15th ICCRTS
"The Evolution of C2"

Agility in an Extended Space of Constructible Organisations

Topics: 3, 7

Alexander Kalloniatis, Iain Macleod, Elizabeth Kohn

POC: A. Kalloniatis

Defence Science & Technology Organisation
Defence Establishment Fairbairn
24 Fairbairn Avenue
Canberra, ACT
Australia

Telephone: +61 2 612 86468

E-Mail: Alexander.Kalloniatis@dsto.defence.gov.au

Agility in an Extended Space of Constructible Organisations

Alexander Kalloniatis, Iain Macleod, Elizabeth Kohn
Joint Operations Division
DSTO Canberra
Australia

Abstract

Traditional theorists, such as the Contingency School[1], classify the modes of coordinating distributed human work using a geometrical "organisational space". Such a space may be labelled by the dimensions of distribution of decision making rights and specialisation mix, or those of the C2 Cube Model[2]. Within such spaces reside, for example, Mintzberg's[3] five organisational types. In light of modern information technology, Groth[4] has extended Mintzberg's list to include five new modes.

By examining characteristics such as coupling and complexity, we position Groth's new modes in an extended geometric organisational space. Contingency Theory asserts that no single organisation can be structurally optimised to match every type of environmental contingency and work structures should adapt within an available "organisational space". How then can modern military organisations use new modes enabled by information technology? We use Perrow's Normal Accident Theory[5] to correspondingly analyse the space of environmental contingency or the military "problem space". Building on our previous work[6], we extend a concept of military headquarters agility, seen as movement through such a space of constructible organisations according to changing contingencies, now in light of degrees of freedom offered by information technology. We compare this to the concept of the Edge Organisation[7].

[1] For example, Donaldson, L. *The Contingency Theory of Organizations*, London: Sage Publications, 2001.
[2] Alberts, D. S., and Hayes, R. E. *Understanding Command and Control*, CCRP, 2006.
[3] Mintzberg, H. *The Structuring of Organizations: A Synthesis of the Research*, Englewood Cliffs, NJ: Prentice Hall, 1979.
[4] Groth, L. *Future Organizational Design: The Scope for the IT-Based Enterprise*, New York: John Wiley & Sons, 1999.
[5] Perrow, C. *Normal Accidents: Living with High-Risk Technology*. New York: Basic Books, 1984.
[6] Kalloniatis, A., et al. "Bounding Wicked Problems: The C2 of Military Planning", 14th ICCRTS, 2009 and Kalloniatis, A. and Macleod, I. D. G. "Formalisation and Agility in Military Headquarters Planning", International C2 Journal, **4**, 1, pp1–41, 2010.
[7] Alberts, D. S., and Hayes, R. E. *Power to the Edge: Command and Control in the Information Age*, CCRP, 2003.

1. Introduction

Changes in the organised conduct of shared work are an intimate part of human social evolution, reflected in the growth of varieties of types of organisation and the tools that have been used. These changes are bound up in corresponding changes to the external environment in which organised work has been performed. As change has occurred for tribes, nations, empires, guilds, factories, firms and university schools, so too has it for that group of people, the staff, around a military leader enabling the exercise of command over an armed force. A military headquarters, charged with overseeing the planning underlying and the promulgation of the Commander's orders, will look much like any other administrative body once the military uniforms are swapped with business suits. A number of Command and Control (C2) Theorists, for example [Nissen, 2007], have proposed over the years that there is much to be learned from the administrative and business scientific communities. This paper builds on such work by addressing the question: given the evolution of organisational modes of human work over millennia and a sober assessment of what modern Information and Communication Technology (ICT) provides, what models can realistically enable more agile C2 for military headquarters of the future?

The evolution of human organisations over the centuries up to the height of the Cold War era has been studied in depth by many organisational theorists. Henry Mintzberg has classified the organisations that have existed from primitive times through to the late 20th Century under five configurations or types [Mintzberg, 1979] which we summarise in Section 2. Mintzberg belongs to a school known as Contingency Theory which posits that there is no universal organisational configuration or type that is optimal for all administrative/business/military environments; rather, organisations settle into structures and processes according to the external contingencies they confront. Donaldson [2001] provides a review of the literature of this field. The organisational types identified by Mintzberg have demonstrated effectiveness through the ancient, mediaeval, renaissance and industrial ages. In addressing the opportunities provided by the modern computer age, Lars Groth [1999] has extended Mintzberg's work by another five organisational types. Referring to a "space of constructible organisations" which he "extends" with his five new types, Groth develops these types through a sober analysis of what modern ICT offers in the coordination of human work.

In this paper, we take things a step further by formulating a geometric model for the organisational space which suffices to represent and distinguish all the Mintzberg types as well as three of Groth's. Despite being a decade old, we argue that Groth's analysis remains valid even with the advance of social networking technologies. Significantly, Groth tempers his predictions of the future through his recognition that it is fundamentally the same human being at the nodes of a technologically enhanced organisation. We expand on the applicability of Groth's types within a Contingency Theoretic perspective, which we provide here within the context of military headquarters organisations. In particular, we adapt the framework of Perrow's Normal Accident Theory [Perrow, 1984] to characterise the space of contingencies in terms of interactive complexity and tightness of coupling of elements in the external environment, with an additional parameter: environmental spread or "problem size". We present a model for agility representing movement or adaptation transitions through this geometric space.

Our basic result is that a number of possibilities exist for the organisational structure of future ICT enhanced military headquarters, including organic peer-to-peer, a variation on bureaucratic forms and highly centralised structures. Each is based on a different type of technology enabled coordination mechanism. Each is appropriate to a different type of contingency, though all these contingencies may be confronted by future military forces, even in the "War-among-the-people" paradigm [Smith, 2005] of our current conflicts. Agility, which for us means ability to change modes of headquarters structures and work activity, requires the capacity to move between all these organisational forms. However, the organisational theoretic literature suggests that there are challenges to such adaptations, related both to human-centric issues as well as technology. In other words, the Edge organisation [Alberts and Hayes, 2003], which we argue is related to one of Groth's types, is not guaranteed to be the unique outcome of future military headquarters evolution.

The paper is organised as follows. We first present a summary of the organisational configurations or "types" of both Mintzberg and Groth. We then present a geometric model that represents these forms,

capturing the original and an extended "space of constructible organisations". We subsequently relate these types to structures in military headquarters through examples of different ways of structuring planning teams. We explore the relationship of the Edge organisation to Groth's types. We then summarise our results and conclude.

2. Organisational Designs

In previous work [Kalloniatis et al., 2009; Kalloniatis and Macleod, 2010] we adopted a 2-D model to describe a design space of organisational types (see for example, Hollenbeck et al. [2002]). This space has as its two axes the distribution of decision-making authority and the organisational departmentation (which describes how personnel are grouped according to their specialist skills). This model enables a distinction between two types of organisation: the Organic and the Mechanistic. Organic organisations are characterised by distributed decision-making and a mixture of diverse specialist skills. Mechanistic organisations, by contrast, have centralised decision-making and compartmentalised or departmentalised personnel according to their skills. Useful as this model is, it is inadequate to represent the larger spectrum of five organisational types catalogued by Henry Mintzberg [1979]. Later we present a geometrical model that encompasses these types. But, to begin with, we outline Mintzberg's framework and subsequent five classical organisational types.

Mintzberg begins with a reflection on the coordinating mechanisms used in the conduct of distributed human work. These mechanisms are: mutual adjustment, direct supervision, standardisation of work processes, standardisation of work outputs and standardisation of work skills. Whereas the first two mechanisms rely on direct human-to-human communication, negotiation and instructions, the latter three represent an external formalisation of the means and outcomes of work. The placement of these mechanisms in different configurations leads then to the five basic organisational types, as follows (concrete examples will be given as we consider instantiations of these in military headquarters).

Adhocracy: This is the most informal of organisations, with fellow workers collaborating at a peer-to-peer level through mutual adjustment towards achievement of common goals. Groth [1999] sees this type as the most primitive of organisations. However, Mintzberg [1979; 1994] specifies that, in its modern forms, the Adhocracy is populated by skilled experts in their fields.

Simple: This type builds on the Adhocracy in retaining mutual adjustment between organisational members, but they are overseen by a single decision maker. Because of limits on the capacity of any individual to oversee multiple sophisticated activities by a number of subordinates, this type is limited in the size it can attain.

Machine Bureaucracy: In order to sustain larger sizes than is possible for Simple organisations, the Machine Bureaucracy relies on standardisation of specialised and compartmentalised work practices with decision making concentrated at the apex. The outputs of the Machine Bureaucracy are correspondingly standardised (which the centralised decision making enforces) so that the contributions made by each compartment can be readily composed. The larger the size of the organisation, the more that compartments need to be encapsulated and overseen locally by delegation to subordinate decision makers. A hierarchy is the natural consequence.

