High-level management functions in MET

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ABSTRACT

Recent trends in MET in Croatia show a significant increase in the number of requests for courses dealing with high-level management functions and which are dedicated for the top-level onboard personnel. These requests, primarily from well-established shipping companies, are well defined in respect of the curricula and duration, with clear goals and, as a rule, exceeding the scope of the STCW 95 convention. Basically, they are intended to improve various management capabilities of the onboard personnel such as team management, resource management, handling of sophisticated units, units with unusual characteristics or in a particular environment, etc.

Such courses have been held at Faculty of Maritime Studies, University of Rijeka, over past two years. Based on the experience already gained in such courses, the paper discusses their general structure and main features as well as their advantages and drawbacks, as seen by teachers and lecturers. Particular attention is paid to feedback and comments from responsible persons in shipping companies. Also, the possibilities for inclusion of the content and experience into the regular education are discussed.

Finally, a proposal for the unification and standardization of such courses, particularly in respect of their syllabi, duration and main objectives is presented and offered for discussion to IAMU members.

1. Introduction

The main goal of shipping industry since its beginnings has been to produce as high a profit as possible under given (international) market conditions. The profit is the *raison d' tre* of shipping industry and, at the same time, the principal propulsive force demanding application of the technological advances.

The main restrictions come from two different sources: the first is inherent in any business activity, i.e. it is the consequence of business competition between shipping companies, while the second is the consequence of the influence exerted by the state to shipping, particularly in respect of the safety of life and maritime environment protection. Beside these two main sources, there are several other sources that influence maritime sector to a much lesser extent.

During the last decades, maritime transport has been under a constant and complex change, both in the organisational and technological sense. The main driving force for this change is, above all, a fierce competition among shipping companies and port operators on the global scale. In such circumstances, the winner is the one who is capable to offer the service on lower price. Consequently, it has forced large operators to exploit as much as possible the economy of scale — on one side it resulted in building larger and faster ships and on the other it resulted in the merger of shipping companies and the offer of common services wherever it was possible.

In order to make shipping more cost-effective it was necessary to introduce a sophisticated technology on board wherever it promises higher competitiveness and profitability. All these factors taken together exerted additional pressure on ships and their crews — the margins for deviation, both in time, space and expenses, become very narrow.

At the same time, the basic shipboard organisation and the supporting educational system did not follow these changes. They are mainly inherited from the 60's when the shore cargo technology as well as bulk of the world fleet was on a much lower technological level than the typical vessel of modern times. These differences have increased the operational workload, which in turn results in a decreased level of safety and a higher probability of maritime accidents and pollution. As a consequence, the number of accidents does not decrease to the extent it was once expected.

Obviously, negative consequences arising mainly because of increased workload of ship officers and ratings are already recognized by a number of shipping companies. The probable solution is sought out in additional education for their masters and officers, particularly for those with management responsibilities.

