

Methodological issues of preparing and conducting computer-assisted exercises on maritime security matters

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1 Introduction

Computer-assisted exercises (CAX) have established themselves as the most effective form of preparing personnel engaged with crisis management, including the training future merchant marine officers in the broad-ranging and often contradictory issues of safety and security.

This paper is based on the thesis that CAX should become the main form of the all-around training for the future specialists from the maritime transport system (MTS) for issues of security. Only if they are actively utilized can the above-mentioned issues and contradictions be overcome. They are not a panacea, but only a tool that provides highly adaptive training at relatively low costs. In order to be effective, this tool should be utilized correctly from a methodological, organizational and technical point of view.

On this basis, the paper presents some methodological issues related to preparing and conducting computer-assisted education and training for maritime officers, focusing on computer-assisted exercises in maritime security matters.

2 Current status of maritime security officer education and training

The current maritime safety and security related education and training (E&T) process suffers the following practical problems:

- Ship officers have little knowledge of the whole maritime safety and security system, the functioning of which has become significantly more important in the light of the ISM [3] and the ISPS Code [4]. Very often, the lack of this knowledge leads to demotivation of the main participants in the process of maritime transport;
- The training pursuant to the ISPS Code relies on the acquisition of standard tactical and technical methods of protection, which provides general standard basic knowledge and skills. Even though this is

necessary, it contradicts the idea of proactiveness and creative problem solving;

- The increased requirements of the STCW Convention [7], which already cover all the categories of maritime transportation system security officers, now demand a new system of training and a suitable learning environment;
- Developing and maintaining such an environment requires significant expense and the employment of a very well-prepared team, which is beyond the resources for many maritime training institutions.
- These problems are exacerbated by some contradictions in the computer-assisted E&T process:
 - Developing and maintaining an expensive and complex environment for CAX is not affordable for most maritime training institutions;
 - Training in security issues should not be confined only to the framework of the merchant marine;
 - The future watch officer should receive a much broader range of training in the issues of safety and security than the minimum required in order to be an active organizer and an adaptive participant in the processes occurring in the world ocean;
 - The total time for training future maritime officers is reduced; because of this, the necessary balance must be struck in their fundamental training in safety and security, and a new level of knowledge and skills must be achieved by applying both traditional and new training techniques.

These issues are a practical and direct result of the lack of common methodology for preparing and conducting computerized training related to the general subject area of maritime security.

3 Analysis of goals and objectives of security officers education and training in maritime safety and security matters

When providing education and training (E&T) for maritime security personnel, the most significant problem we usually meet is “How do we provide practical orientation of the E&T process for a wide range of possible security situations in a relatively unpredictable environment?” The problem is exacerbated by the fact that the training addresses an audience from different institutions.

The classical approach for dealing with similar obstacles suggests that the E&T process has to be focused on the concrete objectives of the Maritime Safety and Security System (MSSS).

Notwithstanding the rationality of this approach, the risk of incorrect operationalization of the objectives is significant. A strong argument is provided by the fact that the factors, which the MSSS is to counter, are organizations

which perform continuous adaptation of their strategy and/or structures in the circumstances of the dynamic conflict environment.

This fact provokes the idea that the “*traditional approach*”¹ for defining the objectives of the MSS suffers two typical defects: “*subjectivism*” and “*excessive practicality*”.

The “*subjectivism*” is a result of limited predictability of the environment and the tendency to overcome this obstacle by applying a scenario-based approach when studying the objectives of the MSS. The possible aftermath can be summarized as “*situational orientation*” of the objectives defined.

The necessity of the practical orientation is indisputable but the risk comes from the possibility of missing the moment of emergence of synergetic properties of the MSS in the process of the decomposition of goals to the system of objectives.

As a result, there is a real danger in elaborating a concept of a virtual environment for E&T, which may suffer from incorrect basic assumptions.

In order to overcome the possible problems mentioned above, and taking into account the artificial nature of the MSS, we applied the “*mission approach*” for functional analysis, which studies functional orientation of the objectives performed by the MSS on the background of the “*life-cycle*” of the negative factors, presented by their evolution in the logical sequence: “*challenges – risks – threats*”².

