

Linking Leadership Theory to C2 Theory: Enriching C2 approach space and OODA loop

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Abstract:

In military doctrine, leadership is the first of three interrelated aspects of C2. Leadership is a social process by which the leader influences a group of people to achieve a common goal. Initially, leadership theory focused on the leader's physical and intellectual traits. Thereafter, research widened to investigate the leader's behaviour, the situation's demands, what needs the leader meets, the interaction between leaders and followers, and how leadership and followership evolved.

Despite its importance in military doctrine, leadership is hardly mentioned in the literature on C2 theory. C2 theory covers the other two aspects of command: decision making and control. Decision making is the cognitive process of selecting a course of action from a set of alternatives, relying on intuition and good judgement based on awareness and intelligent understanding of the situation. Control is the coordination of activity, often delegated to specialist staff. A significant proportion of the C2 literature is taken up with what the commander needs to make decisions, the process of making decisions, the quality of such decisions, and how the decision is communicated.

The purpose of this paper is to show that applying selected ideas from leadership theory can enrich C2 theory, viewed as command arrangements, command, and command support systems. The paper reviews the relevant theory, both on C2 and on leadership. Two illustrations of enriching C2 theory

are given, one applied to the C2 approach space and the other to the OODA loop. Further research on relating C2 and leadership theory is recommended.

1. Introduction

In military doctrine, leadership is an essential element of Command & Control (C2). Leadership is a social process by which the leader influences a group of people to achieve a common goal. According to British defence doctrine, leadership, decision making, and control are three inter-related aspects of command. US Marine Corps' doctrine states that "command is inseparable from leadership". Under Australian defence doctrine "the power and authority of command is important, but leadership is also essential", and in Dutch defence doctrine the "commander is the embodiment of effective leadership".

Leadership theory is an inescapable part of military officer training. In the late 1960's, the author received training at Royal Air Force College Cranwell, UK, into the traits (Stogdill, 1948), behavioural (Tannenbaum & Schmidt, 1958; 1973) (Blake & Mouton, 1964), situational (Hersey & Blanchard, 1969), and functional (Adair, 1983) approaches to leadership. Forty years on, the Royal Netherlands Army manual on leadership (HBLGKL, 2002) adds only the more recently-developed transformational leadership model (Bass, 1996).

Given the centrality of leadership to C2 in military doctrine and officer training, it is surprising to find how little leadership theory appears in the C2 literature. Just 16 of the 2053 papers in the International Command & Control Research & Technology Symposium (ICCRTS) proceedings from 2000 to 2015, one of the 58 International C2 Journal (IC2J) articles, and none of the 42 DoD Command & Control Research Program (CCRP) books have the words "lead", "leader", or "leadership" in their title. Of the 16 ICCRTS papers and the single IC2J article, just three refer to the leadership literature (and then only to a highly specific part of the literature on emergent leadership). By contrast, other disciplines such as decision theory, control theory, socio-technical systems, social network analysis (SNA), and organization and management theory (OMT) (Alberts & Nissen, 2009) are well represented in the C2 literature.

The purpose of this paper is to show, by means of two illustrations, that applying selected ideas from leadership theory can enrich C2 theory, with C2 being viewed as command arrangements, command, and command support systems (Cropley, Sproles & Cook, 2005). In the first illustration, we show that the allocation of decision rights (ADR) dimension in the C2 approach space (Alberts & Hayes, 2006) can be grounded in Tannenbaum & Schmidt's (1958; 1973) continuum of leadership patterns. ADR gains structure, leader-subordinate interaction gains detail, and the forces influencing the leader's choice of C2 approach are clarified. In the second illustration, we show how models of the C2 decision making process (e.g. Boyd's (1996) Observe-Orient-Decide-Act (OODA) loop) can be broadened to cover all the functions of a leader/commander by borrowing insights from functional leadership (Adair, 1983). Finally, we demonstrate the synergy between the two illustrations.

This paper contains six sections. After this introductory section, the second section reviews the relevant literature both in C2 theory and in leadership theory. The third section grounds the C2 approach space in Tannenbaum & Schmidt's (1958; 1973) continuum, and the fourth section extends

the OODA loop using ideas drawn from functional leadership. The fifth section looks at the synergies between the two illustrations, as well as the broader implications. Finally, the sixth section draws conclusions and recommends further research.

2. Relevant Literature

2.1 C2 theory

This subsection makes a distinction between theory that is specific to C2 and a set of reference disciplines, i.e. theories developed and used elsewhere that have been applied to C2. In some cases, the distinction is fuzzy. For example, Boyd's (1996) Observe-Orient-Decide-Act (OODA) loop is a C2-specific model of the decision making process. However, there are many similar models of decision making in reference disciplines, e.g. Plan-Do-Check-Act in the (risk) management field.

The elements of C2 theory have been largely drawn from the CCRP literature, including the ICCRTS proceedings, the IC2J articles, and the CCRP's own published books. This source has been supplemented by other C2-related books, such as Van Creveld (1985), Harris & White (1987), Beam (1989), Coakley (1991), Builder, Bankes & Nordin (1999), Stanton, Baber & Harris (2008), Walker, Stanton, Salmon & Jenkins (2009), and Vassiliou, Alberts & Agre (2015).

