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Using i* Modeling for the Analysis of Strategy Documents

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Table of Contents

Abstract			
1 Introduction			
2 Study Objectives and Overview	7		
3 The i* Framework and Evaluation Procedure			
3.1 The i* Framework			
3.2 The i* Qualitative Evaluation Procedure			
4 Study Claims			
4.1 Document Comprehension			
4.2 Strategy Analysis			
5 Study Design			
5.1 Case Study: FIS Strategy Document			
5.2 Case Study: NSSUSA			
6 Discussion			
6.1 Evaluating Existing Claims			
6.2 Additional Discoveries			
6.3 Potential Benefits for Strategy Document Authors			
6.4 Requirements for Tool Support			
6.5 Guidelines for Future Application			
7 Threats to Validity			
7.1 Construct Validity			
7.2 Internal Validity			
7.3 External Validity			
7.4 Reliability			
8 Related Work			
9 Conclusions			
Acknowledgements			
References			
Appendix			
A.1 Section Specific Models from FIS Case Study			
A.2 Additional Questions and Issues Arising During Modeling			

Abstract

The production of strategy documents, outlining the strategic plans for the future of an organization, has become increasingly common. However, creation of such plans is influenced by several objectives beyond the description of an organization's goals and intended actions. Strategic plans are often written to paint the organization in a positive light and may be left intentionally vague to avoid specific commitments. As a result of these conflicting objectives, strategy documents, as well as their underlying plans, are often difficult to understand and effectively analyze. This work proposes the use of strategic, intentional modeling, specifically, the i* Framework, as a means to facilitate the analysis of strategy documents, discovering interesting issues and questions. The stakeholders, objectives, actions and relationships described in the document are depicted via i* models, facilitating improved understanding and qualitative analysis. Exploratory hypotheses concerning the benefits of such analysis are described, including the facilitation of document understanding, the assessment of plan achievability, the discovery of conflicting objectives and the detection of vulnerabilities. The hypotheses are tested with the execution of two case studies involving strategy documents for the Faculty of Information Studies at the University of Toronto and the National Security of the USA. Case study experiences lead to the discovery of further exploratory hypothesis concerning document organization. Hypothesis concerning the potential benefits of i* modeling for strategy authors are outlined. A high-level description of the tool support required to facilitate this type of analysis is provided, along with recommended *methodological guidelines.*

1 Introduction

Often it becomes necessary for an organization to produce a document outlining strategies and plans which direct the future of the organization. Such documents usually contain a description of the objectives of the organization; including the actions that the organization plans take in order to meet its objectives. Depending on the nature of the organization, be it a business, educational institution or government division, such plans may include, for example, new or maintained areas of business focus, plans for strategic alliances, descriptions of new or expanding target markets, plans for new personnel, or details of a physical expansion.

Strategy documents can be produced for several reasons, and can be aimed at various audiences. The first and most obvious reason to create a strategy document is to outline the future strategy and plans for an organization. However, beyond this, a strategy document may act as a medium for positive advertisement or promotion. Its purpose may be to paint the organization and its future in a favourable light, giving it the right "spin". It might be intended as a way to impress or gain the favour of several parties, including higher-level authorities who may be responsible for approving the strategy or for the general direction of the organization; employees, shareholders or other parties involved in the organization; and, if the document is publicly available, the general populace, including the media or government.

Due to the presence of multiple, sometimes conflicting motivations for the creation of strategy documents, such documents can be difficult to interpret and create. From the point of view of the reader such documents can suffer from several problems, including a general difficulty in understanding the content, often due to the complex and extravagant language used; confusion as to how exactly each objective will be accomplished, or to what objective each part of the plan aims to address; and an uncertainty as to how to assess the progress an organization may have made in accomplishing the plan. Furthermore, although some of the intrinsic problems in such documents may be apparent to document readers, others may go unnoticed without a more in-depth evaluation. Strategy document readers may be too caught up in understanding the details of the document to ask potentially important "how?" or "why?" questions, or to notice conflicting objectives.

For an example which potentially highlights some of these problems, we can examine several related excerpts from an Academic Strategy document for the Faculty of Information Studies (FIS), explored in more depth in Section 3.

" β . At the level of **information practice**: take a leadership role in establishing a wide range of strategic partnerships..."

<Two more paragraphs here>

"Understanding how the β -part fits into the mission requires understanding a university's overall information strategy in terms of 3 interrelated levels:"

"L3. …"

"L2. Information **practices**: An intermediate level of socio-technical information practices, including publication, peer review, libraries, student work, financial and administrative services, etc."

"L1. …"

What conceptual map would readers develop of the strategic plan after reading these sections of the document? What questions would they have? Perhaps they may ask "Partnerships with whom?" or "What is an information strategy?" or "Are the two sections concerning information practices consistent with each other?". Do these questions get to the root of potential confusion, or are important questions being missed? Is there a way to aid the user in discovering and effectively expressing useful questions concerning these and other document excerpts?

From the point of view of the authors of the strategy document, there is a potential difficulty in finding a balance between the multiple objectives of producing a strategy document. On one hand, the author(s) would (most likely) want to depict an accurate and complete description of the strategic plans of the organization, in order to acquire constructive feedback from concerned individuals and to unite the organization in a clear and decisive plan of action. On the other hand, the author(s) would always like to paint the organization in as favorable light as possible, which may discourage the authors from complete honesty concerning past accomplishments or the current state of an organization. Furthermore, the author(s) may not want to be completely precise in their description of the intended actions of the organization, in order to allow for a sufficient degree of freedom for potential changes to the specifics of the plan, or in order to avoid potential negative consequences if the actions in the plan are not executed as described. These varied motivations may contribute to the reader's difficulty in interpreting the document.

In a further example, the National Security Strategy of the United States of America (NSSUSA) for 2006 includes the following paragraph while describing lessons learned from new challenges in globalization:

"Existing international institutions have a role to play, but in many cases coalitions of the willing may be able to respond more quickly and creatively, at least in the short term. For example, U.S. leadership in mobilizing the Regional Core Group to respond to the tsunami of 2004 galvanized the follow-on international response."

It is apparent that this passage attempts to portray the previous actions of the USA in a favourable light. In addition, the relationship between existing international institutions and new coalitions seems under-specified. How can a thorough analysis of this passage and its impact on the strategic plan be facilitated?

In this work, the application of strategic, intentional, agent-oriented modeling is proposed in order to help readers perform an effective analysis of strategy documents. We introduce several exploratory hypotheses that describe the benefits of this type of modeling on strategy documents analysis. Our approach is intended for use by anyone who is required to read and assess a strategy document, be it the persons responsible for approving the document, individuals within the organization, or outside parties such as media, potential customers or investors. Although our evaluation of the proposed approach focuses on the interpretation and analyses of strategy documents from the viewpoint of the document reader, such analysis can also be helpful to the document author(s), potentially providing guidelines for the creation of effective strategy documents.

In this study, the i* Framework for strategic, intentional modeling has been selected as the intentional modeling framework of choice due to its flexibility, ability to focus on high-level strategic concerns, and the presence of an accompanying qualitative evaluation framework [1][2][3]. This type of strategic modeling, capturing the goals and actions of intentional agents, has been previously applied in several areas including requirements engineering (see, for example, [2]), process analysis [4], investigations of security and privacy concerns [5], analysis of knowledge management needs [6], selecting COTS (Commercial Off-the-shelf Software) options [7], and agent-oriented software production [8].

Although the original proposal for the i* Framework does not outline a specific methodology for the application of the framework, generally the creation of i* models involves the identification of actors or stakeholders who are involved in a domain of interest. The dependencies between these actors are identified and modeled using a Strategic Dependency model. The motivations behind these dependencies in terms of the explicit intentions of the actors are identified, explored and modeled in a Strategic Rationale model. Such models are meant to be iterative and exploratory, used as tools for brainstorming, analysis and planning. The presence of a qualitative evaluation procedure, allowing an analysis of the achievement of the intentions of each actor, further facilitates iteration and exploration of the models.

Due to the ability of strategic modeling and the i* Framework to capture the intentions of, and interactions between, actors possessing explicit strategies, there is an apparent synergy with the analysis of strategy documents. By creating models representing the objectives and plans described in strategy documents, it can be

hypothesized that several benefits could arise. Concerning document comprehension, the act of creating or reading models offering a visual summary of the document may help the reader to better understand the contents of the document, including a clarification of the specific relationships between various objectives. Considering the analysis of the strategies within the document, creating and reading corresponding strategic models could allow an evaluation of the achievability of the objectives described in the document in light of the specific plan of action, including the discovery of contradictions between objectives. By modeling the relationships between stakeholders as described in the document, vulnerabilities in terms of unreciprocated dependencies could be revealed. Overall, a general analysis of feasibility or viability of the plan could be facilitated. In addition, a visual summary of the strategy document may aid the reader in assessing the progress made towards the execution of the strategic plan.

Concrete examples of the potential benefits of i* modeling to strategy document analysis can be seen by returning to the earlier examples from the FIS and NSSUSA documents. For the first example, to summarize and describe the intentional information provided by the quoted sections, a modeller may create a model snippet such as is shown in Figure 1 (the specifics of the i* Modeling Framework are described in more detail in Section 3.1).



Figure 1: Section of an i* Model Depicting the FIS Academic Plan

By creating a simplified conceptual model of the concepts in this section of the document, the reader can try to construct a clearer picture of the content and can better detect gaps in understanding. In this case, modeling helps to emphasize the circular nature of the content. The β mission involves information practices, and in order to understand a university's overall information strategy, three interrelated levels need to be understood, including L2, which involves information practices. In other words, in order to understand how β fits into the mission, the reader must understand β . This is assuming that L2 and β generally describe the same concepts, as they both use the term

"information practices", which may instead indicate a problem with naming in the document.

In the second example, a reader may draw a partial model like the one shown in Figure 2. Here, the two potential options, the role of existing international institutions or the formation of coalitions of willing respondents are shown to have differing positive effects on a more quick and creative response. The lack of detail in this model may help prompt the reader to ask "why?" questions. Why are coalitions of willing respondents more effective at responding quickly and creatively then existing international institutions? Is this really the case? Who are these institutions? Furthermore, when considering the role of dependencies between agents, as emphasized by i* modeling, it is apparent that the USA depends on the willingness of other nations to respond to crises in order to accomplish its intentions. This critical dependency is de-emphasized in the text. The formation of such a model may lead the reader to question other nation's motivations to respond, something not considered in the text.