Regardless of the variety of possible approaches for deconstruction of a system’s goals of functioning, there are two groups of goals:

¹ The “*traditional approach*” [1, p.62-68] suggests the following sequence:

- Definition and analysis of the MSS goals;
- Decomposition of the goals to the system of objectives for their achievement;
- Elaboration of a strategy as a set of objectives arranged in time perspective, whose fulfillment ensures the achievement of a separate goal. In practice, this process is a synthesis of an operational structure;
- Elaboration of a technology as a relationship between the strategy and the existing system’s structure.

² For the purpose of this study, we consider any factor that threatens maritime security as an organization whose evolution follows the sequence: “*emergence of a challenge – evolution to a risk – formation of a threat*”. In fact, we propose a different point of view presenting the terms “*a challenge*”, “*a risk*”, and “*a threat*” as three different stages of the process of formation of an organization. For a more detailed explanation of the sequence “*a challenge – a risk – a threat*”, the “*mission approach for functional analysis*” and its application on studying MSS functioning see: Mednikarov B. and K. Kalinov, “*An alternative of the system approach to functional aspects analysis of the Maritime Crisis Management System*”, *Information and Security. An international Journal* Volume 22,2007 [5].

- The first one includes these functional directions, which are related to the reason for the establishment of the system³:
- Preparation for reaction in response to a manifestation of a negative factor or a combination of negative factors;
- Reactions in terms of short-term adaptiveness, long-term adaptiveness, and evolutionary adaptiveness⁴;
- Acquisition and analysis of information concerning the environment and the negative factors.
- The second group of goals is related to the self-reproduction and self-maintenance of the system. Classically, this set of functional directions includes educational, administrative, and legislative activities.
- The general congruence between negative factors' "life-cycle" and the main functional directions in MSSS's functioning is given in *fig. 1*.

³ The practical dimensions of the reason for MSSS establishment could be summarized as a counteraction, in the sense of reaction, to the negative factors' manifestations. In this context, it is possible to unify the different reactions in function of adaptation. The MSSS performs predominantly adaptive functions in relation to the suprasystem. When applying such an approach, it should be considered that there are three different levels of adaptiveness: short-term adaptiveness, long-term adaptiveness, and evolutionary adaptiveness. Taking into account that the reactions of a system are based classically on preliminary preparatory for action and acquisition of the information necessary, we have to add to this group these functional directions, which have a direct relation to the achievement of the global goal of the system: acquisition and analysis of information concerning the negative factors and the environment, planning, and training.

⁴ Short-term adaptiveness is a process of adaptation to the current situation. That is why it is a process of direct and situationally-oriented adaptation. It is performed predominantly by functional adjustment. Long-term adaptiveness is a process of adaptation to relatively predictable future conditions of the environment. It is performed by elaboration of structural prerequisites for functional adjustment to possible future situations. Evolutionary adaptiveness is observed in unpredictable situations. That is why it is performed by elaboration of structural prerequisites for the necessary system's properties for adaptation in cases of emergency.

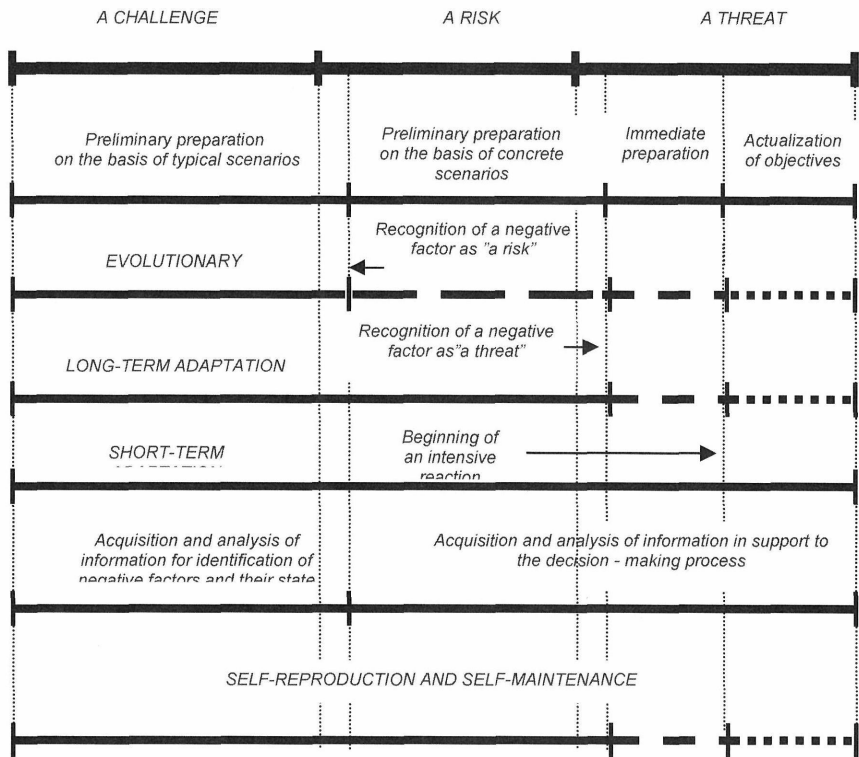


Fig. 1 General correspondence between negative factors' "life-cycle" and the contents of the functional direction of the MSSS's functioning