2. The influence of technological advances on shipboard organization

The new technological devices or systems could be introduced on board ships in two different ways depending on the purpose of such a device or system.
If the primary task is to improve the level of safety and/or pollution prevention it would be first recommended by IMO or, to a smaller degree, by national authority. If such device or system proves its efficiency, it will be formally standardized and confirmed mandatory on worldwide level by its inclusion in the appropriate international convention such as SOLAS or MARPOL. An example of such approach is the AIS system, recently made mandatory by amendments of the SOLAS 74 Convention.[1]
The devices or systems intended to improve commercial efficiency of the ship could be developed by independent ventures and offered to ship owners directly or through shipyards. Sometimes, they could be developed on ship owner s request in order to solve the particular problem. In any case if, after some time, their commercial efficiency is proved, the device or system becomes a standard part of ship s equipment. The same principles apply not only to the particular device but also to the new and more efficient construction features such as ship s hull design or new type of propulsion. In such case the organization acting on behalf of the government has to verify that the novelty does not interfere with the functionality of other safety systems as required by the international conventions.
Whatever development approach is used, the developer will try to make such a device or system as applicable to various ship types as possible. As a consequence, such devices or systems usually offer a wide variety of options and capabilities. Moreover, in order to operate correctly they more than often require thorough understanding of underlying principles, additional education and/or training of the crew. In the case of sophisticated equipment dedicated for the control of complex technical systems, the probability of undesired interferences among various components or with already installed equipment is also increased. A good example of such system is the cargo control system on large chemical tankers where numerous pumps, valves and other equipment have to be simultaneously operated and controlled by one person from one room, demanding prolonged periods of high mental concentration.
Probably the most important factor affecting shipboard organization is the increased number of sophisticated devices that have to be used concurrently. Thanks to modern technology there is usually clear distinction between actuators i.e. parts of a device that actually carry out intended function, such as pumps, generators, lifting devices and winches, and their control units that are usually centralized on several locations. The most probable locations where control units are concentrated and could or should be monitored and/or triggered simultaneously are the ship s bridge, the engine control room and, depending on a ship s type, the cargo control room.
From the operator s viewpoint, all these control units are sources of information about present and future status of the technological system he is trying to control and could be divided in three main groups:

- indicators, showing the current status of the particular process,
- controls, used for activating or deactivating different control functions,
- alarms, used to indicate that value of the monitored function has outreached predefined limits.

Each of them requires different mental and physical activities of operator controlling the process, and supplements information he can obtain directly by using his own senses — mainly by looking and hearing.
Indicators require a constant monitoring and comparison with value deemed to be correct. The supposedly correct value depends on knowledge about the controlled process and previous experience with the particular system or operation. If there exists a difference between actual and supposedly correct value the operator has to decide what action is appropriate to decrease the observed difference. Before any remedial action is taken the operator has to take into account other influences such as the reliability and accuracy of the indicator, the delay time, the extent of difference, the probable consequences on other components of the system and so on. Beside a technical device, a source of observed value could be even an experienced seafarer. The typical examples of indicators are the temperature of exhaust gases, the distance from the pier (for example observed by a mate during an approaching manoeuvre and reported to the master) or pressure created by a cargo pump during discharging operations.
Controls are used to change the status of a control device in order to change the rate of progress of a technological process. The most basic types of controls are on-off switches, multilevel controls or continual controls. As a rule each control will, if it is operational, change the status of the process after some time and in order to be used correctly the operator must be aware of this time delay. A number of controls require that some other conditions be fulfilled. The example of such control is the rudder. The delay before the course starts changing after rudder is put aside depends on ship speed — higher the ship s speed will cause decrease of response time. The example of conditional controls is a switch for hydraulically operated valves. The valve can be opened or closed if the pump is already operating and the pressure is high enough. Some shipboard controls do simple technological action(s) but others could change the way of operations of complex subsystems. The example of such system is the bridge

propulsion control. The simple pull or push of a control lever will produce changes in operational status of numerous technological units in the engine room.
Alarms are generally self-activated devices or a part of the control unit. They are activated when measured value exceeds the predefined limits indicating conditions that could jeopardize the proper operation of the whole system or its subsystems. They can be categorized as subclass of indicators that requires immediate corrective action and as such they are always equipped with more or less disturbing sound and/or light signals. In many cases the level of disturbing effect could be twofold or even threefold. The example of such approach is the fire alarm system — after an indicator detects fire-like conditions, the alarm system will signal it by sound and light; if after some time the operator does not accept this initial signal the general alarm will be raised. It has to be emphasized that in particular circumstances the effectiveness of built-in alarm functions could be significantly decreased. For example, in case of major malfunction when a number of alarms are activated simultaneously it is not easy to recognize what went wrong.
From the above examples it is clear that with increased number of control units on the spot the operator s workload is also increased. It has to be emphasized that it is not only the number of control units that counts. It is also their more or less ergonomic design, different operational conditions, a site layout and a relative position in respect to other units, information payload and significance, importance for the particular operation, a number of different options, etc.
And, as it can be concluded from recent trends in electronics, computer science and other related technologies, the number and complexity of sophisticated onboard equipment on a standard ship would probably increase. Consequently, it can be expected that in the years to come, even greater part of the time will be spent on controlling and regulating various instruments and devices, thus changing the way in which the ship is managed.

