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Title of Paper

Performance of Municipal Crisis Management Teams –

The impact of GPS in a C4ISTAR mission environment

Topic(s)

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ABSTRACT

This research investigates the impact of a geographical positioning system (GPS) on two different participant groups, university students and municipal crisis management teams. The goal is to identify differences in the work processes of teams that have access to a GPS in their command posts, compared to teams that use paper maps.

A total of 132 students and 108 professionals, forming 40 teams, where tested in a simulated C4ISTAR mission environment.

The identified differences was mapped to the corresponding C4ISTAR notions, indicating an influence on decision quality and performance, not only for military use but also for control and communication systems, designed to support municipal crisis management teams in Sweden.

INTRODUCTION

Many municipalities involved in crisis management in Sweden today have made, or shall make, investments in different information and communication technologies. The investments intend to increase performance, regarding decision quality in relation to available time, and control of the organization's everyday emergencies as well as crises. The assumed benefits have often not been evaluated empirically.

The two studies reported on in this paper utilize a micro-world simulation (Brehmer & Dörner, 1993; Brehmer, 2004) to study a global positioning system (GPS) concept on command and control teams. The goal was to identify differences, with regards to performance and communication, in the work processes of teams that had access to a GPS in their command posts, compared to teams that did not. Study 1 tested 132 university students, forming 22 groups. Study 2 tested 108 professionals, forming 18 crisis management teams.

The paper has six parts. Part one starts with this introduction and includes *C2 and its extensions C4ISTAR* and *Micro Worlds*. Part two, *Two studies designed to explore GPS impact on performance and communication*, describe the method for the studies as well as mapping of the GPS to the micro world and the C4ISTAR notion. Part three, four and five consist of the *Performance*, *Critical Area* and *Communication* result. Part six concludes the paper with *Discussion* of the results.

C2 and its extensions C4ISTAR

C2 (command and control) in principle have the same intention as C4ISTAR (command, control, communications, computers, intelligence, surveillance, target acquisition and reconnaissance), frictionless and fast gathering, processing, dissemination, transport and exchange of information. The differences lie in the number and quality of factors involved. It lay in the improvement to C2 performance by processing a complex system of network related factors and their interdependencies. The factors are designed to mirror a concise image of the real world, which was not possible to be provided by traditional C2 components alone. While C2 mainly focus on bringing the “order-information” from commanding level to tactical units and reconnaissance-data from tactical units to commanding level, C3 (communications) adds the communications technology, alternatively communication procedures between persons. C4 (computer) includes computers to direct, process, visualize and accelerate information streams. I (intelligence) and R (reconnaissance) bring in the processing of reconnaissance and intelligence data as new and important facets of modern leadership. TA (target acquisition) aims at the possibility to detail “effectors” for a special “target”. S (surveillance) can be seen as a continuous systemic function, covering the entire area of operations, from combining intelligence and reconnaissance data to sensor-reports with the communication network as an indispensable precondition for immediate and sufficient reaction.

Micro worlds

Micro worlds are simulated environments where the system designers select important characteristics of the real system and create a small and well-controlled simulated system based on these characteristics (Granlund, 2002). Micro worlds have, in the field of psychology, been viewed as tools to overcome the tension between laboratory research and field research (Dörner & Brehmer, 1993). The problems of laboratory research are the lack of relevance or external validity. The problem of field research is the lack of control and problems in finding causal interpretations of the results. The root of these problems lies in the inability to handle complexity, too little respectively too much complexity. Typical environments that can be simulated by using a micro-world are

ecological, political, economical systems, military systems, and forest fire-fighting emergency management (Granlund, 2002).

The advantage of using a micro world is that the complex, dynamic and opaque characteristics generated by a proper micro world represent the cognitive task people encounter in real-life systems (Brehmer and Dörner, 1993; Dörner & Schaub, 1994; Granlund, 2002). The complexity lies in that the participants need to weigh a number of contradicting goals and causes of actions that are coupled via processes within the system. The actions of the participants will form the systems state as well as the system it self, that change autonomously and create dynamics to the world. Opaqueness refers to dimensions of the simulation that the participants cannot figure out. Dimensions they need to explore in order to understand and control. Moreover, another important property of micro worlds is that they provide means to present a number of different problems for the participants, rather than a single, well-defined task (Granlund, 2002). Not to understand side effects of actions, adopt an ad hoc behavior as well as thematic vagabonding, and to have severe problem with delayed feedback are typical errors that participants make in micro worlds. Inability to understand regularities in the time-course and overlook checking the outcomes of actions are others (Granlund, 2002).

The micro worlds characteristic, the ability to present a set of tasks and all possible errors make micro worlds stimulating for the participants; they take their assignment seriously and, accordingly, are valuable for the researchers (Dörner and Schaub, 1994; Gray, 2002).

The micro world utilized in this research, C3Fire, is specially designed for command and control studies (www.c3fire.org, Granlund, 2002; Granlund & Johansson, 2003). C3Fire generates a dynamic forest fire fighting task and has been used extensively in previous research on network based command and control (Artman and Wearn, 1999; Granlund, 2002, 2003; Johansson et al., 2003), on effects concerning information support systems (Granlund, 2004; Johansson et al., 2005; Granlund et al., 2010) and on cultural differences in teamwork (Lindgren & Smith, 2006a, 2006b).

METHOD

Study 1, participants

A total of 132 university students, forming 22 groups participated in the study (Johansson et al, 2010).

Study 2, participants

A total of 108 professionals, forming 18 crisis management teams participated in the study, 26 females, and 82 males.

The participants had computer experience. 46% worked at the computer 4-8 hours per day. 46% worked at the computer between 1-4 hours per day, 8% less than one hour per day, but none indicate that they are not daily users of a computer.

The participants were inexperienced when it came to playing computer games. 82% did not play at all. 18% played 2-8 hours per week. No one played more than eight hours per week.

