**8th International Command and Control Research and Technology Symposium**
**June 17 – 19, 2003**
**National Defense University**
**Washington, DC**

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**Paper attached**

**Topic:** Information Age Transformation

**Title:** The future of military HQ: An exploration of the organisational design implications of modularisation.

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# The future of military HQ: An exploration of the organisational design implications of modularisation

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# The future of military HQ: An exploration of the organisational design implications of modularisation


## Abstract

When organisations operate in an environment that is dynamic, complex and unpredictable they need to develop more flexible structures if they are to increase their chances of surviving. Advances in information and communication technology (ICT), implemented with the appropriate process and structural change, offer the prospect of improving the flexibility of organisations. It is proposed that future military headquarters (HQ) can achieve this flexibility through Modular Capability Expansion (MCE), which is a modular organisational structure enabled by networked information management and communication technologies. This paper provides a critical examination of MCE and reports the results of an experiment exploring some of the technological and organisational design issues associated with modularisation.


## Introduction

The strategic context within which UK Forces now find themselves is characterised by complexity and dynamism. They are required to be prepared to engage in a range of different operations across the continuum of the conflict spectrum, from disaster relief, peace support and other low intensity conflicts, through to regional or inter-state warfighting. In addition, such operations will often involve the UK being part of an alliance or coalition. This increased complexity is being driven by events occurring in a dynamic and somewhat unstable world, which reduces the UK Forces' ability to plan ahead. Adversaries are not always clearly identifiable and forces are not always separated by observable boundaries. Modern opponents may operate covertly, or even in the virtual environment[1]. In such a context, military organisations need to become more flexible, adaptable, and organic[2] if they are to increase their chances of responding appropriately to changes in the environment (Mintzberg, 1979; JDCC, 2001).

Advances in ICT, implemented with the appropriate process and structural change, offer the prospect of improving the flexibility of organisations[3]. However, in the military context, the ability to create more adaptable and flexible command and control (C2) structures and processes is compounded by the need to be robust and reliable. In considering future military organisation designs, it is therefore important to balance the need for increased flexibility, with the potentially competing needs for robustness and reliability. Achieving reliability requires an ability to respond

[1] This would include activities such as computer virus attacks on, or 'hacking' into, military or public information systems.

[2] An organic structure lacks formalisation and standardisation, has a network structure and lateral communications, that is, the inverse of the bureaucratic structure.

[3] Use of the term organisations throughout this paper applies to all organisations operating in complex, dynamic environments, not just military organisations. Many commercial organisations operating in environments with similar challenges to those faced in some military operations have successfully (or in some cases less successfully) deployed ICTs to revolutionise their operations, and there are valuable lessons to be learnt from their experiences.

appropriately to unexpected events and problems. Organisations that are particularly good at doing this are called High Reliability Organisations (HROs). HROs, such as those operating nuclear power plants, function in complex, demanding, and potentially hazardous environments, but still manage to achieve outstanding safety records (Weick and Sutcliffe, 2001). Processes used by HROs to achieve reliability in demanding environments include prioritising safety and reliability, establishing standards against which they evaluate themselves, a preoccupation with identifying and learning from failures rather than successes, a concern with building a richer awareness of the state of the organisation, a preparedness to identify anomalies and concerns, and a culture that reinforces the appropriate values, beliefs, and interpersonal trust (Weick and Sutcliffe, 2001; Grabowski and Roberts, 2003).

These characteristics of HROs are critical to reliable performance in complex, changing environments. HROs use organisational structure to mitigate risk in dynamic environments (Grabowski and Roberts, 2003). In particular, HROs attempt to remain reliable by ensuring that the requisite variety of the organisation matches the requisite variety of its environment. It is proposed that the Modular Capability Expansion (MCE) concept achieves requisite variety by employing modularity both as a tool to address the dynamism likely in the future military environment, and to provide the core stability necessary for an organisation to function reliably in a complex and hazardous environment.

The Future Command HQ (FCHQ) project (funded by the UK MoD Applied Research Programme) has developed the MCE concept in an attempt to achieve a balance between flexibility and reliability. MCE is a modular HQ organisational structure composed of a stable core that has some of the features characterising HROs, with additional capability provided by modular expansions. MCE is supported by a 'plug and play' (PNP) architecture, composed of people, processes and networked information management and communication technologies, which provides a means of managing and mediating the flow of information around the HQ modules.

This paper describes a rationale for designing more flexible organisations. It will then describe the key components of MCE. Drawing on the research literature, some of the organisational design and context issues associated with modularisation are identified. Issues identified from interviews with military Subject Matter Experts (SMEs) are then considered. Following this, a recent investigative experiment designed to explore some of the technological and organisational design issues associated with modularisation is described. In closing, some of the key issues and challenges for MCE are discussed, and suggestions for improving the chances of successfully evolving military organisational designs are offered.