3. The analysis of the shipboard management functions

The complex operations that require a synchronized and coordinated work of several persons are not a novelty in shipping. Probably the first such operation was the berthing and unberthing manoeuvre of the ship. Other excellent example of such operation from the past is setting up and lowering down the sails on large sailing ships, particularly clippers.
But, there is a significant difference between those operations and complex operations on modern, much larger ships. On the ships from the past all activities are performed by the seafarers who can adapt to different circumstances. The person who controls the operation, usually the master, personally monitored the advance of each sub-activity and change the order of executions if necessary. The number of persons on board was for the most part sufficient. The number of operations in which the available time is a critical factor has been relatively small.
On modern ships the conditions are quite different. The majority of operations are activated and executed remotely from control stations. The knowledge on local circumstances is in many cases limited to what indicators are showing. The outcome of an activity is rarely observed immediately after its execution starts off. More than often the order of execution cannot be changed once it starts. The number of available replacement seafarers with necessary knowledge, skill and experience is very limited. And probably the most important difference, the number of time critical operations is much higher than in the past.
The direct consequence of an increased number of complex systems on board and conditions existing at the present time is that the majority of routine operations have to be carried out not by one person but as teamwork with clear division of duties and responsibilities.
Before any further examination it must be noticed that seafarers presently take on several different roles: they are acting as a part of the communication chain, sometimes they only collect information, in some cases they control some less demanding sub-process and sometimes manage overall progress of an complex operation.
The person on board is used as a part of communication chain in the cases when there is no direct link between measurement device and control post or it is not functional. It is usually a monotonic and time-consuming task. As communication device the simple VHF radio is usually employed. The necessary skill is a sufficient command of the working language.
Information collection by the human operator is used when adequate measuring devices are not available or does not exist. Depending on the complexity of an operation the necessary knowledge, skill and experience could be highly variable. Typical examples are estimating a distance between the ship s bow or stern and a pier during a berthing manoeuvre, measuring a distance and bearing from an object during navigation in narrow waters, draft measurement or provisory checking of cargo weight during loading/unloading of bulk-carriers. In many cases information collection assumes informing on current status of some parameter, usually to higher-ranking person, depending on their importance and previous standing orders.

Controlling sub-processes includes usually a number of different lower to middle level tasks that have to be executed during regular working time. Each of them taken separately does not produce significant workload but taken together they can, in certain circumstances, increase the operational workload above the acceptable level, thus endanger the safety of a ship. Typical examples include executing navigational or engine room watch during expected sailing conditions, monitoring the simple loading/unloading operations and regular maintenance duties. In many cases in order to carry out such tasks it is necessary to use more or less sophisticated equipment and several subordinates. The necessary knowledge, skill and experience highly depend on type of ship, equipment used, external conditions and complexity of particular task. In the STCW convention this group of tasks are identified as operational level tasks.

The traditional definition of management defines it as the effective use of resources to achieve the organization s objectives. Following this definition high-level management tasks on board should include all activities in which, in order to be successfully completed, it is necessary to simultaneously use the sophisticated equipment and a number of operators coordinated in space and time. In that respect it is to a certain degree a more restricted definition than traditional one since it as resources requires a number of different devices of witch at least some of them are sophisticated and a number of persons using that equipment. In addition, primary because of limited human resources on board, it is assumed that their knowledge, skill and experience are also at different levels.

High-level management tasks are characterized with multiple possible progress paths, each of them more or less equally successful. Which one will be followed, has to be decided well in advance. Furthermore, execution of the majority of these tasks follows the more or less formal plan. A good example of such approach is the cargo plan that in traditional way describes the final stage of cargo loading. Some other tasks, for example the berthing manoeuvre, are executed in accordance with personal preferences (style) of the person who executes them. And the last group of high-level tasks are externally formalized tasks. The good example of such approach is a repair and maintenance procedures that are, as a rule, prescribed by shipping company wishing to harmonize them across the fleet.

