Postprint

This is the accepted version of a paper presented at *4th International Conference on the Design of Cooperative Systems (COOP 2000). The Use of Theories and Models in Designing Cooperative Systems, May 23-26, 2000, Sophia Antipolis, France.*

N.B. When citing this work, cite the original published paper.

Old practices – New Technology: Observations of how established practices meet new technology[1]

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Abstract: Most technology for command and control units is developed from top-down visions and models of an ideal team and technology fit. Such models seldom pay attention to social and historical practises. In Sweden there is a futuristic command and control post under development. The system is intended for civilian and military handling of crises. In spring 1999, a training session was carried out in an elaborated virtual environment. The session was video recorded. In this paper we present and discuss our observations from this session. We have especially focused on the team organisation and use of technology from a bottom-up perspective. As we suspected we found a clash between old practices and what new technology affords. We describe our observations and discuss them in connection to how the system is coupled to external units. One main conclusion is that the team members seem to be more coupled to their subordinate units than to the command and control team.

Keywords: Command and Control, CSCW, Decision system, Human Co-operation, Practice, Information Sharing, Information System, Shared workspace, System Evaluation, Team Processes, Virtual environment

1. Introduction

This paper starts with the question of how new technology is introduced and used within an old and relatively socially homogeneous community. We have studied a command and control unit, which has new technology and a different physical team organisation compared to traditional and more sequentially organised command and control units [1]. The unit is organised so that the team members sit around a shared overall representation, a computerised map of the situation. This representation is meant to be a collective "conversation piece" where the team members can anchor their reasoning and arguments for different decisions or assessments [2]. The command and control unit is organised from a theoretical top-down model with the intention that the team members either work towards the team or individually away from the team with information that is in agreement with what the team has decided. The military organisation and practices are known to be quite formal and therefore the physical and technological organisation is organised from a point of view that it should support creative, reflective and innovative discussions. The collective workspace is supposed to be enhanced by the fact that the team members sit

around a table and are facing each other, as well as having a common representation on the table. The individual tasks can be managed facing away from the group and so are supposedly not disturbed by team discussions or processes (see [3] for a comparison between central and distributed teams). The command and control has many more public representation spaces and displays, and a greater technological sophistication than is usual for contemporary command and control posts. We expected that there might be a clash of cultures between established work practices and new requirements from technology. We therefore explore the social context of embedded technology use. The question is therefore less coupled to what the technology enables, than to what the social context allows.

2. ROLF and AQUA – vision and implementation

A widespread opinion in many command and control establishments is that success in the future control of dynamic systems will be dependent on the ability to quickly understand and control it by having the means of dominating the information environment or being ahead of the actual situation. Being able to do that creates a need for high capacity, decision support systems (DSS) as well as new planning tools for shortening the decision cycle. The request for managing the supposed command and control (C2) situation in the future and the speed of technological development show that there is a need for construction of artefacts and C2 systems that support groups of humans that will collaborate in problem solving and decision making processes.

In a Swedish project, called The Mobile Joint Command and Control System 2010 (ROLF 2010), a mobile command post is under development for meeting the demands of future dynamic situations. The work in the project is based on an overall vision of the future, which describes how Sweden's national defence and rescue services command and control units may appear within 10-15 years' time. The vision is continuously being developed with support from worldwide research and proven national and international experiences (see e.g. [4]). The fulcrum of the vision is to be found in the present tasks assigned to the Swedish Total Defence, including civil and armed defence. Some of these tasks have been newly defined by the Swedish government and are to be considered as requirements for means of supporting military and civilian command and control in a wide spectrum of more or less chaotic situations in peace, crisis or war, both nationally and internationally [5]. As a consequence, when designing the envisioned future command and control system, considerations have to be taken because it will be manned by a varied number of military as well as civilian command and control personnel. The different requirements of personnel are dependent of the level of crisis. Accordingly, the presentation of information must be highly adaptable and changeable for being adequate for current personnel executing the command and control.

The AQUA project

The project ROLF 2010 has generated the idea of a device for adapted presentations of a situation, support for decision-making and distribution of decisions. The device is called the Visionarium™ and includes a Visioscope™ in which a shared multi-view presentation of information can be done (*fig. 1*). The work of developing this idea has been managed in a separate project called AQUA, mostly so that the ROLF 2010 project should avoid losing its overall perspective.

