

The Concept of C2 as a Capability

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Abstract

The UK Joint Concept Note 2/17: Future of Command and Control (C2) argued for the need to treat C2 as a more holistic capability and to develop it as “a dynamic and adaptive socio-technical system”. Whilst there has been an acceptance of these ideas since the publication of the JCN in 2017, initiatives to develop C2 as a capability have been slow to appear. This may be due to disagreements or misunderstandings about the nature of C2 or that Defence has historically focussed on improving technical systems. Equally it is possible that an impediment to change is a lack of common understanding of what the original “C2 as a capability” concept entailed. This paper therefore seeks to address this issue by discussing: (i) how C2 capability is currently developed; (ii) the distinction between design and emergence; and (iii) some of the challenges that need to be address by to improve C2 capability development. In summary, it seeks to stimulate discussion and, ultimately, agreement about what “C2 as a capability” means and entails as a step towards improving C2 capability development.

Keywords: Command and Control, military capability, capability development, design, emergence.

1 INTRODUCTION

Before we consider the nature of C2 capability it is necessary to explore the broader defence concept of military capability, including how it has changed over the last 25 years and more. The starting point for reviewing the evolution of this concept considered in this paper is the UK MOD Smart Procurement and Acquisition Organisation Review [1] (AOR), conducted in 1997. During one of the workshops conducted as part of this review, the then UK Chief of Defence Procurement (CDP) presented his personal views on the nature of capability. As the precise nature of the concept he was explaining remained somewhat unclear, questions were posed as to (i) who was responsible for deciding on required capabilities and (ii) who was responsible for ensuring that all necessary changes across the Defence Lines of Development (DLODs)¹ would be enacted to create any desired and intended capability. In response to these questions CDP said that the organization he led, the Procurement Executive (PE) – now Defence Equipment and Services (DE&S), was only responsible for delivering equipment. The rationale for this view was that the PE only had direct influence over this particular DLOD component and thus other parts were outside of its

remit. Whilst reasonable in terms of conveying the bounds of an organisation’s authority and responsibility, this response highlighted a persistent confusion that has existed within the defence sector between “equipment” and “capability”. Associated with this has been a general lack of clear understanding of who is responsible for capability development and sustainment. These deficits have been particularly damaging for C2, given its human-centric nature, and because its development is dependent on coherent improvement-centred activities being undertaken across multiple DLODs.

The equipment-centric perspective conveyed by CDP in 1997 continued until at least 2003, when an early definition of UK MOD capability can be found: “The capacity afforded by an equipment to a unit or force element to perform a task in a given environment or operational context” [2]. Subsequently, MOD added to this definition the need for through-life capability management, with the then Director of Strategy for the Defence Logistics Organisation (DLO) noting that MOD “has encouraged industry to focus on selling a product, not on sustaining a capability through its life” [3]. This elaboration started to broaden the concept of capability development and the need for a “whole-system outlook taking an integrated approach to delivering all of the components of military capability not just the equipment” [4].

¹ Training, Equipment, Personnel, Information, Doctrine and Concepts, Organisation, Infrastructure, Logistics, and Interoperability.

More recent definitions of capability have also been difficult to find, but a 2020 UK National Audit Office report on defence capability described it as follows: “The Ministry of Defence (the Department) develops and operates military capabilities in order to meet its strategic requirements and objectives. A military capability is not simply a piece of equipment such as a tank. Rather, it is a tank with a trained crew that: can communicate with others on the battlefield; can meet identified threats; and can be properly maintained and repaired during its lifetime.”[5]

This brief history shows that since the discussion with CDP in 1997 there has been a gradual shift towards a view that defence capability development should take a more holistic approach. However, despite these improvements, there is still no definitive and authoritative description of military capability that covers the need to treat capability in a holistic manner. Such a statement would provide a stable reference point for C2 capability development, as well as many others. Because of this deficit, the UK Joint Concept Note on the Future of C2 [6] published in 2017 (JCN 2/17) explained the problem that was created in the context of C2, noting that: “Technology alone will not deliver the capability leap we need. As a socio-technical system, this will require planned change in the whole of our C2 system – people, processes, structures and technology – if it is to be match fit for the information age and able to exploit the cognitive advantages of both human and machine. This change will need to be led across organisational, environmental and capability programme boundaries. This needs C2 to be treated as a capability in its own right and delivered in a programmatic way, with a clear Defence lead responsible and accountable for the change.”

