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SYSTEMS ARCHETYPES FOR MILITARY DYNAMIC DECISION MAKING

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Abstract

The complex and dynamic nature of operations-other-than-war (OOW) (e.g., peace support, the 3-block war concept) in which Canada and allied nations are increasingly involved requires Canadian Forces (CF) officers to call upon high-level dynamic decision making (DDM) skills to an unprecedented degree, especially at the strategic and operational levels. One possible method of improving the DDM skills of CF personnel is the application of 'systems thinking', in particular, the possibility that a limited number of recurring patterns (archetypes) can be used to explain all military situations and thus aid DDM. If successful, this approach would enable the CF to achieve its objectives efficiently with minimal unexpected outcomes (e.g. second- and third-order effects). This work looked into the applicability of archetypes for training DDM, through analyzing and modeling military history scenarios. The applicability of existing archetypes is discussed along with suggestions concerning new archetypes that apply to military scenarios.

Résumé

La nature complexe et dynamique des opérations autres que la guerre (OAG) [p. ex., le soutien de la paix, le concept de guerre à trois volets] auxquels participent le Canada et ses alliés obligent les officiers des Forces canadiennes à faire preuve d'une plus grande aptitude à la prise de décision dynamique (PDD) que jadis, surtout sur le plan stratégique et opérationnel. Une des façons d'améliorer l'aptitude à la PDD des membres des FC est l'application de la « pensée systémique », en particulier l'application d'un nombre limité de modèles récurrents (archétypes) qui pourraient éventuellement expliquer toutes les situations militaires et ainsi aider à la PDD. En cas de réussite, cette méthode permettrait aux FC de réaliser leurs objectifs de façon efficace, avec un minimum de résultats inattendus (p. ex., les effets secondaires et tertiaires). Cette étude examine la pertinence de l'emploi des archétypes en vue d'améliorer la PDD, en analysant et modélisant des exemples tirés l'histoire militaire. En plus d'examiner l'utilité des archétypes existants, l'étude suggère de nouveaux archétypes pertinents à des certains scénarios militaires.

Executive Summary

The complex and dynamic nature of operations-other-than-war (OOW) (e.g., peace support, the 3-block war concept) in which Canada and allied nations are increasingly involved requires Canadian Forces (CF) officers to call upon high-level dynamic decision making (DDM) skills to an unprecedented degree, especially at the strategic and operational levels. One possible method of improving the DDM skills of CF personnel is the application of 'systems thinking', in particular, the possibility that a limited number of recurring patterns (archetypes) can be used to explain all military situations and thus aid DDM. If successful, this approach would enable the CF to achieve its objectives efficiently with minimal unexpected outcomes (e.g. second- and third-order effects).

The overall aim of this work/project was to provide a set of dynamic systems archetypes suitable to training DDM for the CF. To this end, the project had the following sub-goals:

- determining the applicability of the archetypes given in Senge (1990) to describing and modeling military scenarios that the CF have been or will be engaged in; and
- determining whether there are other "generic structures" that recur in these scenarios that are not accounted for in Senge's list

Three past military history examples were selected for analysis (Desert Storm, Winnipeg Floods, and Somalia). An analysis process to map archetypes to these scenarios was created and applied and two new potential archetypes are suggested.

Highlights from discussions about the training of systems thinking, dynamic decision making and archetypes included:

- Though CF training does include second and third order effects, there is no explicit training in dynamic decision making or systems thinking
- A list of 6 recurring systems issues identified in the scenarios (but not mapped to any archetypes) should be further investigated for their CF training applicability
- Training involving archetypes would need to include early warning signs and solution strategies beyond the basic archetype structures

Sommaire

La nature complexe et dynamique des opérations autres que la guerre (OAG) [p. ex., le soutien de la paix, le concept de guerre à trois volets] auxquels participent de plus en plus le Canada et ses alliés obligent les officiers des Forces canadiennes à faire preuve d'une plus grande aptitude à la prise de décision dynamique (PDD) que jadis, surtout sur le plan stratégique et opérationnel. Une des façons d'améliorer l'aptitude à la PDD des membres des FC est l'application de la « pensée systémique », en particulier l'application d'un nombre limité de modèles récurrents (archétypes) qui pourraient éventuellement être utilisés pour expliquer toutes les situations militaires et ainsi aider à la PDD.

Le but de cette étude était principalement de fournir un ensemble d'archétypes de systèmes dynamiques favorisant l'amélioration de la PDD au sein des FC. À cette fin, les objectifs secondaires de l'étude étaient les suivants :

- évaluer la pertinence des archétypes présentés par Senge (1990) pour la description et la modélisation de scénarios militaires auxquels ont participé ou participeront les FC;
- déterminer s'il y a d'autres « structures génériques » qui reparaissent systématiquement dans ces scénarios et qui ne sont pas incluses dans la liste dressée par Senge.

Trois interventions militaires passées ont été retenues pour analyse (celles qui se rapportent à l'opération *Desert Storm*, aux inondations de Winnipeg et à la guerre civile en Somalie). Un processus analytique visant à lier des archétypes à ces scénarios a été créé et appliqué, et deux nouveaux archétypes éventuel ont été suggérés.

Les points saillants des études concernant l'amélioration de la pensée systémique, la prise de décision dynamique et les archétypes sont notamment les suivants :

- bien que l'instruction des FC traite notamment des effets secondaires et tertiaires, elle n'aborde pas explicitement la prise de décision dynamique ou la pensée systémique;
- six sujets récurrents relatifs aux systèmes qui ont été relevés dans les scénarios (mais qui ne sont liés à aucun archétype) devraient faire l'objet d'une étude approfondie en vue d'évaluer leur utilisation éventuelle pour l'instruction des FC;
- l'instruction basée sur des archétypes devrait inclure des signes avant-coureurs et des stratégies de résolution de problèmes allant au-delà des structures d'archétypes de base.

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1 Introduction

The complex and dynamic nature of operations-other-than-war (OOW) (e.g., peace support, the 3-block war concept) in which Canada and allied nations are increasingly involved requires Canadian Forces (CF) officers to call upon high-level dynamic decision making (DDM) skills to an unprecedented degree, especially at the strategic and operational levels. Dynamic decision making tasks are usually characterized as tasks that require a series of interdependent decisions, whose states change both autonomously and as a result of the decision maker's actions, and where decisions have to be made in real time (see Brehmer, 1995). DDM is a skill that is notoriously difficult for human beings, even after many years of experience (Brehmer, 1995; Dörner, 1996; Sterman, 1994). There is therefore a need to develop effective training programs for DDM in the CF.

Real-world dynamic systems have complex and ambiguous feedback structures that make the learning of DDM skills difficult. In particular, the effects of a decision-maker's actions are often perceived by the decision maker only after significant delays; this temporal distancing between action and effect makes it difficult for people to learn the relevant causal relationships that arise in typical dynamic decision-making situations (Brehmer, 1995; Dörner, 1996, Sterman, 1994). An additional problem is that real DDM situations (especially those of a strategic or operational nature) tend to play out over relatively long time-spans (weeks, months, years), reducing the opportunities to rehearse DDM skills (Bakken & Gilljam, 2003b).

In order to overcome the two temporal obstacles to developing DDM described above, researchers have proposed training DDM with microworlds: simulated interactive models that capture the high-level dynamics of relevant DDM situations while stripping away details deemed unnecessary (Haberstroh et al., 2005; Senge, 1990; Shanteau et al., 2005; Sterman, 1994). Microworlds have also been recently been proposed for training high-level military DDM (Bakken & Gilljam, 2003b). Microworlds allow people to experience the dynamics underlying a complex DDM situation within a compressed timeframe. It is hypothesized that the time compression allows people to rehearse DDM skills more often and makes it easier to learn correct cause-and-effect relationships despite the feedback delays inherent in the systems that are modeled (Bakken & Gilljam, 2003b). Nevertheless, there is evidence that learning in microworlds, while better than experiential learning in the real world, is still poor (Brehmer, 1995; Dörner, 1996; Gonzalez, 2005; Sterman, 1994). This is likely due to the fact that, despite being much simpler than the real-world systems they are meant to represent, microworlds are still relatively complex, non-linear dynamic systems.

Learning DDM in microworlds may be improved if there were a set of dynamic systems "building-blocks"; simple, generic dynamic patterns out of which more complex systems could be constructed. This would allow a part-task approach to training DDM in microworlds, whereby people could be trained on the "building-blocks" before being exposed to the more complex microworlds. A set of generic structures, or "archetypes",

have been proposed in the systems thinking literature and could fulfill the purpose of dynamic systems building-blocks for part-task DDM training. These archetypes have been derived from the observation of dynamic systems in many different fields (biology, ecology, social systems, and business management, to name a few), and have been compiled mainly in the work of Senge (1990). However, there is disagreement (Wolstenholme & Corben, 1993) as to exactly how many archetypes there are, and the degree to which they are truly generic, rather than merely exemplifying structures typical of the particular domains from which they were derived (mainly ecology and business management). Determining which of the archetypes proposed by Senge (1990) are in fact relevant to military DDM, and whether there are other archetypes typical of military scenarios and strategic/operational decision making principles that are not included in Senge's list, is a necessary step towards improving DDM with archetypes.

This work intends to review Senge's (1990) archetypes alongside those of Wolstenholme and Corben (1993) in the context of Canadian military history examples. These examples will represent significant case study learning opportunities for officers in the CF. The notion that these archetypes can be used as building blocks for microworlds will then be tested by implementing these examples, in accordance with their identified archetypes, in a systems architecture application called 'iThink'.

The current project has been contracted to Humansystems Incorporated under contract no. W7711-037871//001/TOR, Call-up No. 7871-08. The Scientific Authority (SA) for this work is Dr. Jerzy Jarmasz.

1.1 Objective

The overall aim of this work/project is to provide a set of dynamic systems archetypes suitable to training DDM for the CF. To this end, the project has the following sub-goals:

- determining the applicability of the archetypes given in Senge (1990) to describing and modeling military scenarios that the CF have been or will be engaged in; and
- determining whether there are other "generic structures" that recur in these scenarios that are not accounted for in Senge's list.

Determining whether there is a set of archetypes that can be used to model a wide range of military dynamic decision making situations will allow the development of an effective microworld-based strategy for training strategic and operational DDM in the CF.

1.2 Approach Taken in this Report

This report describes a consideration of systems archetypes and their applicability to teaching DDM skills to CF personnel.

This report has five main sections:

1. Introduction and Method;
2. Systems Thinking;

3. Archetype Analysis of Military Examples;
4. Discussion; and,
5. Conclusions and Recommendations.

These sections encapsulate the work items described in the Statement Of Work (SOW).

1.3 Method

The SOW listed the following work items:

1. Familiarize with the methods of systems thinking (causal loop diagramming) & dynamic control systems (if required);
2. Familiarize with the notion of archetypes, and the specific archetypes presented in the systems thinking literature, as exemplified by Senge (1990);
3. Study historical military events, and military operational/strategic principles taught to officers in the CF, for (1) applicability of the "Senge" archetypes and (2) other possible recurring dynamic patterns that might not be covered by the "Senge" archetypes, with particular focus on the following domains:
    a. recent OOW / 3-block war situations in which the CF has been involved (Bosnia, Afghanistan etc);
    b. classic historical examples taught at Canadian Forces Staff College (CFC);
4. Based on the work in (3), develop a set of archetypes specifically for use in modeling military DDM scenarios (ranked in order of usefulness or relevance to military scenarios);
5. Familiarize self with the iThink (isee Systems) dynamic systems modeling software (if required);
6. Implement the set of archetypes using iThink; these would provide "templates" for building dynamic models of military scenarios for future training (HSI did not implement these. Instead they were found at http://www.systems-thinking.org/arch/ithink/archi.zip)
7. Implement the four most relevant archetype "templates" as worked examples based on the military materials studied in (3).

In the process of carrying out the work it was determined that not enough background analysis existed to adequately consider CF involvement in Bosnia or Afghanistan, so it was decided to concentrate on examples taught at CFC.

Additionally, the work items concerning iThink have been delivered separately to this deliverable. Four 'template' archetypes were implemented based on the 3 military scenarios studied (described in more detail in Section 3.7).

Work item (3) was the most intensive of the tasks. This demanded that a systematic approach to consideration of military history examples be developed to ensure that the analysis outcome was acceptable to the work's audience. This approach will be described in more detail in section 3.

2 Systems Thinking

2.1 Introduction to the Systems Thinking Approach

Systems thinking involves looking beyond events to see patterns of behavior and the underlying systemic interrelationships. System thinkers realize that it is through interpreting these underlying interrelationships that a better understanding of the system is achieved (Richmond, 1992).

2.1.1 The Counter-Intuitive Relationship between Cause and Effect

When implicitly considering cause and effect, most people assume that cause and effect are in close proximity. However, cause and effect need not be closely related in time or space – the world is not that simple. If there is a problem with recruitment to the military, marketing and new recruitment incentives are not guaranteed to work. If there is a problem with low mission success, increased pressures on the planning staff are not guaranteed to work. The persistent belief that cause and effect are related and pursuing solutions consistent solely with that perspective leads to decision makers blindly pursuing the same non-solution over and over again.