Figure 1   Example of interior and equipment in the future Visionarium™ with its Visioscope™. A future perception room in which decisions can be made (Illustrated by Martin Ek, FOA tidningen, who has kindly permitted us to use it)

The construction of The Visionarium™ and the Visioscope™ is basically founded on three metaphors for facilitating the work conducted by the command and control personnel. These metaphors work as top-down models, which highlight observations from one environment and determine how a different environment could be designed. The metaphors that have determined the implementation of the command and control unit are:

Firstly, the "camp-fire" metaphor, which is inspired by how people in all times have gathered around a campfire to discuss problems or enjoy themselves. This phenomenon is also found in modern companies, where e.g. the board gathers around a table to discuss the corporate future. To gather around a table with some common artefacts and information, and at the same time be able to monitor each interlocutor's eyes and interactions is thought to be one of the best ways to start a creative discussion with a *common* focus. There is of course also a danger with very cohesive in-groups who may start to develop thoughts that are only allowed to be confirmed rather than being discussed from manifold perspectives (e.g. groupthink) [6]. As discussed elsewhere [7,8,9] in teams where each interlocutor is constantly reminded and connected to an outer-world through goals, distributed responsibility and tasks, less emphasis is put on having a complete and coherent common picture. This may reduce the danger of groupthink.

Secondly, the "look out" metaphor, which is represented by large, vertical displays. The intention of this is to be able to view actual conditions or capture real-time information from the field. The presentations could be made with multimedia capabilities and video

conferences. These screens can also be used for presenting general information for the team members, for example logbooks or general goals that the division should accomplish. Thirdly, the "look in" metaphor, which is represented by the Visioscope™. The Visioscope™ is a horizontal screen, used e.g. as a replacement of the traditional field map for showing an overall view with resource diagrams, flows etc. In order to support the team's understanding of the situation there are apparently inbuilt capabilities to present moving images that are simplified pictures of reality. In the vision, information that feeds the system is to be fetched from different sensors, by agents or by subscriptions to databases in several intelligence systems. Today the system is not as sophisticated, instead information must be fed manually by the actors in the team. Thus, the system is analogous to a traditional map, except that it is possible to include more units and information connected to those units.

Finally, every member of the team that exercises command and control has his or her own working place behind their backs when turned towards the Visioscope™. The choice of producing such a design is made primarily from two considerations. Firstly, while a discussion is taking place around the Visioscope™, the participating personnel will not be disturbed by changes on their own screen interfaces (e.g. incoming mail etc.), nor will they be easily tempted to release their concentration from the discussion by taking actions and making inputs of their own. Secondly, when a participating member really needs to make an external contact through his or her private workstation, the body movement turning the back against the rest of the crew clearly signals that - "I am not participating in the discussion any longer".

3. Background

The Swedish Defence College annually arranges a large training session for officers doing the programme for advanced command studies. In spring 1999 the above mentioned AQUA implementation was decided to be the platform for a military staff who are to control a scenario of a crisis of political and military aggression. The training session was three days long. The trained were to operate a large manoeuvre to protect an area from military aggression, by co-ordinating actions from different units. The command and control team consisted of six officers; one commander responsible for the command and control unit, three officers who were to command one fighting service each, a logistics officer and an officer for intelligent services (see fig. 2 for a picture from the session).

Figure 2   A live picture from the planning for the training session, spring 1999. (Photo by Martin Nauclér).

The independent agency, National Defence Research Establishment, made an evaluation of how the command and control unit functioned, with special emphasis on how the team members used and assessed the computerised resources and decision process. One of their main critical points was that the team members did not have adequate knowledge of how to use the technology. The suggestion was to train the officers better in handling the technology. This may be one very critical point for the less than satisfying use of the technology, and which also has some support in the team members' evaluation of how trained they were.

Still, co-operation and use of co-operative technology does not only come down to how well a specific individual knows the instrument, but also how well this individual can use it to support co-operative processes, and how other team members may use the information someone else organises [10]. This turns the questions from the individual's knowledge to shared knowledge within the team [11].

In the evaluation, co-ordination is mentioned, but from the idea of co-ordinating *units* on lower hierarchical levels, rather than co-ordination of information within the team. In this article we are mainly interested in how co-ordination *within* the team is organised and how this is connected to the use of technology. Furthermore, there is a question of how well the physical and social contexts support the use of technology. The physical context can be how far co-operative actors sit from each other to in what media form they are connected. The social context can be each individual's expectations of information sharing to what co-operative practices the team members are used to using. The physical context is quite clearly dealt with within the ROLF and AQUA projects, while the social agenda is

less emphasised. From the vision and theoretical ideas of ROLF the physical face to face organisation around the Visioscope™ should contribute or support a creative, collective atmosphere where vivid interaction takes place. This has not been found by any observers in the interaction between the team members. On the contrary, most observers, including the evaluators within the National Research Establishment, find the interaction severely regulated and distant.

Our point of departure is therefore to understand if there is more than inadequate knowledge as a reason for why, on one hand the technology was not used, and on the other hand why the creative discussions did not happen. We are thus interested from a bottom-up approach, what hindered the predictions from a top-down theoretical perspective. This understanding may then guide what and how practices should be developed, or at least give guidance of what should not be done.