Professional Bureaucracy: If the outputs of the organisation do not require standardisation, then decision making can be located lower down in the hierarchy, within compartments themselves. The organisational members are nonetheless highly skilled individuals, often working in sub-organisational Adhocracy or Simple structures with standardised outputs appropriate to the skill specialisation of their compartment but not constrained to fit with any other outputs.

Divisional: Whereas the specialised skills in the Machine Bureaucracy are compartmentalised, the Division integrates these while maintaining standardised outputs. This form is still based on standardised work processes; however, these processes must be correspondingly more sophisticated because of the diversity of skills integrated into key process steps. There are sub-types within the Divisional form, depending on the degree of centralisation, interdependencies between divisions and similarity of outputs, but we do not elaborate on these here.

We see that three key parameters recur throughout these types but with different settings: *the distribution of specialist skills, the distribution of decision making and the organisational size*. In Sections 4 and 5 below we use these as the basis for our geometric model. We can also see that as organisations grow in size, the capacity of any single decision maker to maintain oversight of subordinate activities forces either increases in the number of levels in a chain of delegation, devolution of decision making or the integration of organisational functions. In terms of the 2-D model we can straightforwardly see that the Adhocracy and Divisional types are special cases of Organic structures, though the Divisional form does have a comparatively constrained distribution of decision-making authority. The Machine Bureaucracy is (naturally) Mechanistic. Finally, the Simple and the Professional Bureaucracy can be regarded as "hybrid" forms [Hollenbeck et al., 2002] from the 2-D perspective: Organic with Centralised decision-making (Simple) or Functional skills distribution with Decentralised decision-making.

Written in the late 1970s but further refined through the subsequent decade, Mintzberg's classification is regarded as a relatively comprehensive catalogue of organisational types. These started as primitive social models (Adhocracy, Simple), saw extension into the early industrial era (Machine) and flourished in the lead-up to the late 20th Century (Professional and Divisional forms). Note, however, that some primitive models have resurged in the era of technical expertise (Adhocracy). These types very much represent *where we have been*, in the spirit of the current ICCRTS theme of agility. We later explore *where we are going* in light of the advances in modern ICT as illuminated by Lars Groth [1999].

Mintzberg's Types and Military Headquarters

Joint Military Headquarters are traditionally structured according to the Continental or Common Joint Staff System (CJSS), with a typical assignment of responsibilities to the J-units as follows: J1 – Personnel, Administration; J2 – Intelligence; J3 – Current Operations; J4 – Logistics; J5 – Plans, Strategy; J6 – Communications; J7 – Exercises; J8 – Development; J9 – Civil-Military Engagement[8]. Depending on the size of the headquarters and the seniority of its Commander, the J-Heads may be Colonel level or One Star equivalent officers with staff officers populating the J-organisations in a correspondingly decreasing rank scale. In our earlier work [Kalloniatis et al., 2009; Kalloniatis and Macleod, 2010] we have argued that this structure is rather hybrid from an organisational perspective. Whereas areas such as J1, J2, J4 and J6 involve somewhat specific specialist skills, the key areas of J3 and J5 involve integration of the products produced by the former: a plan (generated through a Military Appreciation Process, for example) or an operation (the execution of the plan) rests on a foundation of Administrative, Intelligence, Logistics and Communications considerations but is something more than the sum of those parts. Therefore from a J1, J2, J4, J6 perspective a headquarters is Functional in nature: these specialist functions can develop products in relative isolation. However, from a J3, J5, J7 perspective it is Divisional: the plans and operational orders developed here require integration across functions. For this reason, recent Joint Operational Headquarters designs (Australia, United Kingdom and New Zealand) have adopted core Operations, Plans and Exercises pillars with other functions folding in correspondingly as Support elements. Adding the centralisation influence of the Commander and the J-Heads, we can identify the J1, J2, J4, J6 areas as Machine Bureaucracy in structure when centralisation is strong but approaching the Professional Bureaucracy structure when this is relaxed. For the J3, J5 and J7 areas, depending on the strength of the centralisation by the Commander and J-Heads, the structure can vary within the sub-types of Divisional forms.

We have argued elsewhere [Kalloniatis et al., 2009] that this co-existence of types gives J-structured headquarters a unique flexibility compared to many pure Functional and Divisional organisations. This is reinforced when the full list of Mintzberg types is considered: an organisation in which a variety of pure organisational types simultaneously co-exist has the potential requisite variety [Ashby, 1957] to respond to diverse environments, *if the degrees of freedom can be adequately manipulated*.

3. Modern Information Technology and Groth's Extended Organisational Space

Groth [1999] explored the impact of technology on organisational types. He conducted an in-depth exploration of likely future technologies, and argued that although information technologies can change the way in which we work, and the skills that we work with, they can make only limited

[8] For the higher J-numbers (J7–J9) the functions may vary between military forces.

changes to the way organisations are structured as a result of the limited input/output capabilities of humans. Groth sees that ICT has triggered an evolution in Mintzberg's coordinating mechanisms in the following set of computer dependent co-ordinating mechanisms: Implicit Co-ordination, System Supported Supervision, Programmed Routines, Hyper Automation and System supported Skills.

Groth expects that organisations will become largely model driven: the hard wiring of technology into the organisational framework through explicit complex conceptual models. He sees three such models, based on a combination of computer dependent co-ordinating mechanisms: the Mediating Model, the Regulating Model and the Assisting Model. The Assisting Model does not lead to a new computer dependent organisational type and is not discussed further herein. The other two models support multiple organisational types that vary in the scope and tightness of model wiring.

New Organisations based on a Mediating Model
Interactive Adhocracy: This organisation is built on peer-to-peer collaboration across a common system or cluster of systems. This system-supported collaboration captures the collective knowledge of professionals with diverse skills, relevant to the problem in hand. Groth sees a technology supported Adhocracy as enabling greater collaboration across distance, time and scale. Effectively, the Mediating Model facilitates mutual adjustment between team members while reducing the need for explicit communications. This in turn allows Interactive Adhocracy organisations to be larger and more diverse than their non-ICT enhanced siblings.

The Organised Cloud: This is one of the two new organisational structures that Groth proposes. This is a technology driven organisational structure which focuses on simple but extremely dynamic environments. In some respects this type is not a true organisation in that the majority of activity conducted by the sub-organisations has little overlap. Rather, the ICT systems enable implicit coordination of the very few activities of the organisations that need to be synchronised. Modern airline booking systems through which travel agents manage flight bookings is the classic example of this type. Because of the diffuse nature of this type, we do not consider it further herein.

New Organisations based on a Regulating Model
The Joystick Organisation: This is an ICT enhanced version of the Simple Organisation. The main limitation of the Simple Organisation is the amount of activities a single decision maker can oversee. With the aid of technology to manage and organise, the information and delegation processes for the single decision maker they are able to increase the complexity or size of operations. Thus the ICT enhanced Joystick Organisation is able to grow larger beyond the scale of the simple organisation.

The Flexible Bureaucracy: Mintzberg's Machine Bureaucracy allows larger organisations through standardisation of work processes. Groth argues that with the aid of technology it is possible to have a more flexible standardisation to deal with slightly more complex situations, with more exceptions to hitherto idealised but rigid sequences of work activity. This organisational type exploits variation within a type rather than producing completely new objects.

The Meta-Organisation: Groth uses this term to describe two (or more) closely coupled organisations, in a mutually beneficial relationship, that function as relatively independent partners. The constituent organisations are most likely to be Machine or Flexible Bureaucracies. An example here is the relationship between a car manufacturing firm and external suppliers of parts. When these relationships are close, car manufacturers may use "just in time" logistic systems, relying heavily on timely delivery of parts by their suppliers. Groth argues that this is a new organisational type, but we could potentially argue that the Meta-Organisation is a different form of ICT enhancement of Mintzberg's Machine Bureaucracy compared to the Flexible Bureaucracy. However, technology facilitates much closer relationships, underpinned for example by real-time knowledge of inventory status, meaning that the constituent organisations become so dependent on each other that they really do form what is in effect a new organisational type.

Groth does not see Mintzberg's last two types, the Divisional and the Professional Bureaucracy, as undergoing substantial changes with the advent of improved ICT. The main area of change for the Divisional form is in ICT enabling greater centralisation within the type, but no distinct new organisational form emerges. The Professional Bureaucracy relies on highly skilled individuals whose

work in providing professional judgement has limited automation capabilities; their judgement might be improved and better informed but without obvious change to the organisational structures employed.

