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SC-Method of Adaptation Marine Navigational Simulators for Training River Shipmasters

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ABSTRACT: The article provides an actual overview of navigational simulators for training shipmasters to control vessels on inland waterways in Russian Federation. There're considered methodology of adaptation "marine" navigational simulators for training "river" shipmasters, based on SC-method ("the Safety Cube" method).

1 INTRODUCTION

Among the most important tasks of the professional training for the interior water transport specialists are the safety of navigation and the decrease in the number of accidents on the inland waterways. This is achieved largely by the up keeping of knowledge, skills and practice of the navigators at an appropriate level. The navigational simulators have been the main tools for training and monitoring the vessel navigator's level of skill. In spite of the measures to enhance the professional level of the inland water transport specialists, the number of accidents due the vessel navigator's mistakes is not diminishing. According to data provided by the RF State Organization for Naval and River Navigation Supervision from 2005 to 2010 (see ref.1), the accident number remains at the same level and even has the trend to increase. This fact indirectly shows a low effectiveness of the existing methods of the navigator's professional training.

2 BASIC CONCEPT OF THE SC-METHOD

The analysis of the recent publications on the problems of increasing the navigators qualification level (see ref.2,3) permits to draw the conclusion about the need to improve in the fast place the methods of using the navigational simulators to train the inland water transport navigators. At present time there is no in Russia common concept of using the navigational simulators for the river vessel masters training. The training with simulators has been envisaged only for the "river-marine" vessel navigators. As for the other categories of inland water transport navigators, the right to choose the mode of their training has been delegated to the leaders of particular water basins and steamship companies. Therefore, the selection of navigational simulators to be used in training centers depends in a large degree on the competence of decision taking leaders and on the financial prosperity of organizations. Thus, there is a real need in developing clear criteria of evaluating the effectiveness of simulators, produced by different companies to be employed in training specialists for specific water basins of the Russian Federation.

Table 1. Typical transport infrastructure facilities of real basins from the RF inland waterways. XY-projection according to SC-method

Water basins	Transport infrastructure facilities																											
	Vessels								Hydrotechnical constructions						Distinctive parts of the inland waterways													
															Free rivers (rivers without obstacles)						Rivers with gateways				Bridges			
	Self-propelled ships	Haulted ships	Kicked ships	Passenger carriers*	Dangerous goods carriers	Rapid ships	Barges	Rafts	Suction-tube dredgers	Single-ribbed locks	Double ribbed locks	Single-chambered locks	Multi-chambered locks	Moorings	Group rifts	Rifts between riversides	Rifts with placers	Rifts along ravines	Abrupt turns	Lateral channels	Lake segments of the water basin	River segments of the water basin	Lakes	Channels	Single-span bridges	Multi-span bridges	Areas with avanport	Seasonal prevalence**
Azovo-Donskoy	+	+	+	+	+	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+
Amursky	+	+	+	-	+	+	+	-	+	-	-	-	-	+	+	+	+	+	+	+	+	+	-	-	-	+	-	+
Volzhsky	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+
Vostochno-Sibirsky	+	+	+	-	+	+	+	+	+	-	-	-	-	+	-	+	-	+	+	+	+	-	+	-	-	+	-	-
Enisejsky	+	+	+	+	+	+	+	-	+	-	-	-	-	+	-	+	+	+	+	+	+	-	-	-	+	+	-	-
Kamsky	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	+
Severo-Vostochny	+	+	+	+	+	+	+	-	+	-	-	-	-	+	-	+	+	+	+	+	-	-	-	-	+	-	+	+
Severo-Zapadny	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-	+	-	+	+	-	-	-	+	+	+	+	+	-
Severny	+	+	+	-	+	+	+	+	+	+	-	+	-	+	-	+	+	+	+	+	-	-	+	+	+	+	+	-
Obsky	+	+	+	-	+	+	+	-	+	+	-	-	+	+	+	+	+	+	+	+	-	+	-	-	+	+	+	+
Ob'-Irtyshsky	+	-	+	+	+	+	+	-	+	-	-	-	-	+	-	+	+	+	+	+	-	-	-	-	+	+	+	-
Centralny	+	+	+	+	+	+	+	-	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-

* Considered 3-screws passenger ship with a separate management for machine (screw).

** Under the seasonal prevalence understood multifactorial concept that consists of: changes in the position and direction of the fairway due to due to rearrangement of sediments; changes radar images in connection with water discharge in the upper reach of the reservoir; изменение скорости и направления течения; change in the depth of the fairway, and other factors..