4. Method

The whole three-day session was recorded on audio-video tape. The whole data material includes more than 40 hours of data. This amount of data is clearly too much, as well as far too complex for detailed analysis of all sorts of situations. We therefore focused on meetings where all team members gathered to share information and specifically on the team interaction. This part of the data is approximately eight hours of the total amount of recorded data. We organised our observations by studying how the team used the technology and in what way they interacted and used each other's information. From these general interests we discussed the team member's interactions and organisation of their collective work. We have observed the videos together as well as individually. We wrote down our interpretations of the processes in the team and distributed them between us and then discussed the interpretations together while observing the videos. As observers we have quite different backgrounds, one as an academic studying control rooms and the other with a military rank as well as an academic degree. Through these differences our interpretations differed and we could give each other explanations and comparative situations for some actions. We have then clustered these interactions furthermore in some obvious categories.

5. Results

Put in a simplified way one can say that the team is either working in collective *information sharing sessions*, or *individually* with specific, often predefined, task assignments. There are of course special cases when individuals start a dialogue from their specific needs. We call those dialogues sub-team interactions. We first discuss our observations of the team organisation, and then how the team members use the technology. In the following section we analyse and discuss the consequences of the team processes.

Team organisation

One of the most important wishes of the described vision for a new command and control post was that the physical organisation and the common representation in the Visioscope™ should elicit creative and reflective discussions. These discussions should break-down

formal rank and let each interlocutor take the floor as he or she feels there is an opportunity to contribute to the discussion. This was not what happened. Rather the opposite, according to those who saw and could compare other more traditionally organised command and control units, who were trained at the same session.

General Agenda for Sharing Information

The order of speaking is very regulated. It is the commander who sets the agenda at the beginning of each meeting and thus distributes the order of speaking. At the beginning of the training session we observed that the order held was very tight. Instead of discussing possible co-operative efforts or general problems concerning the represented situation, they let each and every team member talk about their specific assessment of the situation, without any interference. In the beginning the interactions around the table were organised in a clockwise fashion. Furthermore, the order of how the officers were sitting around the Visioscope™ determined who would speak rather than the urgency of the problem or information. Thus, the social order rather than the campfire metaphor determined how information was shared.

As time goes this strict organisation is loosened. The commander still sets the speaker agenda, but it is less organised in a clockwise fashion and more coupled to the emergency and pragmatics of the situation. Still, we have not found any situation or indication that the commander asks the team members explicitly during a meeting or implicitly before a meeting who would like to start. Thus, the speaker agenda must be based upon the commander's assessment of the situation and he alone decides who has the most important or urgent information to share.

The interaction between the team members is also loosened later in the second and third day, but in a very moderate way. The turn taking is regulated throughout the three days. However, after each given speaker has closed his speech other team members sometimes give subsequent questions. Although, directly after such subsequent questioning they resume the speaker agenda.

The Centrality of the Commander

The commander is central as usual in military organisation practice. The commander sets the agenda from his assessment, and he distributes the word when appropriate. As already mentioned, in the beginning of the training each information sharing session starts with the person next to the commander and works its way around clockwise until all officers have shared their specific information on their specific units. This is a very apparent and symbolic way of exercising the commander's centrality. Each officer also addresses the commander by gaining eye contact or trying to get response from the commander during the speech rather than addressing other team members. In subsequent questioning the team members also ask the commander for permission to speak by waving their hand before they start to question the officer who had the floor. Thus, the commander and the team members confirm the traditional view of the centrality of the commander in their way of approaching any other team member during the information sharing sessions. We are well aware of the fact that these sessions may not be assisted by an anarchistic forum, where any team member talks at anytime and with anyone, but the confirming of the traditional organisation of one commander seems to be contra-productive to the vision of a functional co-operative environment. By functional co-operative environment we mean that the most

appropriate function within the team should be the determiner at any specific moment. This though, must then be incorporated into the team members' conception of how they should work, if the vision of ROLF is to be realised. One idea could be that operators could rate their emergency of information and the system distributes the speaking order.

Team-followers and passivity of interaction

Discussion between the team members is rare while meeting around the Visioscope™ for updating the situation. Each of the team members mainly reports his or her specific part of the puzzle of the battlespace, and sometimes they get subsequent questions. Still, we have not seen any discussions during the information sharing sessions where several team members contribute to a discussion of the relevance and consequences of the information. In one sense this can be an expression of respect for each team member's knowledge, but in effect this passivity of listening without directly responding undermines any form of direct discussion. Each later person in the sequence may of course indirectly respond to former statements, but this is also rare.

The passivity when each and every team member is reporting one's perspective and information has greater complication. That is, the team seldom discusses common situation awareness. Each officer gives his or her view of the situation, framed by their specific function, but there is no discussion of how to apply the specific information in a holistic picture or within different time frames. As discussions of how the different functions are connected fail to appear, a general common view of the situation is never articulated. We have only observed one occasion where the commander explicitly asks a team member to take the perspective of the enemy, and thus play the devil's advocate. This elicited a longer discussion but was quickly dropped when an urgent message was received and announced by another team member. This message dissolved the problem and changed the direction for further problem solving.

