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Abstract

This paper provides the background rationale for and description of a prototype culture tool, the Soft Factors Modelling Tool (SFMT), which is one of the outputs of a DTC-funded research project. Following an introduction, the paper considers several issues associated with autonomy and culture. A description of the researchers' Soft Factors Modelling Tool' and its application is provided.

Keywords: Autonomy, semi/autonomous systems, culture, cultural factors, missions, SFMT

Introduction

The wars in Iraq and Afghanistan have provided a stimulus to the development and application of unmanned semi-autonomous/autonomous vehicles (S/AVs) and systems (S/ASs) for surveillance, targeting, communications and as weapons platforms. S/AVs provide many benefits including reduced risks to personnel, more accurate and timely intelligence and, in some cases reduced costs. Although S/AVs are unmanned, humans are involved in system design, testing and, depending on the degree of vehicle autonomy, operation and control of the vehicle.

Further factors associated with the wars in Iraq and Afghanistan include the increase in multinational coalition force groups, the large number of operations other than war (OOTW), e.g. the building of roads and provision of medical facilities to local populations, and the requirement to collaborate with non-government organisations (NGOs) such as aid agencies. Such multinational, multi-organisational situations will be a feature of future military scenarios that Western countries will be involved in. As a result, military command and control (C2) systems will have to interact with an increasingly wide range of 'hard' systems (communications equipment, weapon systems, etc.) and 'soft' systems (organisations, rules and regulations, individuals, etc.). Each of the above soft and hard systems is developed largely within a particular country or region, and subject to a particular national culture.

Semi/autonomous vehicles and systems

Autonomy is primarily about the locus of control and decision-making within a system or subsystem (i.e. its degree of independence from higher level interference).

For the purposes of this paper, a semi/-autonomous system (S/AS) is considered to be a configuration of technical components (vehicle, weaponry, external communication and control systems, etc.) and non-technical components (people, rules, procedures, etc.).

Humans are expected, for the foreseeable future, to retain ultimate responsibilities for strategic mission planning, control and decision making with regard to the operational deployment of autonomous vehicles and systems. However, the location of the control interface and the allocation of decision-making autonomy within the system will vary from system to system depending on factors such as the embedded intelligence within the overall system, the

task requirements, mission complexity, environment and personnel.

The American Department of Defense utilises a 10-point scale of autonomous capability levels (ACLs), from 'remotely-guided' to 'fully autonomous swarms'. On this scale, the Predator is at point 2, and Global Hawk is a little higher. The UK's Taranis unmanned combat air vehicle (UCAV) demonstrator is designed to be capable of higher autonomy than these, as it is required to plan multiple targets and to defend itself against enemy aircraft.

The basic hypothesis of the Loughborough research project is that the human decision-making behaviour required in S/AS is directly impacted by the cultural factors described later in this paper and, as such, these factors must be taken into account during the design and operational configuration of S/AS.

Cultural influences on autonomy

Some cultural traits are inherent in the design of technical systems, and the degree of autonomy assigned to them. As an example, the French-dominated Airbus company and the American Boeing company have different design philosophies, which are largely products of their differing cultures. The French view their engineers as an elite group, and the aircraft is therefore designed to function effectively with a minimum level of input from the pilot - i.e. to possess a high level of autonomy. However, American pilots epitomise the independent American stereotype; therefore the plane is designed to be on a more interactive footing with the pilot. As a result, Airbus and Boeing differ in their approaches to fly-by-wire (FBW). In both cases, computers are inserted between the pilot and the flight controls, engine controls, etc., but the ultimate levels of autonomy and control are different.

In the case of the A320 and later Airbus models, the flight envelope protection provided by the FBW system retains ultimate control at all times - the pilot cannot fly outside the normal predefined flight envelope [1]; under certain conditions, the FBW computer will make further decisions (e.g. that the plane is landing), and override the pilot inputs, (e.g. for more power). In a Boeing 777, the pilot can always override the system, although strong warnings will be given; this allows the aircraft to be flown outside the standard flight envelope in emergencies.