Figure 2: Section of an i* Model Depicting the NSSUSA

Generally, by trying to convert the document to an intentional model, the reader is lead to more carefully consider the ideas described in the document, making discoveries and raising questions that may have otherwise gone unnoticed. Such discoveries can help a reader to evaluate the quality of a document and the viability of the strategic plan therein.

2 Study Objectives and Overview

This exploratory study has several objectives. The primary objective can be described as follows:

• To formulate the apparent synergistic benefits of i* modeling with strategy document analysis and creation in a series of exploratory hypothesis. The hypotheses concerning strategy analysis will be tested by applying i* models to

strategy documents in exploratory case studies. Interesting findings including unanticipated results derived from the execution of these case studies will be described and formulated as new hypotheses for future investigation.

The secondary objectives of this study include:

- To determine the importance of tool support for this type of analysis. Specifically, can this type of analysis be performed effectively with minimal tool support, i.e., model drawing software, or are more sophisticated tools required? If so, what form should these tools take? What features should they offer?
- To create a series of guidelines and recommendations for future application of i* modeling to strategy documents. This may include an outline of a methodology for the creation of i* models in this context. Although these guidelines may include the use of appropriate tool support, the description will go beyond tools to give broader methodological recommendations.

This report is structured as follows. After having introduced the problem and approach, the i* Framework and evaluation procedure are described, using examples. The exploratory hypotheses concerning the use of i* modeling for strategy document analysis are described in further detail. After discussing the design of the study, the first case study, involving the analysis of an academic strategy document for the Faculty of Information Studies at the University of Toronto, is described. The second case study describes the analysis of selected sections from the 2006 National Security Strategy of the USA. The results of these case studies are assessed in terms of the hypothesis, including a discussion of newly discovered hypotheses. Potential benefits of this approach specifically for strategy document authors are outlined. Sections 6.4 and 6.5 describe the need for tool support and provide guidelines for strategy document analysis with i*, respectively. Finally, after evaluating the threats to the validity of this study and reviewing related work, conclusions are provided.

3 The i* Framework and Evaluation Procedure

This section provides a brief overview of the i* Framework and the qualitative i* evaluation procedure, using illustrative examples.

3.1 The i* Framework

The i* Framework represents the intentions and dependencies between agents in a social network using the concepts of **actors**, **elements** and **links**. The Strategic Dependency (SD) model focuses on the dependencies between actors. It may contain several actors of various types that may depend on each other for various elements, shown using **dependency links**. The i* Framework contains three types of actors, an **agent**, which can be a human or software agent, a **role**, which is a set of responsibilities taken on by an agent, and a **position**, which is the combination of several roles. Actors are related to each other using **association links**, an agent **plays** a role, a position **covers** a role, an agent can be **part-of** another agent, or can be an instantiation of another agent

via **is-a**. Despite the existence of relationships between actors, each actor is an autonomous entity with its own individual intentions.

Actors depend on each other to accomplish their objectives. The i* Framework differentiates between four types of dependencies: task, resource, goal and softgoal. A task dependency is a dependency from one actor to another to perform a specific task in an agreed upon manner, where as a **resource dependency** is a dependency on a thing, either a physical or abstract resource. **Goal dependencies** indicate that an actor depends on another actor to accomplish a goal, without being concerned with the methods used to achieve the goal. A **softgoal dependency** is similar; however, where as a goal or "hard" goal has clear-cut criteria to determine whether or not the goal is met, a softgoal lacks these clear criteria. Determining the satisfaction of a softgoal is more qualitative and subjective. The distinction between these concepts is inspired by the presence of both functional and non-functional requirements in requirements engineering, as described in the NFR (Non-Functional Requirements) Framework [9], a Framework which influenced the development of i^{*}. A functional requirement such as elevator button must light up when pressed is expressed as a goal, either the button lights up or it does not. A non-functional requirement such as Elevator button must be easy to see is represented as a softgoal, as "easy to see" has a more qualitative, subjective judgment for satisfaction. The graphical representations for these and other i* constructs are shown in Figure 3.



Figure 3: Legend of i* Constructs

Figure 4 contains an example of an i* SD model for an expanded version of the model shown in Figure 2. This model shows two actors, specifically agents, the USA and Other Nations. Two dependencies are shown, a goal dependency from the USA to Other Nations that Other nations be willing to respond, and a softgoal dependency from Other Nations to the USA, to Support International Institutions.



Figure 4: Example i* SD Model Extrapolated from Content of NSSUSA

In an i* Strategic Rationale (SR) model the rationales for the various dependencies shown in the SD model are given by expressing the individual intentions of each actor. Each actor is given an **actor boundary**, and the elements inside the boundary are those that are intentionally desired by that actor. The elements used to express an actor's rationale are the same as are used in dependency relationships: tasks, resources, goals and softgoals. The relationships between these elements are represented using means-ends, decomposition and contribution links. Means-ends links represent alternative tasks that accomplish a goal. Multiple means-ends links to a goal represent multiple alternatives. **Decomposition links** represent the sub-elements required in order to accomplish a task. These sub-elements can be further tasks, goals, resources or softgoals. Contribution links show the qualitative effects of the achievement of elements on the achievement of softgoals. The i* Framework distinguishes between seven types of contributions, three positive, three negative and unknown. The positive contributions include **Make**, meaning that the achievement of an element will cause the achievement of the recipient softgoal; **Help**, meaning that the achievement of an element will positively contribute to the achievement of a softgoal, but is not in itself sufficient to achieve that softgoal; and **Some**+, meaning that the contribution is positive, but of an unknown strength (either Make or Help). The negative contributions are similar, but contribute in the opposite polarity. Break indicates that there is enough evidence to prevent the achievement of a softgoal, Hurt indicates that there is negative evidence that is not in itself sufficient to prevent the achievement of a softgoal, and Some- indicates that there is negative evidence of an unknown strength. An Unknown contribution links indicates that the achievement of an element would have an effect on the achievement of a softgoal, but that it is not known whether this effect is negative or positive.

An example i* SR model is shown in Figure 5. This example was created by extrapolating from the NSSUSA excerpt, meaning that the additional detail beyond the detail contained in Figure 2 was not present in the document, but added from general knowledge in order to create a more coherent example model. In this model the USA, an agent, wants to respond more quickly and creatively to crises. When responding to crises, the model shows two alternative tasks, using existing international organizations or forming coalitions of willing respondents. According to the document, although existing international institutions have "a role to play", interpreted here as a partial positive contribution, forming coalitions of willing respondents is a more effective way to respond quickly and creatively. In order to form coalitions of willing respondents, there is a dependency on Other Nations, also an agent, to be willing to respond.

Examining the rationale of Other Nations, when creating an international crisis policy they can use existing international institutions or join coalitions. The task of using existing institutions is divided into being able to use the UN and UNICEF (as example institutions), and also having such institutions be effective. This effectiveness depends on support from the USA. If Other Nations chose to use existing international institutions they will gain the favour of all nations, but there is an unknown effect on gaining the favour of the USA. If Other Nations chose to join coalitions there is a partial positive effect on gaining the favour of the USA, meaning that although this action would have a positive effect on this softgoal, additional actions would be needed to fully gain favour. Finally, both gaining the favour of the USA and gaining the favour of other nations contribute positively to favourable international relations,

but the Some+ link indicates that gaining the favour of all nations may potentially have a stronger effect than gaining the favour of the USA alone.



Figure 5: Example i* SR Model Extrapolated from Content of NSSUSA

More details concerning the i* Framework and examples of i* models can be found in several sources, including the i* Quick Guide [10] and previous work such as [2], [11] and [12]. A comprehensive list of previous work involving i* can be found in the publications section of the i* Wiki [13].

3.2 The i* Qualitative Evaluation Procedure

The process of creating i* models in and of itself can be useful to help conceptualize, analyze and communicate ideas about a domain. However, the utility of models can be further increased when they are evaluated, promoting potential model iteration and raising interesting questions concerning the domain. The process of model evaluation involves posing one or more interesting questions concerning the subject matter of the model and then expressing these questions by assigning initial evaluation labels to elements in the model, most often leaf elements (element which are not recipients of links). These labels are propagated throughout the model using a combination of propagation guidelines and modeller judgment. The final results are interpreted as the answer to the interesting question provided by the model. If the results seem contrary to reality, the model can be modified to better reflect the modeller's conceptualization of the subject matter. The qualitative evaluation procedure for i*, described in [3], is based on an earlier procedure included in the NFR Framework [9].

More specifically, the evaluation procedure uses the idea of element satisfaction, or satisficing, and element denial, where satisfaction refers to the achievement of "hard" elements such as goals, tasks and resources and satisficing, from "sufficiently satisfied", refers to the qualitative satisfaction of softgoals [14]. For example, referring back to the elevator example, Elevator button must be easy to see, if the button is judged to be in an

obvious place, large enough to be distinguished from the surrounding wall, this softgoal could be judged to be fully satisficed. However, if the button is in an obvious place, but is very small, or the same color as the surrounding wall, this softgoal could be judged to be partially satisficed. The concept of element denial is treated much the same, with softgoals being fully or partially denied. For the purpose of greater expressiveness the model evaluator can relax these guidelines by allowing "hard" elements to take on partial values. This is especially useful for tasks that have softgoals as decomposition elements or any hard element that depends on a softgoal.

The concepts of element satisfaction and denial are captured using seven qualitative labels: satisficed, partially satisficed, conflict, unknown, partially denied and denied. The conflict label is used when the positive and negative evidence towards the satisfaction of a softgoal is approximately equal and the unknown label is used when the value of the element is not known, or as a default evaluation value. The graphical representations of the i* evaluation labels are shown in the first two columns of Table 1.