Several issues arise in relation to Groth's work being published in 1999, over ten years ago. In the interim there have been substantial advances in the ICT area that he did not fully foresee, such as the extent of world-wide connectivity via the Internet, improvements in search capabilities, augmented reality and the advent of Web 2.0 (technologies that facilitate interactive information sharing and user-centred design). Our judgement is that Groth was quite prescient insofar as these developments facilitate instantiation of his models rather than extending or superseding his work. A further issue with Groth is that he perceived technology as having to be relatively hard wired into organisations. This is where information technology was heading in 1999; however, developments in Business Process Modelling and supporting tool suites mean that organisational models can now be developed and modified much more easily. This means that some of the difficulties in organisational change that Groth foresaw are no longer as significant.

Groth's main argument though is that there are limits to Input/Output Mechanisms of human beings (ICT enables a bigger "hose" but the "nozzle" is the same [Groth, 1999]) that even with improvements in technology we still have not surmounted. Another limitation that he alludes to is lack of human trust in technology. In the future it is possible that limits to human Input/Output and trust in technology will be overcome, which could in turn lead to revolutionary changes in organisational design. For the foreseeable future, however, Groth's basic findings remain valid.

4. Geometric Model I: Organisations

Plotting Mintzberg geometrically

Groth [1999] refers to a "space of constructible organisations" by which he refers to the collection of viable organisations fit-for-purpose (though the purposes may differ). Mintzberg has provided one such collection, to which Groth has added, thereby "extending the space". However, our first aim here is to present the Mintzberg and Groth "spaces" *within a single geometric space*.

In Section 2 we started by using a 2-D model, but this is inadequate to cleanly separate the various organisational types of Mintzberg and Groth. To achieve this separation, the minimum requirement is a third dimension. In that sense we are approaching a framework such as the cube models (C2 Problem and Approach spaces) of Alberts and Hayes [2006]. However, the axes will largely differ here: distribution of decision-making (which agrees with the C2 Approach space), skills mixture (as in our earlier 2-D model) and, the new element, *organisational size*. Certainly, within Mintzberg's types, size could be replaced with number of levels of hierarchy: coordination of work in larger organisations becomes unwieldy without the device of delegation and encapsulation of work within subordinate units. However, the key feature of modern ICT is to enable larger scale collaborations to be coordinated without, necessarily, relying on this traditional mechanism. Therefore, in order to plot Groth's organisations in the same space we need to decouple the degree of hierarchy from organisational size.

We first present the geometrical model in Figure 1 by plotting only Mintzberg's five organisations, in order to first enable the reader to become familiar with the model. This representation helps to emphasise the point that some of the types are indistinguishable in any 2-D representation: Adhocracy and Simple (top square in Figure 1), and Professional Bureaucracy and Divisional type (bottom right square). Further reflection on this representation yields a picture of how organisations evolve out of the Adhocracy, as size and internal diversity increase, through migration into different parts of the space according to the degrees of freedom becoming available.

Plotting Groth

Next we plot Groth's organisations in this space in Figure 2. To reduce clutter, however, we drop the Professional and Divisional types (which, anyway, according to Groth will not see much change within such a classification through ICT enhancement). Furthermore, we exclude the Organised Cloud and the Meta-Organisation which describe the coupling of otherwise quite autonomous sub-organisations and therefore are not immediately relevant to a single military headquarters and its

internal structures and activities. In this representation we indicate in some cases through an arrow how Groth's types can be seen as evolutions, through ICT systems, of Mintzberg's types. For example, in the bottom right square of Figure 2 we see that the Interactive Adhocracy and the Joystick Organisation, respectively, enable in turn the basic types of Adhocracy and Simple Organisations to become viable for larger sizes without the creation of more intervening layers of hierarchy. Similarly, the Flexible Bureaucracy represents a shift of the (already large) Machine Bureaucracy to richer skills mixtures and relatively more distributed decision making (bottom left square of Figure 2).

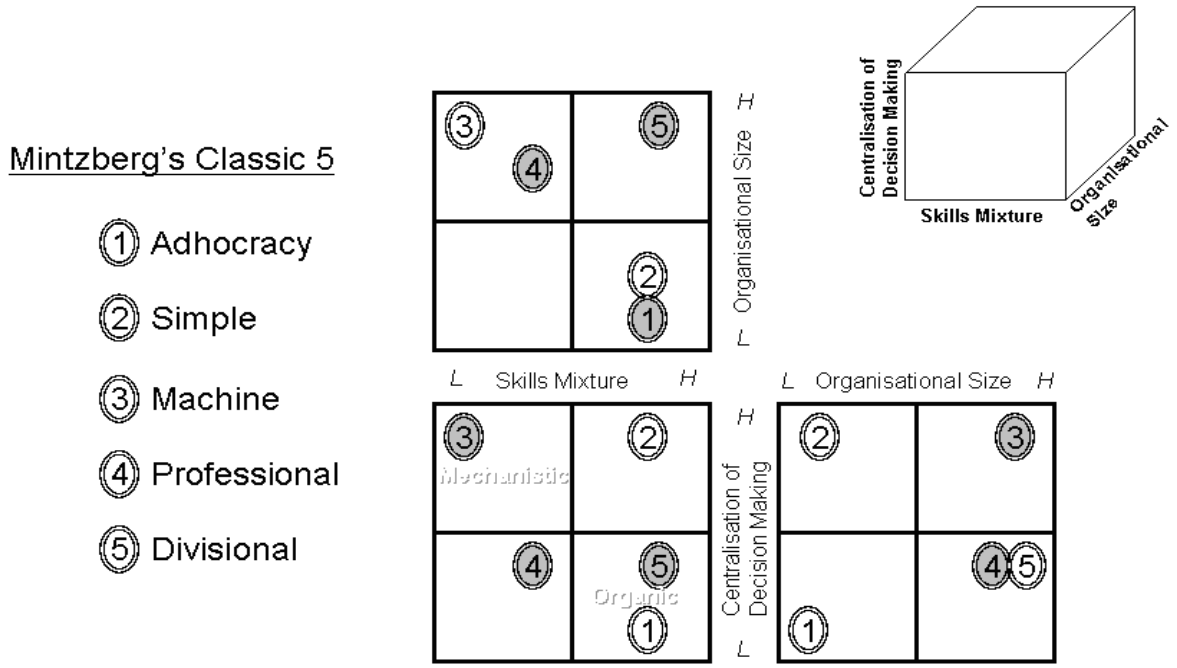

Figure 1 3-D geometric organisational space representing the five classic organisations of Mintzberg. Rather than plotting all the types in a cube we present the perspective of three faces (in plan, side elevation and end elevation views), indicating by grey-shading which points lie deeper inside the cube from the given perspective.

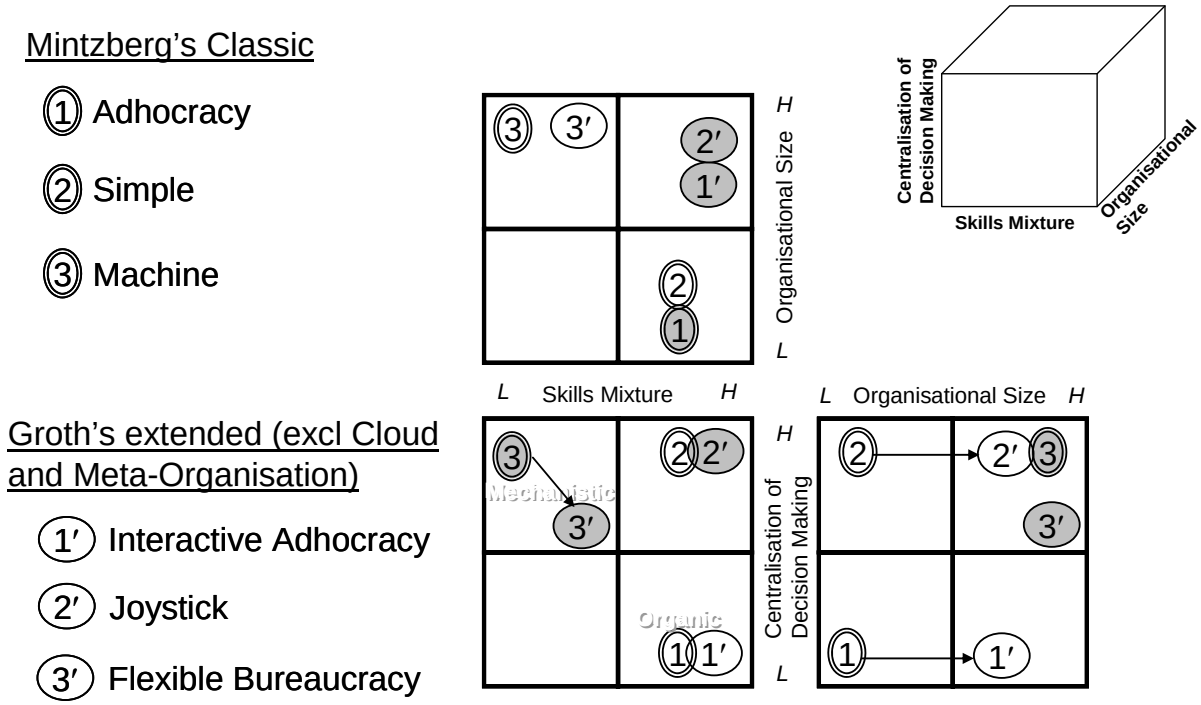

Figure 2 3-D organisational space including some of Mintzberg's and, now, Groth's types. The arrow connecting organisations indicates Groth's types as representing evolutions, through enhanced ICT systems, of an original Mintzberg type. Perspectives are as for Figure 1.