The preferences of pilots for one or the other system also tend to be strongly biased by their culture. Western pilots, in particular Anglo-Saxon pilots, generally prefer the Boeing model, and tend to have doubts about increased computerisation of flights in general, as they consider that it leaves pilots less alert and less able to respond to emergencies. Eastern pilots tend to prefer increased computer control of flights.

An understanding of the impact of national and other cultural traits on overall system behaviour will provide greater insight as to the levels of system autonomy that can be achieved in a given set of circumstances.

The effects of culture on people

Hofstede [5] defines culture as:

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

This implies that the acquisition of culture is an unconscious, subtle process, which leaves people with only a limited awareness of culture's influence on their behaviour.

Hofstede [5] states that there are three broad perspectives on culture as depicted in Figure 1:

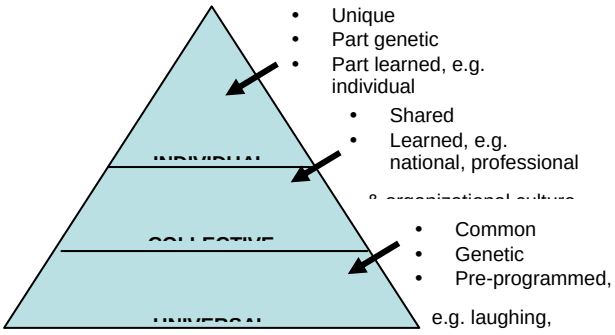

Figure 1: Hofstede's perspectives on culture

The implication of Figure 1 is that the areas amenable to changes in what Hofstede termed their 'cultural values' are at the *individual* and the *collective culture* levels, where value is seen as 'a broad tendency to prefer certain states of affairs over others'.

The three cultural perspectives (sources of cultural influence) are described further below:

1. National (or ethnic) culture: National or ethnic culture is usually a product of heritage religion, history, language, climate, population density, availability of resources, politics, etc. National culture affects attitudes and behaviours, for example with regard to leadership and communication styles, criticism, attitudes to rules and trust.

National culture is usually acquired during the formative years and is therefore difficult to change significantly later in life.

2. Professional culture: Professional culture is usually manifested in its members by a sense of community and by the bonds of a common identity. Features associated with professional culture can include jargon, restricted entry, prestige, resistance to change and binding norms of behaviour.

3. Organisational culture: Organisational culture arises out of the history of the organisation, its leadership, products or services, etc. Although there will be a common layer across the organisation, in the case of multinationals, significant differences will emerge due to differing national cultures. These will appear as differing leadership styles, manager-subordinate relationships, etc.

Organisational culture is more amenable to carefully-planned change than are either professional or national cultures. Organisational culture channels the effects of the other two cultures into standard working practices, therefore changes to it that are sympathetic to national culture can bring significant performance benefits.

The measurement of culture

In order to predict the performance of individuals, groups and systems on the basis of their cultures, we must have relevant cultural 'yardsticks'. Researchers have produced several overlapping sets of cultural factors (also called cultural attributes or cultural dimensions); these are typically described in terms of two extremes of a scale. Research by Hofstede [5,6], Trompenaars [10], Trompenaars & Woolliams [11], the GLOBE study [7] and others have identified several highly influential 'core' cultural factors. Three of these are listed below:

- Individualism vs. collectivism
- Low vs. high power distance
- Masculinity vs. femininity

There is still only limited agreement between researchers as to a more comprehensive set of cultural factors, some of which are listed below:

- Low vs. high uncertainty avoidance
- Mastery vs. fatalism
- Power by achievement vs. power by status

The Loughborough researchers have chosen a set of factors that appear relevant for military missions and scenarios.

Air accidents and cultural factors

Following Hofstede's large study of managers across IBM's international operations [5], many more focused studies have been carried out, in particular in the field of aviation.

Even taking account of differing fleets, facilities and training, there is considerable variance in commercial air transport safety across national cultures. In particular, collectivist cultures (see later) tend to have a high power distance; this hinders communication and has resulted in many avoidable accidents. Most commercial aircraft are designed in individualist countries, and incorporate cultural assumptions about their users, in particular the flight crews [3]. It is becoming increasingly clear that these assumptions do not fully meet the needs of non-individualist cultures. The Airbus 'model' is a closer fit to the collectivist pilot than the Boeing 'model' is (see earlier).

