

# **Complexity and managing to survive it**

(Subtitle - 'Playing with CARS')

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## **ABSTRACT**

*Much is written about complexity from the perspective of the theory of systems and research into emergence. In the Defence and Security field there is an increasing awareness of the complexity of current and future conflicts, and of the military enterprise needed to successfully engage with and survive them. However, the various management, engineering and scientific practices used by Government to direct and control the development of policy and capability are still rooted in conventional design and control paradigms. Enterprise executives seeking to design and manage complex enterprises face many challenges and the value of complexity thinking lies in its ability to inform effective executive action. Issues such as identifying the appropriate role of analysis in management, designing effective strategies for managing adaptation, understanding the cultural and social process aspects of management, and generating practical heuristics for managers to use. Executives need two things from science and consultancy - understanding of the options for effective intervention and confidence to take action in the presence of risks (not necessarily connected to understanding!). Drawing from the diverse themes of the workshop this paper will try to form up a synthesised picture of this 'problem' space followed by a 'distillation' of key questions that executives and managers need analysts and scientists to answer (as well as some challenges for analysis and science itself). It will cover a number of strands and try to weave them together to provide the workshop with a coherent 'landscape' of connected ideas and challenges spanning the physical, informational, cognitive, organisational and social domains.*

## **Introduction**

This paper seeks to cover a network of ideas for which no single linear story will suffice. The ideas, therefore, should be seen more as a walk through a rich and varied landscape, with no particular destination in mind, occasionally looping back across ground already covered, or branching off temporarily into interesting cul-de-sacs. The goal is not to arrive at simple conclusions, but to explore and map out a problem space as a guide to future, more directed travellers.

Much is written about complexity from the perspective of those for whom it is a research topic. There are debates about the relative merits of top-down thinking, drawing on systems theory or insights gained from the study of naturally evolved systems, and the bottom-up approach using simulations to generate emergent behaviour and drawing inferences by analogy with the real world. There is a large literature on mathematical systems designed to exhibit complexity and much very interesting discussion of the

occurrence of complex phenomena in both natural and man-made systems. What is less discussed, perhaps, is the “So what?” question. What does complexity thinking have to offer the busy executive or enterprise manager? How do these ideas interact with well-established management practices? What do they tell us about how to manage better? What do we need to know about a system to be able to analyse and interpret its behaviour for managers?

If it is accepted as true that human enterprises are complex adaptive systems (CAS), then it must also be accepted that existing management practice has at least some capacity to cope with complexity. Hence, the would-be management consultant or operational researcher needs to address some key questions. What value is added by more explicitly embracing complexity thinking? What considerations must be borne in mind when seeking to support management from a complexity perspective? What validity criteria should be used when seeking to choose effective enterprise support? In other words, we need to justify our place at the executive table.

The problem of complexity is compounded when one considers the internal politics of enterprise management and fact that human enterprises have an added characteristic not present in many CAS, namely ‘self-awareness’ and the ability to reflect upon their own existence, behaviour and adaptive responses. Avoiding, for the moment, the obvious metaphysical arguments concerning the nature of awareness, it is clear that human enterprises are capable of ‘anticipatory adaptation’, responding to perceptions of future interventions and context changes, and having multiple interacting loops of perception and pre-emption.

The problem space thus concerns the analysis and management of complex adaptive reflexive systems (CARS); hence the rather poor pun in the sub-title of this paper! It is an exasperating problem because CARS have a habit of changing in response to attempts to manage them, or even in anticipation of such interventions. From an analysis perspective complex adaptation presents problems enough, but the self-reflecting nature of human systems adds additional cognitive and social dimensions which can confound analysis. This broadens the scope of the management support problem and raises significant ethical issues for the analysts and engineers.

This paper arises from many years of thinking through this problem from the perspective of Defence Operational Analysis (OA)<sup>1</sup>. It begins by assuming that OA has something of value to offer, and then seeks to establish the criteria for adequate support to executive action. In the end, the question is reversed to explore what follows from a conclusion that OA (at least as it currently exists) is incapable of adequately supporting management in a complex adaptive context.

### **Management and Complexity in the Defence Enterprise**

In the Defence and Security field there is an increasing awareness of the complexity of current and future conflicts, and of the military enterprise needed to successfully engage

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<sup>1</sup> ‘Operational Analysis’ is the term used to describe Operational Research in the Defence domain in the UK (to avoid confusion with the term ‘Operational Requirements’).

with and survive them. These considerations, in turn, give rise to a complexity problem in the development and sustainment of Defence and Security capabilities both at national and international levels.