As a final comment for this section, we mention two contrasting positions between Contingency Theorists: some, such as Mintzberg, propose that there exist only a small number of viable configurations while others see many possible intermediate states lying between these pure configurations[9]. Donaldson [2001] argues that empirical data supports the latter position. In our previous work [Kalloniatis et al., 2009, Kalloniatis and Macleod, 2010] we too have argued that intermediate states between pure Mechanistic and Organic structures can, at least crudely, be achieved. In this paper we persist with the "pure" types of Mintzberg and Groth to keep the discussion simple.

5. Geometric Model II: Contingencies

Structural Contingency Theory postulates that no single organisation performs optimally or is fit-for-purpose for all possible contingencies; organisations that confront a variety of environments must correspondingly adapt their structure and processes – basically Ashby's Principle of Requisite Variety [Ashby, 1957]. This builds on traditional Contingency Theory which, since the 1960s, has mounted empirical evidence that specific organisations are fit-for-purpose for specific contexts. Donaldson [2001] provides a recently updated summary and defence of the approach. Contingency Theory seeks then to identify the environmental contingency factors corresponding to which organisational degrees of freedom enable fitness-for-purpose; increases in a particular contingency factor in the environment requires changes in a particular organisational design property to enable the organisation to perform better. This means we need to be able to relate the three dimensions of our organisational geometric space to properties of the environment – to the "problems" that the organisation seeks to solve.

Two of the Contingency Factors: Environmental Complexity and Problem Size

Some of the contingency factors are straightforwardly deduced. The skills mixture in an organisation reflects the heterogeneity exhibited in the organisation, in its "internal variety". Contingency theorists here refer to task inter-dependence [Dess and Beard, 1984] and its corresponding contingency factor is variety in the environment, the degree of interconnectedness of external variety or heterogeneity. *Environmental Complexity* is another pertinent description, which we adopt here.

Contingency Theorists, such as Donaldson, often see organisational size as a contingency factor in its own right, not as an organisational design factor. In other words size causes *other organisational properties* such as formalisation or bureaucratisation. We take a different perspective. In focusing on military headquarters we acknowledge that the total military forces of a particular nation are a mature (often ancient) organisation with a total size reflecting its periods of growth and contraction over many years of conflict. However, the creation of a standing headquarters, such as at the Joint Operational level, over some shorter period (in a specific extended war or period of heightened operational tempo) reflects the overall capacity of the forces under its command and the range of operations it is charged with overseeing (at its creation or in its foreseeable future). For example, the recently established Headquarters Joint Operations Command (HQJOC) in the Australian Defence Force (ADF) has its size determined fundamentally through two considerations [Leschen, 2007]:

- the number of domestic, regional and global operations undertaken by the ADF, and
- the separation of Raise-Train-Sustain functions from Operations.

The size of an organisation is additionally related to the amount of slack resources (known as munificence by Contingency Theorists [Donaldson, 2001]); however, the anecdotal evidence is that contemporary Coalition militaries are stretched by their current operational commitments. Therefore, the size of a military headquarters is reasonably contingent on the size of operational commitments which in turn is related to the "spread of environmental activity" to which military forces are required to respond.

Contingency Factors for Centralisation

A profound question is: what contingency factor leads to centralisation of decision-making authority, the other dimension of our space, *improving performance in an organisation*? This question is vexed and is clearly clouded by many subjective, political and historical factors. Certainly historical data [Child, 1973] indicates that organisations of larger size show greater decentralisation. However, this is

[9] Donaldson [2001] refers to these positions as, respectively, "Configurationalism" and "Cartesianism".

evidently a consequence of the limitations of supervision as a means of coordination and is compensated for by greater formalisation and standardisation as an implicit means of achieving coordination. Within the Divisional structure, Donaldson [2001] summarises evidence that greater task interdependence leads to greater centralisation. However, the same author points out that the studies supporting such a conclusion are more focused on the organisation from its overall administrative activities (financial, human resources and such decisions) or macro-perspective rather than on the task activities themselves or micro-perspective. At this level, as task uncertainty increases in the face of a highly dynamical environment both task formalisation and centralisation of decision-making are found to be relaxed in organisations. Also, the new factor of modern ICT systems may break the nexus between possible hidden variables intermediate between centralisation and, say, task uncertainty, rendering historical data no longer applicable.

Environmental hostility has also been examined as a contingency factor for centralisation [Khandawalla, 1977]. However, it is unclear whether this actually leads to increasing performance, or simply is a manifestation of leaders becoming defensive, undermining their trust in subordinates and generating organisational rigidity and inflexibility, thereby undermining performance. Clearly, centralisation can also be generated by the personal preferences of the leader. However, as the leader is part of the organisation and not the external environment this would be regarded as inadequate from a contingency theoretic perspective.

On a somewhat sounder basis is the contingency factor known as "public accountability" [Donaldson, 2001] which also empirically correlates positively with centralisation [Pugh et al., 1969]. Whereas private organisations are free to optimise purely internally determined measures such as profitability, public-sector organisations are under greater pressure to comply with various public concerns (for example anti-discrimination, occupational health and safety or environmental standards). High demands of public-accountability on an organisation lead to a higher degree of centralisation of decision-making, basically because one person must answer to the public for failure (or success). What distinguishes this from the factor of leader preference is that the degree of accountability by the public, expressed through the mechanisms of parliaments and government, is not one easily manipulated by the organisation. The political dimensions here are highlighted, for example, by Arambula [2008].

Donaldson [2001] is equivocal as to whether there is empirical support for greater centralisation *increasing performance* in the face of a higher requirement of public accountability. We suggest that, in the context of military organisations, there is an extra dimension to the "environment" that may be missing from existing empirical studies. Military organisations in western democracies ultimately serve a higher national civilian goal which (though part of the strategic level of C2), being outside the military organisation, should be seen as much a part of the "environment" as the adversary. It is useful then to separate the "near environment" (home front, media, political leadership) from the "far environment" (the adversary, other in-theatre non-military entities). Seen in these terms, a failure of public accountability for the military organisation even with military success (for example, a military victory with high civilian casualties generating public furore on the domestic front) legitimately detracts from the performance of the military organisation and can lead to a perception of defeat, as various campaigns in the last forty years have demonstrated. The empirical data reported by Donaldson, being purely business/administrative in nature, does not capture such cases.

We can relate public accountability to a notion of coupling: the tightness of coupling between the near and the far environments. We therefore adopt the factor of *near-far coupling*.

These considerations lead us to the following Organisational - Contingency relationships:

- Skills-diversity ↔ Environmental Complexity.
- Centralisation ↔ Near-Far Coupling (*aka* Public Accountability).
- Organisational Size ↔ Problem Size.

Normal Accident Theory

Some of the environmental variables we have introduced are close to those in Perrow's Normal Accident Theory [Perrow, 1984], which uses tightness of coupling of the components of a system (here, including our environment) and the interactive complexity of its internal structure. Perrow

developed his framework to understand how systems (which could be organisations, such as those regulating nuclear and chemical plants, but also the facilities as environments in which the regulating organisation seeks to exercise control) can exhibit catastrophic behaviours.

For Perrow, interactive complexity relates to opaqueness of the interconnectedness of the system: for a linear system one can oversee and account for all possible connections while for a complex one the chain of connections becomes difficult to track. Certainly complexity is a vexed concept which we do not seek to define here. In [Kalloniatis and Macleod, 2010], by considering a system or environment as a network of components we have argued for a mathematical definition known as Off-Diagonal Complexity [Claussen, 2007]. However, in this paper we persist with qualitative notions of the term.

Coupling in Normal Accident Theory is the strength across the connections in the system (as a global parameter). In turn it is related to the dynamism of the environment: fluctuations in the state of an element in a system with slack/tight coupling will propagate slowly/quickly to adjacent elements. This means that, in the extreme case of a tightly coupled complex system, small perturbations lead to large system wide changes that may manifest in pathological behaviours in unexpected parts of the system.

