Understanding the dynamic socio-technical aspects of merger and acquisition integration in the IT industry: A model-based framework

by

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Instituto Tecnológico y de Estudios Superiores de Monterrey

Submitted to the System Design and Management Program in Partial Fulfillment of the Requirements for the Degree of Master of Science in Engineering and Management at the Massachusetts Institute of Technology

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Abstract

Mergers and acquisitions (M&A) enable organizations to broaden their set of capabilities that equip them better to deal with the challenges lying ahead. While M&A transaction values account trillions of dollars each year, their success rate is surprisingly low. In spite of this, the amount of research aimed at reducing the uncertainty and risk associated with a M&A transaction is limited. In order to continue filling this gap, this research focuses on the socio-technical aspects of a merger or acquisition in the IT industry.

This thesis examines available research literature and current best practices in the industry. Additionally, this study identifies five focus culture areas from empiric qualitative data acquired in the field. The focus areas examined in this thesis correspond to the most significant cultural challenges faced during an IT acquisition.

Based on the initial findings stemming from a literature review and data analysis, this thesis develops a system dynamics model, which simulates transient behavior of the complex socio-technical underlying structures of an IT merger.

This thesis thereafter proposes a model-based IT integration framework to assist the M&A management team and decision making leadership in their assessment, development and maintenance of a sound organizational model geared at supporting current and future M&A transactions.

Given the fact that research on this topic is limited, this thesis represents only an initial effort to further the understanding of M&A. Further research must be developed in the future to validate this model-based IT integration framework, including improved methods of acquiring socio-technical attributes.

Thesis Advisor
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Lead instructor, System Design and Management Program
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Chapter 1  Introduction

In 2015, the global volume of M&A (or just mergers as denoted moving forward) soared to $4.3 trillion, surpassing its previous peak of $4.1 trillion in 2007 (Bloomberg Finance L.P., 2015). Based on the 2015 World Bank report, this figure represents roughly 5.7% of the global GDP (74.12 trillion USD, a figure higher than the GDP of many countries (World Bank, 2017). Surprisingly, research suggests that the failure rate of mergers and acquisitions ranges between 70% and 90% (Clayton M. Christensen, 2011). The reward? These mergers have enabled organizations to (1) acquire current or new technologies, products, and market access; (2) generate economies of scale, and (3) establish a global brand presence. While the risks of such an investment are high, it is clear that the ability to acquire new capabilities and boost performance or move to new emerging markets is indeed of great interest to high level executives.

Previous research has been focused on the financial and market aspects of the M&A transactions (Cartwright, 2006). However, the integration of two complex systems such as organizations, presents a broad range of challenges in multiple disciplines, including those in the financial, strategic, social, technical and cultural fields. This thesis will address the merger integration process as a multi-disciplinary system focusing on both the social and technological aspect.

M&A transactions can be generally described in two broad phases. The first phase relates to the pre-merger evaluation which encompasses identifying the set of capabilities to be acquired, a financial planning and the preparation and negotiation of the deal. The second phase, post-merger integration phase focuses on integrating the previously identified capabilities to create a desired target value. In this thesis, we will address the dynamic socio-technical behaviors that affect the value created during the transient state of the second phase, the post-merger. Specifically, this thesis will examine the cultural and technological aspects that affect the transfer and application of capabilities during the integration process.

Additionally, this thesis proposes thereafter a model based M&A Integration framework to support the management team in the initial evaluation phase of the merger. We hope to reduce the costs and associated risks by assessing the added coordination efforts in this initial stage.

In the future, further research work will be needed to expand and validate the attributes of the model based framework developed in this document, as well as to assess the level of confidence of the time and cost outputs of the model.
1.1 Motivations

While mergers aim to improve the financial performance and/or reduce risk, they continue to present an alarmingly high failure rate. In contrast, data shows that the number of companies and deals undergoing each year continues to grow. The following figure by Bloomberg (Bloomberg Finance L.P., 2015) supports the statement.

![Global M&A Quarterly volume (2015)](image)

**Figure 1: Global M&A Quarterly volume (2015)**

M&A transactions have occurred since the 19th century (Owens, n.d.). However, research has been focused on individual aspects, leaving mergers and acquisitions as an integration process of two complex systems with social and technical components mostly out of scope. Interestingly, research shows that initial integration between the organizations plays a major role in the resulting performance (Barkema & Schijven, 2008). Additionally, a study done by McKinsey & Company suggests that there is a great need for understanding the cultural aspects of the merger, ninety-two percent of the survey respondents said that their deals would “have substantially benefitted from a greater cultural understanding prior to the merger.” Seventy percent conceded that “too little” effort focuses on culture during integration (Deutsch, 2010).

Despite the fact that there has been a significant amount of research on acquisition performance, little research has focused on helping us better understand how acquisitions can be successful. This comes as a surprise given the high failure rate and increasing volume in transactions in the industry (Hitt, Harrison, Ireland, & Best, 1998).

The following motivation case study presents the need outlined before. Where a model-based framework to support the M&A management team could have provided helpful prior to the merger.
1.2 Motivation case study

1.2.1 Overview

The following case study is presented as an example based on professional experience that provides an industry perspective. This brief case study does not present the application of any framework, nor does it provide a proposed solution. However, it does support the motivation for this research. Finally, aspects of the acquisition have been overstated in order to illuminate key aspects of the dynamic socio-technical processes that undergo during a M&A.

The case study is based on two fictitious companies, Cambridge Bank and Zephyros Technologies. Where Cambridge Bank has acquired Zephyros in order to transfer and apply its business capabilities in order to expand into new markets.

1.2.2 Background

Cambridge Bank is a leading financial institution and serves individual consumers, small and middle-market businesses and large corporations with a full range of banking, investing, asset management and other financial and risk management products and services. Cambridge Bank possesses total assets over 80 billion and is one of the nation's strongest financial holding companies. Through its banking subsidiaries, the company provides deposit, credit, trust, and investment services to a broad range of retail, business, and institutional clients. Other subsidiaries provide mortgage banking, brokerage, investment management, equipment leasing, and capital market services. Massachusetts-based Cambridge Bank enjoys leading market positions in some of the highest growth markets in the United States and also serves clients in selected markets nationally.