Experimental design

The study had a between-group design with one factor: (a) command teams using GPS, and (b) command teams using paper maps (Figure 1). The difference between the two conditions was the type of support the participants obtained in terms of information visualization and data sources, GPS or paper maps.

In each team, three participants worked as commanders in a command post and three participants worked as ground chiefs on the simulated field (Figure 1). The commanders in the command post consisted of one commanding officer and two liaison officers. They worked on an operational level and commanded the ground chiefs. The commanders had no direct contact with the simulation and only controlled the simulated world by commanding the ground chiefs. The ground chiefs controlled three units (fire brigades) each in the simulation.

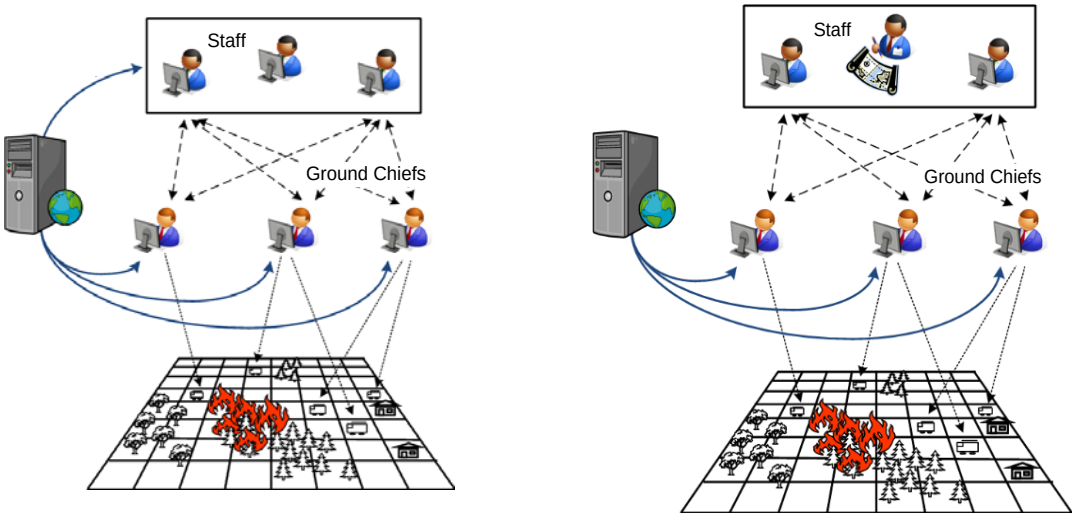

Figure 1. GPS condition and paper map condition

The GPS condition:

The teams in the GPS condition had, during the experiments, real-time data from the GPS available, as well as four digital map layers, but they faced the problem of handling the extra technological dimension the system represents.

The command post used three terminals. One terminal was equipped with the GPS. In the map layers, precise position data was displayed, in real time, for the 9 fire fighting units that the ground chiefs controlled. The user interface of the management support also displayed detailed information about each fire fighting unit's characteristics and actions. In addition to the GPS terminal, the command post had access to two liaison terminals for communication with the ground chiefs (Figure 1).

Each ground chief had access to one digital map layer, integrated with a tool for communication with the command post (Figure 1). The ground chiefs used the digital map to command their fire fighting units. Each fire fighting unit had a limited field of vision in the simulation, and reflected only the simulated reality in the immediate surrounding area of the unit. Each ground chief had thus three fields with valid information of the simulation. This information they passed on automatic to the command post, via the GPS. The command post had accordingly information about 9 fire fighting units.

The paper map condition:

The teams in the paper map condition had no management support and obtained their knowledge about the state of forest fires and fire fighting units by communicating via email, with each ground chief (Figure 1). Although this is less precise and a slower way to get data on the state of the simulation, the command post in this condition had the advantage of working with a familiar medium, a paper map.

The command post had access to a paper-based map equivalent to one of the four digital map layers. C3Fires coordinate system was on its axis. In addition to the paper map, the command post also had access to two liaison terminals for communication with the ground chiefs (Figure 1).

The ground chiefs was working under the same circumstances as in the GPS condition, meaning they had access to a digital map layer integrated with tools for communication with the command post (Figure 1). The ground chiefs used the digital map to command their fire fighting units. Each fire fighting unit had a limited field of view in the simulation, and reflected the simulated reality only in the immediate surrounding area of the vehicle. Each ground chief had thus three fields with valid information of the simulation. This information they conveyed to the command post, via the email system. The command post had the information given to them by the ground chiefs.

Apparatus, GPS and micro world mapping in relation to C4ISTAR

In the C3Fire micro world the participants' organization, resources and communication structures was set up in accordance with the research goal. The user interfaces and communication tools was individually set-up for all participants. For these studies a GPS module was connected to C3Fire. All events occurring in the world and all text messages were saved into a database for analyses and for instant replay of the simulations during the experiments.

As mentioned above, micro worlds are simulated environments where important characteristics of the real system are selected as base for a small and well-controlled system. For these studies four characteristics of a GPS was picked out; unit position, unit state, view of sight and wind. In the C4ISTAR, the GPS condition and the paper map condition had different features corresponding to the notions.

The *C2 (command and control)* was not affected by the conditions; rather these are the notions on witch the conditions are supposed to have an impact.

The *C3 (communications)* differed. In the paper map condition all communications was done by text messages via the liaison terminals. No information was exchanged between the command post and the ground chiefs in any other way than by the text messages. In the GPS condition the text message communications was severely extended by automatic, visual, real-time information on all four chosen GPS characteristics. The automatically transformed GPS data could be used by the team, command post and ground chiefs, as a way to communicate. The automatic communication had one direction, from tactical units to command level, not the other way around.

The *C4 (computers)* differed. The command post in the paper map condition had two liaison computers. The GPS condition had two liaison computers and one computer exposing the GPS for the commanding officer.

I (intelligence) and *R (reconnaissance)*, the ground chiefs' activities, done in order for the command post to be able to have control, was not really affected by the conditions; rather they were like C2, seen as notions on which the conditions was supposed to have an impact.