However, the various management, engineering and scientific practices used by Government to direct and control the development of policy and capability are still rooted in conventional design and control paradigms. At the core of these paradigms is a need to predict the consequences of interventions, using this prediction as the basis for planning and course of action selection. Historically, OA has used scientific methods to provide analytic support to management and engineering decisions.

Enterprise executives seeking to design and manage complex enterprises face many challenges and the value of complexity thinking lies in its ability to inform effective executive action. It is important here to recognise the difficulty in defining effectiveness in relation to management. Typically, effective management is seen as that which produces valued outcomes. From this perspective, one can only declare management to be effective when decisions have been implemented and outcomes have emerged.

In managing a CAS this is problematic, since adaptation means that the fitness function itself may have changed in the process of, and in response to, to the intervention made. In driving CARS there is the added complication that definitions of value in outcomes are socially constructed (at least to some degree) and are, therefore, dependent on post-hoc rationalisation processes involving self-justification and ego-maintenance on the part of enterprise stakeholders.

In the face of such subjectivity and adaptability in concepts of outcome value, the question of effectiveness in management support needs to be reconsidered. An alternative definition of effective management might be that all opportunities for useful action were identified and fully exploited. This removes the definitional dependency on outcome success, but still leaves a question over the concept of 'useful action'. The difference is that this concept is now temporally localised and can be interpreted as action that could reasonably be understood to be useful at the time of the decision and with the knowledge then available. The importance of this rather more hedged and complicated definition of effective management is that it opens the way for inferring appropriate actions to develop and sustain effective management capability, which is our immediate goal. It also focuses attention on how science and analysis can support the executive now, rather than pontificating in retrospect or speculating about ideal futures.

### **Role of Science and Analysis in Supporting Executive Action**

Executives need two things from science and analysis - understanding of the options for effective intervention and confidence to take action in the presence of risks (not necessarily connected to understanding!). This two-fold need is identified in Military Doctrine through the terms 'Will' and 'Capability'. 'Capability', in military doctrinal terms, comprises the knowledge, skill, resources, organisations and processes that facilitate the delivery of military effect. 'Will' encompasses the formulation of intent the commitment to act, and the morale to sustain action in the face of adversity. Similar

considerations can be applied to any enterprise executive. During the Twentieth Century, rather too much attention was paid to developing one's own (and attacking an enemy's) Capability and only recently has the emphasis shifted back towards sustaining and engaging the Will. In the process, the scope of scientific disciplines recognised as essential to informing and supporting the executive has expanded. This, in turn, has raised the problem of incongruence and incoherence across the scientific knowledge base.

Gaining an adequate understanding of CARS requires appropriate explanations of the mechanisms through which intervention influence or shape outcomes. Such explanations are offered from many disciplines encompassing many domains of knowledge. A useful taxonomy of domains, derived from work in the area of Network Centric Operations, is Physical, Informational, Cognitive, Organisational and Social.

The Physical domain is where actions and movement take place, and where resources, like people and equipment, have physical existence. The Information domain where information is created, manipulated, shared and consumed, and information systems have their functional existence. The Cognitive domain is where perceptions, awareness, beliefs, and values reside and where sense making and decision making exist. The Organisational domain is where enterprises are conceived, formed and operated. Finally, the Social domain is where people interact in cultural and social networks.

These domains have proved useful in ensuring a comprehensive consideration of enterprise issues, providing an aide-memoir of the full range of disciplines needed. However, there remains the problem of how explanations of phenomena derived from disciplines in each domain can be synthesised in order to allow synchronised portfolios of intervention by enterprise executives.

There is little or no motivation for current scientific disciplines to take the trouble to integrate with each other. Even disciplines with closely related histories tend not to talk to each other, e.g. cognitive psychology and neuroscience or physics and chemistry. The disciplines are taught in separate schools and discussed at separate conferences. Success is measured by citations in discipline-based journals with largely incompatible review criteria (inhibiting cross-publication and joint-publication). Those who seek to operate across disciplines can suffer prejudice in equal measure from all sides, either because the breadth of their research necessarily means less depth or, more perniciously, because the specialisation of disciplinary languages makes outsiders sound like country bumpkins!

If disciplinary siblings have such trouble integrating, then what hope is there for more distant cousins whose integration is required if we are to understand CARS? Where is the common ground in which conceptual and linguistic congruence can be achieved between psychology and sociology; organisation science and systems engineering; teamworking and architecture; anthropology and political science; or theology and economics?

Surviving in this scientific 'Tower of Babel' requires a strongly pluralistic approach and a willingness to see the world through a wide variety of conceptual and linguistic lenses.

## **Looking through different lenses**

The pluralist approach can be thought of using a number of metaphors.