After talking to Subject Matter Experts (SMEs) who are part of the Canadian Forces (CF), the analysts noted that the CF are starting to look at second and third order effects in training Effects Based Operations (EBO). These are effects caused either directly or indirectly by direct (first order) action. For example, the first order effect may be to disrupt the electric grid. However, this can result in second-order (unintended) effects like disrupted petroleum deliveries to airfields, which then disrupt the air operations (third order effects) (Williams and Kendall, 2004). Through considering these additional effects, the CF is acknowledging the benefit of looking deeper into cause and effect relationships and, thus, adopting a systems thinking paradigm. Other nations (e.g. Norway, US) are also looking into EBO (Bakken, 2004; Williams and Kendall, 2004). Systems thinking teaches that counter-intuitive relationships between cause and effect are a natural occurrence in complex systems and outlines ways to identify these relationships.

2.1.2 Appropriate Use of Leverage to Address Systemic Problems

Another feature of a systems understanding is the fact that by acting upon strategic points, one can produce an effect that is greater than would have been predicted by the act alone. A small, effective change can generate dramatic positive results. Areas of the greatest leverage are often the least obvious and often the most obvious solutions don't work. Solutions which provide the greatest leverage are never close in time and space to the obvious symptoms.

Systems tend to be designed in a way that makes it difficult for people to see the important interactions (i.e., reinforcing rigid boundaries that inhibit inquiring across divisional boundaries). An effective business approach is to assemble interdisciplinary teams with offices in the target market community (i.e., highly integrated product development cycle). Community leads to Design which leads to Development which leads to Product. From a

military perspective, this would seem to advocate including local representatives (from the area in which the operation is being conducted) in a planning headquarters to help understand the inter-relationships within the system. Leverage should be seen as lying within the interactions that exist between the pieces of the system, rather than by altering the pieces themselves.

2.2 Communicating Mental Models

Humans are very good at communicating meaning; however, humans find it very difficult to communicate an understanding or 'mental model' of a system. This is partially due to the fact that the mental model must be coherent, complete and consistent for the communication to be successful and humans' mental models of systems tend to remain clouded due to the size and complexity (Senge, 1990). As well, the mental models in our heads tend to be a selective abstraction of reality that incorporates potentially incorrect assumptions and biases (Richmond, 2004). As systems get more and more complex in our modern day world and the magnitude of change increases, these communication issues are exacerbated (Hirsch and Immediato, 1999). Through internal scrutiny, our mental models can be clarified and then successfully communicated.

The successful communication of mental models has many advantages, including:

- Perceiving potential problems before they occur
- Resolving errors by addressing the root cause rather than the symptoms
- Realizing the active role individuals can play in optimizing the system
- Increased and improved collaborative work, as everyone has a shared understanding

There are two main 'languages' that systems thinkers use to communicate. The first 'language' is Causal Loop Diagrams (CLDs). In these diagrams, characteristics that are a part of the system are outlined, and the interrelationships are made clear through circular arrows. Balancing and reinforcing loops are the basic building blocks.

The second language is Stock and Flow models. These models include flows (i.e. verbs) into and out of stocks (i.e. nouns) with additional connectors that affect these flows. Relationships between stocks, flows and connectors are defined. Stock and Flow models are quantitative, unlike CLDs. As such, CLDs tend to be more generic than stock and flow models. Because of their generic nature it can be hard to determine when two different CLDs with different structures might be equivalent. As well, goals and critical events are not well incorporated into CLD diagrams. Issues with converting between CLDs and stock and flow models are discussed in Section 4.2.

2.3 Archetypes

Soon after 'systems thinking' emerged, the creation of generic structures that seem to occur repeatedly in different (even all) systems began. These generic structures (which have come to be known as Archetypes) are models that can represent systems across

different domains. They serve as a means for gaining insight into the underlying systems structures from which the archetypal behavior emerges (Braun, 2002). The original goal of archetypes is to show insights into counter-intuitive real world systems by mapping them to a predictable generic structure (Lane and Smart, 1996).

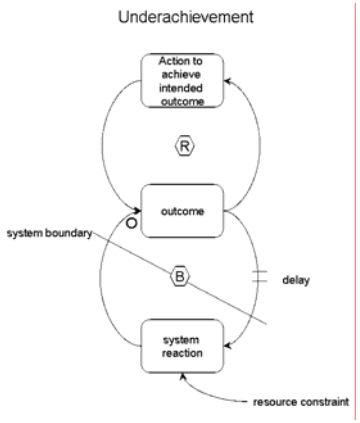
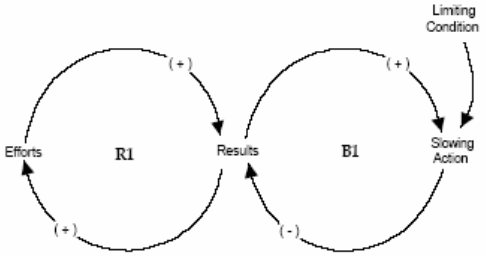
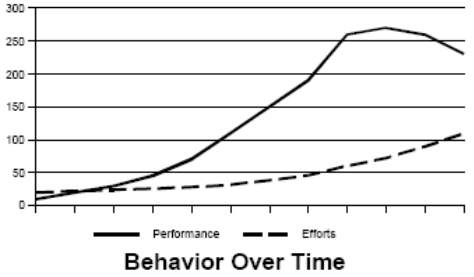
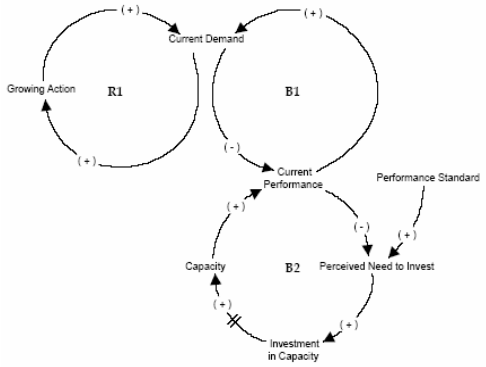
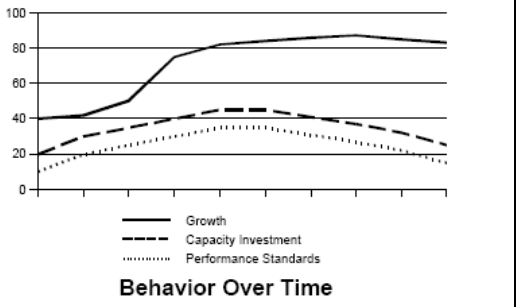
Systems thinkers have been debating about the applicability of archetypes for a long time (Lane and Smart, 1996). Some believe applicable generic structures can be created that sufficiently cross domains (Senge, 1990); others believe that archetypes are too domain specific; still others feel certain archetypes are too generic and thus applying them to different systems does not lead to any new insights. Even among those thinkers that agree about the applicability of archetypes, there is disagreement on what the actual archetypes structures are (Wolstenholme, 2003). Senge himself proposed 8 (1990), then, in a later paper, only described 4 of them plus a new one (1994).

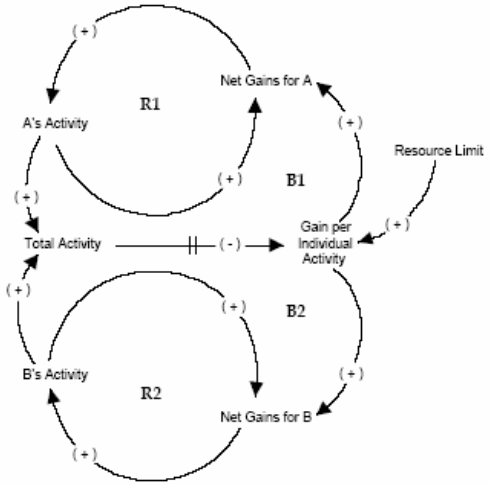
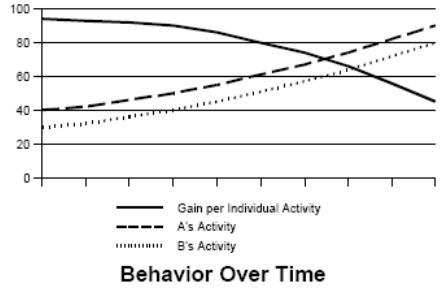
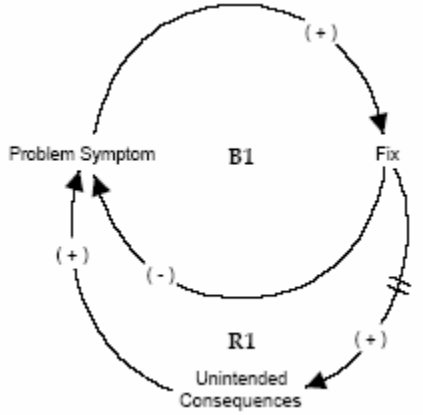
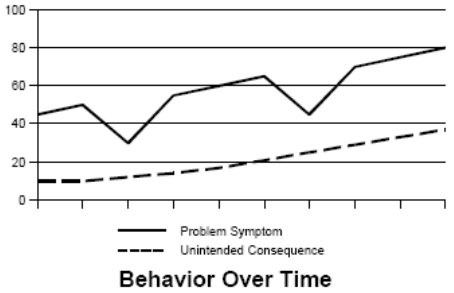
For the purposes of this project 3 different sets (or perspectives on) of Archetypes were studied. Attempts early in the project by the analyst to mentally simplify the archetypes led to errors in applying them. Each archetype has its own complexities and intricacies that, when understood, lead the observer to see the counter-intuitive systemic results.

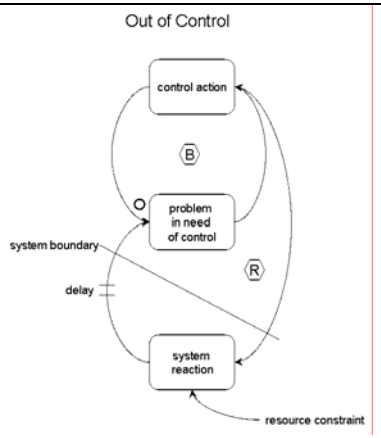
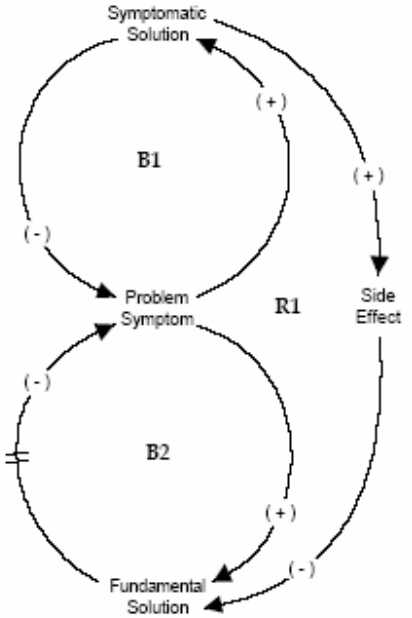
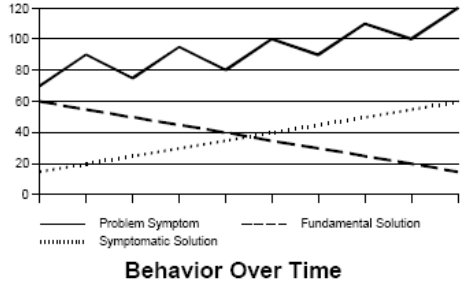
- Senge – there are 9 Senge archetypes (8 of which were outlined in Senge (1990) and an additional one (accidental adversaries) from Senge (1994)). These are the most widely applied archetypes (Braun, 2002). The CLDs for these archetypes contain 1-3 loops.
- Wolstenholme's (2002) Archetypes –.Wolstenholme felt that Senge's archetypes were too specific, and so created 4 higher level archetypes (of which Senge's archetypes are examples). Wolstenholme also suggests solution archetypes for each of the 4 problem archetypes. System boundaries are shown explicitly in the Wolstenholme archetypes, and all contain only 2 loops in the CLDs.
- Richmond – Using the other 'language' of systems thinking (Stock and Flow models) there are 5 generic templates outlined in Richmond (1992). These are called Generic Flow Templates and were created to be used as building blocks of models. These templates are independent from both Senge and Wolstenholme's archetypes and are included to show that the Stock and Flow modeling language does have its own set of generic structures.

