Improvisation, Innovation and In Situ Development – An Example from Military Command Work

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This paper is a case study that describes an in situ *information systems (IS) development effort carried out with only local resources and staff in military (Swedish army) medium level headquarters (HQ). Originating in a qualitative study of command practice, this paper tracks the design and development of a simple hypertext application (a spreadsheet cluster) built from off-the-shelf software and describes the application's evolution over time into a control and coordination tool. The chain of events during a series of five military Command Post Exercises (CPXs) that led to the development of the application is described briefly here. First promoted by a few staff, it evolved over six months through these five CPXs. It was meant to be a complement to a new top-down common IS architecture in the HQ, one meant to support flexible teamwork and coordination. The application became so much a part of daily work practices that it became "invisible". Internal IS evaluations after the CPXs did report on it but neither were its benefits discovered, nor did it get approval for further development. To help make sense of this development effort and how the application was used, we found the notion of boundary object useful.*

Background

Context, Control, and Organizational Design

The military has tried hard to find their way when designing modern organization and practice, implementing new control methods and technologies. Within the military, force reductions and modernization

tend to dominate the agenda. Some influences, originating from grand strategy and politics, coincide with the very rapid development and implementation of new control, weapon and support technologies. The context of this article, which it describes briefly, is the ongoing change process within the Swedish military. The case however has parallels elsewhere.

Organizational engineering and training have traditionally been the mechanisms the military has used to build adequate organizational forms and work practices – seemingly relevant standard units and procedures for command in battle and war, aiming at reliability and controllability. Modern information technology (IT) replaces legacy systems in a process which is accelerating since 15 years, leading to a successively more integrated infrastructure. At the same time the uncertainty concerning what constitutes efficient command work remains considerable. There is a widespread need to learn how to use and make sense of modern control technologies. This agenda makes it necessary to critically analyse and possibly redefine traditional control mechanisms such as bureaucracy, discipline, drill and training, all being components in the managerial control system.

Science and the idea of "rational" management have strongly influenced what IT is and what the ideal command and managerial practice should be, especially in the military. The common ideal is a far-reaching automation, aimed at predictability and thus controllability (Beniger 1986). The paradox is that when automation is possible in basic work activities and when modern technologies become simple to use, the organizations and their control mechanisms in various ways become more complex and often not possible to automate. In dynamic environments such as war, few social actions can be predefined in advance and implemented as rules or programs to follow (this has been a common military control strategy). Therefore, as time has passed, the need to find flexible ways to handle the everyday evolving events has become an object of research for the military.

Method: Fieldwork and Data
Fieldwork

The qualitative fieldwork Persson had undertaken on command practices coincided with a major development and reformation phase of the lower and medium level Swedish army command structure, which was linked to a series of CPXs (command post exercises) held between November 1997 and May 1998 (table 1). The new organization and its working procedures had been modelled during a few years within a traditional top-down systems development process. To some extent this process has also been participatory, involving at different points in time a large portion of the army's command staff.

The verification and test cycle of the new command organization, its procedures and technologies, constituted the context for this fieldwork and was in fact what initiated it. The purpose of the fieldwork was to observe up close some of the "command work", work processes the army has difficulties describing. The subsequent analysis intended to formulate IS design suggestions for work in dynamically evolving environments. Therefore it was necessary to try to discover and record the use of new technologies and working procedures over time.

In all, there were 5 CPXs (table 1) during 6 months. They involved two division HQs (A and B) and a number of brigade HQs. Three of the CPXs were observed for 3–4 days, while the last one (CPX 5) was a one week long event.

Exercise	Research purpose and fieldwork
CPX 1: HQ A, November 1997. Indoors, some mock-up vehicles, somewhat reduced staff. First use of new central IS, substituting another and delayed one (see text below).	First meeting with new technology, new working procedures. Thorough work for getting access. Aim to study the total design of HQ workspaces and vehicles.
CPX 2: HQ B, January 1998. Outdoors, real workspace, limited area, some reductions in staff. Revised working procedures.	Limited participation, aim to establish social relations and inform about later research, learn HQ B configuration which deviated somewhat from HQ A.
CPX 3: HQ B, early April 1998. Outdoors, full scale with few limitations. Partially temporary staff.	Closer study of logistics and procedures. Overall impression of a full-scale event, problem searching.
CPX 4–5: HQ B late April and early May 1998. Outdoors, full scale test of new organization and infrastructure. Ordinary staff.	Main fieldwork, detailed study of work procedures and technologies over time. Comparison with CPX 1 concerning some workspace design issues.