In fact, the MSSS's E&T process is a part of the functional direction known as "preparation for reaction in response to a manifestation of a negative factor or combination of negative factors"⁵.

⁵ In fact, the E&T process belongs both to the functional direction "preparation for reaction in response to a manifestation of a negative factor or combination of negative factors" and the functional directions of the self-reproduction and self-maintenance of the system. For the purpose of this study, we are interested in these educational and training patterns, which are directly related to the

As a result of applying the mission approach to study the MSSS's functioning, we derived the following conclusions⁶:

The MSSS is formed after the recognition of the negative factor as “*a risk*”.

The recognition of the negative factor as “*a risk*” finalizes the preliminary preparation on the basis of typical scenarios.

After the recognition of a negative factor as a threat, the short-term adaptation process becomes dominant in relation to any other functional direction.

Every conclusion poses concrete requirements to the E&T process. That is why it is appropriate to consider all of them.

The fact, that the MSSS is formed after the recognition of the negative factor as “*a risk*”, means that we have a complex of interacting components rather than a system. The aftermath is that the MSSS has almost no practical experience. Obviously, the main “*source*” of practice is the E&T process. This E&T process relies predominantly on the Computer-Assisted Exercises (CAX) conducted in a virtual environment provided by simulators. The logical recommendations are:

The virtual environment for the MSSS's E&T process has to provide both “*technical experience*” and “*management practice*” for the personnel. The “*sub-recommendations*” are:

The simulators have, on the one hand, to be in full compliance with the equipment, and on the other – to “*reflect*” the existing organization of the MSSS;

Both the simulators and the CAX methodology must be flexible enough in order to “*shift the emphasis*” of the training from “*predominantly technically oriented*” to the “*predominantly management-oriented*”.

The virtual environment for the MSSS's E&T process has to model a great variety of possible safety and security situations.

Any reaction in a particular situation is based on behavioral models which have “*worked*” in similar situations. The lack of real practical experience of the MSSS leads to the idea of providing the MSSS with an “*artificial memory*”. This means using an opportunity to acquire data of situational games in virtual environment, analyzing the data collected, deriving indicators for recognition of the particular situation, and suggesting a management decision. The recommendation is:

The simulators have to provide an opportunity for “*case management*” by modeling specific situations, acquisition and analyzing data and suggesting a particular course of action.

reaction of the MSSS to crises or emergencies. That is why we do not examine the E&T functions, related to the self-reproduction and self-maintenance of the system.

⁶ The paper presents only these conclusions which are directly related to the MSSS's E&T process.

Taking into account, on the one hand, the dynamic nature of the security environment, and on the other – the abstract charge of the social comprehension for “*safety*”, the next recommendations are:

The simulators have to provide an opportunity for upgrading and modernization; The CAX methodology and the supporting base (databases, software, workstations, etc.) must be flexible enough to allow their adjustment to the changeable organization of the MSSS.

The necessity of the simulators and CAX methodology flexibility can be developed in one more direction – the idea of using the virtual environment for scientific purposes. The possibility of testing different realizations of the MSSS’s architecture is to be provided by specialized software.

The second conclusion suggests that there are distinctive “*accents*” of the E&T process.

Preliminary preparation is performed on the basis of typical scenarios. The E&T process is carried out in circumstances posed by “*an unidentified risk*”⁷. Logically, the recommendation is:

The simulators have to support the following activities:

- Development of typical scenarios;
- Development of typical reactions in context of the typical scenarios;
- Examination of the MSSS’s functioning in the environment described by the typical scenarios.
- The simulators support the following activities: training, planning, and research.

The recognition of the negative factor as “*a risk*” finalizes the preliminary preparation on the basis of typical scenarios and the focus of the E&T process shifts to preliminary preparation on the basis of concrete scenarios. The recommendation is: The simulators and the CAX methodology have to be able to select scenarios adequate to the current situation and to provide reliable prognosis for the possible development of the situation.