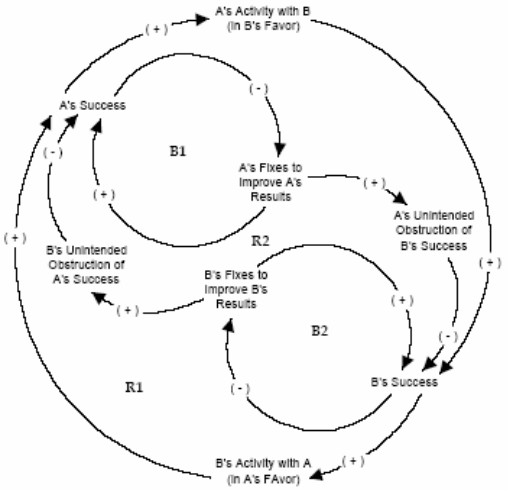
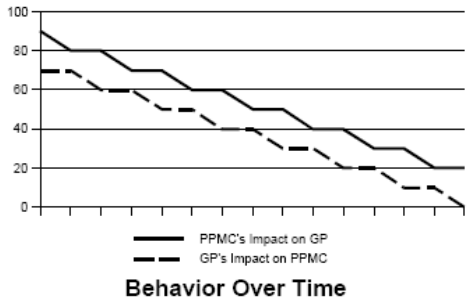
Table 1 below summarizes both the basic Senge archetypes and Wolstenholme's organization of these archetypes. CLDs and Behaviour Over Time graphs are from Braun (2002) and Wolstenholme (2003).

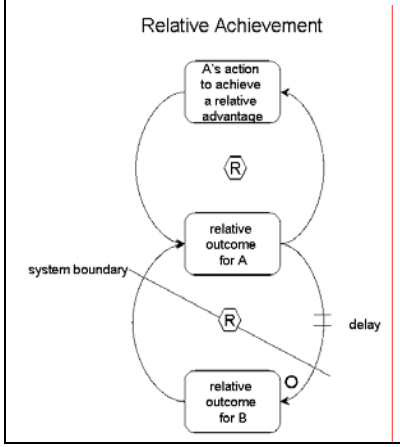
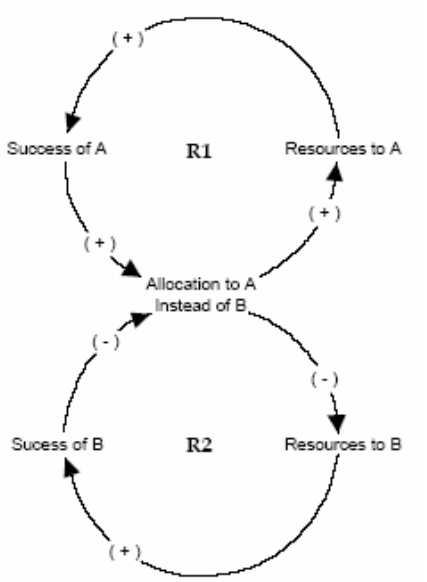
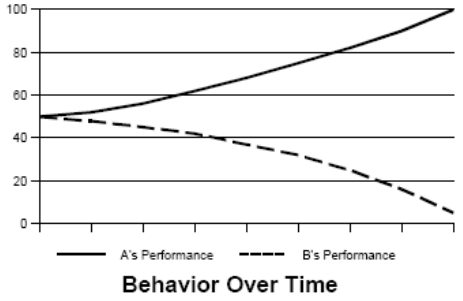
Table 1: Senge (1990) and Wolstenholme (2002) Archetypes

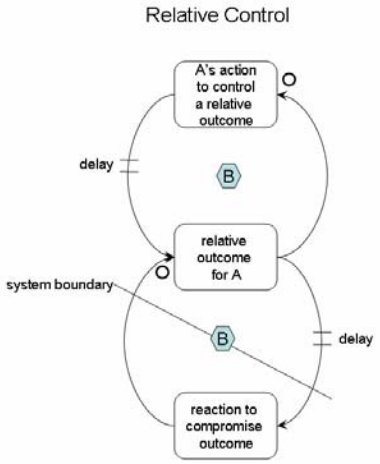
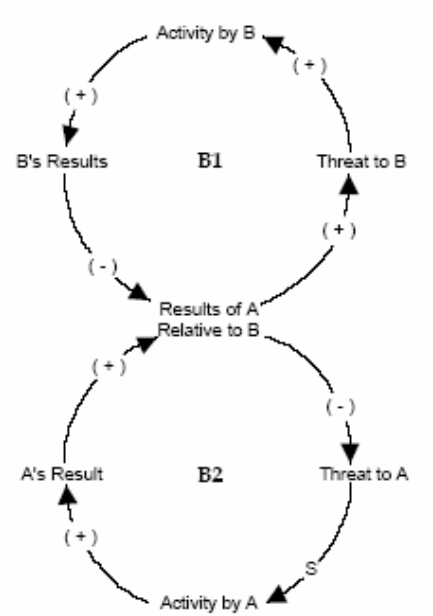
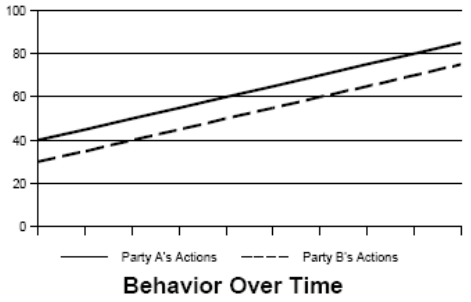
Wolstenholme	Senge Archetypes		
Under-achievement Archetype intended achievement fails to be realized 	**Limits to Success** Reinforcing process created to produce a desired result. Creates a spiral of success, but also an inadvertent balancing loop that eventually slows the success (idea of 'compensating feedback')		
	Growth and Under Investment Growth approaches a limit which can be eliminated or pushed into the future if the group invests in additional 'capacity'. But the investment must be aggressive and sufficiently rapid to forestall reduced growth, or else it will never get made.		

Wolstenholme	Senge Archetypes		
	Tragedy of the commons Groups use a commonly available, but limited resource. At first rewarded for using it, but overtime they get diminishing returns that lead to intensified actions. Ends in resource being totally used up or severely depleted.		
Out of Control Archetype intended control fails to be realized	**Fix that Fails** A fix, effective in the short term, has unforeseen long term consequences which worsen the situation. May require even more use of the same fix.		

Wolstenholme	Senge Archetypes		
	**Shifting the Burden** Underlying problem generates symptoms that demand attention. Symptons are repeatedly addressed, but the original problem continues to get worse (while the symptoms disappear), and system eventually loses ability to solve the underlying problem.		

Wolstenholme	Senge Archetypes		
	Accidental Adversaries When teams or parties in a working relationship misinterpret the actions of each other, the synergy can be lost and will decrease the productivity of all parties involved.		

Wolstenholme	Senge Archetypes		
Relative Achievement Archetype achievement is only gained at the expense of another 	**Success to the Successful** 2 activities compete for limited support or resources. The more successful one becomes, the more support it gains, thereby starving the other.		

Wolstenholme	Senge Archetypes		
Relative Control Archetype where control is only gained at the expense of others  	**Escalation** 2 or more groups depend on a relative advantage over each other. When one side gets ahead, the other is more threatened, leading it to act more aggressively to reestablish its advantage. (The US/USSR arms race is a classic example).	 	

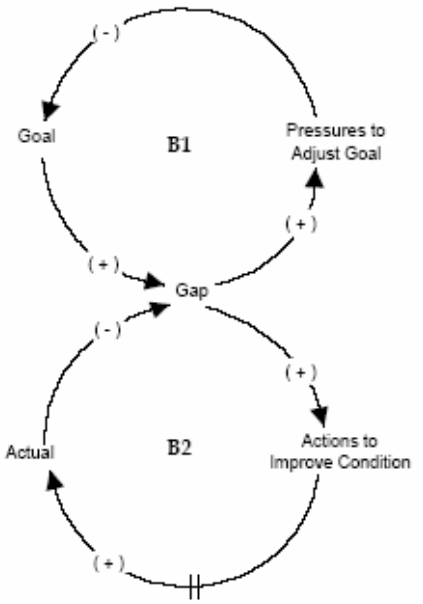
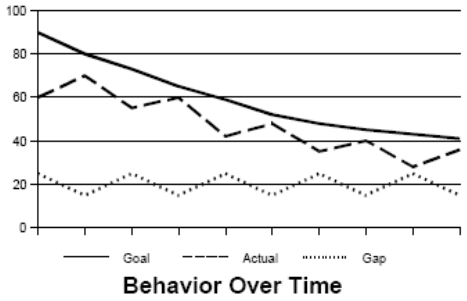
Wolstenholme	Senge Archetypes		
	Drifting Goals Shifting the burden type of structure, in which the short term solution involves letting a long term, fundamental goal decline.		

Table 2: Richmond's (1992) Generic Templates

External Resource Process	When some resource, other than the stock to which the flow is attached, provides the basis for producing the flow (i.e. External resource is not consumed in the creation – e.g. as programmer creates code you don't lose the programmers)
Co-Flow Process	The title is a shortened "Coincident Flow" . Represents a process that has an "activity basis" in a parallel flow. The 2 flows will differ only by conversion coefficient.
A Draining Process	Represent the draining, passive decay or aging of some stock. The flow is generated by the stock to which it is attached.
A Stock Adjustment Process	Represents situations in which a Stock 'adjusts to' a target value. (can be used to represent the way that perceptions, opinions, etc are adjusted as new 'data' become available).
Reinforcing Feedback Loop (also called Compounding)	Self-reinforcing process. Is a backward version of 'A draining process'

2.4 Software and Systems Thinking

2.4.1 Use of Microworlds

Training in systems thinking is complicated by the fact that real systems are often too big and independent to be amenable to instructional manipulation. However, the development of microworlds has increased the ease of communicating mental models and the potential to train systems thinking (Bakken & Gilljam, 2003a) . These microworlds enable users to both conceptualize the system from a higher level as well as manipulate the system from this higher level.

This high level viewing perspective is known elsewhere as '10,000 foot thinking' (Allen, 2001). To provide an example, 10,000 foot thinking refers to thinking about the flow of traffic, rather than thinking about the brand and colour of cars when looking at a highway (Richmond, 1992). Simply looking and understanding the system from this higher level offers similar training that archetypes offer. However, microworlds also offer the ability to manipulate the system from this level and see the system's reaction. This additional ability to develop procedural knowledge about the functionality of the system may provide a more complete system understanding.

Richmond (1992, 1993) outlines four systems thinking perspectives that are successfully implemented in microworlds:

- Operational Thinking – thinking in terms of how things really work—not how they theoretically work.
- Closed-Loop – involves seeing the world as a set of ongoing, interdependent processes rather than as a list of one-way relations between a group of factors and a phenomenon that these factors are causing. Furthermore, looking to the loops themselves (i.e., the circular cause-effect relations) as being responsible for generating the behavior patterns exhibited by a system.
- Non-linearity – Linear relationships rarely exist. In linear systems, if a particular 'input' is tweaked by X%, then one would expect mX% change in the output (where 'm' is a constant). However, the 'elasticity' of any particular linkage within a web of closed-loop causal relationships is highly dynamic.
- Impacts are delayed – There may be some immediate reactions to things, however, usually other reactions are set in motion and take time to play out.

2.4.2 iThink System Thinking Models

iThink is an application that uses the stock and flow language. Once models have been created in iThink, the software can be used to exercise the mechanics of the system. Creating a model turns an esoteric concept into something concrete, thus allowing others to understand and validate the model. Models in iThink are dynamic so one can see/verify/predict how the model will change over time and how changes to variables will affect the model.

3 Archetype Analysis of Military Examples

3.1 Selecting the Three Military Historical Scenarios

Separate discussions were initiated with 2 military Subject Matter Experts (SMEs). One SME was a retired naval officer who held the rank of Lieutenant-Commander and had acted as a Sea Trainer at the Canadian Forces Naval Operator School (CFNOS). Thus the SME would understand the manner in which naval crews were trained, and have an insight into the system and how to create conditions that would lead to unintended consequences. The other SME is a former Lieutenant-Colonel in the US Army with Staff experience at Division level. Currently, he teaches the Operations Planning Process (OPP) and the Advanced Military Studies Course (AMSC) at Canadian Forces College (CFC). This SME is responsible for developing scenarios to train CF personnel at Major/Lieutenant-Commander level and above. These scenarios include difficult and complex systems, where the impact of a decision may be separated in both time and space.

During these discussions the SMEs were asked to list past military history examples and whether or not the scenarios were currently taught at CFC or CFNOS. The examples were then discussed to determine their possible relevance. There were certain characteristics the SA (ideally) wanted the scenarios to have:

- Involves the Canadian Forces;
- More recent (1990s or later, to adequately cover the evolution of the '3 block war');
- Currently taught at CFC;
- Complex (i.e. many contributing factors);
- Timescale is over weeks or months (i.e. not days); and,
- Is at the operational or strategic level.

Three scenarios were determined to best meet the needs of this project. Table 3 below outlines the scenarios discussed. In Table 3, the bold rows show the three military history examples chosen to be used for the remainder of the project. An overview of each military history example is provided below (in no particular order).

Table 3: Military Scenarios Researched

Scenario	Description	Selected for use in this project?
Saratoga (1971)	USS Saratoga accidentally bombed a Turkish ship	No. Not recent, and no Canadian involvement. Not taught at CFC.
GTS Katie (2000)	A disagreement with contractors led to problems delivering the ship	No. Not complex enough. Not taught at CFC.
Friendly Fire in Afghanistan (2002)	F16 bombed CF members who were doing a routine training exercise	No. Though Canadians were shot, they were not involved in the error. Not operational error. Not taught at CFC.