Reference disciplines have been identified from the C2-related books, several different nations' C2 doctrine publications, and an ICCRTS paper on the science of C2 (Cropley et al, 2005):

- Cybernetics a.k.a. control theory;
- Decision theory, including rational/analytical and intuitive/naturalistic decision making, as well as various models of the decision making process;
- Information theory;
- Communications theory, in the engineering sense;
- Political science and business communications, i.e. marketing and how to influence people;
- The data-information-knowledge-wisdom (DIKW) pyramid;
- Social science, psychology, cognitive science and engineering, including cognitive/mental models and socio-technical systems;
- Human factors and ergonomics;
- Organization and management theory;
- Planning and scheduling theory;
- Network theory, a.k.a. graph theory;
- Engineering and design science;

- Computer science, software engineering, and information systems;
- Leadership theory; and
- A variety of related branches of mathematics.

For the purposes of this paper, the following elements of C2-specific theory have been identified:

- *OODA and other feedback loops.* There are well over 20 models of the C2 process in the literature, most of them being variants on Boyd's (1996) OODA loop. All are cyclic, with one or more feedback loops. Several authors (e.g. Builder et al (1999) and Brehmer (2005)) have noted that the cybernetic (Wiener, 1948) paradigm predominates. Most models represent real-time activity during an operation, and are purely reactive. Few include a deliberative planning sub-process, and none include learning. Most models pre-date the CCRP literature, but different sets of models have been surveyed by Mayk & Rubin (1988), Grant & Kooter (2005), and Stanton et al (2008).
- *Information-age C2.* Information-age C2 (Alberts, Garstka, Hayes & Signori, 2001) takes advantage of computer and communications networking. Instead of information flow being predominantly up and down the organizational hierarchy, information can be exchanged between any unit or team, even between different organizations, enabling them to self-synchronize. This speeds up operations, but demands interoperability (Alberts & Hayes, 2003). The resulting way of working has been termed Network Centric Warfare (NCW) in the US (Alberts, Garstka & Stein, 1999) and Network Enabled Capabilities (NEC) in NATO and many European nations. (We use the term NEC in this paper.) The primary aim of the CCRP was to develop NEC thinking. NEC focuses on the combat power that can be generated from the effective linking or networking of the warfighting enterprise (Alberts et al, 1999, p.88). The development of, experimentation with, and evaluation of NEC concepts and information-age C2 systems is a major aspect of the CCRP literature.
- *The physical, information, cognitive, and social domains.* Alberts et al (2001) introduced three domains – the physical, information, and cognitive – to understand how information affects the ability to perform military operations. The physical domain is where the situation exists that the military seeks to influence, with strike, protection, and manoeuvre taking place across land, over the sea, in the air, and in space. The information domain is where information is created, stored, manipulated, and communicated. The cognitive domain is in the minds of the participants, where perceptions, awareness, understanding, beliefs, and values reside and decisions are made. C2 systems represent the means for translating events and action in one domain to another. Sensors translate physical events into information, and effectors turn information into physical acts. Computer displays enable information to change a user's awareness and understanding, and computer controls enable a user to translate the results of decisions into information. A fourth, social domain was added later (Alberts & Hayes, 2007), making it possible to represent the transmission of (information about) one participant's cognitive state to change the cognitive state of other participants.
- *NEC tenets a.k.a. NEC value chain.* The NEC tenets are four principles for network-centric operations. An initial version can be found in Alberts et al (1999, Figure 9, p.89), but the

definitive version is in Alberts & Hayes (2003, Figure 12, p.108). The NEC value chain is a way of presenting the tenets visually. The visual representation has changed over the course of time, mapping the NEC processes onto the four domains. The four tenets are:

- (1) A robustly networked force improves information sharing.
 - (2) Information sharing and collaboration enhance the quality of information and shared situation awareness.
 - (3) Shared situational awareness enables collaboration and self-synchronization.
 - (4) These, in turn, dramatically increase mission effectiveness.
- *C2 approaches*. A spectrum of six C2 approaches, consisting of three major types, each with two subtypes, was introduced in Alberts & Hayes (2003). The cyclic subtype was the most centralized approach, with highly-detailed orders issued on a regular schedule. By contrast, the control-free subtype was decentralized, with orders being confined to what the subordinate units should achieve, i.e. their mission goals, leaving the subordinate unit free to choose how they achieve these goals. The C2 approach space was introduced in Alberts & Hayes (2006, Figure 11, p.75), separating the one-dimensional spectrum of C2 approaches into three dimensions: allocation of decision rights, patterns of interaction, and distribution of information. This C2 Approach Space was adopted by the NATO SAS-050 project.
 - *Agile C2*. Agility, together with its six attributes (robustness, resilience, responsiveness, flexibility, innovation, and adaptation), was introduced in Alberts & Hayes (2003) and developed more fully in Alberts (2011).
 - *Command concepts*. Builder et al (1999) argue that current C2 theory is largely about organizations and communications. A comprehensive C2 theory should also describe the high-level, creative aspects of command. In particular, it should describe the *command concept*, defined as the commander's vision of a prospective military operation that informs the making of command decisions during that operation. This provides an important clue to the minimum essential information that should flow within C2 systems.

This variety of elements of C2 theory and reference disciplines are like pieces from a jigsaw¹. No meta-model has been proposed in the C2 literature as yet that integrates these pieces into a coherent whole. Consequently, there is a possibility that one or more pieces may still be missing.