## Rationale for Flexible Organisations

Appropriate exploitation of information, the use of ICT to support new ways of organising and communicating, and the development of flexible organisational structures, are three ways that enable an organisation to deal effectively with its environment. Technology can be used to support organisational process and structure change because it allows new organisational forms and activities to be developed.

ICTs create opportunities for new ways of managing and conducting work that may not have been possible (or at least not practical) before the advent of these technologies. Technology also provides the means to exploit information more effectively as it allows better information collection and dissemination, superior knowledge management and facilitates new ways of organising to use the information advantage gained.

The MCE concept involves an investment in technology as a means by which its modular structure can function effectively. The modular capability concept is a method for achieving the necessary organisational flexibility to allow future military HQ to respond adaptively and proactively to challenges likely in the future environment. The MCE concept supports the UK MoD Network Enabled Capability (NEC) initiative. This is the UK equivalent of the US drive towards Network Centric Warfare. The aim of the NEC programme is to enhance military capability by better exploitation of information. Exploiting information is a method of effectively managing the organisation's relationship with its environment. It is increasingly accepted that information, if exploited effectively to further organisational goals, has the potential to provide competitive advantage and sustain success (Kirk, 1999; Phillips and Louvieris, 2002; Marsh and Burke, 2002; Almen, Anderson, Lagerlöf and Pallin, 2000).

Within the modular capability concept, the emphasis is on using technology as an *enabler* of a wider process change wherein technology is used to exploit information more effectively in order to enhance capability. For example, effective exploitation of information will enable improved situation awareness (SA) which could facilitate superior decision-making processes and enable increased tempo of operations, thereby creating advantage over opponents. Technology is being used to support more efficient and effective organisational processes, with the overall goal of improving organisational competencies in line with strategic goals. It is good management practice to be clear about the goals of the proposed organisational change so that it is driven by the strategic goals of the organisation, rather than being driven by technology or management fads (The Economist, 2001; Phillips and Louvieris, 2002).

Successful organisations attempt to develop processes that capture the informal, interdisciplinary and individual aspects of knowledge (Phillips and Louvieris, 2003). For example, creating a knowledge sharing culture or using internal networks to create communities of practice (Kirk, 1999; Phillips and Louvieris, 2003). It is this type of process that is central to creativity and innovation. One of the roles of ICTs is to support organisations in gathering, processing/filtering, manipulating and disseminating information, which, if applied appropriately, can facilitate knowledge sharing and support communities of practice. This information supports human cognitive, social and sensemaking processes, which enhances the ability of organisational members to adapt, respond to, and shape their environment effectively, increasing the organisation's chances of gaining competitive advantage (Kirk, 1999).

Technology development, implementation and its use does not occur in a vacuum. Culture is a 'mediating variable' influencing how new technologies will actually be adopted and used within the organisational context (Symon, 2000a, 2000b; Rammert, 2001; Bradley, Strickland, Walker and Wooddisse, 2002). Organisational and military research clearly shows that technology tends to be adopted by users for their

own purposes, and exactly how it is used is heavily influenced by the extant organisational culture (Symon, 2000a, Storr, 2002; Bradley et al, 2002; McNally, 2002). As was discussed earlier, culture is also an important feature of HROs. Therefore, in order to achieve the envisaged organisational enhancements facilitated by ICTs, there needs to be an organisational culture that can effectively support and exploit ICTs.

Nadler and Tushman (1997) point out that there is no single organisational design that will achieve perfect flexibility. Any particular configuration will involve trade offs. Continual redesign is becoming accepted in an increasingly complex and competitive environment. Successful organisations will learn to create flexible architectures that can accommodate constant change, but without leading to massive disruption to the organisation. One approach makes use of 'organisational Lego' that consists of modular components removed or attached without causing significant disruption to the organisation. The ultimate design will be flexible enough to accommodate the company's core competencies but with porous external boundaries (Nadler and Tushman, 1997; Thackray, 2001).

Organisational survival is about rapid innovation supported by a relatively stable base (Marsh and Burke, 2002). To survive in the ever more chaotic and dynamic environment characterised by increased globalisation, competition and uncertainty about the future, organisations should develop stable, yet flexible, component processes, structures and relationships (Marsh and Burke, 2002; Phillips and Louvieris, 2002). The MCE concept addresses the organisational goals of the military by providing the capability to address a variety of environmental challenges. Modular structures based around a relatively stable core may provide the adaptability and flexibility necessary for command and control in a range of situations.

**Modular Capability Expansion**

Under the Applied Research Programme, a socio-technical enhancement concept titled Modular Capability Expansion (MCE) which used 'Plug and Play' (PNP) agent architectures was developed (Christie and Diethe, 2002). 'Plug and Play' is a term used to describe the easy way in which new external devices can be added to an existing computer system. The main goal of PNP is to take the complexity away from the computer user (who often is not conversant with the technology) in what is essentially quite a complex task (merging a new device with currently existing devices).