Table 2. Transport infrastructure facilities which are modeled in navigational simulators. XZ-projection according to SC-method

Navigational simulators	Transport infrastructure facilities																												
	Vessels									Hydrotechnical constructions					Distinctive parts of the inland waterways														
															Free rivers (rivers without obstacles)							Rivers with gateways			Bridges				
	Self-propelled ships	Haulted ships	Kicked ships	Passenger carriers*	Dangerous goods carriers	Rapid ships	Barges	Rafts	Suction-tube dredger	Single-ribbed locks	Double ribbed locks	Single-chambered locks	Multi-chambered locks	Moorings	Group rifts	Rifts between riversides	Rifts with placers	Rifts along ravines	Abrupt turns	Lateral channels	Lake segment of the water basin	River segment of the water basin	Lakes	Channels	Single-span bridges	Multi-span bridges	Areas with avanport	Seasonal prevalence **
«NTPro»	+	-	+	-	+	+	+	-	-	-	-	-***	-	+	-	+	-	+	+	+	-	+	+	-	+	+	+	-
«MARLOT»	+	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	+	+	-	+	+	+	+	+	-	-
«MASTER»	+	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	+	+	+	-	+	+	+	+	+	-	-
«RNM»	+	-	-	-	+	-	-	-	-	+	-	+	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-	-
«Riv.Sim. 2.5»	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+	-	-	-	-	-	+	-	-

* Considered 3-screws passenger ship with a separate management for machine (screw).

** Under the seasonal prevalence understood multifactorial concept that consists of: changes in the position and direction of the fairway due to due to rearrangement of sediments; changes radar images in connection with water discharge in the upper reach of the reservoir; изменение скорости и направления течения; change in the depth of the fairway, and other factors..

*** Gateway as an object of transport infrastructure not realized in full in “NTPro”. Only entry or exit from the gateway are modeled without the implementation of the locking process.

Table 3. Navigational simulators which are used for training shipmasters to control vessels in real basins from the RF inland waterways. ZY-projection according to SC-method

Water basins	Navigational simulators				
	«NTPro»	«MARLOT»	«MASTER»	«RNM»	«Riv.Sim. 2.5»
Azovo-Donskoy	+	-	+	-	-
Amursky	+	-	-	-	+
Volzhsky	+	+	+	+	-
Vostochno-Sibirsky	+	-	-		+
Enisejsky	+	-	-		+
Kamsky	+	-	-	+	-
Severo-Vostochny	+	-	-	-	+
Severo-Zapadny	+	+	-	+	-
Severny	+	+	-	+	-
Obsky	+	-	+	+	-
Ob'-Irtyshsky	+	+	+	+	-
Centralny	-	+	+	-	-

In order to substantiate the optimum criteria of employing simulators for the purpose of training the specialists of inland water transport, the author have analyzed in the period of 2009 to 2010 the database of the simulators used in 33 training centers of the RF inland water transport. In the course of research the author has taken into consideration the requirements contained in guidance documents (see ref.4-7) as well as the published materials (see ref.8,9).

In general, the number of parameter groups that can be used to compare the simulators, may be rather large. At the same time, any systematic apparatus should be developed in the interests of its practical use and must be easily understood by the specialists having a different level of mathematical knowledge. Therefore, in the process of developing the methods for the efficiency evaluation for the navigational simulators used in training of vessel navigators of the inland water transport, the basic data was grouped according to the following three categories:

1 transport infrastructure facilities (i.e. vessels, hydrotechnical constructions, distinctive parts of the inland waterways;
2 water basins;
3 navigational simulators used for the training of inland water transport navigators.

The mathematic models realizing method called "the Safety Cube" (SC-method) (see ref.10) are the best suitable for the solution of multi-criteria optimization tasks of similar class. This approach consists in establishing interconnection between the constituent elements (components) of researched categories and comes to the construction of developments along the axes XY, XZ and ZY (see fig.1)

Tables 1, 2 and 3 contain the detailed characteristics of interrelation of the components of the researched categories. They are grouped according to the evolvent XY, XZ and ZY correspondingly.

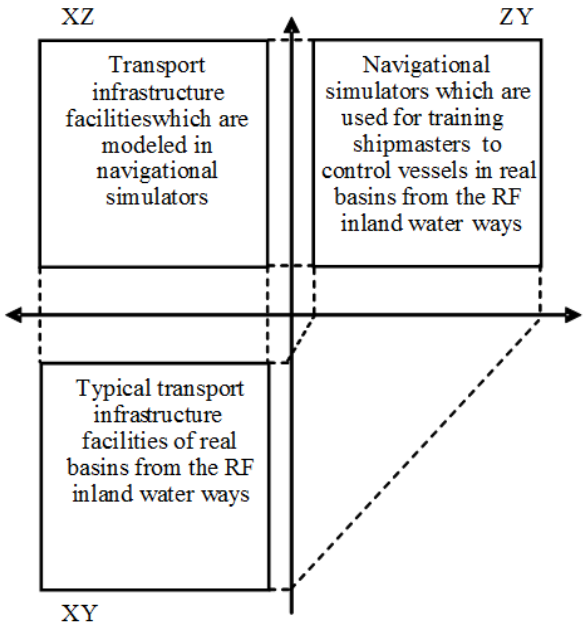

Figure1. The interrelation of categories used for evaluating the effectiveness of navigational simulators, using the SC-methodology apparatus

3 USING THE SC-METHOD TO ASSESSING EFFECTIVENESS OF MARINE NAVIGATIONAL SIMULATORS FOR TRAINING RIVER SHIPMASTERS

A detailed analysis of evolvents of "the Safety Cube" allows detecting individual features of navigational simulators which are used in training centers for training navigators. Knowledge the differences and shortcomings of navigational simulators from different manufacturers may help decision makers (managers of shipping companies, leaders of basins, etc.) to plan effective teaching and/or retraining of crew for the operation vessels in specific inland water basins.

