RECORDING AND EVALUATION OF HUMAN FACTOR EVENTS WITH A VIEW TO SYSTEM AWARENESS AND ERGONOMIC WEAK POINTS WITHIN THE SYSTEM, AT THE EXAMPLE OF COMMERCIAL AERONAUTICS

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Abstract: The risk for human errors is particularly high, if a person has not considered enough information about his situation. This consideration of information also can be described as situation awareness. It will become dangerous, if a person assesses his awareness higher as it is actual. This discrepancy between subjective and actual situation awareness can be found out at almost all Human Factor (HF) Events. With the examination of the situation awareness, the event analysis is carried out consistently from the point of view of the man. By this concept, HF Events can be examined even more on ergonomic aspects. It is however necessary that reports about HF Events provide sufficient information about the situation awareness. For this a computer-based event analysis scheme is used to report events interactively. With this software, we currently investigate how it is possible to create uniform and comparable event reports. The complete event is divided up into sub-events and is described using the Man Machine System framework. The demarcation of the sub-events is mainly made by allocation of the persons involved. This human and system related view also allows describing the situation awareness of this person and provides data for the later analysis of the situation awareness.

Keywords: Situation awareness, Human Factor, Event reporting, Event evaluation

INTRODUCTION

Which roll play the situation awareness (S/A) at human factor events? To follow this question, the course of the S/A must be determined at an event. The concept S/A means the ability in a situation by selective analysis of current objects and events in front of the background of former experience to work out an active, stable construction of the reality [1]. Since the S/A is a mental process, it can't be determined exactly in quantitative terms. Therefore at the analysis of the S/A the question must be asked, which awareness apparently wasn't available. This operation should be carried out at the analysis of event reports. This also means however that the event reports have to be elaborated more strongly on the description of the S/A. In connection with this, an event report program is introduced which strictly orientates itself at the Man Machine System. This program is mainly an interactive input surface to assure that event reports remain the same analysis quality. Independently of point of view and technical qualification of the reporting person the event reports should have a uniform structured and comparable form. The evaluation of the reports can then be carried out with the existing event analyzing method CAHR [2].

STRUCTURE OF THE TEXT

An introduction of the concept "Situation Awareness at Human Factor Events" is carried out first. This is to understand the theoretical bases of this cognitive aspect. In the following example the S/A is applied qualitatively on the crash of an commercial aircraft near Cali/Colombia at the 20th Dec 1995. After this the method for the determination of the S/A is introduced. A discussion about the advantages of the examination of the S/A follows and completes the section about the situation awareness. The second section is about the recording of Human Factor Events. The S/A can be evaluated only from events in which this cognitive aspect is taken into account. In addition, a report method should guarantee that different events are represented comparably, and reports of different persons lead to a single result report. Following these requests a computer based input surface which these shall fulfill is described. The final outlook is about the possible uses of these findings.

1. SITUATION AWARENESS

1.1. Situation Awareness during an Event

At first a possible course of situation awareness during an event is described qualitatively. At this you distinguish between the subjective and the actual situation awareness. The subjective situation awareness represents how a person judges about his knowledge about the situation. The actual situation awareness of this person gives back the objective state of knowledge about his situation. In the favorable case the actual situation awareness goes equal or slightly below the subjective course. This means that the impression of the person about her situation corresponds to the reality roughly. But then, it can become critical, if the situation changed unnoticedly of the active person. Such an event is represented in Figure 1 as an exemplary.

On the vertical axis the situation awareness is shown in percent, on the horizontal axis the event progress. Between