S (surveillance), seen here as the command posts processing of intelligence and reconnaissance data, differed as the GPS condition supplied automatic sensor-data, the paper map condition did not.

TA (target acquisition) differed. In the paper map condition all detailing of effectors (fire fighting units) to a special target (forest fire or houses) was manually transferred to a paper map on the basis of textual information from tactical units to the commanding level. In the GPS condition the same detailing of units position, view of sight and the wind condition was made automatically by the GPS.

Experimental procedure

The experiment was performed in three steps, introduction to C3Fire and hands on training, five session cycles and a concluding debriefing (Figure 2). For study 2 the experiments were conducted in the participating municipality's regular emergency management offices. This meant that the entire computing environment was moved before each experiment. This was not the case in study 1, where the whole experiment series was conducted in the same computer room.

When the participants arrived, they got an introduction to the task and performed an exercise simulation for learning how to manage the C3Fire system. The exercise was followed by questions to the instructor and time for team talk. The training required about 40 minutes.

After training, the team performed five session cycles (Figure 2). The number of simulation trials was limited to five as previous studies of Svenmarck & Brehmer (1991) showed that performance stabilizes after three to five performed trials. Also, the teams need several attempts to develop distinctive strategies depending on condition, GPS or paper maps. The fifth and final trial will thus be the most important for analyses. The strategies are at this point most distinct. The experiment as a total took 6 hours to complete.

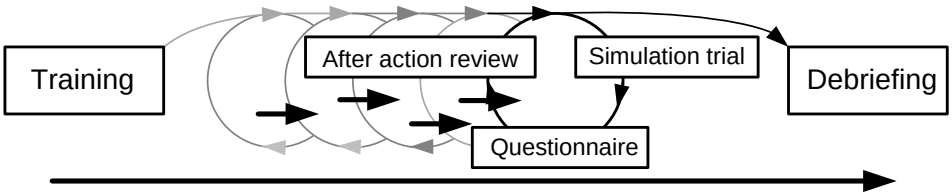

Figure 2. The experiment method with; training, five session cycles and a concluding debriefing.

Each session cycle consisted of 20 minutes C3Fire simulation trials, 5 minutes for individual surveys and 20 minutes after action review. A session cycle took about 50 minutes.

During the after action review the participants watched a recording of their last trial. The recording replayed not only the different firefighting unit's actions in the game, but also the total fires spreading. This gave the participants a greater understanding of the dynamics of the situation. They discussed their results and made operational plans for the next simulation session. This phase was intense and often took as much time as the simulation itself.

The debriefing increased the participants' awareness of the learning processes they had gone through during the whole day's trials and was facilitated by the instructor. This differed from the after action review, which was controlled by the participants themselves. Debriefing extends the time scale and change the focus of learning in the direction of a collective awareness of the general principles of crisis management (Granlund et al., 2001).

RESULTS, PERFORMANCE

Performance is measured by the amount of burned out area at the end of each simulation. A small amount burned out area is preferable to a large. The results are from the study with students as participants and from the study with professionals. The results are presented with respect to the two conditions GPS and paper map. The latter study is presented partly with overall results and partly with results assigned to two professional subgroups.

Performance, students

For students the performance results showed no significant difference between GPS and paper map over the five simulation trials. The mean value indicate that groups with GPS support had a better performance than the groups who used paper maps (Figure 3).

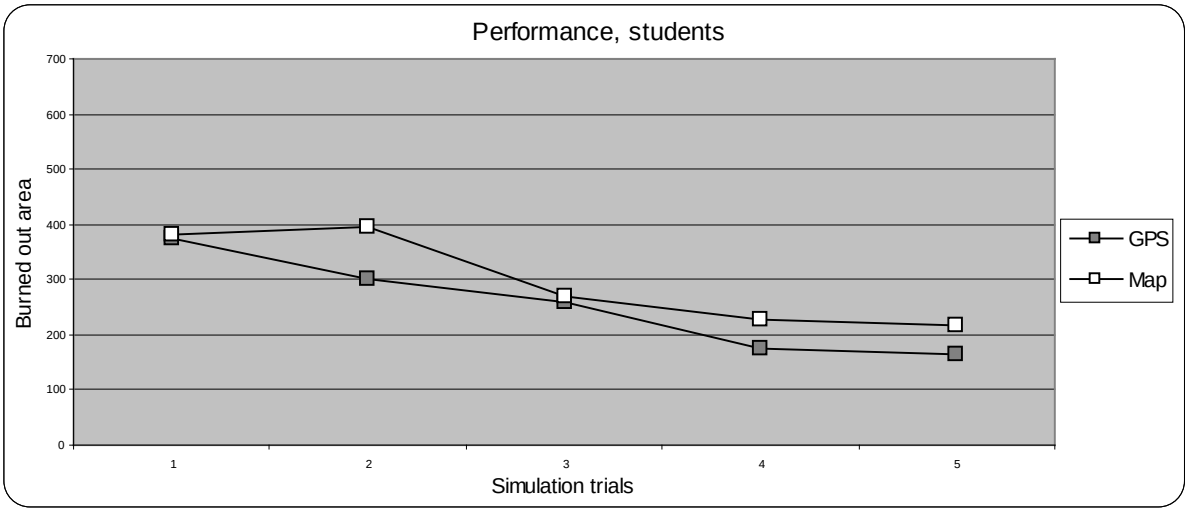

Figure 3. Burned out area in end of each trial for students, GPS vs paper map.

Performance, professionals

For professionals there was no over all performance difference between GPS and paper map in the simulation trials and the trend of teams with GPS to have a smaller amount of burnt out area is wrecked in simulation trial 5 (Figure 4).