Each and every team member may of course have an idea of how others' information is connected to their function (or other functions). Since it is not articulated or discussed in an open forum, there might be as many ideas as there are team members or at best overlapping ideas. We cannot, nor can the team member, know as this was not directly investigated by us or articulated during the session. A consequence of this is also that many of the wished for synergies of having different functions clustered within the command and control room fail.

Coupled to the centrality of the commander it is mainly his idea of the situation that decides the general goals and actions. The commander listens to the information that the officers are reporting. Probably he is then assessing the greater or added situation and decides upon a picture. This general picture may implicitly be included in the decisions he makes, but since assumptions behind the assessment are seldom articulated, other team members are not given the chance to object or discuss the plan or decision.

Sub-team interaction

While the team is not interacting actively during the reporting session, we see many team members interacting in between the reporting sessions. It seems that the team members form sub teams where they more directly can discuss a concrete problem, and in that way discuss and form common views ad hoc for specific problems. This makes the team able to create overlapping views rather than a common view as well as co-ordinating external

units to handle an emergent problem. This may or may not be the best way to handle continuous problems depending on task assignments and how coupled they may be. In any way, sub-team interaction is risking that someone else's statements are re-interpreted in such a way that general and agreed upon decisions and tasks are no longer valid, because the sub-team has started a parallel or contra-productive interpretation and handle upcoming situations from this re-interpretation. But sub-team interaction is also a must as many situations demand that different units co-operate and the units' commanders must co-ordinate their intentions and resources accordingly. It is apparent that these instances of sub-team interaction are more vivid and dynamic than other team constellations as in the information sharing sessions.

Use of technology

The purpose of bringing together different functions within the command and control system is to support co-operation, and the possibility of creating synergy between different functions. Information technology is meant to be one very important mediating instrument to share information. The Visioscope™ and the four vertical displays are such displays where common and relevant information can be presented. The team members also have personal technologies where they can process information for their own purposes.

Use of personal technology

Each team member has a personal computer with a commercial office package as well as a specific program to visualise the common and detailed situation area.

   The e-mail program was used as a communication tool to communicate with distributed units as well as a logbook for all incoming and sent messages. A calendar was used to plan and remind actions, and a notepad was used as a checklist for actions. A word processor was mainly used to document actions and orders, and a presentation program was used to depict a personal and static view of the situation.

   We can see that each team member heads towards his or her personal computers as soon as the information sharing sessions are over. We can see that the team members work quite fervently on their computers, although we cannot observe from the video-representation what tasks or programs they work with. The main point is that much external communication and many tasks are conducted through the personal computer console. Consequently, the tasks and information is not articulated for other team members.

Use of co-operative technology

The Visioscope™, where a map is projected, is mainly used as a spatial representation of the units and the area. The map that should be the main co-operative technology is not used as a representation where the team members anchor their statement or intentions or show projections of the possible developmental paths. Mostly, especially in the beginning, the Visioscope™ is not used at all. It is there in front of everyone but is not used in any overt sense.

   As time passes and the team members become more confidant in their interactions, the use of the map becomes more frequent. Occasionally the team members point at the map to anchor a statement or show some direction. But this is so rare that it can be seen as exceptional, and can possibly be attributed to individual personality. One reason for why

