From Single Task to Full Mission Simulation

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Capt. Stephen J.Cross, FNI
Senior Advisor
Norcontrol Systems as.
Horten, Norway.

INTRODUCTION.

With the continuous further recognition and application of simulators for marine training purposes, the need for some kind of categorization of types of simulators has become apparent.

The classification of simulators drafted by IMSF and submitted to IMO for consideration in the revision of the STCW convention is highlighted and explained, related to applications and the relevant learning objectives.

As technology advances and a multitude of software based simulation programmes are becoming available, it also seems useful to make an inventory of requirements justifying the use of full mission, operational (meaning real life-size) simulation equipment and the obvoius higher investment required.

Even though radar functions or ship images can be presented on any type of VDU and clever advertising lets one believe that any basic processor can be designated a "full mission"simulator, there are numerous written and unwritten arguments and requirements which have to be remembered before making choices as to suitability of simulation equipment.

A distinction of these arguments and requirements can be made as follows:
factual requirements, pedagogical requirements, practical requirements.

The factual requirements refer to existing publications of rules and courses.
The revised STCW Convention code dictates a number of mandatory applications of simulators as well as the possibility to use simulators to show proof of competency of certain described skills and functions.
As there are very few shipboard skills to be performed on pc keyboards it seems obvious that the appropriate simulator systems meant will be reallife hands-on replicas of ship systems in practice.
As to the pedagogical requirements, aspects stated here are commonly accepted ideas and principles retrievable in all standard literature and based on own experience and education.
The practical requirements are observations and conclusions based on experiences, both own and of colleague lecturers and mariners.

Even though emphasis is placed in this paper on radar and bridge simulators as this is the oldest field where the greatest number of simulation systems are available, most of the arguments presented will hold for other areas of maritime simulation as well: engine room, cargohandling, gmdss, vts.

In conclusion this all will enable a better understanding of the possibilities belonging to each category of simulators, which in turn will give better insight into the pro's and con's of each level and so offer the objective arguments for identifying equipment requirements for both training courses and competency assessment and proficiency testing.

1. FACTUAL REQUIREMENTS

1.1 STCW 1978 / REVISED 1995

REGULATION
Regulation I/12
Use of simulators
1.The performance standards and other provisions set forth in section A-I/12 and such other requirements as are prescribed in part A of the STCW Code for any certificate concerned shall be complied with in respect of:

1. all mandatory simulator based training
2. any assessment of competency required by the STCW Code which is carried out by means of a simulator
3. any demonstration by means of a simulator of continued proficiency required by the STCW code

PART A MANDATORY STANDARDS
Section A-I/12
Standards governing the use of simulators

General performance standards for simulators used in training:

2 "be capable of simulating the operating capabilities of shipboard equipment concerned to a level of physical realism appropriate to the training objectives....."
3. "have sufficient behavioural realism to allow a trainee to acquire the skills appropriate to the training objectives"

General performance standards for simulators used in assessment of competence:

2 " be capable of simulating the operating capabilities of shipboard equipment concerned to a level of physical realism appropriate to the assessment objectives....."
3. "have sufficient behavioural realism to allow a trainee to exhibit the skills appropriate to the assessment objectives"

Radar simulation:

4. Radar simulation equipment shall be capable of simulating the operational capabilities of navigational radar equipment which meets all applicable performance standards adopted by the Organization.....

ARPA simulation:

5. ARPA simulation equipment shall be capable of simulating the operational capabilities of ARPA's which meet all applicable performance standards adopted by the Organization.....

Section A-II/1
Mandatory minimum requirements for certification of officers in charge of a navigational watch on ships of 500 gross tonnage or more.
Table A-II/1

Function:	*Navigation at the operational level*
Competence:	*Use of radar and ARPA to maintain safety of navigation*
Competence:	*Maintain a safe navigational watch*
Competence:	*Use of radar and ARPA to maintain safety of navigation*
Competence:	*Respond to emergencies*
Competence:	*Respond to a distress signal at sea*
Competence:	*Manoeuvre the ship*
Function:	*Cargo handling and stowage at the operational level*
Competence:	*Monitor the loading, stowage, securing and discharging of cargoes and their care during the voyage:*
Function:	*Controlling the operation of the ship and care for persons on board at operational level*
Competence:	*Maintain seaworthiness of the ship*

Methods for demonstrating competence: examination and assessment of evidence obtained from..... approved simulator training where appropriate

