Simulating the Dynamics of Information and Knowledge Operations

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Abstract

The notion of Thought Warfare and Anti-Warfare (TWAW) has been introduced in earlier work as a way of thinking about future military conflict and its avoidance. TWAW involves the dynamic interaction of allies' and adversaries' Thought Systems, [Burke 2000a; Burke 2000b]. Current Thought Systems involve entities capable of cognition, emotion and volition - typically (groups of) people - interacting via networks of information and data systems.

Other work [Burke, 2001] explains the relevance of this way of thinking to Knowledge and Information Operations and identifies the key issues involved.

This paper attempts to model the dynamics of the interaction of Thought Systems in Information and Knowledge Operations using a theoretical framework of "universals", [Kearney 1984], derived from world view theory. The key universals considered are:

- Self;
- The Other;
- Causality;
- Classification;
- Time;
- Space.

A scenario involving the interaction of adversarial Thought Systems is explored. Key factors considered are:

- Strategic, Operational, and Tactical levels of command;
- Scale:
  - Size;
  - Connectedness;
  - Consequences.
- Time:
  - Duration;
  - Tempo;
- Media;
- Entities;
- Culture:
  - Belief systems;
  - Languages

1. Introduction

"Information Operations (IO) involve **actions taken to affect adversary information and information systems** while defending one's own information and information systems."(DOD, 1998)

It has been amplified elsewhere (Burke, 2001) that information is symbols to which meaning has been assigned, and information systems are entities that process information. It has also been propose that there are other significant factors in modern warfare and anti-warfare, namely:

- the thought processes by which meaning is derived from information;
- the thought processes by which decisions are made;
- the cultural processes by which meaning is shared amongst groups of people.

Strong arguments have been made to suggest that our ways of thinking about future military conflict and its avoidance need to be extended to include not just the physical and information domains but the domains of knowledge and culture. This extension beyond the limits of Information Operations will be referred to in this work as Knowledge Operations.

2. Knowledge Operations

In previous work (Burke, 2000a; Burke, 2000b) the concept of ***Knowledge Operations*** - orchestrated activities in the knowledge and culture domains that have defence objectives - was introduced. Knowledge Operations are often, but not always, conducted in conjunction with Information Operations.

Three modes of Knowledge Operations are distinguished:

- War
- Anti-War
- Operations Other Than War and Anti-War (OOTWAW)

War is a state of open hostility between two or more adversaries in which the opposing parties attempt to exert their will on each other, using means that are outside the laws, agreements, or treaties that would otherwise govern their inter-relationship. ***Anti-War*** is the state in which one or more protagonists act in attempts to avoid war or to regain peace after war has broken out.

Operations Other Than War and Anti-War (OOTWAW) are operations that may be called upon conducted that do not fall under the categories of War or Anti-War. Typically, they involve considerable interaction with other government and non-government agencies.

Knowledge Operations are concerned with the ways, and means, by which meaning is assigned, derived and shared and so can be used in any of the three modes described above. Information Operations are concerned with the symbols to which meaning has been assigned and the ways and means by which such symbols are processed. In a case where a parallel Knowledge and Information Operation is being carried out the purpose is thus to change a perspective on the way in which meaning is assigned to a symbol within a given culture.

2.1. Entities within Knowledge Operations

Thoughts, thinking processes, and Thought Systems are the primary foci of Knowledge Operations. Burke (Burke, 2000a) defines these concepts as follows.

"Thought is meaning derived from knowledge, will, feelings and other thoughts; it is a state of mind. **Thinking** is the process by which meaning is derived from knowledge, will, feelings and other thoughts. A **Thought System** is an entity capable of thinking; it deals with data, information, knowledge, will and feelings. Thought exists only in Thought Systems; it is what a Thought System thinks"

Thought Systems, therefore, are the entities that are the "targets" of Knowledge Operations.

There are two classes of Thought System that are anticipated to be the major concern of Knowledge Operations in the foreseeable future:

- People. Notwithstanding any advances that may be made in Artificial Thought Systems, it is expected that the majority of important cognitive thinking in defence affairs, and all emotional and volitional thinking, will be conducted by human minds. Even if some cognitive activities become the exclusive realm of Artificial Thought Systems, the most adaptive element in the overall defence Thought System of which they are components will remain the human mind.

- Collective Thought Systems. Collective Thought Systems are an important class of Hybrid Thought System, in which, typically, large groups of people interact via networks of information and data systems to create emergent properties

. The dominant architectural characteristics of Collective Thought Systems include:
  - Extremely large group sizes
  - Extremely high levels of data and information usage
  - Poor levels of coordination
  - Widespread distribution
  - Extremely high levels of diversity
  - The emergent property of Collective Intelligence

2.2. Knowledge Operation Hierarchies

Knowledge Operations can be categorised broadly in terms of a Knowledge Operations Hierarchy with five indicative levels:

- Trans-National Strategic;
- National Strategic;
- Military Strategic;
- Operational;
- Tactical.