A number of studies have been carried out on military aircraft, in particular a comparative study by Soeters and Boer of 14 NATO air forces using, in many cases similar aircraft and undergoing similar training [9]. In this article, strong positive correlations were found between the three cultural factors listed below and increased accident rates:

- Collectivism (or low individualism)
- High power distance
- High uncertainty avoidance.

See the next section for a brief description of two of the above cultural factors.

Overview of the cultural factors used in the SFMT

There are currently nine cultural factor pairs in the SFMT v2. Of the nine factors, five can only be exhibited by human agents, and four factors can be exhibited by both human (i.e. non-technical) and technical (i.e. software and hardware) agents, as shown in Figure 2.

Cultural factors can relate to a single system (e.g. an individual or missile launcher), a group of sub-systems (e.g. a troop or a communications infrastructure) or an overall system (e.g. the army or the full set of assets carrying out a mission).

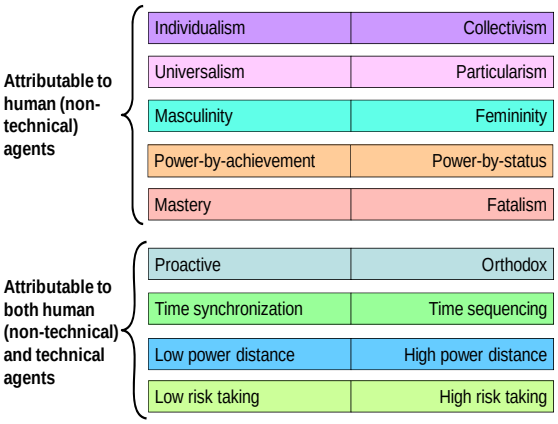

Figure 2: Soft factor (cultural factor) pairings

Each factor is described in terms of two extremes (representing extreme scores from a range of possible values), with a description of the likely beliefs, perceptions, etc., manifested at each extreme end. Individuals and other agents select a position in between, but rarely occupy the absolute extremes in all contexts. It should be remembered that the factor scores, of themselves, are not right or wrong, merely more or less appropriate given a required level of performance in a particular environment.

There is insufficient space to provide a detailed description of all the cultural factors used in the SFMT, but two truncated examples are presented below. Details of other cultural factors are provided in Hodgson & Siemieniuch [4].

- **Individualism vs. collectivism:** This refers to the balance struck between individuals and groups. In *individualistic* societies, ties between individuals (other than immediate family members)

tend to be loose; an individualist takes responsibility for his or her actions, tends to speak directly and factually and is willing to argue and to question others' views. Generally, individualists tend to exhibit a higher level of trust than collectivists. In *collectivistic* societies, individuals are integrated into closely knit groups, often in the form of extended families; in return for unquestioning loyalty, they gain the group's protection. People from outside the group tend to be treated with suspicion. Collectivists try to avoid direct, confrontational approaches and find criticizing others difficult. Hierarchies tend to be rigid, and losing face is to be avoided at all costs.

- **Low power distance vs. high power distance** is about the relationships between subordinates and superiors. In *low power distance* organisations, decisions are more likely to be made by agents with appropriate knowledge and experience, irrespective of roles; inequality of agent roles is a matter of tradition and convenience and can change within an operational environment. Superior officers/agents rely on experience and on lower ranking personnel/agents, and lower ranking agents expect to be consulted. Decisions can be questioned and over-ridden in particular circumstances. In *high power distance* organisations, there are centralised decision structures and a high concentration of authority. Decisions are made by agents in authority based on their roles in the organisation, and are despatched downwards through the organisation; the inequality of agent roles reflects reality. Superior officers/agents rely on CONOPS, procedures, etc., and lower ranks/agents expect to be told – decisions are rarely questioned and never overridden in any circumstances. Privileges and status symbols for higher ranks/agents are expected.

The Soft Factors Modelling Tool

As part of the research project activity, several prototype culture tools have been built to investigate the feasibility of capturing and applying information relating to culture and its effects on system performance. The early web-based tools are described in further detail in [2] and [8]. This section of the paper will concentrate primarily on the latest prototype version of the Soft Factors Modelling Tool (SFMT v2). The detailed cultural factors have been changed more than once in the SFMT v2 and, as a result, the model has been adapted to enable rapid, simple factor removal or addition.