The company operates approximately 1,000 retail branches and 2,000 ATMs in the East coast and along the mid-West. In recent months, Cambridge Bank has decided to broaden their service offerings and expand their operations by acquiring Zephyros Technologies, a new startup in the tech space that develops software as service to accelerate digital transformation in the financial services sector. The software developed by Zephyros Technologies will provide Cambridge Bank customers with full range of technology-based banking channels, including Internet, mobile, PC, and Automated Telephone Banking. The acquisition of Zephyros Technologies provides Cambridge Bank the opportunity to expand its market reach with access to global online markets. Additionally, Cambridge Bank hopes to attract a younger clientele where its exposure has been virtually nonexistent.
1.2.3 Post-merger state

The acquisition of Zephyros Technologies gave Cambridge Bank the competitive edge that it was seeking to compete in the digital space with its rivals. Unlike the past, with Zephyros Technologies the Cambridge Bank accounts are now 100% accessible via the web as well as a simple mobile application in which customers can view account balances as well as transfer funds between Cambridge Bank accounts.

Due to the acquisition of Zephyros Technologies, Cambridge Bank has significantly grown its product and service capabilities, customer footprint, and channels for access. In turn, this has created greater operational complexities and additional operating costs, while inviting further scrutiny to pre-existing costs. The acquisition of Zephyros Technologies was not only complex and multidimensional, but also challenging for people across all lines of businesses in both companies. Acquisition challenges and increased operation cost drivers include:

**Technology Costs:** Cambridge Bank has a large legacy infrastructure and its technology operating model has evolved over the years to support a Waterfall software development and IT service delivery model. The IT organization is well versed in compliance and security requirements for a mid-size bank, but may not accommodate the needs of a larger bank after Zephyros Technologies’ acquisition. Cambridge Bank’s executive leadership is unsure how to integrate Zephyros Technologies’ platforms, agile delivery teams and innovative service delivery methods into this environment while retaining the strengths of both organizations.

Data investments are at the core of providing a consistent customer experience. In addition, Cambridge Bank’s lack of focus on using technology to improve analysis and review of customer data across channels has impacted the effectiveness of understanding customer behavior. Currently, analytics teams are formed but are not enabled with proper business intelligence capabilities. The alignment of systems and data across channels takes time and considerable IT expense.

Since the acquisition, there has not been a review of IT demand to reprioritize the existing IT project portfolio nor improve the efficiency of project execution and delivery. The IT Chief Operation Officer (COO) has lobbied for a more simplified technical infrastructure despite not always having clarity on the full suite of applications and systems in the existing architecture. Historically, IT spend has been managed within individual technical silos without consistent alignment to the enterprise business strategy.

**Culture:** Up to the point in the transaction when the papers were signed, the acquisition between Cambridge Bank and Zephyros Technologies was predominantly financial - valuing the assets, determining the price and due diligence. However, this financially-
driven deal quickly became a human transaction filled with emotion, uncertainty, and survival behaviors.

During the acquisition, Cambridge Bank leadership focused on managing the financial and operational aspects of the acquisition; tracking results closely and holding executives accountable for hitting their targets on schedule. Integrating Cambridge Bank and Zephyros Technologies' cultures, by contrast, seemed "soft"—both difficult to measure and almost impossible to manage directly. The leadership, thus, did not apply the same rigor to managing and steering cultural integration as they would to a conventional, hard-dollar synergy. Individuals holding leadership positions had not been identified to be 'on-point' or accountable for cultural shifts in the organization. As a result, senior leaders at Cambridge Bank have found themselves in the uncomfortable position of watching the problem unfold without knowing what to do about it.

Despite aggressive coaching to help Cambridge Bank and Zephyros Technologies employees understand and embrace the new corporate culture, some employees are unwilling or unable to change their behavior. Employees at Zephyros Technologies are accustomed to easy access to top management, flexible work schedules, and even a relaxed dress code. These aspects of a working environment may not seem significant, but if Cambridge Bank removes them, it could cause resentment and diminish productivity. After the acquisition, there has been limited retained understanding of the Bank's broader strategy, brand recognition, and corporate cultural implications. In addition, the culture clash is also fueled by Zephyros Technologies' high-volume, fast-to-market strategic focus verses Cambridge Bank's more convoluted and lengthy sales cycles.

1.3 Aims and Objectives

This thesis aims to expand on the research and findings of existing literature and to provide a model-based framework to guide organizations on assessing integration efforts, in a time frame previous to a merger. Firstly, this thesis provides an overview of the different aspects involved in mergers and acquisitions. Specifically, the overview reviews cultural and technological angles based on previous research serving as a foundation for this work. The thesis therefore builds on previous exploratory work and attempts to bridge the gap between research models and the actual M&A management in the industry. It focuses on modeling cultural and technological aspects based on data acquired, rather than relying solely on the analysis of financial records.

In the next stage, this thesis will articulate a model based M&A integration framework which will support organizations in the assessment of social and technology gaps in order to leverage such knowledge effectively.

The following research objectives can be identified from the narrative above:
a. Conduct a literature review to assess cultural and technology aspects of the merger integration.
b. Provide a research methodology and rationale for developing a dynamic model to support the M&A integration framework.
c. Identify key attributes that will help model the cultural and technological aspects of the integration. This process will create the inputs of the model and identify further opportunities and shortcomings.
d. Integrate both the literature review and developed model in an interpretative manner to formulate the M&A Integration framework that will help support the management team.

1.4 Research Objectives and Questions

Even though experience and research indicate that gaps in (a) culture and (b) technology may lead to disastrous events, both these factors remain nebulous and are largely unassessed during a merger and acquisition (M&A) (Tajima, 2010). Firms choose to focus on financial models without addressing the underlying socio-technical aspects of the M&A process. By leveraging dynamic models to understand the cultural and technological behavioral differences inherent in each organization, management could pre-assess post-merger integration challenges and increase value creation. System Dynamics (SD) models will enable us to capture the complex, interdependent web of causal relationships among variables within organizations.

To achieve the above aims and objectives, the key research question was designed using a To-By-Using framework which articulates the System Problem Statement (Crawley, 2016). It accentuates the problem statement on the intent on value delivery to the primary beneficiary, in this case the M&A management team where the value relies on understanding the social-technical aspects of the integration. The framework is shown below:

- **To** ... [statement of intent]
- **By** ... [statement of function]
- **Using** .... [statement of form]

While the framework is generally used to state the problem of the system being designed, we apply this same framework to develop the thesis statement for this research. The underlying principles remain. Thus, the thesis statement circles around the value delivered to the primary beneficiary while providing the specific-system form.

1.4.1 Thesis Statement

**To:** Support M&A management teams in assessing the complex socio-technical aspects of the transaction.
By: providing an understanding of the key cultural and technology factors that affect the coordination efforts of the dynamic integration.