Or	iginating Label			Cont	ribution	Link Typ	e	
Label	Name	Make	Break	Help	Hurt	Some+	Some-	Unknown
1	Satisficed	~	X	1.	×	√.	¥	?
√.	Partially Satisficed	√.	×	1.	×	√.	×	?
×	Conflict	×	×	×	X	×	×	?
2	Unknown	2	2	2	?	2	2	?
X	Partially Denied	×.	√.	¥	√.	×	1.	?
X	Denied	X	1.	×	√.	X	√.	2

 Table 1: Propagation Rules Showing Resulting Labels for Contribution Links

An evaluation of a model begins by placing initial labels reflecting an interesting domain question. For example, in the Figure 6 example model, reproduced from, Figure 5, we ask the question: "What is the effect of the USA and Other Nations choosing to use This question is reflected in the initial placement of satisfied international coalitions?" labels on this task in both actors. In addition, the other leaf elements, task decompositions of use international institution are also marked as satisfied. These elements are highlighted in vellow in Figure 6. After initial labels have been added, these labels are propagated from element to element via the links of the model using propagation rules. Evaluation values propagated across means-ends links are resolved by taking the maximum label of the alternatives, treating these links as an OR relation. Values propagated across decomposition links are resolved by taking the minimum label of the components, treating these links as an AND relation. In order to determine the maximum and minimum value of the evaluation labels, the following ordering is used:

>1.> × >?>1.> X



Figure 6: Example Evaluation of i* Model Extrapolated from Content of NSSUSA

Evaluation values are propagated as is through dependency links. Propagation across contribution links takes the type of link and contributing label into consideration, as shown in Table 1. Generally, if the contribution is positive, the label is propagated with the same polarity, possibly reducing the strength of the label for Help and Some+ links. If the link is negative, the polarity is reversed and possibly weakened, depending on the type of contribution link.

At various points in the evaluation an element will receive multiple evaluation labels. This occurs for "hard" elements when they are involved in more than one type of link (a dependency and either decomposition or means-ends) and for softgoals when they are the recipients of more than one contribution link. In the first case, the labels are resolved using an AND relation, or by taking the minimum label. In the second case the set of labels collected for a softgoal are resolved using either a set of automatic cases or human judgment. Generally, if the bag of received softgoal labels contains labels of only one polarity, and one of these labels is a "full" label, the label can be automatically resolved to a full label. In all other cases, when only partial labels are present, when labels of conflicting polarity are present, or when conflict or unknown labels are present, the resolution of the labels is left to the judgment of the evaluator based on their knowledge of the domain. The need for human judgment in the resolution of these labels is a reflection of the informal nature of i*. As i* captures high-level, social interactions models can never be fully complete or completely correct, instead they are complete and correct enough to facilitate useful understanding and analysis. As a result of this incompleteness tacit human knowledge is needed to augment the qualitative evaluation.

Finally, when all labels have been propagated the results of the analysis are analyzed. In our Figure 6 example, USA has a partially satisficed value for its high-level softgoal of responding quickly and creatively, and Other Nations are able to partially gain the favour of the USA while partially losing favour from other nations, creating an overall conflict for the high-level softgoal of favourable international relations. During the propagation of labels, interesting relationships can be observed. For instance, because the USA does not choose to use existing international institutions these institutions are not effective, and therefore, as this softgoal was made an essential component of use existing international institutions for Other Nations, Other Nations are not able to use existing international institutions, even if they choose. Likewise, it can also be seen that the USA would not be able to form coalitions of willing respondents if Other Nations are not willing to join. This can either indicate that the model should be modified in some way, for example, so that effectiveness is not necessary in order for Other Nations to be able to use international institutions, or it can be interpreted as an interesting discovery: neither the USA or Other Nations will be able to satisfy their goals of responding to a crisis or choosing an international policy if each agent makes opposite choices concerning the formation of coalitions.

This evaluation would be followed by additional evaluations posing additional interesting questions. During each evaluation, modifications to the model will likely be made; such modifications bring the physical model and the mental model of the evaluator closer together. During this process, areas of confusion or gaps in the domain as depicted in the model could be revealed, prompting potentially interesting questions.

4 Study Claims

In the introduction, several exploratory hypothesis concerning the potential benefits of i* modeling to the analysis of strategy documents were outlined. In this section, these hypotheses are described in more details to better facilitate the later collection of evidence that seems to support or refute the hypothesis. For this initial study, we will focus on the benefits of the modeling of strategy documents from the point of view of the reader and analyst. Exploration of the potential benefits of i* modeling for document authors would require case studies involving the creation of strategic documents. Although hypothesis concerning the potential benefits of strategic modeling for authors will be discussed in Section 6.3, we leave explicit studies of these benefits for future work. The hypotheses relating to document analysis are grouped into two categories: Document Comprehension, and Strategy Analysis.

4.1 Document Comprehension

DC 1 Facilitating Understanding. The creation of i* models can help to facilitate understanding of strategic documents. Specifically, it is hypothesized that the creation of a physical model summarizing the information in the document will help the reader to retain a more explicit mental model of the concepts in the documents. Modeling will force the reader to play closer attention to the contents of the documents, grouping ideas into elements and analyzing the text to determine the relationships between these ideas/elements. This hypothesis is expected to apply especially to the person creating the model, although benefits may also occur for those reading a model and the document concurrently.

DC 2 Clarifying Goal Relationships. The relationships between concepts described in a strategy document can often be unclear, making it difficult to find the correct "structure" amongst intentional elements extracted from the text. For instance, is goal A desired in order to accomplish goal B, or is goal B desired to accomplish goal B, or are they at the same level of a decomposition structure, both aiming to accomplish another goal altogether? Such potential confusion could be used to derive interesting questions concerning the relationships between document concepts. Generally, analyzing such relationships can lead to greater document understanding.

4.2 Strategy Analysis

SA 1 Evaluating Strategy Achievability. By modeling the intentions contained within a strategy document, potential gaps between the document goals and proposed actions become clearer. Creating i* models could help to answer questions concerning goal achievability. What part of the plan accomplishes what goals? Given the plan, are the goals achievable? Are concrete steps and action items provided? Are actions described which do not accomplish any known goal? Furthermore, the qualitative evaluation procedure could be used to assess the achievability of goals in light of the described plans.

SA 2 Finding Hidden Contradictions. When document goals are explicitly modeled, it is easier to see conflicts or negative contributions amongst them, including contradictions between goals, which were not explicitly mentioned or considered in the text. Analysis of such contradictions or negative contributions could reveal flaws or faults in the strategic plan.

SA 3 Revealing Vulnerabilities. The creation of a model showing strategic dependencies between actors helps to reveal unbalanced dependency relationships. The organization that produces a strategy document may depend on many other organizations to accomplish its goals, but it may not be clear why other organizations would want to fulfill these dependencies. In other words, reciprocal dependencies motivating the fulfillment of dependencies are not described in the document.

SA 4 Assessing Progress. Models that depict a strategy document could be used to evaluate current strategy progress. The actions described in the document, now captured in a model, could be compared to the actions that the organization has actually taken. These actions could be evaluated in terms of their contributions to strategic goals, assessing whether the goals have been achieved at a certain point in the progress, and whether there is a mismatch between the actions taken and the actions described in the strategy.

5 Study Design

The hypotheses defined in this exploratory study are qualitative and difficult to measure using quantitative, traditional experiments. Consequently, the viability of our hypotheses is explored using two exploratory case studies, each focusing on creating models that reflect a different strategy document. An attempt has been made to select

subject documents that differ in style and content. The focus of the first case study is on an academic plan for FIS (Faculty of Information Studies) at the University of Toronto, written in 2004 [15]. The second case study looks at the National Security Strategy for the United States of America, produced in 2006 [16]. The processes used and experiences gained through the production of models reflecting the content of these documents are described in the following sections.

5.1 Case Study: FIS Strategy Document

The Faculty of Information Studies (FIS) is a department in the University of Toronto that focuses on academic areas such as Archives, Information Systems and Library and Information Science. It is primarily a professional graduate faculty in that it offers post-graduate degrees with an emphasis on professional skills and course work. As of 2004, FIS had approximately 350 students and 16 faculty members [15]. The publicly available plan for FIS, *Stepping Up: Information Practice in the 21st Century*, outlines a plan intended to guide the department from 2004 through to 2010.

In using i* modeling to analyze this document, the original intention was to create one large, comprehensive model reflecting the contents of the entire document. The creation of a single cohesive model would better facilitate the application of the i* evaluation procedure to determine the overall satisfaction of the objectives outlined in the plan. To this end, after an initial reading, the document was read more carefully, starting from the executive summary. After reading each small section of the document, from a single sentence to a full paragraph, the section was analyzed to determine if it contained descriptions of intentions. If such descriptions were found, the intentions were expressed as i* elements, taking the element name directly from the document with occasional modification or paraphrasing. The type of i* element was determined by the nature of the intention. Then, based on the contents of the text, links between intentions were derived. The physical model was created using the Microsoft Visio modeling software, with a specialized i* stencil.

As the purpose of the modeling was to increase understanding of the document and to assess the feasibility of the underlying strategic plan, issues or questions discovered in the document, or with the modeling process in general, were recorded. Issues found with the content of the document itself will be analyzed and discussed in light of our hypotheses in Section 6.1.

The process of converting individual text to i* constructs often proved to be difficult. It was sometimes problematic to determine whether or not a phrase represented an intentional desire, and was often difficult to derive relational links between intentions. For example, consider the first paragraph of the executive summary:

"In recent decades, in response to the profound impact of computing, the Faculty of Information Studies (FIS) has expanded its core expertise in library and information science to consider a wide range of information practices. In this it joins an elite group of North American faculties collectively known as the "Information Schools," or i-schools. They are forging the future of information studies—but they also face daunting challenges. The intellectual landscape of information practice is evolving so rapidly, and involves such a wide swath of the university (as well as of society in general), that maintaining leadership—even: establishing identity—defies traditional planning." In this section, what can be considered intentional objectives? Some of the most obvious intentions may be: respond to the profound impact of computing, join i-schools, forge the future of information studies, maintain leadership, and establish identity. But what about the phrase "expanded its core expertise in library and information science to consider a wide range of information practices"? This is something the faculty has done in the past, but is it a goal they are still pursuing today? Also, consider the phrase "face daunting challenges". This may be a valid softgoal, but is it too general? Is it useful to include without knowing exactly what these challenges may be? Perhaps the points mentioned further in the paragraph, maintaining leadership and establishing identity, are the challenges being referred to, or perhaps there are other, more general challenges.

Furthermore, based on the content of the paragraph, can relationships between elements be derived? It seems that "expanding core expertise to consider a wide range of information practices" is desired to "respond to the profound impact of computing". In addition, by adding "In this…" to the beginning of the next sentence may imply that the ischools share some of these goals, but which ones? Overall, our analysis of this paragraph produced the model in Figure 7. However, it is apparent that this process is quite subjective; a different modeller may produce a much different model.



