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Impact of Cultural Attributes on Decision Structures and Interfaces'

Mrs C E Siemieniuch
Loughborough University
Department of Electronic and Electrical Engineering
Garendon Building
West Park
Loughborough
LE11 3TU
+44 (0) 1509 635230
c.e.siemieniuch@lboro.ac.uk

Mr M A Sinclair
Loughborough University
Department of Human Sciences
Loughborough University
Leicestershire
LE11 3TU
United Kingdom

Tel: +44-(0)1509-223002
m.a.sinclair@lboro.ac.uk

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Mrs C E Siemieniuch and Mr M A Sinclair
Loughborough University
Loughborough
LE11 3TU

The paper reports on work carried out for the UK Ministry of Defence in the area of the control and operation of Semi/Autonomous Systems). Increasing use will be made of 'uninhabited' systems in all types of military operations but the degree of decision making autonomy and the position of the control interface will vary according to context. Given the increase in coalition force groups, OOTW, collaboration with NGOs etc, C2 systems must deal with a range of organisational systems which come from and operate within different cultural contexts and hence exhibit a range of cultural attributes. These not only impact on decision making / decision execution processes but also increase the capacity for conflict and misunderstandings in communicating and implementing 'Commander's intent'. The paper begins with some background rationale for the work and is followed by a brief description of the aims and objectives of the research and descriptions of two prototype tools: a Cultural Values Modelling Tool and a Cultural Attributes Framework, both of which are at the heart of the research. A discussion on initial findings and future directions will complete the paper.

1 BACKGROUND RATIONALE

The UK Government, and its Ministry of Defence in particular has recognised that there will never be enough funding available to keep abreast of the latest defence developments. It has also recognised the speed with which civilian technology is advancing, often outpacing analogous military developments; these two factors have led to the development of a number of Defence Technology Centres, as a means of entraining the best of both arenas for the betterment of defence technology.

The aim of the Systems Engineering for Autonomous Systems Defence Technology Centre (SEAS DTC), the fourth DTC to be established by the UK Ministry of Defence, is to research innovative technologies relevant to autonomous systems, from system-of--system down to sub-system level and, through the adoption of Systems Engineering approaches, to facilitate pull-through of the technology into military capabilities. Its particular research domain is the development of novel technology-based system solutions to the understanding and advancement of uninhabited military vehicles. This includes adaptive management and control whether air, land or sea in the context of information sensing, processing and networking (but excludes the full network itself).

It is generally accepted that in future military operations much greater reliance will be placed on 'uninhabited' systems for surveillance, targeting, communications and as weapons platforms in all environments - in space, on land, in the air and at sea. This has many advantages in terms of cost, safety etc. However, 'uninhabited' does not equate to an absence of humans from the system: humans are involved in the system design, testing, operation and of course control. It is also clear that humans will retain the ultimate responsibilities for mission planning, control and decision making with regard to the operational deployment of this class of capability – although the position of the

control interface and allocation of decision making autonomy within the system will vary from occasion to occasion depending on the embedded intelligence within the overall system, task requirements, context etc. It is the various combinations and configurations of technical and non-technical components that make up what is termed in this paper Semi/Autonomous Systems (S/AS)

Secondly the increasing use of multinational forces, working with NGOs and operating in conflict suppression / peace- keeping roles in a range of theatres around the world is self-evident. However, this requires the ability to co-ordinate and control a set of organisational systems which come from and operate within different cultural contexts and which exhibit a range of cultural attributes and values: these differences in cultural attributes will impact on decision making and decision execution processes and hence increase the capacity for incoherence and misunderstandings in communicating and implementing 'Commander's intent' within the sort of multi-national coalition forces outlined above.

With regard to this 'workforce mixing' UK forces use 'force packaging' (i.e. modular structures defined as a "series of coherent, self-contained, mix-and-match sets of units borrowed from the various organic commands for a given mission"). Such modules can be assembled at short notice to form a mix of force appropriate for the specific demands of unforeseen crisis demanding the use of armed forces (Dandeker 1999). In the NEC battlespace both technical (IT&T) and non-technical (personnel, process, organisation) interoperability within these units/modules is a critical capability to ensure collaboration among different service and organisational cultures and to maximise operational efficiency.

Finally, it should be noted that the combination of different operational contexts, different goal sets, and ever-changing circumstances, allied to different operational contexts, different policies and procedures, and different technical support create a more-than-sufficient set of conditions for the effects of complexity to be demonstrated in the form of emergent, usually undesirable, behaviour of the combined effort. For example, any particular global mission may experience:

- mission plans that turn out to be unrealistic;
- considerable redeployment of resources;
- unexpected interactions and feedback loops that manifest themselves in undesirable ways later;
- out-of-context information flows;
- failures of organisational understanding;
- clashes of roles and goals;
- dysfunctional and demotivated teams;
- failures in the delivery of service (availability, reliability, etc.).