The intended users of the SFMT v2 are mission planners who are required to put together a set of resources (comprising human and technical components) to carry out a mission in a particular environment. The culture tool could be utilised in order to answer a question such as the following example:

" Is a particular configuration of military assets tasked with carrying out a mission, capable of demonstrating appropriate decision-making, communication, adaptive skills and behaviour in an environment where the command style is control free, authority is delegated, operational tempo is unpredictable and the battlespace is ill-defined?"

The SFMT v2 enables mission planners and other leaders or managers to enter estimates of the positions of mission resources with regard to the SFMT's nine cultural pairings (see Figure 2). They can enter up to three sets of values, e.g. representing platoon members, platoon leader and C2.

Following entry of these estimates, feedback is presented to the user(s), highlighting potential conflicts between the actual (estimated) cultural attribute values and the values considered to be optimum for the

mission (or environment) and for the desirable behaviours for that mission

Impact of cultural factor values on the environmental performance

Clearly, military environments will vary considerably in terms of climate, topography, etc. However, variations will also occur in terms of the context within which military operations will take place. The researchers believe that agents or systems exhibiting certain positions on the cultural factor pairings will inhibit or facilitate agent or system performance in an environmental context exhibiting certain characteristics.

Figure 3 illustrates an exemplar section of the 'environment master sheet' (note that, due to space limitations, only two of the nine cultural factors and three of the eight environment classes are included). This sheet provides the estimates of the optimum required cultural factor scores for each of the environment class characteristics for any mission environment requirement, i.e. it relates cultural factors to various environmental/organisational characteristics.

Environment class	Class characteristics	Individualism (-5) vs. Collectivism (5)	Universalism (-5) vs. Particularism (5)
Command structure and style	Centralised structure	2	-1
	Decentralised structure	-3	-2
	Authoritative/interventionist	2	NA
	Collaborative/control free	-2	NA
	Formal communication structure	NA	NA
	Informal communication structure	NA	NA
	Strong directive leadership	0	NA
	Consensus based leadership	-3	NA
Function/ authority/ skills distribution	Stovepiped function distribution	2	NA
	Dispersed function distribution	-2	NA
	Centralised authority over actions	2	NA
	Delegated authority over actions	-3	NA
Degree of interop'ity	Largely heterogenous systems	-2	-1
	Largely homogeneous systems	NA	NA
	Largely heterogenous SOPs	-2	-1
	Largely homogeneous SOPs	NA	NA

Figure 3: A section of the environment master

As an example of the use of the environment master sheet, if the authority distribution is required to be '*centralised authority over actions*' then the 'ideal' individualist-collectivist score is +2, implying a position towards the collectivist end of the scale; however, if the authority distribution is required to be '*delegated authority over actions*', then the ideal score is -3, implying a position towards the individualist end of the scale.

Note that the environment master sheet is stable, and does not change with changing missions.

Impact of cultural factor values on the desired behaviour

It is believed that certain combinations of cultural factor values facilitate or inhibit certain types of decision-making behaviour.

Figure 4 illustrates an exemplar section of the 'behaviour master sheet' (note that, due to space limitations, only two of the nine cultural factors and three of the eight behavioural categories are included). This sheet provides the estimates of the optimum cultural factor scores for each of the behaviour traits, i.e. it relates cultural factors to various behaviours.

As an example of the behaviour master sheet's use, if a mission requires a soldier to '*say what you mean and mean what you say*', then a cultural factor score (-4) towards the individualist, rather than collectivist end of the scale would be preferable; however, if the requirement was to '*convey meaning indirectly*', a more collectivist soldier (+2) would be preferable.

Note that the behaviour master sheet is stable, and does not change with changing missions.