The levels in the hierarchy are distinguished on the basis of the nature, purpose, desired outcomes, and timescales of Knowledge Operations. (Levels do not depend on the scale of the operation, or the level of command involved.) In practice, specific Knowledge Operations may not fall neatly into any one of the levels but may "span" the boundaries between levels. For example, specific tactical Knowledge Operations can also have strategic implications at both the national and trans-national level.

2.3. Use of Different Media in Knowledge Operations

There are various media that can be used in the conduct of Knowledge Operations. These include:

- <u>People</u>. Traditionally, people have been the most important medium in the conduct of Knowledge Operations. They can be involved in the creation, destruction, manipulation, influence, etc of most categories of Thought Systems, particularly other those involving other people.
- <u>Material</u>. Physical material items, e.g. explosives, bullets, shells, etc, may be used in Knowledge Operations that involve physical attack or destruction of Thought Systems.
- <u>Electromagnetic.</u> Electromagnetic and directed energy may be used as the medium to conduct Knowledge Operations.

- Systems. Various types of engineered systems, in particular information systems, may be used as the medium to conduct Knowledge Operations.
- Networks.
- Platforms.

2.4. Time

Knowledge Operations usually involve the dynamic interaction of two or more Thought Systems. The Thought System that starts such an interaction is said to have taken the initiative in the Knowledge Operation. If, however, another Thought System succeeds in taking over control of the dynamics of the interaction, then it is said to have gained the initiative in the Knowledge Operation. As in other forms of military operations, taking (or gaining) the initiative can be a critical factor in the outcome of a Knowledge Operation.

2.5. Speed

The rate of development of a Knowledge Operation is referred to as its speed. The speed of Knowledge Operations can vary enormously.

2.6. Duration

The period of time over which a Knowledge Operation is conducted is referred to as its duration. The duration of Knowledge Operations can vary enormously ranging from split seconds to decades or more. Typically, but not always, Knowledge Operations at lower levels in the Knowledge Operations Hierarchy will be of shorter duration than those at higher levels.

2.7. Tempo

The tempo (or rhythm) of a Knowledge Operation is the rate of development of the Operation relative to that of another party, usually an adversary. Again, the tempo of Knowledge Operations can vary enormously. A critical success factor in Knowledge Operations is dominating or controlling its tempo.

2.8. Size

The number of Thought System components in a Knowledge Operation is referred to as its size. The size of Knowledge Operations can vary enormously ranging from just two to billions.

2.9. Range

The physical distance over which a Knowledge Operation is conducted is referred to as its range. The range of Knowledge Operations can vary enormously ranging from the immediately local to global.

2.10. Connectedness

The extent and manner in which the Thought System components in a Knowledge Operation are accessible or linked with one another is referred to as its connectedness. The connectedness of Knowledge Operations can vary enormously from disconnected – no Thought System components are linked to one another - to completely connected – all Thought System components are linked to one another. Although the medium used to conduct a Knowledge Operation can be a strong factor, the connectedness of a Knowledge Operation is ultimately an architectural issue.

2.11. Consequences

The impact of the outcomes of a Knowledge Operation is referred to as its consequences. Consideration of the examples outlined above shows that consequences may be beneficial or undesirable and can vary from the almost inconsequential to profoundly significant

3. Interaction of Thought Systems in Knowledge Operations

It has been stated above that thought processes are the method by which decisions are made and meaning is shared by a group of people. Culture is the term that is used to differentiate between the meanings derived by different groups.

This is well illustrated in the following definition of culture, which is most found in the literature of science, derived from that of anthropologist Clifford Geertz:

> The concept of culture I espouse ... is essentially a semiotic one. Believing.. that man is an animal suspended in webs of significance he has spun, I take culture to be those webs, and the analysis of it to be therefore not an experimental science in search of law but an interpretive on in search of meaning. (Geertz, 1973, p.3)

Geertz' definition is one which proposes that a person's knowledge of his or her world, his or her world view, is essentially mediated by signs, and it is the structure of these signs which establishes reality for an individual or a group. The role of the anthropologist is to act as the interpreter of the structure of the signs that are revealed by a distinct people group to members of other groups.