Table 1. Series of CPXs for fieldwork

Before the exercises, to facilitate entry and follow-up work, the research project and its agenda were presented to the staff. Between each CPX there was some time for data analysis. Except for the first one, they went on around the clock. Given this, and the length of the fifth CPX, this posed a particular challenge. Fatigue and logistics became significant fieldwork constraints.

What makes this case worth reporting on is the chain of events which evolved within the context of the new IS (information systems) architecture and the new communications infrastructure which were to be used and tested. The development process and delivery of the new IS architecture were delayed but as the scheduled CPXs were meant to be important test situations also for certain new command principles and a new work organization they went on as planned. A substitute IS structure for support of staff work was thus needed from the first CPX

and was created out of existing army IS applications and commercial software. It was designed to mimic the essentials of the delayed system and was implemented successively from November 1997 and on. One result of this delay was that the already modelled operating procedures and methods had to be somewhat redesigned. This work was systemized from late January and on, the exercises being the proving grounds, especially the fifth and longest one (table 1).

It was the constraints arising from the reliance on the new combination of mainly standard (military) office software presupposing new operating procedures, and the series of exercises, which initiated work upon an application for support of workgroups and functional subsections within the HQ. During the spring, a few individuals designed and *in situ* developed this into a cluster of linked EXCEL spreadsheets, a loosely linked hypertext application, which was then used during the last two CPXs. It inherited its name, *Actualities Table*, from a traditional paper-based work tool.

Data

In total, some six weeks were spent in the field during this series of exercises (see table 1) when the design and development related to this hypertext application occurred. Much of this design and development effort was observed and recorded. Two follow-up interviews in December 1998 and January 1999 filled in and confirmed the initial data, clarifying the links between the central development work within the army, and what happened during the first half year during the series of CPXs (fall of 1997–spring 1998).

The field data produced include observation notes, recordings and documents. The recordings are audio (about 13 hours) and digital photographs (some 300), marked by time and place. The audio recordings are of three kinds: short individual interviews carried out during the CPXs, discussions and briefings during the CPXs, and then post-CPX interviews. Documents include print-offs generated during the CPXs, from the hypertext application, other documents and e-mail. The traditional

paper Actualities Table and its transition over the CPXs is recorded in photographs, documents, field notes and in interviews (audio taped) with key actors. The photographs show how the application evolved and was used from November 1997 and onwards. At the end of the last CPX it was also possible to do a rough evaluation of the new application using the local area network (LAN) in the HQ.

Case Description
The Case and Some Design Principles

The successful *in situ* development of the hypertext application occurred during the CPX series (table 1). This development was both stimulated by and a response to the ongoing army top-down change process that included the implementation of new technologies for control and for cooperation. The intent was to arrange charts, spreadsheets, and text documents under a common interface, an upper level "gate table", called the *Actualities Table* after its predecessor. This table is a traditional way of representing military units and their capabilities. It usually takes the form of a static spreadsheet or table.
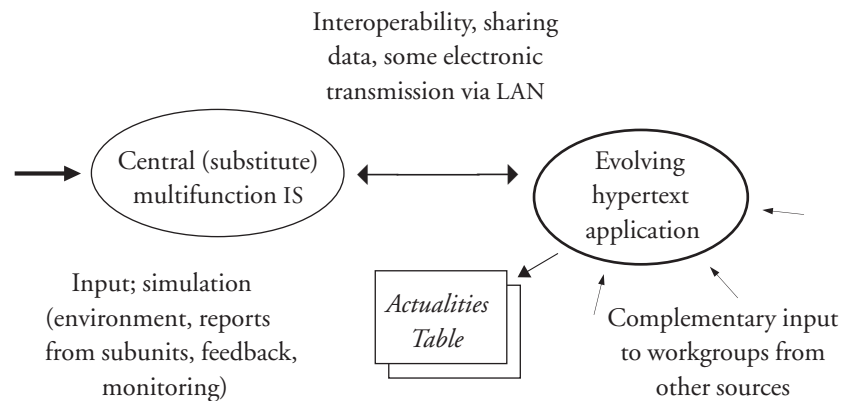
Interoperability, sharing
data, some electronic
transmission via LAN

