the ease of remote managing of the systems since the data of these systems is also accessible as a result of integration, meaning that it can be used for maintenance and the like.

The "fourth generation" differs from the third generation because the "fourth generation" is simply a 100% integrated systemic third generation solution in which operations are performed exclusively on local monitors. The requirements that the system has to fulfil in order to be part of the "fourth generation" and its advantages for the user are the following:

- High quality of the product and high advantage of the system. This is inevitable since the user must rely 100% on the system.
- Diagnosis of defects with manual help-function. If there is a defect in the system it has to be plainly and understandably shown by the system. The help-function gives the user additional information and enables clear instructions for eliminating the defects. Thus, long and tedious search for the defect is avoided and maintenance is shorter.
- Simple maintenance by replacement of module. If the modules are defective and need to be replaced, the replacement should be as simple as possible.
- More memory space for data and evaluations. This extends the maintenance interval.
- Openness. Openness refers to accessible data structure which enables the use of the data from the system of management and monitoring in other programs and computer systems.
- Facilitating operations by a well made high display quality of operator-mechanism relationship. Since the entire operation is conducted by means of workstations, it is of utmost importance to have well indicated elements/ components process/power plant, but mainly the system of management and control must have peak graphical high display quality so that the user "can see what is happening", having as a result the user-friendly operation.

3. EXPECTED IMPROVEMENTS OF THE SYSTEM OF CONTROL AND MONITORING

In the previous chapter we got acquainted with the present-day technology and it is impressive what this technology can achieve. Therefore, the question that spontaneously comes to mind is: what further improvements can systems of management and monitoring bring us in the future?

Evaluation and interpretation of data through the use of diagnostic and expert systems

The evaluation of accessible data will be the central task in the future. Indispensable diagnostic and

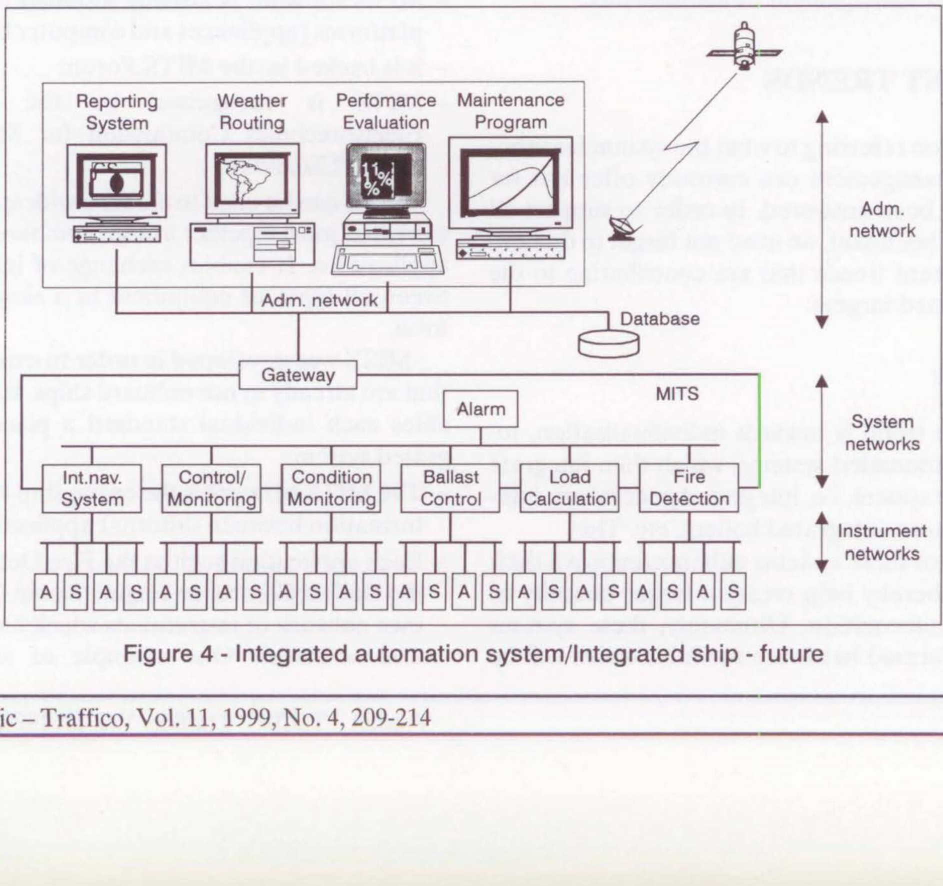

Figure 4 - Integrated automation system/Integrated ship - future

expert systems can be installed either within the system for control and management or within the main computer. In any case, these systems should help the user by giving him the required operation instructions. For example: Blackout: What should be done? Fire in the engine room: What should be done? Result: Simplified management of the system and easier maintenance.

