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Organisational Structure and Information Technology (IT): Exploring the Implications of IT for Future Military Structures

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ABSTRACT

This report provides a conceptual framework for describing organisational structures based on the work of Mintzberg (1979) and Groth (1999), and considers the implications of information technology (IT) for current and future military organisational structures. The various components that influence organisational structure are considered: coordinating mechanisms, design parameters and contingency factors. When combined together these components form various structural configurations. The role of IT in modifying and extending the range of coordinating mechanisms and structural configurations is also described. These configurations and associated components provide a framework within which military organisations can be categorised. This framework is used to describe a current joint operational level headquarters (HQ), and to explore the implications of emerging IT for future HQ.

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Executive Summary

The environment within which military forces now find themselves is complex, dynamic, and uncertain. Mintzberg (1979) argues that in order to respond appropriately to such environmental contexts organisations need to be flexible and adaptable. Military forces are investing heavily in information technology (IT) in the belief that this will facilitate the fundamental changes in organisational structure required to generate improvements in flexibility, adaptability and mission effectiveness. However, this belief in the transformational power of IT needs to be informed by a good understanding of the ways in which IT influences organisational structures. This report aims to facilitate such an understanding by providing a conceptual framework for describing organisational structures within which the implications of IT for current and future military organisational structures can be considered.

The conceptual framework outlined in this report is based on the seminal work of Henry Mintzberg (1979) on structuring organisations, and the more recent work of Lars Groth (1999) that extends Mintzberg's work by considering the particular implications of IT for current and future organisational structures. The conceptual framework is composed of three primary components that assist in describing organisational structure: *coordinating mechanisms*, *design parameters* and *contingency factors*. When combined together these components form various *structural configurations*. For example, one of the structural configurations is called the simple structure, in which the *prime mechanism for coordinating* the efforts of personnel engaged in different tasks is through direct supervision. One of the key *design parameters* is the vesting of power over business decisions in the hands of one or a few individuals, referred to as centralisation. Organisations with this structure are often dominated by an entrepreneurial owner/manager. *Contingency factors* influencing the formation of a simple structure include organisational size, age, and environmental context. In particular, the simple structure is often found in young, small organisations operating in simple but dynamic environments. The role of IT in modifying and extending the range of coordinating mechanisms and structural configurations is also described. The various *structural configurations* and associated components provide a conceptual framework within which military organisations can be categorised. This framework is used to describe a current joint operational level headquarters (HQ), and to explore the implications of emerging IT for future HQ.

Drawing upon the conceptual framework, the report provides some predictions regarding how a joint operational level HQ in 2015 will be augmented by IT, and possible human resource and structural implications. It is predicted that:

- The professional and managerial work of HQ staff and commanders will continue to rely heavily on those human characteristics and capabilities that are difficult to

replicate or capture within a computer system. Nevertheless, they will be more efficient and effective in undertaking their work, due to the support provided by increasingly sophisticated computer systems that augment human memory, thinking, and decision making. In addition, richer communication will be possible between system users due to widespread use of computer supported cooperative work tools (e.g. e-mail, electronic whiteboards, web-based meeting systems etc). However, face-to-face contact and informal communication between HQ personnel will remain a very important part of staff work.

- Computer automation of routine tasks, underpinned by increased numbers of centralised databases, and improved system interoperability, will become more pervasive in military HQs, with some reductions in those positions that currently undertake routine tasks. However, for jobs that require extensive professional and/or managerial experience, such systems will not lead to significant reductions due to the difficulties in explicitly capturing the tacit knowledge that is such a critical component of effectively working in these domains. Furthermore, given the long lead times for large information infrastructure acquisitions it is likely that significant work will still need to be done to improve system interoperability, and increase data sharing and centralisation of information bases.
- In order to effectively exploit ongoing improvements and developments in IT, 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 will 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.
- As more organisational tasks, routines, and processes become augmented or replaced by IT, the software that controls these systems will increasingly come to embody certain structures and processes. By 2015 these structures and processes will largely be related to support functions, for example, the identification and management of logistics requirements of a deployed forces will be enhanced by systems which automate certain parts of the process, such as replenishment of certain classes of supply, and maintaining visibility of goods in transit. Other support areas that will benefit from advances in IT include information systems support and personnel management. Meanwhile, core structures and processes related to warfighting will continue to rely heavily on tried and tested methods and arrangements.
- For certain types of operations, such as those with a high political profile, or those that use relatively small forces, a joint operational level HQ will be easier to sideline, due to the improved ability of strategic HQ to command and control forces. However, a joint HQ will continue to be an important mechanism for coordinating the efforts of the different services.
- Matrix structures will be employed in joint operational level HQ in order to address multiple strategic priorities. To preserve professional identify and expertise it is likely that staff will continue to be grouped around their professional expertise or function. However, the NATO J structure, which is a functional arrangement of personnel, will no longer be the primary dimension for describing the structure. Instead, personnel will be formed up into project teams or modules. Currently such teams are largely collocated, however, with advances in information and communication technologies teams and team members will be able to be distributed and arranged with greater speed and flexibility to meet the unique needs of particular operations. The flow and management of information between modules, and the addition and removal of

modules to meet particular operational requirements, will be facilitated through employing a 'plug and play' agent architecture. Such a capability will considerably reduce, but not eliminate, the need for the collocation of augmentees that currently occurs when fixed joint HQ are augmented to meet a surge requirement. In the context of deployed joint HQ, this modular approach will facilitate some reduction of HQ staff required in the area of operations.

In summary, it is predicted that developments in IT will enable many routine positions to be eliminated, however, some new positions will need to be created to handle and manage the increasingly sophisticated IT systems, and organisational structures and processes. These structures and processes will be faster and easier to modify and adapt to meet particular operational requirements, due to the capabilities offered by IT, and will help to reduce the collocated HQ staffing requirements in both fixed and deployed joint HQ.

The above predictions may seem overly conservative to technologists, however, a consideration of the nature of work undertaken in HQ, the contingency factors operating on HQ and the possibilities offered by current and emerging technologies suggests the structure of HQ is unlikely to be radically transformed in the next 10 years.

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Abbreviations

AI	Artificial Intelligence
AM	Artificial Memory
CAD	Computer Aided Design
CAE	Computer Aided Engineering
COP	Common Operating Picture
CSCW	Computer Supported Cooperative Work
HQ	Headquarters
IT	Information Technology
J	Joint
J2	Joint Intelligence
J3	Joint Operations
NATO	North Atlantic Treaty Organisation
NCW	Network Centric Warfare
NHS	National Health Service
SOP	Standard Operating Procedure
US	United States

1. Introduction

"There are no single prescriptions for success, and no single pattern of development and organization that is destined to percolate through the world and gradually make all organizations and societies similar" (Groth, 1999, p. 173).

The environment within which military forces now find themselves is complex, dynamic, and uncertain. Mintzberg (1979) argues that in order to respond appropriately to such environmental contexts organisations need to be flexible and adaptable. Military forces are investing heavily in information technology (IT) in the belief that this will facilitate the fundamental changes in organisational structure required to generate improvements in flexibility, adaptability and mission effectiveness. The thesis is that dramatic increases in mission effectiveness can be brought about via improved networking of force elements, which improves information sharing, thereby enhancing information quality and shared situational awareness, collaboration, sustainability and speed of command (NCW Report to Congress, July 2001). However, this belief in the transformational power of IT needs to be informed by a good understanding of the ways in which IT influences organisational structures. This report aims to facilitate such an understanding by providing a conceptual framework for describing organisational structures within which the implications of IT for current and future military organisational structures can be considered.