The rationale behind the MCE concept is that military HQ organisational structures must be adaptive to changes in the socio-political and military environment. Within a distributed information system an extra unit could plug in or an existing unit could be removed and, ideally, the system would adapt itself to incorporate the benefits of the new unit or to reallocate the responsibilities of the old unit. This would be achieved with the minimum of complexity and with the full knowledge of all participating units.

Recent evidence suggests that current organisational systems in HQ are having difficulty in differentiating between relevant and irrelevant information (Storr, 2000).

Salient and/or critical information does not appear to be reaching the correct decision maker in a timely manner. It is proposed that PNP could alleviate this problem through the development of agent architectures that provide an information-mediating function. The most common use of agent architectures is as computerised implementations in which each 'agent' is a specially written piece of software. However, the concepts behind agent architectures can be discussed where 'agent' means an 'autonomous independent unit'. This could be a human, a software program or a whole computer system. This mediating function would be able to organise a hierarchy of information in terms of saliency and criticality and direct this information to the appropriate personnel.

A modular organisational structure may provide the inherent flexibility required in a future deployed HQ. It provides for HQ either to be concentrated in one location or distributed across the battlespace or to change dynamically between being tactical HQ to operational level as required by the operational environment. A module can be a co-located team or a distributed team. For example, it may have one or two members deployed as part of the HQ and the rest of the team located in the rear of the battlespace or back in the UK. The role of the module is to support the Commander in his/her operational decision-making activities.

As envisaged by Thackray (2001), a Core Warfighting C2 Module, within which the HQ Commander sits, can be augmented by a Joint C2, Multinational C2 or an Other Ops C2 Module depending on the situation. Modular augmentation can be achieved by a 'Plug and Play' / MCE System or prior to deployment in the Force Preparation phase. Modularity enables a HQ's C2 function to change its configuration, size, location and function flexibly in accordance with the operational environment it faces, by appending or removing specialist modular teams.

It is envisaged that a MCE system will give a HQ the necessary capability to work virtually[4] and temporarily with other commands to solve military problems. It can also allow the 'plugging-in' of UK-based support and provide access to constant, almost 'real-time' updates of intelligence sensors and in-theatre support functions, thus providing the flexibility to adapt to environmental events via improved information mediation. This in turn can improve situation awareness, decision-making and organisational response. This way of organising work in the digitised operational environment represents a possible instantiation of a network enabled organisation.

### *MCE and the information mediator function*

The MCE capability is dependent upon the information mediation function for its success. This function, which would comprise a PNP agent architecture together with a human operator, represents a socio-technical system that would perform the task of mediating the information flow into and out of modules associated with a HQ. The information mediator function has three main roles:

- facilitating the management of information to reduce the likelihood of information overload;

[4] Virtually here meaning the ability of HQ staff to work collaboratively with other HQ staff whilst not being co-located. Virtual in regard to computers: "Not physically existing as such but made by software to appear to do so from the point of view of the program or the user" Oxford English Dictionary (1989).

- ensuring that information is appropriately disseminated; and
- enabling the relatively rapid plugging in of new modules and unplugging of redundant or compromised modules.

Figure 1 below provides a representation of the information mediation function.

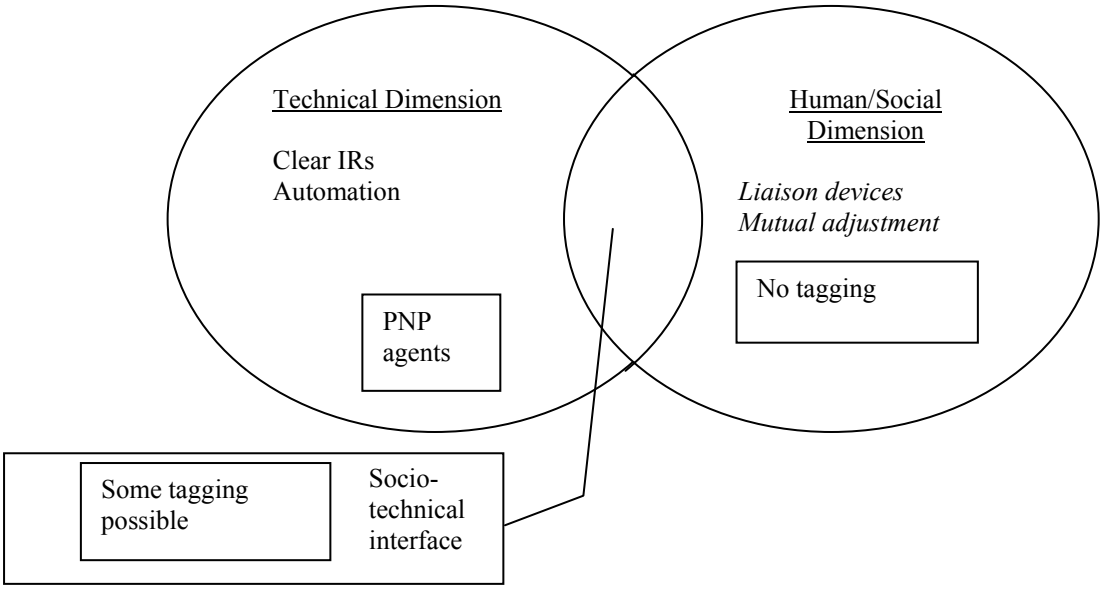


*Figure 1. The information mediator function*

The information mediator function could operate in at least three different ways.