More recent defence publications have also been helpful in conveying similar ideas. For example, a MOD guide from 2020 states: “There are a number of factors that the Military Commands must consider when making decisions on Military Capability. These factors combined are known as the Defence Lines of Development (DLODs) and are used to ensure that an integrated, secure and comprehensive Military Capability is delivered.”[7]. Similarly, an early version of the Target Operating Model [8] discussed the concept of pan-DLOD coherence and Joint Service Publication (JSP) 906 [9] refers to the need for capability management to be underpinned by systems thinking and a defence systems approach to change management.

2 CONSEQUENCES FOR C2 CAPABILITY DEVELOPMENT

The constrained views of the nature of capability just

discussed historically influenced the structuring of defence procurement and capability management organisations, and in so doing, amplified problems associated with C2 capability development. Specifically, and aligned with the CADMID² process and the development of equipment capability, UK MOD created organisations with responsibility for end-to-end development and delivery of equipment (not capability) programmes. One of these focused on Command, Control, Computers and Communications (C4) programmes, and tended to constrain itself to the development of information technology and infrastructure (i.e. computers and communications). Very little attention was given to the broader capability of command and control. This equipment-centricity obviated the need for Defence to decide who should be responsible for the C2 aspects of a wider C4 capability. A clear statement of policy and intent is therefore needed to ensure that the pan-DLOD coherency described in recent guidance is achieved. JCN 2/17 noted that this need for coherency creates another challenge, given that responsibilities for DLOD elements are dispersed across many parts of the defence enterprise. The challenge is that no individual has the authority to address the coherency issues, except at a very senior level; one which is inappropriate for management of an individual capability. There is also the issue of practicality, in that a single authority is unlikely to have the capacity and expertise to manage (or govern) capability development across the entirety of the defence enterprise, especially as C2 practices (and associated capability needs) vary dependent on operating environments (Air, Land, Maritime, Space, Joint, Cyber and Electromagnetic). A more practical approach might be a federated approach to capability management, but this also comes with its own challenges in terms of coordinating the efforts across a federation of what may sometimes be conflicting ideas, priorities and interests. Similar issues will apply to C2 in its broader and more generic form, i.e. when considering capability management to enable improved alignment and interoperation of capability with national and international partners and allies. So to sum up, this may itself be an example of a wicked problem in that there is no obvious silver bullet solution, and all solutions come with potential negative consequences which would need to be mitigated.

3 CAPABILITY DEVELOPMENT – INAPPROPRIATE APPROACHES FOR C2

² Concept, Assessment, Demonstration, Manufacture, In-service and Disposal / Termination (CADMID/T) [10]

Another significant problem for C2 capability is the nature of the traditional and typical defence approach to capability development. That is, there is a strong connection between the concept of systems, requirements and a ‘lifecycle’ approach. In UK MOD, given its historic equipment focus, capability development has tended to employ a variant of CADMID (an instance of the traditional ‘waterfall model’³) that was designed for equipment development where clear, stable and standardised requirements could be written. Two implications of applying a CADMID-like approach to C2 capability are discussed below.

The first implication relates to a recognition within MOD of the need for alternative approaches, as discussed in a recent review of responses to the UK House of Commons Defence Committee. Specifically, the MOD has now promoted the Integrated Procurement Model [13] which proposes a policy of “Spiral by default to drive pace” and “a cultural shift to put greater value on pace”. However, there are some potential differences of perspective on the purpose and benefits of taking this more evolutionary (or spiral) approach. In the context of C2, a primary benefit is the ability to constantly monitor and take account of the impact of technical system changes on the “socio” aspects, and consider the effectiveness of the overall capability. That is, asking whether the capability is being improved, enhanced or degraded by the imparted changes. There are techniques that can be used within such an evolutionary approach to help guide development, for example combining research and improvement, frequently referred to as action research [14]. In contrast to this perspective, the perceived benefit of evolutionary-type lifecycles implied in recent defence publications, such as that on integrated procurement, appears to be that of more rapid technology development and acquisition. Whilst this is one of many potential benefits, it is not the most helpful for C2 capability, given that rapid development and insertion of technology might have negative effects if human and organizational factors are not sufficiently understood and taken account of in design and implementation.