The last conclusion of the analysis led us to the idea that the short-term adaptation process becomes dominant in relation to any other functional direction. In fact, after the recognition of a negative factor as “*a risk*”, the other functional directions, in practice, stop and “*melt*” into the background of the short-term adaptation. Obviously, the paramount role of the short-term reactions suggests that the E&T process first has to provide “*technical experience*” for the operative personnel and “*management practice*” for the low hierarchical level managing staff⁸, and only after that – to put attention on the preparation of long-

⁷ “*An unidentified risk*” means that the negative factor is in a stage of “*a challenge*” or it has already evolved to a state of “*a risk*” but the security system has not recognized that development of the factor.

⁸ It should be noted that the short-term reactions will be undertaken predominantly at a local level – at the level of the crisis and/or conflict. This

term oriented adaptive reactions. This motive led us to the idea to try to answer the question, is there is any relation between the different accents of the E&T process and the safety and security concepts?

Professor Donna J. Nincic provides an interesting metaphor explaining the difference between safety and security concepts: “*safety is doors open to allow free access for escape or rescue in a dangerous or unsafe situations. Security, on the other hand, is doors closed to prevent access to those who might wish to do us harm*” [6, p.147]. Assuming, that “*security can be considered protection from active malicious agents*” and “*safety, on the other hand, can be considered protection from accident, maritime casualties...*” [6, p.147], we went one step further and say that safety is an “*effect-oriented countering*” concept, which means short-term oriented. On the contrary, security is a “*cause-oriented countering*” concept or long-term oriented. Logically, the E&T process has to consider that safety related E&T is the basic prerequisite for the security related E&T⁹. The recommendation is: The CAX methodology has to provide correct balance between the safety and security orientations of the E&T process.

4 Conceptual model of computer-assisted education and training in maritime security matters

Obviously, the computer-assisted E&T process has to overcome current E&T problems and meet the requirements formulated above. We can formulate additional requirements: efficiency, effectiveness, universality, etc. But we are addressing one aspect of the flexibility of the computer-assisted E&T process, which reflects the overall logic underlying in the E&T process. It comes from comprehending that one’s reactions to a particular situation are an original “*cocktail*” of previous experience and the ability to estimate and respond to the particularity of the situation.

The initial E&T process has to establish behavioral models necessary for quick response to a familiar situation. In other words, the purpose is to give the trainee an adequate “*memory*”. For this reason, the basic level of the computer-assisted E&T has to provide a typical situation in a typical environment. The next stage of the E&T process is to make the trainee “*overcome*” the framework of the behavioral models learned, to “*recognize*” the specificity of the situation, and to elaborate a proper (which means specific) response. In order to support this idea, the computer-assisted E&T has to provide a non-routine situation in a non-routine environment.

results in the fact that the preparation of the operative personnel and the low hierarchical level managing staff is of vital importance for the final result.

⁹ The idea is not to make a clear distinction between safety E&T and security E&T, but to underline that more technically-oriented safety E&T should precede more “*creative*” security E&T.

The next level of the E&T process explores the idea of giving the trainee the ability to make logical relations in unrelated (at a first glance) processes and events, to recognize the patterns that they have in common and “*cause - effect*” relations, and on this base, to elaborate basic and widely applicable behavioral models.

Obviously, the computer-assisted E&T has to be flexible enough in order to be able to “*shift*” the accents of the overall E&T process.

Taking into account the recommendations and the idea that the MSSS’s overall goal is adaptation of “*a suprasystem*” (the society) to the dynamic safety and security environment, we defined three different stages in the E&T process: general (short-term reactions oriented) E&T, long-term adaptation oriented E&T, and evolutionary adaptation oriented E&T. Table 1 presents general description of the E&T processes.