The conceptual framework presented in this report is based on the work of Henry Mintzberg (1979) on structuring organisations, and the more recent work of Lars Groth (1999) that extends Mintzberg's work by considering the particular implications of IT for current and future organisational structures. Both of these researchers have developed theoretical frameworks that have been strongly informed by practical experience in supporting the design and development of public and private organisations.

In this report, organisational structure is defined, and the variety of coordinating mechanisms and design parameters that constitute the building blocks of structure are described. Consideration is then given to a range of contingency factors, with a particular emphasis on IT, that help to explain why organisations are structured in particular ways. The building blocks of structure and the contingency factors are brought together and described in terms of a number of pure structural configurations. These configurations and their associated components provide a framework within which military organisations can be categorised. This framework is used to describe a current joint operational level headquarters (HQ), and to explore the implications of emerging IT for future joint HQ.

2. Organisational structure

Like many of the terms used in discussions about organisations, the concept of organisational structure takes on a variety of different meanings. Perhaps the most common conception of organisational structure is the view that structure is synonymous

with the organisation chart. In the military, this formal structure is clearly manifested through the chain of command, and through the use of rank identifiers on the clothing of military personnel. This makes it very easy for military personnel to identify their formal position within the organisational structure, and their official reporting relationships. However, this is only a part of the picture. Organisational structure has also been defined as:

> "*the sum total* of the ways in which [the organisation] divides its labour into distinct tasks and then achieves coordination among them" (Mintzberg, 1979, p. 2; *italics* added).

The structure as represented in the formal chart only *partially* identifies how labour is divided and tasks coordinated. It does not capture the richness and variety of mechanisms available for coordinating work, nor does it assist in identifying the parameters that can be varied to achieve changes in organisational structures.

2.1 Coordinating mechanisms

There are five basic types of coordinating mechanisms that represent the fundamental means by which organisations achieve coordination: mutual adjustment, direct supervision, standardisation of work processes, standardisation of work outputs, and standardisation of worker skills (Mintzberg, 1979). As Mintzberg points out "these should be considered the most basic elements of structure, the glue that holds organizations together" (p. 3). With the advent of IT, these elements or mechanisms are being extended in ways that afford new choices for structuring organisations. Mintzberg's five coordinating mechanisms will now be described, followed by their IT enabled extensions.

Mutual Adjustment achieves coordination of work through the simple process of informal communication between employees. With mutual adjustment the workers control the work. The division of labour is negotiated and discussed informally between workers. Mutual adjustment is often all that is required in small simple organisations. However, it is also of critical importance in the most complex organisations, since the precise division of labour is not possible and therefore requires negotiation and discussion.

Direct Supervision achieves coordination through having one individual taking responsibility for the work of others. A supervisor typically issues instructions and monitors the performance and behaviour of subordinates. Most military personnel above the lowest level in the chain of command have, to varying degrees, a supervisory role.

Standardisation of work processes can be said to have occurred when the content of work is specified, programmed or proceduralised. The stripping and assembly of a fire-arm in the military represents an example of standardising a work process. In the military such standardisation is referred to as a Standard Operating Procedure (SOP).

Standardisation of outputs involves specifying the dimensions of the product or performance resulting from work, without specifying the means by which to complete the work. For example, a subordinate Commander may receive an order that broadly specifies

the desired performance objectives, associated with the senior Commanders' intent, but without a detailed description of how to achieve the objectives. Such mission type command achieves coordination amongst forces on the ground through standardisation of outputs.

Standardisation of skills and knowledge occurs when the training required to undertake a job is specified. This type of standardisation is required for jobs where coordination can not be effectively achieved through standardisation of work processes or outputs. A medical specialist undergoes extensive training, both externally in a university or college, and internally, within the medical establishment. In the military context standardisation of skills is used extensively. For example, promotion requires undertaking a course to equip service personnel with the necessary skills to perform new roles. Military specialists, such as doctors, nurses, psychologists and engineers, also undergo extensive external and internal training before their skills and knowledge are deemed sufficient to undertake effective work.

After undertaking an extensive review of the capabilities offered by IT for organisations, Groth (1999) further extends the coordinating mechanisms outlined by Mintzberg. The coordinating mechanisms are summarised in Figure 1, with Mintzberg's mechanisms on the middle row, and Groth's extensions on the bottom row in italics.[1] Each of Groth's extensions will now be considered.

[1] The reason for there being no IT enabled extension to standardisation of outputs, is because Groth does not view it as a form of coordination, and therefore excludes it from his taxonomy of coordinating mechanisms. His view is that standardisation of outputs involves prescribing a certain result, such as a certain profit or total sales, but does not involve coordination of people or work in an organisation. Standardisation of outputs only specifies what management expects of a particular division or group, where as the other coordinating mechanisms describe how coordination among group members can be achieved.

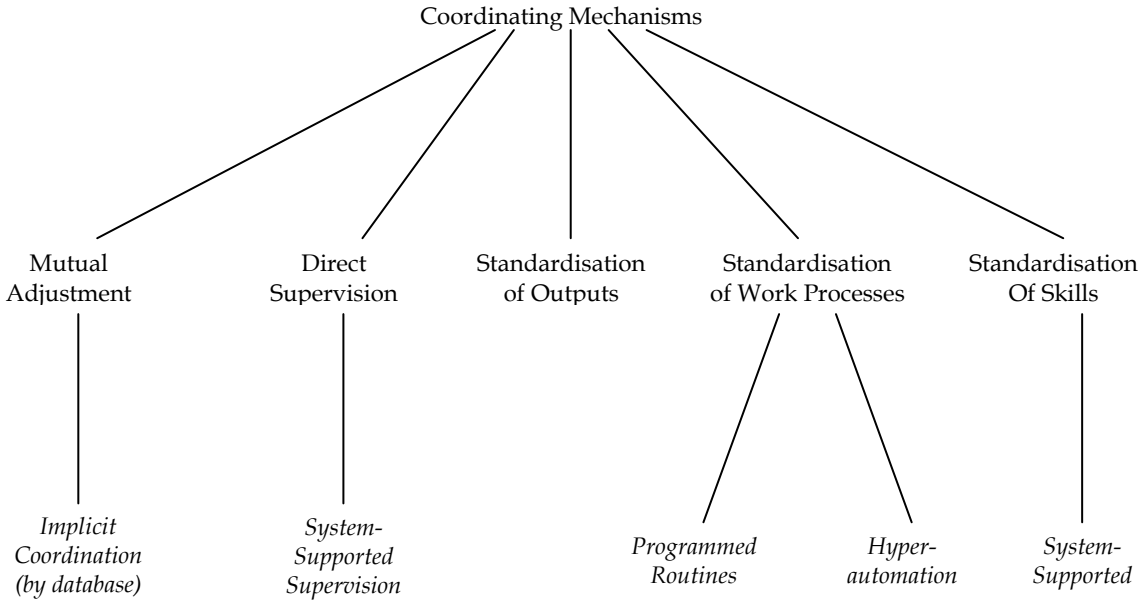

Figure 1 Taxonomy of coordinating mechanisms extended by the use of IT (Modified from Figure 14-1 in Groth, p. 330)

Implicit coordination is achieved through enabling people to share a common information base, such as a paper file or an electronic database, to achieve coordination without having to talk to each other (Groth, 1999). Unlike mutual adjustment, where coordination is achieved by direct information exchange, implicit coordination achieves adjustment through indirect communication via a common information repository. It is essentially coordination without human communication. In the context of this report, it is implicit coordination by database that is of interest, however, the importance and value of paper based implicit coordination should not be forgotten. According to Groth "the vast improvement and extension computers bring to implicit coordination represents one of their most revolutionary aspects – and one we find behind most of the familiar success stories that circulate in … business" (p. 304) The use of shared and structured databases makes it feasible to provide services and undertake tasks and activities that previously would have been nearly if not impossible to complete. For example, withdrawing money from an Automatic Teller Machine, or booking a seat on a plane are both made possible and cost effective through structured databases. The development of the Boeing 777 provides another example, where Computer Aided Design (CAD) and Computer Aided Engineering (CAE) systems enabled a very large group of designers and engineers to work together on the project, with coordination being largely achieved through the CAD and CAE systems. The software did the job of ensuring that different design components didn't occupy the same space in the aircraft, for example.