Culture, in conjunction with several other approaches, is an efficient and effective tool in mitigating these outcomes. We return to this issue in the discussion.

Thirdly the development, implementation and use of technology, such as Semi/Autonomous Systems (S/AS), does not occur in a vacuum. Culture is a 'mediating variable' influencing how new technologies will be designed, adopted and used. Organisational and military research clearly shows that technology tends to be

adopted by users for their own purposes, and exactly how it is used - or misused - is heavily influenced by the extant organisational culture. Therefore, there is a need to identify and develop appropriate system/organizational/team/individual cultures that can effectively support and exploit emerging S/AS effectively.

1.1   Automated v Autonomous Systems

It is worthwhile spending some time clarifying the authors' understanding of autonomy when used with regard to Semi/Autonomous Systems in a military context. The Oxford English Dictionary (OED) defines a System as "a set or assemblage of things connected, associated, or interdependent, so as to form a complex unity" – '*things*' would comprise technical (IT&T) and non-technical (personnel, process, organisation) capabilities.

The authors make a clear differentiation between Automated Systems, where automation is defined by the OED as "the use of electronic or mechanical devices to replace human labour" and Autonomous Systems where autonomy is defined as "the condition or quality of being autonomous, independent …… self governing…". For example a system may be fully automated but have a low degree of autonomy such as an automated assembly line.

Automation in systems often occurs for 'negative' reasons (e.g. the availability of more advanced technology or in reaction to accidents) or as a result of the 'Left-Over' principle (Chapanis 1970; Hollnagel 1998) whereby the designer will automate anything that can be automated and leave the remainder for the human operator(s). Unfortunately these approaches to automation take into account neither the value added by human operator(s) nor the implications of interactions between the technical and non-technical elements of the system in question.

Autonomy on the other hand has more to do with the locus of control and decision-making within a system or sub system (i.e. its independence from higher level interference). Mouloua, Gilson et al. (2003) refers to a choice between full manual control, supervisory control, and full automation. In a manufacturing context Sheridan (1980; 1994) describes autonomy on a 10-point scale;

- The computer offers no assistance, human must decide all
- The computer offers a complete set of action alternatives
- *And* narrows the selection down to a few, *or*
- Suggests one,
- *And* executes that suggestion if the human approves, *or*
- Allows the human a restricted time to veto before automatic execution, *or*
- Executes automatically, then necessarily informs the human, *or*
- Informs the human after execution only if it is asked, *or*
- Informs the human after execution if the computer decides to do so
- The computer decides everything and acts autonomously, ignoring the human

Full autonomy across the complete range of military systems in the sense described by Sheridan is unlikely in the foreseeable future, particularly where weapon utilization is involved. Therefore it is reasonable to suggest that humans will continue to be involved in the decision-making loop within the class of Semi/Autonomous Systems (S/AS) of interest to the authors. In his excellent book, Sheridan (2002) also captures the intrinsic

paradox of human & machine capability:

> "In comparing humans with machines (in determining allocation of functions between humans and machines and assessing reliability of human-machine systems) there is a tendency to regard people as having a few simple failure modes, much as machines do. In fact, humans differ enormously from machines, in that they are inherently variable and unreliable in their detailed behaviour, while simultaneously being hyperadaptable and metastable in their overall behaviour because they perceive and correct their own errors. Thus they have uncountably many failure modes and are not amenable to being characterised by simple reliability numbers."

Since Military Systems, whether Semi or fully Autonomous, comprise both technical and non-technical elements, the variability in these 'behaviours' will affect the ability of the system to a) achieve its goals, b) make decisions and c) react to unexpected events. The basic hypothesis of the research project is that the required human decision-making behaviour in S/AS is directly impacted by the cultural attributes described later in this paper and, as such, needs to be taken into account during the design and operational configuration of S/AS systems.

Furthermore, the technical components of the S/AS will also need to demonstrate appropriate decision-making behaviour within the levels of autonomy assigned to them within the overall system. Some cultural attributes are inherent in the design of these technical subsystems as described by Helmreich and Merritt (1998):

> "We can say Airbus conceptualises the plane at the top of the design hierarchy with pilots subordinate, while Boeing conceptualises the pilot on a more interactive footing with the plane".

The rationale for this is that French engineers are seen as an elite and therefore the end product is designed to function as perfectly as possible; American engineers are caricatured as dull and inflexible whilst the Pilot epitomises the independent American stereotype so the plane is designed to be on a more interactive footing with the pilot. Since the latter is fixed but not necessarily understood and the former is variable and dependent on a particular instance of system operation, understanding the impact of cultural attributes on overall system behaviour will provide greater insight into the desirable and achievable levels of system autonomy that can be achieved in a given set of circumstances.

