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Interpretations of Human Error in Aviation

The author attempts to describe whether the human errors in aviation could be taken out of the system, or otherwise they are useful and prevention methods could be based on them. The human error, as parts of safety philosophy, are examined by many theories like the Reason theory, the SHEL(L) theory, and the SRK theory. Although, approaches and perspectives from which they circumscribe most of the frequent types of human error are different theories and conclusions have some similarities. One common element of them is, that they could not tell whether human error is acceptable or unacceptable. So as to answer this question the author points out the difference between old fashioned and modern safety philosophies.

Keywords: *decision making, flight safety, human error, human factor, Reason theory, SHEL(L) theory, SRK theory, system model*

1. What is Human Error?

Human error as a term used in everyday life does not mean the same thing to everyone. Even if the phrase is well understood, since it makes sense in itself, we cannot be sure that we mean the same thing. Mistake is associated with all human activities. This is not the case with safety-sensitive systems so we have to reckon with the fact that human imperfections in the aviation system, which are usually identified as human error, also contribute greatly to incidents in aviation. The consequence of errors in most cases is that the outcome of the flight is somewhat different from normal. This in itself does not mean that flight safety is greatly reduced by a single failure, but rather the combination of several failures can lead to a serious aviation incident. The fundamental differences in interpretation are caused by the fact that the concept of human error can be relevant from at least several different equivalent points of view. In this way, the concept can be interpreted as the cause of a problem, an event, or a consequence of something. The three views, of course, affect the interpretation of the error as follows:

- **blame**, when the focus is on the action that is the presumed consequence of the event (accident, incident) that occurred;
- **an event**, that emphasizes human action regardless of whether the error led to adverse consequences. Subjectively assessed, the impression of the errant in this case is in fact, that he erred, since a missed step in the checklist is assessed as an error even if it had no tangible consequences;

- **a consequence**, that highlights the result of the error. In this the interpretation is twofold. According to the first and most obvious approach, there is an inseparable, direct causal relationship between human error and adverse consequence. In this case, the close causal relationship actually combines the wrong action with the consequence.

According to the other approach human error has a latent but clear detrimental effect. The interpretation also implies that human errors are latently hidden in the system, even if they are repeated, and although they do not manifest they exert their harmful effects [1].

1.1. Human error in descriptive models

The concept of flight safety, including human error, is explained by several theories such as the Reason model, the SHELL (L) model, and the SRK model. Given that a significant proportion of errors, such as aviation incidents, originate in the field of the human factor, research has been aimed at finding and explaining the human error and other factors that have led to it for decades.

1.1.1. Reason model

The most widely known model was developed by James Reason. The basic idea of the model is that to prevent it, it is necessary to find the underlying causes of human error through a kind of event investigation chronology. The concept is based on exploring deep correlations that explore the evolution of error step by step, thus revealing the dormant factors that, when conserved in organizational culture, rules, or other factors, pre-encode the possibility of human error. The model here contrasts sharply with the outdated interpretation of human error, where "man in the flight system is nothing more than statistically proven to be the main cause of aviation incidents, so a "necessary evil" [2]. According to the outdated notion, a safe technical system must be protected from the human factor and its role in the operation of the system must be reduced by automation. In contrast to the modern notion where we must accept that the aviation system is fundamentally unsafe. Therefore, it carries risks and human error is not the result of accidental malfunctioning of the system, but other problems lurking in the system. Thus, between the event investigation steps, we need to make the analysis of human error the starting point of the investigation and not the end point. Otherwise, we can easily fall into the error of blaming without revealing the more distant correlations with the factors that led to the event that contributed to the human error. The central theme of Reason's research is this modern safety philosophical approach in which the development of fault models plays an important role. According to the focus of the model, there are basically three types:

- **person-centric model**
Concept: He views human error as a psychological factor. It traces the error back to the functioning of mental processes, stubbornness, inattention, forgetfulness. Hence, he finds the main cause of the error in the wrongdoer, and sees the solution

in its naming, punishing, shaming, and intimidating. It solves the problems that arise with more and more regulatory acts.

The downside is that it removes the error from its context and is therefore ineffective in exploring deeper connections.

→ legal-centric model

Concept: Aviation professionals are responsible for their actions, so they should not make mistakes. Although errors are rare, no matter how small, they are just enough to cause damage. The mistakes that led to aviation incidents are the result of negligence and recklessness, actions that deserve exemplary punishment.