Scenario	Description	Selected for use in this project?
Vincennes (1988)	USS Vincennes accidentally shot down a civilian airbus	No. Not recent, and no Canadian involvement. Not taught at CFC.
Chicoutimi (2004)	Fire onboard the HMCS Chicoutimi that resulted in the death of one CF member	No. Too tactical. Not taught at CFC.
HMCS Kootenay (1969)	Explosion in the engine room of Kootenay resulted in the death of 9 CF	No. Too tactical. Not taught at CFC.
HMCS Huron (2005)	After maintenance, took on a lot of water. Led to technical issues.	No. Not complex enough. Not taught at CFC.
Rwanda (1993)	Peacekeeping mission in Rwanda, that could not stop the genocide of 800,000 Rwandans	No. Though Canadians were involved, the decisions to not send more support were from the UN. Not taught at CFC.
Desert Storm (1990)	**The first US led war on Iraq (Gulf War)**	**Yes. There was Canadian involvement in this complex, operational level, scenario, and it is currently taught at CFC.**
Winnipeg Floods (1997)	**A joint domestic operation to handle a large flood in Winnipeg**	**Yes. This is a complex Canadian situation at the operational and strategic levels that is also taught at CFC currently.**
Pacific Campaign (1941-1945)	The Pacific War during World War II	No. Not recent (though it is taught at CFC).
India-Pakistan (1971)	Maritime component of India-Pakistan war	No. Not recent (though it is taught at CFC).
Suez (1956)	Peace support mission led by the United Nations	No. Not recent (though it is taught at CFC)
Somalia (1993)	**CF members torture and kill a Somalian teenager during a peace-keeping mission in Somalia.**	**Yes. Though not taught at CFC, this is a complex scenario that reaches to the operational and strategic levels that involved Canadian Forces members.**

3.2 Desert Storm

The first scenario was Desert Storm. This was the first US-led war against Iraq that occurred in 1991. The lead up to the war began with the Iraqi invasion of Kuwait on

August 2, 1990, following unproven Iraqi contentions that Kuwait was illegally "slant-drilling" oil across Iraq's border. The UN immediately condemned the invasion, and swiftly introduced the first resolution (of 12) demanding an immediate and unconditional withdrawal from Kuwait. The coalition air offensive (Operation Desert Storm) commenced less than a day after the deadline for Iraqi withdrawal passed. The air attack achieved all but one objective in less time and with fewer losses than analysts predicted. Though Iraq did fire missiles on Israeli cities, the war zone remained within Iraq, Kuwait, and bordering areas of Saudi Arabia. (Canadian Forces College. R/JC/PLN 321/Cs-1)

This military history example is currently taught at CFC and is recent. Even though there was Canadian involvement in the Operation, the analysis performed for this project focuses on the planning aspects from the US perspective (this is consistent with what is taught at CFC). The system under analysis has widespread impacts on the global economy that would not have been anticipated when decisions were being made at the operational and strategic level, much less the tactical level.

3.3 Winnipeg Floods

The second scenario was the Winnipeg Floods. In the spring of 1997, southern Manitoba experienced its worst flooding in over 150 years. On 19 April 97, late in the preparation or warning phase, the Province formally requested open-ended support from the Minister of National Defence to begin on 21 April. Thus began OP NOAH which, on 24 Apr 97, was renamed OP ASSISTANCE as its scope expanded. What started out as a request for one hundred soldiers to help fill sandbags quickly escalated within two weeks to a Joint Force operation encompassing approximately 8,500 CF personnel, 2,850 vehicles, 131 water craft and 34 aircraft drawn from across the entire country. (Canadaian Forces College. R/JC/OPS 322/CS-1/TM2-CS)

The Winnipeg Floods military history example is also taught at CFC. As military and civilian organizations raced to respond to this natural disaster, unique systems issues developed through the interactions inherent in a large-scale ‘open’ system that may be encountered by future domestic joint operations.

3.4 Somalia Affair

The final scenario was the Somalia Affair. Somalia was in chaos, created by political upheaval combined with the effects of civil war and a severe drought. There was a breakdown in the social structure and police services had fallen apart. As part of Operation Deliverance, a brigade from the Canadian Airborne Regiment (CAR) was sent to Somalia in mid-December 1992 on a mission to deliver humanitarian aid and restore order to the African nation. Unfortunately, the beating, torture, and death of a local Somali teenager (Shidane Arone) while in the custody of 2 Canadian Forces members occurred on March 16th, 1993. Eventually a full inquiry was called by the Minister of Defence resulting in the disbandment of the CAR. (Somalia Inquiry).

The Somalia Affair led to the discovery of deep problems in the leadership of the Canadian Forces and affected the Canadian Forces peacekeeping reputation. Though this scenario is

not taught at CFC, a systems thinking/archetypal analysis highlights interesting issues that led to the brutal violence and resulting changes to the CF (especially with respect to its policy on the educational qualifications of its officers).

3.5 Analysis Procedure

With the three scenarios selected, the archetypal analysis of each of the scenarios began. Copies of the analysis spreadsheets described below can be found in Annex A.

After reading different references describing each of the scenarios, a chronological listing of what occurred in the scenario was created and entered into the first column of a spreadsheet. Each line of the spreadsheet represented a discrete event in the scenario. Though chronological entry made the most sense for directly mapping the references into spreadsheet format, the form did not provide any additional insights into how systems thinking was represented in that event. As such, the next task undertaken by the analysts was applying their understanding of Systems Thinking by noting in the next column consequences or systems issues that relate to each line of the spreadsheet. This step allowed the analysts to link across time events that affected how the scenario played out. Finally, lines that had relevant archetypes were noted in a final column.

Originally, it was envisaged that every line in the spreadsheet would have an archetype mapped. However, after going through every line it was apparent that many lines could not be mapped. Each archetype is comprised of specific complexities and interrelationships which not every line of the description contained. As such, only certain lines were mapped (and each line is not standalone, many times the archetype would build upon lines that preceded the line to which it was actually mapped). Any lines that showed potential to represent a new archetype were marked separately. A discussion on new archetypes occurs later in section 3.7. Further detail on the mapping of the archetypes can be found below in Section 3.6. Table 4, Table 5 and Table 6 below outline the Archetypes mapped for the Desert Storm, Winnipeg Floods and Somalia scenarios (respectively). As previously mentioned, the full spreadsheet for each scenario can be found in Annex A.

Table 4: Archetypes mapped to the Desert Storm military example

Tragedy of the commons	The US Air Force and the US Navy both required air resources in order to meet their mission objectives. Had this dual-demand continued unabated, the result would ultimately have been mission failure as those resources ran out (e.g. lack of available aircraft or available aircrew) or began to operate less effectively (e.g. required aircraft maintenance, crew rest schedules). The situation was resolved before their mutual requirements began to harm each other's mission success.

Fixes that Fail	Before the war, the UN had heavy sanctions against Iraq which they hoped would stop Saddam Hussein from taking action against his neighbours. These didn't work, and instead just led to more sanctions

Table 5: Archetypes mapped to the Winnipeg Floods military history example

Out of Control Archetypes	Recommendation for CDS Warning Order not issued as early as possible to designate command relationships and authorize the conduct of joint planning activity. As a result the flooding could not be controlled.
Growth and Underinvestment	There is underinvestment in training and education in the military as it grows. Holistic Solution: Readily apparent that 'operations' training of the staffs assigned to function in a JTFHQ is required. This training must include the JHQ augmentees identified and provided by the respective Force Generators
Accidental adversaries	Integration of both Maritime and Air components into the JHQ was difficult. Some issues caused friction, at times causing them to work against each other.
Out of Control Archetype	A full scale joint operation was not envisaged from the beginning. (It is usually more difficult to change the modus operandi in mid-stream.) Due to the inappropriate plan for the scale of the operation, the operation grew well beyond the initial doctrine.
Shifting the Burden	The limited degree of 'joint-ness' in the day-to-day structure and working procedures of the Division Head Quarters created obstacles and impeded the end result of the operation. A problem still exists at same level of severity, only symptoms were addressed as the problems were passed back and forth.

Table 6: Archetypes mapped to the Somalia military history example

Out of Control Archetype	From a Canadian perspective, the goal was to go in and control the violence that was occurring in Somalia. Ended up causing more violence. (i.e. Intended control fails to be realized)
Underachievement Archetype	In terms of reputation, the Canadian government hoped to continue Canada's peace keeping legacy, but this mission tainted that image.
Underachievement Archetype and Limits to Success	Canadians had a spiral of successful peacekeeping missions, but then overstepped their bounds (especially if CAR chosen because other troops were tired from recent missions); results in Canadians losing some of their respect as a peacekeeping nation (that they perhaps just thought would just keep growing).
Shifting the Burden	Kept sending 'bad apples' to CAR; was fine for other units, however, did not deal with having these 'bad apples' in the military
Fixes that Fail	Though the CAR was effective in the beginning in getting control of the area, they ended up going to far.

Reinforcing Loop	From the perspective of the person in charge, he's watching his guys do 'not so good' things, and not punishing them for it. This lax attitude becomes a problem.
Out of Control Archetype	DND wanted to maintain control of information concerning Somalia affair, but it totally blew up.
Drifting Goals	Short term solution of sending the CAR over, ended up diminishing the morale and funding (long term goals) (from the perspective of the Canadian Forces)
Success to the Successful	Had proper funding been provided to the military in the first place, the entire Somalia Affair may have been avoided. Instead, the government further cut the funds for the military after the operation.

It is interesting to note that archetypes were mapped at both high levels (e.g. archetype represents entire scenario) and at lower levels (e.g. archetype represents a small aspect of the scenario). Though this project focused on mapping archetypes at the strategic and operational levels, it is interesting to note that archetypes were also mapped at the tactical level.

3.6 Archetype Mapping Process

A diagnostic tool was created based on Wolstenholme (2002) to assist in this mapping process. This diagnostic tool is shown below in Table 7. The left portion of the tool proved useful for characterizing Wolstenholme archetypes. However, the right portion of the tool used descriptors that proved to be too strict (based to Wolstenholme's interpretations of systems). Additionally, applying the diagnostic tool involves having already created CLDs for each potential archetype. Different analysts implemented the systems differently (as there are few rules governing CLD creation), resulting in more confusion than clarity.

Instead, the analysts' mental model (i.e. understanding) of the Senge/Wolstenholme archetypes was used to map the examples. This understanding led to a two-step analysis process which involved identifying the main actors in the scenario and determining the outcome of the scenario for those actors (e.g. improved/suffered, rose/fell, more/less, etc.). If the mental model of an archetype appeared to describe the system, then that archetype was mapped.

The partial success of the diagnostic tool suggests that additional work could produce a viable diagnostic tool for the Senge/Richmond archetypes. This work would focus on developing a more general set of descriptors to be used (perhaps descriptions of the behaviour over time of the different archetypes) to interpret scenario narratives with respect to archetypes.

Table 7: Diagnotic Tool

				Delay?	If No to Delay, then:					If Yes to Delay, then				
Example	**Is Intended Consequence Balancing the feedback loop (i.e. "Declining") or Reinforcing the feedback loop (i.e. "Positive Growth")**	**Is Unintended Consequence Balancing the feedback loop (i.e. "Declining") orReinforcing (i.e. "Positive Growth")**	**Archetype Type**	**Is the delay always between result of action and the system's reaction?**	Is the delay between applying fix and problem worsening?	Is the delay between the system's reaction and the problem worsening?	Is the delay between the fix applied and the state of the system worsening? Is the system is a partner on whom the actor depends?	Is the delay between changes resulting from action and the system's compromising reaction?	Is the delay between the action taken to control the outcome and awareness of mission outcome relative to goal?	**Is there a constraint to success?**	Is success constrained by a limiting action inherent to the system?	Is success constrained by under investment in the system?	Is success limited by a shared finite resource?	**Problem Archetype**
A product line grows rapidly at first, but eventually begins to slow or even decline	Reinforcing	Balancing	Underachievement	Yes						Yes	Yes			Limits to success
Sales exceed production lead time	Reinforcing	Balancing		Yes						Yes		Yes		Growth and under investment
Too many tourists	Reinforcing	Balancing		Yes						Yes			Yes	Tragedy of the commons
Addiction	Balancing	Reinforcing	Out of Control		Yes									Fix that fails
Problem child	Balancing	Reinforcing				Yes								Shifting the burden
P&G v. Walmart	Balancing	Reinforcing					Yes							Accidental adversaries
Beta v. VHS	Reinforcing	Reinforcing	Relative Achievement	Yes						Yes				Success to the successful
Arms Race	Balancing	Balancing	Relative Control					Yes						Escalation
Mission Creep	Balancing	Balancing							Yes					Drifting goals

3.7 Implementing iThink Archetype Examples

The translation of Wolstenholme and Senge's archetypes into iThink models was desirable to 'test' the function of the archetypes. As outlined in SOW objective 4 the analysts were tasked with implementing applicable archetypes in iThink using the stock and flow terminology. An internet search found generic implementations of Senge's archetypes at http://www.systems-thinking.org/arch/ithink/archi.zip.