the representation on the Visioscope™ is not used may be that it is too detailed and contains too much information. It is hard even for a very trained eye to see all the units presented on the digital map (see fig. 3). Although the computer program has the functionality to filter information and scale the representation these functions are not used. The team, or at least the commander, seems to prefer to have a detailed and mostly corresponding picture of the situation.
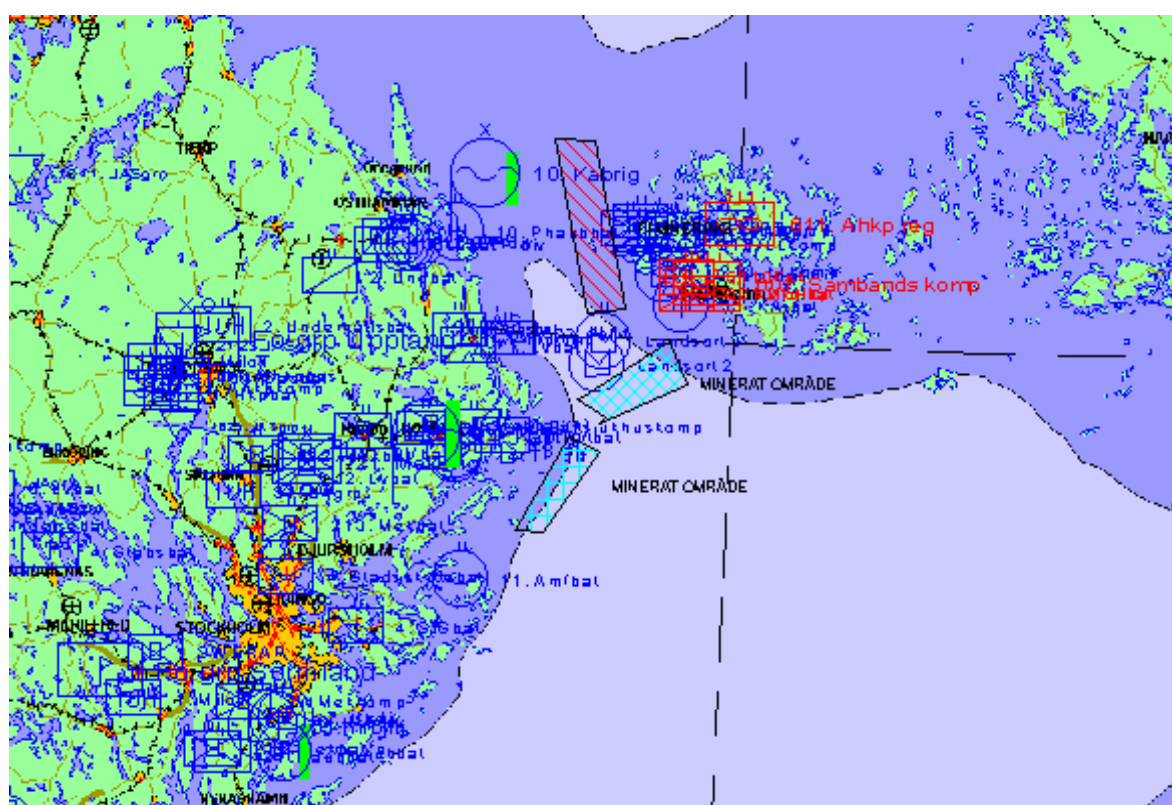

Figure 3   Example of how information was presented on a digital map without use of scaling and filtering functions.

The four vertical displays show information from the branches of functions. Three are used for specific functions and one is a general logbook of decisions made by the commander. During the information sharing sessions these are not used at all. Occasionally we can see sub-teams use them to discuss emergent situations. Mainly the information presented on the vertical displays is not used, and does only give a hunch of, or function as a logbook of, what actions and decisions are made.

The technological resource that the command and control unit has at hand does not seem to directly correspond to the needs of the officers to promote a creative discussion.

Making the individual presentation collective

As the above categorisation of technology use may suggest, there is quite a sharp distinction between technologies used for individual respectively collective work. Our observations suggest that this is the case. Although, it becomes evident on the third day that some team members produce images of their assessment of the situation at their personal console. Such images are used for personal assessment as well as to distribute orders to subordinate units. On the third day such static and simplified images of the