One candidate meta-model is Cropley et al's (2005) "three views" on C2. Drawn from military doctrine, Cropley et al identify the following views:

- *Command arrangements*. Command arrangements describe the degree of operational authority between headquarters, formations, and units, and are concerned with assigning missions and tasks. They refer to issues such as the number of echelons, the span of control, the pattern of linkages, and whether relationships are permanent or transitory. Cropley et al

¹ Cropley et al's (2005, p.11) Figure 2 does indeed depict the framework of ideas in C2 science as a jigsaw.

(2005) would regard the C2 problem and approach spaces as being aimed at determining command arrangements.

- *Command*. Command is concerned with the management, leadership, and coordination of activity, and focuses on the person of the commander and his/her job of leading, guiding, and motivating subordinates to achieve the mission. Clearly, the OODA loop and similar C2 process models are part of the command view.
- *Command support systems*. Support systems include entities, such as headquarter staffs, communication networks, doctrine, messaging systems, computers, maps and geographic information systems, software, standardization agreements, procedures, control measures, and databases. Thus, software-based C2 systems are part of the command support systems view.

2.2 Leadership theory

This section briefly reviews the development of leadership theory since the start of the 20th century to date. Leadership theory covers leadership styles, philosophies, and models. A *leadership style* is a description of the main ways in which real-life leaders behave. For example, we may say that a particular leader has a directive, authoritarian, paternalistic, or democratic style. A *leadership philosophy* contains value-based ideas about how a leader should be. For example, servant leadership is the philosophy in which the leader believes that he/she should serve his/her followers. A *leadership model* is a theory or collection of ideas about how to lead effectively. For example, action-centred leadership identifies a set of actions that leaders should be able to perform. To become better, a leader should master a broader repertoire of actions, rather than stick to using a small subset. In essence, styles are descriptive, philosophies are normative, and models are prescriptive. In this paper we focus on leadership models.

Thinkers and researchers have developed a variety of theoretical models over more than 150 years. This development has progressed through a series of models, from heroic, through trait-based, behavioural, situational / contingent, and functional / action-centred, to integrated models of leadership. Recently, these models have been supplemented by complex adaptive / evolutionary / participative models. It should be noted that each new model does not supplant the older ones, but typically adds complexity to gain explanatory power. There is also related research into followers and followership (Kelley, 2008), and into trust and other relationships between leaders and followers (Schriesheim, Castro & Cogliser, 1999) (Cropanzano & Mitchell, 2005), and into how leadership and followership has evolved (Van Vugt & Ahuja, 2010). This sub-section briefly outlines these developments, dwelling in more detail on the models relevant to C2 theory. More detail on Tannenbaum & Schmidt's (1958; 1973) continuum and on Adair's (1983) three-circles functional leadership model can be found in the next two sections.

Some writers would trace the development of leadership models back to Plato's *Republic* (c. 380 BC) and Plutarch's *Lives* (c. 98 AD). In *Heroes and Hero Worship* (1841), Thomas Carlyle identified the talents, skills, and physical characteristics of men who rose to power. In his *Hereditary Genius* (1869), Francis Galton examined leadership qualities in the families of powerful men, showing how the eminence of their relatives dropped off the more distantly they were related. These writings into what is now known as *heroic leadership* lent support for the idea that leadership could be explained in

terms of the leader's individual qualities. Moreover, they suggested that leaders were born, not made.

Leadership began to be studied scientifically from around the start of the 20th century. The *trait-based model* of leadership evolved from the heroic model in emphasizing the leader's qualities (traits). Researchers distinguished the leader's physical, intellectual, and moral qualities, general development, specific knowledge, and experience. The first four aspects are general, while the last two are specific to the leader's position in the organization. However, Stogdill's (1948) survey of the literature showed that, while some traits are common, the majority of qualities valued in leaders varied according to the situation.

The research focus then shifted to investigating effective leadership behaviours. Like the traits models, the behavioural leadership models focus on the leader as a person. A key development was Blake & Mouton's (1964) managerial grid. This was a two-dimensional model, plotting the extent to which a leader's behaviour is task-oriented against the extent to which it is relationship-oriented. This suggests five styles, corresponding to the four corners of the grid and a fifth at its centre. Although this model suggests the most effective style should be maximising both task- and relationship-orientation, researchers again found that effectiveness depended on the situation.

Of the four situational / contingency leadership models, two are worth mentioning here. Fiedler (1967) investigated the interaction of leadership style and situational favourability. The situation is favourable when there is a good leader-subordinate relationship, a highly structured task, and the leader has high position power. Fiedler found that task-oriented leaders are more effective in extremely favourable or unfavourable situations, while relationship-oriented leaders perform best in intermediate situations. Hersey and Blanchard's (1969) model incorporates four leadership styles and four levels of subordinate development. For effectiveness, the leadership style should match the level of subordinate development. In this model, leadership behaviour depends on two types of entity: leaders and subordinates.

The functional leadership theory is particularly useful for identifying leadership behaviours that contribute to organizational performance. This theory takes the view that the leader's primary concern is to facilitate performance by meeting the needs of the task, the needs of individual subordinates, and the needs of the team. In their summary of the functional leadership literature, Klein, Ziegert, Knight and Xiao (2006) observed five broad functions a leader performs: monitoring the environment, organizing subordinate activities, teaching and coaching subordinates, motivating others, and intervening actively in the team's work. Adair (1983) identifies eight functions of a leader, each of which contributes to meeting the task needs, the team's needs, and the individuals' needs. Adair's colleagues in Evolve Teamlead Ltd (2011) extended this to 11 functions: defining the task, organizing, inspiring, supporting, reviewing, planning, briefing, evaluating, controlling, motivating, and setting an example. Four entity-types can be found in functional leadership: the leader, the task, the team, and the team members, i.e. the individual subordinates.