In the military, coordination of effort requires considerable "de-confliction" to ensure that different force elements are not working at cross purposes. While considerable emphasis is being placed on building more "joined up" and joint military organisations, it is perhaps

not cultural transformation but implicit coordination effected through sophisticated databases that will contribute most to this vision. The accidental bombing of Canadian soldiers in Afghanistan by a United States (US) pilot could have been avoided if the pilot was supported by a system that provided timely updates on the position of friendly forces. Just as the CAD/CAE systems of Boeing ensured that physical components could not occupy the same space it is possible to envisage military systems (supported by structured databases) that ensure own or friendly force personnel do not occupy the same space as intended targets. However, given the slow progress being made within most western militaries toward consolidating databases and systems and improving interoperability, compounded by the long lead times for large system acquisitions, it is unlikely that such systems will be in widespread use by the end of this decade.

Nevertheless, shared and structured databases are being used extensively in the military, and there are significant developments planned. Examples of such current and planned databases include: common operating pictures designed to provide shared, near real-time geo-spatial information about force elements; intelligence and sensor information repositories; and moves to consolidate and develop personnel and logistics management information systems.

System-supported supervision refers to the conscious direction of the work of subordinates, either in greater depth, providing detailed guidance to subordinates, and/or greater breadth, increasing the number of different tasks and subordinates that can be monitored and controlled, based on information collected, aggregated and presented through a computer system (Groth, 1999). An example of the provision of detailed guidance to subordinates is the use of decision support systems that provide employees of call centres with prompts and guidance on acceptable behaviour and actions. Such systems also enable increased supervisory breadth, through allowing a supervisor to monitor the performance of large numbers of call centre employees.

Programmed routines are computer based implementations of usually quite simple routine tasks, such as making calculations in a spreadsheet or CAD system, automating various aspects of document production previously undertaken by typing pools, or automating the process of billing customers for telephone calls. Any processes or routines that involve the handling of structured information are particularly amenable to being automated, especially when the information is quantitative (Groth, 1999). In the military context, information receipt, acquisition, management and processing are critical to building effective situation awareness. To the extent that this information can be structured, programmed routines hold great promise in reducing the need for personnel to undertake routine information management tasks.[2] The use of standardised message formats within

[2] However, concerns have been raised that too much automation can decrease situational awareness. As Kardos (2004) states "when humans become relegated to monitoring functions…, they tend to lose sight of both the incoming information and the processes used to turn that information into knowledge. One of the benefits of the current manual system of planning and information processing is that the human stays 'in the loop', and maintains up to date awareness of what is going on" (p.18).

the military, for example, represents one way of leveraging the processing power of computers to improve information exchange between different intra and inter-organisational information systems. These formats "reduce the time and effort required drafting, transmitting, analysing, interpreting, and processing messages" (ASMTFMAN Volume 1, 2005, p. 20). However, such approaches can generate significant user frustration, due to users having to adapt to the constraints imposed by the system. There is also a risk that the limits imposed by the system will lead to misuse or disuse (Lee and See, 2004).

Hyperautomation also draws upon computer dependent automation. The term has been created to differentiate computer dependent automation from mechanical automation. It differs from *programmed routines* by encompassing a larger range of routines and processes and has the potential for automating or eliminating "significant administrative processes" (Groth, p. 299). Such automated processes might include the monitoring and fusion of information from multiple sensor feeds. Administrative processes can also be eliminated by exploring the fundamental purpose of a process and redesigning and reengineering it to leverage the benefits of IT, such as removing the need for a purchasing department to handle purchase requests, by enabling users to serve themselves. The need for someone to place an order can also be removed by automating the purchasing process completely, such as can be found in some automobile manufacturing plants, where suppliers are coupled to the main vehicle assembly process, and provide parts as required in a 'just in time' fashion at the appropriate points in the process.

System-supported skills provide a means of improving the quality and consistency of professional work through the use of various computer support tools. Through employing artificial memory (AM), artificial intelligence (AI), and embedded knowledge systems it is possible to expand the "effective span of competence" of professionals (Groth, 1999, p. 258).

AM is the provision of computer-based information to support decision-making and problem solving. For example, to support reduced manning levels of information system support personnel in a deployed HQ, a computer system could provide information to a smaller number of information system specialists about how to solve system problems. This information might include the application or system help functions provided by the manufacturer, information systems standard operating procedures, and solutions to previously encountered problems. AI can expand competence through providing support to military personnel in undertaking a variety of different tasks. AI is already used extensively in such things as voice recognition, handwriting recognition, and decision support in aircraft. AI also underpin systems that learn in response to users' action when using such systems and modify system behaviour to better support users' needs, for example through tailoring information filtering.[3] In the future it is envisaged that in the military domain semi-autonomous ground or air based robots could be used to provide improved situational awareness to soldiers. Such systems would rely heavily on AI to

[3] Such functionality is employed in many online stores, such as Amazon.com, which present customers with recommendations based on prior viewing and purchasing choices.

assist with movement and detection. Finally, competence can be expanded through embedded knowledge - the rules or knowledge embedded within the data structures and functions of a computer system. For example, a legal officer could use an expert system, which has relevant international law embedded within it, to assist with providing advice to the Commander about the rules of engagement, or an expert system could aid medical officers in improving diagnosis and treatment of injuries and illnesses.

An appreciation of the mechanisms for achieving coordination serves as a useful foundation for understanding the variety of design parameters that influence these mechanisms and the division of labour.

2.2 Design parameters

Designing organisational structures is not an activity that is limited to senior executives or management consultants. Whilst these individuals are more visibly engaged in design activities, anyone who devises ways of changing the coordination of work or how tasks are divided is engaged in design. Design activity therefore occurs throughout organisations. There are a variety of design parameters that assist in describing the choices available to designers. There are four main categories of parameters: design of positions, design of the superstructure, design of lateral linkages, and design of the decision-making system (Mintzberg, 1979). Each of these categories will now be described and examples given of how they relate to the military context with a particular emphasis on Australian joint operational level HQ.

2.2.1 Design of positions

There are three means by which an organisation can design positions: job specialisation, behaviour formalisation, and training and indoctrination (Mintzberg, 1979). *Job specialisation*, or the division of labour, can occur in two dimensions. Firstly a job can vary in terms of its breadth, that is, the variety of different tasks that a worker undertakes and "how broad or narrow is each of these tasks" (p. 69). A job which entails performing a limited range of narrow tasks is referred to as horizontal job specialisation. This form of specialisation (or enlargement) is the predominant form of division of labour in organisations. Secondly, a job can vary in terms of its depth, or the extent of control the worker has over the work. If a job is highly specialised in this dimension there is a clear separation between the administration of the work and the performance of the work. In other words the worker has little control over changes to the work, or the goals and standards associated with the work. This is referred to as vertical job specialisation.[4] *Behaviour formalisation* is the mechanism by which the organisation achieves standardisation of work processes, thereby regulating the behaviour of workers. If behaviour is highly formalised then workers have little discretion over how to behave. *Training and indoctrination* relates to specifying what knowledge and skills the worker

[4] It is important to note that a separation is being drawn here between the workers who perform the work and those who manage them.

requires and the norms he/she is expected to follow. Training is not very significant for unskilled work, however, where the work is highly complex, requiring professional knowledge and skills, training becomes very important. Indoctrination involves socialising members into the culture of the organisation.