We need to contrast Perrow's notion of coupling with our near-far coupling: Perrow describes the strengths of interactions *purely within (what we have called) the "far" environment*. Since this coupling generates dynamism in the environment which leads to unpredictability, this becomes a contingency factor for task uncertainty [Dess and Beard, 1984]. Our geometric model in Figure 1 does not include this dimension (but could, in a 4-D model). This implies that the organisational units need to correspondingly reflect dynamism to adjust to changes in the environment. This calls on a greater internal coupling in the organisation – but horizontally not vertically. *This is not the same as centralisation*, which could be seen as a tightness of coupling between an individual and their subordinates (though a central node may be required to trigger an overall internal increase of coupling in the organisation). We therefore need to be cautious in comparing our conclusions to standard statements from Perrow and other Contingency Theorists.

We arrive then at the 3-D model of Figure 3 where, because we have matched the organisational dimensions with those of the environmental contingency space, we are able to map organisations directly into sectors of the cube. Our caution about comparing directly to Perrow [1984], in light of our modified use of his model, relate now to interpreting the significance of the High Near-Far Coupling and High Complexity region in Figure 3. High coupling and complexity is usually the "danger zone" in Perrow's considerations: tightly coupled interactively complex systems are precisely those he deduces are subject to systemic "accidents" that can become catastrophes [Perrow, 1984]. This is *not* identical to the corresponding region of our space which covers both high and low "far couplings". Unfortunately, this is difficult to visualise in the absence of a fourth dimension.

6. Agility for Military Headquarters in the Extended Space

Defining Agility
The NATO C2 Reference Model [NATO SAS-050, 2006] proposes its own "cube model" with the C2 Problem and Approach space. The dimensions it focuses on explore the allocation of decision rights, the allowed interactions among entities and the distribution of information. This model, in reference to agility, elucidates the requirement for agility of a force in the following way:

> Indeed, dynamics across the three fundamental dimensions of C2 Approach and the ability of a particular force to operate differently over time and across function are key indicators of the capacity for agility. In particular, the capacity for adaptation (change in organisation and work process in response to differing conditions in the operating environment) is directly reflected in the range of C2 Approaches a given force is capable of adopting.

We focus on two of the measures of agility presented in the NATO Reference Model:
Adaptiveness: The ability to change work processes and the ability to change the organisation.
Flexibility: The ability to employ multiple ways to succeed and the capacity to move seamlessly between them.

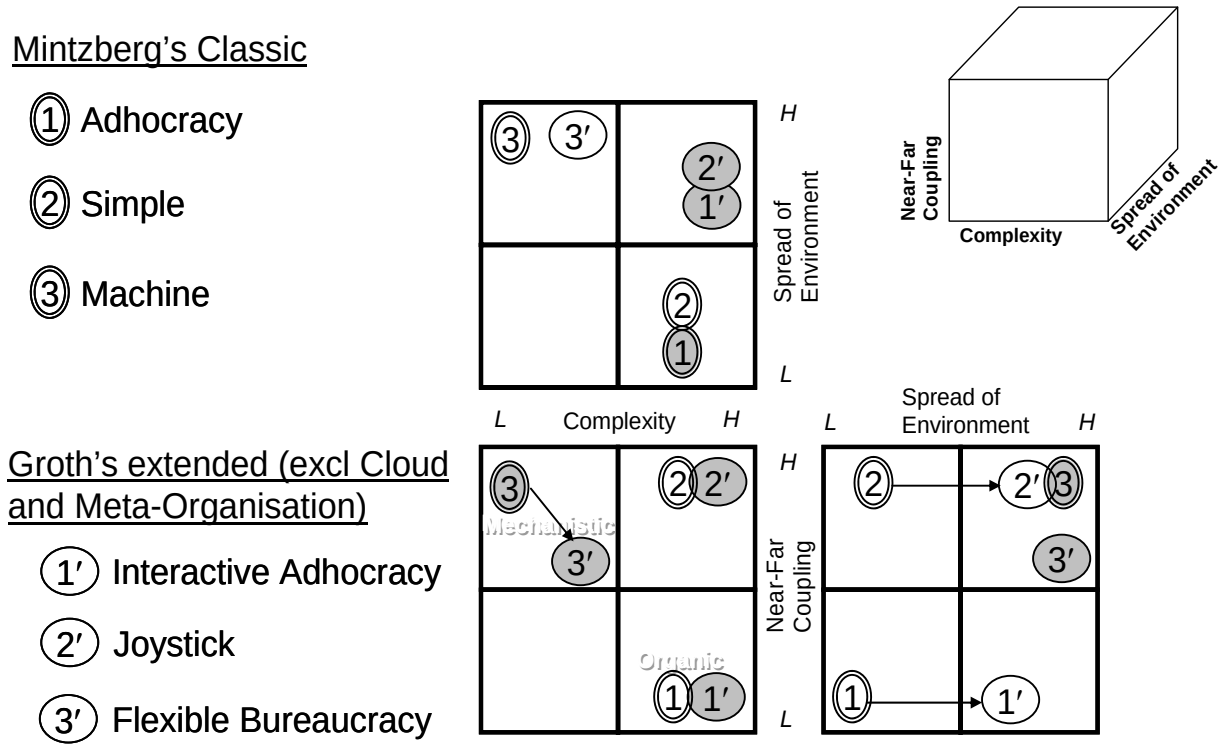

Figure 3 A 3-D model for the space of environmental contingencies. Each region in this space represents a different possible contingency that may confront an organisation. The appropriate organisations, fit for purpose, for the contingencies are placed in the space. Perspectives are as for Figure 1.

Given the Contingency Theoretic determination of environmental circumstances under which the Mintzberg and Groth organisational types are fit-for-purpose, we argue that these two measures of agility and those intrinsic to the types suffice to cover the spectrum of agility. For example, *Innovation*, the ability to do new things and old things in new ways, is intrinsic in the Mintzberg framework to Organic modes of work. In [Kalloniatis et al., 2009] we have reflected on this in light of the Pigeau and McCann [2000] definitions of Command and Control[10]. *Responsiveness*, the ability to react to a change in the environment in a timely manner, is also implicit in the Organic structure – where quick mutual adjustment between team members is the mode of coordination – and also in the ability of an organisation to switch into this mode from working in a more Mechanistic way. Similarly, *Resilience*, the ability to recover from or adjust to misfortune, is similarly reflected in properties of Organic structures.

Therefore agility means that a single headquarters can, in response to different threat contexts, modify itself as a whole or adopt for substructures such as planning teams a variety of different forms fit-for-purpose according to the contingency. In our earlier work we discussed this form of agility with reference to a 2-D model involving Mechanistic and Organic forms. We now extend this to cover Mintzberg's catalogue and then, drawing on the promises of modern ICT, we explore a corresponding future model of agility using Groth's organisational types.

Scenarios with Mintzberg's Types

We have discussed how, seen as a whole, a J-structured military headquarters is a hybrid Machine-Divisional construct. The question now is, in response to specific scenarios, how can one structure those sub-organisations invoked from within the headquarters to develop military responses, and what types of change between these from scenario-to-scenario are possible? As in our previous work [Kalloniatis et al., 2009; Kalloniatis and Macleod, 2010] we focus on a planning team that is responding

[10] Command: the creative expression of human will necessary to accomplish the mission
Control: the creative expression of human will necessary to accomplish the mission
Command and Control: the establishment of common intent to achieve coordinated action

to events to occur in the time frame of from several weeks to a month. We have also simplified the scenarios in order to identify "pure" organisational types, though we agree that intermediate settings of the contingency factors require intermediate form organisations for fitness-for-purpose.

We consider, as a baseline case, the planning by staff in the military headquarters for a UN-endorsed peacekeeping operation in response to a border conflict between adjoining nations. A Joint Task Force is to "keep the peace" between the belligerents by monitoring military movements in the vicinity of a demarcation zone, where we vary:

- the size of the two belligerent forces,
- the complexity of their relationships, history and geography,
- the level of political sensitivity, which correlates with threat level on the spectrum from peacekeeping (Chapter VI, UN Charter), through peace enforcement (so-called "Chapter VI-and-a-half" [Alberts and Hayes, 1995]) to peace imposition (Chapter VII), and
- the completeness of information available to planners in the conduct of their work.

In all cases, there is a need for specialist input into administrative/personnel (J1), logistics (J4), communications systems (J6), civil-military affairs (J9) as well as regular intelligence updates (J2) in collaboration with core-planners (J5). The planning is to determine how peacekeepers should be based and supported in order to verify that belligerent forces vacate the demarcation zone and avoid hostilities. As the planning is initiated, the two sides are in the midst of peace negotiations brokered by the UN. These have progressed far enough that resolutions have been passed, the UN has identified one (or more) nations to contribute to the peacekeeping force and the government(s) has (have) accepted. The strategic level overseeing the headquarters of the respective military forces has in turn requested that planning be completed in 2–4 weeks so that the peacekeepers are prepared to begin their mission on signing of the cease-fire. The time frame fits the Immediate Planning context.