2   WHAT IS CULTURE?

It is not the intention of the authors to provide the readers with detailed discussion on Culture – the literature on this subject matter is large and varied.; for military culture see Dandeker and Mason (2000); Alberts and Hayes (2003); and English (2004); for civilian/ commercial culture see Hofstede (1984; 1991); Hampden-Turner and Trompenaars (1994); Helmreich and Merritt (1998); Meier (1999); and Moray (2000). However a few key points of relevance to this paper are emphasised in the following sections.

2.1   Example definitions and perspectives on Culture

Kibr (2003) defines culture as a system of collectively shared values, beliefs, traditions and behavioural norms unique to a particular group of people, agreed over time. Culture is very important to people because it confers membership of the group and affords recognition by the members of the group, and it provides norms for their behaviour and perspectives that enable easy communications and assistance within the group, and preference for cultural values is often emotional as much as rational. They may even regard certain social norms and traditions as eternal and sacrosanct.

Smircich (1983), elaborating this definition, states that organisations have their own cultures unique to that organisation. He believes that culture is not something that an organisation has but something that an organisation is. Furthermore, individuals belonging to a profession will share a professional culture influenced by training and education, and professional cultures will often transcend organisational boundaries. Finally, he states, culture varies between countries. Organisations in different countries in the same category were often structured and behaved differently - these differences were most striking when they were detected in the subsidiary companies of the same multinational organisations. This suggested that national cultural differences help to shape organisational design and behaviour at local level.

Handy (1976) has sought to identify some of the differing cultures of organisations. For example, the 'role culture' is often stereotyped as bureaucracy, and the role fulfilled by an employee is generally more important than the employee filling the role. The organisation requires the satisfactory performance of the role, and the role culture is best suited to operating in a stable environment. Processes and procedures are considered more important than the results that they achieve. Role cultures can be frustrating for ambitious employees, but offer security and predictability. In contrast, in a 'task culture' the emphasis is on getting the job done. The culture seeks to bring together the appropriate resources, the right people at the right level of the organisation and let them get on with it. The task culture is very much a team-based culture and therefore highly appropriate to organisations that are project-based or where flexibility and sensitivity to the market or environment are important.

The literature also reveals that there are elements of Human Research Management approaches, anthropology and organisational sociology involved in the study of culture. There is a view that organisations are like miniature societies with unique configurations of heroes, myths, beliefs and values. This is a popular view, around which there are four schools of thought:
- Human relations - this is based on new theories of motivation and group dynamics and has adopted a frame of reference which emphasises that organisations exist to serve some human need – both the customers' needs and those of the people within the organisation.
- Modern structural theory - this considers organisations to be rational, goal-orientated, and mechanistic, focusing on issues of authority and hierarchy as manifested in organisational charts. This approach emphasises the importance of such concepts as differentiation and integration.
- Systems theory - this approach suggests that organisations are best thought of as interdependent systems linked by inputs, outputs and feedback loops. They are composed of cultural systems rather than cultures. This emphasises the importance of analysing the organisation in its environment, the stresses placed on organisations

due to uncertainty, and the limited scope that employees have for exercising their individuality.

- Power and politics perspective - this suggests that organisations are complexes of individuals and coalitions with different and competing values, interests and preferences. It argues that organisations often act irrationally, that their goals and objectives often emerge through a process of negotiation and influence, and that organisations are composed of groups (coalitions and subcultures).

A number of theorists have also identified a number of elements or aspects of culture often called Artefacts (e.g. Schein 1985; 1996), which are said to be the most visible and most superficial aspect of organisational culture. They can include: material objects including brochures, annual reports, etc; physical layouts; technology; language; symbols; rules, systems, procedures, programmes. The importance of artefacts stems from the link they are assumed to have with the deeper levels of an organisation's culture, of which they are generally thought to be indicators. For example, separate offices are said to reflect the ethic of individual autonomy and independence, while open plan offices reflect a cultural inclination for co-operation and team-work and for control through peer pressure.

However there is general agreement on Hofstede's (1991) definition of culture as it applies to humans, and it is this definition that has been adopted by the authors for this paper:

"the collective programming of the mind which distinguishes the members of one human group from another. ... Culture, in this sense, includes systems of values; and values are among the building blocks of culture".

Hofstede's (1984) four dimensions still figure under various guises in most research in this area:
- Power distance: high (considerable dependence of subordinates on superiors and little inclination to question decisions) v low (preference for consultation)
- Individualism v Collectivism: individualist (consider the implication of their behaviour within a narrowly defined area of personal values costs and benefits, independence and self sufficiency are values) v Collectivist (behaviour is linked to the group, the extended family or organisation which must not be let down or disgraced, loyalty and harmony and predisposition by fate)
- Uncertainty Avoidance: high (have more people who feel under stress at work, want rules to be respected, want a long-term stable career) v low (tend to be more relaxed at work, can live with chaos and ambiguity, shorter term career changes etc) Based on country not individual correlations.
- Masculinity (gender roles are clearly distinct, aggressive assertive men and modest gentle women, reward the strong, economic growth versus protection) v Femininity (social gender roles overlap and there is greater concern for quality of life)

Major studies since (Connection 1987; Schwartz and Bilsky 1990; Trompenaars 1994) have found particular overlap with Hofstede's dimensions of Power and Individualism. Note that Hofstede's country scores represent only a broad brush picture from a large scale study and intra- and inter-cultural effects should not be overlooked nor the fact that the local context can be critical for interpretation.