Table 1

General description of the E&T stages and the measures to satisfy the requirements

Stages	1 st level E&T	2 nd level E&T	3 rd level E&T
General description	Short-term reaction oriented E&T More “ <i>safety oriented</i> ” than “ <i>security oriented</i> ” Focused on technical experience and standard management procedures (tactical management) Object oriented approach to safety and security matters	Long-term adaptation oriented E&T Dynamic balance between safety and security orientation. Focused on the management of the system in a dynamic environment (strategic management) Zone-oriented approach to the safety and security matters	E&T is evolutionary adaptation oriented Predominant “ <i>security orientation</i> ” Focused on management in “ <i>extreme</i> ” situations (continuity of operating) Optimization of the performance Critical infrastructure understanding
General goal	To provide basic technical and management skills To establish behavioral models for standard situations	To provide sound management abilities To create abilities for “ <i>overcoming</i> ” the standard behavioral models and for elaborating reactions adequate to the particularity of the situation	To provide strategic management abilities To create abilities to “ <i>overcome</i> ” the “ <i>preventive - responsive</i> ” nature of MSSS functioning and to perform active management of the security environment
Targeted audience:	Operative personnel and low hierarchical level managing staff	All hierarchical levels of the managing staff	High hierarchical levels of the managing staff. Research institutions personnel.

Stages	1 st level E&T	2 nd level E&T	3 rd level E&T
Objects for modeling in virtual environ-ment	Technical systems Organizational structures Typical scenarios Real past situations (lessons learned)	All of the previous stage objects Not typical scenarios Adaptive opposing agent (pirates, terrorists, etc.)	All of the previous stages objects Scenarios for “ <i>extreme</i> ” situations Non-existing organizational models and technical systems
Objectives of computer-assisted forms for E&T	Acquisition of technical experience Learning standard operational procedures Learning tactical management procedures Learning procedures for interagency cooperation Certification of the personnel	Actualization of the previous level E&T Learning strategic management procedures Testing technical systems and/or organizational decisions Case management	Actualization of the previous level E&T Developing long-term security environment prognosis Testing viability of different variants for optimization of the MSSS

5 Estimating the applicability of some simulation systems

The main instruments for conducting CAX are different simulators, simulation systems, simulation environments, etc. For the purposes of one of the studies conducted by the authors, a comparative analysis, has been carried out, some of the results of which are shown in Table 2.

Table 2
Results of the comparative analysis of some simulation systems

The main indicators for the analysis	Simulation system type		
	Oriented to the ship	Oriented to the entire maritime transport system	Oriented to a common national (regional) security system

Example realization	"Mars2" Maritime Safety and Security Training Environment Rheinmetall Defence Electronics GmbH (Düsseldorf, Germany),	Crisis Management System, integrated with a simulator Tranzas (UK, Russia)	"EU-TACOM SEE 2006" Simulation environment for conducting CAX in the civil security sector Institute for Parallel Processing, Bulgarian Academy of Sciences
Purpose	In compliance with ISM and ISPS Code, preparation and training for seafarers in all aspects of safety and security in the course of the operations of a merchant vessel	All aspects of crisis management in MTS and its separate branches	All aspects of crisis management in the civil protection system with a focus on the protection of critical infrastructure
Personnel trained	Watch offices and other personnel with special responsibilities concerning the safety and security of the ship	Crisis response teams from the port and the flag state; Consequence management teams Coordinators and operators in C2 and C4IPS systems;	Crisis response teams on an institutional and state level; C2 teams for crisis situations; Management personnel; Research teams
Mode of training	Individual training; Training of a crisis response team from a ship	Mainly – group training; Individual training for management personnel; CAX	Mainly – group training; Mainly – group training of several command positions; CAX
Main objectives	Fundamental training for students at the maritime Academy; Refresher training; Company training (particularly for special high-risk vessels); Certification / verification / assessment	Fundamental and refresher training of a broad group of MTS personnel Fundamental and refresher training of teams; Vocational training; Retraining and enhancing qualifications;	Fundamental and refresher training of a broad group of security system personnel; Working on interagency interaction Fundamental and refresher training of teams; Academic research

		Academic research work; Testing of plans	work; Testing of plans
<i>Visualization</i>	Detailed graphic display of: all the decks; functioning systems	No data	2D electronic chart display; For separate sites - 3D display (optional)
<i>General characteristics</i>	Specialized simulator	Possibility of integrating different simulators	Possibility of federating different simulation environments
<i>Models used</i>	Relatively constant, with a possibility for fixing them to a particular ship	Preset typical models of different crisis situations	Broad-ranging, adaptive models

The main disadvantage of the analyzed systems leads to the conclusion that, in spite of being applicable to the process of computer-assisted E&T, they do not cover the whole E&T period and do not satisfy the requirements described above.

6 Conceptual model of computer-assisted education and training system in maritime safety and security matters

The considerations taken into account when elaborating the model of computer-assisted education and training systems are presented by the following “trinity”: formulated recommendations, existing decisions, and the idea to serve not only the E&T process, but also the practice.