The integrated leadership theory attempts to integrate the strengths of the older theories, while addressing their limitations. Scouller (2011) proposed a three-level model, in which the three levels are public, private, and personal leadership. Public leadership focuses on 34 behaviours involved in influencing groups of two or more subordinates. Private leadership focuses on 14 behaviours

needed to influence subordinates individually. Personal leadership focuses on growth in the leader’s own presence, knowhow, and skill.

Complex adaptive, evolutionary, and participative leadership models are currently under development. There is also extensive research into followership (Kelley, 2008) and into what is exchanged in the social relationship between leaders and followers (Schriesheim, Castro & Cogliser, 1999) (Cropanzano & Mitchell, 2005). Van Vugt and Ahuja’s (2010) evolutionary leadership theory is unique in arguing that leadership and followership are themselves the products of evolution. They say that the form of leadership that people are most comfortable with is participative (a.k.a. democratic) leadership based on expertise and skill, as found in small bands of hunter-gatherers. Van Vugt and Ahuja identify why this form of leadership is a misfit with modern large-scale organizations, showing how this leads to narcissistic and even toxic leaders. Unfortunately, they fail to characterize what form would better fit the modern environment.

Unlike C2 theory, leadership theory hangs together. Each new model builds on previous insights or the shortcomings of the preceding ones. This can be seen in terms of the entity-classes involved. Heroic and behavioural theory concerns one entity-class: the leader. Entity-classes are progressively added: the task, subordinates, the leader-subordinate relationship, the situation, the team, etc.

3. Enriching the C2 Approach Space

The relationship between a leader and his/her subordinates is central in both C2 theory and leadership theory.

In the 1980s, the US DoD sponsored broad research into a variety of C2 systems approaches to command arrangements. One product was the identification of three major types of C2 approach, each with at least two important subtypes (Alberts & Hayes, 1995). The key distinction between approach types is the level of centralization, coupled with the level of detail of the leader’s instructions (Table 1). Interaction between leader and subordinates varies according to subtype.

Table 1. Spectrum of C2 approaches (adapted from Alberts & Hayes, 2003).

Subtype	Centralization	Instructions	Interaction
Control free	Decentralized	Mission statement	Leader assigns mission; subordinates trusted to execute independently.
Selective control			Leader assigns mission; subordinates trusted to execute independently. Leader monitors & intervenes if major opportunity or threat arises.
Problem bounding	Intermediate	Set of objectives	Leader assigns set of objectives with boundaries. Leader & subordinates in continuous contact during execution by subordinates.
Problem solving			Leader assigns missions & objectives with substantial guidance, for 2 levels down. Leader & subordinates in

			continuous contact during execution.
Interventionist	Centralized	Detailed orders	Leader issues detailed, pre-planned orders prior to operation. Subordinates report progress in detail during execution, and leader maintains detailed operating picture.
Cyclic			Leader issues detailed, pre-planned orders on regular cyclic basis. Subordinates report progress in detail during execution, and leader maintains detailed operating picture.

All six C2 approaches have been successful, but their suitability depends on the situation. Factors influencing suitability include (Alberts & Hayes, 2003):

- Whether the situation is static or dynamic;
- Whether communications between leader and subordinates are available and reliable;
- The quality and timeliness of the information exchanged between leader and subordinates;
- The professional competence of and mutual trust between the leader and subordinates; and
- The creativity and innovation expected of the leader and of the subordinates.

Since 2003, Alberts & Hayes (2006) have extended their representation of C2 approaches from a single-dimension spectrum to a three-dimensional C2 Approach Space. The three dimensions are:

- *Allocation of decision rights (ADR)*, defined as the distribution of the authority to take decisions within the international community, a nation, an enterprise, an organization, or a team. At one end of the ADR dimension is full centralization, i.e. all the rights are held by one actor. At the other end is full decentralization, i.e. all actors have equal rights.
- *Patterns of interaction (POI)*. Ranging from tightly constrained to unconstrained, POI takes the form of a social network. It has three elements (reach, richness, and quality), of which reach (i.e. the number and variety of participants) and quality (of interactions enabled) are the most important.
- *Distribution of information (DOI)*. DOI ranges from a tightly-controlled central repository of information to broad dissemination of information to everyone.

Alberts & Hayes (2006) emphasize that the three dimensions are not independent. ADR is the most fundamental dimension, impacting the other two, with DOI also being determined by POI (ibid., p.81).

Walker, Stanton, Revell, Rafferty, Salmon & Jenkins (2009) have given each of the three dimensions a quantitative measure using social network analysis. They map ADR to sociometric status, POI to network diameter, and DOI to network density. Their choice is based more on an appeal to

plausibility rather than on an explicit selection process from the hundreds of possible measures in the network science literature. To give Walker et al their due, they do test the measures using the archetypal network forms of a chain, a Y, a star, and a circle, and example hierarchical and edge organizational structures from the NEC literature. Nevertheless, their chosen measures can be criticized on additional grounds. All three measures are at the network level, and based primarily on the numbers of nodes and arcs in the network. The number of messages and the path length between node-pairs are also used in measuring ADR and POI. Looking at ADR in more detail, sociometric status can be said to measure the “verbosity” of nodes (i.e. military units and individuals), but verbosity is not necessarily an indication of decision making. Moreover, none of the measures take either the importance of nodes (typically measured using the node’s degree) or the importance of the information into account. Thus, two corporals chatting about the football results might be measured as having a higher sociometric status than the general who merely gives the signal to attack and then quietly waits for key reports indicating whether or not the operation is going according to plan.