2.2   Key contributors to Cultural Values

The Loughborough University team decided to focus on three widely accepted classes of culture, each of which could individually and collectively influence the set of cultural values exhibited by an individual, team, organisation or system. The following three sections provide a brief overview of each.

National Culture

National culture is a product of heritage: religion, history, language, climate, population density, availability of resources, politics etc. The following can vary according to national culture and can therefore shape expectations and performance

- Leadership styles (hierarchical v consultative)
- Superior – inferior relationships (accept v question decisions)
- Communication styles (direct and specific v indirect and non-specific)
- Reading emotional reaction (showing reaction, emotion or aggression v hiding reaction)
- Following v breaking rules

Professional Culture

The culture of a profession is manifested in its members by a sense of community and by the bonds of a common identity (Goode 1957). Attributes of professional culture can include:

- Members have specific expertise and a shared professional jargon
- There are norms for behaviour
- Common ethical values are binding
- Selectivity and competition for entry
- Prestige and status
- Badges or defining uniform
- Extensive training required
- Professional and gender stereotyping
- Gender differences (but note the model woman scores more like a man)
- Sub groupings or cultures can exist
- Status differentials
- Self regulation
- Institutional and individual resistance to imposed change
- Reluctance to admit error
- Denial of 'vulnerability'
- Reduced awareness of personal limitations

Organisational Culture

Definitions of organisational culture vary. Business schools tend to define organisational culture as a phenomenon which can be managed and manipulated. Sociologists and anthropologists may say that each organisation is a unique, historically derived, subjective phenomenon beyond simple manipulation and organisational psychologists tend to reduce the phenomenon to its sub components. Helmreich and Merritt (op. cit.) define organisational culture as

> "values, beliefs, assumptions, ritual, symbols and behaviours that define a group, especially in relation to other groups or organisations."

Some researchers, such as Morgan (1986) see culture as a metaphor whereas Gold (1987) sees culture as an objective identity. Metaphors allow us to understand organisations in terms of other complex identities, such as the machine, and the organisation. However, most commentators have chosen to think of culture as an objective identity; an organisation is, quite literally, a culture, and features of a culture, including its systems, policies and procedures and processes are elements of its cultural life.

Two layers of organisational culture are often found:
- Formal, surface, visible structures e.g. members' uniforms, symbols, routines, documents etc
- Informal, inner, invisible layer e.g. values, beliefs, subconscious assumptions.

Organisational culture is more amenable to influence than professional or national culture and yet it is organisational culture which essentially channels the effects of the other two cultures into standard working practices. Organisational culture is also unique and what works in one organisation is unlikely to work in another. Some of the factors thought to influence or engender organisational culture include: strong corporate identity such as the nature of the product and market in which the organisation operates; effective leadership; moral association or belief in the company's mission and products; high morale and trust e.g. in senior management; confidence e.g. in quality and safety practices, management communication and feedback; cohesive team working and cooperation; job security; development & training; degree of empowerment etc

2.3   Military cultures and profiles

Nuciari (2003) describes two opposing views with regard to cultural and organisational changes required in [Australian] Armed Forces with the onset of Networked Enabled Capability (NEC).

One view states that new skills and competencies would be involved in a NEC environment, with future warriors needing:

- a good understanding of what their systems could do, of all the capabilities present in the battlespace, and the ability and initiative to apply them to get best effects,
- the freedom to question, risk, innovate, and learn,
- the ability to interpret and make decisions on incomplete data, and/or handle being flooded by data,
- a lot of training to deal with information overload and to think and act differently,
- the capacity to absorb information and sort the 'wheat from the chaff' (tactical decision-makers will need a broad understanding of all the capabilities),
- to be allowed to make mistakes and learn from them,
- a supportive organisational culture,
- to operate in flatter organisational hierarchies since "the traditional hierarchy saw the commander with the coarse, big picture while the soldier had the detailed, local picture". In the future, with everyone having access to a common picture, is there a need for a hierarchy? Furthermore, "increased tempo under NCW operations requires devolved control and separation of command from control".

Those who held this point of view believed that it was necessary to give attention to the organisational cultures and working environments that engendered these qualities, with a

particular emphasis on the need to flatten hierarchies. Cultural change would be of paramount importance as military systems sought to take full advantage of networking capabilities.

