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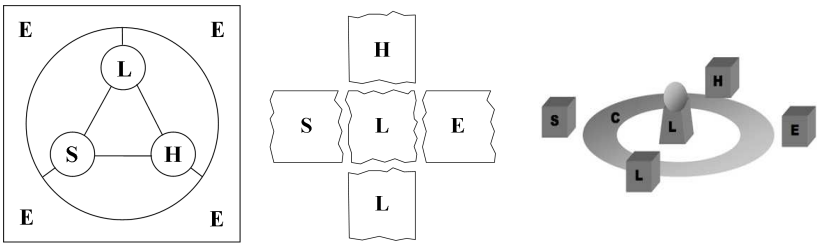
The Development of Ideas about Human Factor

The interconnections between the objective requirements for a human in a socio-technical system and the operating philosophy from designers' point of view, on the one hand, and the real human performance characteristics and the professional worldview of the personnel in the specific organizational culture, on the other hand, are analyzing on the basis of idea of the organizational culture importance in the structure of human factors. The model of dangerous inconsistencies in a socio-technical system which may influence on its reliability is proposed.

As practice shows, automation creates new opportunities for humans, but it also causes new challenges. It is obvious that a view of innovation from the perspective of the human factor, i.e. the entirety of the consequences of human contact with information, tools, tasks and rules of activity, as well as the physical and social environment in the process of activity in new conditions, can significantly help to improve existing and create new socio-technical systems.

The human factor is characterized by the complexity of its structure and interrelationships of elements, which makes it difficult to assess and correct the consequences of the constant evolution of technology and equipment in terms of the role and capabilities of a human.

The evolution of human factors concepts reflects the desire to cover its important aspects comprehensively (Fig. 1).



a b c

Fig. 1. Variants of vision of the human factors model: a) the SHEL model (E. Edwards, 1972); b) the SHELL model (F.H. Hawkins, 1987); c) the variant of presentation of the SCHELL human factors model [7] (A. Keightley, 2004).

Thus, the development of the concept E. Edwards (Fig. 1a) was proposed F. Hawkins improved model (Fig. 1b), which included two elements are «Liveware». Element L, located in the external circuit models Hawkins reflects

factors such as teamwork, communication, leadership, social norms, while the central element L defined by a set of human individuality aspects such as knowledge, attitudes, cultural characteristics, manifestations of stress, etc. [2].

The essential question is: how important is the interconnection between the S-H elements for a special analysis? The SHEL model considers this connection, while the SHELL model ignores it.

The argument in favor of an affirmative answer to this question is that equipment and rules are created by people under the influence of their ideas about a wide range of human characteristics and ways to optimize the human factor. Such ideas may differ from person to person.

A human being as a personality is a carrier of an individual “inner world” with an inherent system of aspirations, feelings, ethics. This is clearly evident in the field of professional activity. Unlike physiological and psychophysiological factors which can strictly determine the operational capabilities and limitations of a human operator, psychological and socio-cultural factors have a complex effect on what a person brings to a work situation due to many features formed in ontogenesis, such as values, behavioral attitudes, style of relationships with others and lifestyle, communication skills, knowledge, professional and life experience.

Attention to cultural (socio-cultural) aspects of the human factor observed for a long time [3, 4, etc.], including in the context of improvement of crew resource management programs [5]. Socio-cultural aspect found expression in a model of the human factor SCHELL (Fig. 1-B), where component C is defined as "organizational and national cultures that influence the interaction" [6, 7, 8].

We analyzed complex and contradictory processes manifestations of socio-cultural factor in the post-soviet space in the context of regulation joint activity in the composition of the flight crew and practices of crew training by programs for learning effective interaction [10, 11]. It has been shown there are phenomena that can directly threaten flight safety in a collision of different professional worldviews, traditions and individual differences of professional experience.

Thus, the analysis of crew's training programs prevalent on the post-soviet space testified that some of them directly contradict the modern concept of CRM, but consistent with the inherited corporate culture and individual professional worldviews [10]. Under these conditions at some stage of society transformation the whole layer of problems occurred against the backdrop of transfer into post-soviet space of air transport industry some norms and rules of interaction between members of flight crews that were established in accordance with the representations that differed from prevailing in the entrenched culture.

The model of the human factors can be understood as the *risk map* which helps to see hazardous areas of inconsistencies. We see that it is evolving in the direction of increasing the number of its components. They will lead to a further increase in model complexity, but certain phenomena associated with the human factor, obviously require additional constructs.

Output may be to the basic concept supplemented other agreed models aimed at disclosing some aspects that were not direct representation in the main concept. Next our steps are directed to this goal.

In spheres where sophisticated equipment is operated, an important component of the human factor is the specific entity that we call *operating philosophy*. Under this concept we understand the basic ideas and requirements for the content and organization of the process of people activity as a part of socio-technical systems, as well as ways to ensure reliability of human component and the whole system. One of the functions of operating philosophy is to ensure the unity of design solutions machine component and specified operational rules. But the fundamental role of operating philosophy is a conceptual agreement between all the components of the human factor.

The content of operating philosophy is usually determined by aircraft manufacturer and should be based on operational experience. Inconsistency of prescribed operating philosophy and socio-cultural features of the operating organization can be a very real danger (Fig. 2).