Conceiving the disciplines as islands of comfort set amidst a turbulent sea of reality has some useful expressive power. The attempt to build bridges between the islands by stretching out from each shore with an ever less stable cantilever of knowledge is likely to have limited utility. What is needed for effective bridge-building is for a few brave souls to step out from the comfortable islands of knowledge and step into the uncertainty of the intervening space, where there are few solid concepts and little secure definition, and to start building foundations there. But if the result of such efforts is only a new specialist discipline – a new island of comfort – then little integration is achieved. Complexity ‘Science’ runs this risk.

Another powerful metaphor is to think of disciplines as viewing the world through differently formed lenses. A lens allows the observer a limited view, in which some features are brought to sharp focus and others are distorted and unclear. If we ask a global question such as “What is the best strategy to use if you are a manager<sup>2</sup> or analyst of (or embedded in) a complex adaptive reflexive system?”, then different lenses will reveal differently useful answers. Four such lenses are particularly useful in this context, namely the Philosophic, the Principled (or Ethical), the Pragmatic and the Political.

These lenses invite specialisation of the global question into key subsidiary questions, through which useful insights can be gained.

### Philosophic lens

*Key Question: What does it mean to manage in CARS?*

This lens invites us to consider what could be. It is the lens through which possible futures are envisioned and conceptual models are brought to the fore. It requires a rigorous treatment of language, without losing the richness and diversity of meaning inherent across the many specialist languages involved, and of reasoning, without being too reductionist. It also requires us to be clear about the nature of our models. Four key classes of model are used in normal reasoning: Description, Explanation, Analogy and Metaphor.

Descriptive models provide data about reality organised and structured using taxonomies and relational constructs. They embody worldviews and can imply explanations. Often language is borrowed from other contexts, implying analogies and even metaphors. This is a very weak form of modelling, but is closest to observed reality. They can only be used for prediction on an actuarial basis, making the assumption that the future will be an extrapolation of the past.

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<sup>2</sup> Note: ‘Manager’ is used in a broad sense here and, as such, it includes roles such as Military Commanders and Policy Maker. Whilst there are important nuances implied by the use of these words, they are largely irrelevant to the present discussion, and what is common between them is the main focus of attention.

Explanatory models go further, providing constructs that encode understanding of (or conjecture about) why the world is as it is and the mechanisms of its future evolution. Explanations have more power than descriptions because, if correct, they allow evidence of current phenomena to be correctly interpreted and they are more reliable predictors of phenomena not yet experienced. Wrong explanations, of course, can be very misleading.

When new areas of reality are being explored we will often resort to Analogy as a modelling device. Analogies take descriptions or explanations from other, seemingly similar, areas of reality. The analogy is then used both to describe and to begin to explain. In the latter role, it is all too easy for the analogy to be stretched beyond credibility. Analogies can be very seductive because they allow rapid development of (apparent) understanding, and this can facilitate sloppy reasoning. A common analogy in enterprise analysis is the treatment of teams and organisations using the language of individual cognition.

Metaphor is the most dangerous type of model, largely because it is not intended to be a model capable of sustaining inference and reasoning, but an educative device to aid initial acceptance of a new area of knowledge. The danger lies in taking metaphors to be analogies or even descriptions and explanations.

The bulwark against sloppy use of modelling is a rigorous philosophic approach to the use of inductive and deductive logics, and to concepts such as data, evidence, and prediction. This last is key, since management is fundamentally about seeking to control what is predictable in order to achieve what is desirable. Managers take executive actions in anticipation of future effects or benefits arising. Without this anticipation there would be no reasonable basis for action. Even managing through heuristics is based on the assumption (sometimes implicit) that using those heuristics will lead to future success.

There are serious philosophic and sociologic problems with concepts such as evidence and prediction as a basis for action in CARS. However, we can work around these by arguing that prediction need not be absolutely right, only better than the intuitive predisposition of the executive (where 'better' means more likely to lead to desired outcomes). If intuitive executive decision-making were like throwing dice, then effectiveness is loading the dice in favour of better choices. It is important to remember that the executive still owns the risks of the decision and its consequences, so weak guidance can still be valuable.

Time is a key variable in prediction. The temporal validity of assumptions and the time cycle of executive action combine to limit the utility of predictions. Concepts like dynamic, stable, adaptive, etc. are contingent on the time window of interest, and linking effects and interactions may require quite different or multiple time horizons. Hence, the useful definitions of system boundaries and effect spaces can be time sensitive.