The second dominant point of view was that people issues were already being handled. No extra refinement or development would be necessary; for example some skill sets are already present– "If you can survive on the Internet, you'll be able to do NEC." –. Moreover, existing concepts for delegation would handle the flattening of hierarchies.

These two polarised views still exist in military circles today although it is fair to say that a combination of increasing use of multi-national coalition forces, greater networking and communication activity, together with increasing levels of intelligence in software-based systems are handing the advantage to the first view described. However, as with all research into the area of 'softer' aspects of system design and deployment, the key area is in identifying and quantifying these issues. For example under exactly what conditions is a rigourous hierarchical decision-making structure inappropriate and what improvement in performance could be gained from replacing it with a flatter hierarchy? The issue this paper tries to address is the impact that cultural values can have on system performance.

2.4 Culture and performance

Consider the following quote from NASA. Following a detailed investigation of the Columbia disaster, the Columbia Accident Investigation Board concluded that the organisational causes of the accident were rooted in the Space Shuttle Program's history and culture: "In the Boards view, NASA's organisational culture and structure had as much to do with this accident as the External Tank foam." (Johnson 2004)

One of the fundamental disagreements revolves around the 'culture-as-a-variable versus culture-as-a-metaphor' debate. (Smircich, 1983). The first view holds that culture is an objective reality that can be measured and changed; the counterview asserts that culture is a mental state that has to be tolerated since it is incapable of being changed. This project holds to the former view: i.e. that it is possible to identify which cultural attributes impact on which behaviour and hence use techniques such as training programmes or system re-design to deal with issues arising.

This approach is born out by output from a workshop (Johnson, 2004) entitled 'Introducing Innovation and Risk: Implications of Transforming the Culture of DoD'. The following key points from that workshop have relevance for the British Armed Forces:

- Culture is learned from experience and the interpretation of experience.
- Culture operates at different levels of awareness: values, beliefs, attitudes, and behaviour.
- There is no monolithic American military culture. Each Service has a different culture and subcultures, reflecting different historical antecedents and differences in operating environments.
- Culture looks more similar from the outside than from the inside (e.g., military vs. civilian, Army vs. Navy, conventional vs. SOF, or SEALS vs. Rangers).
- Change is characteristic of military culture (e.g., evolution of doctrine and social issues such as volunteer force and integration of the races and sexes.

- Inertia is characteristic of military culture.
- There are levers for changing culture such as training, personnel and reward systems, changing organisational structures and processes etc.

The end view of this workshop was that culture includes systems of values or attributes which act as criteria and reference points for determining behaviour; that a culture is particular to one group and not others; and that culture is learned and is not innate. Hence culture can be re-learned.

3   THE CULTURAL VALUES MODELLING TOOL

A Cultural Values Modelling Tool (CVMT) has been developed during a current UK EPSRC funded project – 'Virtual Organisational Rig for testing and investigating company structures (VORTICS)'. The aim of VORTICS is to create the building blocks of a coherent enterprise modelling capability, comprising a portfolio of models of 'soft' enterprise characteristics linked to existing enterprise models. The Cultural Values Modelling Tool (CVMT) is part of a suite of enterprise modelling tools being developed within the project and its purpose is to allow individuals, groups or organisational systems to identify current or 'as is' sets of cultural values and hence identify commonalities or mismatches, within or between groups or with regard to desirable or 'to be' sets.

At this stage in its development the CMVT has 2 aims:
- **AIM 1:** To allow individuals, groups or organisational systems to identify the current or 'as is' set of cultural values and hence identify commonalities or mismatches
- **AIM 2:** For a given set of strategic goals to identify an appropriate 'generic' set of cultural values that will aid in the achievement of these goals. Comparisons can then be made with this 'generic' set and the 'as is' set identified for the relevant individuals, groups or organisational systems.

Table 1 provides a set of cultural values that illustrate the points made above. They have been developed from Hofstede's set described in section 2.1 above. From the VORTICS perspective, values can be held by individuals, groups and organisational systems / sub- systems. Values can relate to a perception of self, the group or the organisational (sub)system. Each pair of values defines a range, with a description of the likely beliefs, perceptions manifested etc at each extreme end. Individuals et al will select a position towards one end or the other, but rarely occupy the absolute extremes in all contexts. Note that cultural values per se are not right or wrong – rather relative positions on each of the spectrum will be more or less suitable for particular contexts

Universal: 'One size fits all'. A generic version or rule or process is applicable to everything e.g. LCM applies *in toto* to every programme irrespective of size, value, purpose and local circumstances. Formalisation and mandated processes in all areas. Other examples include the fads for Artificial Intelligence, and the 'lights-out' factory.	V	**Particular**: Local characteristics prevail; local rules and procedures are created, over-riding mandated processes as necessary, to get to the goals more readily. Examples include worker participation, quality circles, tiger teams, specialist teams, crisis management, etc