Section AII/2
Mandatory minimum requirements for certification of masters and chief mates on ships of 500 gross tonnage or more
Table A-II/2
Function: Naviagtion at the management level

Competence:	*Plan a voyage and conduct navigation*
Competence:	*Determine positionand the accuracy of resultant position fix by any means.*
Competence:	*Determine and allow for compass errors*
Competence:	*Co-ordinate search and rescue operations*
Competence:	*Establish watchkeeping arrangements and procedures*
Competence:	*Maintain safe navigation through the use of radar and arpa and modern navigation systems to assist command decision making*
Competence:	*Manoeuvre and handle a ship in all conditions*
Competence:	*Operate remote controls of propulsion plant and engineering systems and services*
Function:	*Cargo handling and stowage at the management level*
Competence:	*Plan and ensure safe loading, stowage, securing, care during the voyage and unloading of cargoes*
Competence:	*Carriage of dangerous cargoes*

Function: *Controlling the operation of the ship and care for persons on board at the management level*
Competence: *Control trim, stability and stress*
Competence: *Monitor and control compliance with legislative requirements and measures to ensure safety of life at sea and the protection of the marine environment*

Methods for demonstrating competence: examination and assessment of evidence obtained from..... approved simulator training where appropriate

Section A II/3
Mandatory minimum requirements for certification of officers in charge of a navigational watch and masters on ships of less than 500 gross tonnage, engaged on near coastal voyages.
Table A-II/3
Function: *Navigation at the operational level*
Competence: *Plan and conduct a coastal passage and determine position*
Competence: *Maintain a safe navigational watch*
Competence: *Respond to emergencies*
Competence: *Respond to a distress signal at sea*
Competence: *Manoeuvre the ship and operate small ship power plants*

Function: *Cargohandling and stowage at the operational level*
Competence: *Monitor the loading, stowage, securing and unloading of cargoes and their care during the voyage*

Function: *Controlling the operation of the ship and care for persons on board at operational level*
Competence: *Maintain seaworthiness of the ship*

Methods for demonstrating competence: examination and assessment of evidence obtained from..... approved simulator training where appropriate

Section A-IV/2
Mandatory minimum requirements for certification of GMDSS radio personnel
Table A-IV/2
Function: *Radio communications at the operational level*
Competence: *Transmit and receive information using GMDSS subsystems and equipment and fulfilling the functional requirements of GMDSS*
Competence: *Provide radio services in emergencies*
Methods for demonstrating competence: Examination and assessment of evidence from practical demonstration of operational procedures using: .....GMDSS communication simulator where appropriate.

PART B RECOMMENDED GUIDANCE

Section B-I/12

Guidance regarding the use of simulators

Training and assessment in radar observation and plotting

2. Training and assessment in radar observation and plotting should:

.2 .....incorporate the use of radar simulation equipment

Setting up and maintaining of displays

8. A knowledge should be attained of:

.3.....controls and settings.....

.4.....dangers of maladjusted controls

Training and assessment in the operational use of ARPA

18.Training and assessment in the operational use of ARPA should:

.2 .....incorporate the use of ARPA simulation equipment

Setting up and maintaining displays

32. Ability to demonstrate:

.1 correct starting procedure to obtain the optimum ARPA information.....

.3 .....the correct adjustment of all variable radar display controls

Recommended performance standards for non-mandatory types of simulation

36 Performance standards of simulation equipment including but not limited to:

navigation and watchkeeping,
shiphandling and manoeuvring
cargohandling and stowage
radiocommunications
main and auxiliary machinery operation

37 Navigation and watchkeeping simulation watchkeeping equipment should.....be capable of simulating navigational equipment and bridge operational controls which meet all applicable performance standards adopted by the Organization.....

.1 create a real time operating environment, including navigation control and communications equipmentand equipment appropriate to the navigation and watchkeeping tasks to be carried out and manoeuvring skills to be assessed

.2 provide a realistic visual scenario .....as seen from the bridge.....

.3 realistically simulate own ships dynamics..... including currents and interaction with other ships

38. In addition shiphandling simulation equipment should:

.2 realistically simulate own ships dynamics in restricted waterways including shallow water and bank effects

40 Cargo handling simulation equipment should:

1. create an effective operational environment including a cargo control station with such instrumentation as may be appropriate.....

2. model loading and discharging functions and stability and stress....

3. simulate.....calculations for stability, trim, list, longitudinal strength, torsional stress and damage stability.