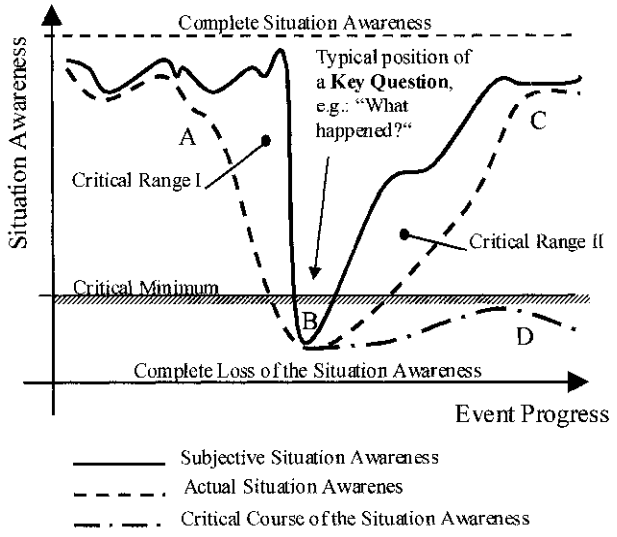

Fig. 1: Situation Awareness during an Event

complete and total loss of the situation awareness a critical minimum can be accepted. If the actual situation awareness is below the critical minimum, the active person cannot accomplish the present task. In Figure 1 both awareness graphs go normally at the beginning. In A it comes to an unnoticed disturbance. The common course divides and the actual situation awareness starts to decrease. The Critical Range I results from this discrepancy. Because the situation changes further unnoticedly, the actual situation awareness diminishes on a level, which can lie below the critical minimum. The course of the subjective situation consciousness remains on it's level until the active person recognizes the disturbance. Then the subjective awareness fell down to a level of to the actual value (B). Indications that the active person sees his lack of knowledge about the present situation are *Key Questions* like "What happened here?" or "Where are we?" (Aircraft accident, Cali/Columbia, 1995). If the active person has seen the trouble, the action phase starts. The person must try to bring his actual knowledge about the situation over the critical minimum. If the subjective assessment of the awareness increases faster than the actual knowledge, the critical range II arises. This range is dangerous because the active person thinks wrongly that he has coped with the event. Often an inaccurate knowledge of the disturbance cause is the reason for the critical range II. If the situation awareness remains below the critical minimum, the trouble cannot be solved.

1.2. Example

Crash of a commercial aircraft near Cali/Colombia at the 20th Dec 1995 (Fig. 2)

At this event it came to an unnoticed change of course by a false input at the navigation computer of the airplane. The false course led the aircraft into mountainous terrain in the north of Colombia. The pilots notice the difference first when they recognize during the radio traffic with the control tower that their distance to the airport becomes enlarged. As countermeasure they try to catch the old course again. By the darkness they overlook however that the course correction conduct the aircraft against a mountain massif. By the steep rise of the rock face the ground approximation warning system reacts very late so that the pilots don't manage to overfly the mountaintop.

How can the situation awareness during this event be described?

When it comes to the unnoticed change of course in A, the subjective S/A remains on its normal level. The pilots have the assumption that they fly on correct course. In reality they are neither on the assumed course nor they know their position. Therefore they are missing decisive information about their situation. Their actual S/A lies far under the subjective, the Critical Range I arises. In the flying the dates position and course are so much essential that the actual S/A of the pilots can be described as below the critical minimum. [The critical minimum can be defined freely]. When the pilots recognize the problem in B, their subjective S/A also falls on a lower level. But they only partly see their situation: it seems that they do not realize that the false course led in mountainous terrain and they possibly fly too deep. Because of this, they carry out only a change of course and no flight level change. Their subjective S/A increases again while the actual remains below the critical minimum. From this discrepancy the Critical Range II arises. The actual S/A takes the critical course. There are no suspicious circumstances for the pilots, that their situation is critical furthermore. The subjective S/A falls again when the approaching massif triggers the ground approximation warning.