In reality, all the above characteristics of management functions are more than often mixed in various proportions as a result of national tradition, market conditions, the ships type, the prevailing service area and established practice and experience. However, basic high-level management functions are more or less clearly recognized and described in the STCW convention as obligatory functions or competences required for the highest duties on board in both deck and engine room department.

4. High-level management functions in MET

The very basic goal of any maritime education and training (MET) institution is to prepare a would-be seafarer to do his duties as skilful and competent seafarer. In order to achieve this goal any MET institution has to start with basic knowledge and primitive skills and then to upgrade this capabilities up to the target level. If future seafarer is not supposed to do the highest-ranked duties then high-level functions could be omitted. But, on the other side, if a future seafarer is supposed to assume the highest-ranking duties he has to be trained in the organization and management of the most complicated operations.

In order to be successful, such training can begin after some basic conditions are satisfied. First of all, it has to start after all traditional knowledge and skills regarding ship s construction and equipment are mastered. Second prerequisite is a thorough knowledge of basic working procedures that are assumed for target level of responsibilities, the most important being duties executed during navigational or engine watch or cargo handling. In other words the candidate must be proficient in all tasks that can be and usually are carried out as single-person tasks.

Being able to perform management functions assumes use of several important concepts. The first of them is resource management. The basic condition for successful resource management is a clear objective of what has to be accomplished (for example, to berth the ship alongside). The second condition is a clear idea about existing or potential restrictions regarding available technical facilities, equipment and human resources with particular attention to resources reusable under specified conditions. Examples of restrictions are the fuel available, the accuracy of the navigational equipment or the number of available seafarers with necessary knowledge and skills.

The second concept is time management. It is based upon particular restrictions such as the total available time for whole operation, time available for each task, time of availability for a particular resource, and conditional restrictions including as the most important the impact of the available resources to the available time for the particular task and vice versa. Examples of particular restrictions are time when tide is high enough to permit passage and time for tank cleaning with built-in equipment while examples of conditional restrictions include time for position fixing using different navigational aids or time needed for repair work using onboard or shore workforce.

The next concept is task management. It basically cover up the selection of the appropriate task order in cases in which several orders are equally possible as well as mutual impacts of various tasks that can or should be executed concurrently. For example, various strategies in respect of the task management could be easily noticed in loading/unloading sequences on large chemical tankers or container vessels.

The last concept is cost management. It covers costs of the overall operation and of the particular task. Usually, it is defined as achieving specific goals using the minimal financial resources. Examples of cost management are utilization of shore equipment or tugs in such way to create the minimal costs for ship owner.

In order to attain all the previously stated management capabilities it is necessary to apply a proper pedagogical methodology. It seems that the most appropriate learning methods are learning by example, as a first stage, and by experience, as the second and final stage.

Learning by example includes fictitious and/or real examples in which the student can clearly observe all or most of management capabilities. It could be done in several steps. The first one could be a complete cause — effect analysis of several selected cases. It has to be carried out by an instructor who should pinpoint particular learning objectives in each case, particularly identification of resources and their restrictions, time constrains, evaluation of tasks and other possible conclusions. The second step should be the same analyse carried out by students themselves. The outcomes should be verified by the instructor and discussed among students. And the last step should be analyses of cases presented uncompleted where students are required to complete the sequence.

Learning by experience could utilize several pedagogical methods such as games, role-playing and simulation. It any case, they have to promote a common spirit and clearly emphasize a need for close cooperation among group members (for examples see Klippert, 1998). Therefore, each of these methods should be limited to the group work while single-person involvement should be avoided. While games are well suited to encourage the spirit of teamwork, they treat each group member as equally important which is rarely the case in real situations. In that respect the role-playing could be treated as a good compensation since it resembles this aspect of real situations more closely. While scenarios for games do not need to be from maritime milieu, scenarios for role-playing should be selected from real-life situations as much as possible.