41 GMDSS communication simulation equipment should be capable of simulating GMDSS equipment which meets all applicable performance standards adopted by the Organization.....:

3. provide voice communication with background noise

4. provide printed text communication facility

5. create a real-time operating environment, consisting of an integrated system incorporating at least 1 instructor and 2 GMDSS ship stations

42. Engine room simulation equipment should be capable of

1.create a real time environment for seagoing and harbour operations with comunication devices and simulation of appropriate main and auxiliary propulsion machinery equipment and control panels

2. simulate relevant sub systems

3. monitor and evaluate engine performance and remote sensing systems

8 provide a facility to isolate certain processes ....for specific training tasks

Section B-IV/2

Guidance regarding training and certification of GMDSS radio personnel

Training related to GOC

35 Practical training should be given in:

1 correct and efficient operation of all GMDSS subsystems and equipment

2. safe operation of all GMDSS communications equipment....

3. acurate and adequate keyboard skills.....

4. operational techniques for

4.1 receiver and transmitter adjustment.....

4.2 antenna adjustment and re-alignmnet....

4.3 use of radio life saving appliances

4.4 use of EPIRB's

Training related to ROC

42 Practical training should be given in:

1 correct and efficient operation of all GMDSS subsystems and equipment prescribed for A1 area's

2. safe operation of all relevantGMDSS communications equipment....

3. operational techniques for

3.1 VHF use and adjustment.....

3.2 use of radio life saving appliances

3.3 use of EPIRB's

3.4 Navtex receivers

Section B-V/3
Guidance regarding additional training for masters and chief mates of large ships and ships with unusual manoeuvring characteristics
3. before assuming command the master should have:
1 sufficient experience manoeuvring a ship with similar characteristics .....or
2. have attended an approved shiphandling simulator course .....

1.2 IMO MODEL COURSE 1.07 Radar Observation and Plotting
Part A Course Framework
Teaching Facilities and Equipment
"The course requires a marine radar simulator or one or more functional marine radar sets.....Each display should be fitted with a reflection plotter. A plotting table, plotting charts and instruments should be provided adjacent to each set."
"A navigation simulator or a radar equipped training vessel is required to practice radar navigation".

Part B Course Outline
Hours
"Demonstration using radar 6.5 hours,
Exercises on radar 12 hours "

Part C Detailed Teaching Syllabus
Learning objectives
Chapter 2 Setting up and maintaining displays (8 hours)
sub 2.1 Function and adjustment of controls
".....demonstrates the use of main controls, transmitter controls, receiver controls, display controls....."
Chapter 7 Review and final Assessment
"A final evaluation of the trainees attainment of the learning objectives should be conducted, preferably by a written test and practical demonstration of their acquired skills on a marine radar simulator or functional marine radar set".

Part D Instructor Manual
Introduction
".....practice should be given on the radar set to familiarize each trainee with the reflection plotter. A radar navigation simulator or a training vessel is essential to practice radar navigation"

1.3 IMO MODEL COURSE 1.08 The Operational Use ofARPA

Part A Course Framework

Teaching Facilities and Equipment

"The course requires either an ARPA simulator or an ARPA set with means of target injection and simulation of own ship's course and speed. The sets should be fitted with reflection plotters."

Part B Course Outline

Hours

" Simulator : 26 hours"

Part C Detailed Teaching Syllabus

Learning objectives

Chapter 7 Setting up and maintaining displays

sub 7.2 "..... correctly adjusts the radar controls....."

Part D Instructor Manual

Simulator exercises

" Exercises should be carried out on ARPA equipment or ARPA simulators ....."

Preparing and conducting simulator exercises

" .....produce the greatest impression of realism....."

Guidance notes.

1. Review of plotting techniques

reflection plotter. " This training should be followed by simulator exercises using a

2. Principal ARPA systems

"....display characteristics and facilities available on ARPA sets...."

11. System Operational tests

" .....testing the ARPA for malfunctions....."

1.4 IMO MODEL COURSE 1.09 Radar Simulator

Part A Course Framework

Teaching Facilities and Equipment

" The simulator should include two or more own ship stations each with separate helm and engine controls..... The simulator and each own ship radar display should comply with IMO Resolutions A.574(14)- General requirements for electronic navigational aids and A.477(XII)- Performance standards for radar equipment. Each own ship display.....should be installed in a room or cubicle provided with a plotting table, plotting charts and instruments and a reflection plotter"

Part B Course Outline

Hours

"Simulator 24 hours".