The second implication is that, historically, CADMID has insufficiently explained the need for, and the ways to, consider pan-DLOD issues. This situation has improved recently, and there is now more guidance available. For example, a MOD “How to guide” [15] states that its purpose is to “ensure that the Defence Line of

Development (DLOD) projects within a programme form a coherent set” and that key dependencies and assumptions are identified. This includes the identification of combinations of viable DLOD changes to collectively enable the achievement of programme objectives and to fill a capability gap. Despite the availability of this new guidance, experience suggests that for C2 capability, it is typically not followed, perhaps through lack of awareness and/or understanding of how to put it into practice. In addition, there is a tendency for such guidance to be written from a “hard-systems” engineering perspective. Consequently, broader matters, such as organisational change management which are important for strongly socio-technical systems such as C2, receive insufficient attention.

4 CAPABILITY – DESIGN VERSUS EMERGENCE

Figure 1 highlights the importance of a pan-DLOD⁴ approach and introduces the distinction between the design and emergence of capability⁵. To allow emergence a different type of design is needed based on flexibility, constraints and purposefully leaving some options open⁶.

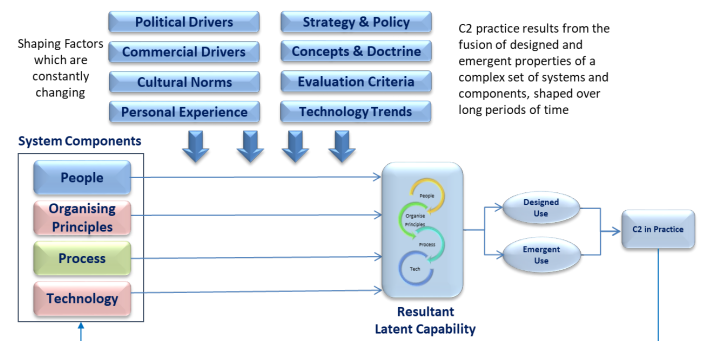


Figure 1: Evolution of C2 Capability

There are two points to consider. Firstly, with a typical systems engineering approach, it is assumed that well-defined requirements enable the design and

⁴ Simplified here to just four components: people, organizing principles, process and technology.

⁵ “Emergence is the production of global patterns of behaviour by agents in a complex system interacting according to their own local rules of behaviour, without intending the global patterns of behaviour that come about. In emergence, global patterns cannot be predicted from the local rules of behaviour that produce them. To put it another way, global patterns cannot be reduced to individual behaviour”[16].

⁶ This is based on the concept of ‘enabling constraints’ which positively contribute to coherency, emergence and innovation. “It is important to reiterate that, in complexity theory, individuals matter; they are not pawns of collectives. Their actions matter; they are not simply reactions to external stimuli. Their behavior is in-formed by the self-organized dynamics that define them. That said, it is the workings of enabling and constitutive constraints—among individual entities, processes, and actions—that generate novel properties. [17]”

³ Apparently misattributed to Royce, as contrary to received wisdom on who said what about the waterfall model, elements of it can be found in earlier papers from Benington and Hosier, and Royce proposed an iterative approach [11,12].

delivery of a capability that gives predictable outcomes. This approach works for well-understood engineering systems that have clear and bounded requirements. However, to build a capability (such as C2) that needs to deal with diversity, complexity and the evolving nature of the operating environment, the capability must be built with adaptability, agility and resilience in mind so that it can cope with diversity [18] and unpredictability. For C2, the adaptive agents are individuals and collectives (teams, organisations and enterprises). Because of the adaptive nature of this class of system⁷, the interplay between people, ways of organizing, processes, and technology is not predictable, and therefore neither requirements nor designed features can ever be fully anticipated. This leads onto a second consideration: one of how to deal with complexity in the operating environment.

