Chapter 11
Models of Decision-Making Operators of Socio-Technical System

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ABSTRACT

In this chapter, the authors present Air Navigation System (ANS) as a Socio-technical System (STS). The authors present models of decision making (DM) operators of STS, such as the deterministic models obtained for using network planning; the stochastic models obtained for using decision-tree; models in uncertainty obtained for using criteria Vald, Laplace, Savage, Hurwicz and other. The authors presented also DM models of operators in ANS, such as the neural network models, fuzzy models, the Markov network models, GERT-models for modelling and forecasting of behavioral activity of ANS's Human-operator (H-O) in flight emergencies situation. The scenarios of developing a flight situation in case of selecting either the positive or negative pole in accordance with the reflexive theory have been obtained. They demonstrate some examples with DM's deterministic and stochastic models for engineers, pilots, air traffic controllers, Unmanned Aerial Vehicle (UAV) operators, managers etc. In addition, the chapter presents some examples of DM models developed by the author and students at National Aviation University.

MODELS IN AIR NAVIGATION SYSTEM AS SOCIO-TECHNICAL SYSTEM

Air Navigation System referred to STS within which close co-operation between human and technological components occur (International Civil Aviation Organization [ICAO], 2002; 2004; 2009; 2013). Actual represent models of DM by the ANS's operator in emergency situations (ES). Currently, one of

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the main strategic problems of mankind on the path to sustainable development is the safety and stability of technogeneous production. It is already known that technogeneous production is a complex system that contains interrelated technical, economic and social objects. For many years, scientists have been research in the field of improving complex system as STS, aviation safety, decision models, problem of learning from failure, airline accidents of human factors (HF), human error, etc. (Emery, 1959; E.Trist, 1981; Clegg, 2000; Kuchar $ Yang, 2000; Pasmore, 2001; Carayon, 2006; Hendrick, 2006; Mumford, 2006; Fedja Netjasov. 2008; Baxter & Sommerville, 2011).

As a result of the previous studies the factors which affect the DM by an ANS's H-O have been determined, namely: level of knowledge, skills, abilities, preceding experience as well as the factors of *professional* and *non-professional* nature (psycho-physiological, individual-psychological, social-psychological factors). The systemic analysis which has been carried out as well as the formalization of the factors which affect DM by H-O in the conditions of the progress of a flight situation from normal to catastrophic obtained (Kharchenko, Shmelova & Sikirda, 2011, 2012, 2016; Shmelova, & Sikirda, 2012, 2013a, 2013b, 2015, 2016, 2017) and obtained *models* of preferences by an H-O under the influence of *social-psychological* factors; preferences by a H-O depending on the significance of *individual-psychological* factors in the conditions of development flight situations from normal to catastrophic ones; the models of diagnostics of *psycho-physiological* factors at the score of monitoring the emotional state of H-O; the models of personality, behaviour and activity of Air Navigation system's H-O and models of DM in ES etc. The authors of this manuscript researches are: decomposition of the process of DM by H-O ANS, systemic analysis, and formalization of the influence of the factors on the DM within ANS treated as complex STS; working-out of models DM by H-O in socio-technical ANS (DM under Certainty, DM under Risk and DM under Uncertainty); calculation the scenarios of the flight situation development using GERT's and Markov's networks (Kharchenko, Shmelova & Sikirda, 2011, 2012, 2016; Shmelova T., Sikirda Y. 2012, 2013, 2015, 2016, 2017). For the formalization of the behavioural activity of H-O ANS in flight situations those models seem to be suitable which present the process of appearance of separate preconditions and their development into the causal chain of events in the form of proper diagrams of causal-consequential relations. Nowadays the most widely spread are the diagrams in the form of different graphs (or current states and transitions), trees of events as well as functional networks of stochastic structure (Kharchenko, Shmelova & Sikirda, 2012). The structural analysis of developing flight emergencies (FE) and DM by aircraft (AC) crew and air traffic controller (ATC) in FE with the aid of decision-tree enabled to obtain such results: graphical-analytical models of FE development and DM by a H-O (controller, pilot) in FE; stochastic models type GERT network (Graphical Evaluation and Review Technique), decision-trees and Markov chains; reflexive models of bipolar choice in FE under the influence of external environment, previous experience and intentional choice by H-O.

Decision Making by Human-Operator in Flight Emergencies

The environmental conditions determine the reaction of H-O, while the reaction of the latter, in its turn, changes the environmental conditions themselves. The systemic analysis which has been carried out as well as the formalization of the factors which affect DM by H-O (individual-psychological, psycho-physiological and social-psychological) in the conditions of the progress of a flight situation from normal to catastrophic, models in this situations as the models of DM in Risk and Uncertainly, the models of preferences by an H-O under the influence of social-psychological, individual-psychological