Using: Literature review and system dynamics modeling techniques to explain the underlying structural behavior driving increased costs and time.

In order to answer the above main research objective, the following detailed research questions and hypothesis have been developed.

1.4.2 Research centric questions.

- **RQ1:** What are the main cultural and technical factors that drive rework in the M&A drive post-merger integration?

  a. **RQ1.1:** How does rework generated by these factors drive cost and time?

There seems to be a need from industry to further define cultural and technical factors that affect M&A integration. While there may be several gaps among what are the issues that drive rework, culture is a recurrent subject that is usually mentioned as challenging but never addressed given the failure to understand and quantify it (Tajima, 2010). This lack of understanding motivates the first Research Question (RQ).

- **RQ2:** How can these factors be included in a dynamic model to assess the structure behind the rework generation in the M&A process?

Atkinson and Gary (Atkinson & Gary, 2015) provide the most recent research that aims to assess the post-merger dynamics of M&A. Following their work, we aim to integrate RQ1 into a system dynamics model that integrates previous research in order to assess the behavior that drives costs and time.

- **RQ3:** How can management leverage the information from the model to implement a risk mitigation strategy?

Finally, refining our understanding of the dynamics and relationships from the model we seek to provide an initial answer to some of the challenges present in the IT industries. RQ3 intends to provide an initial step that can be leveraged by the industry.

1.5 Outline of Thesis

This thesis consists of 8 chapters that describe the background, literature review and analysis, research methodology, model development, results and analysis, and conclusions derived from the above research questions. This section briefly describes the content of these chapters.
Chapter 2
Review of existing literature from journals, research and industry papers, magazines and internet on previous research regarding post-merger integration. Specifically, this chapter will provide a review of the literature on the cultural and technical aspects of the integration. This chapter provides the foundation for the subsequent sections of the thesis. Finally, the hypotheses are drawn based on previous work.

Chapter 3
Details the methodology approach and data analysis for the development of the M&A integration model. Also, a rationale for the methodology used is provided in this chapter.

Chapter 4
Details the quantitative analysis method used to analyze the interview data.

Chapter 5
Development of the system dynamics model, its structure and underlying feedback loops. The outcome covers the key attributes and their dynamic behavior through time. The aim of this section is to integrate the identified set of attributes into the model and assess the additional coordination effort.

Chapter 6
The results and analysis focus on the findings of the model, including a sensitivity analysis, and suggest a way to integrate the model into a management framework to be leveraged by a M&A management team.

Chapter 7
Proposition of a M&A model-based integration framework for the IT industry to support management teams and leadership.

Chapter 8
Summary of findings of this research study and recommends area for future work.
Chapter 2  Background and Literature Review

This chapter highlights previous academic research and current industry practices in the integration phase of mergers. Following is a presentation of the context and definitions regarding mergers and acquisitions.

2.1  Background

The terms "merger" and "acquisition" are often used interchangeably. At a macro level, there is little difference between them, as both merger or acquisitions may be defined as the integration or combination of two or more companies. In legal terms the difference between this two terms, resides at the transaction level. A merger involves a previous negotiation before the combination takes place, usually with Board of Directors approving such transaction. For instance, company B merges with company A in order to create a synergy of capabilities and increase value creation. In this case, the merger would benefit both companies. In contrast to mergers, an acquisition does not necessarily involve a negotiation. An acquisition takes place when a company acquires a majority of shares of a company. For example, if company A acquired the majority of the shares of company B. In this case, company B becomes wholly owned by A ("Mergers And Acquisitions - M&A," n.d.). Moreover, the acquisition might not even be a friendly transaction. While technically an acquisition, this is typically called a takeover.

This thesis is not concerned with studying the above legal distinctions. Thus, the term merger and M&A will be used interchangeably. The focus of this research aims to support the management team make decisions in the pre-merger stage based on dynamic models of the post-merger integration. This can be leveraged in a merger during the negotiation phase, or during an acquisition, when performing a financial analysis to determine the return on investment or else, while developing the M&A project management plan.

Depending on their strategic intent, mergers can be categorized into five categories (Bower, 2001):

1. **The Overcapacity M&A.** The acquiring company increases market share by acquiring its competitors. This category accounts for 37% of the M&A transactions according to the Harvard Business School study.

2. **Geographical roll-up.** While similar to overcapacity, it differs in its intent. This type of merger seeks to expand the global market of the acquiring company global.

3. **The Product or Market Extension M&A.** The third category involves the addition of product lines or markets by acquiring or merging with a company.

4. **The M&A as Research and Development.** The acquiring company may not have the time or resources to develop new required capabilities. As a result, it may choose to merge with another company to inject such capabilities into its pipeline.
5. The Industry Convergence M&A. When boundaries between industries seem to disappear, companies merge in order to develop a new industry and/or business model.

Each type of the M&A described above requires a different approach for integration. This thesis will not focus on a single type of M&A but will rather operate on a more general level. Specifically, the framework developed in this thesis will consider mergers in the same country within the IT industry. The thesis is based on the analysis of data from real acquisition transactions between US companies. Further research will be required to expand the scope of this research and increase the reliability of the model input attributes.

2.2 Literature Review

This literature review examines previous research supporting this thesis. Furthermore, it analyzes the observations from the industry literature highlighting current practices, and documenting the industry’s need for the model developed in this thesis. This review considers literature directed to the management level and, literature aimed at facilitating the decision-making process of the merger team during the integration phase. Finally, company research was carried out to support the development of the framework.

Literature review outline:

**Literature research on M&A Technology and Culture assessment**
- This research was conducted using academic journal articles, research papers and published graduate thesis. The review of this research provides the basis for this thesis.

**Literature research on M&A practices in the IT industry**
- This research was conducted using reports, news articles, consulting reports and company papers. Such reports, which include market research from large consultancy firms operating in the IT space such as Ernst & Young (EY), PricewaterhouseCoopers (PwC) and EMC Corporation. These reports were often based on internal client surveys, which are useful approximations of the best practices and gaps in the industry.

**Company research at IBM**
- This research was conducted using informal interviews and working meetings. All proprietary information from these sources has been stripped and/or masked from this thesis. This data was used to develop the attributes for the system dynamics model.
2.2.1 Literature research on M&A Technology and Culture assessment

First, let us define the term organization. Chester Barnard, provides a basis for defining organizations as a form of system:

“A cooperative system is a complex of physical, biological, personal and social components which are in specific systematic relationship by a reason of cooperation of two or more persons for at least one definite end. Such a system is evidently a subordinate unit of larger systems from one point of view; and itself embraces subsidiary systems - physical, biological, etc. - from another point of view. One of the systems comprised within a cooperative system, the one which is implicit in the phrase “cooperation of two or more persons” is called an ‘organization’.”