Central (substitute)
multifunction IS

Evolving
hypertext
application

Input; simulation
(environment, reports
from subunits, feedback,
monitoring)

*Actualities
Table*

Complementary input
to workgroups from
other sources

Figure 1. Overview of IS architectures in HQ

The new application was sketched out, designed, built and then continued to evolve when used operationally during the last two CPXs. Its position within the total IS structure is depicted in figure 1. The application was not built or designed to satisfy a particular, explicit set of design requirements. Instead it was designed as a cluster of work tools, visualization aids, and coordination mechanisms (mainly documents such as operations orders, plans, directives and assessments). Nor was it ever "complete" or "finished". For example, the application could not link fully to the central (substitute) IS system.

The development process essentially built a more flexible, multi-view version of the old table with different linked documents – one which any workstation in the new IS infrastructure could support. The interface was an EXCEL spreadsheet that listed the subordinate units, their current status and situation over time, further augmented by the use of a colour scheme (red to green) for certain capacities. By clicking in various cells programmed as buttons on the spreadsheets, a user could access other linked documents (or tables), as for instance detailed figures on technical and operational capabilities or a long-term prognosis sheet that visualized the current operations plan and displayed activities across time (days).

The application was implemented in the division HQ LAN with its distributed client-server architecture. It also to some extent "mirrored" the central (newly implemented, substitute) IS, providing an alternative view of data. For example it relied on spreadsheets and buttons, not catalogues or files. The same standard software was used. This allowed written orders and reports to be edited and produced in the central IS structure and then partly or wholly incorporated in the other (more local) hypertext structure. Both kinds of data representation and storing (spread-sheet and files) fit into the same control superstructure, satisfying the global command requirements. Some data were even input data in both structures. However, while the hypertext application served mainly internal local demands, the other IS structure (and document) consisted of distributed resources that spanned several command units

within the division. This framework thus allowed amendments in the form of new spreadsheets or documents according to the situated needs among the various HQ subsections, for example a customized telephone list.

The Development Process

The development process started during the first CPX in November 1997 in HQ A. In the course of his work, one officer (he was to be a key player in this *in situ* development effort) discovered the need for a better overview of subordinate units' status. During the second CPX (January 1998) he was assigned to HQ B and carried the idea with him. There, another input seems to have come from the then new division commander who wanted to get a better overview of his resources, given the new IS. Later in HQ B, during the third CPX in early April 1998, the first officer, having imagined that this design could be handled by off-the-shelf spreadsheet applications, began to discuss possible design alternatives with a visiting colleague (observed by Persson). His idea was given support, in part because this other officer had developed similar tools when serving in Bosnia in 1993 (Persson 1997).

Later (in a May 1998 conversation) the Operations team leader in the HQ B Command Centre described how he and his colleagues took a blank sheet of paper (sometime in the period January–April) and started to sketch out a design. They saw this as 6 or 7 subordinate (function) tables all linked to the top level, each one showing an aspect of the command information and situation. They included for instance the long-term prognosis, (battle) capacity, current and distributed orders and the mailing list. Other pages included weather forecasts, daily agendas and a HQ work schedule.

The first LAN tests of the new *Actualities Table* were inconclusive partly because it had initially been designed as most single user EXCEL applications although consisting of several documents and spreadsheets. Few of those involved in the project had realized the complexities arising when they implemented it in a multi-user environment. A reservist, in his civilian life a systems developer, helped with some

necessary macro commands in late April before the fourth CPX. Data quality control and the problems of how to allocate write/read responsibilities in the actual environment were however never entirely resolved. A partial solution was to make a "read only" copy available over the network and to allow only those who were authorized to update the Master Table.

A January 1999 interview with this reservist revealed more about the development process. Prior to the first demonstration in late April 1998 to people outside the design and development group, the new application was described as and thought to be just another table or template and did not attract much interest. He made it clear how surprised he was when he, at the first demonstration, realized what exactly the new *Actualities Table* was and how far it had evolved. Had he known about the direction this work had taken, he said, he probably would have been able to contribute to a more robust design, as he could see how to avoid some difficulties. Other key actors in this work were a number of enlisted soldiers and sergeants who were skilled in computing. One of them implemented the macro commands in the EXCEL spreadsheets during the fourth CPX.