In addition to the generic implementations, SOW objective 6 outlined the implementation of specific archetype examples from the military scenarios. Four examples were selected for implementation and they (and the issues involved in their implementation) are outlined below. A legend for the models appears in Figure 1.

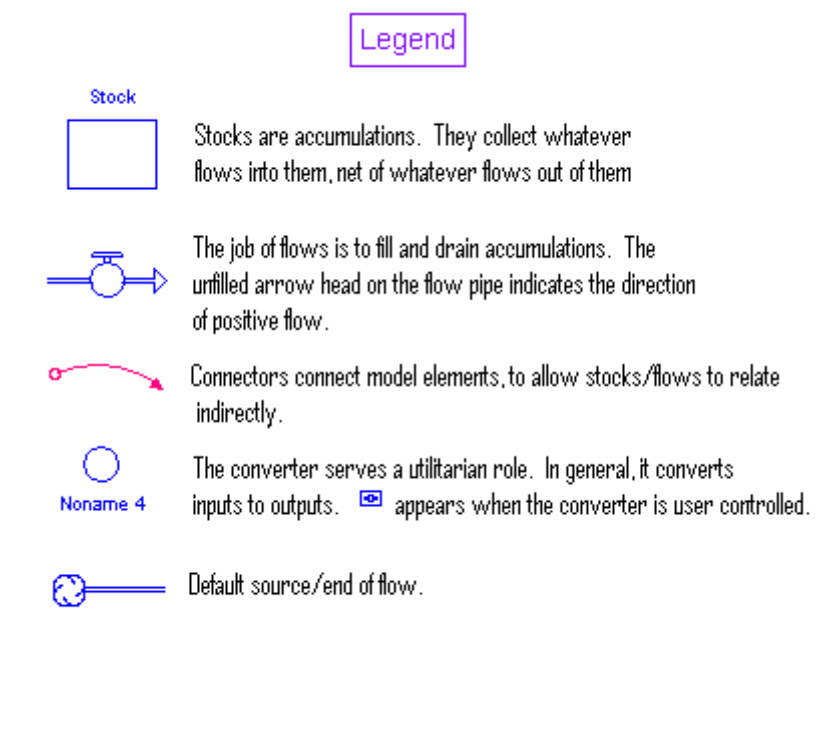


Figure 1: Legend for iThink Stock and Flow models

3.7.1 Somalia Affair – Reinforcing Loop

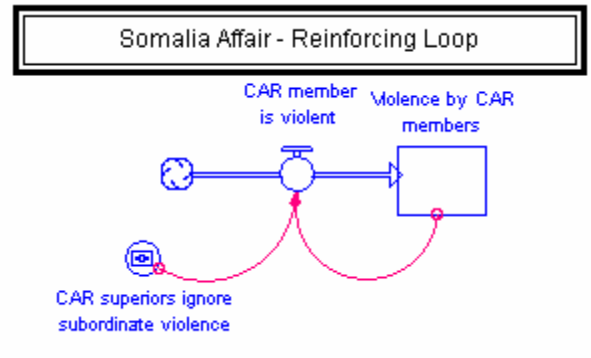


Figure 2: iThink Model implementing a reinforcing loop as part of the Somalia scenario

In the Somalia affair, there were numerous incidents of violent actions by CAR members against intruders that were not questioned by the Commanding Officers, and may have been encouraged. For example, a reconnaissance patrol platoon shot 2 young Somali night-time infiltrators (one was killed and one was injured) a few nights before the torture-death of Shidane Arone.

This and other condoned violent actions served as a reinforcing loop, which increased both the 'quality' and the quantity of violence by CAR members - especially against intruders. This increase has been modeled as a reinforcing loop, which culminated in the torture-death of Shidane Arone.

3.7.2 Winnipeg Floods – Shifting the Burden

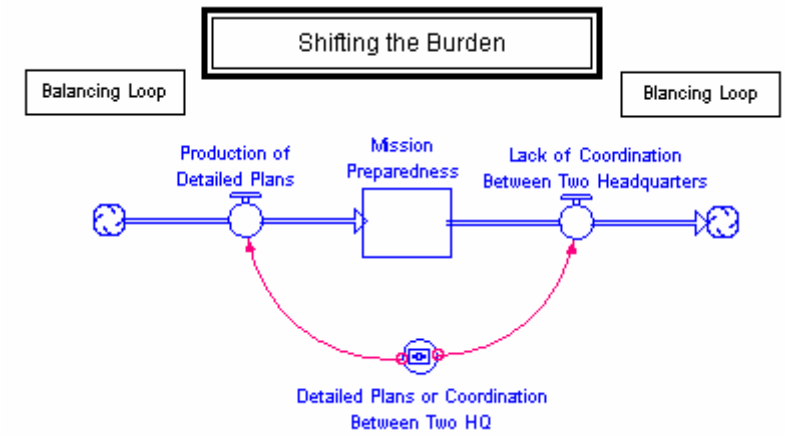


Figure 3: iThink Model implementing a Shifting the Burden as part of the Winnipeg Floods scenario

The CF had limited time to respond to an increasingly serious domestic crisis in Winnipeg due to extreme flooding. With delays in receiving the official CDS warning order and lack of detailed knowledge of the mission, each headquarters (HQ) had to make tradeoffs (shown by the user defined converter) with regard to the "Production of Detailed Plans" and prudent preparations for conducting "Coordination between Two Headquarters".

3.7.3 Desert Storm – Limits to Success

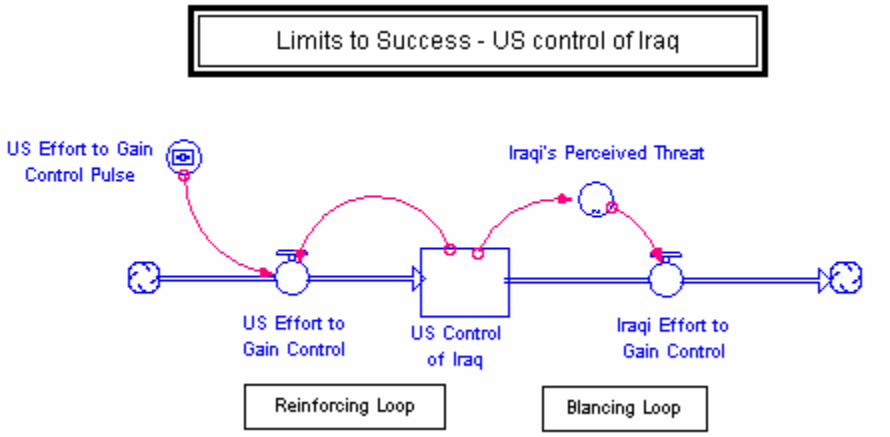


Figure 4: iThink Model implementing Limits to Success as part of the Desert Storm scenario

A Limits to Success structure is characterized by a reinforcing loop which is offset by a balancing loop. The reinforcing loop initially shows added performance for additional effort, which in turn feeds additional effort. This continues until some constraint produces a limiting action and additional effort does not produce additional results.

In this example 'US Effort to Gain Control' is balanced with 'Iraqi Effort to Gain Control' so US Control of Iraq remains constant. If the US increases 'US Effort to Gain Control Pulse' it will increase 'US Control of Iraq' which will increase the 'Iraqi's Perceived Threat'. At some point the Iraqi's will perceive 'US Control of Iraq' to become a threat and respond by increasing 'Iraq Effort to Gain Control'. This will limit 'US Control of Iraq'.

3.7.4 Desert Storm – Tragedy of the Commons

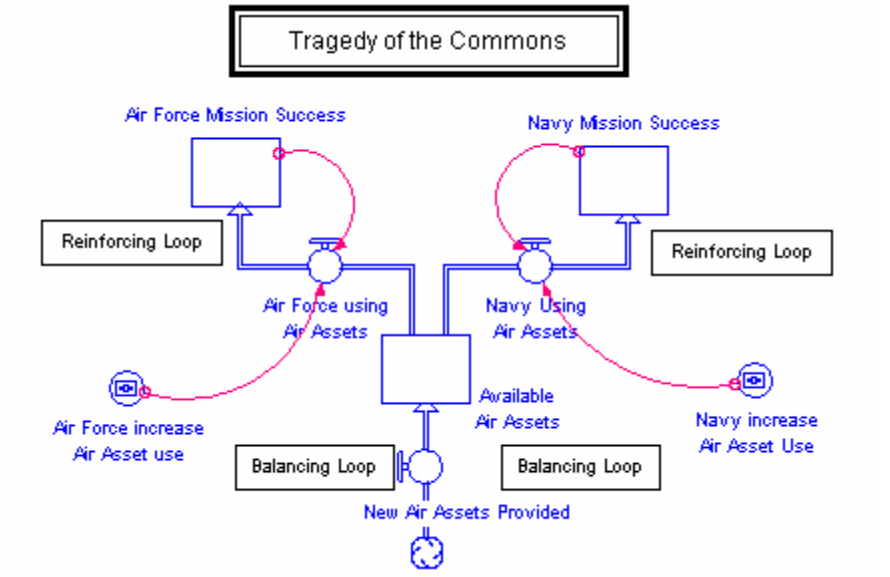


Figure 5: iThink Model implementing Tragedy of the Commons as part of the Desert Storm scenario

A Tragedy of the Commons structure is characterized by two reinforcing loops which are offset by two balancing loops.

In this example the Air Force and the Navy both rely on the same common resource (air assets) for their gains. As each gains it increases its use of the common resource, until such time as the use of the common resource exceeds the replenishment of the common resource (they are not able to make new aircraft). When this occurs, the gain of both the Air Force and the Navy is limited.

3.8 Identification of New Archetypes

3.8.1 Process of Creation

An exploration of any new archetypes that apply to the military domain was the next task performed by the analysts. It was originally postulated that after the archetypes had been mapped there would be sections of the scenario descriptions left unmapped, and that these would serve as good starting places for new archetype creation.

Though not all unmapped sections showed potential for new archetypes, the analysts were hopeful that certain sections could give rise to new archetypes. Unfortunately, after attempting to map these scenarios, no new archetypes were found. Though many showed potential, after further exploration some systematic issue slowly revealed themselves as already existing archetypes and others just led to dead ends in terms of new archetypes visualization.

Next the analysts attempted to use the diagnostic tool (shown above in Table 7) to determine new archetypes. This too led to no new archetypes being created. Analysts used the tool to create unique combinations of criteria that were not already part of the definitions of existing archetypes. However, problems were encountered with the narrow descriptions and realistic implementations of the newly-created unique combinations could not be found.

Finally, a focus was placed on the systematic outcomes of certain scenarios that did not correspond to any other archetypes. Specifically, interest was taken in an outcome that resulted in an exponential growth (similar to a reinforcing loop) and then a sudden crash (Figure 6 below). An example is the CAR's mission in Somalia. The mission started out well with the CAR gaining control of their areas, and expanding their operations; soon afterward, however, the murder of the young Somali signaled a great drop in their success rate. From this starting point the analysts attempted to define the causal loop diagram for such an archetype.

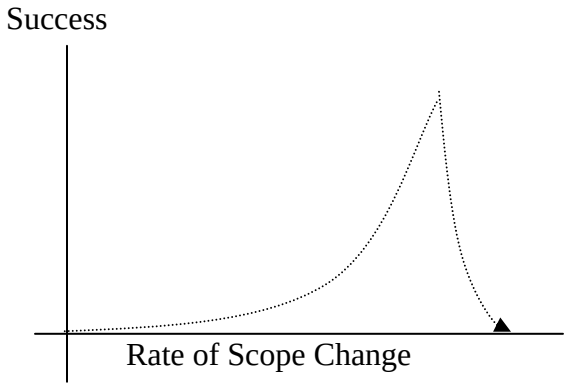


Figure 6: Output Diagram for New Archetype

3.8.2 First New Archetype – Mission Creep

The new archetype is a 2 loop archetype consisting of 1 reinforcing loop and one balancing loop (which places it under Wolstenholme's Under Achievement Archetype). The new archetype is called 'Mission Creep'. One of the loops represents the system's reaction and tends to resist the changing scope, and the other loop represents the actor's actions and tends to reinforce change. There is a delay in the system's reaction loop causing secondary system reactions to not be made known for some time. This archetypes is already commonly referred to in the CF and is shown below in Figure 7. In Mission Creep, as success starts to be realized during a mission, the scope of the mission tends to be increased. Similarly, as the scope of the mission expands there are secondary and tertiary systemic and internal reactions whose effects are delayed. When too much scope is added too fast, the system reacts strongly resulting in the intended actions backfiring. The original mission may never actually be achieved. When the scope is expanded slowly, the system absorbs the changes with ease.