Scenario 1: Here the two rival forces are small and a single troop contributing nation will provide the peacekeepers. One Staff Officer from each specialist J-unit in the headquarters suffices, giving a team of a J1, J2, J4, J5, J6 and J9. The belligerent forces have already agreed to withdraw to their respective isolated bases, removed from civilian populations and sufficiently removed from the disputed border regions. This is treated as a Chapter VI case of the UN charter. However, the border is ambiguous because of the mountainous landscape; this, after all, has generated the long-standing dispute. In turn this means that information on the physical environment and local infrastructure is incomplete and constantly subject to updates, forcing constant revision to the Logistics and Communications and Information System requirements. However, the small team is able to mutually adjust their contributions to the operational concept on-the-fly as the J2 receives and provides situation updates. The J5 is nominally the leader, but the time frame for briefing the Commander is two weeks away, giving scope for detailed negotiations and consensus building between specialists without the J5 having to intervene.
Contingency Factors: Environmental Complexity – High, Near-Far Coupling – Low, Size – Low.
By inspection of Figure 3, the *Adhocracy* is the appropriate model for the Planning Team.

Scenario 2: We now change the previous scenario with the feature that the disputed border region is populated with numerous small villages of mixed ethnicity. This creates concern among all parties for civilian casualties or, even worse, ethnic cleansing by potential paramilitaries on either side, of which there has been a history. This sits in the ambiguous "Chapter VI and-a-half" divide [Alberts and Hayes, 1995]. Correspondingly, Government insists on frequent updates to the plan, heightening the urgency with which interim decisions need to be made and cascading centralisation down the chain of command. Information about villages and local infrastructure is still poor, as in the previous scenario, and subject to frequent revision. The Planning Team again consists of single representatives from the J-branches. However, the J5 Staff Officer, while integrating and constantly adjusting the operational concept as intelligence updates trigger changes to what is logistically and technologically feasible, also exercises greater leadership in arbitrating negotiations, taking on the risk of making decisions when information is poor and informally updating the J5-Head and Commander on progress.
Contingency Factors: Environmental Complexity – High, Near-Far Coupling – High, Size – Low.
From Figure 3, the *Simple Organisation* is the appropriate model for the Planning Team.

Scenario 3: In this scenario the military forces of the belligerents are large, with units located in disparate multiple sites outside of the disputed ambiguous border area that the peacekeepers (from a

single nation) are required to monitor. In this case the belligerents were previously in a long-standing Federation that was dissolved by mutual agreement, with a Commission established to resolve an ambiguity in the border. This Commission has broken down in mutual recriminations, precipitating the present conflict with a brief engagement in hostilities. This places matters beyond the range of Chapter VI operations, in that violence could resume and engulf the joint force. This history means that territory has been well-mapped and reasonable technology infrastructure established. Civilian populations reside in the vicinity of the respective belligerents, creating, as in Scenario 2, concerns about potential casualties if violence resumes. With the larger scale, a number of representatives from each J-unit are drawn together with each given responsibility for refining parts of the plan for different phases of the operation which, in turn, are intricately tied to the separate geographic locations. After an initial briefing by the J2 and scoping, the J5 generates a draft Mission Analysis which is briefed to the Personnel, Logistics and Communications specialists who then separately develop respective subordinate concepts under the direction of the most senior J1, J4, J6 and J9 representatives. These are then briefed back to the J5 before, in a similar sequence, they move on to Courses of Action. At each step, the Commander is briefed and guidance provided.
Contingency Factors: Environmental Complexity – Low, Near-Far Coupling – High, Size – Medium to High.
The *Machine Bureaucracy* is the appropriate model for the Planning Team, as can be seen from Figure 3.

Scenario 4: Again, here, the two belligerents represent large forces that have relocated to a number of bases outside the disputed region. However, in contrast to Scenario 3 but like Scenarios 1 and 2, details of the geography and ethnicity of villages are sketchy. The Planning Team is broken up into several sub-teams of mixed J-specialists, each with a particular geographic zone in the prospective Area of Operations (or this might be teams in a coalition or multi-national headquarters, if time has allowed the standing up of a headquarters function here). After an initial high level planning conference at which areas of responsibility and points of overlap are established, the J5 presents an overall concept to the teams. The separate teams, each with their own J-specialists, separately plan the sub-operations through the traditional sequence of Mission Analysis, and Course of Action Development and Analysis with briefs at each stage. At these points, the states of the plans are compared and finer adjustments made.
Contingency Factors: Environmental Complexity – High, Near-Far Coupling – High, Size – Medium to High.
Though we do not (for readability) place the *Divisional structure* in Figure 3, from the first diagram we can see that this is the appropriate model for the Planners in any one of the national headquarters[11].

Scenario 5: In a break from the previous cases, now we consider that a headquarters is directed by the strategic level to contribute to a *contingency plan* for peacekeeping operations in a generic future complex border dispute scenario but with a coalition partner with which standing relationships exist. The strategic level develops a broad framework that the J-staff (J1, J2, J4, J5, J6, J7, and J9) are to flesh out in generic terms but from the perspective of interoperability of specialist systems with the partner. This entails at least two J-specialists with engagement with respective Liaison Officers. On submission of the various specialist contributions, little detailed "smoothing between the edges" is possible, in the absence of a higher fidelity specific scenario.
Contingency Factors: Environmental Complexity – Medium to High, Near-Far Coupling – Low, Size – Medium. From similar considerations, the *Professional Bureaucracy* is seen to be the appropriate model**.**

Two further comments are warranted here. Many of the work practices implicit to the different organisational types given here match those described for various types of peacekeeping operations by Alberts and Hayes [1995]. We are distilling best practice from long-standing organisational theory in relation to these scenarios, which happily agree with Alberts and Hayes. Also, we have avoided the actual Perrow danger case of tightly coupled (or unstable) and interactively complex far environments. For small sized "problems" with low near-far coupling, we agree with Mintzberg [1979] in recommending the Adhocracy. As the near-far coupling increases, typical when kinetic military force will be employed, we are in the regime where Contingency Theory provides no ideal organisation: the high near-far coupling generally leads to centralisation, namely the Simple Organisation, while the high far coupling (where the force is to be employed) demands decentralisation. When the scale is large matters are worse as the Simple Organisation is no longer

[11] Depending on the diversity of the multi-national force elements, the Planning Team may adopt the structure of one of Mintzberg's Divisional *sub-types* (see [Mintzberg, 1979]).

viable. This is arguably the situation where many Crisis events reside, requiring rapid large scale military response in unstable, hostile environments. We explore in the next section how far modern ICT can solve this, given Groth's extension of Mintzberg's organisational types.

Hindrances to Agility within Mintzberg's Types

The key to our model for agility is that as scenarios that the headquarters confronts change, so too do the organisational types its planning and operations teams should assume. *A headquarters can move its substructures (individual planning teams) through the geometric space of Figure 1.* However, are all parts of the space of Figure 1 as easily accessible from other parts? According to several experimental studies the answer is: no. There exist asymmetries in adaptation paths, labelled "asymmetric adaptability" by Moon et al. [2004]. Similar results have been reported by Leweling and Nissen [2007] between Hierarchical to Edge organisations, to which we return in Section 7. For example, within the 2-D models used previously it appears easier for teams to move from Mechanistic to Organic organisational types. The causes of such asymmetries remain obscure; entrainment theory [Ancona and Chong, 1996], entropy [Johnson et al., 2006, Kalloniatis, 2008], and Weberian cultural factors [Kalloniatis and Macleod, 2010] are some possible explanations. There is earlier evidence of such asymmetries in the Centralisation-Decentralisation [Ellis et al., 2003] and Functional-Divisional directions [Moon et al., 2004]. In later work though, Jundt et al. [2005] argue that these directions are not necessarily independent[12]. Specifically, as argued originally by Burns and Stalker [1961], decision-making authority distribution and functional diversity are typically correlated in real organisations: organisations that centralise are typically also structured functionally. This is consistent with Mintzberg's identification of "pure" configurations (though we argue intermediate states are possible; see our comments above). Implicitly, then, the earlier studies of asymmetric adaptability may not have been constraining behaviours in orthogonal (i.e., independent) directions and are thus in part reflecting the fundamental asymmetry in the Organic to Mechanistic direction.

Assuming these results can be scaled, these considerations in the 2-D space imply a corresponding preference in the transition paths between Mintzberg's types: it is easier for Machine organisations to transition to a Divisional structure than the reverse. In light of the lack of constraint of orthogonal directions in the earlier asymmetry studies, there is arguably weaker impediment to transitions between Adhocracy and Simple structures (for small teams), or between Professional and Divisional organisations (for larger teams).