(Barnard, 1961)

For the purpose of this research, we will define an organization as the cooperation between at least two individuals working towards the achievement of a definite end. In this case, the definite end of the organization is restricted specifically to the IT industry, with Information Technology (IT) encompassing hardware, software, services and infrastructure to manipulate data in its various forms (CompTIA, 2016).

The term sociotechnical was introduced by Eric Trist during a study of the English coal mining industry where the introduction of technology to increase value had actually decreased worker productivity. In his study, Trist proposed that systems have both technical and human/social aspects which are tightly coupled. Additionally, a system is made of various elements including components and interfaces. The relationships between these elements will determine the performance of the system (Trist & Bamforth, 1951). An IT merger holds this same principle. The performance of the transaction is a function of both the capabilities being acquired and the integration of the organizations involved in the merger. The cultural gaps between the organizations represent the social aspects that have an effect over performance. Note that while the organizational culture has been tentatively linked to productivity, the culture does have direct influence in the processes of reorganization and adaptation, which ultimately affects performance (Frank & Fahrbach, 1999).

Such cultural gap presents perhaps the vaguest metric to measure success, and ironically, ignores an element with representing the highest potential for failure. The "ability to manage the integration process - particularly the sociocultural aspects - in an efficient manner is a key factor in determining the extent to which synergies are realized”(Stahl & Voigt, 2008).
The culture sub-model developed for this research will be built on the following fundamental principles of psychology that relate the interactions of individuals within each organization considering also their cultural differences. First, individuals naturally seek a balanced relationship (Davis, 1967). Second, personal culture is influenced by the interactions each person has with peers and other individuals. (Anderson, 1971). Third, the research from Frank and Fahrbach suggests that two individuals will move towards an agreement in almost all cases. The exception being if the two individuals start with complete opposite beliefs. For the purpose of this research, we will assume that based on interactions through the M&A Integration, two employees of each organization will move towards agreement in almost all cases. Finally, the time span through which this organization cultural gap closes during the integration phase, will affect the process of reorganization and adaptation which will ultimately affect productivity and synergy realization of the merger (Frank & Fahrbach, 1999).
While the cultural gap closes through the interactions of individuals. It is interesting to mention, that the M&A adaptation process will affect productivity. Recently, it was determined that integration fatigue is a key leverage point in the realization of the transaction synergies given its tight relationship with productivity (Atkinson & Gary, 2015).

2.2.2 Literature research on M&A practices in the IT

In order to understand current best practices in the industry we reviewed whitepapers and articles published by major consulting firms. These firms provide expertise built on assisting clients on divesting or acquiring new capabilities. We analyzed materials from PwC (Nahass, Smith, & Curragh, 2013), EMC (EMC Corporation, 2012), EY (Ernst & Young LLP, 2011) and Deloitte (Blatman, Walsh, & Powers, 2008). While each had a different approach, they did agree on several items based on their professional experience.

First, a thorough due-diligence process can help present value erosion, especially with regards to IT systems (Ernst & Young LLP, 2011), (Zhao, 2006). This process helps management gain a comprehensive understanding of the transaction while identifying risks and opportunities. Moreover, during the due-diligence phase, the team is able to identify decisions or actions before the merger execution takes place.

Second, definition of the IT integration strategy. While each firm has developed its own proprietary M&A framework, they do agree that based on the findings of the due-diligence performed, an effective strategy must be defined to reduce the IT integration complexity. BCG (Duthoit, Dreishmeier, & Kennedy, 2004) proposed an interesting application clustering methodology to find nuggets. The application is described as a set of isolated applications that are crucial for the delivery of capabilities. In any case, whatever the framework or methodology followed, the output should align both its IT...
integration and business strategies, independently on the type of merger (types listed in section 2.1).

Third, the degree of interdependency or coupling has a direct impact on length, cost and risk of the M&A integration project. In general, there are three levels of coupling. A highly interdependent business with significant data and application implications will imply high risk, higher cost to integrate and longer time to complete. An interdependent merger with significant dependencies will have medium risk cost and time. Lastly, an independent business with no dependencies will have a short risk and cost with lower completion time.

In conclusion, best practices in the industry agree on the importance of a thorough due-diligence process. Additionally, the coupling level is an important factor that will affect risk, time and costs of the technology integration. This includes applications, data, infrastructure and the IT organization.

2.2.3 Company research at IBM

"If the company is interested in retaining and growing the talent that came into the company, the company must do more to make this happen" (Quoted from a data acquisition interview).

The data acquired for this research was collected through 1 hour informal interviews and meetings that included twenty different questions. The overall goal of these interviews was to gain insights into the talent that was acquired through M&A transactions and use these experiences to build a dynamic model to improve the integration process.

Twenty-five employees participated in the interviews. Invitations were sent to people in six different roles which included: operations, procurement, engineering, logistics, order desk, and supply/demand. Moreover, the employees came from four different business units within IBM and included six different acquisitions.

While there were large amounts of data recorded, some key findings relate to the surprising answers to question 2 – specifically describing what didn’t work well or was confusing during the integration process.
While culture shock was specifically identified a small percentage of times, the majority of issues originated in the contrasting company cultures in general. This corporate cultural element relates to the implicit values, beliefs and assumptions that impact the behavior of the individuals in the organization (Nasreen & Yasmeen, 2016). Culture has a direct impact on key "soft" human processes, including communication and collaboration within the organization.

Finally, the following chart demonstrates an importing knowledge gap. Question 18 measures— who to involve and who to inform when operating in the IBM Matrix. It is significant to note that 64% of the individuals interviewed did not know who to contact within the acquiring company. This important factor has a strong impact and directly affects productivity.
The key findings from the data acquired can be categorized broadly into five different focus areas depending on the challenges faced during cultural integration. The analysis and method of defining these areas can be reviewed in chapter 4. After listing these areas, we will present a table that correlates the above items with different action areas (teams) involved in the merger. Note that these focus and action areas are specific to the data analyzed. Further work is required to validate them based on additional data.