Figure 7: Model Results of the Analysis of the first Paragraph of the FIS Academic Plan Executive Summary

During the creation of the single model aimed to represent the FIS Strategy Document, it became quickly apparent that the complexity and size of the resulting model was becoming unmanageable soon into the modeling process. After creating model elements and relations reflecting the first three and a half (full text) pages of the strategy, the resulting model contained 86 elements, 151 links¹ and 19 actors. In order to impose some level of organization on the model, elements derived from a particular section were grouped together in a shape outlined with purple. Therefore the structure of the model

¹ During the first phase of the analysis contribution links which seemed to represent reasonable contributions between goals, but which were not explicitly mentioned in the text, were added. This practice was later discontinued in an effort to reduce the complexity of links and have the model better reflect the content of the text.

somewhat reflected the structure of the original document. A high-level view of this model can be seen in Figure 8.



Figure 8: High-Level View of Model Capturing the first Three and a Half Pages of FIS Strategy Document

In order to deal with model complexity yet continue the modeling process, the approach was modified such that each section was modeled in a separate physical model. In an effort to continue the creation of one, all-encompassing model, these separate models were each pasted into the original, larger model and integrated or merged with the larger model. The integration step was necessary due to the potential overlap between new model elements and elements in the original model. For example, a concept, such as joining the i-schools movement, may be mentioned in several document sections. If these sections are modeled separately each model piece may have an element referring to this

concept. When the models are combined together, these elements should be merged in order to create a single cohesive model. The steps in this new approach are summarized in Figure 9.

- 1. Extract Model: Read a section of the strategy document identifying goals, softgoals, tasks, etc and the relationships between them.
 - a. Excerpts from the text should be paraphrased and phrased as an intentional element.
 - b. Model explicit and implied relationships between structures, trying to determine if something is the "how" or the "why" to help form a structure.
- 2. Create a partial model for each section or subsection; label each model by the document header.
- 3. Record questions and confusions rising from the process of creating the model.
- 4. When two or more sections have been modeled, combine the new section in with the older combined section(s), i.e., the all-encompassing model.
 - a. Initially, the new model piece can be pasted into the combined model.
 - b. Reorganize model elements by subject matter, not document structure. Group elements that are related together. Similar elements from different sections that are likely referring to the same concept can be merged into a single element. All of the links going to and from each element are transferred to the new, combined element.
- 5. Repeat above steps until the entire document has been modeled.

Figure 9: Modified Approach used for Model Creation

In addition to problems concerning complexity, it was discovered that the in-depth text analysis as well as the drawing of the physical model required by the modeling process was a laborious and tedious process. It was difficult to maintain sufficient concentration to continue the process for long periods at a time. Although the exact time taken to perform the modeling was not meticulously logged, it is estimated that converting one page of text into a strategic model would take an expert i* modeller about two hours.

Despite the modification of the modeling approach to deal with issues concerning scalability, due the increasing complexity of the all-encompassing model, as well as the laborious nature of the process, only the first 15 pages of the document were modeled. In total, in addition to the all-encompassing model, 5 physical models representing document sections were created, as shown in Figure 27 to Figure 31 of the Appendix. The document level captured by these models varied from subsections to larger sections with subsections. Each model was pasted and then merged into the all-encompassing model, combining like elements, and moving elements into semantically related groups as judged by the modeller. In total, 53 similar elements were merged together during all of the model merges. The final all-encompassing model, as a result of the merging process, purple shapes indicate semantic groupings instead of document sections. The 20 semantic groupings, including sub-groupings, derived from the first 15 pages of the document, are listed in Table 2.



Figure 10: High-Level View of All-Encompassing Model for the First 15 Pages of the FIS Strategy Document

1	High-Level Goals					
2	• Identity					
3	Diachronics					
4	• Excellence					
5	i-Schools					
6	Students					
7	Information Subject Matters					
8	Collaborative Academic Incubator					
9	• Information Subject Matters: Within the Faculty					
10	At the Level of Information Practice					
11	IT (Information Technology)					
12	Resources					
13	Department Organization					
14	Inforum (FIS Lab)					
15	Open-source					
16	Programs					
17	Information Alliance					
18	Leadership					
19	Pilot Project/McLuhan Institute					
20	U of T					

Table 2: Semantic Groupings found in Figure 10 Model

Details concerning the document issues brought to light by the modeling as well as findings concerning the need for tool support and the potential benefits for document organization will be evaluated in Section 6.

5.2 Case Study: NSSUSA

The focus of this case study, the National Security Strategy of the USA for 2006, is publicly available on the White House website [16]. This 54-page document is meant as an overview of the United States' Security Strategy from 2006 to 2010, roughly one presidential term. As the strategy is publicly available, it can be assumed that the plans inside are at a fairly general level, not providing specific details that may undermine the security of the nation. The document has a simple structure, divided into eleven sections, nine of which describe general focus areas such as Champion Aspirations for Human Dignity, Strengthen Alliances to Defeat Global Terrorism, and Work to Prevent Attacks Against Us and Our Friends. As the intended audience of the document is expected to include the general populace of the United States, the language and concepts are easier to understand when compared to the FIS Strategy Document, which is intended to be read by the academic community.

Keeping in mind the lessons learned during the execution of the FIS Document Case Study concerning the rapid increase of model size and the laborious nature of the manual analysis, the intention for this case study was not to model the entire document, but smaller selections of the document, in order to corroborate or contest the findings from the FIS Document Case Study. Models were created of the one-page NSS Document overview, and of Section 10: Engage the Opportunities and Confront the Challenges of Globalization. The models covered a total of three document pages. As in the previous case study, Microsoft Visio was chosen to create the physical models.

The approach developed in the first case study was applied to this study, with the overview and the Globalization section modeled separately then merged together. The first model, shown in Figure 11, covered the overview and contains 27 elements, 23 links, and 2 actors. The second model, covering the section on globalization, contained 35 elements, 39 links and 4 actors. The final merged model, shown in Figure 12, covering both sections, contained 60 elements, 62 links and 5 actors. These figures indicate that two elements were merged together during the merge process, specifically the elements concerning national security and creating a world with democracy, which were mentioned in both sections.



Figure 11: Overview of Model Representing the Overview Section of the NSSUSA



Figure 12: Model Representing the Overview and Globalization Section of the NSSUSA

In general, this document proved somewhat easier to represent in a model, as the contents of the document were simpler; however the problems concerning scalability remained. Further discoveries made during the modeling of this document will be discussed in Section 6.

6 Discussion

In this section the existing hypotheses will be evaluated based on evidence collected in the case studies. New claims will be described in the form of new hypotheses. Highlevel requirements for tool support and guidelines for future applications of this approach are outlined.

6.1 Evaluating Existing Claims

Based on experiences from the case studies, the exploratory hypothesis made in Section 4 will be evaluated. The primary means of evaluating these hypotheses is to list examples of specific related discoveries derived from the attempt to create i* models reflecting the strategy documents. Most of these discoveries are in the form of interesting questions or issues concerning the document. The existence of such questions could help an analyst to judge the general quality of the strategy document, including the quality of the underlying strategy.

Document Comprehension

During the analysis of both the FIS and the NSSUSA documents, several questions or points of clarification concerning the conceptual understanding of the document arose.

DC 3 Facilitating Understanding

Some of the questions derived from the modeling process had to do with the precise meaning of phrases. For example, Section 2c describing the Fundamental Priorities, contains this phrase: "(i) to reconfigure the place of systems and technological expertise within the Faculty, in order to tie it more closely to other FIS strengths". What does it mean to reconfigure the place of expertise within the Faculty? How can this be tied more closely to other strengths? Questions such as these also relate to the second hypotheses section, involving strategy analysis, as in questioning the meaning of a concept, the means to achieve a concept are also sought.

Other questing and issues that arose during the modeling process had to do with the assignment of responsibility. For instance, Section $2a.\beta$ contains the following paragraph:

"At the level of information practice: take a leadership role in establishing a wide range of strategic partnerships—across campus, with other universities, and throughout society—to explore, develop, prototype, and study the new and reconfigured academic and administrative information practices being unleashed by developments in underlying information technologies."

The attempt to assign model elements to specific actors leads to the question: where do the developments in underlying information technologies come from? Are they developed by FIS, its partners, both, or some other external entity? In this case the text was interpreted such that both FIS and its partners provided such technological developments, as shown in the model excerpt in Figure 13. Similar to the previous example, these questions also relate the Strategy Analysis Hypothesis, in that they may reveal vulnerabilities in the form of dependencies on other actors for the development of new technology, and for the development of new academic practices.



Figure 13: Model Excerpt describing part of Section 2a in the FIS Strategy Document

DC 4 Clarifying Goal Relationships

Other questions derived from modeling had to do with the relationships between various entities or concepts in the documents, brought to light when the modeller attempted to make connections between these entities. For example, consider this excerpt from the executive summary of the FIS strategy document:

"In terms of subject matter, it casts its net widely—identifying its mission, goals, and programs relationally, in terms of an encompassing plan for a collaborative information alliance to study the informational realm through interdisciplinary and interdivisional partnerships;..."

From this paragraph, the following softgoals can be derived: Cast net widely for subject matter; Identify missions, goals and programs relationally, in terms of an encompassing plan; Have encompassing plan for collaborative information alliance; Study the information realm; and Create interdisciplinary and interdivisional partnerships. But, how do these entities relate to each other? This example is similar to the one described in Section 5.1. When something is identified "in terms of" does this mean that the plan is necessary in order to identify the

mission and goals, or that these objectives are defined in order to guide the plan? The model developed to represent this excerpt, shown in Figure 14, takes the former interpretation, with the presence of an all-encompassing plan helping to identify missions and goals. Generally, although these relational questions arose often when creating models reflecting the document, many of them were not explicitly recorded due to time constraints.



Figure 14: Model Section Describing an Excerpt from the Executive Summary of the FIS Strategy Document

In addition to the examples described here, eleven more issues having to do with model comprehensibility were identified in the case study analysis. These issues, grouped by document and document section, are described briefly in Section A.2 of the Appendix.

Strategy Analysis

The creation of models reflecting the case study strategy documents lead to the discovery of various questions and issues having to do with strategy analysis, including issues concerning achievability, contradictions, and vulnerabilities.