The staff within a HQ have some horizontal job specialisation in terms of performing a limited range of tasks, and have some vertical job specialisation, in that they have somewhat limited control over their work. However, horizontal and vertical specialisation decreases for those staff in more senior positions, such that higher ranking personnel tend to perform a wider range of tasks and have more discretion over changes to their work. There is considerable on-the-job-training, since many military personnel posted into a joint HQ have little or no previous experience of working in such an environment.[5] However, joint HQ indoctrination is quite limited[6], when compared to the extent of indoctrination that occurs within each of the particular services. This is perhaps due to the purpose of the HQ being somewhat unclear, the presence of different service and cap badge cultures within the HQ, the limited time for a joint culture to develop, and the quite limited posting period within a joint environment.

2.2.2 Design of the superstructure

Design of the superstructure is concerned with addressing the following two issues: the ways in which positions should be grouped into units, and the number of positions within each unit (Mintzberg, 1979). *Unit grouping* is a fundamental part of organisational structure. Grouping encourages mutual adjustment, and typically creates common measures of performance and sharing of resources. Furthermore, as Mintzberg (1979) states, "it is through the process of grouping into units that the system of formal authority is established and the hierarchy of the organization is built" (p. 104). There are a variety of different ways in which positions can be grouped: by function, which includes grouping by knowledge, skills, and work processes; by market, which includes grouping by output (e.g. different groups for different product lines), by client, and by place (e.g. the geographical region serviced); and by time (e.g. different shifts). *Unit size* has a bearing on how many individuals should report to a manager, his/her span of control. It also has a bearing on the shape of the superstructure. The two basic shapes are tall and flat. "A tall structure has a long chain of authority with relatively small groups at each hierarchical level, while a flat structure has few levels with relatively large work groups at each" (Mintzberg, 1979, p. 136).

The grouping of positions within a joint HQ is functional and is described according to the North Atlantic Treaty Organisation (NATO) Joint (J) designation framework.[7] The HQ also

[5] These personnel do, however, have significant training in particular functional areas and military domains.

[6] Annual induction training is one attempt to provide some indoctrination.

[7] This framework ranges from J0 through J9 with each number corresponding to different functional areas, for example, J2 is the intelligence function.

has quite a tall or hierarchical structure, with a number of different levels of authority and relatively small numbers of personnel in each work group.

2.2.3 Design of lateral linkages

Planning and control systems, and liaison devices constitute the two mechanisms through which lateral linkages are created (Mintzberg, 1979). A plan specifies a desired output or objective, where as the control system determines whether or not the particular output or objective has been achieved. The *planning and control system* therefore standardises and regulates the outputs of different units in order to achieve coordination between them.

When the design of positions and the superstructure fail to produce effective coordination, organisations turn to a variety of *liaison devices*, such as liaison positions, task forces, standing committees, integrating managers and matrix structures.

- A liaison position is created to facilitate coordination of work between two units.
- Task forces and standing committees are gatherings of people that are designed to facilitate coordination through mutual adjustment. A task force is formed to satisfy a particular goal or objective and then disbanded. A standing committee is a more permanent inter-unit, or interdepartmental arrangement, for discussing issues of common interest.
- Integrating managers represent a liaison position except that some formal authority is also provided. This authority only relates to decisions that cut across the units of concern, not decisions within the particular units.
- The matrix structure represents an attempt to combine the strengths of different ways of grouping personnel, such as combining functional and geographic based groupings. Functional groupings provide an environment within which workers with common skills and knowledge can learn from each other and derive a sense of belonging, such as an Army infantry Corps. Geographic based groupings provide an environment through which work is geared toward satisfying a particular region, often bringing together workers from different functional specialisations, such as the wide range of specialists that can be found in a regional combatant command, such as the US Pacific Command in Hawaii. A matrix structure attempts to address multiple strategic priorities, however, it does so at the expense of the principle of unity of command. Instead of workers reporting to one manager, they instead report to two, each of whom may have equal formal authority over the workers. This can create problems both for the managers, in terms of conflict, and workers, in terms of lack of role clarity. Multinational forces can manifest similar problems as a result of some personnel reporting to both the multinational force commander and their national commander.

In an Australian joint operational level HQ, plans or the required outputs from the various groups are specified, and these outputs are in turn regulated. For example, various groups contribute to the brief provided to the Commander, who has particular information needs. If a group fails to satisfy the Commanders needs, the control system (in the form of feedback from the Commander and others) will ensure that the required information is provided in future. A variety of liaison devices, such as liaison positions and standing

committees are also employed. For example, liaison positions will often be created, such as the J2/3 position, which links the intelligence and operations branches. Meetings between the heads of each J branch also occur regularly to assist in coordinating their efforts. Task forces are also formed on occasion to assist with addressing such issues as the organisational development of the HQ.

2.2.4 Design of the decision-making system

The design of the decision-making system in terms of whom within the organisation has power over the decisions made can be understood in terms of the extent of decentralisation. Where the power over decisions is vested in only one individual then an organisation can be described as centralised. Where power is dispersed, this can be described as decentralised. It should be apparent that decentralisation/centralisation is not a dichotomy but is best viewed as continuum with autocracy representing the extreme form of centralisation and democracy as the extreme form of decentralisation. Mintzberg (1979) also draws a distinction between vertical and horizontal decentralisation. *Vertical decentralisation* involves the dispersal of authority down the chain of authority, to subordinate managers. At the base of this chain is the operating core of employees who perform the central work of the organisation. This chain of authority and the operating core is focussed on producing the products or services. *Horizontal decentralisation* involves non-core managers and staff having control over decision processes. These staff sit outside of the chain of authority and the operating core and provide such services as human resource management, public relations, research and development, legal support, information systems management, organisation development and so on.

The design of the decision-making system within a joint HQ is one of limited vertical and horizontal decentralisation[8]. The authority to make decisions is largely vested in the Commander with some authority delegated down the chain of command to the J staff heads engaged in managing the core activities of the HQ (operations, intelligence, plans, and logistics). This represents limited vertical decentralisation. In addition, decision making processes are largely controlled by the Commander and his core J staff heads. However, the non-core managers and staff, engaged in work in such areas as legal, public relations, operations research, and communications and information systems, do have some influence and control over certain decision processes but not over making decisions (limited horizontal decentralisation). These staff have control over the advice and information provided to the chain of command as a result of their knowledge, expertise, or analytical skills, but do not have the power or authority to make command decisions.

3. Contingency factors

Four categories of design parameters have been described, however, considered in isolation these parameters tell us nothing about why an organisation has designed its

[8] The decision–making system could also be described as predominantly centralised in the vertical and horizontal dimensions.

structure in a particular way. Choices about which of these parameters to change will be contingent on a variety of factors, such as the age of the organisation, its size, the complexity of its technical system, the nature of the environment and power issues. Mintzberg proposes a number of hypotheses, supported by empirical research, that relate to the impact of different contingency factors on the structure of organisations. Those hypotheses that relate to the military are as follows (material taken from Mintzberg, 1979):

- "The older the organisation, the more formalised its behaviour" (p. 227).
- "The larger the organisation, the more elaborate its structure, that is, the more specialised its tasks, the more differentiated its units, and the more developed its administrative component" (p. 230).
- "The larger the organisation, the more formalised its behavior" (p.233).
- "The more sophisticated the technical system [the collective instruments used by the operators to do their work], the more elaborate the administrative structure, specifically the larger and more professional the support staff [such as information system specialists, research and development etc]," and the greater the decentralisation of authority to those staff over decisions relating to the technical system (p. 262).
- "The more dynamic the environment, the more organic the structure" (p. 270). An organic structure is one which lacks formalisation and standardisation, has a network structure and lateral communications, that is, the inverse of the bureaucratic structure.
- "The more complex the environment, the more decentralised the structure" (p. 273).
- "Extreme hostility in its environment drives any organisation to centralise its structure temporarily" (p. 281).
- "The greater the external control imposed on the organization, [for example through government regulations,] the more centralized and formalized its structure" (p. 288).