Intelligent management of the alarm

This issue will certainly have to be considered from a wider aspect since there are many ideas on how to solve it. An intelligent system of managing the alarm should at least satisfy the following requirements:

- Obliteration of alarms that are not original (blotting out all alarms that are the cause of the previous alarm)
- Identification of defects, e.g. alarm with frequent repetitions
- Combination of different alarms into a single one or into a warning notification, e.g. measuring the temperature of engine plate on a liner ship on port and starboard sides. The alarm goes off only after both values have been exceeded.1
- An intelligent representation of alarm on the monitor so that the conditions on board the ship can be seen immediately, e.g.
- Demands for an integrated bridge. A display of all parts of the system and an intelligent alarm indicator. Result: user-friendly operation.

Anticipation of performance

Finally, the system could autonomously evaluate future work/ship capacity as a whole and prepare procedures for operating on such a basis (expert system). Result: simpler management of maintenance.

4. CURRENT TRENDS

The question referring to what the system for monitoring and management can currently offer has for the most part been answered. In order to support all that has so far been said, we must not forget to demonstrate the current trends that are contributing to the above mentioned targets.

4.1. Systems

Today, the trend is towards individualisation, towards small automated systems, which then integrate into the whole system, i.e. integrated generators, integrated separators, integrated boilers, etc. The

producers of these systems enhance/improve their systems and thereby help create a larger quantity of high quality information. Ultimately, these systems will have uniformed hardware modules which will be programmed by different software (standard IEC 1131). This will enable the fulfilment of the wishes of shipping companies for a unified onboard hardware (as much as possible) for the purpose of simplifying maintenance and storage of spare parts.

There is a rapid increase in the use of communication links between actuator and sensor, since their application lowers costs. Standard communication links, due to their simple structure, are a guarantee for easy installation, and the same cable also transmits feedback as well as data, thereby decreasing the cost of materials and installation, enabling fast and simple inspection.

The application of this technology will provide additional information. Further advantages for the user are: simple structures guarantee easier handling and an increase of operational reliability for permanent monitoring.

4.2. International standards

MITS (Maritime Information Technology Standard) has developed as a plain and cheap solution of the problem of connecting equipment of different producers into a unique ship system of management. The other characteristics are:

- this is a safe, simple and cheap access to maritime information
- this is a complete tool for integrating of ship systems of management
- it is open and independent of the seller
- it is based on standard industrial components.

MITS software is transferable and is easily installed into existing or new equipment

- MITS software is already installed on most ships' platforms (appliances and computer based systems)
- it is backed by the MITS Forum
- MITS is recognised by the International Electrotechnics Commission for Standardisation (IEC TC80/WG6)

MITS can be used to create a widespread ship network that joins together a large number of operational applications. It enables exchange of information between all types of equipment in a simple and direct form.

MITS was developed in order to expand standards that are already in use onboard ships. Its structure enables each individual standard a place in the integrated system.

- The MITS network is the entire ship exchange of information between different applications
- Each application such as the Fire Detection Alarm, the Ballast Control or Engine Room Control has its own network of instruments which includes sensors and actuators. One example of an established

instrument network standard is the NMEA 0183 for navigation.

- The majority of modern ships have a greater number of PCs for administrative purposes that are integrated into the Administrative Network and conected by modem to the coast or to other ships.

The MITS characteristics enable the buyer and constructor of the integrated system of management to choose the best solution for every part of the system. MITS enables all components that are compatible with MITS to mutually co-operate.

What does MITS offer from the viewpoint of the shipowner and crew?