Part D Instructor Manual
Guidance Notes

2. Review of basic radar and plotting
" This training should be followed by simulator exercises using a reflection plotter."

1.5 IMO MODEL COURSE 1.22 Ship Simulator and Bridge Teamwork

Part A Course Framework
Objective

"....trainees will gain.....a greater understanding and awareness of efficient bridge procedures during watchkeeping and shiphandling"

Teaching facilities and equipment

"This course requires a shiphandling simulator with a fully equipped bridge, including instruments showing course, speed, rudder angle, rate of turn, engine RPM, propeller pitch and relative wind direction and speed."
"The simulator must have a visual system capable of handling a number of ships in addition to land masses."
"The bridge should be equipped with a simulated VHF telephone..."
"Similarly an internal telephone to the engine room should be connected to the instructor station."
"Means of producing sound signals required by Colregs 1972 must be provided for other ships in the vicinity as well as for own ship."

Part B Course Outline
Hours

"Simulator - 24 hours"

Part C Detailed Teaching Syllabus
Learning objectives

2. Familiarization with the bridge
".....demonstrates the operation of the different instruments on the bridge. .....uses the rudder and the engine controls."
3. Standard manoeuvres
" carries out a turning circle....."
" carries out a crash stop....."
" carries out a coasting stop....."
4. Wind and current effects
" repeats a standard manoeuvre with wind and current....."
5. Shallow water effects
" repeats a standard manoeuvre in shallow water."
6. Bank, channel and interaction effects
" applies a knowledge of bank effect in exercises in confined channels."

7. Anchoring and single point mooring
" carries out the planned mooring."
"carries out the prepared anchor plan."
8. Planning and carrying out a voyage.
" carries out the planned passage and monitors the progress"
" demonstrates compliance with rule 10 of Colregs 1972....."
" demonstrates correct procedures when communicating with a vessel traffic service."
"demonstrates the approach to or departure from a pilot station....."
" demonstrates skill in approaching or leaving berths under various conditions of wind and tide."

Part D Instructor Manual
Simulator exercises
The other members of the bridge team should be engaged in the exercise
Preparing and conducting simulator exercises
"The exercises should produce the greatest impression of realism."

1.6 SIMULATOR CLASSIFICATION

As can be seen from the above, emphasis is placed on competence and the demonstration of such competence by a choice of methods. One of these is in the cases stated the use of simulation equipment where appropriate.
This implies that the characteristics of the simulators should match the competencies which are to be assessed. This in turn means a careful consideration of which types of simulators hold the required characteristics.

It is here that the classification of simulators can prove it's value and give some needed guidance. Prepared by IMSF and submitted to IMO for inclusion in the revised Code a classification scheme containing four levels was set up for navigation, engine room and cargohandling simulators.
The names originally used to describe a level of simulator were complemented with simple category numbers in order to make the system as clear as possible and comparable to a similar classification in the airline training industry. In the final version of the revised code the classification was not included, as the conference's general opinion seemed to be that too much technical detail should actually be left to the designers and engineers and was not appropriate in the code.

Some reference to the classification was included in the present edition of the STCW as to the perfomance standards required for simulators should they be used for training and/or assessment stated in section A-I/12. Future efforts from IMSF will certainly further elaborate on the classification as it is considered essential in order to relate the training objective to a class of simulators. The classification in it's latest version is shown here.

SIMULATOR CLASSIFICATION SYSTEM

BRIDGE

Category I Full Mission

full visual navigation bridge operations, including capability for advanced shiphandling and pilotage training in restricted waterways

Category II Multi Task

full visual navigation bridge operations ,as in Category I above, but excluding the capability for advance restricted water manoeuvring

Category III Limited Task

limited (instrumentation , or blind) navigation and collision avoidance

Category IV Single Task

operation of particular bridge instruments, or a limited navigation manoeuvring scenario, but with the operator located outside the environment (e.g. desk-top simulator utilising computer graphics to simulate a birds-eye view of the operating area

ENGINE

Category I Full Mission

full control room and engine room operations with the use of local and mimic panels for the operation of all systems generally available on the installation being simulated

Category II Multi Task

control room and engine room operation representation with the use of local and mimic panels but with audio and visual cues providing computerized controlled access to all operational systems generally available on the installation being simulated

Category III Limited Task

no details described

Category IV Single Task

specific control room and engine room operations without the use of local and mimic panels for the operation of specific propulsion systems and sub-systems. Audio and visual cues providing computerized and or local controlled access to the operational system. All other systems may be isolated or fixed to have no effect on the operation of the installation.