1. Collaboration
   a. Listening to coworkers
   b. Considering new approaches (ideas)
   c. Understanding of why processes can or cannot change

2. Orientation
   a. Understanding scale and scope of IBM
   b. Grasp of its organization and management systems
   c. Basic knowledge on how to adapt to a large organization

3. Functional training
   a. Knowledge on how to perform specific transactions, use tools, and who to ask for help
   b. Training is concentrated up front and may become stale if not applied
   c. Trainers may have subject matter expertise, but may not be effective teachers

4. Mentoring
   a. (lack of) Access to an SME for informal guidance
   b. (lack of) Career mentor
   c. (lack of) Career focus and understanding of future opportunities

5. Management
   a. Time pressure: timeline vs resources available
   b. (lack of) Feedback and communications
   c. (lack of) Clarity on roles and responsibilities
2.3 Hypotheses

Based on the previous literature research, the following hypotheses are proposed:

1. **H1**: A pre-merger model-based framework will increase the value creation process involved in a M&A transaction in the IT industry. If the M&A management team develops a model-based approach for the integration phase, the group will be able to manage decisions more effectively and reduce risk. By doing this, the overall value of the merger measured in time (schedule) and/or budget will increase.

2. **H2**: Based on the socio-technical differences of the two companies, it is possible to assess post-merger integration costs and time frames, especially in situations where these socio-technical aspects compromise the complex organizational interactions between culture (people) and technology (software/hardware).

3. **H3**: The application of a model-based framework for mergers and acquisitions is appropriate in fast paced industries such as the commercial IT industry. However, even when overall value can be increased, the given approach might not fit the average requirements of all the industry.
Chapter 3   Research Methodology

This chapter describes the research methodology utilized in this thesis. As noted previously, an M&A transaction encompasses both two domains: social and technical. Thus, the research methodology of this study combines both social sciences as well as scientific research methods to intuit a holistic understanding of the dynamics behavior involved in M&A integration.

Mergers, in general, are analyzed using static financial data, despite the fact that the nature of a merger itself is dynamic by definition. During a merger integration two organizations undergo a fundamental change in their operations. The development of the cultural and technical integration processes has a direct effect on the overall success of the merger. In essence, the performance of the merger is not static and evolves through time, thus the overall merger process requires an alternative non-static modeling approach. In order to address this issue, section 3.1 describes briefly the research approach sustaining this research. Section 3.2 outlines the research design and methods. Section 3.3 highlights the limitations of this overall research methodology.

3.1   Research Approach

This research utilizes a qualitative method approach based on data-collecting interviews to support the consideration of the socio-technical aspects of the merger. This will allow us to explore and describe the existing M&A system using a dynamic model. Furthermore, we will focus on the underlying feedback loop structure that will drive management level recommendations to adjust the original M&A integration plan.

Presently, there is limited literature on M&A integration processes based on system dynamics. This is despite the fact that system dynamics, which is based on control theory and the modern theory of nonlinear dynamics, is designed to be a practical tool to assist management in solving pressing issues (Sterman, 2000). The abstraction of the mathematical equations that lie beneath the dynamic model, make system dynamics a tool capable of delivering useful models in both academia and industry.

System dynamics is particularly useful in the context of supporting strategic decisions. The centralized models provide a basis for healthy discussion to identify and prioritize relevant decisions (Schmid, Gallati, Hügel, & Loher, 2008). This thesis relies on previous research by Shanie Atkinson and Michael Shayne Gary who analyzed how different policies for managing merger integration may lead to different levels of performance (Atkinson & Gary, 2015). Based on the above research, this study develops a system dynamics model to provide M&A management with a centralized source of information that will drive successful strategic decisions.
3.2 Research design and methods

Due to the fact that this thesis does not aim to provide a definitive answer to the M&A socio-technical integration challenges, we have chosen to present an exploratory research study, based on qualitative methods to answer the research centric questions posed in section 1.4. This is explained partly due to the scope and the unavailability of relevant data. While this research is based on data acquired from real industry experiences, the whole breadth of technologies and cultures in the IT industry is not included in this research. The alternative conclusive research is not explored given the same reason. Further research on expanding the scope of this framework will be required in the future.

Primary data will be collected from qualitative interviews as described in section 2.3. Qualitative analysis is preferred as opposed to quantitative approach given the dynamic nature of the research. Specifically, we will consider a grounded theory approach to analyze the transcription of the interviews in order to iteratively build casual loop diagrams.

Finally, we present a system dynamics model as part of our model based framework, based on the casual loops and the primary data. As seen in the literature review, there is some existing research on mergers and acquisitions. However, a very limited subset of this literature has been focused on dynamic modeling. The chosen research design and methods aims to build on the little research done reduce the large gap between M&A dynamic models and the IT industry. Thus, in designing this research we have focused on cost and time as outputs of the model, where the model itself is a function of the cultural gap and technology integration challenges. We used the system dynamics model to establish a framework to be leveraged by the M&A management team. Additionally, this research aims to contribute to the overall research of the M&A integration process.

3.3 Casual loop diagrams

Causal loop diagrams (CLDs) were used as a tool to capture the structure of the M&A socio-technical system. This includes casual loops as well as stocks and flows. Based on the analyzed primary data, several simplified diagrams were built and iterated. As described in section 2.3, results from the interviews shaped a notion of recurring rework based on a lack of integration. CLDs allowed us to quickly capture behavior and derive a hypothesis (Sterman, 2000).

By leveraging CLDs as a tool for our research, we were able to structure our hypothesis and analyze the data to identify the main underlying socio-technical relationships, that we identify as main drivers of the dynamic behavior of M&A integration.

In general, a causal diagram consists of variables and causal relationships connected by arrows which denote influences. Moreover, the link polarity defines how a dependent variable will behave upon a change induced by the independent variable. Finally, important loops define if the feedback is negative or positive. Notation in this thesis is
based on the work of John Sterman. The following is an example that includes the notation used in this research.

![Causal loop diagram notation](image)

*Figure 6: Causal loop diagram notation (Sterman, 2000)*

### 3.4 Data collection

The data described in section 2.3 was acquired through a set of informal interviews and meetings. Individuals interviewed were selected to cover an ample set of M&A cases. We were able to access individuals from six different acquisitions with six different business roles. The twenty-five participants participated in semi-structured interviews to allow additional discussion on topics they felt were important during their experiences. The twenty questions were open ended. After transcribing the interviews and analyzing the data, we were able to group responses into the five different focus areas mentioned in table 1:

1. Collaboration
2. Orientation
3. Functional training
4. Mentoring
5. Management

All interviews were conducted face to face in the office. The duration of each interview was approximately 60 minutes. Each individual was asked a question, then, he/she was offered time to reflect and answer based on his/her personal experiences during the acquisition. Finally, all data collected was transcribed to a spreadsheet for further analysis.
3.5 Limitations

A comprehensive survey of literature and a qualitative analysis of data from six different acquisitions by a single company is not likely to yield a commercial-ready framework. M&A integration is a broad, diverse and complex topic that changes based on many factors. An additional approach to gain further knowledge on this, would require to organize future research into the different taxonomies of M&A to develop a more specific framework based on specific classifications.