situation area are presented to the team members within the unit on the Visioscope™ (an example is presented in fig. 4). As can be seen if comparing figure 3 and figure 4, which both at some level represent the situation at the front, the later representation although a very simplified version also represents some predicted developments using arrows.
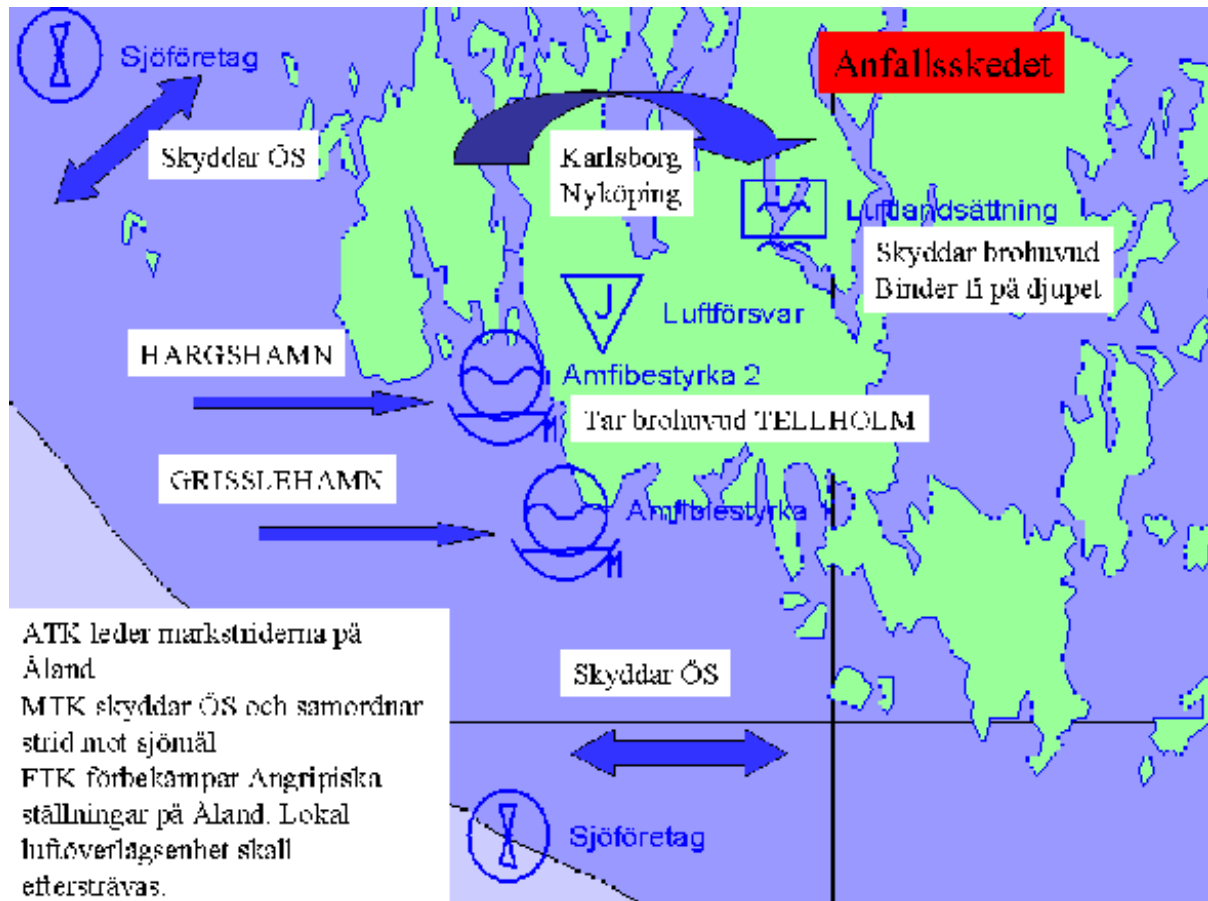

Figure 4   Example of a personal simplified presentation of the situation.

By presenting personal images to the team the incitement to discuss the situation assessment increases, although not to the degree that is wished for. We interpret that these idiosyncratic representations of the front excite, or possibly cause a breakdown, in other team members' minds, by presenting information that they have not seen before, or from a perspective that they have not been part of producing.

6. Discussion

The effort of trying to achieve a purposeful command and control system in the ROLF 2010 project is basically built upon top down models of how command and control is expected to be exercised in the future. The construction of these models is based on the belief that new media, new technologies and metaphors of how humans best work together, will support interaction and information mediation between the team members as shown in figure 5. Considering the models of how information is supposed to be mediated between the participating members, the aim is to create a shared and common view of a current situation.
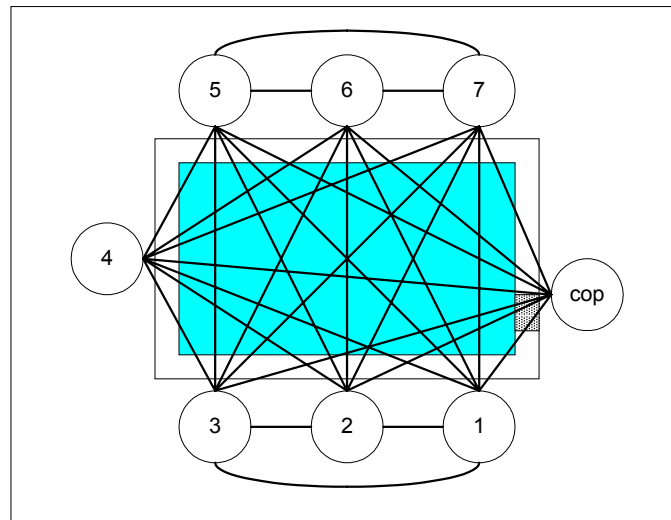
Figure 5 The ideal communication and mediation of information
among participating members in the team.

One assumption with the campfire metaphor is that the organisation of the team in a "circle" is supposed to make it easier to obtain and support a more creative environment for discussions. A motive expressed is that a possible hierarchical order among the members is reduced, which might increase creativity. Furthermore, another presumption is that having the team sitting round a table will imply that information is easier to share equally by the team members. As the information is received it is supposed to be evaluated and discussed between the members in the team. Hereby every member is supposed to participate in the discussion to some extent. Finally an agreement upon the presentation of the current situation and what action to be taken next, is supposed to be reached. When studying the concept from a bottom-up perspective, as presented in the analysis of the video recordings above, shows that the expected results do not meet the expectations from the models used for creating the command and control environment.

