# AUTOMATED MODELING OF THE NAVIGATOR'S MOTIVATION STRUCTURE BASED ON FUZZY SETS

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**Introduction.** The analysis of factors affecting the navigation safety is increasingly faced with problems in the qualification of crew [1-5]. At the same time, the navigators' qualification parameters are documented by diplomas and certificates. However, it is the insufficient level of qualification, in fact, that is cause of a significant increase in the risk of sea transport accidents [6-10].

**The main research material.** Despite the above, there is a driving factor that creates conditions aimed at increasing navigational safety, improving the trend of navigator's qualifications during the navigation watch [11-17]. This leads to a deeper analysis of navigator's motivational structure using automated modeling tools (Fig. 1).

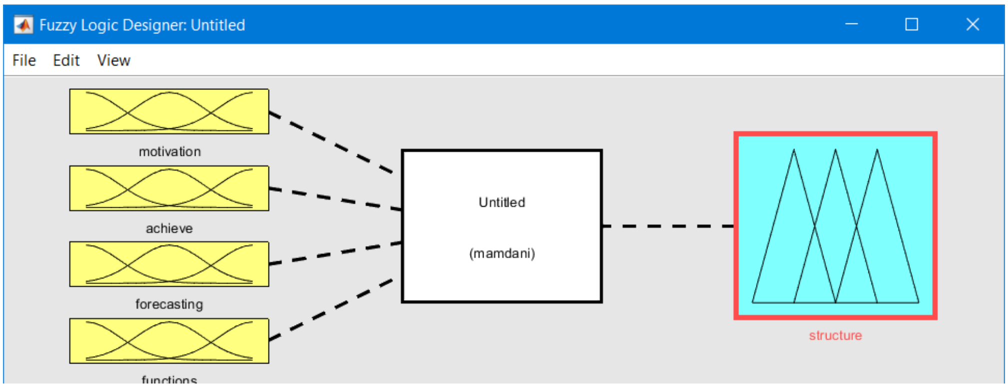



Fig. 1. Construction of a fuzzy analyzer

Therefore, a motivational structure of the navigator was proposed, which is described by a fuzzy set: unmotivated "unmotivated" - 20%, indifferent "indifferent" - 40%, motivated "motivations" - 70%, highly motivated "highly motivated" - 80%, excessively motivated " overly motivated" – 90% (Fig. 2).