Finally, the proposed framework aiming to understand and assess the socio-technical aspects of an M&A IT integration is yet to be tested in a real-world scenario. Despite the fact that this research is based on real data from a number of acquisitions, the limitation previously described limits the applicability without further research. Given the growing number of acquisitions and value of each transaction, we anticipate that research and testing opportunities will grow in the near future.
Chapter 4 Qualitative data analysis

As described in section 3.4, data was collected through informal face to face interviews which allowed the participants to share personal experiences. Afterwards, the interviews were transcribed to a spreadsheet. This chapter describes the qualitative method used to overcome some of the challenges of analyzing semi-structured data.

For this research, a method developed by Philip Burnard to analyze qualitative interview data is outlined as a stage-by-stage process. The original method was developed to meet the need to explore the interviews from nursing education. However, the clear documentation of the method in fourteen stages allowed us to easily adapt it to fit our needs. Note that, not all stages were leveraged for the purposes of this research. Each stage used in this research of the methodology by Burnard is described as adapted to this research. Where the end goal was to generate cultural focus areas of the M&A integration.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Notes are made during each interview. Afterwards, impactful answers are highlighted. From the highlighted answers, memos were written as specified in the method in order to link an idea to specific instance.</td>
</tr>
<tr>
<td>2</td>
<td>The transcripts were read across while keeping notes on general themes within the data. The goal of this stage was to become familiar with the data.</td>
</tr>
<tr>
<td>3</td>
<td>Transcripts were read through again on a loop until all the necessary focus areas to describe challenges within the content were written down. In this case, we were looking for areas that described the data while keeping the literature review notes to create a bridge from the previous work to our current categories.</td>
</tr>
<tr>
<td>4</td>
<td>The list of focus areas was reviewed by the researcher with the goal of grouping similar areas.</td>
</tr>
<tr>
<td>5</td>
<td>Similar to stage 4, the list of broad focus areas was reviewed over and over until a final list was complete. This list of areas, while broad, had to relate to issues from the data.</td>
</tr>
<tr>
<td>6</td>
<td>The final list of focus areas was presented to people who were interviewed. The goal was for them to validate their experiences with the abstract categories identified from the acquired information. The interviewee should agree that if the cultural focus areas were addressed, the integration would have been more successful.</td>
</tr>
<tr>
<td>7</td>
<td>Transcripts were re-read alongside the final list of focus areas. Each issue must fit into a focus area. Adjustments are made as necessary.</td>
</tr>
<tr>
<td>8</td>
<td>Each transcript is worked through with the list of focus areas. Complete phrases from the interviews are linked to their corresponding focus area. While the method suggests color coding, we used a spreadsheet to fragment the data.</td>
</tr>
</tbody>
</table>
Mainly, the insights gathered from this method are the five focus areas. However, other common environmental factors influencing integration were identified. This include:

1. Timeline of the project – schedule
2. Mindset of both companies
3. Lack of understanding from employees in company B
4. Fear that leads to commitment issues from company B employees
5. Scarcity of resources and funding from company A

I would like to highlight some quotes from the interviews which clearly depict the generation for rework during the integration process.

"Often meetings where no one had an answer to how an IBM process works or who to contact"

"A bit of a false start, trained for a September ToB, then moved ToB to January. Had to relearn and work thru issues. Then, our pilot was due and did real time testing with real orders which had more risk"

Both if the quotes bring added rework to the integration process. In the first, employees from company B did not know who to contact in company A. Thus, meetings had to take place several times until the right group was present. The second quote, brings both rework and risk. The team from company B had to retrain and execute on live orders. Clearly, there are several cultural integration issues that have added both cost and time to the M&A process.
Chapter 5  Dynamic model - M&A Integration

"All models are wrong but some are useful"  
George Box, 1976

We will define a model as a mathematical construct or representation of the merger. Specifically, we will use a system dynamics model to represent its underlying dynamic behavior. The model should be able to predict the result of the integration phase under a specific set of operating conditions. In our case, we are interested in the time and costs variables, as a function of the effort expended to integrate a set of previously identified capabilities. The simulation will then instantiate the model under the given set of operating conditions. For the purpose of this research, we will base certain social and technical inputs of the model on the data acquired. Additionally, we define a series of assumptions in order to complete the model's mathematical equations.

The model we develop represents the acquisition of a company B by a larger company A. We have chosen this scenario based on data obtained from a similar transaction involving the acquisition of a small company with under 15,000 employees by a larger organization with over 250,000 employees. This unequal distribution of power has some implications in the different ways in which company B will be obliged to adapt to the culture of company A.

The objective of the model aims solely to simulate the transient state of the integration phase. Thus, the model does not contain representations of the pre-merger and due-diligence phases even though some inputs occurring therein are required. For instance, the number of identified capabilities to be transferred have been assumed and placed as input variables. Furthermore, the focus of the model design vector refers to the social and technical aspects of the merger. As previously noted in section 2 (literature review) the identified variables include:

Social (all these items are assessed on a scale from 1 to 9 based on the data):

1. Collaboration: refers to the level of collaboration within teams as well as among teams in the organization. A low level of collaboration would indicate close to null teamwork within and among teams.

2. Management: the organization and coordination of company activities communicated and managed with clarity towards support employees in an effort to be successful. This includes having a defined layout plan of the organization and its management structure available for consultation for any given employee within the company.

3. Mentoring: the experienced resources available that provide knowledge to new and current employees on future opportunities and the support to manage an employee's career within the company.
4. Training: the state of documentation and resources available to employees that clearly describe the different processes of the company.

5. Orientation and onboarding: how the company handles orientation and onboarding for new hires. This includes organization, business unit, department and team specific operational training.

Other social aspects that could be taken into account based on literature review but were not included in this model (Besner, 2015):

- Communication: ability to effectively communicate and suggest ideas across the team and to/from leadership.
- Innovation: employee’s ability to communicate ideas, clarity on how these ideas flow through the company and how open is the organization to support new ideas in its different forms.
- Agility: ability to change and react timely to both internal and external changes such as adopting new technologies while meeting customer requirements and industry regulations.
- Alignment: mission and value alignment between employees and the company. Employees should not only know and understand company values, vision and mission, but work and align actions within this framework.

