Evolution in the training of RNN Marine Engineer Officers
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Abstract

The introduction of the information age brought about considerable changes in the professional world of the Marine Engineer Officer RNN. The traditional training program entailed a combination of military subjects, general education and technical subjects. Naturally a seagoing practical training period was the final integrating exercise. The introduction of the computer in its various shapes created a totally different automated world, where knowledge based systems assist in controlling complex energy converting machines, where information is widely and readily available and where the intellectual technical work more and more is carried out ashore. The marine engineer is confronted with complex systems, dominated by management problems related to the operation of ships. He has to change from technical problem solver to technical manager.

The new curriculum presents, based on fundamental knowledge and understanding of mathematical and scientific subjects, systems science, economics, logistics, human resource management, energy transformation systems, operational research and a management based practical training period at sea. Naturally the military subjects and the general education have been preserved, but in a modernised way.

The complete training programme takes nominally 5 years. The first 3 years are presented in the Naval College. The 4th year is divided in a half year seagoing training period and a half year technical management at the Naval College. The 5th and final year is a combined Naval College and University of Technology programme. Students graduate (bachelor level) in one of the following subjects: PlatformSystems, Maintenance Engineering, Maritime Electrical Energy Systems, Production Operational Management and Maritime Materials Engineering.

The modern marine engineer in the RNN will be a Scientific Educated Operational Manager of Technical Systems. He will also have the intellectual base to find his way in the maze of the uncertainties of the future.
Challenge

Educating aspirant marine engineers poses a real challenge. The shaping process of the curriculum is dominated by various conditions. One has to realize that today's aspirant will serve in a future Navy.

This future Navy is composed of present generation ships, operated in present organizational conditions, but also of future generation ships in future organizational conditions. If one could restrict the curriculum to the conditions of the present, then things are very straightforward. The challenge appears when the future is taken into account. Predicting the future seems impossible. The only real possibility to that effect is recognizing present trends and extrapolate those trends. So one goes out and explores developments in society, in particular those in the fields of science and human behavior. Then one translates the findings to Naval conditions. Perhaps then the basic conditions for a curriculum can be defined.

Designing a curriculum then is a rather complex process, selling the curriculum to those who are supposed to deliver new subjects and approaches and to those who are the traditional clients is really complex and difficult. One has to avoid revolutionary changes. Evolution is the key-word!

In the exploratory phase it was found that a shift from the dominance of the tools towards the dominance of the organizational conditions takes place. Apparently the development of mechanical systems drifts away from conventional technology towards, in theory already known, but in practice infant technology. (e.g. from diesels and gasturbines towards fuel cells and Stirling engine).

The consequence of this trend is that new ways of system building have to be found. It was found that again electrical propulsion arrives at the scene, thereby opening ways to disband mechanical reduction gears and introducing the powerplant concept on board ships, where the shaft is just one of the powerplants clients, competing for energy with weapon systems. It was found that electronics were applied to automate the traditional way to deal with machinery. It is a happy development that systems design seems to prevail and automation concepted from there. It was found that society is changing. Information on about everything is readily available to whoever. This is resulting in new classes, being those who know and those who don't.

Translating these terms via a marinization process to the old curriculum resulted in the realization that at speed the technical emphasis should change to technical management and that a systems approach is necessary.

Profiles

The education and training of the marine engineering officer has to be related to the present and in the future expected professional roles. So these roles have to be assessed for the present and at forehand defined for the future. What is the reason of being? In my opinion, shared by a majority of my predominantly junior marine engineering colleagues, the marine engineering officer provides for the mobility of the fleet. What is mobility and what are the activi-
ties to take place in order to provide for this.

Perhaps mobility is the capability to transport seapower to whatever location on the globe where it is required. Mobility then is the indispensable transportation function in a chain, originating ashore and ending somewhere at sea. The RNN defines this transportation capability in house (staff requirements), plays a key role in the development, is guiding in the building process and definitely maintains and operates the capability.

The marine engineering officer should in order to assure the transportation capability, be able to translate fundamental and technological insight and knowledge to organizational conditions. This as well as on the level of the organization of the Navy as on the lower levels of parts of that organization. Even more, he contributes to the realization of his Navy's future in a process in which "Technology" appears to be one of the instruments.