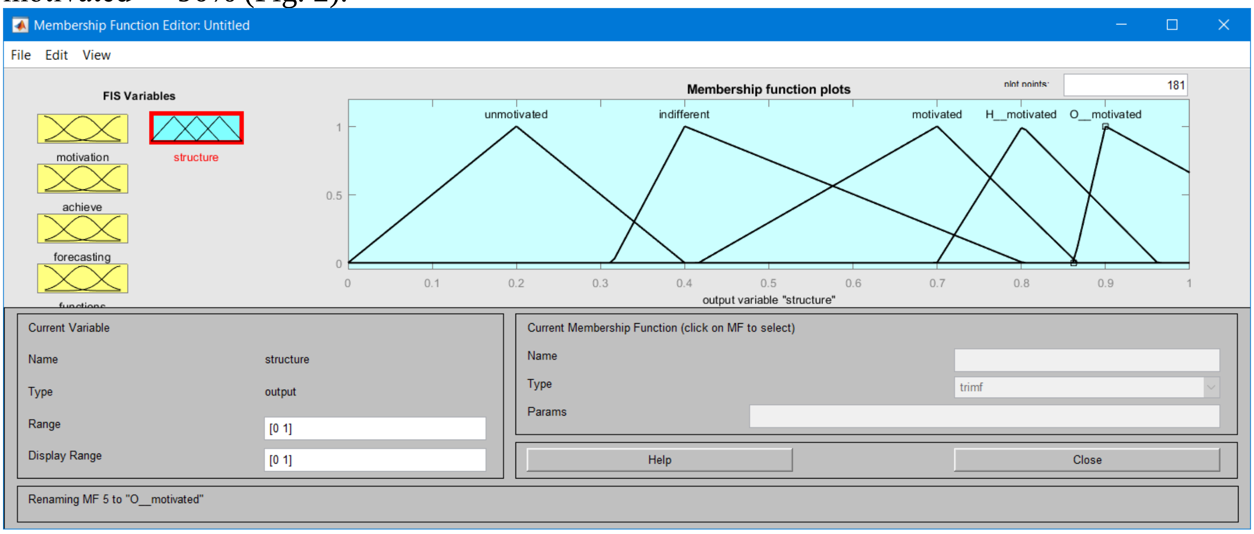
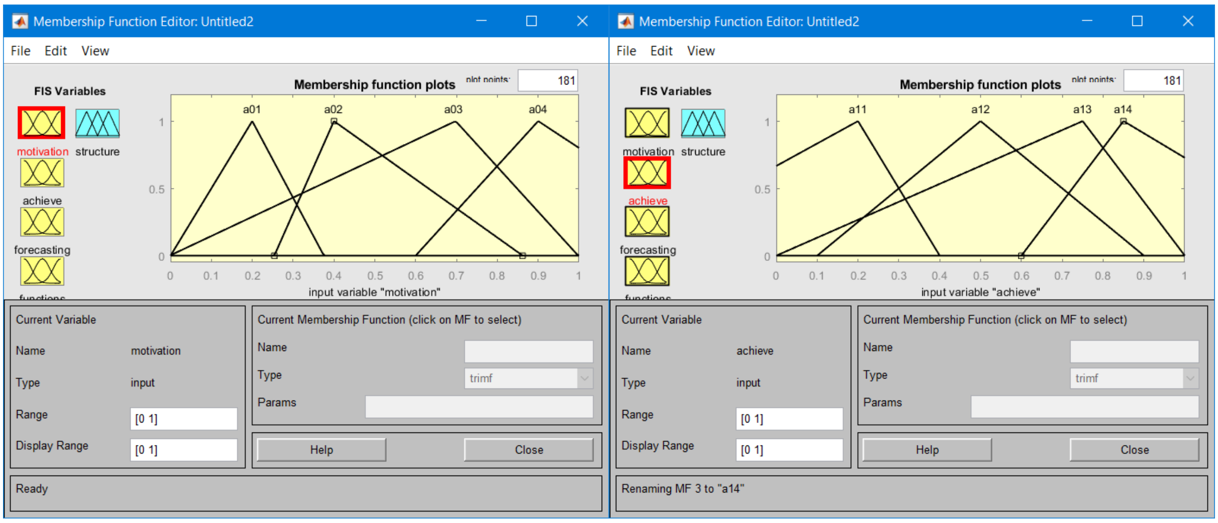



Fig. 2. Fuzzy membership function of the navigator motivational structure

$\alpha_{01} = 0,15$ - the motives of the navigator are not clearly expressed, $\alpha_{02} = 0,4$ - ensuring the usefulness of the performed task, $\alpha_{03} = 0,7$ - application of new knowledge - acquisition of new experience, $\alpha_{04} = 0,9$ - reduction of the level of danger when performing the task, $\alpha_{11} = 0,2$ - the navigator does not see the connection between the means, the action and the result, $\alpha_{12} = 0,5$ - the navigator connects the action and the result, $\alpha_{13} = 0,75$ - the navigator connects the action and means of achievement, $\alpha_{14} = 0,85$ - the navigator connects the means and the result, $\alpha_{21} = 0,35$ - belonging to the sea team, $\alpha_{22} = 0,55$ - career of the future captain, status in society, $\alpha_{23} = 0,65$ - economic and social security, $\alpha_{24} = 0,8$ - development of professional qualities, $\alpha_{31} = 0,4$ - "orienting" - the navigator's choice of behavior most acceptable to him in this situation, $\alpha_{32} = 0,55$ - "meaningful" - the navigator is guided by the subjective significance of the behavior for the image of the shipmaster, $\alpha_{33} = 0,75$ - "mobilizing" - the navigator mobilizes the internal reserve to demonstrate his best qualities in critical situations, $\alpha_{34} = 0,85$ - "exculpatory" - the navigator demonstrates normative behavior in all situations.

The rules for navigator #1 constructed in this way will also be based on the following linguistic variables (Fig. 3). We will construct fuzzy membership functions for the variables: $\alpha_0$ - the core of motivational structure "motivation"; $\alpha_1$ - motivation to achieve "achieve"; $\alpha_2$ - prognostic assessment of "forecasting" activities; $\alpha_3$ - functions of motives in accordance with the performed activity "functions".