Furthermore, we derived the above five attributes to assess the cultural integration from the data we gathered. Future research could repeat this framework or method to extract or validate further the key cultural attributes.

It is important to note that this model is the first iteration of many in the model iteration cycle presented later in chapter 6. Additionally, this version applies only at a level that reflects the data available for analysis. This means that cultural attributes do not necessarily emulate the complete international entity of IBM. We extracted data points from people in only some of the many business units existing in the corporation. General data across the board should be acquired for an actual application during an integration process, involving all the specific entities merging with company B, ideally at the department or team level. In essence, the model being applied during a real integration should be have attributes that describe the sub-units of the organization involved. However, this is an initial exercise that will be helpful to understand general behavior patterns, based on acquired data.

The complete system dynamics model has been divided into five main views in order to segment the structure and adopt a partial model testing strategy. This methodology allowed us to isolate specific variables and test them thoroughly before their integration into the main model.
5.1 Model exploration by view

We will explore the behavior of each section next. Note that each view is connected via shadow variables.

<table>
<thead>
<tr>
<th>Model view</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capabilities</td>
<td>Identified capabilities from due diligence, transfer of capabilities and rework generation based on integration challenges.</td>
</tr>
<tr>
<td>Schedule</td>
<td>Initial scheduled completion date, schedule slip due to estimated person-months to complete the transaction and willingness to slip schedule based on fraction of work completed.</td>
</tr>
<tr>
<td>Social attributes</td>
<td>Inputs of collaboration, management, mentoring, training and orientation. Initial cultural differences are assessed on a scale between 0 and 1. Culture adoption rate is based on a number of interactions between companies. The final stock of the model is the total change in the culture of company B.</td>
</tr>
<tr>
<td>Technology infusion</td>
<td>Assesses the effects of technology integration on the transaction based on TRL, coupling level and change propagation. Additionally, the strategic intent of the transaction will impact the output.</td>
</tr>
<tr>
<td>Integration Fatigue</td>
<td>Given the social and technological attributes affecting the generation of rework and schedule slip, the quality of work is affected by integration fatigue.</td>
</tr>
</tbody>
</table>

Table 3: Model views

5.1.1 Capabilities

This model assesses progress based on the transfer of strategic capabilities identified during the due-diligence phase. The whole purpose of the merger relies on the strategic intent to acquire or merge these capabilities. Haspeslagh and Jemison concluded that “acquisitions create value when the competitive advantage of one firm is improved though the transfer of strategic capabilities” (Haspeslagh & Jemison, 1991).

Given that the transfer and integration of these capabilities are a project in itself, we break down the identified capabilities into a set of tasks to be accomplished. In essence, each capability is broken down into a set of tasks that need to be completed. Once finished, the transaction is complete. To do so, we have assumed an average set of tasks for each capability.

The following view denotes the main stocks and flows of the view. While most of the variables in this view are missing, they have anyhow been cropped for purposes of clarity. A full view can be seen in the appendix. With this assumption, we can approach the model as a rework cycle (Rahmandad & Hu, 2010). Additionally, we can estimate the costs.
added by the rework if we make another set of assumptions such as cost per task or resources needed to complete the backlog.

For the purpose of modeling, we have no loss of capabilities and we initialize the stock of "Identified capabilities in B" to the "initial work to do". The merger is only complete when the threshold of required transferred capabilities as a significant percentage is complete. In Figure 7, we can see the "Identified capabilities in B" which carry units of tasks. Based on the quality of the work a "Fraction of work correct" is accomplished, the remaining percentage will go to the stock of "undiscovered rework from transfer tasks". A basic problem in this view is that no definition of this variable is available in the literature despite the quantification of the identified capabilities. However, when breaking down the capabilities into tasks, the management team could alternatively provide input from the Work Breakdown Structure (WBS).

Two main variables drive the transferal depletion rate for "Identified capabilities in B". First, the "Original Work Being Accomplished", in units of "Tasks per Month", is given by:
MIN(Staff on Original Work
* Productivity, Maximum Work Rate Based On Original Work Tasks Available)

Where “Productivity” is affected by in “Integration Fatigue”, “Integration commitment” and “Uncertainty”.

Secondly, the “Fraction of work correct” as a percentage (synonymous to quality of work) is represented by the number of “Tasks per month” actually being achieved based on the integration challenges.

MIN(1, Normal Fraction of Work Correct
 * Effect of Cultural Difference on Fraction Correct
 * Effect of Technology Integration on Fraction Correct)

In the following graph of “Fraction of work correct” we can see how the social and technical aspects of the merger will have an effect on the work being achieved. The initial months of the project have a low fraction of work correct given the socio-technical gap. This will have a direct impact on the rework generated. As rework is generated, employees will start to increase fatigue and other aspects that affect productivity. Clearly, we can start to see a dynamic cycle that could drive the project to failure if not managed correctly through appropriate policies.

Figure 8: Fraction of work correct vs Time
The details of the cultural and technology effects will be covered in their own particular views. However, we begin to appreciate the underlying behavior and changes in the initial assumptions. Note that as the schedule progresses approximate numbers become more and more relevant, and thus, the initial model version can be of assistance to the management team so that they may establish policies to inhibit undesirable behavior. For this, we identify main feedback loops in the capabilities view.

**Balancing loop: Rework Discovery**

In this loop, we see how, with more capabilities for transferal, we can expect to identify additional rework. This is marked as a balancing loop given that rework discovery actually depletes the "Identified capabilities in B" stock. Variables involved in the loop include:

- Identified capabilities in B
- Fraction of Original Work Complete
- Fraction of Rework Discovered
- Rework Discovery (rate)
- Undiscovered rework from transfer tasks

**Reinforcing loop: Rework Cycle**

"99 little bugs in the code.  
99 little bugs in the code.  
Take one down, patch it around.  
127 little bugs in the code..."

(Anonymous, 2000)

This model includes a reinforcing loop which accounts for rework generated on actual rework tasks. This means that employees can generate rework when trying to fix a particular issue. This is a recurring theme in the technology industry, especially in software. Variables in this loop include:

- Undiscovered rework from transfer tasks.
- Rework discovery.
- Rework tasks to be completed.

**Balancing loop: Staff Allocation**

Here we assume that additional resources, or staff, will decrease the amount of work and thus decrease the number of staff needed. However, we are assuming a "Maximum Work Rate Based on Original Work Tasks Available". This imposes a limit to the minimum time required to finish even with unlimited resources. The variables included in this loop are:

- Identified Capabilities in B.
- Planned Work Rate Based on Original Work Tasks Available.
- Average Time to accomplish a task.
- Average time to accomplish a rework task.
- Staff.
- Staff on Original Work.
- Original Work Being Accomplished.
- Original Work Done Correctly.