It has been shown elsewhere (Slay and Burke, 2001) that seven logico-structural categories contained within a given individual's world view:

- The Other
- Classification
- Causality
- Relationship
- Self
- Time & Space

can serve as a framework for analysis of that world view. In order to determine the world view of an individual, his or her understanding of the seven categories of Other, Self, Time & Space, etc., need to be identified and integrated to produce a picture of the complete world view.

4. *Gathering Data to Support World View Analysis*

Qualitative research, anthropological fieldwork and ethnography provide basic data that can indicate, to a researcher, basic information about the meaning that a particular cultural group assigns to a particular piece of data. An example of this is found in a particular cultural understanding of "time". For Western thinkers, time is a linear variable, never repeated, while, for some from a different culture, time is non-linear and seen to be a permanently repeating loop. This means that there might be a weak emphasis placed on speed of response to a stimulus, or in decision making, inherent to members of that cultural group – coupled with a particular belief system there may in fact be more than one opportunity to complete a particular task.

4.1. The Validity Of Qualitative Data In Scientific Research

Many researchers who have originated in scientific and technical fields have been challenged by the concepts of "validity" and "reliability" which are embedded within qualitative research. Within science education, Guba and Lincoln (1985) have introduced alternative measures for the quality of qualitative research. They have replaced the familiar positivist concept that the 'Quality' of research is equal to the sum of its 'Validity + Generalisation + Reliability + Objectivity', with that of 'Trustworthiness' which can be gauged by its 'Credibility + Transferability + Dependability + Confirmability'.

Research in science education has been influenced for about 20 years by forms of representation that originated in other domains. Science educators have embraced qualitative and interpretive research approaches. They have been influenced generally by the work of Denzin and Lincoln (1994) and particularly by those working in the fields of ethnography (Erickson, 1986) and narrative inquiry (Clandinin & Connelly, 1996) It appears valid then these now well received methodologies may be used to develop similar research in computer science and information systems.

Denzin and Lincoln (1994, p.2) indicate that qualitative research is a 'set of interpretive practices' which have varied with the arguments of prevailing epistemologies. Their definition of qualitative research includes the point that qualitative researchers 'study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them'. They produce the powerful metaphor of the qualitative researcher as bricoleur, producing a bricolage, 'a pieced-together, close-knit set of practices that provide solutions to a problem in a concrete situation'.

4.2. Making Assertions from qualitative data

Quantitative research results in some form of raw numeric data from which conclusions may be drawn. Within qualitative research, different techniques must be used to prove the quality of the research. It is helpful therefore to replace the common concept of a "conclusion" from quantitative data with that of an "assertion" based on qualitative data.

Erickson (1986, p.146) explains that there has to be 'an evidentiary warrant for the assertion that one wishes to make'. He states that assertions are generally made 'through induction' and may be based on the analysis of 'field notes, interview notes, tapes or other site documents'. The nature of the assertions may be broad or narrow in scope and high or low in 'inferential level'. He emphasises the need to search the data continually for discrepancies and linkages. These linkages provide the key to identifying patterns of generalisation from which to identify the assertions.

The first author (Slay, 2000) made the following assertions after comprehensive ethnographic fieldwork carried out among college students in Australia and China (PRC). These provide a comparison of Chinese and Australian attitudes to science, as demonstrated in their understanding of the natural world.

4.3. Chinese study

1. Chinese college students tend to discuss the natural world using a homogeneous set of perspectives set of perspectives. The students do not display a diverse range of attitudes.

2. Male and female college students appear to describe nature in a very similar manner and there does not appear to be any correlation between the range of concepts used by Chinese college students to discuss the natural world and gender.

3. Spiritual beliefs and traditional concepts are articulated in some Chinese college students' thoughts on nature. The strength of spiritual beliefs varies among students but does not appear to play a part in shaping the students' scientific perspective on nature.

4. The level of science integration with everyday thinking is high. Discussion of nature by Chinese college students involves the use of school science knowledge.

4.4. Australian Study

1. College students from semi-rural Northern Queensland tend to discuss the natural world predominantly using a wide range of aesthetic and religious perspectives. These views do not appear to be linked or to or held in tension with scientific ones.

2. College students from semi-rural Northern Queensland tend to discuss the natural world using a conservationist perspective.

3. There does not appear to be a correlation between the concepts used to describe nature by College from semi-rural Northern Queensland and gender.

4. The level of science integration with everyday thinking is low. Discussion of nature by semi-rural Northern Queensland College students involves little use of school science knowledge.

This kind of qualitative data is useful in providing a general indication of patterns of belief and behaviour. Qualitative data can provide results that can be expressed as traditional statistics, which give an indication of features of a culture. These can then provide a simple graphic description of a culture. Qualitative data such as that produced from fieldwork sometimes provides incomplete and contradictory information, and in this case, fuzzy logic and rough sets can be used to generate an algorithm on which a dynamic simulation of interacting thought systems could be based.