What is striking about this effort is that these practitioners found working with off-the-shelf products like MICROSOFT OFFICE attractive because they found this genre of products to be cheap, relatively easy to build and to link. Also, some argued that when compared to larger applications, these products could achieve much of the same functionality in less time and for less money. Nevertheless, one informant said that IS professionals often consider them to be less exciting and challenging than *new* kinds of technologies.[1]

Post CPX Evaluation

A few weeks after the last CPX, staff evaluated work procedures, the central (substitute) IS, the organization and its infrastructure for communication and support. This evaluation took the form of a structured questionnaire and was intended to provide input for the next phase of

design and development within the central army project. In the evaluation report, primarily its appendices, the *Actualities Table* was mentioned (in positive terms) and supported by some. In the report Summary, the primary part, the Table is mentioned once, briefly, and it is not endorsed. In part, this was a consequence of the evaluation path and its reliance on a structured questionnaire with pre-defined evaluation issues. However, the result is surprising given that the *Actualities Table* emerged and evolved over at least three CPXs, and that end users had found it not only complementing but extending the central IS resources.

Two follow-up interviews helped explain what had happened. One informant, an officer who had been working with the central IS design and management, said that the staff first had simply "forgotten" the application. When they finally (early autumn 1998) discovered its potential and tried to get it back into the larger (previously delayed) IS project, they were not allowed to do so. As a tactic, confirmed by another informant, what they did next was to redefine the application. In short, it was given a new name and functionality – one more "interesting" than the "simple" one it had previously. Now, it was to be (part of) a new "intranet web-interface" project. This project *had* been part of the army's overall IS effort but work on it had not yet begun during the 1997–1998 development cycle. The *Actualities Table* was used to help "kick off" the army's intranet project.

With a new name, it became central to the pre-existing intranet project, now designed to support convenient, rapid access of information stored on the HQ servers. This information had previously been accessible only through the central (substitute) IS with its standard (Windows) set of finding tools and file catalogues. With this new interface and an intranet, these tools and catalogues were no longer necessary to access the central IS resources. Together, the new interface and the intranet would allow direct access to servers and databases and allow users to bypass the central IS standard interface, which was an obstacle for many users during the CPXs. This was because it presupposed Human Computer Interaction (HCI) skills and use of pre-defined

procedures. During the CPXs, after a few days, this (and the amount of data) made information management time intensive and slowed down certain procedures within the command work, further promoting workarounds.

Analysis and Related Research

Usability Accounts

The development of the application was initiated with little IS insight. It proceeded thanks to some local IS expertise and because initiatives to build and test pragmatic solutions to work problems generally were encouraged by command staff. The case illustrates how staff made sense of an organization, their work and an external environment (war simulation) where surprise and improvisation are commonplace. With the help of the hypertext application, spreadsheets and traditional documents were linked. The result was that the various HQ B teams and experts could update, display, retrieve, and transmit information to other teams and experts within the HQ and thus support work in the total command and control structure. The case also shows how staff received support for an *in situ* IS project twice, first informally in their own unit, and then formally within the army project.

In the HQ B Command Centre, which was responsible for coordination of staff work, the application was frequently used during the last two CPXs to coordinate and to record the activities of subordinate units within the HQ. For example, when Duty Officers succeeded each other, the application helped them clarify some critical aspects of command and coordination: what units were available, what they were doing, and how to communicate with them. Some of the issues that were not resolved fully were read and write rights, updating – both of data and time lines – and moving the application from a point to point resource to a distributed (LAN) resource. What users said they valued was the common template, a single, familiar interface, and that different (and different views of) data were available from one point. Compared to central IS resources, the users said, the application was easy to use and

to update. Our interpretation of this is that the application helped staff address and work through central issues of command work, control and coordination of one's assets.

Toolkit Fit and In Situ *Development*

Tables have long been part of the staff and command work toolkit. In the final CPX the artillery support subsection used the new, hypertext table as much as they had once used the paper tables. In fact, in this CPX they used the *Actualities Table* more often than central IS resources, which they felt were hard to understand and manage. What we can learn (once again) from this is that with centralized top-down development and distribution of software products, there can be problems of fit. This raises a critical issue, particularly in the military. In Sweden (as in most nations) few military IS resources have been tried out in full scale, actual practice. Nor are Swedish army command units normally fully operational except in training. In short, "fit" has seldom really been put to the test. Having said this, data from Bosnia (Persson 1997) suggests that this approach (which also informs the army's IS strategy) is strong and flexible enough to handle real world events, however unpredictable or violent.