Shipowners:

- *Reduced costs of establishing the system*. MITS is open and standardised. Each part of the equipment can use a single cable, regardless of the producer. MITS compatible standard reduces costs of installation and inspection.
- *Reduced maintenance costs*. MITS stimulates the use of usual components for equipping the system of management. There is greater compatibility between different producers and maintenance costs can be reduced.
- *Improved training of crew members*. MITS compatible producers co-operate in creating safe and simple working procedures. This simplifies the system and enhances the crew's qualifications.
- *Less dependency on the supplier*. MITS provides combined and integrated equipment from various producers. Upgrading is also simplified, regardless of the producer.
- *Expanded quality of the system*. By use of a single integrated network with a smaller number of less specialised serial leads reduces complexity and makes it more robust.
- *Increase of ecological safety of the ship*. Better systems (based on components by MITS compatible producers) reduce the probability of working errors and general failure of the system. This contributes to the decrease in the number of accidents.
- *Chain integration of maritime traffic*. The use of standard industrial equipment facilitates the connecting of shipboard computers to systems on land or on other ships.

Ships' crews:

- *Permanent high display quality of operator-engine relationship*. MITS producers have agreed on the basic principles for displaying the operator-engine relationship. Simplified operation with different types of equipment, including computers used for administrative work.
- *A decrease in monitor screens*. Applies standard industrial protocols to enable integration of management functions of a larger number of producers onto a single monitor. This can to a great extent reduce the number of monitor screens on the bridge.
- *Safer ships*. The permanent display of operator-engine relationship and the added new functions (diagnostics, simulators, etc.) reduce the number of user's errors. The new functions may be used for quicker troubleshooting before an accident happens, thereby increasing the ship ecological safety.
- *Integration of administrative tasks*. Facilitates gathering of status data from the system of management and uses the data for administrative purposes, e.g. maintenance planning and reporting on the condition of the ship.
- *Easier maintenance*. Using standard industrial components makes maintenance and repair an easier task. Communication protocols enable simple remote access to the ship by qualified servicing personnel from anywhere in the world.

The standards and trends herein mentioned enable the fulfilment of this vision in the near future:

- Forming and connecting the system should be simple;
- Information from individual systems should be accessible in optimal format;
- Graphic display of management with options and operation instructions;
- Maintenance instructions;
- Documents with instructions for exercising;
- Other information from producers.

5. CONCLUSION

It is impressive what present-day technologies can achieve to carry out the modern demands of shipboard work. The progress in communication technology makes possible the extensive use of information science technology which will bring further improvements to the system of management and monitoring in the future.

Systems of the future do not have to be much more expensive than conventional systems, for, after all, "standard" components may be used. It is important that the shipowner, the shipyard and the supplier of equipment develop the concept as early as possible, during the project planning phase directed specifically to the type of ship and its requirements. Errors in this phase can later be corrected, but at a very high degree of effort and investment. Particular attention should be directed to maintenance strategies along with the support of producers, then, to the development of programs for anticipation of performance and development of diagnostic systems within the system for control and management. This would facilitate the actions of crew members in complex situations and simplify and expand the efficacy of inspection by classification societies and authorities.

SAŽETAK

OČEKIVANA POBOLJŠANJA SUSTAVA UPRAVLJANJA I NADZORA NA BRODU

Međunarodna regulativa sve je stroža u pogledu sigurnosti plovidbe i zagađivanja okoliša. Mogućnost rješavanja problematike leži u poboljšanju funkcija upravljanja i održavanja broda uz široko korištenje informacijske tehnologije što je omogućio napredak u komunikacijskoj tehnologiji. Na osnovu prikaza automatizacije brodskih sustava u prethodnom periodu u ovom radu razmatraju se poboljšanja koja se mogu očekivati u bliskoj budućnosti. Razvoj automatizacije na brodu prikazan je kroz četiri generacije. Dane su karakteristike pojedinih generacija i zahtjevi koje sustav upravljanja i nadzora mora ispuniti da bi pripadao određenoj generaciji. Razmatraju se buduća područja poboljšanja sustava upravljanja i nadzora koja će biti odlučujuća za povećanje efikasnosti poslovanja i sigurnosti broda. Da bi se poduprla navedena razmatranja prikazana su i trenutna kretanja u razvoju standarda, opreme i sustava, kao i utjecaji na brodovlasnika i posadu.

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