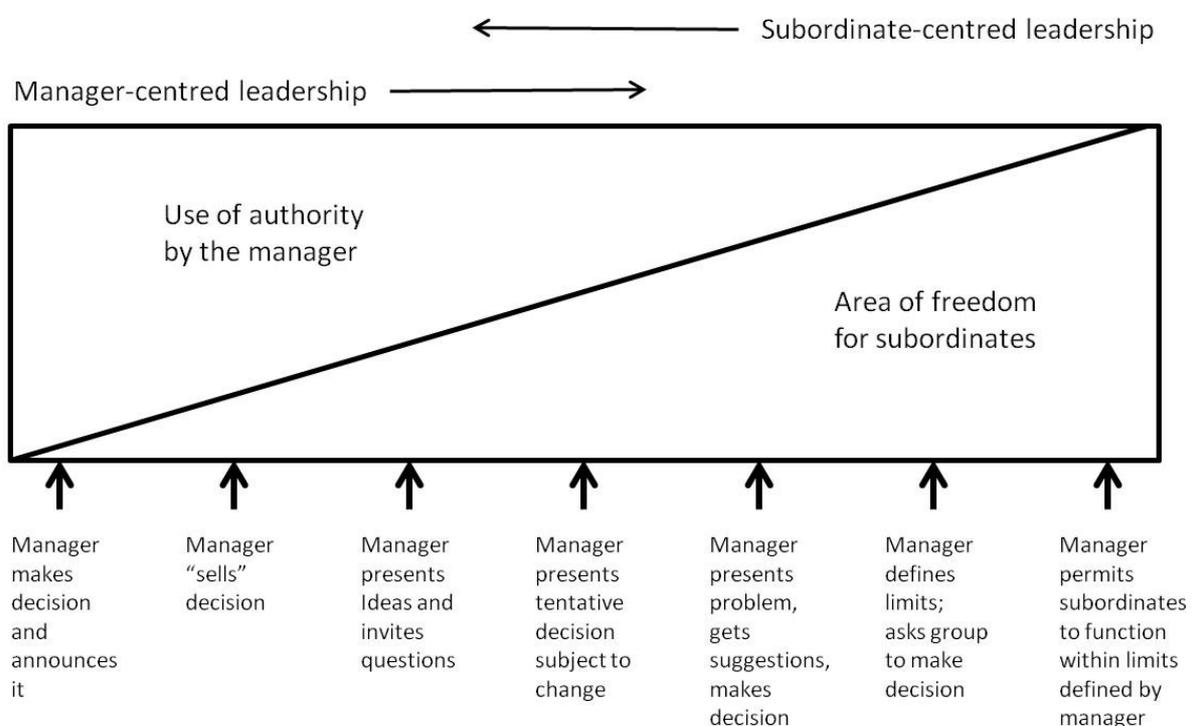


Figure 1. Continuum of leadership behaviour (Tannenbaum & Schmidt, 1973, exhibit 1, p.4).

In the leadership literature, Tannenbaum & Schmidt’s (1958; 1973) continuum between the level of authority used by a leader and the level of freedom given to his/her subordinates is highly influential. Their work is not confined to the academic literature, but has also appeared (twice) in the Harvard Business Review, as well as being a staple in management and military officer training (e.g. see Waddell III, 1994). It pre-dates the US DoD-sponsored research into system approaches to command, but is not cited in any of the CCRP publications.

Tannenbaum & Schmidt's (1958; 1973) continuum is motivated by the dilemma that leaders² face between reconciling the demand to be democratic in their relations with subordinates while, at the same time, maintaining the necessary authority and control in the organization. The purpose of their Harvard Business Review article is to suggest a framework that managers may find useful in grappling with this dilemma. Their framework (Figure 1) identifies seven positions between the extremes of fully centralized and fully decentralized decision making. The extreme positions coincide with those of Alberts & Hayes' (2006) ADR dimension.

Tannenbaum & Schmidt (1958; 1973) discuss in detail what factors or forces a leader should consider in choosing a position along the continuum, grouping these forces as follows:

- *Forces in the leader.* Leaders perceive their problems in a unique way according to their background, knowledge, and experience. Among the important internal forces affecting them will be the leader's value system, his/her trust in their subordinates, his/her own leadership inclinations, and his/her feelings of security in uncertain situations.
- *Forces in the subordinates.* Leaders will be aware that subordinates, like themselves, are influenced by many personality variables. In addition, each subordinate has an expectation about the leader's behaviour. Tannenbaum and Schmidt (1973, p.7) state that, generally speaking, leaders can permit subordinates greater freedom if the subordinates:
 - Have a high need for independence.
 - Have a readiness to assume responsibility for decision making.
 - Have a relatively high tolerance for ambiguity.
 - Are interested in the problem and feel that it is important.
 - Understand and identify with the organization's goals.
 - Have the necessary knowledge and experience to deal with the problem.
 - Have learned to expect to share in decision making.
- *Forces in the situation.* Certain characteristics of the situation also affect the leader's behaviour. Among the more critical environmental pressures are the type of organization (including its values and traditions, the size of teams, its geographical distribution, and degree of inter- and intra-organizational security required to attain the organization's goals), the effectiveness of the team (including their experience in working together and the degree of confidence they have in their ability to solve problems as a team), the problem itself (including its complexity and the range of specializations needed to deal with it), and the pressure of time.