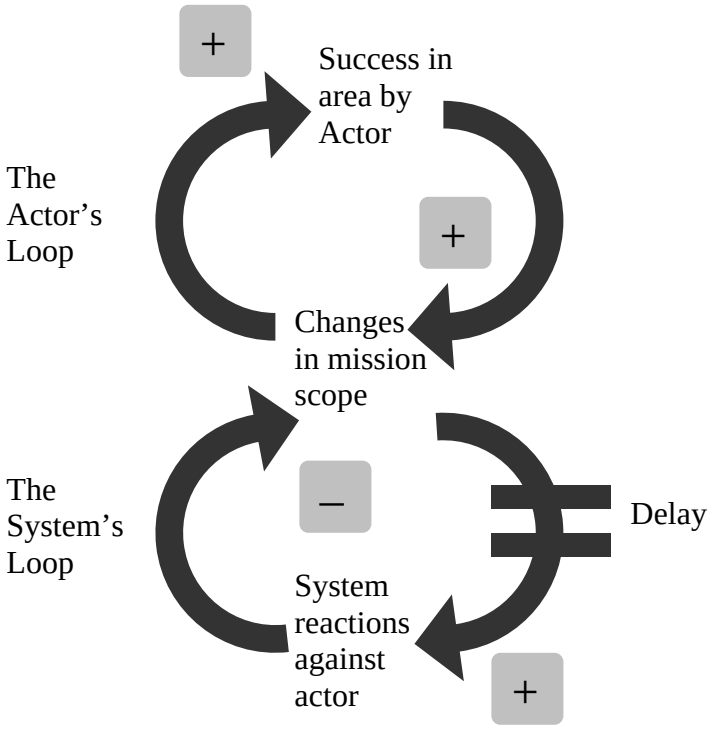


Figure 7: Loop Diagram of Mission Creep Archetype

The Drifting Goals archetypes is somewhat opposite to this new archetype, where instead of the ultimate objectives of the systems being gradually reduced (Drifting Goals) the ultimate objectives are in fact increased (Mission Creep).

Though there are strong similarities between the proposed Mission Creep archetype and the Limits to Success Archetype (including the same CLD structure), there are subtle differences as well. In Limits to Success one is trying to get more of a single variable (e.g. increased sales), however, in Mission Creep, one is also changing variables, not simply wanting more of the same. This expansion can lead to unsuccessful attempts to satisfy the needs of the new variables, but also not getting accomplishing what were the objectives in the first place. Unfortunately differentiating between more of the same, and changing variables is not clearly visualized using CLDs. Additionally, it is not only the system fighting back, but also internal limitations that limit mission success. In Limits to Success it is the system's reaction that causes success to fall; however, in Mission Creep, failure is due partly to the system, but also partly to internal limitations (e.g. staff fatigue). Again, this difference is not well represented through CLDs.

In short, though this archetype does have the same CLD as Limit to Success, there are still subtle differences noted, which are not easily shown through CLD structures. More discussion about CLDs can be found in Section 4.2. From the perspective of the project team, this new archetype shows a great deal of face validity. Reinforcing loops are noted

throughout systems thinking literature. However, an archetype that contained the rise and crash commonly associated with reinforcing loops was never explicitly encountered.

3.8.3 Second New Archetype – Forever Fluctuating

A second archetype was also created. An example of the second archetype is the CAR's increasing tolerance of violence against locals until some threshold is passed and then the tolerance of violence reduces (partly through less missions/funding by the government). One could postulate that a similar scenario is playing out with the US Army in Iraq who are facing mounting criticism concerning military conduct in Haditha and Mahmoudiya.

This archetype is characterized by a critical event triggering a massive increase in some factor (e.g. consumption of antiviral drugs, use of antiseptic hand wash, safety features, material, etc.). Subsequent to this critical event, the level of this factor diminishes very gradually, until the level observed before the critical event is reached (see Figure 8), rendering it conceivable that a similar critical event may occur again. Without the drop, the critical event would be prevented. The analysts named this archetype "Forever Fluctuating".

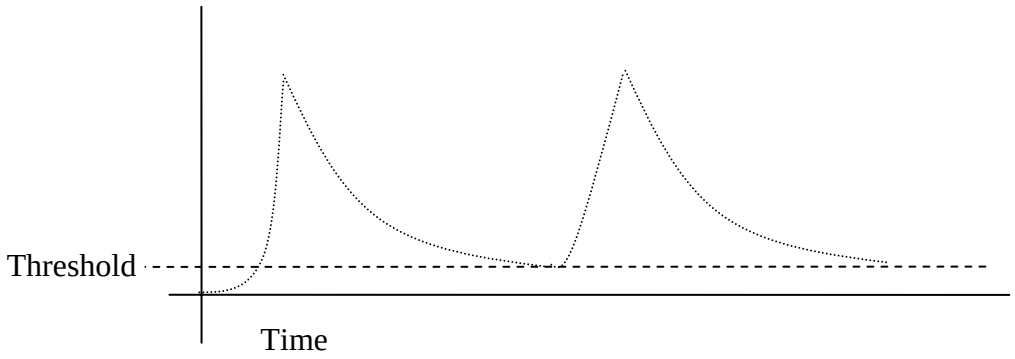


Figure 8: Graph of the outcome of new Archetype (Forever Fluctuating)

There are many non-military examples that would seem to support the existence of this archetype. For instance, the construction of bridges exhibits phases, beginning when a bridge collapses. Subsequently, all bridges are over-engineered, but over time the degree of over-engineering diminishes as constructors seek to reduce costs and time to build. This continues until a bridge collapses and the cycle begins again. The SARS outbreak of 2003 also has these patterns. When SARS occurred, people visiting hospitals and nursing homes wore masks and washed hands with antiseptic wash. People disinfected door knobs and phone receivers. This pursuit of scrupulous hygiene has gradually diminished to today, where the level of hygiene is probably the same as prior to SARS.

This archetype also brings to mind the psychological principle of Risk Homeostasis (Wilde, 1982). This theory posits that everyone has an internal threshold to the amount of risk they deem acceptable. When something happens to change the level of risk to which we perceive ourselves subjected, we modify our behaviour. A bridge collapse increases

our perception of risk, deaths due to SARS increase our perception of risk, and in all cases we take steps designed to return our perceived level of risk to normal. Over time, our internal level of risk adjusts, or we even cease to attribute the same risk to the issue in question, and we start to engage in old behaviours.

4 Discussion

4.1 Systems Thinking and the Military History Examples

Though many of the archetypes were successfully mapped to the different scenarios, the analysts also noted certain commonalities that kept arising throughout the analysis that were not archetypes. These 'systems thinking' issues are identified below in Table 8.

Table 8: Systems issues identified in military history examples

#	Summary	Description	Archetypes that relate
1	Ego-centristic views.	The societal/cultural/religious/etc differences between self and the area of operations need to be taken into account. Both in terms of helping civilians, and in terms of the best way to achieve your effect (i.e. What would negatively affect own forces may have no impact on opposing forces; What interventions help our own society may not help other society). Similarly, negative effects can occur within own operations, where certain groups cannot accurately communicate with other groups (can be due to verbal differences (jargon, language), non-integrated technology, non-integrated protocols/doctrine). Need to look at things from *other* perspectives.	Limits to Success; Escalation; Accidental Adversaries
2	Lose focus on highest level goal.	Maintained focus on the 'ultimate goal' is lost due to selfish considerations E.g. Don't let personal issues between self and other Cdr's or governing personnel take precedent over mission success (e.g. Desert Storm where Navy/Marine resisted control of air assets by Air Force); Come across secondary issues that want to deal with, but don't realize that dealing with those secondary issues may affect achievement of overall goal.	Growth and underinvestment; Fixes that fail; Shifting the Burden; Accidental Adversaries; Drifting goals
3	Financing takes control.	Financial pressure, especially short term, can cloud the decision maker's view. Trying to save money can cause larger problems than original problem that had to be dealt with. (Eg. GTS Katie, Chicoutimi, use of contractors in military situation, rather than training more soldiers).	Growth and underinvestment; drifting goals; limits to success
4	Group Think.	Both positive and negative characteristics can be reinforced under certain circumstances. These circumstances include: a narrow focus, a lack of consideration of other options, and dissenting opinions forbidden. Steps need to be taken to avoid the 'groupthink' trap, especially by those in leadership postions (Eg. CAR, Nazi, Taliban)	Limits to Success; Escalation; Fix that fails; Shifting the Burden

#	Summary	Description	Archetypes that relate
5	Differences in Procedural versus Social Rules	There can be large gaps between what military personnel are supposed to do according to their rules and procedures, and what they are supported in doing by their peers and superiors. If lower auth are not following orders, and are not punished (or even encouraged to not follow the rules), then the rules are no longer effective. Quickly things can get out of order.	Growth and underinvestment; Accidental Adversaries, Success to the Successful, Fix that Fails

4.2 Conversion from Causal Loop Diagrams to Stock & Flow

Due to the strict and specific requirements of properly functioning stock and flow models, converting causal loop diagrams to generic stock and flow models is complicated. Three complicating factors are discussed below.

Firstly, causal loop diagrams tend to link loosely related factors together with a syntax that does not require detail about the relationships between the factors. It is even hard to tell when you can have different CLDs of the same archetype. CLDs can have arrows to and from completely different types of generic entities (i.e. arrows connect "unintended consequences" with "problem symptom"). Its lack of strict rules is one of the advantages that causal loop diagrams offer. However, stock and flow models have a structure that controls what can and cannot flow into and out of the same stock, as well as rules that govern the types of relationships that connectors can have to stocks and flows. Though this gives stock and flow models a heightened validity (a main advantage of stock and flow models), it greatly restricts direct implementation of loosely related causal loop links. Time is also not well represented on CLDs, limiting the implementation of "critical events" as they occur in the real world.

Secondly, there is a 1-to-N mapping between generic causal loop diagrams and implemented stock and flow models. This is due to the fact that it is impossible to create stock and flow models as generic as CLDs. The rules that govern stock and flow connections and relationships are strict (which ensure model validity). Relationships must be definitive. Stock and flow models are meant to model concrete examples, and there are many concrete examples that map to a single causal loop diagram.

Thirdly, causal loop diagrams offer a variety of perspectives simultaneously by showing the whole system from a high level; while stock and flow models work best when framed from a single perspective. This isn't too say that stock and flow models can't also show the system from a high level, only that when the model is meant to graph outcomes based on user inputs it makes the most sense to frame the archetype from that user's perspective. This gives the user a realistic experience and more accurately portrays what the user can and cannot change. This is very hard to accomplish when the stock and flow model is not created from that perspective from the beginning, further complicating the causal loop diagram conversion.

Wolstenholme (2004) does outline a trick for conversion from causal loop diagrams to stock and flow diagrams:

> *"All that is necessary to achieve a one-to-one correspondence between causal maps and stock-flow maps is to show the relationship between every outflow rate from a stock and the stock itself as an opposing influence, rather than a flow."* (Wolstenholme, 2004, p. 351)

The analysts do not recommend following the trick, as it forces the two model types together somewhat artificially, and thus adversely affect the validity of the model.

4.3 Archetypes Relevant to Military Decision Making

A variety of approaches were used to develop a subset of archetypes that are specifically relevant to military decision making. In effect, however, the subset is actually identical to those archetypes described by Senge (1990), with the addition of one new archetype identified during the course of this project. The military domain is complex, comprising any and all systems that can be discerned in the world, making it unsurprising that all archetypes would be relevant to military decision making. Further, it has been noted elsewhere that the Wolstenholme archetypes are too generic to be useful, thus the Senge archetypes seem a more relevant subset for military decision making.

Every effort was made to find new archetypes. The diagnostic tool, which considers every variable in an archetype, was used to uncover combinations of archetype variables that are not used to define existing archetypes. This systematic approach, while resulting in theoretically-possible archetypes, did not lead to the identification of any new archetypes in the scenarios (as described in the documents referenced).

So, since no real subset of archetypes could be created, nor could new archetypes be identified, the analysts attempted to make the archetypes more relevant to military decision making by changing the names. The resulting list of archetypes relevant to military decision making is outlined below in Table 9. New names that relay a more accurate picture of the pre-existing archetypes are suggested, as well as the new archetype. The new names incorporate military terminology.

Table 9: Suggested Senge Archetype Names

Original Name	***Suggested Name***	***Reason***
Limits to Success	**Limits on Success**	Suggested name implies that the limit affects the quantity and quality of success, not success in time/space.
Growth and Under Investment	**Commit and Stick**	As capacity limits of a system are reached, aggressive investment must be undertaken to maintain growth. The suggested name acknowledges both the need to commit to investment and to stick to this investment when the reward may not immediately be delivered.
Tragedy of the commons	**Tragedy of the Commons**	No change suggested.