The conceptual model of computer-assisted E&T system in maritime safety and security matters is presented in *fig. 2*.

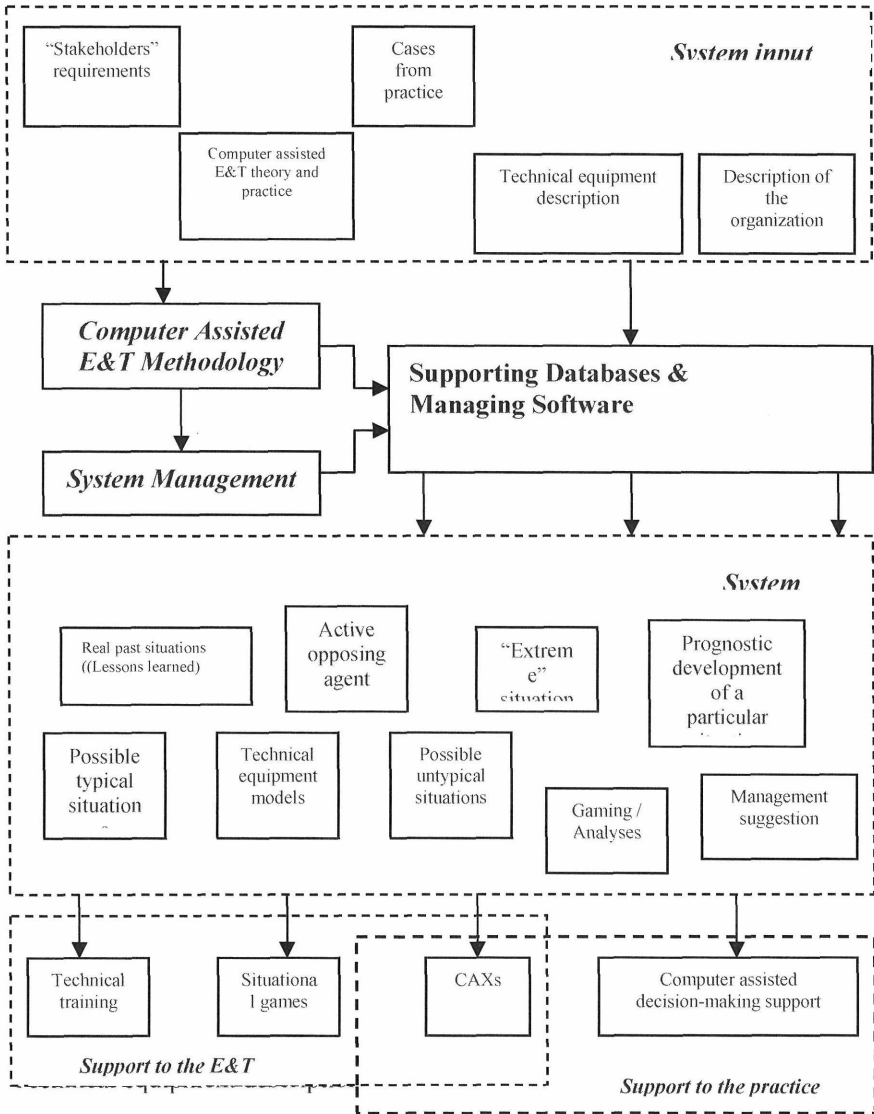


Fig. 2 Conceptual model of a computer assisted education and training system

Description of the organization.

“*Input*” serves the following functions: Elaboration of a computer-assisted E&T methodology and data acquisition.

Taking into account the particular purpose of the E&T process and related computer-assisted E&T methodological procedures, the managing body (system) of the E&T process formulates the desired “*output*” products. This task is supported by a specialized case software.

Different combinations of the products are “*unified*” by the managing system (using the support of related managing software) in different E&T forms and/or forms of providing computer assistance to the decision-making process.

7 Conclusion

Even a passing glance on the proposed conceptual model of a computer-assisted E&T system proves the important role played by the computer-assisted exercises in the whole system for maritime safety and security management and related E&T process.

Taking into account the indisputable importance of CAX, we are conscious that the system proposed is a kind of “*perpetuum mobile*” for the moment. But many things that were “*fiction*” in the past are parts of our life nowadays. The real problem for elaboration of a similar computer-assisted E&T system is not “*technical*”, but it is related to our willingness to solve it.

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