In large scale IS efforts, the work practices these applications and resources are intended to support are often not well understood and/or idealized. What we found here, with this hypertext application, is something different. In this case, when staff, through their work, discovered some requirements they considered desirable, they were able to initiate a rapid design and development cycle. In this case, local expertise, on-site cooperation and iterative trials led to a robust hypertext application. As it evolved it was flexible enough to adapt to a contingent, dynamic and realistic environment. Its evolution and design augmented staff participation and influence, access and adaptation. With their own application, the staff felt that they could easier represent and solve operational problems than in the substitute IS which they had only worked with for a short time. This case illustrates a pragmatic *in*

situ development effort and suggests that the driving force behind this development effort was the need to get the job done. Actually, here we have two development cycles. The substitute IS proceeded according to traditional (participatory) design and prototyping principles, while the hypertext application evolved from and embodies central principles of command work.

In Situ *Systems Development*

Bödker (1991) describes this model for systems development with support of activity theory. *In situ* development, based on practice and the development of working praxis in context, implies that during design and re-design the *users* are simultaneously *designers* and *developers*. This was most evident in the hypertext case that we have described here. The substitute IS was more dependent upon external resources and conditions. Among these was how the army had defined and implemented its central IS strategy. Still, our hypertext case was initially triggered by and in some aspects then competed with the substitute IS.

It may be worth pointing out that development agendas like this have been more hoped for than achieved. Further, in the HCI/CSCW (computer-supported cooperative work) literature, they have been more argued for than found or studied. This is also true of information science literature (for an exception, see Clement & Halonen 1998). While there may be legitimate reasons for this, the literature on *in situ* development is still not strong.

In fact, it seems as if the literature on *in situ* development tends to stop too soon. In other words, the research agendas that could further *in situ* development agendas have not been analytic enough. In particular, it seems as if common sense ("I know what work is") and ideology (for example "work [and the workplace] should be more collaborative, more democratic, more equalitarian … whatever"), in a word direct, uncritical transfers from cultural to academic discourse, are responsible for what we see in this literature, rather than sustained analysis of actual work practice that illuminates what "work" is. If nothing else, this

article presents a case where a low-level development effort, carried out with local resources and off-the-shelf software, led to a hypertext application attractive enough to be "hijacked" (but again, see Clement & Halonen 1998).

Boundary Objects, Linking Distributed Teams and Experts

There is a need to find mechanisms to link distributed and heterogeneous working teams and experts, and to support the kinds of cooperation and coordination that characterize modern organizations, the military being only one example. Most individuals are resources for a complex organization and must be able to link to it, but each carries his own (limited) interpretation of events. Star (1989) has pointed to methods and means that allow people to work together in spite of different perspectives and lack of fully integrated views on a problem situation. Star concluded that a common strategy seems to be that "objects" are created and used as common fields or bridges across different domains or viewpoints, naming them *boundary objects*. Her examples are repositories, artefacts adaptable for various uses or interpretations such as road maps, and even language and concepts. She argues that *boundary objects* are flexible enough to mediate multiple viewpoints in an organization, yet maintain their identity well enough not to confuse people. To achieve this, her work (originating in distributed artificial intelligence) led to objects that support *due process.* In a complex organization, *due process* helps redefine what "matters" in reference to new information and new situational constraints. Here, the actors' intelligence is not artificial, but rather situated. Human actors solve these problems and their support mechanisms need to be designed accordingly.

What Star describes is a set of computational objects that enable insight, information, knowledge and perspective to be brought in from the different participants and successfully reconciled (1989, p. 47 paraphrase). Having said that, for Star the processes these objects support are complex forms of work, but not development and design efforts.

Given how the *Actualities Table* was built and used in this CPX series, it is easy to think of it as a boundary object. However, this application (and this case) extends what Star means by "boundary objects". The Table is not just situated in the work world. Nor is it just a reflection of IS structures and resources. Instead, it bridges and supports both command work and the design/development effort. As such, it not only becomes transparent, it is the very resource that made this *in situ* development effort possible. This suggests that boundary objects like this, helping us to rethink worklife practice and development together, could advance other *in situ* efforts.