Original Name	*Suggested Name*	*Reason*
Fix that Fails	**Fixes that Backfire**	To further clarify the difference between 'Fixes that Fail' and 'Shifting the Burden', the fix here actually has detrimental effects on the system. (Senge, 1994)
Shifting the Burden	**Addressing the symptoms**	Suggested name more accurately portrays what this archetype involves.
Accidental Adversaries	**Accidental Enemies**	'Enemies' offers a more intuitive interpretation of what this archetypes means
Success to the Successful	**Success to the Successful**	No change suggested.
Escalation	**Arms Race**	The 'arms race' is a classic example of this archetype, and so portrays the archetype clearly.
Drifting Goals	**Eroding Goals**	The goals are decreased (not just changed).
Forever Fluctuating	**Forever Fluctuating**	New Archetype
Mission Creep	**Mission Creep**	New Archetype

4.4 Dynamic Decision Making, Systems Thinking, and Archetypes

Military Forces must 'anticipate the unexpected and be prepared for the unimaginable' (Pierce, Bowman and Sutton, 2003) but it is unclear how we can train our military to fulfill this requirement. Both Dynamic Decision Making research and Systems Research has taught that humans are not very good at making decisions in situations that involve time lags, feedback and non-linearities. Humans also naturally seek confirmation for theories which may lead them to execute actions in line with an erroneous theory.

Dynamic Decision Making involves the making of decisions over extended periods of time, when environmental changes and changes in objectives complicate the decisions and actions taken. By studying and training military personnel in Dynamic Decision Making it is hoped that the quality of the decisions made will improve, especially in situations involving previously unexpected and unimaginable circumstances. Dynamic decision making can be either analytic or intuitive, or both. The critical issue is not how the decision is made, but rather how its effects evolve over time.

Similarly, systems thinking, and in particular archetypes, are concerned with viewing systems as a whole. Systems Thinkers strive to see how the system functions operationally and understand what impact all the interrelationships within the system are causing. This similarity of looking through the obvious interrelationships between dynamic decision making and systems thinking leads one to believe that systems thinking, and archetypes, should be applied to the training of decision making skills to realize the full benefits of comprehensive training in decision making.

Conceivably, systems thinking can be applied to military decision making through:

- Teaching the concept of archetypes to identify possible counter-intuitive outcomes;

- Using systems thinking to frame the consideration of examples from military history; and,
- Training to seek alternative strategies and account for delays as well as the realization of one's own human limitations (i.e. learning to appreciate cause and effect relationships).

As already mentioned, another potential benefit of familiarity with systems thinking is an improved ability to conduct effects-based operations (EBO). Because EBO encourages the soldier to think about different methods of achieving an end-state, the cause (what the military does) and effect (the outcome or end state), which may be separated in time and space, can be better understood and exploited. This latter point about cause and effect also points to the potential benefits of a systems thinking perspective on dynamic decision making, where decisions are made and the outcome takes time to reveal itself, during which time it becomes less likely that a decision (or strategy) will be changed.

This is not to say that systems thinking is readily applicable to the training of decision making skills. It is more likely that systems thinking can be of some benefit when targeted appropriately, but of limited utility if applied indiscriminately. This is because systems thinking, focused on application, is likely to lead to an outcome (regardless of whether it is positive or negative) while unfocused application is likely to lead to idle and long deliberations that never lead to an outcome.

The 'skill' of understanding the whole of the system is generally left to time and experience. Typically, novices are taught the declarative aspects of a system and left to their own devices to build an understanding of how they interact. This is more true when one considers multi-dimensional, as opposed to pairs of, relationships. Further research into the development of procedural, as well as declarative knowledge (potentially though the use of microworlds) may expedite systems understanding.

The same is true of dynamic decision making. Humans typically are not good at making decisions where the outcome is revealed over time and possibly in different locations. Further, this is a skill that is not taught in CF command and staff courses. An informal survey of command and staff courses revealed that dynamic decision making is not taught formally in these courses. Systems examples that might help with novice's understanding of systems and dynamic decision making (e.g. examples in which the actions of a commander led to an unexpected outcome) are not framed as such. While novices are given historical examples to learn from, they are not guided to consider the systems view or how an understanding of dynamic decision making (leveraging a systems understanding) could have made a difference.

Thus, a better understanding of systems thinking, leading to staff course content that furnishes the novice with an understanding of the systems with which they are interacting, could result in more 'experienced' commanders in a shorter period. This could be particularly useful given the move from manoeuvre-based warfare to effects-based operations.

This approach, however, assumes that commanders engage in an analytical decision making process. However, not all commanders have time to engage in analytical decision making processes, and not all commanders prefer to make decisions in the analytical manner. Thus, it would be unwise to mandate a formal systems thinking approach to military decision making. For instance, asking the commander to identify the balancing or reinforcing loops inherent in an archetype would unnecessarily constrain the commander. Procedures might mention the 'whole system' that is to be affected, but require the commander to appreciate the whole system, rather than define it. The meta-cognitive abilities of the commander are important.

The alternative decision making approach is intuitive. To become an intuitive decision maker, a commander must have a great deal of experience applying all the analytical processes that permit him to understand the system on which he is acting. Thus, systems thinking still has relevance to the intuitive decision maker, but only at the outset of training to furnish the decision maker with a strong understanding of the system. Where the system is novel (e.g. a commander arrives in a new theatre) systems thinking will necessarily be analytical. The asymmetric nature of current operations also indicates that the commander will not have an automatic grasp of the system and thus intuitive systems thinking will usually be of secondary importance to analytical systems thinking in deployed operations.

This suggests the potential benefit of archetypes. Since archetypes are supposed to be generally applicable to all systems they can be taught to the commander, who then begins to see archetypes in the world and thus better understand the new systems with which he comes into contact. The alternative is that the commander be taught contextual examples in an exhaustive manner, which will likely take a very long time and bore the commander. The combination of teaching archetypes and experience could result in more rapid accumulation of experience, because the commander understands the cause and effect relationships in a new system after a very short exposure to them, rather than implicitly building this understanding over a longer period of time.

The applicability of archetypes toward training decision making needs to be examined further. It has been established that systems thinking and archetypes could be beneficial to analytical decision making and also the more rapid development of intuitive decision making strategies. But perhaps their most significant contribution would be to the dynamic decision making process. Assuming archetypes are used to describe the system being acted upon, there are several difficulties to be overcome.

To exploit archetypes for the purposes of decision making, the archetype would need to be identified at the outset. However, as this work has shown, the actors and the behaviour over time must be identified before the archetype can be characterized. By definition, the behaviour over time will not be known until sometime after the beginning, and without knowing the behaviour over time, it is hard to be certain that all the actors have been identified. That said, a preliminary determination of the archetype would be possible by identifying the actors and the nature of their relationships.

A major issue with archetypes is a lack of consensus on what the archetypes are. Since the CLD structure was first introduces by Meadows in 1982 (Lane and Smart, 1996) there has

been no agreement on what the archetypes are. Even Senge, who originally outlined 8 archetypes in 1990, in his later work (Senge, 1994) only outlined 5 (one of which was not a part of his 1990 work). Though this report does recommend a list of archetypes for the military context, we are only privy to the literature currently available, and believe that a greater consensus will be reached after sufficient verification and validation of a list of archetypes.

This leads to an additional difficulty. Assuming the archetype is definitively identified at some point after the original action on the system, what does the decision maker do if the action taken was based on the wrong archetype or if the system does not behave as expected over time? To use archetypes to effectively support decision making, commanders must be trained to identify archetypes from real-time data, but also trained on how to change archetypes midstream, and how to correct problems in outputs that are based on outputs that themselves are based on archetypes. These requirements mean that the commander must be furnished with the appropriate information, which means that each archetype will necessarily add to the Commander's Critical Information Requirements (CCIRs). Separate work may need to focus on the 'sensing' capabilities of the CF in order to satisfy these CCIRs, and these are likely to be situationally specific and highly variable.

So, although systems thinking and archetypes can enhance the training of decision making for the CF, there is a great deal more work to be done before they can provide a *direct* benefit. However, it is conceivable that with minimal work (largely to formalize the teaching of system thinking at Staff College) the CF can realize much of the benefit that could be associated with systems thinking and archetypes. Such additional training is likely to be of benefit to operational and strategic level decision makers.

5 Conclusions and Recommendations

This project has been concerned with the application of Systems Thinking approaches, and in particular Archetypes, for the purposes of training CF personnel. It is expected that a better understanding of the whole system may be beneficial when training CF personnel in effects-based operations, dynamic decision making, and understanding second and third order effects and counter-intuitive outcomes. Consideration of systems thinking uncovers some promise in these training objectives.

The next issue when determining how systems thinking could be used to train CF personnel is the approach to take, both to describing the system and structuring learning content. A candidate for this is the study of archetypes. Archetypes are attractive because they posit a limited number of 'building blocks' that can be used to describe any system. Trainers can use them to build students' understanding of systems and thus enhance dynamic decision making in the field. The use of archetypes for training purposes was complicated however. They were found to describe much of the military history examples to which they were applied, but there still seemed to be gaps that weren't accounted for by archetypes, but for which no new archetype could be developed. One new archetype was developed to describe identified behaviors over time that were not accounted for in existing archetypes. This new archetype has face validity to the project team, but would require more work to demonstrate more rigorous validity.

The project also had to develop a systematic approach to identifying archetypes from written descriptions of a military operation. The first effort to do this involved the development of a diagnostic tool. The diagnostic tool was partially successful, being able to classify scenario information into one of Wolstenholme's four archetypes. However, the classification criteria for the more detailed archetypes of Senge were themselves too detailed to be usable. The second effort to identify archetypes from written descriptions was arguably more successful. This approach involved identifying the main actors in a system and describing their output/behaviour over time. This allowed the analyst to match the behaviour over time to the work by Braun (2002), thus classifying the archetype. This approach was preferred by the analysts, but it remains to be seen if this is the only information required to identify archetypes. The analysts may be leveraging implicit theories and understanding about the nature of each archetype to reach this classification, thus demonstrating a lack of the necessary rigour for archetypal mappings.

This work leads to a number of recommendations. First and foremost, given the CF's increasing emphasis on effects based operations (according to interviews with SMEs and observations of training exercises), the systems thinking approach should be taught in an accessible manner during staff training. However, additional work is required to establish whether such a training approach provides any benefits over and above the training typically received currently by CF personnel. To this end, an experiment could be conducted in which one group receives standard training in effects based operations and the other group receives such training from a systems thinking perspective. Both groups

would receive the same test of comprehension (and possibly application) so that a direct comparison of training efficacy could be made. The creation of a systems thinking training curriculum would be a necessary precursor to this experiment.

Additionally, a great deal of effort was spent by the analysts understanding the intricacies of the CLDs and functioning of the different archetypes. The analysts are not convinced that such a detailed understanding of CLD diagrams would be time well spent during a CF training program. Furthermore, any training program that delved into archetypes would need to train the early identification of signs of a developing archetype. There is little benefit of post-scenario archetypal mapping, unless the archetype can be successfully addressed mid-scenario.

As implied above, further research into the newly developed archetype is necessary to establish that it is in fact different to those already defined by Wolstenholme and Senge, and establish its validity in a real-life context. This activity would largely be conceptual in nature, although some effort should be expended to find repeated concrete examples in military history and other domains.

The partial success of the diagnostic tool suggests that additional work could produce a viable diagnostic too for the Senge/Richmond archetypes. This work would focus on developing a more general set of descriptors to be used to interpret scenario narratives with respect to archetypes. These descriptors could also be illustrated by clear examples to aid the user in making the classification. Additionally, some effort should be focused at understanding the process that analysts ultimately used to classify scenario information. Again, this would largely be conceptual but should follow the lines of a cognitive task analysis in order to understand on what features of a scenario description the analyst is placing most importance.

Finally, work should further investigate the issues identified in Table 8. These issues, while exhibiting some of the characteristics of existing archetypes, nevertheless don't precisely map on to any single archetype. There may be further archetypes that are not so readily apparent through examination of a system's behaviour over time.

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Annex A: Military History Analysis

DS Strategic Bombing

Desert Storm Strategic Bombing

#	Situation	Further Info on Situation	Consequences	Archetypes?
1	Saddam Hussein leads Iraq to invade Kuwait			
2	UN approves coalition to liberate Kuwait			
3	US strategize 3 types of air strikes: Iraqi army, targets that controlled the air and sea, and strategic targets			
		Strategic Targets further subdivided into: key production (oil, electrical, etc…), deployed ballistic missile forces, lines of communication (LOC),		
4	15% of the targets of the air strikes were strategic			
5	88% of Iraq's installed generation capacity was destroyed or damaged by the US in air strikes		This, and many of the aspects of this article, points to the issue of planners not looking at what would affect the Iraqi army (ie think they are dependent on electricity, when not). Not sure what (if any) arch that relates to.	
		Is expected that they were forced to use backup power and some inconveniences		
		No evidence of disaffection toward the Iraqi leadership		
6	90% of Iraq's oil refining capacity rendered inoperative			

Iraqi forces required very little petroleum (Iraqi air force was not part of war, and forces in Kuwait used Kuwait's oil stocks)

No significant military results

7 Nuclear capabilities were targeted

UN inspector teams identified and destroyed more of the Iraqi nuclear program after war than did the air campaign during the war

8 Scud missiles were to be destroyed

Post war searches showed that the air strikes destroyed few, if any, mobile lauchers (which were able to move, fire and then hide in minutes; also used decoys that would explode like the launch would have)

Underestimated certain aspects (though they apparently overestimated other aspects).