- As a technical system. Some of the information requirements (IRs) of a module could be clearly specified, widely agreed, and embedded within the wider organisation. Examples of possible information sources that conform to this requirement include logistics, personnel management, and geo-spatial intelligence. The information mediator function could enable full automation of information transfer between modules such as automatic updating of platform movements, fuel holdings etc, or partial automation, whereby information is provided to the system in a form that allows it to be processed/aggregated automatically. For example, the use of formatted messaging would allow certain components of a message to be read, stored, and aggregated by the PNP agents. Such partial automation would require the standardisation of information inputs and the associated standard operating procedures to ensure appropriate information is provided. In order for both of these forms of automation to be successful, they also require information systems that are interoperable. Partial, or full automation, facilitated by the PNP agent architecture, represents an effective means of facilitating co-ordination.
- As a traditional liaison device. When IRs are hard to specify/agree upon, the value of a PNP agent is limited. The lack of widespread agreement on how to tag information in terms of criticality, salience, direction and classification means that partial or full automation is not possible. In this situation, the existing strategies of employing liaison positions and mutual adjustment (informal communication) would seem to be far more effective.

- As a socio-technical system. At the mid point, where the technical and social dimensions overlap, the IRs are moderately codifiable, and supported/agreed upon, thereby enabling some shared awareness of information value and ratings of information against salience, criticality and direction. Tagging in this context is possible to some extent. In this context, both formal and informal design parameters need to be considered:
    - formal, such as the creation of a specialist information mediator role, together with some behaviour formalisation (e.g. standard operating procedures), to facilitate information transfer and receipt, and effective information management; and
    - informal, through enabling the staff member performing the information mediator role to use mutual adjustment in order to deconflict ambiguities and misunderstandings in the interpretation of information with mediators in other modules.

**Organisational Design and Context**

In order for a MCE capability and an information mediating function to work in the manner prescribed within a deployed operational setting, it is important to address a range of organisational design and context issues that could support or undermine the successful implementation of modularisation. Drawing upon the research of Mintzberg (1979) and Groth (1999), a range of contextual or contingency[5] factors are identified here. In addition, the implications of these factors for future operational level HQ design, and the MCE concept, are explored.

A deployable joint operational level HQ operates within a complex and dynamic environment. Such an environment provides impetus for the concept of modularization, and the associated concept of network enabled capability, since by adding and subtracting modules the HQ gains the capacity to respond appropriately to the environment. However, external control from government and higher HQ will limit the extent of modularization that occurs, since the need for accountability will tend to drive the HQ toward centralised decision making, undermining the ability of plugged in modules to make a worthwhile contribution to the decision-making process.

An additional influence that could also encourage more centralised decision making is the temptation for higher formation Commanders to take over, or micromanage subordinate Commanders, enabled through the improved information dissemination and aggregation that the information mediation function would provide. This would effectively undermine the doctrine of Mission Command.

From an organisational design perspective, a significant challenge to the MCE concept would be its introduction into a joint and/or multinational situation. The often ad hoc collection of nations, together with problems of technical interoperability, as well as doctrinal and cultural differences, will make the implementation of MCE very

[5] Contingency factors can be thought of as the conditions that influence the structures adopted by organisations. Such factors include the environment, organisation size and age, technical systems and power relationships (Mintzberg, 1979).

difficult. A MCE capability would be of use only if the information requirements are widely agreed, or able to be negotiated, and where the various information systems can be made interoperable. Nevertheless, the discipline and practice of more effectively managing information could enable a UK Force HQ to overcome problems associated with compartmentalisation of information sources more quickly, since the information mediator function is designed to manage information of differing classifications.

Some contingency factors have been identified that could influence the impact ICT will have on the structural forms military organisations are likely to take. But what are the specific implications of these factors for a military HQ? To address this question, a series of predictions is offered that show how a joint operational HQ could be augmented by ICT in the not too distant future.

- The staff work conducted by HQ staff will continue to rely heavily on those human characteristics and capabilities that are difficult to replicate or capture within a computer system. Nevertheless, HQ staff will be more efficient and effective in undertaking their work, due to the support provided by increasingly sophisticated artificial memory, and artificial intelligence systems. In addition, richer communication will be possible between system users due to the widespread use of computer supported co-operative work tools (e.g. email, web based meeting systems etc). However, face to face contact and the need for mutual adjustment will remain a very significant part of staff work. This will lead to modest improvements in the efficiency and effectiveness of staff, and potentially some manpower reductions.