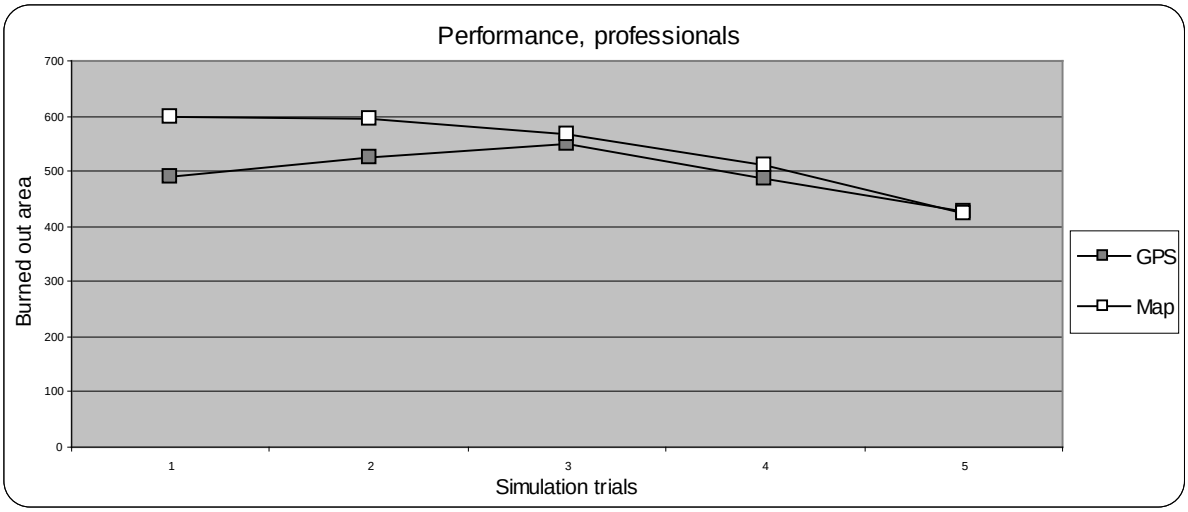

Figure 4. Burned out area in end of each trial for professionals, GPS vs paper map.

The students' performance was likely as the GPS offered real time unit position information, which the paper map did not, and the task should reasonably be easier to solve with this information. Yet, our professionals contradicted the results. Teams in the paper map condition performed as well as teams in the GPS condition (Granlund et al, 2010).

One explanation is that our professionals was not a homogeneous group and therefore may have had a diverse performance result that is not visualized with the mean covering all teams in each condition as in Figure 4. The teams' command post had a decisive influence on the outcome of each simulation trial. It was they who lead the entire operation. The command posts from the study could be sorted according to profession, command posts with only rescue service personnel, RSCP, and command posts with a mix of rescue service personnel and other municipal personnel, MCP.

RSCP (Rescue Service Command Post) teams consisted of a homogeneous group of professionals with common education, training and with experience in commanding crisis events. MCP (Mixed Command Post) teams consisted of a heterogeneous group of professionals varying from rescue service personnel to heads of municipal administrations as well as personnel with security responsibilities. MCP varied in terms of training and experience. Some of the participants were accustomed to command crisis events others were familiar with management, during normal conditions.

GPS condition, command posts with different professional distribution

Figure 5 show performance for RSCP and MCP in the GPS condition only, corresponding to the professionals' performance shown in Figure 4.

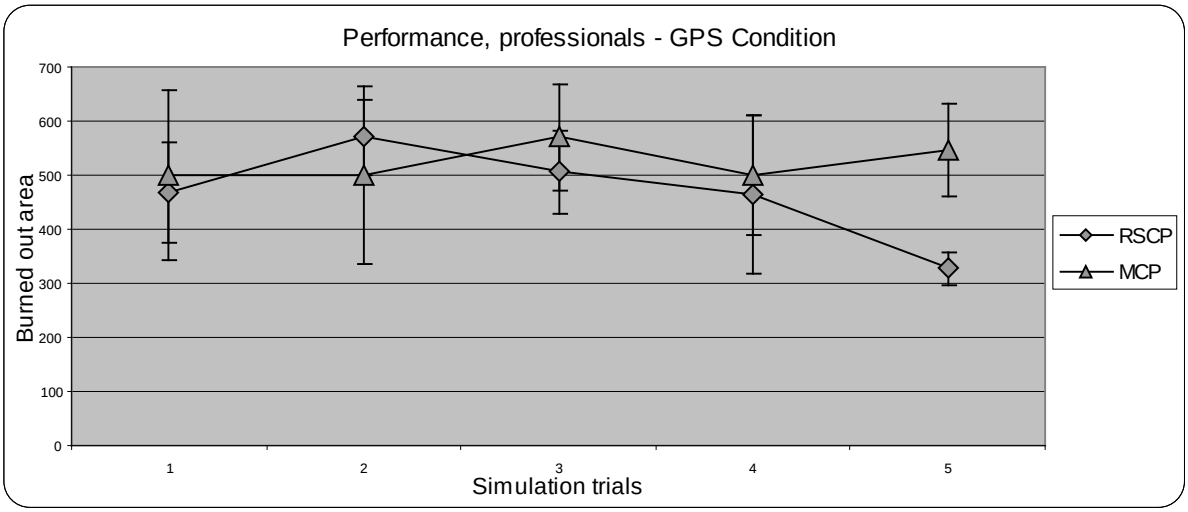

Figure 5. Burned out area in GPS condition for professionals, RSCP vs MCP.

There was a performance difference between the two types of command posts, RSCP and MCP, in simulation trial 5 of the GPS condition. RSCP had significantly better performance than MCP, $t(6) = 4.20$, $p < .006$. The RSCP teams had a positive learning curve through out the 5 trials. The MCP teams had no learning curve. Hence, the RSCP and MCP teams solved the task various well depending on their professional distribution when they were supported by the GPS, a new and information rich technology.

Paper Map condition, command posts with different professional distribution

Figure 6 show performance for RSCP and MCP in the paper map condition only, corresponding to the professionals' performance shown in Figure 4.