On this basis, we previously hypothesised [Kalloniatis et al., 2009] that the Centralised-Divisionalised hybrid mode offers an interim, albeit relatively unstable, stage enabling a return to Mechanised structures from an Organic mode of operation. After a task for which an Organic structure is appropriate, a requirement develops for which Mechanistic structures are desirable: a stable problem arises in a complicated but not complex context for which the inefficiencies of the Organic mode are undesirable. The Commander and other senior decision makers become immersed in the details of the planning together with specialists. As we have commented previously, "This is too unstable to be a permanent mode: sustaining central coordination of detailed discussions across all areas of specialisation" [Kalloniatis et al., 2009]. This can be understood better now using Mintzberg's types: for large organisations, beyond the range of the Simple form, there is no Centralised-Divisionalised hybrid type fit-for-purpose. This lack of fitness matches our notion of instability: for a large organisation in an activity sustained over some period of time, either the work will eventually be partitioned and delegated down but subject to later review (leading to the Machine Bureaucracy) or the centralising role will be surrendered (leading to the Divisional form). Whether this is still the case in the presence of enhanced ICT is discussed shortly.

Default Organisational Type within Mintzberg Types

This now raises the question as to what the default type should be given that none is suited to all contingencies and that some transitions are easier than others. Jundt et al. [2005] find support for the hypothesis that "hybrid" teams, neither purely Mechanistic nor Organic, are able to adjust to restructuring better than the pure types. Within Mintzberg's types, this suggests that the Simple Organisation is a preferred mode if high near-far coupling (namely higher degrees of public-

[12] Note that all these authors are also co-authors of the other adaptation studies and affiliated with the same Michigan State, Arizona and Texas A&M University collaboration team.

accountability) is more frequent, as will be the case for military headquarters. However, this is not sustainable for large organisations. For military headquarters, within our construct of *ad hoc* teams drawn together from standing J-structures in the headquarters to develop responses to specific contingencies, this means that if the headquarters is typically expected to respond to large contingencies, the Simple form is not the ideal construct for a default structure.

We return then to the Machine Bureaucracy as the default mode of conducting military business for any large sized team. Adaptation to a Divisional structure, when required by contingencies, is not impeded. Restoration to the Machine form via an adaptation path through a large, but short-lived, Simple Organisation is feasible.

To make this concrete, some of the levers of adaptation can be spelled out, verbatim from our previous work [Kalloniatis et al., 2009]:

- Specifying the number of discrete stages over which planning will be conducted;
- Specifying the intermediate products required in the course of planning: some, none or all of the traditional products, or occasionally novel products outside doctrinal practice may be required;
- Specifying the breakdown in time for stages of planning;
- Specifying the diversity of participants in the stages of planning;
- Specifying the degree to which the participants must work independently or in collaboration; and
- Varying the degree to which the Commander and senior leaders are also involved in the details of planning.

As mentioned in [Kalloniatis and Macleod, 2010], these correspond to the "degrees of formalisation" by Mintzberg [1994].

Scenarios in Groth's Extended Space

We now consider how ICT advances alter the situation in relation to the above scenarios. Beginning with Scenario 1, we deliberately had to choose it as a conflict between small armed forces of the belligerents in order to guarantee a fit-for-purpose organisation. As soon as these belligerent forces become large the Adhocracy ceases to be a viable organisation for planning a peacekeeping operation, typically forcing the adoption of bureaucratic structures. Now Groth offers the Interactive Adhocracy, but with added features. For example, team members may be able to work in geographically separate clusters. Teams may be enlarged by inclusion of planners from a standing deployable task force and from single service headquarters, all contributing from their own sites in small teams but each mutually adjusting through the mediating model rather than explicit communications. In Australia, such capabilities may be realised through the so-called Joint Command Support Environment[13].

Scenario 2 similarly was limited to small scale but now potentially lethal operations. Increasing the size of the operation will at some point overwhelm the lead J5 planner in trying to adjudicate on multiple complex discussions. Groth's Joystick Organisation offers the prospect of the lead planner, the J5 Head or even the Commander, maintaining control of the planning without necessarily disconnecting from the detail. Dispersion of some planning contributors, as above, may no longer be an impediment.

In Scenario 3 the complexity, namely the "opaqueness", of the environment was chosen to be low – geography was well-mapped and local infrastructure established as a consequence of the Federated history of the belligerents. As the complexity here is increased, the stovepipes of the traditional Machine Bureaucracy will lead to information dislocation and time delays. We cease to have a viable fit type. Groth's Flexible Bureaucracy has the capacity to cope with some degree of this increased complexity. This means that a reasonable degree of interaction between J-specialists can be achieved without bringing them together through the entire planning process.

Scenario 4 need not change, as Groth sees ICT only enhancing centralisation of the Divisional form, suggesting that higher threat levels, with corresponding higher near-far coupling, could be managed.

[13]See: http://www.defence.gov.au/dmo/esd/jp2030/jp2030ph8.cfm

Similarly, Groth sees ICT offering little more to the Professional Bureaucracy so that Scenario 5 may remain unchanged.

We thus see at least three of Groth's types are feasible within a military headquarters construct. What about transitions between these types as contingencies change? Now the technology presents a considerable problem. As Groth points out, within any one of these organisational types considerable flexibility in the conduct of work is achievable. But flexibility outside these modes is extremely difficult: the "hard-wiring" and "canning of complex processes" [Groth, 1999] implicit in the ICT based coordination mechanisms is only a consequence of complex, long and laborious engineering that, once done, is not easily undone *unless adaptability between organisational modes is part of the engineering specification of the ICT systems.* We return to this significant point in the concluding section.

If the technology hurdle can be overcome, there remains the human-centric problem partly reflected in the adaptation asymmetries. Again, it may be possible to engineer the technology to overcome such asymmetries. In the absence of such foresight, by extrapolation we would anticipate asymmetries between some of Groth's types. In particular, the Flexible Bureaucracy may more easily adapt to the Interactive Adhocracy rather than the reverse, while the Joystick Organisation may offer an intermediate path back to the Flexible Bureaucracy.

We concluded earlier that among traditional forms the Machine Bureaucracy is the appropriate default organisational setup of military planning teams in a J-structured headquarters. By extension here, in the presence of future ICT the corresponding type would be the Flexible Bureaucracy. Indeed, we may go one step further. In its capacity to enable centralisation while coping with greater internal variety in the way that specialists interact, the Flexible Bureaucracy may be the happy medium for a broader variety of military planning scenarios with only an occasional need to assume the more extreme forms of Interactive Adhocracy or Joystick Organisation.

7. Comparison to the Edge

We come now to the position of the Edge organisation [Alberts and Hayes, 2003; 2006; 2007] in relation to Groth's extended organisational types. The Edge and the Interactive Adhocracy are both peer-to-peer structures that rely on collective knowledge and collaboration with great freedom of interaction among competent professionals with a mix of skills, who have a shared understanding of mission/project goals, shared situational awareness and achieve self-synchronisation (mutual adjustment) in their endeavours. As organisations, the Edge and Interactive Adhocracy both strive to seek creative solutions to relatively challenging problems, sacrificing efficiency with well-understood run-of-the-mill problems for agility and effectiveness in complex and dynamic environments. Both rely on use of ICT to reduce the need for extensive interpersonal communication and to allow remaining communications to potentially be asynchronous in time and space.

One possible difference between the Edge and Interactive Adhocracy is the degree and manner in which they exploit mediating models to promote implicit coordination. Groth gives as an example the use of 3-D CAD/CAM systems to underpin implicit coordination between design teams working on different aspects of the Boeing 777. Such systems have evolved over many years of experience working with assemblies of 3-D parts, helping to identify potential conflicts in occupancy of 3-D space. While the advent of new concepts, technologies, materials and sub-systems provides new opportunities for creativity in addressing competitive challenges in aircraft design, the CAD/CAM system still acts as an overall mediating model. To the extent that the Edge organisation is intended to cope with novel and evolving situations, we might expect to see implicit coordination facilitated via a *suite* of mediating models that address relatively distinct aspects of the problem domain (such as strategic lift and dynamic provisioning of communications infrastructure) rather than having a single mediating model playing a similar role to a 3-D CAD/CAM system. In this respect, we can see the Edge organisation as lying towards Groth's Interactive Adhocracy on a trajectory from Mintzberg's simple Adhocracy.

An additional distinction can be seen between Groth and Edge proponents in the degree to which ICT support is capable of enhancing knowledge sharing, collaboration and synchronisation. Edge proponents place considerable store in the potential for technology to underpin smart push/smart

pull knowledge management and sharing. Groth has a more-cautious assessment; he sees limitations in various human capabilities as setting bounds on possible enhancements to the Adhocracy without support from a sophisticated mediating model embodying a deep understanding of the problem domain.