- Computer automation of routine tasks, underpinned by increased numbers of centralised databases, and improved system interoperability, will become more pervasive in military HQ. This may result in some reductions in those positions that currently undertake routine tasks. However, for jobs that require extensive professional[6] and/or managerial experience, such systems are unlikely to lead to significant staff reductions due to the difficulties in explicitly capturing tacit knowledge. This knowledge remains a critical component of effectively working in these domains. Furthermore, given the long lead times for large infrastructure acquisitions, it is likely that there will still be significant work to be done to improve system interoperability, and increase data sharing and the centralisation of information bases. Nevertheless, some reductions in staff should be possible.

- In order to effectively exploit ongoing improvements and developments in ICT, the military will have access to organisational engineering and design specialists, to assist in managing and evolving both the human and software manifestations of organisational structures and processes. This could lead to the development of new positions within the HQ. These socio-technical design specialists will provide support to management in developing new or modified designs, and provide assistance with managing the implementation of changes. Given the complex and dynamic nature of the environment the need for redesign will be ongoing (Nadler and Tushman, 1997).

[6] The use of the term ‘professional’ here relates to the work undertaken by HQ staff and commanders in administering, planning for and directing operations.

- As more organisational tasks, routines, and processes become augmented or replaced by ICTs, the software that controls these systems will increasingly come to embody certain structures and processes. These structures and processes will largely be related to support functions, for example, the provision of logistics requirements to deployed forces will increasingly come to rely on systems which automate certain parts of the process, such as maintaining visibility of goods in transit. Other support areas that will benefit from advances in ICTs include information systems support and personnel management. Meanwhile core structures and processes related to warfighting will continue to rely heavily on existing professional and managerial processes and structures.

- For certain types of operations, such as those with a high political profile, or those that use relatively small forces, joint operational level HQ will be easier to bypass, due to the improved ability of strategic decision makers to command and control forces. However, joint HQ will continue to be an important mechanism for co-ordinating the efforts of the different services and capabilities.

In summary, it is predicted that developments in ICT will enable some reductions in HQ size. Whilst many routine positions will be eliminated, some new positions will need to be created to handle and manage the increasingly sophisticated IT and organisational systems.

The specific implications of the above discussion in relation to the implementation of a socio-technical enhancement such as MCE are as follows:

- A human / virtual Liaison Officer system, identified as the traditional liaison device in the MCE information mediator, requires development in order to enable the transmission of context-rich and tacit information that ICTs will have difficulty conveying. The liaison system should build on the established processes already in place in military C2 functions.
- The new systems and processes enabled by new technologies should provide evidence that some administrative positions within the HQ will no longer be required. It should also be shown that organisational engineering and design specialists (and any other specialist or support advice that can be provided from a rear area) can be provided via reachback[7]. However, what may need to occur to improve effectiveness and efficiency of the HQ in line with these changes in structure and ways of working is the development of new staff/task differentiations (i.e. change the current J1-J9 staff functions to new staff functions – such as Information Manager, Visualisation Manager, etc). This implication has been supported by the findings of the investigative experiment outlined later in this paper in which participants did change their job functions in line with new ways of working due to their use of new technologies.
- Any improved HQ staff work processes, artificial intelligence systems or computer supported co-operative work tools implemented will need to support and revolve around the stable core 'warfighting' command team. This is because this team is critical to the functioning of the HQ. In any conflict, and in terms of

[7] Given the advent of new ICTs, it will become feasible for certain staff functions to be performed outside the traditional area of operations; either in a more secure rear area or back in the home base (Thackray, 2002).

command and control of military forces, the ultimate reversionary mode that must be maintained and supported in order for the HQ to survive is the team comprising the Commander and senior planning team conducting the tasks of relaying to units the Commander's intent and orders.

- It may be appropriate, in certain circumstances to bypass the joint operational level HQ due to strategic or political imperatives. However, proven doctrine such as Mission Command must be retained and inculcated in training as it is imperative that the commander on the ground with the most intelligence and knowledge at his disposal has the ability to 'call the shots' if the situation demands it.

**Subject Matter Expert Issues**

Interviews with SMEs from the UK C2 concept development community were conducted to assist in identifying organisational issues associated with the MCE concept (Christie and Fidock, 2002).