Analysis: 'The devil is in the detail'; analytic approaches offer the best hope for efficient management; projects and problems are decomposed into individual elements for simpler solution. Managers demand facts, metrics and 'the bottom line'. Objectivity is possible and sufficient for management.	V	**Synthesis**: 'The whole is greater than the sum of the parts'; emergent behaviour is best handled by recognising patterns and overall configurations; a systems engineering approach is important. Facts are seen in their wider context. Knowledge does not exist in isolation - knowledge is relational.
Individualism: The needs of the individual come before the needs of the organisation. Individual performance and ability are encouraged and individual success or breakthroughs lauded, though a 'blame' culture can emerge. Tends to be associated with entrepreneurial ventures.	V	**Communitarianism**: the needs of the organisation come before those of the individual; team spirit is what achieves results. It is the team that is rewarded, and individuals are valued on their contribution to the team. The close-knit coherent group is the focus of activity, responsibility is shared.
Inner-directed: internal/local values and perspectives are considered to have more relevance than external opinion. Characteristics of 'self-starters' and self-motivated individuals - encourages 'out of the box' thinking	V	**Outer-directed**: extremely responsive to external influences (e.g. customer demands, market trends, etc.). A characteristic of customer-facing groups in areas such as marketing and sales.
Temporal efficiency: Do things as fast as possible in the shortest possible sequence of elapsed time e.g. time-based milestones have over-riding priority. Efficiency is everything, and 'on-time delivery' is the mantra, whether of system elements or the system itself.	V	**Temporal synchronicity**: Synchronisation of effort within and across projects to ensure co-ordinated maturity of engineering performance and organisational learning. Individual groups may find their resources cut, timescales shifted etc in order to ensure overall system quality and maturity when delivered.
Power by achievement: Influential positions/roles are held by individuals with a record of past success; nepotism is rare. Can lead to 'resting on one's laurels'.	V	**Power by status**: Influence is wielded by individuals with high personal status in terms of seniority, qualifications, and varied experience. Can lead to paternalism and conformance to the established view, which may not be connected to ambient reality.
Low power distance: Decisions are made by those with the appropriate knowledge and experience irrespective of role and are filtered outwards in the organisation e.g. flat decision-making systems, consensus-based decision-making. An established characteristic of 'high reliability organisations'.	V	**High power distance**: Decisions emanate from above and are dispatched downwards through the organisation e.g. hierarchical decision-making systems. A characteristic of some family-owned firms, some military units etc
High risk taking: Chaos and ambiguities are common, rules are there to be bent or occasionally broken; risk taking is encouraged. Organisation appears to be dynamic - 3Ms is famous for its dictum 'it is better to ask for forgiveness than to ask for permission'.	V	**Low risk taking:** Rules are there to be respected, desire for long-term stable careers, status quo is encouraged. Characteristic of mature business domains, where little innovation remains, predictable performance is required and profit margins are slim.

Table 1: Pairs of cultural values

At its current stage of development the titles and description of the cultural values are based on civilian commercial terminology and examples and not military ones – this will be addressed in the near future. A third prototype version of this tool has been used in a recent case study and an extract from the Excel based tool is provided in Figure 1. The case study demonstrated the value of the tool in getting individuals and groups to

question and explore the value sets they held individually and as a group and identify areas where conflicts in cultural values could and did affect the performance of the team.
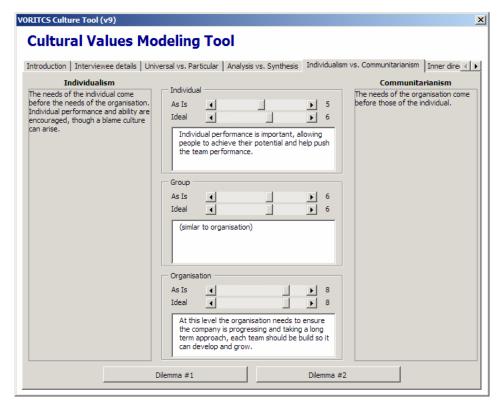

Figure 1: Prototype CVMT

The tool can also be used to identify differences between where individuals/groups/ organisations think they are on the scales and compare this with where they feel they should be. All data can be fed automatically into and Excel Spreadsheet for statistical analyses.

4 THE CULTURAL ATTRIBUTES FRAMEWORK (CAF)

This tool is a derivation of the CVMT described in section 3 and is intended to be used in the particular domain of Uninhabited Autonomous Vehicles. The basic hypothesis of the research project is that Semi/Autonomous systems need to exhibit a range of desired behaviours commensurate with the environment within which they are operating, the tasks they have been set and the degree of autonomy desired. Cultural attributes held by technical and non-technical system components will influence, both individually and as a whole the ability of the system to do this. (Note that the word 'attribute' has replace 'value' since this is more appropriate for the systems approach adopted in this project).