² While Tannenbaum & Schmidt use the term "manager" (or sometimes "boss"), we use the term "leader" for consistency. For clarity, we ignore here the distinction made between management and leadership in the leadership literature. Likewise, although they use the term "group", we prefer the term "team", complying with the convention in psychology that a team is a group with a shared goal.

Finally, Tannenbaum & Schmidt (1958; 1973) discuss the leader's strategy for long-run changes in position along the continuum to gain new insights or skills for themselves, to supply training for individual subordinates, and to provide participative experiences for the team. In addition, the 1973 version of their article adds a retrospective commentary on changes in organizations and the world since the article was first published in 1958.

This section has shown that Tannenbaum & Schmidt's (1958; 1973) continuum adds several insights to C2 theory, as follows:

- It provides more structure (i.e. the seven positions) than the description of the ADR dimension in the C2 literature.
- It describes in more detail what the leader does and how the leader and his/her subordinates interact at each position along the continuum.
- It describes systematically and in more detail the forces influencing the leader's choice of C2 approach, grouping these into forces in the leader, in the subordinates, and in the situation.
- It discusses the leader's long-run strategy for developing himself/herself, the team, and individual subordinates. This insight has no parallel in C2 theory.

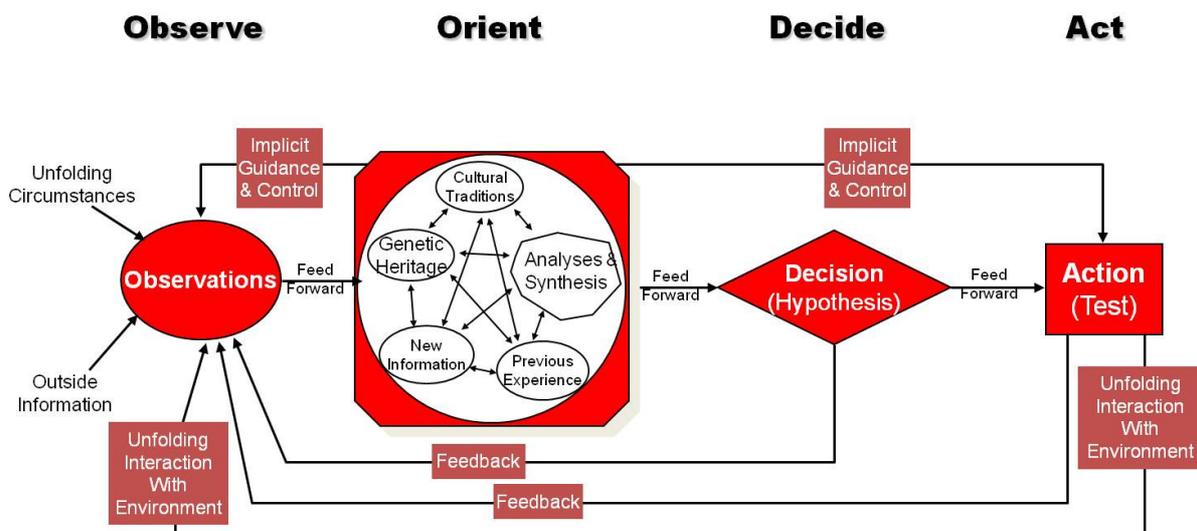


Figure 2. Boyd's (1996) Observe-Orient-Decide-Act (OODA) loop.

4. Enriching the OODA Loop

What the leader does is also central to both C2 and leadership. In C2 theory, the emphasis is on the C2 process, while leadership theory emphasizes the leader's functions. Both process and functional views on C2 are attractive, because they provide a good starting point for specifying C2 systems.

In section 2.1 we observed that Boyd's (1996) OODA loop is a highly influential model of the C2 process, with many variants. Figure 2 shows Boyd's original version. The OODA loop depicts what a

leader does: he/she observes the unfolding interaction with the environment, assesses the situation, makes a decision, and acts. In short, a leader has four functions: observe, orient, decide, and act. While the terminology and number of functions may vary (Mayk & Rubin, 1988) (Grant & Kooter, 2005), the C2 process is cybernetic in nature.

When we compare Boyd's (1996) OODA loop with other similar cybernetic models, we see that they are all cyclic with feedback through the environment, most have three to five functions, and all culminate in making a decision on how to act. As Cropley et al (2005, p.4) notes: *"decision making ... seems to be of particular interest to those concerned with C2. This is apparent in the significant proportion of the C2 literature that is taken up with what the commander needs in order to make decisions, the process of making decisions, the quality of such decisions, and how the decision is communicated ... The frequent references to the cycle of Orientation, Observation, Decision, and Action (often referred to as the OODA Loop or Boyd cycle) are an illustration of this interest."*

Another key thinker on the C2 process, Brehmer (2005) identified eight functions that are required for effective C2, taking van Creveld (1985, p.7) as his inspiration:

"There is, in the first place, the gathering of information on the state of one's own forces – a problem that should not be underestimated – as well as on the enemy and on such external factors as the weather and the terrain. The information having been gathered, means must be found to store, retrieve, filter, classify, distribute, and display it. On the basis of the information thus processed, an estimate of the situation must be formed. Objectives must be laid down and alternative methods for attaining them worked out. A decision must be made. Detailed planning must be got under way. Orders must be drafted and transmitted, their arrival and proper understanding by the recipients verified. Execution must be monitored by means of a feedback system, at which point the process repeats itself."