The disadvantage is that since most errors do not lead to an aviation incident, a more serious case has to wait for the correction to take effect.

→ system-centric model

Concept: Imperfection is part of human nature. Adverse effects do not stem from undetectable mysterious factors. First-line professionals are not the cause but the heirs of the imperfection of the system. Preventive action is based on strengthening lines of defense (technical systems, training, rules) and neutralizing traps lurking for the human factor [3].

1.1.2. SHEL (L) model

The SHEL (L) model is a multidimensional version of the traditional HME (human-machine-environment) model, in which the human element is an equal factor to rules (software), technical systems (hardware) and the environment (liveware) is displayed [4]. The page of the model has the insight that the degree of integration of system components and the level of interconnection not only influence the relationship and cooperation of the elements but also determine the operational quality of the system as a whole. If we look at this operational quality for safety, every connection of each element adds to the level of safety of the system as a whole. We now omit the complete analysis of the model here but it is worth noting that the model has evolved from the original concept insofar as it now interprets the human factor and the connections within it not only in itself but also in its dimension. This means that the model is also able to examine the relationships within system components, so that LL and LE connections are also interpreted in terms of human interactions. Thus, similar to the Reason approach, the effects of organizational and social environment on safety and human effects within this factor may also be at the forefront of the study.

1.1.3. SRK model

A behavior-based approach to human error was examined by Rasmussen. Its decision-making model uses the tools of behavior and cognitive psychology and can be applied to many systems that require precise decisions, including the flight system. Your system differs by three levels, each of which carries the potential for error. These are:

- a level of proficiency where the activity is carried out almost without thinking and with little attention;

- the rules-based level where the rules are consciously applied after the situation has been assessed;
- the knowledge-based level where, in the absence of ready-made solutions in a new and unexpected situation, the acquired knowledge and experience need to be used creatively [5].

In terms of the elements of aviation activity they are based on continuous human decision chains that can be accurately matched to one of the SRK levels and in general it can be said that proficiency, rules, and knowledge are of great importance in the flight system as well. Therefore, the application of the SRK model can be applied to decision-makers in the aviation system without much difficulty. Examining the nature and context of human error more broadly, drawing on the concepts of the models already outlined, the most typical types of human error fit certain elements of the model concepts, such as:

- disregard for rules (rule violation) can be interpreted at the R (rule) level of the SRK model, but also in the S-L (rule-man) relationships of the SHEL (L) model and in the person- and legal-centered approaches of the Reason model;
- procedural errors can be interpreted at the R (rule) level of the SRK model, but also at the S-L connections of the SHEL (L) model if the procedure is faulty, or at the K (knowledge) level if the procedure is not known. Among the lines of defense presented in the Reason model, training and refinement of rules may also suggest avoiding procedural errors;
- communication failures may be detected more narrowly within or between flight crew or organizations or even about the wider political or social environment. In the former cases, for example, unclear procedures, tasks, competencies, in the latter case, undeclared goals and undeclared commitment to safety can be cited as examples. Among the presented models, the L-L and E-L connections of SHEL (L) are worth mentioning;
- proficiency-based errors refer to the S (proficiency) level of the SRK model, but parallelism can be detected with the training among the lines of defense of the Reason model, which in this case should be interpreted as proficiency-enhancing practical training;
- erroneous decisions made at the operational level, mostly related to the SHEL (L) and Reason models, if the former's L-L (human-to-human) and E-L (environment-human) relationships and the latter's modern safety perception point to the safety implications of operational decisions inside and outside the organization [6].

1.2. Interconnections amongst interpretations

Among the outlined conceptions of human error the Reason model points to the fact that the actions of those operating in the flight system are at the same time preconditions for the actions of others. The modern conception of human error highlights that the rigid philosophy of safety according to which human error is bad and must be combated, raises unrealistic expectations as it does not accept that the flight system becomes operational through no fault of human activity, and as such itself is imperfect. In changing, information-poor and

often contradictory operational conditions, a flawless activity cannot be expected, so perfect safety and flawless human activity cannot be realistically achieved. The problem of different interpretations of human error does not end with the diversity of perspectives. The mention of an error in most cases also implies a judgment if the act which causes or may cause an adverse consequence is weighed together with the person causing it, so that the correctness or incorrectness of the act is also judged.