Consideration of the above hypotheses would suggest that the old and large nature of the military, together with significant external control, push military structures toward being bureaucratic. Evidence for the bureaucratic nature of the military is found in the widespread use of standard operating procedures, the presence of highly differentiated units and functions, and a strong emphasis on formal authority exercised through the chain of command. Conversely, the above hypotheses suggest that the increasing complexity of military technical systems and the dynamic and complex nature of the environment push military structures toward needing to be more decentralised and organic.

Evidence for the influence of a dynamic and complex environment on the military can be found in doctrine that recognises the importance and value of some decentralisation of decision-making, referred to as command-by-influence (Marsh, 2001). In the Australian context this is referred to as directive control, which is concerned with empowering subordinate commanders to adapt to situations as they evolve, whilst being guided by the commander's intent (Marsh, 2001). Further evidence can be found in the current trend of building networked military organizations in order to achieve a network centric warfare (NCW) capability that is designed to facilitate more appropriate responses to dynamic and

complex environments.[9] Such a capability is viewed as key enabler that will allow forces to improve information sharing, thereby enhancing information quality and shared situational awareness, collaboration, sustainability, responsiveness and speed of command (NCW Report to Congress, July 2001).

The complexity of current military technical systems is considerable and is likely to increase given ongoing technological advances and the intention to more fully network our forces. The numbers of staff required to support current systems is already considerable and unlikely to diminish. In the HQ context is was argued that communications and information systems staff do have some influence and control over certain decision processes particularly those that relate to the configuration and management of IT. This argument also holds for technical systems in other parts of military, particularly for aircraft and naval vessels, where the numbers of support personnel far outweighs the number of personnel who are engaged in the core business of operating these systems.

Groth (1999) extends Mintzberg's ideas by considering the particular implications of IT for current and future organisational structures. In particular, he explores how IT modifies and extends the technical systems contingency factor. Groth sees IT as extending the possibilities for organisational structuring in some of the following ways:

- Computer automation of administrative tasks and processes (hyperautomation) increases personal productivity, and therefore leads to the elimination of routine jobs.
- Implicit coordination achieved through databases enables the creation of much larger organisations and leads to "extensive elimination of work" (p. 349). Elimination of work is brought about by the database performing the role of coordination that previously would have been undertaken by a variety of personnel.
- Computer supported cooperative work tools, such as email and video-conferencing, can facilitate improved cooperation between geographically dispersed people.
- Separate organisations can be coupled more closely together through the use of IT, such as the example given earlier of car manufacturers being more closely coupled to suppliers. These are referred to as meta-organisations.
- Implicit coordination can enable the creation of large organised entities that are not organisations in the classic sense. Groth provides the example of airline seat reservation systems, and refers to such entities as "organised clouds" or constellations.
- IT can lead to extensive centralisation through providing management with more timely and relevant information, and through enabling system-supported supervision. The elimination of work "also contributes to centralization" (p. 349).
- IT may lead to increased decentralisation through encouraging increased job enlargement, as has occurred with bank tellers over the last couple of decades whereby they have increased the variety of different tasks that they undertake, such as marketing, sales and financial planning. IT may also facilitate increased

[9] NCW is now part of the capstone doctrine in the Australian Defence Force and is mentioned in such doctrinal publications as the *Future Warfighting Concept* and *Enabling Future Warfighting: Network Centric Warfare*.

decentralisation through improving information availability for lower levels in the organisation.

Although all of these issues are having, and will continue to have an impact on military structures, the question of centralisation / decentralisation is of particular interest in the military context, since one of the emerging themes is the greater empowerment of tactical level forces, enabled by advanced IT networks.[10] Creating a network centric force may not bring about improved military effectiveness through improved self-coordination of low-level forces, but through implicit coordination, directed by central staffs that have a much better appreciation of the larger context. The appeal of the centralised approach is supported by other constraints limiting decentralisation, such as significant external control (e.g. accountability to government, international law etc). It is possible therefore, that the capabilities of emerging IT may make it possible, and even desirable, in certain circumstances for the military to shift its doctrine away from command-by-influence, toward more centralised control of forces.

There is anecdotal evidence of commanders using unmanned air vehicles, with video feeds as a tool for commanding forces, not just for maintaining awareness. Whilst this might represent inappropriate use of the emerging technology, since a geographically distant commander will not have the same appreciation of the local tactical situation as the commander on the ground, it does point to a trend toward providing higher-level commanders with improved information about near real time performance of forces. However, computers can also lead to decentralisation through facilitating job enlargement and through providing employees with more and better information. When to centralise and when to decentralise will need to be worked out through experience, applied research, military experimentation, and through careful doctrinal development. Used appropriately, centralisation can lead to significant improvements in efficiency and implicit coordination, and de-centralisation can lead to improved responsiveness to local conditions and requirements.

Another important issue that impacts upon the degree of centralisation/ decentralisation is the existing power and authority structures. An often studied example of how power and authority structures can derail system implementations is the United Kingdom National Health Service (NHS). One of the difficulties the NHS has faced in implementing IT has been the concern of different professional power groupings, such as doctors, to maintain their control within the health sector (Willcocks, 1989; Willcocks and Mark, 1989). Many people have innate desires to maintain their power bases, and preserve and build their empires. Given the strong sense of identity engendered within different regiments, corps and services, within the military, the widespread digitisation of the military is likely to come up against similar constraints, particularly in so far as the systems have implications for the allocation, sharing and management of resources, and the distribution

[10] This empowerment is captured in such notions as self-synchronisation (Alberts and Hayes, 2003) and dynamic self-coordination, which represent efforts to "increase freedom of low level forces to operate near-autonomously and re-task themselves through exploitation of shared awareness and commander's intent" (Rumsfeld, 2003, p. 31).

of authority and responsibility for making decisions.[11] The explicit consideration and management of the potential pitfalls associated with power and organisational politics may assist in improving the success of system implementations.

4. Pure structural configurations

Mintzberg (1979) combined the coordinating mechanisms, design parameters and contingency factors to make five pure structural configurations: the simple structure, the machine bureaucracy, the professional bureaucracy, the divisionalised form, and the adhocracy (see Table 1).

Table 1 The five pure structural configurations (adapted from Mintzberg, 1979)

	Prime coordinating mechanism	Main design parameters	Contingency factors
Simple structure	Direct supervision	Centralisation, Organic structure	Young, small, non-sophisticated technical system, simple, dynamic environment, possible extreme hostility or strong power needs of top management
Machine bureaucracy	Standardisation of work processes	Behaviour formalisation, vertical and horizontal job specialisation, usually functional grouping, large operating unit size, vertical centralisation and limited horizontal decentralisation	Old, large, regulating, non-automated technical system, simple, stable environment, external control
Professional bureaucracy	Standardisation of skills	Training, horizontal job specialisation, vertical and horizontal decentralisation	Complex, stable environment, non-regulating and un-sophisticated technical system
Divisionalised form	Standardisation of outputs	Market grouping, performance control system, limited vertical decentralisation	Diversified markets (particularly products or services), old, large, power needs of middle managers
Adhocracy	Mutual adjustment	Liaison devices, organic structure, selective decentralisation, horizontal job specialisation, training, functional and market grouping concurrently	Complex, dynamic, (sometimes disparate) environment, young, sophisticated and often automated technical system

The defining characteristic for each of these structures is one of the five coordinating mechanisms. For example, in the case of the simple structure the prime coordinating mechanism is direct supervision, such that coordination between the workers is largely controlled by the owner/manager of the business. For a machine bureaucracy,