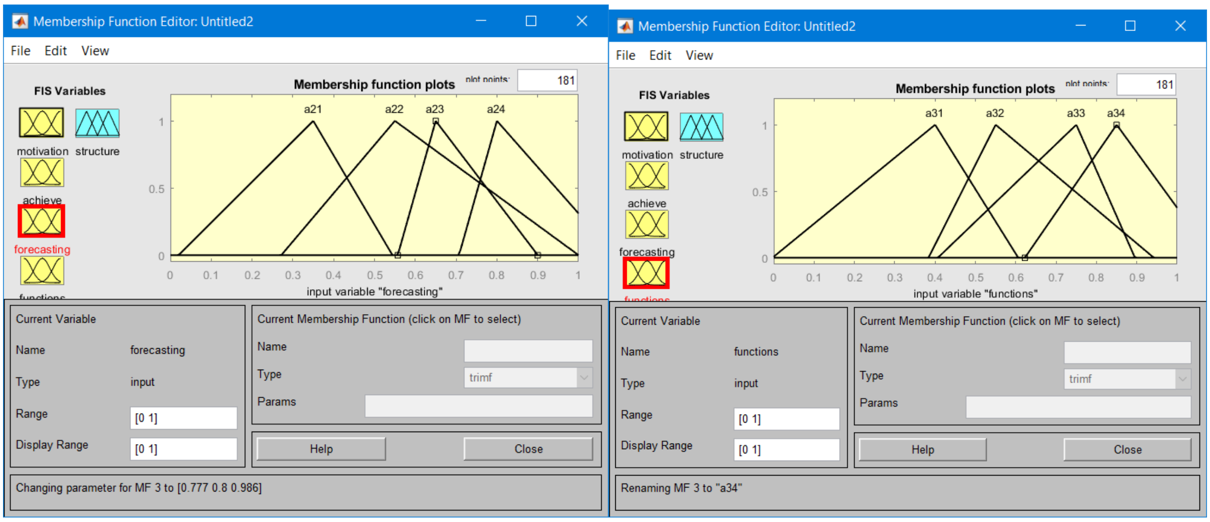


Fig. 3. Formation of fuzzy variable membership functions

Taking into account the individual test results for the navigator, a number of fuzzy inference rules were constructed (Fig. 4 a,b), namely:

1. If it is observed: "the motives of navigator are not clearly expressed", then the navigator is unmotivated "unmotivated".

2. If it is observed: "ensuring the usefulness of performed task" or "the navigator connects the action and result", then the navigator is "indifferent".

3. If the following is observed: "development of professional qualities" or "the navigator mobilizes his internal reserve to demonstrate his best qualities in critical situations", then the navigator is motivated by "motivations".

4. If it is observed: "application of new knowledge - acquisition of new experience" and "economic and social security", then the navigator is motivated by "motivations".

5. If it is observed: "development of professional qualities" and "the navigator demonstrates normative behavior in all situations", then the navigator is highly motivated.

6. If the following is observed: "belonging to a sea team" and "the navigator's choice of behavior most acceptable to him in this situation", then navigator is motivated by "motivations".

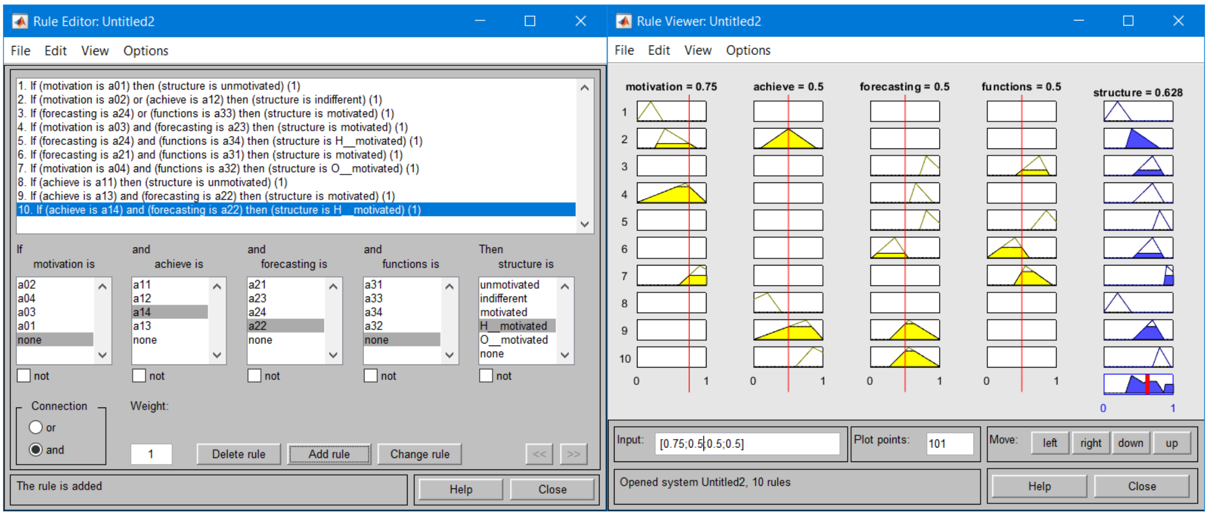
7. If it is observed: "the navigator is guided by subjective significance of behavior for the image of shipmaster" and "a reduction in the level of danger when performing the task", then navigator is overly motivated.