SA 5 Evaluating Strategy Achievability

In total, 15 issues or questions having to do with the achievability of a strategy were recorded, 13 from the 15 modeled pages of the FIS document and two from the three modeled pages of the NSSUSA. Most questions were along the lines of "how?", how is a particular objective going to be accomplished, or "why?", why is a particular action being performed, or, in other words, how do actions relate to the overall goals of the strategic plan. For example, Section 2c of the FIS document describes responding to the

increasing overlap between the roles of museoligists and librarians as a priority, but it is not clear how this priority addresses the goals and objectives outlined in the rest of the document. This becomes especially clear when the model section describing this priority is isolated, not linked to other sections, as shown in Figure 15.



Figure 15: Model Section describing a Priority in Section 2c of the FIS Strategy Document

In an example from the NSSUSA document, after the overview section was modeled, it was apparent from the structure of the model that there was some disconnect between the high-level goals described in the overview and the specific, high-level sections describing the strategy. Although some of these sections specifically address mentioned goals, others are not connected. Conversely, some of the high-level goals are not met by the actions in the various sections. This raises both "why" and "how" questions, why, for example, does the USA want to Champion aspirations for human dignity, and how, for example, will the USA accomplish its goal of creating a world of democratic, well-governed states. Although it is possible that some of these motivations are be outlined in further sections of the document, the inclusion of these motivations in the overview may have better served the reader. An excerpt from the relevant model is repeated in Figure 16. Further questions concerning strategy achievability discovered through the modeling process are described briefly in Section 9A.2 A.2 of the Appendix.

Despite the discovery of multiple interesting questions and issues concerning the achievability of the strategic plans outlined in both documents, an overall evaluation of achievability cannot be made, as the models do not represent the entire document. If a goal described in a part of the document which as been modeled is not met, it is possible that a means to meet this goal may be described in a later section of the document. Although it is possible, albeit difficult given the large nature of the models, to perform a qualitative evaluation using the procedure described in Section 3.2, the results may be cast into doubt due to the incomplete nature of the models. However, as many of the models created in the case studies were done at a local level, depicting the goals and actions described in a single section, the evaluation procedure may prove useful to assess the achievability of the plans described in a single section.



Figure 16: Excerpt from Model Representing the Overview Section of the NSSUSA

For example, consider an evaluation of the model representing Sections 2ai and ii from the FIS document, as shown in Figure 17. Generally, if the assumption is made that all leaf-level elements of the model, shown in orange, are satisfied, then most of the other objectives described in the section are at least partially satisfied. Similarly, consider an evaluation of the model describing the Globalization Section of the NSSUSA, as shown in Figure 18. Again, the majority of goals are at least partially satisficed, assuming the accomplishment of the leaf-level plans. However, the significance of these leaf-level assumptions should be considered. In the FIS example, the leaf-level elements include: tackle L3/Alpha Missions, develop the academic programs detailed in this plan, and serving as a site of leading-edge information practices in both education and research. In the NSSUSA example, such elements include: other nations be willing to respond, effective democracy and full exercise of national power, up to and including traditional security instruments. Although these elements are at the leaf level of these localized models, it is clear that their accomplishment is not trivial or clear-cut. The assumption that these objectives are accomplished is substantial. It is possible that when considered in the context of the larger document, these objectives may be met, and it is also possible that they remain at the leaf-level, indicating potential issues with the overall achievability of the strategic plan. Still, there is some value in the localized level of evaluation as, if the goals outlined in the various sections of the document were not addressed, assuming the achievement of leaf-level concerns, this would raise doubts as to the feasibility of the plans outlined in that section. The exception may be if the actions to accomplish the objectives in a particular section are described in a separate section, raising issues instead with document organization, as will be discussed in Section 6.3.



Figure 17: Evaluation of the Model Representing Sections 2ai and ii of the FIS Document



Figure 18: Evaluation of the Model Representing Section 10 of the NSSUSA Document

In general, the application of the evaluation procedure to the models derived from the strategy documents emphasizes qualities of these models which differ from typical i* models. Specifically, i* Models created from documents are not "well formed", in that the elements are not well connected. There are many isolated clusters of elements that cannot be related through evaluation to other clusters. This is likely due to the attempt of the modeller to accurately reflect the content of the document, only adding links that are implied by the content of the document. In order to produce a model that is more complete and easier to evaluate, the modeller would have to extrapolate relationships which are not present in the text and which may be potentially subjective. This was done to some degree in the case studies when searching for hidden contradictions, as discussed in the next section.

SA 6 Finding Hidden Contradictions

During the modeling of the FIS Strategy Document, several contradictions, or negative contributions between elements, were discovered. These were potential effects that were not explicitly mentioned in the text. Although similar examples were not discovered in the NSSUSA document, the small number of pages analyzed may account for this. In total, 20 contradictions were found and recorded either by a brief description, or with a special red contribution link in the model. These links indicated possible effects that the document did not mention explicitly. For example, the model excerpt shown in Figure 19 shows potential hidden contributions between four specific requirements described early in the FIS Document. The Faculty would like to (i) maintain identity in the face of ubiquitous information projects across campus, but at the same time would like to (ii) move nimbly in the face of fast-paced diachronic change. However, it appears that moving nimbly would have a negative effect on the ability of the Faculty to maintain its identity, and conversely, that maintaining identity would make it difficult for the Faculty to move nimbly. In addition, FIS would like to (iv) integrate its expertise and skills with other universities, a goal which may conflict with the maintenance of the FIS identity. The document also mentions that FIS would like to (iii) preserve and renew expertise..., a goal which seems contrary to the (iv) goal of integrating its expertise and skills with other university divisions.

Further examples of contradictions or negative contributions found in the FIS document are provided in Section 9A.2A.2 of the Appendix. These examples are either described briefly or given by a model snippet showing contradiction in red links.



Figure 19: Model Describing the Four Specific Requirements from the FIS Document

SA 7 Revealing Vulnerabilities

During the modeling of both the FIS and NSSUSA documents, apparent vulnerabilities concerning the primary actors' interaction with other parties were discovered and recorded. Often these vulnerabilities involved the mention of some sort of interaction with another part, where the willingness of the other party to be involved in the interaction was assumed without discussion or explanation. In these cases, in order to

assess the viability of the strategic plan, it is necessary to assess the potential commitment of external parties.

For instance, the Globalization Section of the NSSUSA document mentions the intention to both forge new partnerships and form coalitions of the willing to deal with international issues having to do with globalization, such as natural disasters and illegal trade. However, no mention is made of the other international parties or nations that will be involved in such coalitions or partnerships, and no discussion is present concerning the motivations of such parties or an explanation of why these parties will be willing to participate. When modeling this situation in an i* mindset, considering the potential existence of dependencies, these potential vulnerabilities become more clear. Figure 18 shows the existence of multiple dependencies from the USA to other parties, but no dependencies in the opposite direction, indicating potential vulnerabilities. Of course, the situation is more complex than is depicted in the model or the NSS document. Other nations and international parties often depend on the USA for many things, including financial and political support. A discussion or overview of some of these dependencies that may motivate the participation of other actors would have strengthened the perceived achievability of the USA's National Security Strategy concerning globalization issues.

Similar examples exist within the FIS Strategy document. The strategy frequently mentions the formation of strategic alliances for various purposes. However, the motivations of the actors that may be involved in these alliances are not explicitly discussed. Overall, the all-encompassing model shows a situation where FIS depends on many actors, some of which are unknown, and where these actors do not, in turn, depend on FIS. This situation raises flags concerning the vulnerability of FIS' strategic plan in areas where it is dependent upon the participation of others. Many of these one-sided dependencies can be seen in the overview in Figure 8.

In another example, Section 2c.Priorities of the FIS Document contains the following excerpt: "Yet the Faculty has still had insufficient resources... (iii) to serve the university's need for a coherent information strategy." This statement implies that the University has a need for a coherent information strategy and that there is a desire to have this need fulfilled by FIS, as shown in the model excerpt in Figure 20. However, is this really the case? If the University does in fact perceive a need for a coherent information strategy, would it delegate the formation of such a strategy for the entire university to only one department within the University? Would other departments affected by this strategy not want to have input? This situation is slightly different from the previous example, as instead of FIS depending on other actors to accomplish an objective, they are accomplishing an objective that may not be explicitly desired.



Figure 20: Model Excerpt Showing a Potential Vulnerability in the FIS Strategy

Two other similar examples of potential vulnerability from the FIS document are described briefly in Section 9A.2A.2 of the Appendix. Generally, the presence of such vulnerabilities in the strategy documents analyzed in this study could be a by-product of the typical way such documents are written. It may not be common for such documents to describe the intentions of other organizations, even when they relate to the strategic plan. The inclusion of such information could be criticized as extraneous. Additionally, it may be difficult for an organization to make claims concerning the strategies of other organizations, especially in a public document; or, perhaps a description of the specific motivations of the interactions may reveal too much strategic information to external competitive parties.

Despite these reasons, in order to allow an adequate assessment of the achievability of a strategic plan, interactions with other parties should be described whenever possible, specifically including the means the organization plans to use to insure the participation of other parties. Avoiding the specific consideration of these details may lead to failure of various aspects of the strategic plan. Even if it is not feasible to include such considerations in a public document, they should be performed as part of the more private planning. Use of the i* dependency construct, especially considering the existence of reciprocal dependencies, could aid in this part of the planning process, as will be discussed in Section 6.3.

SA 8 Assessing Progress

The fourth Strategy Analysis Hypothesis involves the claim that the i* framework can be used to assess the progress made in accomplishing a strategic plan. Specifically, once the plan has been captured in one or more i* models, the lower-level action items and their effects can be compared to the actions actually accomplished by the organization. Unfortunately, an examination of this hypothesis for either of the case studies included in this work would require more effort than is available. This type of analysis would require an examination of a large portion of the actions of either the FIS or the USA since the production of the strategy documents. Although this would likely be more feasible for the FIS case, even this would require specific investigation into the operations of the Faculty, with some of the pertinent information potentially not publicly available. Although the SA 4 hypothesis still seems to offer some general promise, it may be best investigated by someone with general access to the organization. Alternatively, if a progress report of some type were created by either organization, a comparison between the actions in the report and the actions from the original strategy model would more easily facilitate the evaluation of this hypothesis.