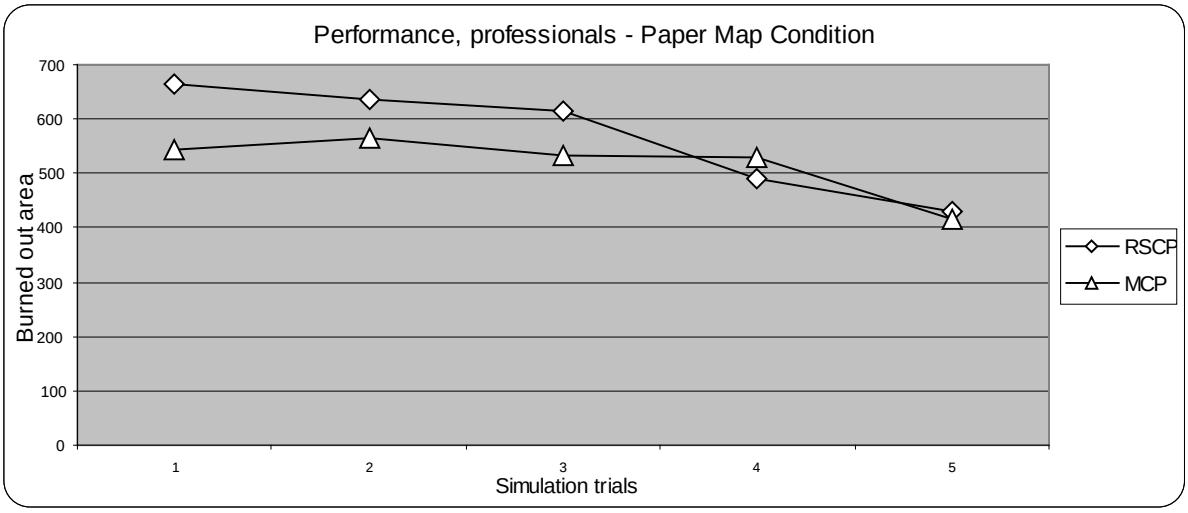

Figure 6. Burned out area in paper map condition for professionals, RSCP vs MCP.

There was no difference between the two types of command posts, RSCP and MCP, in simulation trial 5 in the paper map condition. Both RSCP teams and MCP teams had a positive learning curve. The RSCP and MCP teams solved the task equally well. The task was not too difficult for either professional group when they were supported by paper maps, a well known media without automatic information.

Performance, summary

Professionals in the paper map condition performed the task equally well independent of the command posts professional composition. The task was not too difficult for either subgroup, RSCP or MCP.

Professionals with GPS support performed the task better than professionals with paper maps if the command post had only rescue personnel, subgroup RSCP. They could take advantage of the automatic information.

Professionals with GPS support performed the task less well than professionals with paper maps if the command post had a mix of municipal personnel and rescue service personnel, subgroup MCP. They could not take advantage of the automatic information.

RESULTS, CRITICAL AREA

The critical area is the fire in the scenario that, if allowed to continue unaffected, would have had the most serious consequences for the simulated municipality. The amount of lost houses is used to measure performance in the critical fire area. The measure is only calculated for the fifth simulation trial and the results presented are from the study with professionals as participants. Partly with overall results and partly with results assigned to the two professional subgroups.

Critical area, professionals

For professionals there was no over all difference between GPS and paper map regarding lost houses in simulation trial 5 (Figure 7).

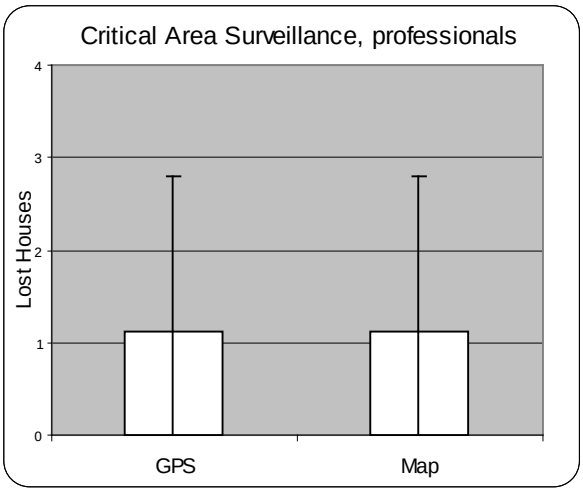

Figure 7. Lost houses in the fifth simulation trial for professionals.

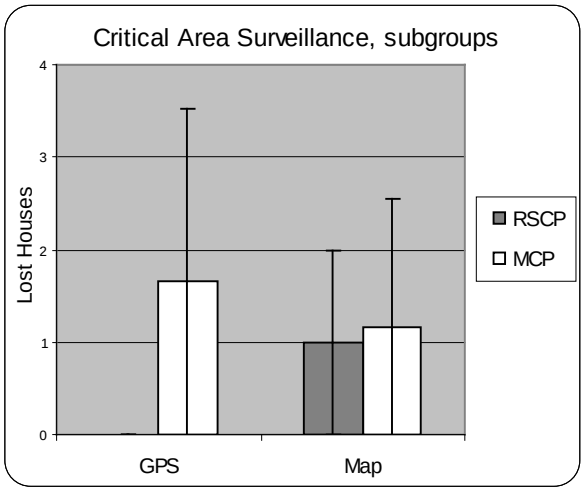

Figure 8. Lost houses in the fifth simulation trial for professionals' subgroups, RSCP and MCP.

Command posts with different professional distribution

Figure 8 show lost houses for RSCP and MCP. It is possible to see trends in how the two different groups acted, but there are no significant differences. In the paper map condition both subgroups performed equally well in the critical fire area. For the GPS condition the subgroups showed a difference. MCP teams lost more houses than MCP teams in the paper map condition. RSCP teams with GPS did not loose houses in the critical area at all.

Critical area, summary

Professionals in the paper map condition save the same amount of houses independent of subgroup, RSCP or MCP. In the GPS condition MCP teams saved fewer houses than professionals with paper maps. The RSCP teams in the GPS condition saved all houses.

RESULTS, COMMUNICATION

The results on communication are from analyses of the text messages send between command post and ground chiefs in the fifth simulation trial of the experiments. At the fifth trial the teams have had opportunity to gain expertise, mutual understanding about the task and mutual communication strategies (Granlund, 2008).

