Information Design for Collaboration in Distributed Team Work

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Abstract—**This paper describes a doctoral research plan on collaborative practices in ATC. The research is in its early phase and intends to investigate ATC collaborative practices under the Target Time of Arrival Project currently under development at EUROCONTROL. Expected outcome will fall in the area of display design and/or validation. Current efforts are allocated to a review of theories and models that characterize human activities in relation to the context. Such review will inform later data collection and design phases.**

Keywords-component: **human factors; collaborative work; distributed team work; target time of arrival (TTA) concept.**

I. INTRODUCTION

Information technology is known as having great potential to improve performance and safety, where that is appropriate, in virtually any domain, including complex and safety critical ones. I focus on a particular area for potential improvement: how can information technology better support the co-ordination of co-operative work? This seems to be a particularly delicate issue in highly distributed work settings such as air traffic control, where the safe management of operations depends heavily on the ability to share in a timely fashion the relevant information.

In particular problems might arise when people use common information in ways different from the intended ones. The Überlingen accident (July 2002) could be regarded as an example of a failure to co-ordinate safety critical information, in the presence of an advanced information technology application (TCAS).

A set of studies have been developed and proposed in the CSCW literature that looked at these issues [1, 2]. According to these works designing new technology to support collaborative environments, cannot be limited to considering the information flow and formal procedures but it has to take into account how people construct shared interpretation of information [3]. In other words an approach requiring an analysis of how Common Information Spaces (CIS) are constructed and maintained seems more appropriate to avoid the risk of "disrupting cooperative work by computerizing formal procedures" [2].

This aspect is particularly true in ATC, where controllers have to coordinate their actions, take real time decisions extract information effectively under often high time pressure.

II. OBJECTIVE

This research proposes to characterize collaboration and co-ordination in ATC with the particular focus on how distributed operators construct a common knowledge representation that supports mutual understanding of goals and intentions.

The candidate application is the Target Time of Arrival (TTA) operational concept. TTA consists in associating to each flight a time windows in order to meet a target time of arrival, thus ensuring improved predictability and reduced traffic buncing. This concept will shift the attention from a sector based perspective to a process perspective, where all of the distributed actors must work together in function of common goal (TTA), instead of sector goal. The level of maturity of the TTA concept is currently between level V1(idea) and V2 (Prototype) of the ATM concept of maturity scale. Initial validation exercises [4] carried out at ECC have indicated that many Human Factors issues are still open, for instance it is not clear how the responsibility between controllers and pilots is going to be shared, how controllers can work with the TTA, what are the HMI information requirements for pilots and controllers. For example controllers felt TTA information was insufficient and need to be further specified. In general the challenge presented to operators appear to be how to achieve effective synchronization between pilots and controllers and controllers of diverse en-route centers to respect the time of arrival.

Research outcomes related to the TTA are expected in the area of display design, i.e. how to portray TTA information in the light of constraints as emerged from a system level analysis, and/or validation, i.e., how to validate, and/or analyze data validation of the distributed display concept.

III. PROPOSED APPROACH

I intend to carry out my work by following a system-centred, rather than "user-centered" approach [5]. Two main assertions are that design has to be grounded on an understanding not

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only of the specific tasks being in the focus of investigation, but also on an understanding of the context where the action takes place. This view suggests going beyond traditional views of human activities as sequential actions, with an understanding of the relations existing between the overall system/organizational goals and the "purposeful" actions carried out in everyday practice.

The second assertion is that such complex inter-relations can only be apprehended through iterative learning cycles. As shown in the operational validation literature [e.g. 6, 7] evaluating an artifact often implies obtaining feedback on its operational impact, thus looking at (i) how the artifact will affect current methods of working; (ii) whether it will introduce new tasks; (iii) how it will relate and co-ordinate with other tasks that although not in the focus of the evaluation, show to be connected in the current working practice.

While some understanding of such functional relationships will come from qualitative and quantitative research methods, it is postulated that evaluation is a *learning* cycle where initially the most valuable and usable feedback is not so much or exclusively on the features of the prototypes but on the structure of the work practice, how tasks are related and organized to achieve the goals that are partly defined by the organization and partly are worked out by the operators (see the notion of "finishing the design" [8]. In this respect, it is our initial model of the operational environment and not only the prototype, which is "tested" during the cyclical evaluation and iteratively revised. The better we understand the activity the more our evaluation can be focused on the right "unit of analysis" that is likely to go beyond what we have originally focused on.

IV. Progress to Date

The research is now in its early stages. An on going literature review is currently looking at theories and models that study air traffic controller activities as a system coupled with their context, rather than as a linear set of operations. This latter approach has known spread diffusion in Human factors and HCI communities despite studying tasks in isolation can lead to oversimplification of the real life operating conditions, thus introducing potential for erroneous actions.

The objective of the review is to provide an inventory list of principles to study collaborative human activities in relation to the context. Such approaches go beyond the traditional focus on individual action and present one or more of the following characteristics:

(a). Go beyond a component de-composition of human activities, typical for instance of Task Analysis;
(b). Characterize the contextual factors where activity takes place;
(c). Might include System Theory concepts such as functional relationship and self regulation.

So far the review has covered works on literature on work group design, accident models and Human Reliability Assessment. The review is covering, but is not limited to, the following theories/models:

- Structural Systemic Theory of Activity (STST) [9]
- Soviet Cultural Psychology [10];
- Systemic Accident Model (STAMP)[11];
- Contextual Control Model (COCOM)[12, 13];
- Cognitive reliability and Error Analysis Method (CREAM)[14];
- Socio Technical System Theory (STST)[15].

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