Overall Assessment

The execution of the two case studies has produced evidence to support all hypotheses, except for the SA 4 Hypothesis, in the form of example questions and issues from the document and the modeling process. Overall, the results suggest that i* modeling can be useful in the analysis of strategy documents for the reasons predicted by

our exploratory hypotheses. The examination of potential threats to the validity of the case study findings will be explored in Section 7.

In term of the overall analysis results for each document, the discovery of multiple issues concerning meaning, achievability, contradictions and vulnerabilities within the sections of the document that were analyzed indicates the presence of flaws within the strategic plans. In the case of the FIS Plan, these flaws appear to be significant enough cast doubt on the overall viability of the plan. In the NSSUSA case, as only three pages of the document were analyzed, it is likely premature to make an overall assessment of the viability of the plan.

6.2 Additional Discoveries

During the process of creating models to reflect the case study strategy documents, interesting discoveries additional to the benefits outlined in the preliminary hypotheses were discovered. One of the primary discoveries concerned the potential use of i* modeling to analyze the structure of a document.

Analyzing Document Organization

While creating the detailed models of the FIS Strategy document, it became clear that some means to group or organize the many elements in the model would help to organize the model, facilitating easier model understanding and making construction of the model more manageable. Two means of model organization became apparent: model organization by the structure of the document, and model organization by semantic categories. In the development of the applied modeling approach, as described in Section 5.1, Figure 9, the model was first created following the structure of the document, with each document section grouped into separate sections by a graphical divider. Figure 8 shows a high-level view of this type of structure for an early version of the allencompassing model. Although the model organized in this fashion facilitated traceability between the model and the document, the model gradually become too complex to manage. In an attempt to reduce the complexity, this model was reorganized in terms of related semantic categories created by the modeller, in order to potentially simplify the model by merging together similar concepts mentioned in multiple sections. Additional model sections were merged into the model using this form of grouping, with the end product all-encompassing model being grouped by semantic categories.

In retrospect, it seems that having a final version of the model grouped by subject matter and a version of the model grouped by document section would offer benefits, disregarding the additional manual labour required to produce the additional model. By having both views of the model, an analyst can attempt to understand a document sectionby-section by viewing parts of the model which correspond to particular document sections, while at the same time, be able to view an overall summary of categorized objectives.

Similar to an analysis of software program quality [17], views showing mappings between documents sections and document categorizations could help to assess the cohesion and coupling of document sections. If elements within the section are grouped

into many different classifications this may indicate poor section cohesion. If there are many conceptual links between document sections, this could indicate high section coupling. This type of analysis makes the underlying assumption that the grouping of model elements in semantic categories and in document sections should be ideally very similar. However, even well organized documents inevitably repeat information in order to emphasize a point, or show relations to previous or forthcoming concepts. A certain amount of overlap between document sections would be expected. Therefore, it is great variance in this overlap, either too much or too little, which may indicate a poorly organized document.

For example, by explicitly recording the merges between similar elements in different document sections, the conceptual links and similarities between document sections could be viewed and analyzed. If, for example, there are many links between model sections representing two document sections, this may indicate high section coupling, meaning that these sections would be better written as one section. An example demonstrating these types of links can be reconstructed from the FIS Case Study. In Figure 21, the top sections depict objectives from sub-sections of the Executive Summary, while the bottom section captures Section 2a.ii.Pilot Project. When these sections were merged together to form the all-encompassing, categorized model, the merges represented by the large pink arrows were performed. By examining these links we can see that there are several conceptual links between the later Pilot Project section and the earlier points within the Executive Summary. However, as no single sub-section within the Executive Summary corresponds closely to the Pilot Project section; it seems that all three points are related. This may lead the analyst to question why the points are initially separated, and then later described together in one section. Overall, this example may indicate a document structure that may be confusing to the reader.

Additional mappings between document views may also prove useful. By keeping a more general mapping between the same elements grouped in both categories and document sections, an analyst could see whether a document section contains information on many different categories (low cohesion), or is relatively homogenous (high cohesion). Conversely, it could be seen whether or not objectives relating to a particular category are described in multiple sections of the document. An example from the FIS Case Study can be constructed. The model depicting Sections 2a.i and ii is repeated in Figure 22. In view of the all-encompassing model shown in Figure 23, the elements that correspond to the elements of Figure 22 can be seen in bright pink. Differences between the number of elements in Figure 22 and the number of pink elements in Figure 23 are due to the merging of elements during the integration of the Figure 22 into the allencompassing model. By examining these figures we see that there are several pink elements in the large grouping on the right of Figure 23 pertaining to the McLuhan institute/Pilot Project (circled in red). As the 2a.i section on the left of Figure 22 also relates to this subject, this clustering appears to be sensible, indicating a cohesive document section. In addition there are several elements in a grouping to the lower left, pertaining to the "At the level of information practice" category (circled in red). Section 2a.ii describes Information Strategy, which, although not especially clear by the title, seems to relate to the Information Practice category. If this is the case perhaps Section 2a.ii may be better included in other sections specifically related to Information Practice, reducing the coupling between sections.



Figure 21: Model Sections Showing Mapping Derived from Element Merges



Figure 22: Model Representing Sections 2ai and ii of the FIS Document



Figure 23: Overall View of the All-Encompassing Model Showing the Position of Elements from Sections 2ai and 2aii

During the modeling process in the FIS document Case Study, several issues and questions concerning the structure of the document in addition to the examples presented here were discovered. These issues are summarized in Section A.2 of the Appendix. The new claims concerning the benefits of i* modeling for document structure analysis can be summarized in the following exploratory hypotheses. The confirmation of these hypotheses through further case studies is left for future work.

DR 1 Modeling to Reflect Document Structure

Grouping intentions together based on the sections of the document can provide the following benefits:

• Creating a natural organization for the graphical layout of the model.

- Creating a model whose layout and organization reflects the organization of the text.
- Creating a model that provides a high level of traceability from a particular element to the area of the document from which it came.

DR 2 Assessing Document Structure and Organization

The process of i* modeling helps to reveal undesirable qualities of document organization including low cohesion of a document section, or high coupling between document sections. These observations can be facilitated by mappings between elements contained in documents sections and elements organized by semantic categories.

6.3 Potential Benefits for Strategy Document Authors

Although the focus of our hypotheses and case studies has been on the analysis of strategy documents using i* modeling after a document has been created, the synergy between strategic modeling and strategy documents as well as the experiences gained during the execution of the case studies allows the expression of several hypotheses concerning the benefits of i* modeling for strategy document authors. The confirmation of these hypotheses could be the focus of future work.

A 1 Strategy Creation

Modeling with the i* Framework could be used in a proactive way to plan an organization strategy before it is recorded in a document. This would help strategy authors to consider facets described in our earlier hypothesis such as the achievability of a plan, potentially unseen contradictions between plan objectives, and vulnerabilities due to one-sided dependencies. Use of the i* evaluation procedure can help to assess these qualities.

A 2 Organization and Reorganization

Strategic modeling could be used to help the strategy author organize the structure of strategy documents based on model structures. This can be especially helpful if the i* models are grouped into semantic categories, as is done in the all-encompassing model in the FIS Case Study. Each section could describe the actions and objectives of one category, possibly making the links between categories as described by the links in the model explicit in the text. Furthermore, laying out the general plan in a model can serve as a visual memory aid for document authors, helping to ensure that all important points are included.

If the document has already been written, i* modeling could be used to facilitate document reorganization. Using the type of analysis described in Section 6.2, the cohesion and coupling of document sections can be assessed, potentially guiding document reorganization, producing a document which may be easier for readers to understand and analyze.

Of course, as mentioned in the introduction, strategy documents can be produced for various reasons, and some of these reasons, including avoiding committal to a specific plan of action, may actually encourage document authors to create documents that are less clear or less clearly organized. Of course, such tactics may be detrimental in the long term, for reasons out of the scope of this study.

A 3 Adaptability

Unforeseen factors may cause even the best strategic plan to undergo future changes. When the strategy for an organization is clearly laid out via the creation of an i* model, necessary changes to this plan can be explicitly considered. Adaptation to the plan can be expressed by changes in the model. For example, new goals can be added, contributions can be changed, or means to accomplish goals can be added or modified. Assessments of the achievability of the new plan can be performed using goal evaluation before the changes are incorporated into a revised version of the strategy document or implemented in practice.

A 4 Assessing Progress

Although evidence from the Case Studies was unable to support the hypothesis concerning the assessment of plan progress, this hypothesis still holds promise, and is equally applicable to strategy authors, who will likely be required to create some sort of progress report assessing the progress of their strategy. By having an i* model which depicts the original strategy, the actions in the strategy can be compared to the actions actually performed by the organization, including an assessment of their effects using i* evaluation. These tools would better able strategy authors to analyze and describe the progress made.

6.4 Requirements for Tool Support

Even though the application of i* modeling to the analysis of strategy documents produced evidence to support our hypotheses, the laborious nature of the manual modeling process may render this approach impractical for anything beyond a small scale application. However, the creation of effective tool support may significantly reduce the effort needed to produce such models and perform this type of analysis, making the approach described in this work more practical and readily accessible. It is clear that support beyond the provision of model drawing software, such as Microsoft Visio, is needed. Although the implementation of such tool support is beyond the scope of this work, the discoveries made during the execution of the case studies lead toward a set of high-level requirements for tool support.

Overview

Generally, the ideal tool would be made of two primary views, a view of the document being analyzed and a view for the created models. The contents of the two

views would be conceptually linked via the actions of the user. The general idea for such a tool is inspired by the Phoenix tool, meant to facilitate a pedagogical analysis of documents. Although this tool does not facilitate i* modeling, it includes a view of the document and a view of a model, with conceptual links between the two views. A screenshot of the main Phoenix interface is shown in Figure 24. More details concerning the effort behind the Phoenix tool are included in the discussion of related work in Section 8.



Figure 24: Screenshot of the Phoenix Tool

Basic Features

1. **Creation of i* elements linked to document text**. Users should be able to highlight a section of document text and indicate that this text should form the basis for a particular i* element. Users should be allowed to input all of the necessary information for such an element including type, name (originally set to highlighted text), actor to which it belongs, and semantic category. The element should be automatically placed on the model view screen, with the option to manually adjust its placement, rearranging the layout of elements.