So the marine engineering officer has during his career to perform in basically two different roles. In his younger years he applies operational concepts, made up by his predecessors. His understanding of the nature of these concepts is important when practical problems fail to be resolved by standard receppee like procedures. He has to function in a military world, set by the conditions of existing organizations, social relations and jurisdictions. This world is very recognizable and can be tackled by a very standard set of professional training mechanisms. In climbing the ranks and getting older he arrives in a world in which foundations have to be laid for the shape of his future Navy. And if he is very successful he arrives at the stage where actual decisions concerning the future Navy are taken. One can say that he will travel from actual technology towards future management. One can say that he departs from a recognizable world towards the world of future shaping political coloured uncertainty.

Tools

In my opinion the marine engineers role over the years has always been the provision of mobility, in present or in future times. This regardless the tools available. Still it is quite interesting to analyse the role of the tools in the marine engineers world. Going back to 1824 when steam propulsion was introduced in the RNN the tools played an all important role in the shaping of the marine engineers world. The imperfect tools required disproportionate maintenance and control efforts. No wonder that the marine engineers corps consisted of artisans. A small number of uniformed and non-uniformed artisans and scientists managed to improve the tools. These processes were leading to generations of "technical orientated" engineering officers, who's primary task was to improve performance of machinery and aiming at substantial higher payloads of weapons and sensors. A high degree of perfection was reached when the gas-turbine made its appearance in combination with digital control mechanisms.

This resulted in a shift from mechanical dominance towards electronical dominance, still developments being steered by technological conditions. The result being the transportation of the major workload from the ship to the shore. The shipborne engineer became a system overseer.
The solving of difficult problems was entrusted to shorebased specialists, who could interven, thanks to advanced communication equipment and the traditional requirement of top-down hierarchical control, almost at every time. The traditional technological approach to problem solving resulted in an abundance of sensors, datalogging systems and control systems. Apparently the engineer had found the solutions. A short visit to a modern frigate reveals a control centre where a watchkeeper controls his world from behind a computerscreen. He is able to present an abundance of data from thousands of different locations in the complexes of technical systems. When data on his screen turn red he has to assess the cause of the problem, thereby depending on his training in abstract thingking.

Perhaps he even needs a specially prepared problem solving routeguide. It is even possible that he interactively can challenge his control system in an attempt to find a better solution than his software producing shorebased collague. Meanwhile he realizes that the mechanical equipment as installed on board has become very reliable. This perhaps to such a degree that the need for problem solving is dominantly restricted to the addition to his traditional mechanical world, the electronical information generating world.

Hovering over this world it is quite easy to see, that again, as has been done since 1824, the love affair with the tools has shaped the way in which the modern engineer provides mobility.

It was in the sixties that the training, until then from a concrete nature, became "Rickovered". This process was assisted by the national Universities of Technology. The "Rickovering" shaped the curriculum according to the rules used by the Universities. Eventually strong tendencies of copying the University curricula could in the early years of this basic change not be avoided. This because there was no experience in building a scientific based curriculum and also because the new staff hired had their roots in those Universities.

The result nowadays is that Universities at home as well as abroad recognize the educational "bachelor" level. This without a formalized Bachelor Degree Course. In many aspects the curriculum prepares the aspirant marine engineer for a Msc Course. In itself this was a good development, in any case as long as the RNN was unable to fly solo in the scientific world. However it is realized that the goals of the curriculum are not by definition to produce Msc-degrees. The main goal is the production of scientifically educated marine engineers who are able to cope with problems as they originate in their Navy.

Again, the world as it traditionally was has not changed! The tools changed! The educational process of the marine engineer over the years was determined by the repair-control trade. Machinery became more complex, control shifted from homo sapiens to homo chippiens and the curriculum shifted from technical instructen towards technical university. The base line of all this was and still is:technology.