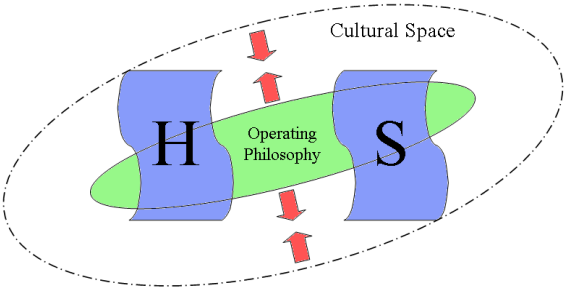


Fig. 2. Field of operating philosophy manifestations

The operating philosophy should fit non-contradictorily into the corporate culture and the space of individual worldviews of the personnel (Fig. 3).

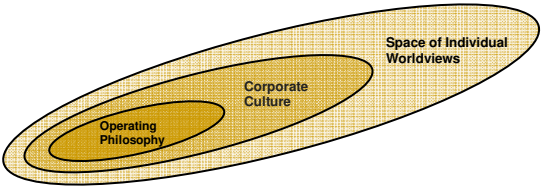


Fig. 3. Acceptable interrelations spaces of operating and regulatory philosophy, corporate culture and individual weltanschauung

In our view, the operating philosophy is based on an understanding of the opportunities and vulnerabilities of human and, accordingly, on a notion situations and risks that can be overcome through human potential, as well as on perceptions of the risks and difficulties that may arise due to limitations of a man (Fig. 4). It is important that this should apply to both individual and team activity.

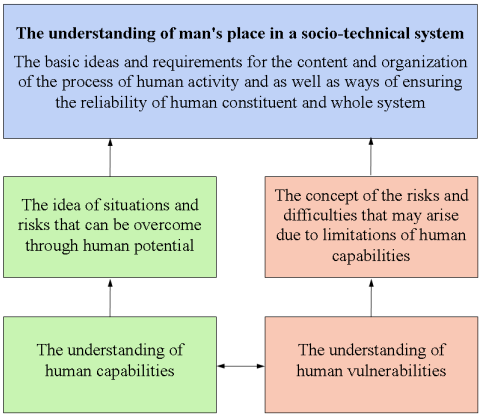


Fig. 4. Genesis of operating philosophy

In addition to the problem of integrity of professional culture of world aviation, there is also a problem of consistency outlooks on the human factor among the designers of aviation equipment and among operators (Fig. 5). Distortion of operating philosophy as a result of many factors at the stage of realization of design intent may exacerbate this problem.

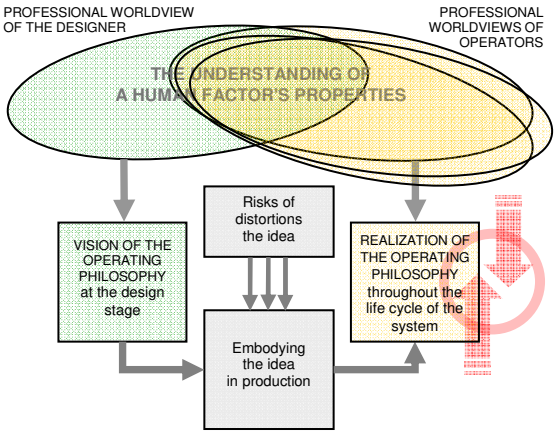


Fig. 5. Coherence of designers' and operators' worldviews as an aspect of the human factor

Professional outlook is defined by the essence of performed activities, which are different for the designers of aircraft equipment and for pilots. It should be noted, that in the context of automation, the worldview of developers more literally

enters into the workspace of operators. It can be said that developers of automated systems are implicitly present alongside pilots in the cockpit, as virtual crew members [9], so in the context of a conversation about the differences in the worldviews of developers and operators, we can talk about phenomena similar to misunderstandings between team members.

Based on the all above, we suggest it appropriate to introduce such aspects as *operating philosophy* and *requirements for a human* into the field of human factors consideration in their correlation with the actual *cultural peculiarities* of professional teams, as well as the actual characteristics of the *personnel performance* based on the real existing capabilities, experience and worldview (Fig. 6) [12].

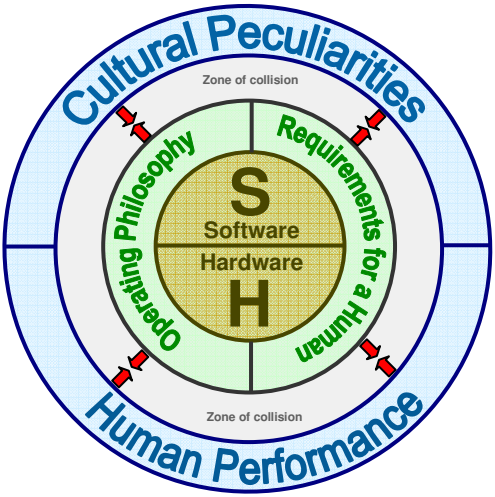


Fig. 6. The Model of Dangerous Inconsistencies in a Socio-Technical System (Petrenko, 2015)

This model corresponds with concept SCHELL and directs attention to the zone of collision between the objectively necessary and the actually available. Thus four key areas for analysis (shown in red) can identify, namely:

– accordance between the cultural characteristics of the local professional group and
  a) the operating philosophy as it was seen by the designer of the technical system,
  b) the objective requirements for a human in this professional activity;
– accordance between the real human performance characteristics and
  a) the objective requirements for a human in this professional activity,
  b) the operating philosophy as it was seen by the designer of the technical system.

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