- 2. Creation of i* links. The application should allow the creation of i* links between existing elements. Sometimes these links could be based on textual evidence, and sometimes they are extrapolated from the content. As a result, it should be possible to link a piece of text to a link in a process similar to the process of creating an element; however, it should also be possible to create links in the model view which are not conceptually mapped to pieces of text.
- 3. **Traceability between elements and text**. After elements have been created, it should be easy for the user to either select an element and be shown the corresponding document text, or select document text and be shown the corresponding element. This could be implemented through the use of some form of highlighting. The same feature should apply to links that are mapped to document excerpts.

Analysis and Evaluation

- 4. **Labeling Contradictions.** It should be possible for a user to label a specific contribution link as a contradiction. These links should be highlighted or marked in a different color than regular links. It would be useful to be able to turn this highlighting or special color on or off with a "Show Contradictions" option.
- 5. **Evaluation Procedure.** The evaluation procedure as described in Section 3.2 should be available in the document analysis tool support. The procedure should be able to be applied to the large, all-encompassing model, and to any subset of this model shown in a model view.

Questions and Issues

6. **Recording questions and issues.** One of the primary outputs of the case studies in this work was a list of questions and issues arising from the strategy document modeling. As a result, tool support should allow the user to record such questions and issues, associating them with one or more model elements or document excerpts. Document excerpts and elements should be able to be added to, or removed from, an association with a certain issue. A view that shows the list of issues should be available. Traceability support between issues, document sections and model pieces should also be available.

Model Organization and Element Categorization

7. **Grouping elements by document section.** Inspired by our hypotheses concerning document organization, tool support should allow the user to select document sections to act as grouping mechanisms for model elements. The application could initially create a default set of model sections, based on document headers, which could be later modified by the user. Once a section of a document has been indicated as a relevant modeling section, all elements with text sources from that section will belong to the same document grouping. A model view should exist which allows the user to view elements grouped by document section either one section at a time, or all together in the same view.

- 8. **Grouping elements by semantic category.** Tool users should be allowed to create and continually modify a set of semantic categories, such as the ones listed in Table 2. When an element is created, or at any other point, it can be grouped into a semantic category. Element categorization should be modifiable by the user. A view should exist which allows the user to see the element within a particular semantic category, or to see all element groupings together in one view, such as was created in the all-encompassing model.
- 9. Facilitate element merging. Tool support should provide the ability to merge multiple similar elements together into one graphical element. This means that one element could be linked to multiple areas of the text. The categorization view will show the resulting, merged element; where as the document section view will show all elements before merging, as pre-merged elements may be located in different sections. Furthermore, the tool could provide help for users who are searching for potential element merge candidates. When this feature is selected for an element, a search could be done for elements that use several similar terms.
- 10. Views facilitating analysis of document organization. As described in Section 6.2, the tool should provide views which show the mappings between different ways to view the model. In the view of document sections, the mapping of merged elements should be optionally visible, similar to Figure 21. It should also be possible to see the document section view and the semantic category view side by side, showing the mappings between elements on each side, similar to Figure 23. In these views, it should be possible to compare a variable number of groupings, from a single grouping on each side, to the full model of groupings.
- 11. **Metrics to facilitate analysis of document organization.** The tool could include various metrics that attempt to measure the level of cohesion and coupling amongst document sections, facilitating an analysis of document organization. Such metrics could include the number of element merges between elements in various document sections, comparing these numbers to numbers from other sections.

Scalability Features

12. **Creation of useful views.** The tool should allow the user to create and manipulate several views of an underlying i* model. The document section and semantic category views have already been described. Furthermore, a user should be able to select one or more element groupings to view separately, or could create views using queries, such as a search for all elements with the word "alliance", or with slices based on model links, as described in [18]. Changes to the view, such as changing an element name or deleting an element, with the exception of changes to element layout, should be propagated back to the original model, as suggested in [19]. Generally, the inclusion of this feature would replace the use of multiple model files as was utilized in the case studies. Users can construct the all-encompassing model in manageable pieces by viewing only elements in the document section that they are currently working on, later adjusting the placement of this model grouping in the larger, all-encompassing model. For example, in Figure 25, the view on the left may be the all-encompassing model, where as the view on the right may be the view the user actually selects in order to add and modify elements.



Figure 25: Example of Potential Model Views

13. **Collapsible element groups.** Previous requirements have described the creation of element groupings by either document structure or semantic category. These groupings, when displayed graphically, could be "collapsible" in that their contents could be collapsed to the size of a single element, with incoming and outgoing links going to this collapsed shape. Allowing the user to collapse, expand and move element groupings would allow them manage the size of large models by allowing them to view the details of only a few groupings at a time while still viewing groupings in their larger context. An example of this type of collapsing and expanding behaviour can be seen in Figure 26.



Figure 26: Example of Potential Collapsing and Expanding Tool Behaviour

6.5 Guidelines for Future Application

Based on experiences from case study application, as well as the outline of tool support needs, guidelines for the future application of i* modeling for strategy document analysis can be outlined. These guidelines assume the implementation of tool support providing the majority of the features described in Section 6.4. Although the guidelines

are presented in order, the order of many of the steps can be rearranged depending on the preferences of the modeler. For example, the modeler can create model views for every document section in the document and then merge them all together at the end of the modeling process, or each model view representing a document section can be merged into the larger section immediately after creation. The guidelines are as follows:

- 1. **Extract Model.** Read a section of the strategy document identifying goals, associating model elements with document excerpts and identifying the relationships between elements.
- 2. **Record Issues.** Record issues and questions arising from the modeling process. If possible, associate these issues with text excerpts or model elements.
- 3. Use Views. When the model becomes a substantial size (>10 elements) or when a single cohesive section has been modeled, indicate that this document section corresponds to a model grouping. Continue to model the document, potentially by using a new view including only model elements from the current section. Perform this step repeatedly, applying further steps when desired.
- 4. **Evaluate Views.** Use the qualitative i* evaluation procedure to test the achievability of model excerpts representing document sections.
- 5. Merge Document Groupings. At some point, the user may want to begin the process of merging elements in document sections together, and grouping elements into related semantic categories. This can be done at any point or at multiple points, after the modeling of only two document sections, after the modeling of all sections in the document, or at any point in between.
- 6. **Analyze Document Organization.** At any point in the process, use different model views and document organization metrics to analyze the organization of the document.
- 7. **Repeat.** Repeat above steps until the entire document has been modeled and the model pieces representing all document sections have been merged and categorized.
- 8. **Evaluate Entire Model.** Use the qualitative i* evaluation procedure to evaluate the achievability of the all-encompassing, merged model. Evaluate several possibilities corresponding to interesting sets of initial values.

7 Threats to Validity

Despite the positive findings concerning the use of i* modeling for the analysis of strategy documents, this exploratory study has several threats to its validity, as outlined in the following section.

7.1 Construct Validity

In this study, the fundamental construct used to measure the utility of the modeling process was the discovery of interesting issues and questions concerning the subject documents. However, it is possible that this is not indicative of the quality of the

analysis. Perhaps these questions are not the "right" questions to ask? Although this may be true of some of the questions derived through modeling, many questions concerning the fundamental understanding of constructs, the achievability of certain objectives and the vulnerabilities to the actions of others are potentially threatening to the success of the proposed plan. The discovery of these issues or potential "holes" in the strategic plan can be of great use in assessing the quality of the strategy.

Furthermore, it may be noted that in the execution of the case studies in this work, no direct contact with stakeholders in the domain was made. The potential of such contact may be to verify the validity of the questions and issues discovered through model analysis. However, although such a follow-up may have been interesting, in many cases this situation reflects real-life practice, as strategy document analysts may not have the opportunity to directly interact with document authors. This would especially be the case for government strategy documents such as the NSSUSA. In addition, even though document authors may have been able to provide further clarification concerning the questions derived from modeling, the strategy document should, ideally, be able to stand on its own, without additional explanation.

7.2 Internal Validity

In terms of the internal validity of this study, it is necessary to question whether the issues and questions were discovered through the use of strategic modeling, or whether they were discovered only through careful and meticulous examination of the documents. Although it is certainly possible that some discoveries were prompted by a careful examination of the document and not by the process of modeling, it was the process of modeling that drove the careful examination. Without having a specific purpose or task in mind, such careful reading of the document may have been difficult to sustain.

In addition, some actions specific to the process of modeling, such as finding the relationships between conceptual entities, matching actions with goals, searching for negative contributions between goals, and modeling the dependencies between actors go beyond the analysis typically required by a careful reading, prompting discoveries beyond what may be typical. The ability to point to specific model fragments associated with many of the issues supports the idea that these issues were discovered through the modeling process.

Future work may attempt to collect more rigorous evidence of this cause and effect relationship through the design of an empirical experiment. Participants could be asked to analyze and find issues in a strategy document, with one group asked to read the document carefully, and another group, with i* training, asked to create i* models of the document. Such experiments are left to future work.

7.3 External Validity

To explore the external validity of the study, it is crucial to consider the conditions under which this study was performed, and whether the results could be generalized to different conditions. Specifically, in this study the individual who executed the case study and the author are overlapping. Although an attempt was made to reduce author bias, it is not certain whether an external individual would produce the same results when analyzing a strategy document using i*. However, the existence of a broad research community of i* users indicates that use of the Framework, at least, will generalize beyond the author of this study (see, for example, the list of i* related publications listed in the i* Wiki [13]).

In a further condition, the individual executing the case studies had several years experience with the i* Framework. It is possible that an individual with less experience may have more difficulty using i* modeling to discover interesting issues. However, in light of the exploratory nature of this case study, it is sensible to use an individual with i* expertise to execute the analysis. If, instead, a person without significant i* experience had been used, it would be difficult to determine if negative results were due to a fundamental flaw in the underlying hypotheses of this work or simply to a lack of experience with i*. Further studies should test the applicability of the hypotheses to less experienced i* users.

7.4 Reliability

In order to demonstrate the reliability of the results of this work, multiple case studies were executed, selecting target documents with widely differing contexts. However, the application of further case studies would continue to increase the confidence in the validity of the positive results.

8 Related Work

This work is novel in that it addresses a problem, the analysis of strategy documents, which has not been specifically addressed, to our knowledge, by previous work. Furthermore, it proposes a method for document analysis, modeling with the i* Framework, that has not extensively been applied to the analysis of documents.