[11] Having said this, it can be argued that the continued and expanded use of combat teams that are composed of multiple corps has already begun to erode the identities of these corps.

standardisation of work processes is the most prevalent mechanism for achieving coordination between workers and work units, and so on for each of the structures. Whilst each structure is defined by a prime coordinating mechanism, other coordinating mechanisms will also be employed to some extent. In addition, each structure can be characterised according to different design parameters and contingency factors. It is important to point out that a real organisation is unlikely to be effectively described using just one of the five configurations. Instead it is useful to consider the five configurations as bounding the conceptual space within which an organisation can be described.[12]

After considering the main IT based coordinating mechanisms, Groth (1999) proposed a further five structural configurations: the joystick organisation, flexible bureaucracy, interactive adhocracy, meta-organisation, and organised cloud. The first three of these represent modified versions of Mintzberg's original structural configurations. The *joystick organisation* is an extension of the simple structure with decision-making power residing in the top of the organisation. However, through system-supported supervision and programmed routines, the top manager will be able to maintain control over a much larger workforce. The *flexible bureaucracy* is based on a machine bureaucracy. Through the use of extensive hyperautomation, programmed routines, and implicit coordination, such a structure will have a larger repertoire of responses to the environment than a traditional machine bureaucracy. As a consequence it will be able to operate in moderately complex and moderately dynamic environments. The *interactive adhocracy* employs implicit coordination mediated by databases to reduce the need for the substantial interpersonal communication that is the hallmark of adhocracies. For those adhocracies that have elements of their problem domain that are relatively consistent there is scope for IT to dramatically increase the number of people that can be coordinated. The Boeing design process for the 777, mediated through CAD and CAE systems, is an example of an interactive adhocracy, which involved thousands of people at more than 20 sites in the US and Japan.

The meta-organisation and the organised cloud represent two new structural configurations that have in large part been made possible by IT. The *meta-organisation* is composed of separate organisations that are tightly coupled to each other through unified computer systems (Groth, 1999). An archetypal example is supplier clusters in the automotive industry where suppliers are hooked into the car manufacturing assembly process providing components in a just-in-time fashion. A defining feature of such meta-organisations is that they involve close coupling between the component organisations, and employ a common systems infrastructure. A variety of terms are used in the literature to describe these developments including networked organisation, virtual organisations, or in the military context, network centric organisations. Groth rejects the term 'virtual' on

[12] It is also important to acknowledge that the frameworks offered by Mintzberg and Groth should not be viewed as providing complete descriptions of organisations. Other frameworks, theories and frames of reference may be needed to effectively describe and address particular design questions. The interested reader is encouraged to consider the following material: Morgan (1997) *Images of organization*; Nadler and Tushman (1997) *Competing by design: the power of organizational architecture*; and Daft (2000) *Organization theory and design* (7th Ed).

the grounds that virtual suggests that it doesn't exist in the real world. He also rejects the term network, "which has a distinctly egalitarian connotation that does not fit many of the actual examples" of meta-organisations (p. 404). For example, in the automotive supplier cluster, the automobile company is in a clear position of power and control. The term also suggests than one can fairly easily connect and disconnect components. However, to achieve the tight coupling required for effective coordination requires considerable planning and design efforts, which counts against being able to easily connect and disconnect[13]. The *organised cloud* is not an organisation in the classic sense, but is a large organised entity that is able to operate in a highly coordinated fashion due to implicit coordination. A good example is the reservation systems used to book airline seats. Many thousands of booking agents are able to simultaneously reserve seats on many different airlines with coordination achieved implicitly through centralised databases.

Groth (1999) does not view IT as leading to the development of modified structural forms based on the divisionalised form or the professional bureaucracy. In the case of the divisionalised form, this is because it is not an integrated entity, but is composed of somewhat autonomous entities (Mintzberg, 1979). IT will influence each of these entities differentially, depending on what structural form they take. However, IT does have the potential to improve awareness of corporate management, increase their ability to control larger organisations, and improve implicit coordination between divisions that have synergies. Groth suggests that this could lead to "reintegration of operations in a large number of instances, reducing the number of divisions or even transforming Divisionalised Forms to clean-cut Machine Bureaucracies or Flexible Bureaucracies" (p. 394). What this means is that through IT, coordination may shift away from only specifying the outputs desired for each division (standardisation of outputs) toward greater control by corporate management of the means to achieve particular responses or outputs (standardisation of work processes).

In discussing the implications of IT for professional bureaucracies, Groth (1999) argues that "the professional bureaucracy is probably the configuration where information technology provides the most limited platform for change" (p. 387). This is because a large part of the work undertaken in such organisations is based on experience and implicit knowledge, which is difficult if not impossible to represent within an information system. However, this is not to suggest that improvements in individual and group productivity can not be achieved through AI, AM, or Computer Supported Cooperative Work (CSCW) tools.

[13] Software agents are being developed to enable more agile and flexible information infrastructures which promise to improve the interoperability between disparate systems (Wark et al., 2003).

5. The structural configuration of a joint operational level HQ[14]

Previously it was argued that different components of a military organisation have different structures. Therefore, rather than consider the military as a whole, consideration will now be given to where a current joint operational level HQ might be seen to fit within Mintzberg's (1979) framework of different structural configurations. Following this, the implications of Groth's ideas for future joint operational level HQ will be explored.

In Table 2 the major coordinating mechanisms, design parameters and contingency factors for a current joint operational level HQ are provided. The major coordinating mechanism is standardisation of skills. The functional NATO J structure is populated by individuals who usually have some experience in their functional domain, such as intelligence (J2) or logistics (J4). Standardisation of outputs is also present in terms of the Commander of the HQ responding to a loosely specified requirement from the Chief of the Defence Force to undertake planning and management of operations, but how the HQ is to achieve its objectives is not specified in detail.

Table 2 Key dimensions of a joint operational level HQ

	Coordinating mechanisms	Design parameters	Contingency factors
Joint operational level HQ	Standardisation of skills and some standardisation of outputs	Some horizontal and vertical job specialisation, considerable on-the-job training but limited indoctrination, usually functional grouping, significant planning and control, some liaison devices (liaison positions and standing committees), limited vertical and horizontal decentralisation	New organisation, increasingly sophisticated and automated technical system, complex, dynamic environment, external control (both strategic and component forces)

In terms of design parameters, the staff within a joint HQ have some horizontal and vertical job specialisation as they perform a limited range of tasks and have somewhat limited control over their work. There is considerable on-the-job-training, however, joint HQ indoctrination is quite limited. The structure is essentially functional, along the lines of the J structure. Their planning and control system is clearly manifested in that the plans or the required outputs from the various groups within a joint HQ are specified. For example, various groups are expected to contribute to the brief provided to the Commander. If the Commander's information needs are not met the control system (in the

[14] The application of the conceptual framework to help describe the structural components of a joint operational HQ is based on the views of the author, who has experience with the behaviour of Australian joint operational level HQ. However, the author's views are necessarily limited, and they do not necessarily generalise to other HQ. Interested readers are encouraged to respond to the views presented.

form of feedback from the Commander and others) will ensure that the required information is provided in future. A joint HQ makes some use of liaison devices, such as liaison positions and standing committees. Finally, the design of the decision-making system within a joint HQ is one of limited vertical and horizontal decentralisation. Power over the decision making process is largely vested in the Commander, and non-core managers and staff have some influence and control over certain decision processes but not over making decisions (see section 2.2 for a more detailed description of how these design parameters are manifested in a joint operational level HQ)

A variety of contingency factors influence the design of a joint operational level HQ: organisational age, IT sophistication, the environment, and external control. In the Australian context, such a HQ represents a relatively new organisational component of the Australian Defence Force. According to Mintzberg's (1979) views on the influence of organisational age, this would suggest a structure that does not employ much in the way of formalised behaviour. This is because "as organizations age, all other things being equal, they repeat their work, with the result that it becomes more predictable, and so more easily formalized" (p. 228).