A future Marine Engineering Officer

Let us imagine the life of SubLt(E) Ian Magine. He is at present taking the
marine engineering course at the RNN. He will graduate August 1996. From then on he will join the fleet and be confronted with ships systems supplied with a complex automated data- and control system. One of the for this responsible developments is the birth of the information age, facilitated by the chip. Computers became smaller and more powerful. They replace humans in the control functions. Ian discovers that he is a junior manager in a maintainers organization. To his enjoyment it appears that damage control exercises require his personal skills in data acquisition, in data processing and in managing people.

Meanwhile he wonders why in this automated world the damage control equipment handling so strongly depends on non automated human beings.

It seems to him that apparently nowadays only low risk machinery enjoys computer control. It also looks to him that build-in automated controlled redundancy enjoys the same low risk assessment.

In his time at the Naval College he was never really theoretically prepared for this fixed world, so he thought. However there were three seagoing apprenticeships confronting him with the world called "Navy". During those months he learned the ins and outs of naval organization, of naval persons, of ships behaviour and of machinery whether they were mechanical, electrical or electronical.

It is a rather abstract exercise for him to see the underlying value of his fundamental scientific orientated technical study. He realizes that this particular education allows him to understand the bits and pieces in a short time. Even he is able to understand why particular operational rules have been designed.

As a manager in an operational technical environment he has to deal with sensor generated machinery data, he has also to deal with the generation of management data, to feed the various management information systems, designed to oil the shore facilities in planning maintenance, in running the logistic engine and in producing the proper salty breed of engineers. To him it is normal practice that direct satcom links with the shore people allow a dense flow of information. Being educated on an abstract level it disappoints him that the real decision making dominantly takes place ashore. He realizes that his real intellectual work is done when the software has not been programmed for a particular event. Then his abstract capabilities allow him to generate a solution. In cases where he is unable to do so he can always ask somebody by satcom. In his silent moments he wonders how this is going to be in wartime, possibly nothing will change he wonders.

Next to his task of machinery MD, he handles maintenance schedules, to plan for the expected and the unexpected. He compares actual spares stocks with desirable stocks, of which the levels have been established by somebody ashore and been based on abstract consumption models, beyond his comprehension. So his years pass by. He climbs the ranks, functions in various shoreduties and seagoing duties until he arrives at higher staff level.

All of a sudden he is in a new job confronted with the task of participating in a ships design team. His new world is far of from the fixed environment of his younger years. It appears that a totally different set of circumstances guide his team. The team is confronted by technological opportunities that were non-existent in his younger years. The political environment has changed and calls
for different roles for the Navy. The industrial base has fundamentally changed, requiring cooperations of new partners. This even accelerated by political change. The environmental lobby is replaced by accepted political environmental positions requiring definite restrictions to emissions of gases and energy. Sociological change in society brought new standards in habitation and comfort. The whole design process appears more open to the scrutiny of every powerblock that manages to involve itself. He works now in a transparant cage on a job under conditions that can hardly be balanced. He now feels the need of hovering above his problem. He wants to discriminate the different levels of importance. He wants to assess the relative value of the various systems, he wants to assess the relative value of different solutions, he wants to find the balanced integration of the various solutions under the different and difficult set of conditions.

Then he thinks again about his training at the Naval College and discovers that his training was satisfying in the fundamental sense, but he could have done better with added organizational skills, with systems science and fundamental training in the being of automation.

He could have done better with fundamental knowledge in dataflow management, enabling him to discriminate between value levels of information. He realizes that technology provides tools to be used in systems designed on a higher level of abstraction.

The curriculum

The yearly intake of aspirant marine engineers consists of two different types of candidates. Traditionally there are the Secondary Educated. For them the curriculum takes 5 years. Then there are the Polytechnic-Graduates who follow a 2 year course.

The 2 year curriculum.

As any Naval curriculum, also this one starts with the process of painting in Naval Grey. Very intensively the aspirant is confronted with Naval culture. He learns to recognize tradition, rank and elementary military skills. Then his theoretical life takes a start. As is the case for every aspirant Naval Officer the General Officers Course is a substantial part of the curriculum.

This course contains subjects like organizational sociology, human resource management, management science, logistics, Naval history, Strategy and Politics. Since he is a Polytechnics graduate it is assumed that his intellectual development in specific fields is up to standard.