Complexity is the subject of DCDC Concept Information Note (CIN) 1 [20], which argues that a fully defined and predictable system for the entirety of defence C2 capability would be undesirable. Instead, many parts of our C2 capability need to remain undefined, to provide freedom to be adaptive, agile, and resilient⁸ to cope with increasingly dynamic and changing operating environments. At multiple organisational scales (enterprise, organisation, team, individual) we need to understand how best to exploit feedback to remain effective in the face of constantly shifting imperatives from the operating environment, which will also include changes required to respond to the actions of allies, neutral actors and adversaries. Such ideas are not new – they can be traced back to at least 2007⁹ – but they have, so far, not been implemented. Another way of looking at adaptation is to consider it from the perspective of emergence¹⁰, as much C2 practice will come about through a process of emergence at the point of use. With reference to CIN 1 on complexity, emergence is itself a property of a complex system and C2 capability is, similarly, a complex adaptive (socio-technical) system. Emergence comes about through the uncontrollable interactions between components of the C2 system (simplified in Figure 1 to People, Organising Principles, Process and Technology). What emerges from such a

system can range from extremely detrimental to highly beneficial; in each case monitoring performance is important from a learning perspective and to provide evidence for future capability development¹¹. These two considerations indicate that balance is needed between design and emergence when building a C2 capability. There is only so much that can be designed; the rest will emerge in the moment due to humans interacting amongst themselves [23] and with the other system components (and in future perhaps with more adaptable technology driven by AI). However, what is designed will enable and constrain that which can emerge, so considerable care is still required with design. In addition, components of a C2 capability are not static. They are shaped by internal drivers (designed or un-designed) and by external drivers (e.g. adversary action) which the defence enterprise does not control. Shaping by internal and external drivers will also occur over longer periods (even decades), with unpredictable results. As examples, personal experiences can be both a limiting and an enabling factor. Equally, the culture, values and norms of an organisation can shape and limit its people.

One final issue to consider is the freedom of defence C2 to be adaptive. If one considers an arc, where left of arc is a fully constrained system, and right of arc is one with total freedom and flexibility, neither extreme is desirable as one side is completely fixed and the other would tend towards chaos and anarchy. The key question is: how far to the right of arc does an adaptive C2 system need to go and how far can it go, given the current constraints of defence organisations? The further one moves to the right, the more likely it is that new challenges will emerge (e.g. adverse human behaviours and an inability to cope with the degree of internal dynamism and variety). If there is too much freedom, for example, even ethical and legislative boundaries may be crossed. A balance should be struck between how much adaptability is needed, and how much can be permitted. As noted above, constraints can also be a necessary enabler rather than a barrier to emergence and innovation [24].

The consequence of capability shaping and driving activities is shown in Figure 1 as “resultant latent capability”, i.e. something which is brimming with potential but may also be hamstrung with limitations. When the point of use is reached, design and emergence will likely re-appear. That is, C2 practitioners will design a ‘system’ that is a reasonable first approximation for what is required for anticipated operational circumstances, knowing that some C2 capability aspects will emerge in

⁷ Note the more general use of the word “system”; this is not a reference to collections of technology [19].

⁸ As long as the staff are educated, trained and experienced in how to best exploit this freedom.

⁹ “Moreover, we will argue that the issue is not about designing a networked force on paper, and then going about an implementation plan of connecting the bits, but rather of employing a truly evolutionary process of force integration supported by iterative concept development, experimentation and evaluation, so that the capability grows in a coherent and cost-effective way” [21].

¹⁰ See earlier footnote explaining emergence.

¹¹ Such as workarounds: “We should see workarounds as valuable feedback, rather than turning a blind eye” [22].

an adaptive manner from the interaction between its components. Over time, the observed C2 will be the result of design and both long-running and nearer-term emergence phenomena. However, current C2 practices have probably emerged and evolved more by default than by design.