The IT within a modern HQ is becoming increasingly sophisticated, with some degree of automation (such as office automation, and some intelligence and geospatial information feeds). In the Australian context, managers and staff who support these systems appear to have considerable influence over decisions relating to the selection, implementation, integration, and modification of these systems. Furthermore, due to the tight coupling of some of these systems with organisational processes, these system professionals are also having an influence on such processes. This tight coupling can seen in the evolution of business practices and processes in response to new technologies, such as the changes to Australian joint operational level HQ information management practices that occurred following the introduction of an electronic document management system in 2003. It is also evident in the creation of an Information Manager role in these HQ. Staff who occupy this position are responsible for facilitating the development of effective IM structures through the use of appropriate IT and supporting policies, processes, practices and roles (Fidock, in process).

The environment is another contingency factor influencing HQ design. The environmental context associated with a joint operational level HQ is often complex - there are variety of different operations that need to be attended to, dynamic – the ways in which operations unfold changes over time, and such changes can often be unpredictable. Such environmental conditions suggest an organic structure as the most appropriate.

In contrast, external control from government and higher level HQ pushes the joint operational level HQ toward being more centralised and formalised in its structure. Governments have military forces to enable them to impose their national will on others, amongst other things. It is therefore important for the executive arm of government to retain considerable control over its forces. This is achieved through senior commanders being held responsible and accountable for their actions, and by imposing clearly defined

standards on them, which has the effect of centralising and formalising the behaviour of military organisations.

Considered from the perspective of Mintzberg's (1979) five pure structural configurations (see Table 1) the key dimensions of a joint operational level HQ (see Table 2) can be seen to combine elements of a professional bureaucracy (standardisation of skills, and considerable training), a divisionalised form (standardisation of outputs, and limited vertical decentralisation[15]), and to a lesser extent a machine bureaucracy (external control, some job specialisation, functional grouping, and limited horizontal decentralisation[16]).

6. Implications of IT for future joint operational HQ

IT has significant implications for future organisational structures.[17] In Table 3 some of the possible implications of IT for future joint operational level HQ are summarised. Those characteristics that differ from the current view are highlighted in *italics*.

Table 3 Implications of IT for future joint operational level HQ

	Coordinating mechanisms	**Design parameters**	**Contingency factors**
Future Joint operational level HQ	Standardisation of skills and some standardisation of outputs *with increasing system-supported skills and some implicit coordination by database.*	Some horizontal and vertical job specialisation, Considerable on-the-job training but limited indoctrination, *possible shift toward project based groupings, increased planning and control*, some liaison devices (liaison positions and standing committees), limited vertical decentralisation, but *increased horizontal decentralisation*	*Relatively* new organisation, *increasingly sophisticated and widespread use of databases, AI, AM and CSCW*, complex, dynamic environment, external control (both strategic and component forces)

In considering current joint operational level HQ it was argued that the major coordinating mechanisms are standardisation of skills, and outputs. In light of the capabilities provided by IT, standardisation of skills is extended through system-supported skills. *System-supported skills* refers to the ability of computers to enhance the quality of professional work through augmenting memory, and the processing of information, through AM, AI, and embedded knowledge systems. Such systems have the potential to significantly improve personal productivity, and increase the breadth or range of tasks able to be undertaken by personnel (Groth, 1999). However, in the military

[15] The authority to make decisions is largely vested in the Commander.
[16] The decision making processes are largely controlled by the Commander and his core J staff heads. However, the non-core managers and staff do have some influence and control over certain decision processes
[17] The time frame in this section is not specified, however, the views expressed are largely based on capabilities that IT systems already possess or are likely to attain in the next 5 to 10 years.

context, many roles and functions will continue to rely heavily on those human characteristics that are difficult to replicate or represent within a computer system.

In the military context, the commander conveying his intent, through giving an order to subordinate commanders that broadly specifies the desired outcomes, is an example of standardisation of outputs. Groth (1999) does not identify any IT enabled extensions to standardisation of outputs because he does not view it as a form of coordination. However, a consideration of Groth's IT enabled extension of mutual adjustment, *implicit coordination (by database)*[18], suggests that the communication of intent could be facilitated by the use IT. Understanding the intent of an order is dependent on both the explicit meaning embodied in the order and the implicit or tacit understanding shared between the commanders, derived from common experiences, indoctrination, and organisational culture. This therefore can be seen to represent a form of implicit coordination, except that it is more than just sharing a common information base, the commanders also share a common value system, culture and background knowledge. The capacity of technology to facilitate implicit coordination of tacit understanding is likely to be very limited.[19] However, where aspects of the intent are characterised by well-structured information then implicit coordination (by database) could generate some improvements. The IT enabled extension of standardisation of outputs can therefore be thought of as being implicit coordination (by database) to some extent.

Implicit coordination (by database) is the sharing of common information mediated through a database, which facilitates coordination without human communication. The most prominent military example that is attempting to generate a degree of implicit coordination is the development of a common operating picture (COP), to facilitate shared situational awareness.[20] There have been significant steps taken toward this goal in the last few years. However, in order for people to act on the information provided by the COP in a coordinated fashion, with reduced human communication, significant changes in doctrine, military culture, structures and processes are required. Even if such changes are made, situational awareness is very much dependent on what people bring with them in terms of experience, background and so on. It will therefore continue to be necessary for people to interact through mutual adjustment to solve problems which are not amenable to being well structured and routinised.

Previously, the five basic coordinating mechanisms have been described. Two of these, standardisation of skills and outputs, were viewed as being the prime coordinating

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[18] This is achieved through enabling people to share a common information base, such as a paper file or an electronic database, to achieve coordination without having to talk to each other.

[19] In the next 10 to 20 years we may begin to see technologies that augment and support communication of some tacit information, for example, talking avatars that provide emotional cues through smiling, frowning and so. To the extent that organisational values systems and cultures can be surfaced, coordination tools could be developed to serve as cultural guides or to perform a liaison role within and between different organisations such as in a multinational force.

[20] Kardos (2004) provides a good overview of the relationship between automation and situational awareness.

mechanisms for a joint operational level HQ. However, each of the remaining three basic coordinating mechanisms - mutual adjustment, direct supervision, and standardisation of work processes – also are utilised. Consideration will therefore be given to the IT enabled extensions associated with each of these mechanisms in the context of joint HQ. The IT extension for mutual adjustment is implicit coordination (by database), which has already been discussed above. Direct supervision is extended through system-supported supervision, and standardisation of work processes is extended through programmed routines and hyperautomation.

The pervasiveness of networked computer systems throughout defence provides a means for managers to improve the collection, aggregation and dissemination of information; and it enables system-supported supervision. For example, senior managers have the capacity to provide orders and guidance to a large and geographically dispersed workforce through email. In certain contexts, such as the maintenance of military assets, inventory and servicing management systems will improve the capacity of managers to monitor and control the performance of larger numbers of subordinates. The ability of managers to provide more detailed guidance to subordinates, and to increase the number of different tasks and subordinates that can be monitored and controlled, may lead to increased centralisation and control of decision making. In particular, systems that support supervision would reduce the autonomy of subordinates and their discretion to act. Increased monitoring of subordinates may also serve to decrease organisational trust and morale. This may in turn undermine the ability of forces to achieve efficient self-organisation, which is an important feature of an NCW capability (Alberts and Hayes, 2003).