The eight functions that Brehmer (2005) extracted were as follows:

- Gathering information on own forces, the enemy, the weather and the terrain.
- Finding means to store, retrieve, filter, classify, distribute and display the information.
- Assessing the situation.
- Laying down objectives and working out alternative means for attaining them.
- Deciding what to do.
- Planning.
- Writing orders and transmitting them as well as verifying their arrival and proper understanding by the recipients.
- Monitoring the execution by means of feedback, at which the process repeats itself.

Brehmer's (2005) list of functions subsumes the OODA loop. The first function is clearly equivalent to Observe, the third to Orient, the fifth to Decide, and the seventh is Act³. From the viewpoint of Cropley et al's (2005) meta-model, Brehmer's second bullet is more related to the supporting C2 system than to command.

In the C2 literature there are other models of C2. For example, Alberts & Hayes (2006, p.47) list the essential C2 functions as follows:

- Establishing intent.
- Determining roles, responsibilities, and relationships.
- Establishing rules and constraints.
- Monitoring and assessing the situation and progress.
- Inspiring, motivating, and engendering trust.
- Training and education.
- Provisioning.

By contrast to Brehmer (2005), Alberts & Hayes' (2006) list of functions only partly covers OODA. Only their fourth bullet maps onto the OODA loop, being equivalent to Observe ("monitoring") and Orient ("assessing"). Cropley et al's (2005) meta-model provides an explanation, in that Alberts & Hayes (2006) is primarily concerned with command arrangements, rather than the exercise of command.

Turning now to leadership theory, functional leadership focuses on what the leader does, i.e. his/her functions. Adair (1983) listed eight functions of a leader, with each function linking the task, the team, and the individual subordinates with what the leader does. Adair's list has since been extended to the following eleven functional areas (Evolve Leadteam, 2011, pp.3-6):

- *Defining the task.* This leadership function concerns taking responsibility for activities such as identifying the overall objectives of the task, establishing a common purpose for the team, and clarifying the objectives for each individual.
- *Organizing.* This function includes incorporating individuals' capabilities when establishing team structure, modifying individuals' roles to play to their strengths, and using suitable systems to carry out the task.
- *Inspiring.* This function includes setting challenging goals which the team has the ability to achieve, and highlighting the benefits of meeting these goals.
- *Supporting.* This function includes providing training in support of the task, encouraging the team, and addressing the problems of individuals.

³ In the form to be expected of a headquarters, namely writing orders for subordinates rather than manoeuvring or engaging the enemy.

- *Reviewing*. This function includes reviewing the outcomes of each part of the task, learning from both failure and success, and assessing each individual’s contribution.
- *Planning*. This function includes ensuring that a workable plan for the task is prepared, getting ideas and suggestions from the entire team, and setting specific goals for each individual.
- *Briefing*. This function includes presenting a clear plan of action, clearly outlining the proposed team structure, and checking the individuals’ understanding of these issues.
- *Evaluating*. This function includes considering implications before acting, enquiring if individuals are comfortable with their role, and reflecting on how well the team is working.
- *Controlling*. This function includes making decisions, correcting unproductive team behaviours, and being assertive with individuals when necessary.
- *Motivating*. This function includes recognizing individual achievement, celebrating success with the team, and communicating the importance of the task.
- *Setting an example*. This function includes working to a high standard, remaining positive when dealing with the team, and treating others as you would expect to be treated yourself.

The OODA loop is embedded in Adair’s (1983) list of leadership functions. While Observe is not stated explicitly, it is implicit in activities such as “enquiring if individuals are comfortable with their role” (in Evaluating). Orient is implicit in “reviewing the outcomes of each part of the task” and “assessing each individual’s contribution” (in Reviewing), and in “reflecting on how well the team is working” (in Evaluating). Decide is explicitly mentioned in Controlling and is implicit in Defining the task and Organizing. Act is implicit in Briefing, Motivating, Inspiring, Supporting, and Setting an example.

Cropley et al’s (2005) meta-model again provides an explanation. The first five functions (Defining the task, Organizing, Inspiring, Supporting, and Reviewing) are at the command arrangements level. Briefing, Evaluating, Controlling, Motivating, and Setting an example are at the command level. Planning could be at the command arrangement level, at the command level, or split over both levels; we have chosen to assign Planning to the command level. There are no functions at the command support system level. Table 2 maps Alberts & Hayes’ (2006) functions from C2 theory and the Evolve Leadteam (2011) version of Adair’s (1983) functions from leadership theory onto the Cropley et al meta-model.

Table 2. Mapping C2 and leadership functions onto Cropley et al's (2005) meta-model.