The issues identified by SMEs were as follows:

- Workload and information overload: SMEs believed that the workload and overload issues associated with the current paper and radio-based communications may simply shift to the Staff computer screen (e.g. too many emails). Workload rates for HQ staff may not decrease with the advent of new technologies but could in fact increase without appropriate information management strategies. Anecdotal evidence from Australian and UK C2 exercises has shown that information overload associated with email traffic has resulted in an increased information processing load for HQ personnel.
- Standard Operating Procedures (SOPs) and generic interface: SMEs pointed out that at present few ICT SOPs exist for the C2 environment. Thus, HQ will promulgate local rules and procedures in order to ensure they have the information and intelligence they need to do the job asked of them. This can lead to different methods of disseminating information in different formats, which will have a deleterious effect on attempts to move information quickly around the battlespace. Therefore, an issue of procedural interoperability exists in that HQ will plug in modules and Reachback cells that will handle and exchange information and intelligence differently to the way the HQ do. This appears to be a recipe for introducing grit into the information-exchange machine, which could mean seamless dissemination of information is unlikely to occur.
- Staff / task functions: SMEs believed that with the advent of digitized networks and concepts such as modularity that new thinking must be initiated in how HQ brigading should work in the future. The current consensus of opinion appears to be that the old J1 to J9 staff structures within the HQ are outdated and with the advent of new organisational structures and technologies, new staff task differentiation should be introduced.
- Information exchange: SMEs identified an issue in the processes required for information exchange (i.e. information that is pushed to users, pulled by users or synchronously exchanged) and how this could be achieved flexibly. There is seen to be a need to provide all three methods of information exchange. For example, Joint targeting and fire support sensor-to-shooter updates need to occur rapidly; therefore, a need exists for doctrine to examine the task requirements to ensure

this information is pushed to forward elements rapidly. Planning of operations takes more time and requires more information, especially when taking the plugging in of modules into consideration, so how should doctrine change to accommodate this type of information exchange? What are the tools and procedures that need to be put into practice for the HQ's ICT cell to accommodate the Commanders' information exchange requirements for each particular phase of the battle?

- Reachback 'connection-time': SMEs saw connection time as an issue of Reachback practicalities and procedures that need to be developed doctrinally before implementation. In regards to plugging in a specialist via Reachback or a non co-located module member, questions were asked as to what the plugging and un-plugging procedures and protocols may be. Does a HQ plug-in a specialist cell and spend thirty minutes bringing it up to speed on the current operational situation for only forty minutes worth of work? SMEs stated that a possible answer to this question might lie in automatically updating information packages on the current state of the operation for each different speciality that specialists can access online before the Commander calls them.
- Delegation of decision making (the 'long screwdriver' effect): SMEs believed that an issue to be addressed is the delegation of decision-making authority. Digitization, improved intelligence and information dissemination will afford a level of SA that will allow strategic level decision makers, both military and political, access to tactical level C2. Therefore, a major issue, especially for Army SMEs, is the 'long screwdriver' effect. SMEs felt that there is very much a need for Commanders on the ground to be allowed to plan and conduct operations with minimal interference from above.
- Information and personal / professional trust: SMEs believed that there were issues of trust pertaining to the information gained from a plugged-in source, whether the plugged-in source is an in-theatre but non co-located module or through Reachback. SMEs were concerned that staff and Commanders would have difficulty in working out the legitimacy of some information or may simply have issues with the professional or personal *bona fides* of personnel they do not know or have never worked with before.
- Quality of Leadership: SMEs saw an issue emerging within the concept of modularity pertaining to how a module would or should be commanded. They saw the module leader's personality (and how he/she took to the command responsibilities of engendering a team atmosphere), levels of the leader's professionalism and sense of importance in the module's task outputs as critical in ensuring a module's success. SMEs believed that modules should be given the flexibility to provide input across the range of Components and not be stovepiped. Module personnel must be made to feel that their work is important, even though they may be thousands of miles away from the Joint Operational Area.
- Reachback: SMEs were of the opinion that personnel who are plugged in *via* Reachback would lack the necessary picture 'richness' required to do the job asked of them. This was not due to any sense that the non-deployed member would not have enough 'time-in-the-seat' experience, but rather that he or she might lack the knowledge of operational conditions in-country relating to that specific deployment.
- Attentional lock: The issue appears to be that doctrine relating to information dissemination and receipt practices within a HQ needs to be improved/developed. Doctrine needs to reinforce the importance of ensuring that operational decision-

making episodes rely on and are cross-verified by as many different information and intelligence sources as time allows. Over-reliance on a single form of intelligence can lead to the development of gaps in the C2 SA and poor decision-making practices. This has the potential to lead to the selection of inappropriate targets.

- 'Cap Badge' rivalry / competition issues. SMEs looked at how different plugged-in modules' information and specialist advice gained by Reachback may be received in the deployed HQ by members of staff. SMEs stated that there was a very considerable level of 'Cap badge' rivalry and competition between different categories and Corps within and between all three Services. They thought that it may prove difficult for the deployed HQ staff to believe that the solutions and advice they are receiving from non co-located personnel of a different speciality or nationality to their own is inherently better or more practicable than a solution that they could come up with themselves.

**The MCE Investigative Experiment**

The issues that emerged from the SME interviews were used to define the content of questionnaires and helped to refine the observations undertaken in a recent investigative experiment. The aim of the experiment was to observe and report on the ways in which the experimental participants interacted and used enhanced ICTs, new organisational structures and ways of working. It is hoped that that this investigative experiment will assist in the development of hypotheses for future experiments.