Skill class	Desired behaviour	Individualism (-5) vs. Collectivism (5)	Universalism (-5) vs. Particularism (5)
Communication / interaction skills	Say what you mean, mean what you say	-4	-3
	Convey meaning indirectly/diplomatically	2	1
	Handle/dispel conflict	NA	NA
	Ability to trust and be trusted	-3	-3
	Willingness to collaborate/co-operate	NA	NA
	Transparency/openness	-3	-3
Information processing	Process information rapidly	NA	NA
	Deal with ambiguity, contradictions & uncertainty	NA	NA
	Deal with complexity	NA	NA
	Deal with incomplete information	-2	NA
	Objective analysis of technical data	NA	NA
	Prioritise information	NA	NA
	Sharing information	-3	-3
Decision making	Ability to deal with risk	-3	NA
	Deal with variable time pressures	NA	NA
	Willingness to take decisions	-3	NA
	Will follow orders and CONOPS	2	2
	Act autonomously	-3	-2
	Recognises mistakes/takes action	-3	NA

Figure 4: A section of the behaviour master

Using the SFMT

The SFMT requires users to enter three sets of information:

1. **The cultural factor scores of individuals, groups and/or systems**: For example individualism vs. collectivism, low vs. high power distance. These are entered in a table by scoring them (from -5 to +5) on the nine cultural factor scales. Both the *actual* scores (based on knowledge of the agent(s)) and the perceived *desirable* scores may be entered.
2. **The environmental requirements of the proposed mission or actual scenario:** For example command structure & style, function/authority/-skills distribution. These are entered on a data input sheet that lists all the environment master class characteristics, enabling the user to define the environment or mission.
3. **The behavioural requirements placed on those involved in the specific mission or scenario**: For example the required communication/interaction skills, information processing skills and decision-making. These are entered on a data input sheet that lists all the behaviour master class characteristics, enabling the user to define the behaviour requirements.

Although an SFMT exercise requires a significant amount of information (see 1 to 3 above), some or all of the information may be available from previous exercises. For example, a platoon and its leader may previously have been 'culturally assessed' for other missions; the environmental requirements or behavioural requirements for this mission may have been assessed and used with another group of people.

Following entry of the three sets of information, the SFMT calculates the differences between the various agents' cultural scores (1) and the optimum scores in the master sheets for the environmental (2) and behavioural requirements (3) as specified in the three sets of information.

The SFMT presents the following analysis for the specified mission or environment:

- Individual, average and overall cultural misalignment to mission and/or environment.
- Major cultural mismatches between up to three individuals or groups.
- Unusual patterns of culture factor scores for any agent, for example, it is unlikely that a highly collectivist agent would have a very low power distance score. This facility provides a useful check for input errors.

Sample results can be seen in Figure 5 (summary environment results) and Figure 6 (summary behaviour results). A 'traffic light' system is used to highlight output values as green, amber or red, depending on whether they are within or outside an acceptable range.