This in itself is an oversimplification as human actions – especially in aviation – seldom influence the development of adverse effects, alone and directly, as a chain of events and mistakes leads to an unwanted event or situation in most cases. Error, as an expression, therefore presupposes a preconception in the chain of events leading to the incident or accident, in so far as it attributes the adverse consequence to the person at the end of the chain. Thus, instead of the deep-seated, latent (organizational, cultural) factors presented in the Reason structure, the focus is on the person in the front line, his right or wrong action, offering a quick solution to explain the situation.

Hollnagel's interpretation can be criticized at this point insofar as it does not go further in its interpretation of human error as a consequence. The error, whether visible or even latent, is interesting not only for the future elimination of the harmful consequence but also because it can be regarded as a consequence in the sense of reason itself. The second step in interpreting the consequence should therefore be to understand that all dimensions of the three-level error structure (rule, proficiency, knowledge) presented according to the SRK model can carry faulty elements that are ready sources of danger for the executor, therefore their prevention or non-prevention is not professionally expected. Therefore, neither the person who erred nor the erroneous act can be judged from the point of view of professional correctness as the result of the performed operation did not intentionally deviate from what was expected. To solve the problems of the judgment-based categorization described, Hollnagel and Amalberti propose the following classification:

- well-executed operations, operations whose actual result is the same as the aims and intentions set;
- corrected operations, operations that have been carried out incorrectly in any way but which deviate from the intended purpose have been detected and corrected during the operation. In forgiving systems, similar faults are not revealed until they can be corrected;
- faulty operations, operations that were performed incorrectly in any way, deviation from the set goal was detected during the operation, but the fault could no longer be corrected due to the irreversibility of the process, lack of time, or lack of resources. The activity is considered defective;
- negligent operations, which were carried out incorrectly in any way, deviation from the intended purpose was detected during the operation but was ignored. The activity is considered defective;
- fatal operations that were performed incorrectly in any way, but no deviation from the set target was detected during the operation, so the error was not corrected [7].

2. Err for safety?

As we look at the above classification, or the theories already presented, we run into the question of whether human error, which seems unpredictable and random, can be squeezed into categories at all with any predictability. When we try to describe the human activity that operates the system of flight with theories, can we approach the variety and creativity that characterizes the activity of the human factor? Is it acceptable that the human activity that operates the system is "active and creative" in the production of errors as well?

To answer the questions, it is worth examining the role of the human factor and its contribution to aviation safety. The effectiveness of a flight safety system can be measured by the success of prevention. Measuring this success is a complex task as in this sense, measuring safety would mean measuring a lack of something, that is, a lack of aviation incidents, or even a lack of human error. This would, of course, be impossible and pointless, as it is possible to measure the consequences of shortcomings in the flight system and not their absence. The performance of aviation safety, or in other words, the efficiency of incident prevention may be illustrated by the number of aviation incidents, but it is increasingly advisable to illustrate this performance by the fulfilment of aviation safety targets [8].

The assessment of both measurement objects relies heavily on statistical methods which allow the long-term comparability of safety indicators by category and professional perspective and the exact assessment of performance targets. Without statistical comparison it is not possible to measure flight safety results with sufficient accuracy just as it is not possible to produce good statistics without an adequate database.

The safety database is uploaded by a number of data sources. The safety-conscious predictive systems are typically voluntary and mandatory reporting systems are supplemented by other data sources that ensure the flow of safety information and data within and between organizations. The primary purpose of aviation safety data collection is to channel detected and identified hazards into the aviation safety system. In contrast to more serious aviation incidents these are of lesser importance but some anomalies are easier to analyze and correct. Once in the system, these data, every day happenings of seemingly insignificant minor errors and discrepancies create the opportunity for proactive prevention through processing, risk analysis, and evaluation. The data to be processed, with regard to the origin, composition, and proportion of error factors, are about the human factor and its major or minor errors. Thus, if we were to think of human error as a malfunctioning of the system, of illuminating it, and of being able to eliminate errors from the aviation safety system altogether, statistics would be empty and analysis impossible. Such a situation cannot, of course, arise because it is impossible to banish the human element from the system. But if we look back at blaming, criminal person-centered, or legal-centered safety philosophies, we can easily see that it is possible to "disappear" a mistake with a simple negative attitude, somehow:

"Mistake is harmful, you must not make one! So the professionals follow the rules and don't make mistakes!" It is the result of this kind of safety philosophy, organizational culture and an atmosphere in which it is better to hide a mistake than it never as if it never was. From such a non-existent mistake, of course, no one will ever learn and prevention will not benefit.