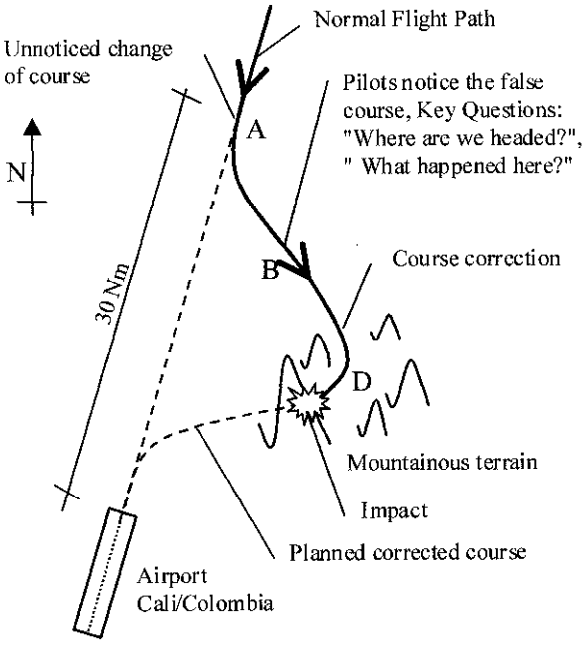

Fig.2: Aircraft Accident near Cali/Colombia 1995

1.3. Method for the examination of the situation awareness at flight accidents

1) Structuring

a) Representation of the complete event process above the time.
b) Splitting the complete event in single events.
c) Define times on which a disturbance probably has occurred.
d) Define times on which this disturbance has been recognized.
e) Define times on which the disturbance has been cleared or compensated.
f) Define times on which a control loss has occurred.

2) Analysis

a) Which is the cause for the disturbance?
b) How could the disturbance have been recognized?
c) How have the pilots recognized the trouble?
d) How long has it lasted till the pilots have recognized the trouble?
e) How have the pilots compensated the disturbance?
f) How long it has lasted till the pilots have compensated the disturbance or lost the control?

1.4.Which findings does the examination of the situation awareness bring?

The situation awareness shows the fundamental problem of man in their work surroundings. To be able to remove a disturbance, following points should be executed as well as possible:

- Recognition - At first the trouble must be recognized.
- Analysis - Then the cause of the disturbance should be analyzed.
- Decision - Now decisions about countermeasures must be taken.
- Execution - Finally the chosen countermeasures must be executed.

The examination of the S/A shall help to find the ergonomic weak points in the system which handicap or delay the trouble management. By the method of the S/A the event is analysed from the view of the man in its Situation. Through this it will be possible to understand the behave of the man at accidents or incidents and optimize man machine interfaces for this behavior.

2. Recording of Human Factor Events

2.1. Requests

The scientific analysis of HF events shall be free of the question of guilt:

Human Factor events are a little tricky. One who reports of an event experienced must admit own faults. Perhaps one who reports of faults of others takes colleagues to the twilight. It is the reason for this dilemma that the question after the fault is equated wrongly with the question of guilt. Having made a mistake means not inevitably that a person is also guilt at an event

The analysis of an event should be fast and uncomplicated for the report persons:

Only from reported events, cognition could be won for the future. One who wants to report an event shouldn't be deterred of much writing work, complex input surfaces or high time expenditure. Usually, severe accidents are already reported in sufficient measure. This is far less the case at smaller incidents or such without consequences. By this practice a high degree of operational experience is lost.

Independently of point of view and technical qualification of the reporting person the event reports should have a uniform, structured and comparable form:

Reports usually are as different as the persons who make it. Every singles event should be analyzed for itself and in connection with other events. To win an optimal experience profit from the events, therefore the reports must be available in a uniform and structured and therefore comparable form. If an event is reported independently by several persons with maybe various technical knowledge, then the reports should be closed on a single event nevertheless and perhaps be combined to one report

2.2. Solution Trial for the Recording of HF-Events

The lecture tries to represent how these requests can be fulfilled with a computer-assisted report input surface. The procedure bases on the event analysis method CAHR (Straeter, 1997) [2], which is already used at events in nuclear power stations. The report input surface has the following characteristics:

- *The input of the event is carried out interactively.*
- *Core of the input surface is a graphic representation of the event process.*
- *The event description is carried out step for step with the Man Machine Model [5], [6].*
- *The situation awareness is taken into account particularly.*
- *To the description of the events a general and a special taxonomy is provided. When required, the special taxonomy can be supplemented with further concepts.*
- *The sense coherence of the event process remains unchanged.*
- *The complete event is divided up in sub-events. The demarcation of the sub-events is either met by the user or suggested by the program.*
- *At the description of the event the user isn't bound to any order.*
- *During the input the giving data will be analyzed and if required sequence of operations the software asks further details about the event.*
- *Depending on state of knowledge the user will be completely or partly led through the input process.*

Representation of the event process

The event is divided up in sub-events, which each are assigned to one person (see Fig. 3). (In special cases the possibility exists, to assign a sub-event to none or several persons).