ENVIRONMENT		DISCREPANCY SCORES					
		AS-IS			DESIRABLE		
Environment class	Class characteristics	JT, RN, KM & PK	Malcolm Reid	Brigade HQ	JT, RN, KM & PK	Malcolm Reid	Brigade HQ
Command structure and style	Centralised structure	0.5	1.3	0.6	1.0	1.2	0.9
	Decentralised structure	2.8	0.3	2.4	1.3	0.8	1.5
	Authoritative/interventionist	0.7	1.4	0.6	1.1	1.2	0.8
	Collaborative/control free	2.7	0.4	2.2	1.1	0.8	1.4
	Formal communication structure	0.4	1.4	0.0	1.1	1.2	0.8
	Informal communication structure	2.3	0.5	1.9	0.7	0.5	1.4
	Strong directive leadership	1.1	2.2	0.8	1.3	1.7	1.0
	Consensus based leadership	1.2	0.7	1.2	0.7	0.6	0.8
Function/ authority/ skills distribution	Stovepiped function distribution	0.2	1.4	0.6	0.9	1.4	1.1
	Dispersed function distribution	3.2	0.4	2.0	0.7	0.4	0.4
	Centralised authority over actions	0.6	1.8	0.3	1.4	1.5	1.3
	Delegated authority over actions	2.3	0.6	1.5	0.8	0.7	1.1
Degree of interop'ity	Largely heterogenous systems	0.0	0.0	0.0	0.0	0.0	0.0
	Largely homogeneous systems	0.0	0.0	0.0	0.0	0.0	0.0
	Largely heterogenous SOPs	1.3	0.5	2.7	0.5	0.4	0.4
	Largely homogeneous SOPs	0.0	0.0	0.0	0.0	0.0	0.0
Degree of uncertainty	Clear role and task definition	0.6	1.0	0.9	0.7	0.8	0.7
	Fuzzy role and task definition	2.5	0.6	2.6	1.0	0.6	1.3
	Tightly defined rules of engagement	1.7	2.4	1.0	2.3	2.1	3.0
	Broader rules of engagement	0.0	0.2	0.0	0.0	0.2	0.0
	Small well defined battlespace	1.8	2.8	0.8	2.8	2.5	3.3
	Large unbounded battlespace	0.0	0.0	0.0	0.0	0.0	0.0
Operation tempo	Predictable	0.4	0.0	0.6	0.2	0.0	0.2
	Unpredictable	2.1	0.9	1.6	0.9	0.9	1.1
	Reasonably static	0.0	0.0	0.7	0.0	0.0	0.0
	Rapid changes	2.6	1.2	1.1	1.0	1.0	1.2
Resource availability	Less than adequate	1.7	0.6	1.9	0.7	0.6	1.4
	Adequate	0.0	0.0	0.0	0.0	0.0	0.0
Decision making	Long horizon	0.8	0.8	0.7	0.6	0.5	0.5
	Short horizon	2.2	1.0	1.0	0.6	0.6	1.1
	Ad-hoc	1.8	0.9	1.9	0.9	1.0	1.1
	Preconceived	0.6	1.2	0.6	1.0	1.0	0.8
Strategic purpose	Offensive warfare	0.5	0.5	0.7	0.4	0.4	0.5
	OOTW - peacemaking	2.1	1.1	2.5	0.9	0.9	1.3
	OOTW - peacekeeping	0.0	0.0	0.0	0.0	0.0	0.0
	Overall mean discrepancy scores:	2.3	1.6	2.0	1.5	1.5	1.7

Figure 5: Example of analysis results for environment

The summary table traffic light system illustrated in Figure 6 shows that there are problems with the as-is behaviour of the 3rd agent (Brigade HQ). Subsequent examination of the detailed tables (not shown in this paper) will reveal the key mismatches for this agent.