In the context of CARS, therefore, the Philosophic lens should let us consider what it is that is predictable and, by implication, what isn't, which in itself is important knowledge. This will allow the identification of what levers managers can pull with confidence, and

the reachability of different effects and effect spaces. Exploiting such knowledge may mean shifting the emphasis from managing behaviours and structures towards managing goals and the mechanisms of adaptation. Even processes may be sufficiently adaptive to be beyond useful prediction, and hence management, at least in the longer term.

The challenge to science and analysis then becomes helping to elucidate the appropriate conceptual models and heuristics for managers to use. Many such models exist and more come into being almost daily. In considering which conceptual models to adopt three basic filters should be used: Reality, Relevance and Realisation.

The Reality filter asks, “Is the concept firmly based in empirical science?”. This filter helps to weed out the inappropriate use of metaphor and analogy, as well as the lure of elegance, to which many modellers fall prey.

The Relevance filter asks, “Does the concept describe/explain phenomena of interest?”. This filter rules out models of academic interest only, and focuses attention on the useful. It may be that less elegant and less well researched models are needed to address key issues of relevance to the executive, especially if the research base has been staying on narrow islands of comfort rather than engaging with messy reality.

Finally, and only after the first two have been applied, the Realisation filter asks, “Can the concept be operationalised?”. A conceptual model is only of value if it can be applied to the executive decision problem at hand. However, the imperative to apply the model can, and often does, lead to the application of unreal or irrelevant models, leading to unreliable advice to executives. This is one of the dangers that requires the use of the Principled (or Ethical) lens.

#### Principled (or ethical) lens

*Key question: What is the appropriate way to interact in CARS to achieve best value for the owner?*

The principled lens goes beyond what ‘could’ be to focus on what ‘should’ be. It emphasises the ethical role for managers (and their supporters) to achieve value for the enterprise owner. While, philosophically, many things could be, it would be unethical to direct or encourage managers to take actions that reduce value for the enterprise.

In order to be principled in the application of conceptual models to support executive action, we need to understand the likely consequences of actions. It is not enough to base interventions on learned heuristics unless there is some reason to believe that those heuristics will be effective, or at least will do no harm. The successful survival of a vast variety of human enterprises suggests that effective intuitive heuristics can be developed, and this source of knowledge should be fully exploited.

However, since intuitive heuristics are learned from past experiences, they may not be reliable for relatively new CARS configurations. Therefore, a key ethical role for science and analysis in developing reliable heuristics for executives to use is to develop a critical

understanding of why human enterprises and their managers behave the way they do. This requires a Pragmatic lens, capable of exploiting the full range of relevant scientific disciplines and empirical knowledge.

### Pragmatic lens

*Key question: Why do managers behave the way they do in CARS?*

If the Philosophic lens focuses on what could, and the Principled one on what should be, then the Pragmatic lens focuses on what is. To understand the behaviour of managers we need to understand the behaviour of humans in general, both individually and in collectives. Significant behaviours and phenomena we 'know' to be 'real' lie in all five of the physical to social domains identified above.

In the Social domain we observe a correlation between size of organisation and the formality of interactions within it. Cultural phenomena in organisations often take years to change, even under pressure from enterprise management. In the Organisational domain we observe that people create and use informal structures, which can be more influential than the formal ones with which we conceptualise and seek to manage organisations. These structures can emerge even when the overt intentions of organisation members are otherwise and can re-assert themselves in the face of attempts at business process re-engineering. Even in safety-critical organisations, people do not consistently follow formal processes.

In the Cognitive domain it is observed that people process information according to their culture, experience, expectation, emotional state. Personality can be as important a factor in decision making as the whole effect of the so-called 'Information Age'. In fact people in natural decision contexts seem to use relatively little of the information available to them to trigger and guide their actions.

Thus, enterprise behaviour viewed in the Information domain is unlikely to follow the cause and effect chains usually assumed by those investing in Information Technology. Indeed, even the Physical domain significant phenomena are observed that need to be explained by our enterprise understanding. For example, a relatively minor technical fault in an enterprise communications network can lead either to a managed recovery or a quite disproportionate reaction that disables the service for most users. The difference between these consequences is critically dependent upon human social and organisational factors, such as the formal and informal processes followed by system managers.

Explaining such phenomena requires us to look more closely at the sources of human variability, both at the individual and group levels.

Sources of human variability are many, and knowledge about them comes from a wide range of disciplines. Individuals vary over time. Human cognition, often analogised to digital computer, is clearly an emergent property of a rich and complex system. From medical research it is known that the two halves of the human brain are capable of hosting different thoughts and even different life goals. Perception and awareness are



largely constructed from prior knowledge rather than being dominated by contemporaneous sensation. Self-perception depends crucially on storytelling, the construction of explanations of our own behaviour that satisfy social and personal need. Memory itself is constructive, hence able to be modified by subsequent experiences. Reasoning is deeply involved with the emotional responses of the brain, allowing autonomic emotional responses from past experience to be encoded in information processing heuristics, and vice versa.