CARGO AND BALLAST

Category I Full Mission

full control room operations, including vibratory and audio cues, providing computerized and manual controlled acces to all operational systems

Category II Multi Task

control room representation providing computerized and manually controlled access to all operating systems

Category III Limited Task

no details described

Category IV Single Task

operation of particular items of equipment

As explained below in item 2.2, the competence based assessment of skills which is relevant in maritime training, is best performed in an environment that most **closely resembles the actual workplace.**

As ships radars and navigation equipment do not (yet) appear in the format of standard off-the-shelf pc hardware and ships bridges are not equipped with such, other than for administrative or communication purposes, it is obviously not applicable, acceptable or valid to try and perform assessment of competence on such equipment. A close match of the objective with the class of simulator is therefore an essential aspect.

2. PEDAGOGICAL REQUIREMENTS

2.1 Types of training

A number of basic types of training and applications can be distinguished when using maritime simulators for preparation for shipboard activities:

a. normal routine techniques:

component training will focus on a single element in the whole of the shipboard operation and concentrate on, for instance, one instrument;

part task training: will involve a number of components grouped together in order to come to a first insight into the relationship of the various elements;

basic operations training relates to the actual operation of a piece of equipment specific to the function for which is being trained;

team training involves practicing with the team in which the decisions are made on evaluation of material required to carry out the necessary operations;

decision making training is done for training personnel in making the right decisions, based on evaluation of a given situation and to carry out the necessary action to reach a defined goal. If the decision maker communicates directly with the equipment rather than through the equipment, the decision maker becomes operator.

b. advanced techniques:

fault finding or trouble shooting training will be required for many of the presently used types of complex equipment. Although extensive repairs are hardly possible with most of the electronic systems, localizing a malfunctioning section allowing for replacement by a spare part is common practice;

maintenance training for both technical or conditional action, be it preventive or corrective, will be required for almost every aspect of technology;

optimalization of processes is especially important when budgets are getting tighter, operational costs are rising and basic investments are becoming more difficult;

process studies will be required for in-depth knowledge of a particular aspect in order to analyze, improve or in the case of a casualty provide evidence on the development of criteria;

procedure training has to be followed in order to safely perform a certain function and requires the necessary training to adapt to;

emergency procedures can be a matter of life or death and as they are not encountered on a regular basis require intensive repeated training in order to be performed properly should the need arise.

From the description of the various forms of training and practicing noted here, which can be performed on maritime simulation equipment, it is obvious that both in normal routine as well as advanced training situations the requirement for fully operational equipment, as life like as possible is evident for:

part task training
basic operations training
team training
decision making training
trouble shooting training
maintenance training
optimalization training
procedure training
emergency procedure training

2.2 Acquiring competence.

Many aspects of maritime training using simulators are aimed at providing the trainee the possibility to acquire certain skills necessary to perform the task on board ship.

The skills training should therefore lead to a certain level of competence related to the rank or function of the person on board. The achieved level of competence will be proven by a system of evaluation or assessment.

Competence based assessment techniques will have to be developed and applied for this purpose. A commonly accepted opinion hereby is that the best accepted evidence of the trainee reaching the level of competence will come from the actual workplace performance.

Actual workplace performance thus means onboard observations of how the trainee is performing. As no instrument is available to achieve such assessment the next best thing should be used. In our case this means an operational simulator system representing as closely as possible the real workplace. This in turn will imply that preferably real stimulated equipment will be needed, or at least simulated generic life size equipment.

2.3 Impact of teaching equipment

A simulator can be regarded as a sophisticated training tool. There are many types of training tools and especially by means of the audio visual aids a powerful effect can be given to the learning experience of the trainee.

The hierarchy of the various audio visual aids can be shown in a diagram whereby the relative position indicates the greater the impact on the learning of the trainee is.

It should be obvious that the full operational version of the simulator is far superior to pc simulation systems which are being offered as the cheap alternative for the real thing.

It even remains to be seen if the use of simple pc simulation is actually even worthwhile to invest in . For example, if basic plotting has to be learned, this can quite efficiently be done by means of simple plotting sheets. The usage of a pc plotting programme is not much more than a modern alternative to the basic tool and hardly an enhancement of the learning experience.