Programmed routines, which are usually quite simple computer based representations of routine tasks, can significantly improve the management and processing of structured and quantitative information. Those individuals in HQs who currently undertake quite routine tasks, such as entering data into systems, or transferring data between systems, should no longer be required. Achieving this is predicated on the increasing centralisation of databases[21], and the concomitant need to improve interoperability between systems. For example, with the introduction of centralised logistics management and in-transit visibility systems, there should be a reduction in the number of logistics personnel required in a HQ due to the automation of many of the information collection and processing tasks.

Hyperautomation is similar to programmed routines in drawing upon computer based automation. However, hyperautomation encompasses a larger range of routines and processes. In the example given above of reducing the number of logistics personnel, it is not sufficient to simply automate existing simple routines to produce significant staff reduction. In addition, considerable efforts would be required to understand the entire logistics management process and how it interfaces with the rest of the organisation and

[21] In the military context (and in the private sector), simply centralising a database is not sufficient, since this provides insufficient redundancy. Instead, developments are focussed on having replicated regularly updated versions of a 'central' database located at multiple sites, although the pace of developments along these lines in the military domain is limited by bandwidth constraints.

reengineering it to make best use of the capabilities of IT. For example, there are efforts underway to integrate disparate logistics information systems and to make changes in end to end logistics processes to take advantage of this improved systems integration.[22] This is a highly complex and difficult undertaking but would be expected to improve both the efficiency and responsiveness of the logistics function. Some integration of systems across functions, such as between planning and logistics systems, will also lead to automation of some of the information sharing required to coordinate military activities.

In terms of design parameters, given the professional and managerial nature of much of the work in HQs, it is unlikely that IT will have a significant impact on existing levels of job specialisation. However, there may be increasing pressure to move away from the NATO functional J structure toward more project-based groupings.[23] Due to improved information availability and aggregation, planning and control systems will become more sophisticated and possibly more widespread. The limited amount of vertical decentralisation is unlikely to change significantly in joint HQ, except that as staff numbers drop, some positions will grow in responsibility and authority. The influence of non-managerial staff over decision-making processes will increase, particularly information systems support, design, and development staff. Organisational designers/engineers may also become more influential due to the importance of their role in managing and evolving the structural and process arrangements within the HQ.

The contingency factors will essentially remain the same as they are currently, except that the particular classes of computer-based systems that provide support are clearer now than they were when Mintzberg wrote his book. Such system classes include databases, AI, AM, and CSCW. Also, joint operational level HQ will have matured somewhat, which could result in some functions, activities and processes being more formalised. The creation of information manager positions in these HQ is an example of this starting to occur.

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[22] Australian Defence Materiel Organisation, Military Integrated Logistics Information System, Joint Project 2077.

[23] Improved implicit coordination may facilitate improved working between different functional groupings. However, much additional mutual adjustment will be required, given the reliance on tacit knowledge in such organisations. So, as implicit coordination improves between the branches the organisation may reach a point where employees increasingly network across functional boundaries in order to address exceptions and clarify meaning, leading eventually to the explicit formation of a project based structure, to leverage and support the development of these networks. The formation of cells to support a particular operation or role with embedded J1 to J9 staff is one example of this. Particular personnel are likely to belong to more than one cell, and will manage the increased complexity and demands this entails through support provided by systems that augment memory and information processing. To preserve professional identify and expertise it is likely that staff will continue to be grouped around their professional expertise or function, with this grouping being overlayed on the project structure creating a matrix.

6.1 A joint operational level HQ in 2015

Up to this point the time frame within which the potential contribution of IT to enhancing future joint operational level HQ has only been broadly specified. To conclude this report, a series of predictions will therefore be offered regarding how a joint operational HQ in 2015 will be augmented by IT, and possible human resource and structural implications. It is predicted that:

- The professional and managerial work of HQ staff and commanders will continue to rely heavily on those human characteristics and capabilities that are difficult to replicate or capture within a computer system. Nevertheless, they will be more efficient and effective in undertaking their work, due to the support provided by increasingly sophisticated computer systems that augment human memory, thinking, and decision making.[24] In addition, richer communication will be possible between system users due to widespread use of CSCW tools, however, face-to-face contact and informal communication between HQ personnel will remain a very important part of staff work.
- Programmed routines, hyperautomation, and implicit coordination, underpinned by increased numbers of centralised databases, and improved system interoperability, will become more pervasive in military HQs, with some reductions in those positions that currently undertake routine tasks. However, for jobs that require extensive professional and/or managerial experience such systems will not lead to significant reductions due to the difficulties in explicitly capturing the tacit knowledge that is such a critical component of effectively working in these domains. Furthermore, given the long lead times for large infrastructure acquisitions it is likely that significant work will still need to be done to improve system interoperability, and increase data sharing and centralisation of information bases.
- In order to effectively exploit ongoing improvements and developments in IT, 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 will 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).
- As more organisational tasks, routines, and processes become augmented or replaced by IT, the software that controls these systems will increasingly come to embody certain structures and processes. By 2015 these structures and processes will largely be related to support functions, for example, the identification and management of logistics requirements of a deployed forces will be enhanced by systems which automate certain parts of the process, such as replenishment of certain classes of supply, and maintaining visibility of goods in transit. Other support areas that will

[24] For example, intelligent agents have been developed to assist with maintaining effective distributed team decision-making in high time pressure situations (Fan et al. 2005).

benefit from advances in IT include information systems support and personnel management. Meanwhile, core structures and processes related to warfighting will continue to rely heavily on tried and tested methods and arrangements.

- For certain types of operations, such as those with a high political profile, or those that use relatively small forces, a joint operational level HQ will be easier to sideline, due to the improved ability of strategic HQ to command and control forces. However, a joint HQ will continue to be an important mechanism for coordinating the efforts of the different services.
- As is already the case in joint operational HQ, matrix structures will be employed in order to address multiple strategic priorities. To preserve professional identify and expertise it is likely that staff will continue to be grouped around their professional expertise or function. However, the NATO J structure, which is a functional arrangement of personnel, will no longer be the primary dimension for describing the structure. Instead, personnel will be formed up into project teams or modules. Currently such teams are largely collocated, however, with advances in information and communication technologies teams and team members will be able to be distributed and arranged with greater speed and flexibility to meet the unique needs of particular operations. The flow and management of information between modules, and the addition and removal of modules to meet particular operational requirements, will be facilitated through employing a 'plug and play' agent architecture (Christie et al. 2003). Such a capability will considerably reduce, but not eliminate, the need for the collocation of augmentees that currently occurs when fixed joint HQ are augmented to meet a surge requirement. In the context of deployed joint HQ, this modular approach will facilitate some reduction of HQ staff required in the area of operations.

In summary, it is predicted that developments in IT will enable many routine positions to be eliminated, however, some new positions will need to be created to handle and manage the increasingly sophisticated IT systems, and organisational structures and processes. These structures and processes will be faster and easier to modify and adapt to meet particular operational requirements, due to the capabilities offered by IT, and will help to reduce the collocated HQ staffing requirements in both fixed and deployed joint HQ.

The above predictions may seem overly conservative to technologists, however, a consideration of the nature of work undertaken in HQ, the contingency factors operating on HQ and the possibilities offered by current and emerging technologies suggests the structure of HQ is unlikely to be radically transformed in the next 10 years.

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Justin Fidock

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19. ABSTRACT

This report provides a conceptual framework for describing organisational structures based on the work of Mintzberg (1979) and Groth (1999), and considers the implications of information technology (IT) for current and future military organisational structures. The various components that influence organisational structure are considered: coordinating mechanisms, design parameters and contingency factors. When combined together these components form various structural configurations. The role of IT in modifying and extending the range of coordinating mechanisms and structural configurations is also described. These configurations and associated components provide a framework within which military organisations can be categorised. This framework is used to describe a current joint operational level headquarters (HQ), and to explore the implications of emerging IT for future HQ.