5. A Qualitative Example Based On World View Theory

The assertions above, and other data (Slay 2000) provide the following table that offers a comparison of three elements of a Chinese and Australian worldview, expressed as probability of the occurrence:

	Attitude to the Other Homogeneous /Individualistic	**Science integration with everyday thinking** Low/High	**Affect of Spiritual beliefs** Low/High
China	(Homogeneous) .1	(High) .8	Medium –low .3
Australia	(Individualistic) .9	(Low) .1	(Medium -High) .7

This means that in a given life situation is very likely that a Chinese person (or group) will think much more homogeneously than a group of Australians, who will be very much more influenced by personal opinion and experience than their Chinese contemporary. The Chinese group are much more likely to apply scientific principles in their decision-making and will not be affected so much by any form of spiritual belief, when compared to an Australian group.

The elements identified above, when applied within a complex Knowledge Operation, would also provide some indication as to cross-cultural effects of that Knowledge Operation. Commonsense would indicate that a cultural group that thinks in a homogeneous manner would be much more connected than one where high degrees of individuality in thinking were found.

If qualitative data gained from anthropological fieldwork can be used to predict homogeneity of belief and scientific decision making, then it can also be used to predict and model related factors within the interaction of Thought Systems in a Knowledge Operation.

These, and other cross-cultural differences, would therefore affect all facets of the interaction of thought systems within knowledge operations, namely:

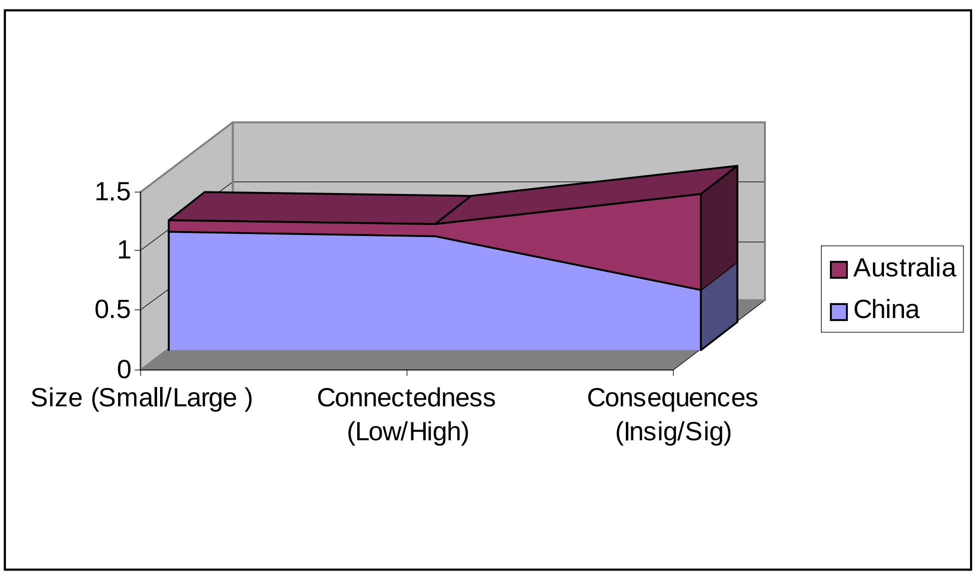
- Strategic, Operational, and Tactical levels of command;
- Scale:
    - Size;

    - Connectedness;
    - Consequences.
- Time:
    - Duration;
    - Tempo;
- Media;
- Entities;
- Culture:
    - Belief systems;
    - Languages

It can be seen that of these factors there is a relationship between, for example, connectedness between thought system components and homogenous attitudes to the world. If a cultural group has a uniform attitude to a particular concept, perhaps it right to sovereignty, then there is more difficulty in conducting a Knowledge Operation than when there is a highly individualistic attitude to the other.

It is then possible to create a table showing a (hypothetical) probability relationship between some of the stated factors of a Knowledge Operation carried out between China and Australia based on two features identified in qualitative analysis, Attitude to the Other and Science Integration.

Factor	**China**	**Australia**
Size (Small/Large)	.99	.1
Connectedness (Low/High)	.95	.1
Consequences (Insig/Sig)	.5	.8



This provides a static illustration of factors under discussion.

6. *Further Work*

This hypothetical and primitive analysis (although based on real qualitative data) on the interaction of Thought Systems with Knowledge Operations will be further extended to provide a 3D simulations of the effects of the elements of world view within a knowledge operation, using an approach based on the algorithm described in Rule Extraction Using Rough Sets When Membership Values are Intervals by de Korvin et al. (1998)

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