Confirming the destruction of mobile launchers during the war

Led to disagreements internal to coalition on how to determine level of destruction

9 Bridges were key targets (LOC)

Iraqis rerouted traffic, constructed temporary bridges, used amphibious vehicles, built earthen causeways. These work arounds were already prepositioned near key bridges.

Iraqis did suffer food shortages; however, was due to mobility denial rather than supply denial (supply denial being the goal of the US)

10 Communications between Saddam and his forces

Many efforts were made to disrupt the communication ability between Saddam and the forces, however, the system had more redundancy and flexibility than anticipated, and never was affected

11 Comparing Desert Storm to the Vietnam war: "Through the ages, airpower apparently has been unable to affect political stability or a population's will to contiue the fight. As noted by the GWAPS team, Iraq's military force proved to be the weak link - not it's political regime. The Germans never overthrew Hitler after the massive area bombings of Germany's cities, nor did the North Vietnamese ever turn on Ho Chi Minh."

Not sure how this fits in either… but the fact that they assumed Iraq would love American and hate Saddam did not occur (and throughout history has never occued) yet this seems to remain a pervasive idea, and something they did not predict.

12 Hi-tech was not necessarily the best - Some of the oldest aircrafta/c in the AF inventory were in greatest demand, only 8% were precision guided

Problem with always wanting the 'coolest toys'. They may not be the most effective (again lose having eye on ultimate goal… get caught up in tech toys)

167 LGBs dropped, 76 missed targets due to pilot error, mech or elec malfunctions or poor weather

288 tomahawk cruise missiles fired by Navy, only half struck their targets

Note: From Saddam's perspective the war was very different. He hoped to attain many things from invading Kuwait (personal prestige, Iraq to reassert it's regional leadership, intimidate Saudi Arabia, distraction from domestic resentment at economic mismanagement, acquire Kuwait's assets). In fact the country was quickly defeated, moral was ruined, subsequent wars.

Israel NOT joining in the war was a very good thing. Good systems thinking from the perspective of the coalition, as it could have led to may unintended consequences.

Winnipeg Floods

Situation	Further Info on Situation	Consequences	Archetypes?
Largest domestic operations ever undertaken by the CF	Command and Control evolved in three stages		
The province did not request or indicate an intention to request CF assistance in a timely manner As early as Feb, 1997 there were plenty of indicators suggesting the probability of massive flooding in southern Manitoba.			
Until the April 18, 1997 when devastation occurred south of the US/CDN border, provincial authorities believed they did not require the assistance of the CF			
No national authority to conduct preliminary joint contingency planning was ever issued	A proper balance had to be reached between prudent joint preparations and the production of detailed plans. Without specific knowledge of the mission and participating forces, wasted effort and resources could result.	Early planning was not coordinated between two headquarters (LFWA HQ and AIRCOM HQ).	Out of Control Type Archetype? Recommendation for CDS Warning Order not issued as early as possible to designate command relationships and authorize the conduct of joint planning activity.
April 19, 1997 Province of Manitoba formally requested open-ended support from the Minister of National Defense. This request was late in the preparation/warning phase.	Phase 1: Commander Land Forces Western Area (LFWA) was appointed Joint Task Force Commander (JTFC). The Joint Task Force (JTF) ultimately included all available elements of the Canadian Mechanized Brigade Group, two Reserve	This decision effectively restrained the commander LFWA's ability to make firm preparations in advance	

	Companies, vangard companies from Land Forces Central Area (LFCA) and Secteur Quebec de la Force Terrestre (SQFT), an Air Component and a Marine Component		
April 24, 1997 support began	OP NOAH renamed OP ASSISTANCE as its scope increased.		
April 27, in a worst case scenario, it was recognized that additional CF assets would be required. A new Command and Control architecture was adopted on April 29		Phase 2: JTFC moved to Winnipeg on April 27	
Between the time LFWA issued initial flood contingency plan (4 March, 1997), and the time LFWA ordered OP NOAH there was minimal planning between LFWA, AIRCOM, and MARCOM.			
ACC was appointed in plenty of time, but there was no information exchanged between his headquarters, the Air Force chain of command or the joint chain of command.	It would seem appropriate that when the constitution of a joint force is being considered, representatives from joint force components (i.e., air and marine components) be involved in the planning stage from the outset.	The synergy required to allow an efficient evolution to the eventual joint structure could not be created until after deployment.	
Level of knowledge of joint doctrine and operations expertise were quite low.	Only 3 of 35 maj/lieut-comm working in JTFHQ were staff college graduates. Not many (if any) JHQ staff members possessed qualifications gained by completing the Joint Warfare Intermediate	A greater understanding of how the various components operate is required by all component staffs and by the JHQ staff.	Growth and underinvestment -- training and education in the military as it grows. Holistic Solution: Readilly apparent that operations training of staffs assigned to function in a JTFHQ is required. This training must include the JHQ augmentees

	Course, an introduction to joint warfare run by CFMWC.		indentified and provided by the respective Force Generators
The role of the Maritime Component Commander (MCC) and the ACC, capabilities and limitations of their respective assets and the component method of command are not well understood or appreciated.	While CF doctrine provides for the overall concept of integration between components, the specifics are not well understood nor addressed at the outset	Integration of both Maritime and Air components into the JHQ was difficult. Some issues caused friction.	Accidental adversaries type archetype?
This operation grew rapidly and did not fit the doctrinal model.		Had a full-scale joint operation been envisioned at the beginning, complete with a JTFHQ, the situation would have been easier.	Out of control type archetype? It is usually more difficult to change the modus operandi in mid-stream. Inappropriate plan for the scale of the operation, Operation grew, unable to establish cmd
Cdn Div HQ responded successfully to the OP ASSISTANCE requirement		A timely transition to a true JTFHQ structure and modus operandi was completed.	
The limited degree of jointness in the day-to-day structure and working procedures of the Div HQ created obstacles and restrained the end result of the operation		The right balance between 1 Cdn Div requirement and JHQ responsibilities still needs to be reached, especially for future large scale operational deployment	Shifting the burden -- problem still exists at same level of severity, only symptoms were addressed.
Lack of approved concept of operations		Shortcomings in Communications Information Systems (CIS)	

Phase 3: JTF levels were gradually reduced after the red river crested in Winnipeg, after water levels fell below threatening levels, and as it became apparent that emergency could be handled by the civil authority

Somalia

#	Situation	Further Info on Situation	Consequences	Archetypes?	Justification for Arch	Issue;
1	Somalia in chaos (famine, civil war)					
2	Operation Deliverance (Canadian part of Operation Restore Hope) initiated			Wolstemholme's Out of Control Archetype	From Can perspective, the goal was to go in and control the violence. Ended up causing more violence. (ie. Intended control fails to be realized)	
3	Goal to deliver humanitarian aid and restore order					
4	Canadian gov't selects Canadian Airborne Regiment (CAR) to send over		Why send this group?	Underacheivement Arch	In terms of reputation. Can gov't hopes to continue Canada's peace keeping legacy, but this mission didn't quite work out that way	
4.1		Cited reason that the CAR is prepared to rapidly deploy into "hot" situations				
4.2		Were there other confounding factors? Other groups recently sent/tired?		Limits to Success	Had a spiral of successful peacekeeping missions, but then overstepped their bounds (expecially if CAR chosen because other troops were tired from recent missions); results in Can losing some of their respect as a peacekeeping nation (that they perhaps just thought would just keep growing)	

4.3		Note: 'bad apples' of certain CF regiments had been offloaded to the CAR	Shifting the Burden	Kept sending 'bad apples' to CAR; was fine for those commandos, however, did not deal with having these 'bad apples' in the military
4.5		CAR was recently reduced to battalion size; therefore, in throes of reorg	??	Possibly a new Arch? Seems like a systems thinking issue…
5	Commanding office Lcol Paul Morneault declared 'rogue commando' unfit for service abroad, and wanted to leave them in Canada			
5.1		'Rogue commando' was a CAR sub-unit known as source of vandalism, indiscipline, and racist attd's (members in white supremacists groups)	Why aren't white supremacists kicked out?	
5.2		During a unit party before deployment, one member of 'rogue commando' is on film saying 'we ain't killed enough niggers yet'		
6	Lcol Morneault was replaced Lcol Carol Mathieu (known for his 'rough and ready' toughness)		Why was he replaced?	Possibly a new Arch? Seems like a systems thinking issue…
7	CAR with all groups deployed in Jan 1993			
8	Based in tents a far distance away from originally planned mission-area		Why based a distance away?	
9	Soldiers lived on hard rations, limited water			
10	Manditorily took mefloquine to combat malaria			
10.1		evidence that this drug causes hallucinations, paranoia and suicidal impulses		
10.2		Not clear what (if any) role this drug plays in the alleged events		

11	During first couple of months, they stood out for rapidly bringing order to assigned area	From Senge, perhaps Fixes that Fail	Though the CAR was effective in the beginning in getting control of the area, they ended up going to far.
12	Patrol from reconaissance platoon shot 2 young somali night time infiltrators (one killed, one injured)		
12.1	Air Force flight surgeon felt that it seemed it was an 'execution' after seeing the body		
12.2	Use of lethal force against infiltrators as in compliance with orders laid out by Mathieu (and all forced in Somalia)		
12.3	No one was charged or punished at the time	Reinforcing Loop	From the perspective of the person in charge, he's watching his guys do 'not so good' things, and not punishing them for it. This lax attitude becomes a problem.
12.4	This was only a week before the killing of Shidane Arone		
13	On March 13, 1993, 2 members (Matchee and Brown) of 'rogue commando' tortured and killed Shidane Arone who was caught trying to sneak into Canadian Camp		
13.1	There was no Somali law or enforcement mechanism, so detained by group		
13.2	At least 16 ppl passed through area of torture that night		
14	Matchee and Brown were arrested and charged with murder		
14.1	Later, Matchee determined unfit to stand trial; Brown found guilty of manslaughter		
14.2	Cdr of 'rogue commando' and a number of his subordinates were found guilty of 'negligent performance of duty'		
14.3	CO of the CAR (Mathieu) was tried twice, acquitted both times		
15	Trophy-type photos were leaked to media	What if the pictures weren't leaked to media?	

16 Kim Campbell was current Minister of National Defence, and in leadership campaign

Media tried to link Cambell to the events (closed all of DND for a day to search for info… found nothing)

17 DND took over all PR of situation, led to media accusing of cover-up

Wolstenholme's Out of Control — DND wanted to maintain control of information concerning Somalia affair… totally blew up.

Senge ?? — Not sure of which Senge this maps to. New Arch?

18 CAR was disbanded in 1995

18.1 Hypothesized that due to budget cuts, but the Somalia Affair gave public support for disbanding

19 An assorted number of polical and military personnel were forced to resign (in partial due to Somalia Affair)

19.1 Including, Chief of Defencs Staff (General John de Chastelain), his predecessor resigned after only a few months (General Jean Boyle), Minister of National Defence (in new Liberal gov't) David Collinette

20 Enquiry came out in 1997

20.1 Was stopped when they started looking the the highest echelons of the military/politicians

20.1 Enquiry noted that, in December of 1992, the CF in Somalia were in fact at 'war' (arms could be used proactively to achieve politico-military objectives)

21 Damaged moral of the CF and DND

Drifting Goals — Short term solution of sending the CAR over, ended up diminishing the moral and funding (long term goals) (from the perspective of the Can Military)

22 Recruitment became more difficult

23 Sharp cuts to military spending introduced by the Liberal government

Had proper funding been provided to the military in the first place, the entire Somalia Affair may have been avoided. Instead, the government further cut the funds for the military after the operation.

Success to the Successful

24 Many policies to avoid such a situation in the future

24.1 Some feel these hamper the flexibility of the operational units

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(U) The complex and dynamic nature of operations−other−than−war (OOW) (e.g., peace support, the 3−block war concept) in which Canada and allied nations are increasingly involved requires Canadian Forces (CF) officers to call upon high−level dynamic decision making (DDM) skills to an unprecedented degree, especially at the strategic and operational levels. One possible method of improving the DDM skills of CF personnel is the application of 'systems thinking', in particular, the possibility that a limited number of recurring patterns (archetypes) can be used to explain all military situations and thus aid DDM. If successful, this approach would enable the CF to achieve its objectives efficiently with minimal unexpected outcomes (e.g. second− and third−order effects). This work looked into the applicability of archetypes for training DDM, through analyzing and modeling military history scenarios. The applicability of existing archetypes is discussed along with suggestions concerning new archetypes that apply to military scenarios.

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(U) dynamic decision making; system archetypes; systems thinking; system dynamics; military decision making; command and control; microworlds; training; effects−based operations; dynamic systems simulation; strategic and operational decision making