8. If it is observed: "the navigator does not see the connection between means, action and result", then the navigator is unmotivated.

9. If observed: "navigator connects action and means of achievement" and "future captain's career, status in society", then navigator is motivated by "motivations".

10. If it is observed: "navigator connects the means and result" and "career of the future captain", then the navigator is highly motivated.

In this way, a system of fuzzy rules was created (Fig. 4 a) [18-20].

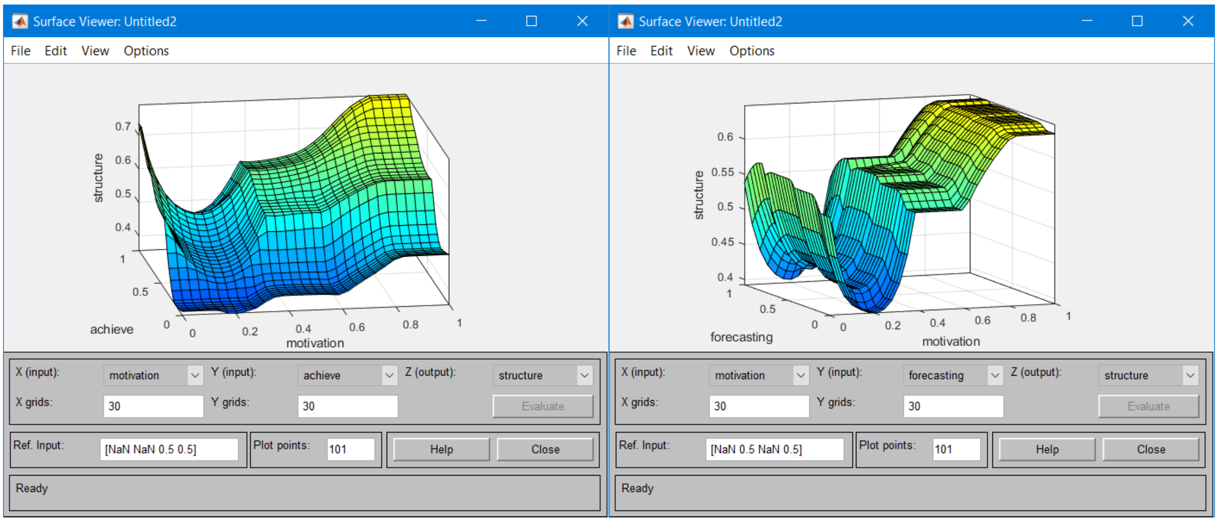



*a* *b*

Fig. 4. System of automated fuzzy rules Fuzzy Logic Toolbox

As can be seen in Figure 4 b, the navigator has an overall speed indicator when working with information interfaces at the level of 62.8%. The most influential factor is After modeling the nonlinear dependence on the most significant parameters of the motivational structure, the following graphs were obtained (Fig. 5 a, b).

The results of fuzzy modeling obtained in this way make it possible to intelligently manage the processes of formation the navigator's motivational structure.




*a* *b*

Fig. 5. Graphs of dependence of parameters when modeling motivation

**Conclusion.** The proposed approach to use of fuzzy sets for modeling navigator's motivational structure during complex maneuvers will bring the process of keeping a navigational watch closer to a safe one. The possibility of automated modeling will make it possible to determine the "strong" and "weak" sides of navigator, determining the vector of his qualification transformation for future. A set of measures on the part organizational and technical system of water transport and educational structures will form the criteria for requalification in real time.

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