The text messages sent between the command post and the ground chiefs have been categorized in accordance with a coding scheme in four main categories; Question, Information, Order, and Other. These four main categories are in turn divided into 11 sub categories (Table 1). The difference between the two different types of "Order" needs clarification. Mission order is an order with a high degree of freedom, for instance "fight the fire west of the town". Direct order is an order with a low degree of freedom, which leaves little room for own initiative, for instance "go to pos 54, 48". The categories are based on work done by Svenmarck & Brehmer (1991).

Question		Information			Order		Other			
1	2	3	4	5	6	7	8	9	10	11
About Fire	About other persons activity	About Fire	About own activity	About other persons activity	Mission order	Direct order	Request for help	Request for clari-fication	Acknow-ledgment on info or order	Misc-ellaneous

Table 1. Communication categories.

Communication Content, Students

The communication result for students show significant differences in category 1, 2, 3, 4, 5, 8, 9 and 10. For category 6, 7 and 11 there is no significant difference (Johansson et al, 2010) (Figure 9).

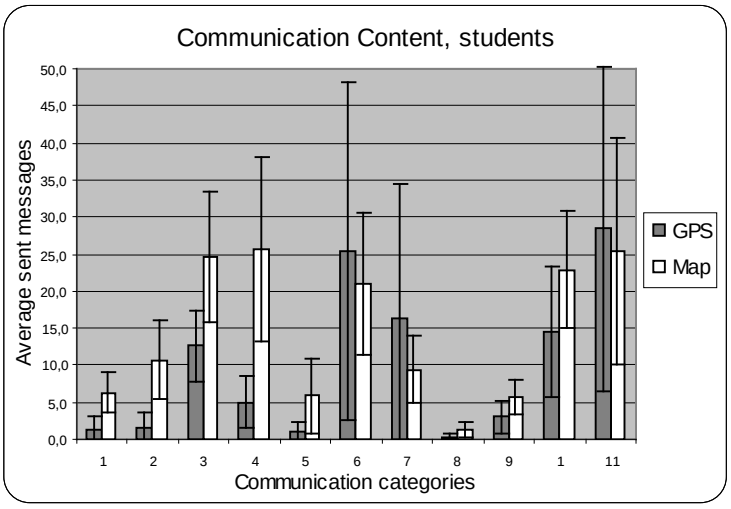

Figure 9. Average send mails in each category, GPS vs paper map.

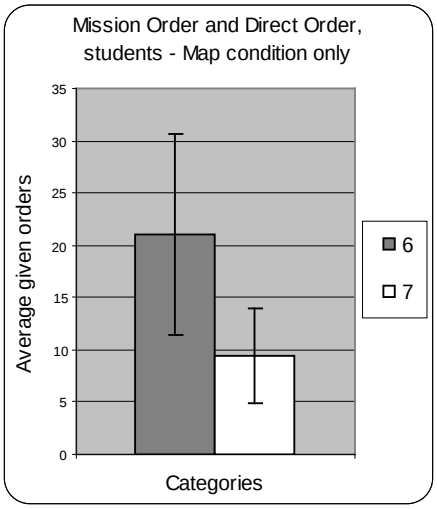

Figure 10. Students paper map condition, Given mission order (6) vs given direct order (7).

Order giving (mission order category 6 or direct order category 7) was one of the means of the command post to manage the firefighting work on the simulated field. The students result shows no differences between GPS and paper map when it comes to mission order or direct order.

Within the paper map condition there is a difference between mission orders and direct orders. The command posts in the paper map condition had significantly fewer direct orders given than mission orders, $t(18)=3.46$, $p<.0028$ (Figure 10). Within the GPS condition no difference is found. Thus, the relative amount of given direct orders are higher in the GPS condition. The GPS detailed representation of reality could encourage the use of direct orders.

Communication, Professionals

The professionals show significant differences in category 2 and 4 only (Figure 11). For all other categories there are no significant differences (Granlund et al, 2010).

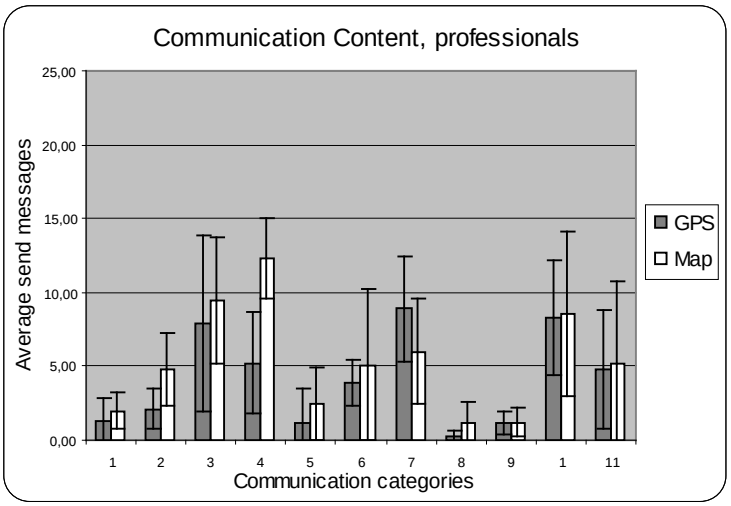

Figure 11. Professionals average send mails in each category, GPS vs paper map.

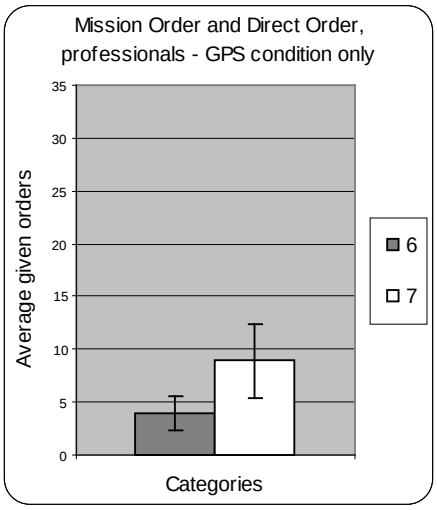

Figure 12. Professionals GPS condition, Given mission order (6) vs given direct order (7).