Research Issues
Systems Design for What Office?

As Bödker (1991) points out, IS standard products seem to have been designed for office-like environments. This in turn led to "modern" development efforts that privilege detailed, finite design specifications. The office-paradigm for systems development seems less relevant today, because it assumes the existence of a highly regulated and predictable working space (not even the military can achieve this). In order to build robust support technologies, it is necessary to understand the real-world complexity in the information management, and to apply situated tool-building (Greenbaum & Kyng 1991). In the world, individuals move around and interact, they invent and use artefacts which are the natural starting point for development processes. As Bödker argues, if design is to be a strong agenda, it has to be thought of as re-design, as an ongoing process of simultaneous use and design. However, when computer artefacts, designed to be only mediators, also *actively change* the practice because they are more than merely *tools*, this is something we know little about.

Our case shows that when the practitioners became constrained by standard IS resources, they went to produce another kind of toolkit. The hypertext application thus emerged from and reflected their ideas about practice. In short, it little altered the CPX work processes. However, over

time, with use and through reflection, change may occur. In fact, boundary objects could be designed and used to support both innovation and continuity in an institution (Bannon & Kuutti 1996 and Walsh & Ungson 1991). Eventually, this means we will have to think more about what kind of rationality is relevant, how work and institution are perceived, and what should guide IS design.

Method and Results: Discussion

There is a demonstrable, fundamental gap between the knowledge the HCI community has tended to value and build from, and that which strong qualitative methods can yield. (This is also true for the information science community). For example, what qualitative method can tell us about practice, that it is contingent, often problematic, informed by context, and is seldom rule bound, challenges many of HCI's strategies, programs and research agendas. So does, as this hypertext case shows, *in situ* development. In particular, this case suggests that practitioners by themselves can, when it comes to terms like technology, information and work, renegotiate these terms and the resources they represent in order to get work done. Having said this, it is worth noting that the developers here almost missed the significance of what they had done. They, it seems, saw what they had done as merely "repair work". As such, they had to work hard to get their efforts recognized.

This is in part because the standard IS approach gives users a diminished or no vocabulary at all to employ when talking about what they do. Nor does it help define for a given workplace what IS can or should be. Judging from the evaluation report, where *"Actualities Table"* is hardly mentioned, their new artefact (and its value) was barely recognized. It can be argued too that IS strategies tend to be, when they turn to complex, professional forms of work, normative and prescriptive in nature. The result is, as we have seen here, that IS efforts tend to mask, ignore, or co-opt local development and design efforts. "Our" practitioners seemingly had to choose between acceptance and loyalty toward the central IS *or* to do their job.

The case also reminds us of what Giddens (1979) has to say about "mutual knowledge" and "common sense". In brief, no set of practitioners, no matter how expert, can articulate "strong enough" analytic frameworks or categories. This is not to deny practitioners' insight or analytic ability (Karasti 2001, p. 134). Rather it acknowledges that in modern organizations, no matter how complex their work is, experts are "laypeople most of the time" (Giddens 1991, p. 138). Consequently, the analysis of complex, professional work requires considerable, second-order effort. This in turn can lead to cooperative forms of design and development. In short, in development efforts, social scientists and practitioners need to work together with designers and developers, the earlier the better (Graves & Nyce 1992). It is in efforts like these that the best hope lies for the reinvention of basic categories, whether we are talking about work or technology. This is something qualitative methods can help with. In particular, they can help build and support dialogue, as we have seen here, that makes sense of what gives technology and work the significance they have. In addition, they can provide support for innovation and change.

Acknowledgements

Per-Arne Persson has been an officer since the late 1960s. He entered the (then) new doctoral program for officers in the early 1990s and finished his doctoral studies at Linköping University in 2000 with an ethnography over military command work, aimed at the definition of principles for the design of information systems. Per-Arne currently works at the Swedish Army Command as a researcher and an organizational consultant within systems development, management and the formation of new research agendas for the future national defence. His research covers topics such as information systems (design), managerial (management) control, CSCW, and the corresponding development of methodology and theory. He is also associated with the National Defence College (Stockholm), teaching within his research field.
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Notes

1. The rationales and rationality behind design choices will be investigated during further research.

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