Then a comparison between his Poly curriculum and the Marine Engineers curriculum leads to the assessment of subjects still to be dealt with. The aim of this part is to exercise on an abstract level in subjects not previously read, but essential to the educational aims. In case he read electrical subjects at the polytechnic then this part will consist of power engineering subjects. Thermodynamics play an important role with regard to acquiring insight in total energy systems. The approach to diesels and gasturbines is from the propulsion sys-
tems point of view. He is presented with the process conditions of the system, whereby process conditions of the machinery play a supportive role. He learns the difference in operating Naval ships from Merchant ships. He is presented with an overview in the opportunities offered by digital tools, used for automation purposes. Finally he will follow two practical courses. One in fuels and fuel treatment and one to prepare him for his apprenticeship of 10 months on board a frigate. Graduation means, that he exchanges his after 14 months acquired Slt(E) rank for a Ltjg(E) rank and is assessed as a worthy member of the marine engineers officers corps. His curriculum is basically technology orientated, preparing him for the fixed world. Subjects read in the General Officers course open for him the way to further management orientated junior positions.

The new 5 year curriculum.

Joining the Navy upon graduation at a secondary education implies the midshipman status. He starts, as does his Polytechnics colleague with being painted in Naval grey. Then his life as a marine engineering student starts. His curriculum is divided in 3 parts. The first two parts take 3 years in succession. There is the extensive General Officers Course, taking 1 year and spread out over the first 3 years of the curriculum. Subjects dealt with are Naval organization, organizational sociology, human resource management, law, management sciences, logistics, strategy, politics and military skills.

The second part is the scientifically based Professional Education. This part takes 2 years, spread out over the first 3 years of the curriculum. The aim of this part is to prepare the midshipman for the concrete dominantly seagoing jobs in the early years of his career. The midshipman reads mathematics, physics, thermodynamics, shipbuilding, ships stability, control engineering, automation and electrical- and mechanical machinery. In contrast with his preceding colleagues for him artisan activities on the lathe and the drawingboard are activities from the past. Computer Aided Design, control technology, automation lead him to a modern world. The end of the first and of the second year are characterized by a 2 months sailing period. The first period introduces the midshipman to Naval life on board. The second period gives the opportunity to explore fundamentals of personnel and machinery in the engineering branch.

The Professional Education is finalized by a course in fuels and fuel treatment preceding a course to prepare him for the 6 months apprenticeship time as Slt(E) on board a frigate.

The aim of the apprenticeship is to offer the Slt(E) the opportunity to express himself in independent jobs like officer of the watch in the machinery control room as well as on deck in port. This apprenticeship is supported by a taskbook containing an extensive set of tasks and questions. The Sub succeeds when his superiors sleep well when he is on duty.

The 3rd part is the so called graduation part and takes 1,5 years. This period is aimed at acquiring a broader scientifically based perspective from the marine engineers world. The Slt takes a number of subjects connected to technical management and to his graduation theme. The technical management subjects are taken at the RNN. There are systems science, economics, logistics, operati-
onial research and reliability engineering. These subjects related to his graduation theme can be taken at the RNN or at a University of Technology.

He finalizes his curriculum study by performing graduation research in principle at the RNN in a subject selected from the abundance of unexplored problems a Navy possesses. It is one of the most important aims of the graduation project to synthesize the various disciplines as are relevant to Naval practice, to translate the synthesis to scientific solutions to operational Naval conditions. This offers ample opportunities to relate technology and tools to technical managements solutions. Upon graduating he will be promoted to LT(E) and will join the Marine Engineering officers Corps as a qualified member.

Above is referred to LT(E) Ian Magine. He is a role model for the marine engineer. Projecting all required requirements on him alone is unrealistic. One has to educate a compilation of marine engineers who share between them the required capacities.

**Assessment**

It is impossible to feed back the Navies experience with the curriculum as a whole. As far as the concrete part is concerned, the early years of the career on board of ships give an abundance of opportunities to feed back. It is for the more abstract scientific part of the education that one has to wait for feed back years after the relevance for that has been in existence.

So both ends, being curriculum design and future curriculum requirements, will never meet. One can just try and work hard in an effort of narrowing the gap.

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