In contrast, a system-centric approach that perceives error as natural does not see it as a cause, but as a consequence of more distant factors, is less likely to fall into the error of blaming. Such a modern approach to safety encourages the detection of errors, analyzes, and

documents cases without the intention of blaming. Prevention is thus able to identify and address safety threats at the level of everyday deviations before major aviation incidents occur.

The fundamental difference between the two perceptions can be seen not only in the contrast between inefficiency and proactivity but also in the presence or absence of risk awareness. The differences and the benefits of a systems-centric approach can be well illustrated using the analogy of the procedures used in statistical hypothesis testing. In the hypothesis test we try to exclude two types of errors. On the one hand, we want to avoid a situation where our assumption is not confirmed, i.e. we stop or disrupt the continuation of the activity unnecessarily so we end up crying wolf. This is called the first type of error. In the aviation safety system this would mean taking action on hazards that do not prove to be real. Fortunately, a well-functioning safety prevention system is able to filter out these quasi-hazards with risk and severity analysis tools. In this case, just as in the case of a statistical first-order error, the probability or risk can be calculated so it is accurately known.

In the other case, however, when we allow an activity to continue without ignoring the underlying problem, we bury one's head in the sand. In the statistical hypothesis test, this is called the second type of error. This means in both statistics and flight safety that a problem, such as a source of danger, is ignored and therefore not analyzed so its risk is unknown and therefore cannot be calculated. In general, but also from a professional point of view, it is always better to know about problems and be aware of the risk than to risk the unknown by sticking our heads in the sand. From an aviation safety point of view the statement is straightforward as is the recognition that a system-based safety approach is more supportive of a more effective prevention system than a person-centered or legal-centered approach. So the question of whether we should make a mistake for safety can now be answered. Theories describing flight view human error from different perspectives and most likely do not provide a reassuring solution to eliminate it. At the same time it is worth asking the question, is it necessary to aim at reducing the number of human errors at all? The answer to this is provided by a modern, non-blaming, system-centric safety philosophy that sees failure as an opportunity. The potential for human error to come to light should be the focus of safety analysis and ultimately serve prevention. From this point of view an error is a useful thing, not a violation to be prosecuted, contrary to the ideas of the person and legal-centered models.

3. Summary

Flight safety depends on several factors but the human factor occupies a prominent place among them as a significant proportion of aviation incidents can be traced back to this area. That's why, when we talk about a human factor, most of the time we think of some kind of human error that triggered the event. So the obvious idea is that eliminating human error will lead to improved safety. However, this approach also leaves room for inhumane perceptions that see the solution in punishment as well as in ever-new regulations. These solutions are accompanied by the stigmatization of the error made as well as the denial of the appropriateness of the error. The solution is thus counterproductive as it triggers the concealment of the error, thus depriving the prevention of useful experience that can be drawn from the error. In contrast, accepting that error is inherent in human nature leads to a level of rationality where

the error is no longer a necessary evil but an opportunity for prevention, provided that their analysis can address and prevent more serious problems before they develop.

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Az emberi hiba értelmezése a repülésben

A szerző megkísérel választ adni arra a kérdésre, hogy van-e értelme az emberi hiba eltávolítását célzó tevékenységeknek a légi közlekedésben. Vagy éppen ellenkezőleg más úton válhat hasznossá. Például úgy, hogy a prevenció eszközévé válik. A repülés biztonságfilozófiájával, ezen belül a humán faktorról és az emberi hibával elméleti modellek (Reason modell; SHEL(L) modell; SRK modell) foglalkoznak. A modellek eltérő nézőpontjaik ellenére szinte kivétel nélkül alkalmassak az emberi hiba leírására, így bizonyos pontokon hasonlóságokat és átfedéseket mutatnak. Ugyanakkor teljes egészében nem adnak kielégítő választ az emberi hiba elfogadhatóságára vagy elfogadhatatlanságára. A kérdést a szerző a túlhaladott és a modern biztonságfilozófia elemeinek bemutatásán keresztül válaszolja meg.

Kulcsszavak: emberi tényező, emberi hiba, Reason modell, rendszermodell, repülésbiztonság, SHEL(L) modell, SRK modell

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