There is no significant difference between the conditions regarding mission order or direct order (category 6 or category 7) between GPS and paper map.

Looking within the GPS condition, though there is a difference. There were significantly less mission orders given than direct orders, $t(16)=3.88$, $p=.0013$, in the GPS condition (Figure 12). Within the paper map condition there were no differences. Thus, the relative amount of given direct orders was higher in the GPS condition. This could, as in the case for students, be an effect of the GPS supports detailed representation of reality that encourages the command post to extended use of direct orders.

GPS condition, Order category for command posts with different professional disposition

Within the GPS condition the RSCP and MCP subgroups both gave more direct orders than mission orders (Figure 13).

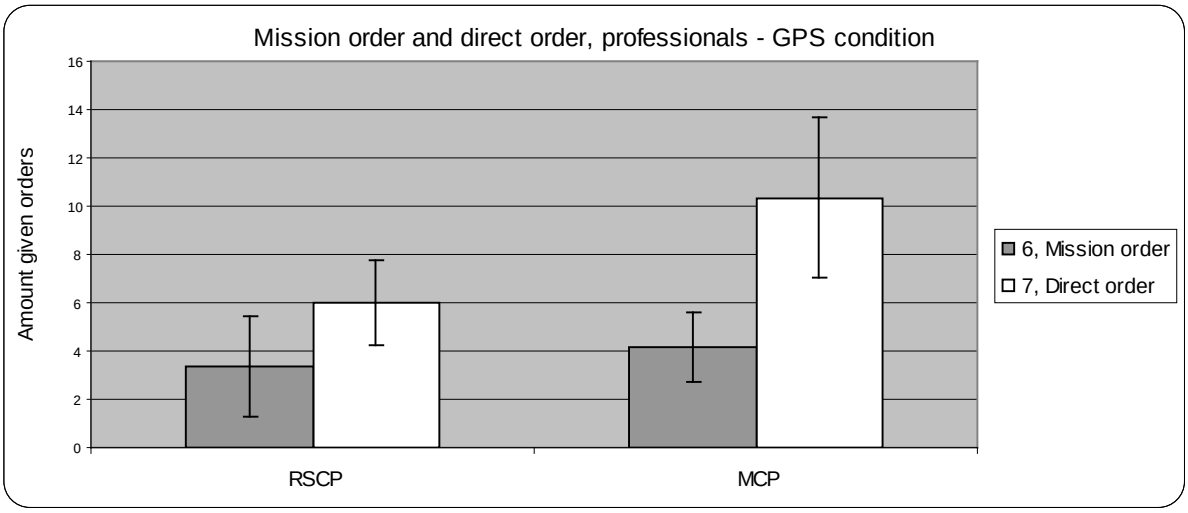

Figure 13. Direct order vs Mission orders within the GPS condition for the subgroups, RSCP and MCP

For RSCP teams the difference was not statistically significant. Whereas the MCP teams had significantly, $t(10)=4.60$, $p<.001$, fewer mission orders given than direct orders in the GPS condition. The result could be interpreted as MCP generally gave more orders than RSCP during a simulation session, and the surplus consisted of direct orders with a high degree of control.

Paper Map condition, Order category for command posts with different professional disposition

Within the paper map the RSCP and MCP subgroups had a similar result regarding the ratio between given mission orders and direct orders (Figure 14), neither RSCP nor MCP showed any significant differences between mission orders and direct orders. The result could be interpreted as RSCP and MCP had the same behaviour regarding giving orders when the means for management was paper maps.

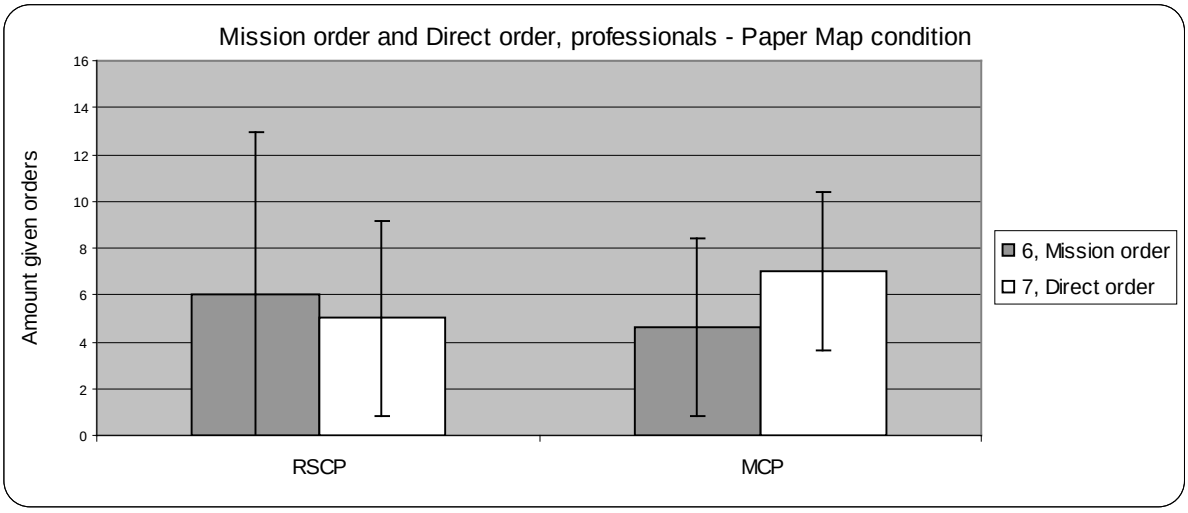

Figure 14. Direct order vs Mission orders within the paper map condition for the subgroups, RSCP and MCP

Communication Content, Summary

In the study with students as participants the teams showed significant differences in 7 of 11 categories between the GPS and the paper map conditions (Figure 9). They did not show any significant differences in the important categories mission order and direct order between conditions. Within conditions the paper map condition show significantly fewer direct orders given than mission orders. The GPS condition showed no significant difference between the two types of order, ie the GPS support raises the amount given direct orders.