The research will enable a greater understanding of the impact that different configurations of cultural attributes can have in facilitating or impeding systems in making, communicating and implementing decisions, including the requirements for organisational change. This project focuses particularly on the context of 'assisted' decision-making relationships inter and intra different groupings of military operators and the range of autonomous or semi-autonomous systems at their disposal. A combat search-and-rescue scenario has been selected for the initial investigations , although as

the project progresses other scenarios may be used for broader validation of emerging results.

The project has 4 aims of interest to this paper:
- Identify a range of cultural attribute pairings applicable both generically and within a particular combat search-and-rescue decision-making context.
- Investigate the implications of these pairings on (a) system decision making behaviours and structures, and (b) the ability to perform in particular environments. This will result in an initial Cultural Attributes Framework (CAF)
- Explore alternative cultural attribute configurations (and any interactive effects) which may facilitate required decision making behaviour (i.e. organisational, social, cognitive) together with any related implications for organisational change.
- Develop a prototype Cultural Attributes Tool (CAT) which enables a) the identification of conflicts in cultural attribute configurations within a system and b) an assessment of the impact of different configurations of cultural attributes on required system decision making behaviours and the ability of the system to operate in different environmental conditions.

4.1 Research issues

Three main challenges have emerged during this project. One is the requirement for 'transformation' into appropriate organisational forms and architectures, within which these S/AS can function effectively. The defining characteristics (Daft and Lewin 1993) of these seem to be:
- Flatter hierarchies
- Decentralised decision-making
- Greater capacity for tolerance of ambiguity
- Permeable internal and external boundaries
- Empowerment of individuals
- Capacity for renewal
- Self-organising units, and self-integrating coordination mechanisms.

The second is identification of the range and combination of system behaviours that will be required in different contexts (e.g. adaptability, flexibility, being able to make sense out of complex and sometimes contradictory information flows; being capable of dealing with ambiguity and with the lethality and accuracy of the new technology, being comfortable with change and with information sharing; having the freedom and ability to innovate and take risks etc). Having identified these behaviours it will be essential to understand which cultural attributes will facilitate or impede these behaviours to ensure that the appropriate level of system autonomy and performance can be defined.

A third area is the relationship between the environment in which the system operates and the attributes the system possesses. For example if the command and control environment is 'control free', then a system which exhibits attributes such as 'high power distance' or 'universal' tendencies will not be able to operate autonomously.

4.2   Cultural Attributes

The Cultural Values of the CVMT in the VORTICS project are being extended and re-described to form nine pairs of cultural attributes which will be tailored to fit the military domain.

It is believed that there is an identifiable relationship between these attributes and both the required decision-making behaviours from the system (figure 2) and the form of the decision-making environment (figure 3).

Skill class	Desired behaviour	UNIVERSAL	PARTICULAR		ANALYSIS	SYNTHESIS
Communication /interaction skills	*Able to interact with other system agents*					
	Handle conflict					
	Trust					
	Collaboration/ Cooperation					
	Transparent/ open					
Information processing	Speed					
	Deal with ambiguity	N	Y		N	Y
	Deal with complexity				N	Y
	Deal with contradictions	N	Y		N	Y
	Deal with uncertainty				N	Y
	Deal with incomplete info				N	Y
	Prioritise information				N	Y
	Sharing information					
Decision making	Risk tolerance	N	Y			
	Receptivity to new info (open or closed)					
	Deal with variable time pressures	N	Y			
	Act autonomously	N	Y			
	Error retrieval	N	Y			
Command and Control	Cyclic	Y	N		Y	N
	Interventionist	Y	N		Y	N
	Problem-solving				Y	N
	Problem-bounding				N	Y
	Selective control	N	Y		N	Y
	Control Free	N	Y		N	Y
Innovation	Risk taking					
	Self organising	N	Y		N	Y
	Self integrating	N	Y		N	Y
	Self-learning					
	Re-configurability	N	Y			
Situational awareness	Learning					
	Predictability/ Consistency	Y	N			
	Achieve SA/sensemaking				N	Y
	Proactiveness	N	y			

Figure 2: Examples of desired system behaviours and the likely impact of [2] cultural attributes on this behaviour

For example if there is a required behaviour for processing information which included the ability to deal with ambiguity and contradictions in the information or to deal with incomplete information, it is evident that an system demonstrating a position towards the analysis end of the analysis v synthesis spectrum would find this difficult. Or, if the command style adopted was to be 'selective control' or 'control free' then a system position towards the universal end of the universal v particular pairing would be detrimental. Both examples are illustrated in Figure 2. In terms of the decision making

environment, a requirement for a flatter organisational structure or greater sharing of information would impair the performance of a system demonstrating extreme positions on the high end of the high v low power distance pairing.

The impacts of these relationships are being explored in the emerging Cultural Attributes Framework, using an initial set of desired system behaviours extracted from the literature and the authors' previous experience. Initially the Red/Green indicators have been used to indicate a positive or negative effect on the behaviours.