There may be a number of reasons why this is the case, but from our observations of the recorded exercise we have found that one possible reason is that the commander creates an individual view of the current situation. Our belief is that the commander forms his view from the information mediated by the team members, which he thereafter uses as a foundation for making new directives for possible actions. As the information presented by every single team member is accepted as it is and generally no active questioning about its accuracy or discussion about actions to be taken occur, the intended responsibility among the team members for achieving a common view of a situation is excluded. We have found two possible alternatives why this is the case;

Firstly, the commander's capacity of exercising command and control and making the best use of his team members could be questioned, alternatively there might be some explanations found in other team members' views of how command and control should be exercised. Secondly, the explanations could be found in the team members' interaction and coupling with the surrounding environment for achieving and mediating received information within the team. This explanation we find as a more plausible cause to why discussions about the information presented by the participating team members was excluded during the exercise.

When analysing the team agendas we found the individuals' interaction and information exchange with external subordinates was more intense and frequent than the internal interaction with team members in the command and control unit. The team meetings had more the character of reporting what was done rather than discussion and planning ahead. In between team meetings the actual exercise of control was conducted. The officers were in control of the information that was sent between them and the external units and the communication was rapid and frequent, which caused commitment. The officer thus was never forced to be out of the control loop except during team meetings, and possibly because of that he identified more with the actions and people external to the command and control unit than the internal team. In figure 6 we have tried to depict the connection between the team members and the external and internal team. With the external subordinate units there was a continuous control loop exercised through electronic mail, while communication towards the team was mainly coupled to give information to the commander.
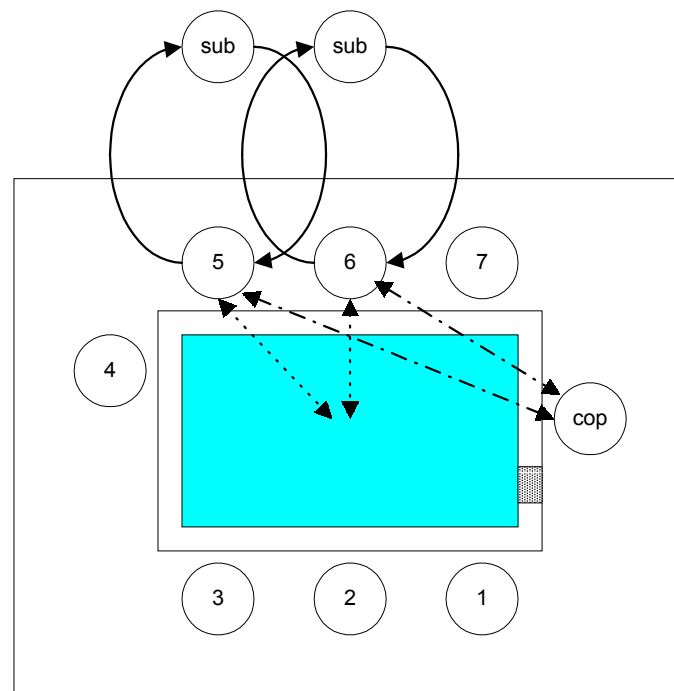

Figure 6   The strength of interaction and information exchange
between external and internal representatives. The heavier
a line is, the stronger is the coupling.

By categorising the team process in three phases: the pre-team meeting, the team meeting and the post-team meeting, we find it possible to make observations and reflections of how intensively a team member engages himself in distributing, questioning and discussing different information. During the phase of pre-team meeting an intense work of exchanging information with external representatives, e.g. a subordinate (sub), could be observed.

The information received during this phase is processed by the individual team member and then generically presented for the commander during the team meeting. During the phase of the team meeting the other members of the team were passively listening to the presentation and accepting the information mediated. When the team-meeting phase reached its end, then the commander gave his directions for the next action. After the

commander closed the meeting the post-team meeting phase started, in which officers turned to their computers and continued to communicate with their external subordinates. We believe that the team members become more coupled to external units because of this rapid, continuous and committed communication as long as its equivalent within the team was not created or supported. How that should be realised must be an urgent question for research within the field of dynamic decision making in the near future.

7. Conclusions – design of co-operative systems

That new technology is seldom used as envisioned or intended by the designer is no news for anyone who has studied people using technology. Still, the predominant perspectives in contemporary system development focus on the infrastructure of technology rather than activities of use. This is even more complicated when discussing technology for co-operative use, as the groups that should co-operate are seldom tabula rasa groups or individuals. Rather a lot of technology for co-operative use is designed for specific groups that have a tradition of doing things. This practice must be considered when developing technology, and it must be adapted to the group conventions, or else the group conventions must be changed to fit the new technology. However, this creates a kind of Catch 22.