Learning by experience could be best exploited using simulators. In that respect the most typical and high-quality simulations could be easily created and carried out using full mission bridge and engine room simulators. However, the simulation should strictly follow the selected scenario until the final objective is reached while every person involved should stick to its role. Otherwise, the simulation lesson could diverge into exploration of visual capabilities or technical features of the equipment. Additionally, each lesson should start with brief introduction into the scenario and conclude with debriefing. If time permits it, the same scenario should be repeated with same group but in various roles and then followed by comparison of outcomes. However, the simulation as a learning method can be used not only for typical tasks such as navigation and engine room watch but also for other learning objectives when availability of dedicated simulators is not necessary required, for example for crisis management or commercial operations of the ship.

The high-value of additional training of ship officers to act as team members has already been recognized by a number of well-established shipping companies who recently start to send increased number of their officers to MET institutions with request to attend courses usually designated as Bridge Teamwork Management (BTM) or as Bridge Resource Management (BRM) course. The BTM course usually follows a curriculum broadly described in the book issued by the UK Nautical Institute and its primary target is to educate ships officers how to carry on their navigational duties as a team. The BRM course origins from human resource management principles as applied by SAS Flight Academy as part of their safety training.[2] It is a worthwhile to note that, since these courses are not required under revised STCW convention,[3] crew managers often prefer to modify a suggested curriculum in order to better customize the course in line with their need. Examples are a company requesting that all exercises during the BTM course have to be carried out using models of VLCCs and a company who requests instructors to simulate circumstances in which their ships already had a collision. Beside those two courses, there is also a third course with a very similar curriculum defined by the IMO as the Model Course 1.22 - Ship Simulator and Bridge Teamwork.[4] Various topics on bridge team management are also added to the revised Model Course 1.09 — Radar, ARPA, Bridge Teamwork and Search and Rescue.

It has to be emphasized again that higher-ranking officers apply the core management functions not only during safety related operations but also in various degrees during most other operations such as maintenance and repair, search and rescue and loading/unloading operations. Therefore, it would be reasonable to include management education and training in the regular curricula for all students enrolling in high-level MET institutions, particularly because a number of ex-seafarers continue their careers on the shore, often at management-level jobs. In order to be successful the subject should be harmonized and standardized at international level. Since it is not reasonable to expect that general management topics will be included in the STCW convention in next several years the most appropriate international forum for this task is the IAMU as the prominent international body committed to high-level maritime education and training. The subject should consist of the general management topics and after that the specific topics for deck and engine departments. For the present seafarers the management capabilities should be acquired in form of short courses whose duration, necessary equipment and curricula also have to be standardized.

5. Conclusions

Over the last two decades, a number of various sophisticated devices installed on board has significantly increased, resulting in the considerably increased operator s workload. Consequently, the number of operations that have to be executed by a coordinated group of officers and ratings has also increased. In order to successfully carry out such tasks and indirectly to maintain at least the present level of maritime safety, pollution prevention and commercial efficiency the higher-ranking personnel must be familiar with general and specific management skills, particularly in resource management, time management, task management and cost management. Probably the best way of acquiring required skills is by applying the learn by example and learn by experience approach based on pedagogical methods suitable for group work. For students in high-level MET institutions the core and specific topics should be delivered in accordance with harmonized and standardized curricula, preferably developed under the auspices of the IAMU, while for the present officers on board the necessary knowledge and skills should be acquired through standardized short courses.

Endnotes

[1] For example, the inauguration of the AIS system has been made as a proposed requirement for ADS system announced to be mandatory for ships sailing to Prince William Sound. See Fairplay, 1st October 1992

[2] The course started in cooperation with several maritime organizations back in 1994.

[3] The BTM course is already included in some voluntary inspection schemes, such as CDI and Shell.

[4] This model course is presently under revision.

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