In the study with professionals as participants the teams showed significant differences in 2 of 11 categories between the GPS and the paper map conditions (Figure 11). Within conditions the GPS condition show significantly fewer mission orders given than direct orders. The paper map condition showed no significant difference between the two types of order, ie the GPS support raises the amount given direct orders. This is the same effect as in the students result.

Concerning order giving and professional disposition in the command post, direct orders are mainly sent by MCP teams. They have a more pronounced usage of direct orders than RSCP teams within both GPS and paper map conditions

DISCUSSION

In the paper map condition the C2 task was traditional. During the over all task of managing one or more forest fires in the simulated world, the communications was restricted to text messages send between command post and ground chiefs. The received intelligence was filtered by humans, ie the ground chiefs decide what information their command post need to know, in which resolution and degree of abstraction. The command post, in turn, had to harmonize contradictory reports of their men. The command post did not have any technological methods for surveillance. The command post needed to request intelligence and reconnaissance information from their ground chiefs. Target acquisition was inaccurate.

In the GPS condition the communications had the basic text message ability as well as automated visual services with real-time unit position, unit state, view of sight and wind. This extra technological dimension had an impact on performance and communication in all of the C4ISTAR notions. The result presented above on performance and communication content effect C2, C3 and TA and S.

GPS effect on the C4ISTAR notions

C2 (command and control): The effect on C2 and order giving, common for both student command posts and professional command posts, was the raised inclination for direct orders. Direct orders are short term orders. They should not be over done by the command post as the command posts main responsibility is long term operational strategies. The value of this lies with understanding the interdependence of GPS-based support to decision making on the one hand, time consumption for the OODA-loop and decision quality on the other. The GPS allowed the command post for precise tasking of ground chiefs. That meant, the ground chiefs did not need time to evaluate a given mission, chose between courses of action and make decisions. However, the command post had to do such an evaluation in advance, with a lower quality than ground chiefs with a real view on the situation could have provided. Vice versa ground chiefs giving information, reconnaissance data, back from the simulation to the command post did not need to collect, process, and harmonize the data. This saved time but lead to a less precise, more contradictory, possibly inconsistent situational awareness that should have been accepted only when time pressure did not allow for an alternative. The GPS of this experiment series, primarily drawing advantage from the possibility of fast information transfer, offered advantage when time pressure for solving a situation was the crucial factor. Whenever decision quality was the decisive capability, the command post would have been better off to use C4I-support that aim at decision support or processing a combination of features like reconnaissance data, own situation, logistic situation and weather data.

The professional subgroups RSCP and MCP, within the paper map condition, showed no differences between direct orders and mission orders, they performed equally well and they had no possibility for faster information transfer. They had to rely on their decision quality capability. Within the GPS condition there was a difference between the subgroups. The MCP teams, contrary to the RSCP teams, gave significantly more direct orders. The MCP teams had the worst performance while the RSCP teams had the best. The RSCP teams combined the GPS fast information transfer with their capability of decision quality, based on their knowledge and experience of methods and procedures for crisis management. By this they overcame the raised inclination for direct orders and clearly benefited of the GPS.

C4I-support could offer the possibility to react adequately to situations in which time pressure, and in which decision quality have priority. When the implemented C4I-systems and capabilities are procured for both purposes and when command personnel is trained to identify and manage both types of request, and to adapt the decision making process accordingly, the capability of crisis management teams improve. The teams react adequately, immediately, sufficiently and with a, over a defined time span, stable decision quality to crisis-scenarios.

C3 (communications): The effect on C3 was most evident for the students. Their actions were to a great extent based on the visual GPS-based information. They communicated with significantly less messages in 7 of 11 categories. In the GPS condition the human to human communication between students highly depended on acceptance of the GPS visual communications abilities. The acceptance could be explained by the students having no experience of crisis management, solid computer skills and high experience of playing computer games. They used the technological advantages of fast information transfer without experience based considerations, like resource management, area prioritizing, goal management or synchronization. They perceived the task as a game that could be won.

The professionals did not rely on the GPS supports benefits as unrestrained as the students. Their communication was similar in all but 2 categories. The professional teams did not explore the benefits of the GPS to the same extent as the students. The restrained behaviour could be explained by the professionals' high experience of crisis management, solid computer skills but little experience of playing computer games. They could make out the similarities between the micro world setting and their real life experiences. They solved the task as they should have done in their every day work, based on security before exploration. They used the technology with experience based consideration. The teams managed their recourses and felt uneasy about not having resources in reserve. They perceived the task as preparedness training.

TA (target acquisition) and S (surveillance): The effect of GPS on Ta and S, where the target is seen as the houses that should be saved, followed the trend of the effect on C2. Teams that could prioritize the needs, fast information transfer versus decision quality, had best outcome in the simulation trials. To be able to save a house, the effort had to start about 5 minutes before the fire is expected to reach the house. This in the simulation that was conducted in 20 minutes of time pressured work. The RSCP teams in the GPS condition were the only teams that fully succeeded in saving all houses. Those teams had both the fast information of the GPS and the capability to decision quality, due to their training and experience of crisis management. The RSCP teams in the paper map condition had the same capability to decision quality, but lacked of the required fast information transfer, thus they where not able to save all houses.

Conclusion

That the GPS and paper map condition showed different features corresponding to the notions, is an indicator that the elements of C4ISTAR exceeding the C2 spectrum has an influence on decision quality and performance, not only for military use but also for control and communication systems, designed to support municipal crisis management teams in Sweden. GPS as an integral part of a complex environment will produce full effect only in combination with those, C2 exceeding features. They are indispensable to achieve a dramatically improved capability to save lives and minimize damages in natural and technical disaster scenarios.

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