BEHAVIOUR		DISCREPANCY SCORES					
		AS-IS			DESIRABLE		
Skill class	Desired behaviour	JT, RN, KM & PK	Malcolm Reid	Brigade HQ	JT, RN, KM & PK	Malcolm Reid	Brigade HQ
Communication/ interaction skills	Say what you mean, mean what you say	1.6	0.4	1.9	1.3	1.0	1.1
	Convey meaning indirectly/diplomatically	0.8	3.6	0.8	0.7	2.2	0.8
	Handle/dispel conflict	3.7	1.7	1.5	0.3	0.7	0.1
	Ability to trust and be trusted	3.3	1.4	0.3	0.9	0.5	0.1
	Willingness to collaborate/co-operate	3.5	2.1	2.1	0.7	0.7	1.5
	Transparency/openness	0.0	0.0	2.0	0.0	0.0	1.0
Information processing	Process information rapidly	2.0	0.0	4.8	3.0	0.2	0.8
	Deal with ambiguity, contradictions &	1.6	0.6	3.5	0.7	1.2	0.8
	Deal with complexity	0.9	1.5	0.3	0.6	0.9	1.2
	Deal with incomplete information	2.5	0.5	5.0	1.8	0.9	0.9
	Objective analysis of technical data	0.4	1.3	0.3	0.5	1.2	1.1
	Prioritise information	1.5	3.6	0.3	1.8	2.8	2.4
	Sharing information	4.0	1.2	1.8	1.2	0.6	2.0
Decision making	Ability to deal with risk	2.2	0.5	2.9	1.3	0.8	1.3
	Deal with variable time pressures	0.8	0.4	2.0	0.4	0.4	0.0
	Willingness to take decisions	1.2	0.8	3.8	0.5	0.8	2.3
	Will follow orders and CONOPS	2.2	3.1	1.8	2.9	2.6	2.8
	Act autonomously	1.3	0.4	1.8	0.8	0.9	1.0
	Recognises mistakes/takes action	2.4	1.8	1.5	1.4	1.4	0.8
Leadership	Ability to motivate others	2.3	0.8	1.4	1.3	1.5	1.0
	Ability to delegate	0.0	0.5	4.3	0.0	0.5	2.0
	Ability to direct others	0.5	2.1	0.3	1.0	2.1	0.5
	Sets the standards for performance	1.8	0.5	2.5	1.3	1.4	1.0
Innovation	Willingness to take risks	1.4	0.9	0.8	1.0	1.1	0.5
	Ability to balance risk	1.8	2.3	3.2	0.8	0.7	0.5
	Can self-organise, reconfigure	4.0	0.4	0.9	1.0	0.4	0.3
	Capable of learning from action/result	2.8	1.6	4.0	0.5	0.5	0.7
Situational awareness	Physical orientation from external cues	2.5	3.5	0.2	2.0	2.5	0.6
	Cognitive orientation from external cues	1.3	1.5	0.6	0.5	0.3	0.0
	Social orientation from external cues	0.8	2.0	0.3	0.6	1.2	0.2
Adaptability	Robustness	3.2	0.0	3.0	0.0	0.8	0.0
	Resilience	2.0	0.8	1.4	0.0	0.8	0.4
	Responsiveness	2.6	0.3	2.3	0.3	0.3	0.5
	Flexibility	2.6	0.3	3.0	0.3	0.3	0.6
	Adaptability	3.2	0.4	1.9	0.4	0.4	0.4
Error management	Cognitive preparedness	0.5	0.6	0.7	0.0	0.6	0.2
	Flexibility in action	3.4	1.2	4.2	1.0	0.6	1.8
Planning	Analytical thinking	1.6	2.1	2.0	1.4	1.9	2.6
	Holistic thinking	0.3	2.5	2.0	0.5	2.5	1.0
	Concrete reasoning	2.0	2.0	1.5	3.3	2.0	2.0
	Hypothetical reasoning	0.0	0.1	2.3	0.0	0.5	0.4
	Overall mean discrepancy scores:	3.0	1.7	3.6	1.5	1.4	1.7

Figure 6: Example of analysis results summary for behaviour

Applications of the SFMT to-date

The SFMT has been applied to a number of historical case study military scenarios where information about the types of personnel, mission details and outcomes were known and where it was considered that culture played a key role in performance and outcomes. The scenarios included elements of the British Army in the Bosnian War, the USS Vincennes incident and the UK Sierra Leone actions. These applications demonstrated the validity of the model (no inexplicable results) and the levels and areas of warning emerging from the SFMT were in general alignment with the known results.

In addition, the SFMT has been applied to a small UK design company, using the services of a person who was not familiar with the SFMT package. The outcomes highlighted some of the issues that were known to be present in the company.

The SFMT would benefit from application by military subject matter experts (SMEs), but this has not been possible to-date.

Limitations of the SFMT

At present, the SFMT deals with each agent separately, highlighting 'mismatches'. Ideally we would in some cases wish to pick a group of agents which, together, would match the requirements of the environment or mission.

Much culture-related research has taken place over the last thirty years, but no definitive set of cultural factors has emerged as a 'clear winner', although there are perhaps three or four outstanding candidate cultural factors. As a result, the SFMT uses more cultural factors (9) than are ideal (perhaps 4 or 5).

Conclusions

A second version of the soft factors modelling tool (SFMT) has been implemented as an Excel-based package and has been evaluated in several scenarios. The package has been structured to enable rapid update of the soft (cultural) factors in the light of improved knowledge gained from subject matter experts. However, the tool still requires this subject matter expert-based testing to take place in order to enable a detailed analysis of its capabilities and limitations.

There is, as yet, no clear, comprehensive set of cultural factors that meet all requirements, and researchers have to pick and choose those that appear to be the 'best fit'. The Loughborough researchers have based their work on the detailed mainstream literature on culture, and also on literature produced by military organisations.

The research described in this paper has produced an improved understanding of the impact that different configurations of cultural attributes can have on the potential mission performance of agents.

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