To a large extent the common understanding of cognition has been coloured by outdated notions of humans as rational agents for whom factors such as those above are limitations and constraints on our ability to choose optimum actions from many options considered. Current psychological theories favour a more naturalistic process, based on serial consideration of options and a satisficing test of acceptability. In this model, conventional rationality, far from being the norm, is a highly trained behaviour requiring much effort and expertise. The naturalistic model of human cognition allows for a much richer understanding of human variability, necessary to appreciate the behaviour of human enterprises.

Understanding human variability, both individual and collective, can be greatly enhanced by looking at it through an evolutionary lens. Humans are an evolved species, and a key consequence of evolution is that it creates multi-layered entities in which behaviours, and the mechanisms from which they emerge, are combinations of primitive and modern elements. For example, the fact that people use only a fraction of the information available to their senses, even when they are capable of doing more, can be understood from the evolutionary perspective.

Primitive elements of the mammalian neural system process sensation in ways that had survival utility in achieving rapid identification of predators and carers. As higher brain functions evolved, there were limitations in working memory and processing capability, which favoured the development of efficient heuristic approaches to cognition. Modern human brains have not evolved physically since the days of the hunter-gatherers in the African plains, meaning that there is still a need to exploit efficient heuristic approaches.

Even if the challenges of survival in modern urban settings are very different from primitive times, it is not always possible or efficient to simply switch off older mechanisms. It seems more likely that new capabilities will be layered upon older ones and the combination adapted to new circumstances. From this perspective, naturalistic decision making and the importance of emotion in reasoning make much more sense, as do the ways in which humans tend to revert to more primitive behaviours when placed under stress.

Collective human variability can be similarly understood using an evolutionary lens. A more 'naturalistic' view of organisations combining primitive socialisation strategies with modern social developments provides a more plausible explanation for the richness of behaviours and the response to stress. It also helps to explain the fact that

organisational behaviour frequently differs from what might be expected from an understanding of formally espoused structures and processes.

One further lens is required to fully understand the needs of the executive. The behaviour of management in CARS, seen through an evolutionary lens, is clearly the product of a rich social process in which the managers are intimately involved and personally engaged. Consequently, there is a political dimension needing to be understood before the criteria for effective decision support can be established.

### Political lens

*Key question: What does a manager have to do to ensure continued survival in CARS?*

It is a common mistake of analysts to presume that options for executive action should be judged from the perspective of their predicted effectiveness if implemented. However, managers, even chief executives, are not entirely free agents. They operate within a social and institutional process, which both empowers and constrains them. They have their own needs and aspirations, and their organisation, similarly, as cultural and social mores that shape individual and collective behaviour.

If we are to be effective in supporting executives, it is important that we understand what advice they are politically capable of accepting, and how to formulate that advice to best effect. This requires an understanding of the politics of the organisation and the constraints on managers arising from their need to survive and thrive politically.

In typical bureaucracies, there is an ethic of rational decision making, and a demand for evidence to support it. As has already been discussed, the natural mode of action for human enterprise is a rich mix of intuitive and informal behaviour in which classical rationality is a special case. Often, in organisation, the espousal of a rational, evidence-based decision process acts more as a social process, facilitating corporate will to act by providing a plausible story behind chosen courses of action that does not challenge the self-stories of the participants. This might explain how enterprises can operate successfully despite the fact that the evidence they generate to support decision making arise from non-requisite models with poor predictive power.

Intriguingly, the importance of the social process surrounding the use of scientific and analytic evidence can present an ethical dilemma. If the chief effect of an analytic decision process in a particular enterprise is not to discriminate options for action, but to engender the collective Will of the executives, then is it ethical to deliver evidence based on poor science, provided only that it does no harm?

### **Summary**

This paper has sought to explore the problem space faced by executive, and those scientists and analysts who support them, in trying to drive CARS.

It has viewed the problem using a variety of lenses, each one giving a different viewpoint and focus. A deeply integrative and pluralist approach is recommended, under which

multiple explanations for enterprise behaviour are derived using knowledge from multiple scientific disciplines and empirical experience.

The paper also discussed ethical issues associated with giving valuable advice and support to executives, including the importance of understanding the politics of the executive's organisation before deciding on the validity of analytic evidence.

Playing with CARS can be a tricky business, but the rigorous application of a pluralist analysis will provide CARS drivers with increased capability to plan effective interventions and to muster the collective will to undertake them.