Comparisons between the Edge and Contingency Theoretic organisational types have, however, been conducted in the C2 literature. For example, Nissen [2007] presents a relatively comprehensive overview of Contingency Theory in comparison to C2 research. More impressive is his summary of research in using Computational Organisational Modelling to quantitatively compare the Mintzberg types against a variety of mission scenarios. These studies include comparisons with the Edge organisation [Gateau et al., 2007]. For example, pitted against a "Cold War" scenario the Machine Organisation achieves a reasonable balance between speed and accuracy over the other types. For a "Global War on Terror" (GWOT) scenario, the Machine Organisation fares poorly while the Edge fares best. (A similar result is obtained by Dekker [2007] by comparing agents networked via regular and randomly re-wired tree graphs solving certain decomposable and non-decomposable problems in Number Theory.)

What is surprising is that the Adhocracy in Nissen's work achieves both the slowest time and a quite high error rate for the GWOT scenario. In the parameter settings of Nissen's computational model [Nissen, 2007, Table 4] there is little to distinguish the Edge and the Adhocracy except for parameters related to "Experience": the Adhocracy has these set to Low while the Edge is set to Medium. The setting for the Adhocracy is in conflict with Mintzberg's description [1994, p398] – "Adhocracy Organisation: Organised to carry out *expert* work in highly dynamical settings, where the *experts* must work cooperatively in project teams, coordinating the activity by mutual adjustment" (our italics). Nor can the poor rating assigned to the Adhocracy be related to its lack of ICT enhancement, given that the ICT systems of the model organisations are not explicitly represented in such computational models.

8. Discussion and Conclusions

In addition to "complex endeavours" [Alberts and Hayes, 2007], much of the planning conducted in a modern military HQ relates to diverse operations, such as peacekeeping and disaster relief, that are relatively well understood and towards the lower end of the threat spectrum. Planning for each operation is best conducted with planning teams whose structure matches the nature of the contingency, requiring organisational agility on the part of the overall headquarters.

In application to military headquarters we have exploited Groth's analysis of the extension by ICT of the domain of suitability of several of Mintzberg's [1979] organisational types, meaning that the evolved types can retain some of the advantages of small and simple organisations while coping with problems of substantial scale and complexity. In confronting challenges where the situation is fluid and uncertain, the Interactive Adhocracy remains viable beyond the limited team size possible with the Adhocracy. Similarly, in situations where consensus decision-making is not appropriate, the Joystick Organisation retains the benefits of centralised control while allowing for an increase in team size over that possible with the Simple Organisation. In situations where efficiency is an important consideration, the Flexible Bureaucracy helps overcome problems with information flow between stovepipes in the Machine Bureaucracy. Applying this to the military planning context, these three evolved organisational types match distinct sets of contingency factors all of which are relevant to military forces of the 21st Century. Moreover, considerations of possible adaptation asymmetries suggest that the Flexible Bureaucracy offers a happy medium, enabling adaptation to more extreme forms when contingencies require and restoration back. This is of course contingent on technologists enabling the enhanced ICT systems to be as flexible as their human users. Taken to its full conclusion, our analysis suggests that flexibility between types should be one of the requirements for the engineering of such systems of the future. Indeed, the absence of such requirements may lead to technology that shackles the flexibility that unassisted human staff officers might otherwise achieve.

Finally, we observe that Edge-like organisations planning for missions in dynamic and uncertain contexts will resemble Groth's Interactive Adhocracy. In the military context, an adversary may well seek to use surprise to exploit inertia and lack of preparedness. Thus, because of the extent of possible prior experience with and analysis of the problem domain, there will be differences in the degree to

which sophisticated ICT systems can support mutual adjustment (self-synchronisation) with the Edge versus the Interactive Adhocracy. However, reliance on such support systems has a potential downside. They can suppress creativity if they are too rigid or fail to incorporate the "requisite variety" to accommodate the complexity of the problem domain. The ongoing challenge with the Edge and the Interactive Adhocracy, as indeed with all ICT-enabled organisation types, is to find an appropriate blend of human creativity and flexibility and automated support.

9. References

Alberts, D.S. and Hayes R.E. [1995], *Command Arrangements for Peace Operations*, CCRP.

Alberts, D. S., and Hayes, R. E. [2003], *Power to the Edge: Command and Control in the Information Age*, CCRP.

Alberts, D. S., and Hayes, R. E. [2006], *Understanding Command and Control*, CCRP.

Alberts, D.S., and Hayes, R.E. [2007], *Planning: Complex Endeavours*, CCRP.

Ancona, D. and Chong, C. [1996], Entrainment: Pace, cycle and rhythm in organizational behaviour, in *Research in Organizational Behaviour*, L.L. Cummings & B.M. Staw (Eds.), **18**, pp251–84, JAI Press, Greenwich, CT.

Arambula, H. [2008], Managerial Discretion for Public Managers and Managerial Autonomy in the Accountability for Performance in Public Organizations: A Review and Research Agenda, *EGPA Conference 2008, Study Group on Governance of Public Sector Organizations*, Rotterdam, The Netherlands.

Ashby, W. [1957], *An Introduction to Cybernetics*, Chapman-Hall.

Burns, T. and Stalker, G.M. [1961], *The Management of Innovation*, Tavistock, London, UK.

Child, J. [1973], Parkinson's Progress: Accounting for the Number of Specialists in Organizations, Administrative Science Quarterly, **18**, pp328–48.

Claussen, Jens. [2007], Off-diagonal complexity: a computationally quick complexity measure for graphs and networks, *Physica A,* **375**, pp365–73.

Dekker, A.H. [2007], Using Tree Rewiring to Study "Edge" Organisations for C2. Proceedings of SimTecT 2007, pp83–88, ISBN: 0-9775257-2-4, Simulation Industry Association of Australia, 4–7 June, Brisbane, Australia.

Dess, G.G. and Beard, D.W. [1984], Dimensions of Organizational Task Environments, Administrative Science Quarterly, **29**, pp52–73.

Donaldson, L. [2001], *The Contingency Theory of Organizations*, London: Sage Publications.

Ellis, A., et al. [2003], The asymmetric nature of structural changes in command and control teams: The impact of centralizing and decentralizing on group outcomes, *8th ICCRTS*.

Gateau, J.B., et al. [2007], Hypothesis testing of edge organizations: Modeling the C2 organizational design space, *12th ICCRTS.*

Groth, L. [1999], *Future Organizational Design: The Scope for the IT-Based Enterprise*, New York: John Wiley & Sons.

Hollenbeck, J., et al. [2002], Structural contingency theory and individual differences: Examination of external in internal person-team fit, *J. Applied Psychology*, **87**, pp599–606.

Johnson, M., et al. [2006], Cutthroat Cooperation: Asymmetrical Adaptation to changes in team reward structures, *Academy of Management Journal*, **49**, pp103–19.

Jundt, D., et al. [2005], The impact of hybrid team structures on performance and adaptation: Beyond mechanistic and organic prototypes, 19th Annual Conference of the Society of Industrial and Organizational Psychology, Los Angeles, CA.

Kalloniatis, A. [2008], Organisations, C2-Entropy and Military Command, *13th ICCRTS.*

Kalloniatis, A., et al. [2009], Bounding Wicked Problems: The C2 of Military Planning, *14th ICCRTS.*

Kalloniatis, A. and Macleod, I.D.G. [2010], Formalisation and Agility in Military Headquarters Planning, International C2 Journal**, 4**, 1, pp1–41, 2010.

Khandawalla, P.N. [1977], *The Design of Organizations*, Harcourt Brace Jovanovich, NY.

Leschen, Peter CDRE. [2007], Challenging tomorrow's leaders today, interview in *Defence Magazine* (Australia), May/June.

Leweling, T., and Nissen, M. [2007], Hypothesis testing of Edge organizations: Laboratory experimentation using the ELICIT multiplayer intelligence game. *12th ICCRTS.*

Mintzberg, H. [1979], *The Structuring of Organizations: A Synthesis of the Research*, Englewood Cliffs, NJ: Prentice Hall.

Mintzberg, H. [1994], *The Rise and Fall of Strategic Planning*, Prentice Hall, UK.

Moon, H. et al. [2004], Asymmetric adaptability: Dynamic team structures as one-way streets, *Academy of Management Journal*, **47**, pp681–95.

NATO SAS-050 [2006], *Exploring New Command and Control Concepts and Capabilities.*

Nissen, M. E. [2007], Enterprise Command, Control, and Design: Bridging C2 Practice and CT Research, International C2 Journal, **1**, 1, pp61–112.

Perrow, C. [1984], *Normal Accidents: Living with High-Risk Technology.* New York: Basic Books.

Pigeau, R., and McCann, C. [2000], "Redefining Command and Control", Chapter 12 (pp163–84) in *The Human in Command,* Pigeau, R. and McCann, C (Eds.) Kluwer Academic/Plenum.

Pugh, D.S. et al. [1969], An Empirical Taxonomy of Structures of Work Organizations, Administrative Science Quarterly, **14**, pp115–26.

Smith, General Sir Rupert [2005], *The Utility of Force: The Art of War in the Modern World.* London: Allen Lane (Penguin).