Previous approaches to the analysis of documents in general, specifically in the field of computational linguistics, have focused on automatic document analysis, attempting to extract document semantics in a form understandable by computers (see for example [20]). Ideas from this field have been combined with intentional modeling in order to attempt to automatically extract intentionality from specific types of text. For example, the work of Hui and Yu automatically extracts the problem-solution relationship from research papers or patents by application of natural language processing techniques, expressing the results in conceptual models using intentional concepts such as goals and softgoals [21]. The approach taken in this work differs from automatic extraction approaches by offering modeling tools and constructs to facilitate a manual semantic extraction. However, with the proposal for tool support outlined in Section 6.4, this extraction would be aided by semi-automatic analysis tools.

Similar work, not focusing specifically on strategy documents or use of the i* Framework, has proposed the manual segmentation of a document to produce a pedagogical ontology of concepts and definitions. Such segmentation facilitates

intelligent searching and reuse of existing documents. To facilitate this work, the Phoenix tool, an inspiration for some of the features described in Section 8.4, was created. This tool allows the association of pedagogical concepts with excerpts from the text, including the definition of concepts through relationships with other concepts or prerequisites terms, forming a graphical hierarchy [22].

In addition to the investigation of exploratory hypotheses, this work has produced overviews of potential tool support and methodological guidelines for the application of this approach. Similarly, several methodologies guiding the creation of i* models in various contexts have been proposed, six of which are summarized and compared in [23]. These methodologies are specifically intended for use as part of a software creation process, differing from the guidelines presented in Section 6.5 which aim only to facilitate document analysis. In addition, related to our consideration of tool support, several tools for use with i* modeling have been created, such as the OpenOME tool [24] and REDEPEND-REACT-BCN [25]. The features of these and other i* related tools are summarized in the i* Wiki [26]. Although none of these tools specifically offer the features outlined in Section 6.4, one or more of these tools may offer a starting point for development of the tool support described in this work.

9 Conclusions

This work addresses the novel problem of the analysis of strategy documents, complicated by the attempt of such documents to achieve several, often conflicting, objectives. Problems with the interpretation of such documents resulting from these conflicting objectives have been outlined.

The primary objective of this study was to develop and investigate exploratory hypothesis concerning the potential benefits of i* modeling for the understanding and analysis of strategy documents. To this end, six hypotheses in two categories were described. The DC hypotheses concern the facilitation of document understanding, including the clarification of relationships between the concepts in the document, represented as intentional elements. The SA hypotheses describe the ability of i* modeling to evaluate the achievability of a strategic plan, to find hidden contradictions amongst document objectives, to reveal organizational vulnerabilities on outside entities, and to assess the overall progress made in executing the strategic plan.

The validity of the exploratory hypotheses was explored through the execution of two case studies, involving the strategic modeling of strategy documents for the Faculty of Information Studies and the National Security of the USA. As the process of manually creating models representing the contents of these documents proved to be laborious, a methodology was developed where smaller models focusing on document sections were created separately, then merged together to create an all-encompassing model. Even with this approach, the case studies only managed to create models representing parts of the strategic documents. Despite these difficulties, multiple issues and questions were discovered throughout the modeling process. These issues and questions were presented in light of the exploratory hypotheses, providing evidence to support the validity of all hypotheses with the exception of the SA 4 hypothesis involving the assessment of plan progress.

Furthermore, interesting discoveries made during the execution of the case studies lead to the development of further exploratory hypotheses. Specifically, case study experiences lead to the formation of hypotheses concerning the benefits of creating models reflecting document structure and the ability of i* modeling to aid in an assessment of document organization. In addition, hypothesis concerning the potential benefits of i* modeling for strategy document authors were articulated, including strategy creation, document organization and reorganization, strategy adaptation, and assessing the progress of a strategic plan.

In addition to the objectives concerning the exploratory hypotheses, this work aimed to assess and describe the need for tool support to provide methodological guidelines for the proposed analysis. The laborious nature of the manual modeling process indicated that simple graphic creation tools would not sufficiently support this type of document analysis. To this end, a high-level description was provided of several requirements for useful tool support, based on case study experience, and corresponding to the benefits described in several hypotheses. Although the creation of such tool support was left for future work, it is our belief that this type of tool support would make the process of analyzing strategy documents through i* modeling more practically applicable. In addition, based on the methodology developed during the FIS case study and the features describing ideal tool support, a methodology for the application of i* modeling to strategy document analysis was provided.

In addition to tool support implementation, future work should include further testing of the initial hypothesis through case study application, including, perhaps, the design of an empirical experiment to increase confidence in the cause and effect relationship between modeling and issue discovery. The potential benefits of i* modeling for assessing plan progress can be explored through the execution of a more detailed study involving detailed knowledge of the actions of an organization. Hypotheses concerning document organization and the benefits of i* modeling for strategy authors should be confirmed through further case studies specifically designed for those purposes.

Although this study has specifically focused on the analysis of strategy documents, many of the benefits of i* modeling identified for these types of documents may apply to documents in general. Benefits concerning the facilitation of understanding and the assessment of document organization will likely apply to many types of documents beyond strategy documents. Generally, the ideas and approaches described in this work draw attention to the broader research area of document analysis using strategic modeling.

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Appendix

A.1 Section Specific Models from FIS Case Study

Figure 27: Model Representing Section 2a of the FIS Strategy Document

Figure 28: Model Representing Section 2ai and 2aii of the FIS Strategy Document

Figure 29: Model Representing Section 2b of the FIS Strategy Document

Figure 30: Model Representing the "Goals" Section of the FIS Strategy Document

Figure 31: Model Representing the Priorities Section of the FIS Strategy Document

A.2 Additional Questions and Issues Arising During Modeling

Document Comprehension

Section 2.a. B, Page 3

• Does this section describe the third mission mentioned previously?

Section 2b Values

• How do the values described in this section relate to the objectives described in 2a?

2c Priorities

Fundamental Priorities

- P2: Is the priority to rethink the IS stream in a wider context, or does it include the elements in the second paragraph, addressing the three problems mentioned?
- Are the three problems identified specifically relating to the IS stream, or are they more general problems?

Goals

- Is the strategy they are forming the one described in this document, or do they have to formulate a new strategy later? Is it their strategy to form a strategy?
- Is the strategy the same or different from the proposal for an information alliance?
- How do goals related to priorities, what are the differences?
- How do you know an IS area needs explicit nourishing, what do you mean by explicit nourishing? Does this mean there are other IS areas that don't need explicit nourishing?
- Are the areas in need of nourishing the same areas as those defined as subject matters for the information alliance?

2.d.i Methodology

• What is meant exactly by methodologically coherent?

NSSUSA

• The proponents of the totalitarian ideology do not necessarily have a clear goal, although it has something to do with a proud religion. In that case, why do they do what they do?

Strategy Analysis

SA 9 Evaluating Strategy Achievability

Section 2.a.Beta, Page 3

• How do you take a leadership role in strategic partnerships? Section 2 a.ii.Pilot Project

• How specifically is an Institute going to accomplish the Alpha and Beta missions? 2c.Priorities

Fundamental Priorities

- Will serving the universities need for a coherent IS strategy help the FIS IS stream? How do they know that such a strategy is needed? Do they really think such a strategy will be accepted by others?
- How would you link IT into efforts of strategic partners? You are going to help partners with their IT? Do they want help?
- How would the actions mentioned together help to solve i, ii, and iii?

5 Additional Priorities

• How do these priorities address the goals and areas described previously in the document? Do they address them at all?

Goals

• Some of the areas are addressing perceived needs in education, programs that do not already exist. Just because a need is there does not mean that FIS should be the one to fill it. Why focus on these needs? How does fulfilling these needs fulfill the larger goals?

2.d.i.Methodology

• How is the division into methodologically coherent faculty and student groups implemented? How can you ensure that the groups will actually be coherent, especially when there is so much collaboration from so many different areas?

2d.iii, iv

• Why is the best way to emphasize health sciences and technology not to separate them out into their own area?

2d.v

- Why does FIS want to involve itself in undergraduate teaching? What are the benefits of the UofT student undergraduate experience? How does this objective address FIS' other goals?
- Does FIS want its programs to shoulder the responsibility for the full student experience, even for undergraduate students when the program does not have an undergraduate division?
- Which Faculties are parts of the information alliance (Figure 32)?

Figure 32: Model Excerpt depicting an Achievability Issue

SA 10 Finding Hidden Contradictions

Figure 33: Model Section showing Contradictions within the Executive Summary of the FIS Document

Figure 34: Model Section showing Contradictions within the Second Page of the FIS Document

Section 2 a.ii.Pilot Project

• How do you achieve breadth, energy, and dense relationality without losing focus?

2d.v

- Does shouldering full responsibility for the student experience conflict with FIS's desire not to mount a full undergraduate program?
- How does the development of the four intellectual areas in the executive summary relate to graduate programs? It is possible to focus on four intellectual areas that do not reflect the graduate program structure?

SA 11 Revealing Vulnerabilities

Goals

- They are forging a vision with greater scope than FIS, but how do they know that all of their potential partners also share this vision, or want to be involved, maybe it conflicts with their plans. No evidence of current collaborations.
- They are formulating an information strategy for U of T as a whole. Shouldn't they have the cooperation of others to do this? How do they know the other parties in the university will want this strategy?

Analyzing Document Organization

DR 3 Assessing Document Structure and Organization

Section 2.a.Beta, Page 3

• Is the list of "how universities conduct their business" the same as new and reconfigured academic and administrative information practices?

Section 2a.i.Information Strategy

- How is this section different from the previous section?
- L3 and Alpha are the same, why list them separately?
- L2 and Beta are the same, why list them separately?
- Why was L1 not listed on Section 2 a?

2.c.Priorities

Fundamental Priorities

- Why are the programs described again in this section? The two model sections on programs are inconsistent, as described in Figure 35. In the first list we have MIS, g.dip.ist, j.d./mist, and ph.d., and in the other we have MIST, MIST with Thesis and Phd, with these programs divided into professional and research.
- Is it necessary to describe the programs in both places, would it be better to describe the programs in one separate section then refer to this section when needed?

Figure 35: Models Depicting Seemingly Contrasting Description of FIS Programs

5 Additional Priorities

• How do priorities differ from the previous sections of the document, are they goals? Why are they so far into the document?

Goals

• Part of the strategies is to adopt the priorities, why not just list them all together, priorities and strategies?

2d.ii

• Is this section necessary on its own? Could this information be described better in conjunction with the section introducing these areas?

Generally

• The document has far too many different types of terms: missions, priorities, goals, and values. What is the difference between these things? How do they relate to each other? What do they mean?