In particular, using the above evolvents can be convincingly argued that in modern navigational simulators the transport infrastructure facilities such as vessels and hydrotechnical constructions (waterworks) are presented to a limited amount and does not fully reflect the real diversity of existing types of vessels and waterworks of the Russian Federation inland waterways. Also, a number of simulators, which was originally designed to prepare the skippers of marine vessels are absent or are not modeled in full amount typical parts of inland waterways (rifts, canals, etc.).

Table 4. Percentages of implementation the transport infrastructure facilities of RF inland waterways in navigational simulators with standard kit

Navigational simulators for RF training centers	Percentage of implementation the transport infrastructure facilities in navigational simulators			
	Vessels	Hydrotechnical constructions	Distinctive parts of the inland waterways	In total
«NTPro»	55.5%	20%	64.3%	53.6%
«MARLOT»	22.2%	20%	50%	35.7%
«MASTER»	44.4%	0%	57.1%	42.8%
«RNM»	22.2%	60%	35.7%	35.7%
«Riv.Sim. 2.5»	22.2%	0%	35.7%	25%

Except qualitative assessments, using evolvents of "the Safety Cube", there is possibility to obtain quantitative expert estimates. For example, in Table 4 shows the percentages of implementation the transport infrastructure facilities of RF inland waterways in navigational simulators with standard kit, obtained from the results of statistical processing the information from the evolvent XZ.

For clarity, the data of Table 4 can be represented graphically by plotting values of the calculated parameters on the axes of the polar coordinate, as shown in Figure 2.

The data in Table 4 allow confirming with quantitatively mentioned above qualitative conclusion about the absence of a complete list of transport infrastructure facilities in modern navigational simulators which are used for training and retraining shipmasters and navigators for inland waterways

On average over all navigational simulators in Russian training centers, are able to simulate only 38.6% of objects from inland water transport infrastructure! In turn, officials of shipping companies which are responsible for the safety of navigation can make a reasoned conclusion about the low efficiency of use of modern marine navigational simulators for training river shipmasters, intended for testing skipper's skills in different shipping conditions on inland waterways.

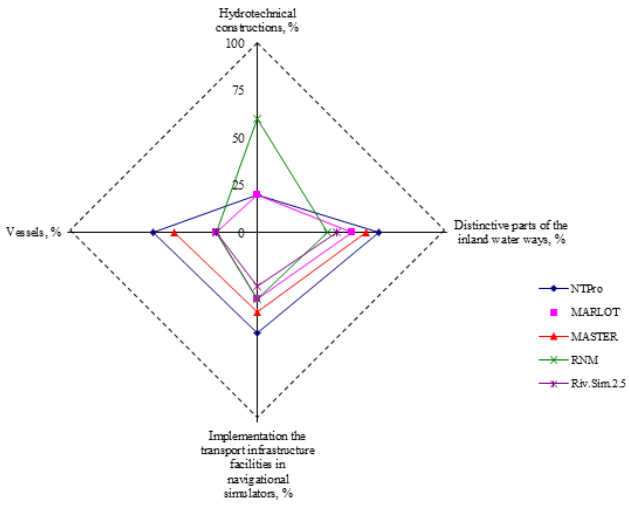

Figure 2. Percentage of implementation the basic groups of the transport infrastructure facilities in navigational simulators with standard complectation

4 CONCLUSIONS

Thus, the SC-method as a variation of methodical apparatus "the Safety Cube" really allows implementing a way of evaluating the effectiveness of the navigational simulators for training shipmasters to control vessels on inland waterways in Russian Federation. Thus, the introduction of SC-method will contribute costs optimization to simulators, will increase the quality of training navigators by rules for necessary adaptation and eventually will decrease the number of accidents and crashes on the inland waterways.

At present time is ready a series of publications how to use proposed in article the SC-method for rationale selecting concrete model and modification of navigational simulators for training navigators for specific river basins of the inland waterways of Russian Federation. Now is developed some practical methodics based on the SC-method for forming requirements for databases of river navigational simulators, taking into account regional specificities, for the following organizations: Bashkir River Shipping, Shipping Company "ORION", Research Company “Systems&Technologies” and Kotlas Rivership College.

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