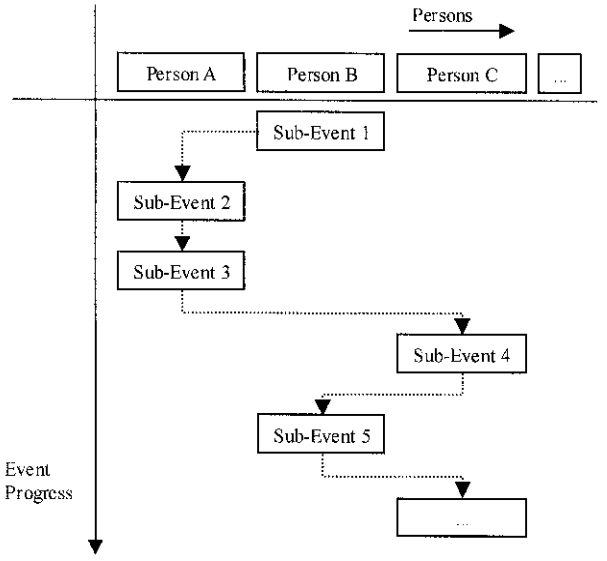

Fig. 3: Person related presentation of the sub-events [2]

Every sub-event describes a man machine system (MMS) (see Fig.4). Every component of the MMS is filled with details and descriptions about object, action, error and cause.

The program led the user through the input procedure. He can start to report with a sub-event of his choice. The software puts questions, if definite inputs are missing. Particularly you ask for broader causes at the cause detail. Particularly it asks during the causes input for possible behind lying reasons. From this events finally going first or following events are generated. A logical sequence of the sub-events arises from this.

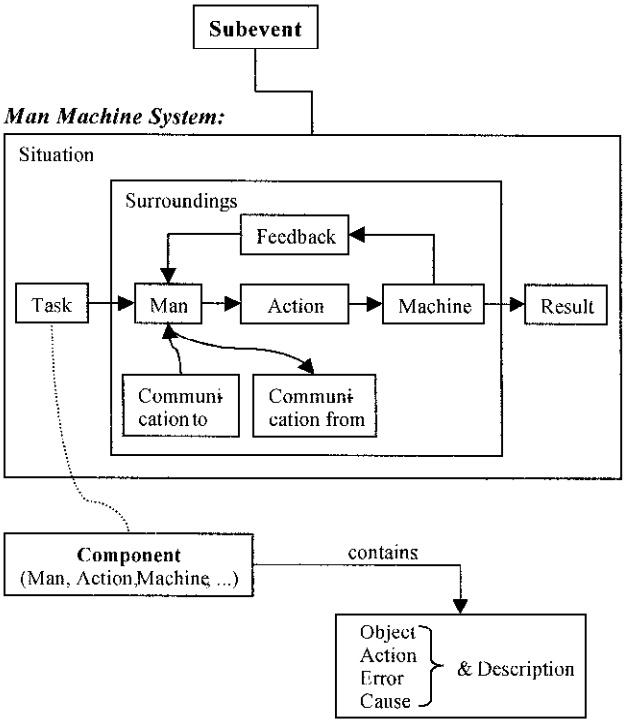

Fig. 4: Description of the sub-events

3. OUTLOOK

The next work shall prove that this event report method delivers the same analysis quality, independent of the complexity of the event and the understanding of the reporting person. In addition, the event reports must contain sufficient information about the S/A, with that it can be compared at various events. For this step essential is a general definition of a quantitative scale for the S/A. At this the principle is chosen to view what a person *didn't* know in an event, which quantity of awareness was missing to a sufficient S/A. An absolute determination of the S/A isn't possible because of the cognitive character. For the S/A in aeronautic events suggestions are worked out together with pilots and put forward for discussion.

The target of this event reporting and analyzing method is to design the work surroundings of man so that a high operational safety can be guaranteed. The ergonomic styling of workplaces is still far remote from this target. It is unsatisfactory to complete an accident examination with the result "human failure". This result raises more questions than it answers. The failure of a man always must be seen in connection with his surroundings and his situation. The examination of situation awareness admits the possibility to see these surroundings and situation from view for the failing man. This gives information about why a man fails and which changes or helps prevent such a failure in future. If it is successful to evaluate situation awareness of a working man in real time, there could be a possibility to assist him immediate in the event process. Till then however still many events must be evaluated.

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