The experiment was a repeated measures design whereby two teams were each split into a forward cell (Operational Liaison and Reconnaissance Team (OLRT)) and a rear or home cell (Joint Task Force HQ (JTFHQ)). Each team was required to plan collaboratively for non-combatant evacuations in a peacekeeping operation whilst the two planning cells were non-co-located. For the initial condition the teams planned utilising current ICT (telephone, email, etc). In the second condition, the teams planned using state-of-the-art, web-based information portals. Modularity was achieved by the 'plugging-in' of the Forward OLRT into the rear-based JTFHQ following commencement of the planning scenario.

In terms of experimental outcomes, researchers and participants both agreed that the teams generally behaved like psychologically discrete entities. This means that they conducted the planning task allocated to them within the physically co-located cell and did not consider the non co-located cell as an adjunct to their planning team. The teams appeared to believe that the task they had before them did not require that they involve the other half of their planning team in anything other than some information exchange.

In the initial condition, where current ICTs were used, when the teams became overloaded with information or the decision-making tempo and planning requirements increased, the participants relied on other members of their physically co-located cell and did not attempt to involve their non co-located team members in alleviating their workload. Thus, it appeared that they reverted to attempting to complete the requirements of the task using the processes and methods they had been trained in and knew how to use rather than incorporate new methods. They appeared to engage in

'satisficing' (March and Simon, 1958) in that participants used a process which they knew generally worked, rather than spend the time and energy in developing procedures which would optimise team performance.

Also, in the initial condition, the teams had poor information management strategies and relied on tried and trusted methods of information dissemination and communication – intra-team verbal and inter-team email / telephone methods of communication. The teams missed required information or did not identify disseminated information because they did not access their emails due to overload and task shedding, so the planning process was hampered. Tasks were allocated along traditional functional lines and the cells were observed to have difficulty in trusting information they received from their non co-located cell.

In the subsequent condition, where new technologies were used, face-to-face discussion and telephone/email were still the preferred means of disseminating information. However, teams changed the way they undertook tasks. They formed their teams more along two lines:

- Information extraction and dissemination: cell members were assigned to identify means and modes of information exchange and information traffic (either through email / web-based information portal or through the Geographical Information System) and direct the information to the required decision maker; and
- Filtering and analysis: cell members were assigned the task of making sense of incoming information, and passing their knowledge on to the appropriate decision maker.

The important observation is that participants attempted to incorporate new task functions through work-arounds or improvisation (the bane of Control but the godsend of Command, according to Pigeau and McCann (1995)). This finding appears to lend support to the contention voiced by the SMEs that task functions within the HQ must change in line with the advent of new ICTs. When participants had to convey context-rich information, they chose communications modalities that allowed those human cues and non-verbal messages to get through, i.e. face-to-face, telephone and Netmeeting (a Microsoft software program that allows computer-generated visual conferencing not unlike Video Teleconferencing (VTC)). This appears to lend support to the development of a liaison system incorporating both human and virtual elements as has been outlined in the MCE information mediator. The liaison system should be built on already well established procedures that can ensure that context-rich information HQ wish to convey is disseminated.

In summary, in order to explore the interplay between people, processes and technology in terms of the key concepts underlying a MCE system, an investigative experiment was conducted. The aim of this experiment was to explore some of the processes and technology required to enable an effective modular capability. Observations of ex-military personnel with C2 experience working in a modular environment showed that information overload and task shedding did occur. To alleviate this, participants changed their task functions from the traditional NATO J1-J9 staffing structure to more situationally specific task functions. Other observations included issues of trust of information sources, sharing of team situational awareness and the reversion to voice and visual communication when attempting to convey context-rich information.

Information pertaining to several of the human factors issues identified by SMEs in previous research has been further reinforced in this experiment. It is hoped that hypotheses can be generated from this information and future research can unearth new information regarding the rest of the issues.

## Conclusion

This paper has argued that a modular organisational design may be the optimum way for future military HQ to respond flexibly and reliably to an increasingly dynamic and complex environment. A socio-technical enhancement such as MCE could provide a deployed military HQ with the ability to exploit information and knowledge, thereby enhancing command and control capability. Effective exploitation will require the HQ to adapt and change its information requirements in response to environmental demands, and will rely on advances in ICT. However, the effective implementation and leveraging of ICT will depend on appropriate organisational design changes.

MCE could be achievable in practice by the implementation of a PNP agent architecture embedded in an information mediation function. Through its reliance on network enablement and the information mediator's ability to manage and disseminate information appropriately, whilst incorporating the rapid connection and disconnection of distributed information sources, it is felt that this constitutes a possible route into first-generation Network Enabled Capability. The next line of research for MCE could, therefore, be the investigation of its ability to be used as part of the information grid connecting HQ with outlying modules in the battlespace as part of a network enabled organisation. It is felt that the issues raised in this paper provide a foundation for undertaking further exploration of MCE and the associated NEC and organisational concepts. Such explorations will hopefully inform the evolution and transition of deployable Joint HQ toward a network enabled organisation.