2.4 Realism of training environment.

In any training programme the learning objectives should be clearly defined. In the case of maritime simulator training this is also required and possible and in some cases actually done in a structured manner.
The level of achieving a certain objective will depend on the training programme, training equipment, instructor ability and competence of the trainee.
If functional understanding of a certain piece of equipment is the learning objective the training tool will have to have as great as possible realism.
Experienced trainees will have the ability to imagine that any presentation of a certain phenomena represents the real thing.

Inexperienced trainees who have hardly or never operated the real equipment will have a much harder time to transfer their learning impressions from the non-realistic training device to the realism of the ships environment.
The danger thus exists that the young cadet, having been extensively prepared for bridge duties by means of pc simulation will search in vain on the bridge for the pc to perform his collision avoidance and navigational routines and when such does not happen to be there, will have a definite setback and need for adaption to the actual new and unfamiliar situation.

Similarly the inexperienced trainee will have a far more difficult time in imagining that the pc screen he is looking at is a ships radar or navigation device rather than a glorified version of some arcade game.

3. PRACTICAL REQUIREMENTS

3.1 Training vessel replacement

One reason for application of simulators in maritime training is the replacement of the practicing tool "training vessel" by thepracticing tool "simulated training vessel". The discussion about the feasibility of such a replacement is lengthy and still continuing and both those in favour and against can produce valid arguments.

Nevertheless the fact remains that more and more countries and colleges are replacing their costly training vessels by less costly operational training simulator systems.

In order to justify such action the quality of the simulator system will have to resemble that of the training vessel. This implies that *validity, reliability and reality* will be assessed before deciding on the replacement of the vessel by simulators.

It is difficult to defend that pc simulation would have reached the level of sophistication to such an extent that all of these requirements are met. This again implies that any training vessel replacement will have to be by an operational simulator system in order to be considered equivalent.

3.2 Sea time remission.

Another aspect of the use of operational simulators comes with the granting of seatime for simulator time.

For whichever purpose such occurs, it is becoming common practice that national maritime authorities are allowing some of the required seatime for further certification to be replaced by structured simulator training.

The ratio's applied in this process of seatime remission vary considerably, (from 1:1 to 1:12 are known to be used), but the fact remains that more and more institutions are recognizing the apparent advantages of properly structured simulation training.

As with the previous item the *reality, reliability and validity* of the simulator system will be of crucial importance in the granting of such benefits. High quality, operational simulator systems, on which a structured, diversified, comprehensive training programme can be run by qualified instructors will meet the requirements laid down by the authorities.

3.3 Man-machine interface

Complex equipment requires intensive training for proper operation. This proper operation starts there where man meets machine, the so-called man-machine interface

The complexity of the operation of equipment originates from this interfacing stage. If proper understanding and operation at this level is not achieved the more advanced, complex operations will cause greater difficulties and will possibly not be able to be mastered at all.

Man-machine interface with a qwerty-keyboard is hardly an item of extensive training and it resembles in no way what is met in real vessel equipment. However the interfacing with controls and gauges fitted on life-like equipment as in the operational simulator is quite different and a basic requirement to further control the more advanced functions of this equipment.

3.4 Comparison with flight simulation.

Although definitely not in all aspects comparable there are certain similarities between maritime and aircraft training. In both cases a form of transportation is involved, which has to be steered, navigated, berthed and unberthed, loaded and discharged, fueled and stocked up, maintained and safety inspected. In both cases a form of simulation is used to train the personnel responsible for commanding the craft from port to port.

In the flight industry the usage of simulators is mandatory, well structured and at certain intervals repeated. And although many versions of pc flight simulation programmes exist, some with a remarkable authenticity, it is in the full mission, operational life-like, flight simulator that the pilots take their training and are assessed for their skills and reactions to emergency situations. Undoubtedly an airline that would train its pilots with pc simulation would very soon be out of business. Strangely enough it appears that a shipping company training on that calibre of equipment is not considered a danger to public safety and environment!

3.5 The shape of things to come

As technology progresses the shape and structure of equipment will be under constant improvement and changes. That means that what now is a standard might become obsolete in future.

At a certain stage radar, charts, communications and control and adjustment systems might even be run from a pc. From an educational point of view that will be the time, when it becomes acceptable to perform maritime training, including radar/arpa and shiphandling training and assessment of competence on such a system.

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