Conventions and practices are seldom as explicit as when confronted with their antonyms. The contradictions that become apparent when homogeneous groups meet new technology and new requirements are not easy to foresee. Furthermore, we often correctly have the idea that humans are adaptable and innovative. A problem only appears when the adaptations and innovations do not meet the expectations. Thus, we need new environments to explicitly see what conventions and practices are hidden in the groups and we want new technology to be fitted into practice (and hopefully also develop the practices to better fit the tasks). New technology does not automatically afford better efficiency. Nor do well-designed environments. Conventions and practices that are held within the human mind must also be developed and adapted to new circumstances. Innovative technology and work environments can mainly be produced from a top-down perspective where guidance for the design is the goal of design. But innovative technology use (or innovative practices to avoid contra-productive technology) can mainly be developed from a bottom-up approach were contradictions become apparent.

In this paper we have analysed our observations in two aspects. Firstly, we have observed that the teams uphold a traditional team structure by overt behaviour. The technology by itself could not help to break down the rank and centrality of the commander. Nor did the technology or practices by the team members create the contradictory climate that would elicit lively discussions.

Secondly, we have seen that the practitioners work with the technology resources in a way that would be hard to foresee. Instead of using the sophisticated computerised map to scale the representation of the front, the team members individually produced static pictures with a simplified notation and presented them for the team during the information sharing sessions. This seems to give a better incitement for discussion although not as much as wished for. More importantly although is that the rapid communication with the external units enabled by electronic mail, made the officers more directed towards the external units than towards the team. One could say that the officers were more coupled to external units than towards the team, as they identified themselves more outside the group than inside. This may be a consequence of the frequent and rapid communication, or as a

consequence of feeling in control of the information that is communicated. Anyway, this is a great problem as one cannot slow down or inhibit the communication with the external units (that could create unwanted consequences). At the same time the command and control unit must be abstracted away from the situation on the field in order to be able to plan ahead and create an advantage before the situation catches up. In a way they are facing the same situation as the system developer, design resources from a vision but at the same time keeping a keen ear on those that have to face the consequences of the vision.

One possible way to deal with this specific problem is discussed in this paper. Viz., that team members communicate more with external than internal colleagues can be dealt with in many ways. The team invented one way of using the technology themselves and that was to abstract away very much information from the Visioscope™ and present a very simplified and idiosyncratic picture of the situation from each team member. By doing that, other team members may ask themselves where they and their units fit into the picture. Another solution could be to have a more active commander who steadily asks the question of how certain pieces of information may affect the other units or the situation as a whole. Still, another would be to design the information flow in such a way that it forces team members within the unit to collaborate more often and intensively.

References

[1] H. Artman, Team Decision Making and Situation Awareness in Military Command and Control. In Y. Wærn (ed.) *Co-operative process management - Cognition and information technology*, Taylor & Francis, 1998, pp. 55-68.
[2] C. Garbis and Y. Wærn, Team co-ordination and communication in a rescue command staff - The role of public representations. *Le Travail Humain*, **62** (3) (1999) 273-291.
[3] R. Samurçay and J. Rogalski, Co-operative work and decision making in emergency management. *Le Travail humain*, **56** (1993) 53-77.
[4] J. Durbin, J. E. Swan II, B. Colbert, J. Crowe, R. King, T. King, C. Scannell, Z. Wartell and Terry Welsh, Battlefield Visualization on the Responsive Workbench, In *Proceedings of the conference on Visualization '98* , 1998, pp. 463 - 466.
[5] C. Sundin and H. Friman (Eds.), Rolf 2010 - A Mobile Joint Command and Control Concept. ISBN: 91 87136 33 3. Elanders Gotab, Stockholm, 1998.
[6] I. L. Janis, Groupthink - Psychological Studies of Policy Decisions and Fiascoes. Houghton Miflin Company, Boston.
[7] B. Brehmer, Distributed Decision Making in Dynamic Environments. Manuscript for The National Research Establishment, 1994.
[8] L. Duffy, Team Decision-Making Biases: An Information Processing Perspective. In: G. Klein, J. Orasanu, R. Calderwood & C.E. Zsambok (Eds.), Decision Making in Action: Models and Methods, Ablex Publishing Corporation, Norwood, N.J., New Jersey, 1993, pp. 246-361.
[9] H. Artman, Vad är det som händer när det som inte får hända händer? - Om dynamiska processer i distribuerade organisationer för dynamiska miljöer. FOG-rapport, NO. 29, Linköpings Universitet, Institutionen för pedagogik och psykologi. 1995. [in swedish]
[10] H. Artman and Y. Wærn, Creation and Loss of Cognitive Empathy at an Emergency Control Centre. In: Y. Wærn (Ed.) Co-operative process management - Cognition and information technology. Taylor & Francis, London, 1998, pp. 69-76.
[11] Cannon-Bowers J.A., Salas, E. & Converse, S. (1993). Shared Mental Models In Expert Team Decision Making. In N. John Castellan (Ed.). Individual and Group Decision Making: Current Issues, pp. 221-245. Hillsdale, New Jersey: Lawrence Erlbaum.