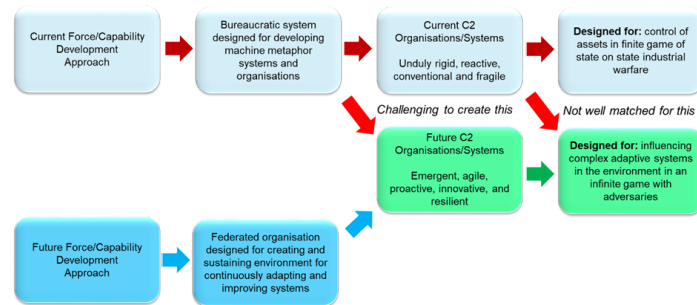


Figure 2: Alternative approaches for C2 capability development

Thus, the central argument of this paper is that designing C2 capability, to purposefully influence both intentional and emergent aspects, would be more beneficial than current approaches. Defence's capability development thinking and processes are not currently configured for such an approach, as illuminated by Figure 2 above, but new thinking related to procurement is encouraging. For example, the Integrated Procurement Model [25] referred to earlier advocates: "Delivering a minimum deployable capability quickly, and then iterating it in the light of experience and advances in technology – rather than waiting for a 100% solution that may be too late and out of date."

In conclusion, the challenges described in this paper may explain, in part, why building, managing and governing C2 as a Capability has proved so difficult. We should also not expect that a complex, multi-faceted, dynamic and adaptive capability such as C2 can be successfully handled by traditional, slow, complicated and overly bureaucratic management approaches (again see Figure 2). It is worth noting that this problem is not unique to one nation – many allied nations have experienced similar barriers to progress in improving their C2 capability¹².

5 SUMMARY

This note has discussed some of the factors that have impacted UK Defence's ability to progress the concept of 'C2 as a Capability' that was introduced over seven years

ago in JCN 2/17. These, and related ideas for enhancing the development of C2 as a complex socio-technical capability, are summarized under five interconnected themes below. This summary also implicitly includes ideas on how to transition C2 as a Capability from a concept to a routine business activity.

- **Think holistically.** C2 should be viewed as a holistic capability by Defence rather than a group of individual components and activities. This requires Defence to address the different elements that constitute C2, spanning the DLODs and including people, enterprises and organising principles, processes, and technology. It should change how C2 capability is developed to ensure the effectiveness of the whole anticipates and responds to future needs.
- **Leadership.** A Defence lead is required, who is responsible and accountable for long-term continuous improvement. This will be challenging, as making coherent changes at pace across the DLOD will require crossing of organisational, domain and capability programme boundaries. It will also require judicious exploitation of socio-technical developments from academia, industry and the defence science communities. However, a single authority is unlikely to be able to direct the management (or governance) of C2 capability across the entirety of the defence enterprise, not least because C2 practice varies dependent on the environment in which it is operating, and across the different partners and allies with whom one is working. Therefore, a more federated approach to capability management may be required.
- **Continuous Development at Pace.** C2 does not operate in a vacuum so the capability needs to be adapted in response to emerging opportunities, risks, issues and threats, at a more appropriate pace, relative to changes within Defence and within the operating environment. C2 thus requires a continuous improvement approach rather than a one-off 'change programme'. The importance of C2 means there is an imperative for Defence to encourage and drive capability change faster than current practices allow.
- **Balanced Investment.** Adopting a holistic approach to C2 capability development entails the need for more balanced efforts and investments across all DLOD, rather than

¹² NATO Research in the HFM Exploratory Team 184, "C2 Capability Lifecycle Management", identified challenges under the themes of: Limited Ability to Evaluate C2 Capability, Limited Ability to Manage C2 Capability, Challenge of C2 Development, Resistance to Change and Lack of Organisational Learning [26]. A follow-on Research Task Group (HFM RTG342) will report additional findings.

continuing with the historic focus on technology/equipment. Investment in new or improved technology is still important, but the benefits need to be weighed against those accruing from investing in other DLOD.

- **Bespoke models for capability development.** There is a need to move from linear lifecycle models (such as CADMID) to a more continuous development model for C2, exploiting as much as is possible of the new MOD guidance, which includes making iterative approaches to capability development the default. This should address some of the pace of change issues noted above but will require new processes, a culture shift, and development of skills to enable building of C2 capability in a way that exploits and balances both design and emergence and addresses the socio-technical nature of C2.

To conclude, the intention of this paper was not to provide an exhaustive list of challenges associated with adoption of the C2 as a Capability concept, nor to enumerate all the mitigations that may be required. Instead, it should be viewed as an initial primer for those with responsibility for developing C2 capability.

Note: This paper is an adaptation and expansion of a DCDC Concept Information Note [27] on the same subject which was published by DCDC in early 2024 as a precursor to a full UK Joint Concept Note being published on the Future of C2.

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