Meta-model	C2 functions	Leadership functions
Command arrangements: (authority, assigning tasks, echelons, span of control, pattern of linkages, and permanent vs. transitory)	Establishing intent; determining roles, responsibilities & relationships; establishing rules & constraints; inspiring, motivating & engendering	Defining task; Organizing; Inspiring; Supporting; Reviewing

	trust; training & education; provisioning	
Command: (management, leadership, coordination, concepts, future state, assigning missions, allocate resources, assess risk, and make decisions)	Monitoring & assessing situation	Planning; Briefing; Evaluating; Controlling; Motivating; Setting an Example
Command support system: (staff, information & communication systems)	(none)	(none)

Given this mapping, it is then possible to identify two OODA loops. At the command arrangements level, Reviewing includes elements of Observe and Orient, Defining task and Organizing covers Decide, and Inspiring and Supporting include Act. At the command level, Evaluating covers Observe and Orient, Controlling includes Decide, and Briefing, Motivating, and Setting an example cover Act.

This section has shown that functional leadership, represented by Evolve Leadteam’s (2011) extended list of Adair’s (1983) leadership functions, adds several insights to C2 theory, as follows:

- What the leader does is a complex interaction between the task, the team, the subordinates, and the leader’s own background, knowledge, and experience.
- What the leader does is considerably more than just making decisions.
- The leader is active both at the command arrangements level and at the command level.

5. Discussion

This section discusses the synergies between the two illustrations, as well as broader implications.

The two illustrations in sections 3 and 4 have considered what leadership theory can bring to enrich two separate pieces of the C2 jigsaw: the C2 approach space and the C2 process. At least two potential synergies can be found. Using Cropley et al’s (2005) three-view meta-model of C2 shows that the C2 approach space concerns command arrangements. C2 process models, such as the OODA loop, are – in the first instance – at the command level. By contrast, Adair’s (1983) list of leadership functions spans both levels. In essence, functional leadership theory provides a link between the C2 approach space and the C2 process.

There is a second synergy to be found between C2 and leadership theory. Tannenbaum & Schmidt’s (1958; 1973) continuum provides a detailed model for varying the allocation of decision rights between leaders and subordinates. The question is: Could similar continua be created for varying the

allocation of other leadership functions between leaders and subordinates, at both levels? Table 3 offers *prima facie* evidence for an affirmative answer. However, further study is needed.

Table 3. Continuum of leadership functions, modelled on Tannenbaum & Schmidt (1958; 1973).

Leadership functions	Fully centralized (hierarchy)	Fully decentralized (edge)
<p><i>Command arrangements:</i></p> <p>(Observe & Orient:) Reviewing</p> <p>(Decide:) Defining task, Organizing</p> <p>(Act:) Inspiring, Supporting</p>	<p>Leader observes outcomes, assessing contributions</p> <p>Leader defines objectives, team structure, & supporting system</p> <p>Leader highlights benefits of meeting objectives, provides training, & encourages team</p>	<p>Subordinates review outcomes & contributions jointly</p> <p>Subordinates collaboratively define objectives, team structure, & supporting system</p> <p>Subordinates train together & encourage one another</p>
<p><i>Command:</i></p> <p>(Observe & Orient:) Evaluating</p> <p>(Decide:) Controlling</p> <p>(Act:) Briefing, Motivating, Setting an example</p>	<p>Leader evaluates subordinates & team performance</p> <p>Leader makes decision & announces it</p> <p>Leader presents plan of action & team structure, emphasizing importance of task</p>	<p>Subordinates give each other feedback & discuss performance</p> <p>Subordinates collaborate on reaching decision</p> <p>Subordinates develop plan of action & team structure jointly, & set each other an example</p>

Potentially, there are broader implications than just the two illustrations and the synergies between them. These implications can be most easily stated in the form of research questions. Could ideas from leadership theory benefit other elements of C2 theory? Could other reference disciplines enrich C2 theory in a similar way? Would it be possible to fit all the pieces of the C2 jigsaw together in this way? Are any pieces missing? Could Cropley et al's (2005) three-view meta-model aid integration? Can any of these insights be projected down to the command support system level, e.g. to guide C2 system design? Clearly, these questions demand further, detailed investigation.

6. Conclusions and Recommendations

In military doctrine, leadership is an essential element of C2. Leadership theory is an inescapable part of military officer training. Yet there is surprisingly little on leadership theory in the literature on C2 theory. By contrast, other disciplines, such as decision theory, socio-technical systems, social network analysis, and organization and management theory, are well represented.

This paper shows that applying selected ideas from leadership theory can enrich C2 theory. The paper reviews the relevant theory, both on C2 and on leadership. Two illustrations of enriching C2 theory are given, one on the C2 approach space and the other on the OODA loop. By drawing on Tannenbaum & Schmidt's (1958; 1973) continuum of leadership behaviour, the C2 approach space can be enriched with more structure, with detail on what the leader does and his/her interaction with the subordinates, with a systematic, detailed description of the forces on a leader's choice of C2 approach, and with a discussion of the leader's long-run strategy for developing himself/herself, the group, and individual subordinates. By drawing on functional leadership theory, C2 process models, such as the OODA loop, can be extended to the command arrangements level. Functional leadership shows that what a leader does is a complex interaction between the leader, task, team, and subordinates, and is more than just decision making. Finally, this paper shows that there are at least two synergies between the C2 approach space and the C2 process, mediated by leadership theory.

The two main contributions of this paper are to highlight the paucity of research into the links between leadership theory and C2 theory and to suggest a way of rectifying this. Two illustrations are given to show the potential benefits from elucidating such links, together with the synergies between them. The main limitation is that this paper has given just two illustrations. There is a need for more research into extending Tannenbaum & Schmidt's (1958; 1973) continuum to C2 functions other than decision making, into systematically exploring additional links between leadership theory and C2 theory, and into similar links between other reference disciplines and C2 theory.

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