The next stage in the project is to expand the Combat Search-and-Rescue Scenario to a stage where it is possible to identify typical goals, tasks, information infrastructures, decision points etc together with appropriate stakeholders or domain experts. Semi-structured interviews will then be held with these individuals or groups to a) validate and/or extend the set of behaviours already identified b) agree the red/green labels indicated in Figure 2 for all cultural attributes and c) to determine some form of weightings system which will help determine the relative impact of particular cultural attributes on system behaviour.

Environment Category	Environment sub-category	Sub Category Attribute	UNIVERSAL	PARTICULAR		HIGH POWER DISTANCE	LOW POWER DISTANCE
STRUCTURES	Command structure	Flat				N	Y
		Hierarchical				Y	N
STYLE	Command style	Collaborative				N	Y
		Authoritative				Y	N
	Communication structure	Formal				Y	N
		Informal				N	Y
	Leadership style	Strong					
		Weak				Y	
		Individual					
		Group concensus				N	Y
DISTRIBUTION PATTERN	Function distribution	Stovepiped	Y	N			
		Dispersed	N	Y			
	Authority distribution	Centralised	Y	N		Y	N
		Delegated	N	Y		N	Y
	Skills distribution	Specialist					
		Multiskilled					
INTER-OPERABILITY	Systems interop	Heterogenous	N	Y			
		Homogenous	Y	N			
	Process interop	Heterogenous	N	Y			
		Homogenous	Y	N			
UNCERTAINTY	Role definition	Clear					
		Fuzzy	Y	N			
	Operating space size	Large					
		Small					
		Bounded					
		Unbounded					
	Degree of change	High					
		Low					
		Predicatable	Y	N			
		Unpredictable	N	Y			

Figure 3: Likely impact of exemplar cultural attributes on system performance within particular environments

In parallel with this activity likely attributes of the environment will be identified and a similar exercise undertaken to determine the impact of relevant cultural attributes on the systems ability to perform effectively in an environment with a given set of characteristics. Figure 3 provides an example of current thinking on how two cultural attributes might facilitate or impair system performance in environments exhibiting certain characteristics.

5   CONCLUSIONS

In conclusion the authors have already established that there is a link between cultural values and team performance. Case studies in VORTICS have shown that conflicts in values held at the individual/team/organisational level can cause confusion, resentment and lead to fragmented and impaired performance of the overall enterprise system. Based on an initial literature review the original set of cultural values, now translated

into cultural attributes also seem to have similar relevance and impact within a military context.

The literature clearly underlines the importance of culture as a variable in military system performance. However the authors have found no other research project that is taking the approach outlined here. If successful, it will be possible to characterise systems by the cultural attributes that they demonstrate. Particular characteristics emerging from particular configurations of cultural attributes will indicate the likelihood of a system being able to perform a particular set of goals in and particular environment. More interestingly it will provide more insight into the advantages/disadvantages and potential impact on system performance of varying levels of autonomy in semi-autonomous systems.

The authors also said earlier that there would be a return to the topic of culture as a tool for mitigating the effect of complexity in joint missions. Interest in complexity tends to be of two classes: (a) the emergence of unexpected order from a disordered context (e.g. the emergence of life); and (b) the emergence of unexpected behaviour from an ordered context (as in organisations). It is the latter that is the focus of this discussion.

In a seminal presentation, Gregg (1996) posited the following as antecedents of unexpected behaviour:

- the mission is comprised of many parts or agents
- there are many kinds of these
- each has a degree of behavioural autonomy
- there are multiple steady states
- behaviour can be in continuous evolution
- there is rich interconnectivity among the agents
- there is non-linear interaction among the agents

If the mission has several of these attributes, then global behaviour will include emergent, most often unwanted behaviour, and this will not be fully predictable. Furthermore, the causes of this emergent behaviour are systemic, and are not likely to be reducible to the actions of particular agents.

Some immediate consequences that emerge from these points are that firstly, the management of such missions is likely to be far more difficult than initially expected, and likewise, performance may be impaired significantly. Both of these outcomes have heavy resource, communications and knowledge implications, and various strategies have been suggested to address these problems. However, it will be appreciated that the behavioural autonomy referred to in the list above (which contributes to the emergent behaviour problem) is also a possible ameliorator of the problem. The key is vision and culture; the management problem is much easier if the people on the journey are already willing to walk together and aim for the same destination, rather than wanting to go in different directions at different paces. This synergy can be aided by culture; with the right culture, roles and authority in place, the agents can then have management devolved down to the agent level, much easing the control and performance problems, and mitigating the effects of undesirable emergent behaviour. Other issues are obviously also important and must be addressed as well; but they will not succeed without attention being given particularly to the cultural issues.

Fortunately, it seems that the Military Mind and Doctrine has adopted this kind of thinking along the Lines of Development, and perhaps the tools outlined above will help to put some of this thinking into effect.

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