**References**


Almen, A., Andersen, M., Lagerlöf, J. and Pallin, K. (2000) The role of command in network centric warfare. *5th International Command and Control Research and technology Symposium* [Online] Available http://www.dodccrp.org/2000ICCRTS/cd/index.htm [2002, March 3].

Bradley, D. J. (Maj), Strickland, G.M. (Maj), Walker, C. R. V. (Maj) and Wooddisse, R. (Maj) (2002) *Network enabled capability and British command culture*. Unpublished MA report. Cranfield University, RMCS

Christie M.J. and Diethe T. (2002) *Modular Capability Expansion: 'Plug and Play' Agent Architectures.* QinetiQ/CHS/CAP/TR020227.

Christie M.J. and Fidock J. (2002) *Human Factors in Modular Capability Expansion.* QinetiQ/KI/CHS/CR021633.

Christie M.J., Lynam T.J. and Channer, M. (2002) *Modular Capability Expansion Collaborative Experiment.* QinetiQ/CHS/W030146.

Grabowski, M. and Roberts, K. H. (undated) *Risk Mitigation in Virtual Organizations* [Online] Available http://jcmc.huji.ac.il/vol3/issue4/grabowski.html#Introduction [2003 February 24]

Groth, L. (1999) *Future organizational design: the scope for the IT-based enterprise*. John Wiley & Sons.

Joint Doctrine and Concepts Centre (2001) *The UK Joint Vision: A paper by the Joint Doctrine and Concepts Centre*. D/JDCC/7/11/1. 31 May 2001.

Kirk, J. (1999) Information in organisations: Directions for information management. *Information research* 4 (3) [Online] Available http://informationr.net/ir/4-3/paper57.html [2002 August 8]

March, J. and Simon, H. (1958) *Organizations*. John Wiley & Sons.

Marsh, G. and Burke, M. (2002) *Resolving the knowledge management paradox: Balancing the mild, the wild and the crazy.* Paper presented at KM Challenge 2002. [Online] Available http://www.knowledge.standards.com.au/KM/INFO/MARSHBURKE/MARSHBURKE.HTM. [2002 August 8]

McNally, M. K. (2000) Managing operational information through the medium of electronic communication. *British Army Review* 124 (pp 13 – 22)

Mintzberg, H. (1979) *The structuring of organizations: a synthesis of the research*. Prentice Hall.

Nadler, D. A. and Tushman, M. L. (1997) *Competing by design: The power of organizational architecture*. Oxford: Oxford University Press

*Oxford English Dictionary* (1989) OEC Online, 2nd Edition, http://dictionary.oed.com/cgi/entry/00278115

Phillips, P. and Louvieris, P. (2002) *Optimisation of organisational structures and processes to benefit from digitisation*. University of Surrey report produced for QinetiQ under contract no CU005-05312

Phillips, P. and Louvieris, P (2003) *Optimisation of organisational structures and processes to benefit from digitisation Part II*. University of Surrey report produced for QinetiQ under contract no CU005-05312

Pigeau, R. and McCann, C. (1995). Putting 'Command' back into Command and Control: The human perspective. *Proceedings of the Command and Control Conference, 25 September 1995*, Congress Centre, Ottawa, Canada.

Rammert, W. (2001) *The cultural shaping of technologies and the politics of technodiversity*. Technische Universitat Berlin Working Papers TUTS-WP1-2001

Roberts, K. H. (Ed) (1993) *New challenges to understanding organisations*. New York: MacMillan

Storr, J. (2000) *A year observing command and control.* British Army Review, Summer Edition.

Storr, J. (2002) A command philosophy for the information age: The continuing relevance of mission command. In D Potts (Ed) *The big issue: Command and combat in the information age* (A view from Upavon) 45. The strategic and combat studies institute (pp 41 – 48)

Symon, G. (2000a) Information and communication technologies and the network organization: A critical analysis. *Journal of occupational and organisational psychology* 73 (4) (pp 389 – 414)

Symon, G. (2000b) Talking about working in a network context: A reply to Sonnentag. *Journal of occupational and organisational psychology* 73 (4) (pp 419 – 422)

Thackray, C.J. (2001) *Future Army Command Structures*. Com Dev; SO1 Comd Concepts. D/DGDD/2/126/8/1.

Thackray, C.J. (2002) The Commander-centric Approach. In D. Potts (ed.) *The Big Issue: Command and Combat in the Information Age*. Strategic and Combat Studies Institute Occasional Paper No. 45.

The Economist Intelligence Unit Limited and KPMG Consulting (2001) *Going by the board: E-business and the role of the board.* An e-briefing by the Economist

Intelligence Unit. [Online] Available http://www.ebusinessforum.com/upload/Board.pdf [2003 February 18]

Weick, K. and Sutcliffe, K. (2001) *Managing the unexpected: assuring high performance in an age of complexity*. Jossey-Bass.