5.1.2 Schedule

While this view is fairly simple, its outputs allows us to compute important behavior such as pressure driven by a schedule slip. It is important to note that the “Indicated completion date based on progress” differs greatly from the “scheduled completion date”. It is possible that employees perceive that the schedule has not slipped too much. Even if they have incurred in much more delays without having much awareness of this.

![Graph 1: Indicated completion date based on progress vs scheduled completion date](image1)

Figure 9: Indicated completion data based on progress VS scheduled completion date

On the right graph, we can see that the team expected to complete the project in 18 months. However, from the start, the model computes a finish time of 25 months. Clearly, there is a disconnect. If the M&A management team were able to understand the source of schedule slip, they could quantify and demonstrate to leadership why the schedule is unfeasible and how rework would further increase risks.

This view includes a variable of “Willingness to slip”. Currently, the input is manual. However, this could present a dynamic behavior depending on the nature of the situation and management team.

5.1.3 Social attributes

This view incorporates the cultural attributes into a stock of “Cultural difference” which is depleted based on the “Culture adoption rate”. We are leveraging the attributes to assess
the initial cultural difference between A and B. Given this gap, the model drives the adoption of culture based on the number of interactions as denoted in the literature review. Other factors, which affect the adoption, include: (a) the value that B puts on preserving its own culture and (b) the possibility to preserve the culture based on the organizational size difference. Finally, as seen previously, the cultural difference is the variable that directly affects the quality of the work being done which is represented by the “Fraction of work correct”.

While the input values vary on a scale from 1 to 9 the value of the initial cultural difference has been normalized between 0 and 1. On the following graph, we can see how the cultural difference peaks in the initial part of the integration. As interactions between employees’ increase given the work being accomplished, it then starts to decrease.
The key aspect of this view is the initiation of the cultural difference transference. For the purpose of this research, the values obtained were based on the data and known experiences from the interviewees. However, we are not precisely interested in exact numbers. Inputs can be tweaked to understand the behavior of the culture integration. For instance, if budget is available on what items should management invest in order to reduce risk? Should management allocate additional resources be to increase mentoring? Or else, should management attempt to increase collaboration amongst teams by hosting face to face events? The system dynamics model does not only allow us to assess transient behavior, it also allows us to examine different policies based on changes.

5.1.4 Technology Infusion

This section of the model attempts to assess the challenges of integrating acquired capabilities into the existing product(s). Based on literature review, it was defined that the level of coupling is a main factor contributing to the integration challenges in IT. For the purposes of this model, we have included two additional variables that help increase the fidelity of the model.

The “Technology integration assessment” is based on three main components. The current model implementation does not include a weighted average or any other technique to increase the impact of an input variable. The technology integration assessment represents an average of the normalized values.
Description and rationale of each technology variable:

- "B Technology TRL": The Technology Readiness Level allows us to assess the maturity of the capabilities being acquired. The capabilities should be evaluated against each technology level and should then be assigned a TRL (Mai, 2015).

![](image)

Figure 12: Technology Readiness Levels (Mai, 2015)

- "Capabilities coupling level": Based on literature review, the coupling level defines how dependent will capabilities be in the overall system. Defined on a scale of low (3), medium (6) and high (9), the degree of interdependence between capabilities will be a function of the current architecture of company A and the strategic plan of the acquisition. In essence, it will show how the capabilities will fit into the architecture.

- "Change propagation in A": understanding on how and why engineering changes will propagate in company A when integrating capabilities of B. Assessed on a scale of low (3), medium (6) and high (9), change propagation can be assessed using system decomposition and Design Structure Matrix (DSM).
The "Technology integration assessment" computes the average based on the normalized values of the different technology attributes. This value then gets integrated into the "Fraction of work correct" through the effect of technology integration variable. This particular view allows us to see how both technology and culture are affecting the quality of the work performed.

5.1.5 Integration Fatigue

This concept is based on the findings and model developed after research by Shanie Atkinson and Michael Gary. Through simulations Atkinson and Gary showed that integration fatigue is a key leverage point in determining the success or failure of M&A integrations (Atkinson & Gary, 2015). Given this, we leveraged the behavior developed in their model and built in integration fatigue which affects productivity levels.
We can distinguish three main drivers of integration fatigue. The first one is the overrun on initial work estimate. Given an initial work estimate based on the due-diligence phase, the M&A integration might take longer than expected. As this effort builds and continues, employees will be affected by this required unplanned additional effort. The second one is the pressure to accelerate the transfer of capabilities based on the expected completion date. This relates to the pre-determined scheduled completion date vs. a revised expected completion date based on actual backlog, which will place a significant effort on the team to deliver the desired transfer of capabilities. This continuous pressure to deliver based on the slip in schedule creates a burden on the team. Finally, this integration fatigue has an effect on the productivity of employees. We can see a connection where, based on integration challenges there is an overrun on the project. This additional work drives fatigue which itself creates more rework. It is important that, if present, the M&A team addresses this dangerous reinforcing loop.
Chapter 6   Model results and analysis

This chapter seeks to address the following hypothesis:

- H2: Based on the socio-technical aspects of the two companies, it is possible to assess post-merger integration cost and time frames, especially in situations where these socio-technical aspects compromise the complex organizational interactions between culture (people) and technology (software/hardware).

In the previous chapter, we revised the main views of the model. In order to better understand the dynamic behavior of the socio-technical aspects of model. This chapter performs a parameter sensitivity analysis (Breierova & Choudhari, 1996). Additionally, the analysis allows us to study some of the uncertainties behind the input values. Given the scope of this research, many parameters were assumed and not computed. However, based on the data, we were able to tune the model to fit the expected output. This approach was valid for exploratory research purposes. Yet, in real life, the M&A team would have to assume, compute and tune the model accordingly.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Units</th>
<th>+/- 30%</th>
<th>Project completion date [month]</th>
<th>Cumulative work done [Tasks]</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>B's value of preserving own culture</td>
<td>Dimnl</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial cultural difference</td>
<td>Dimnl</td>
<td>1.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of interactions for culture adoption</td>
<td>Interactions/culture</td>
<td>400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology integration assessment</td>
<td>Dimnl</td>
<td>0.458</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B's value of preserving own culture</td>
<td>Dimnl</td>
<td>0.7 (-30%)</td>
<td>29.5</td>
<td>1177</td>
<td>Company B reduced value in culture retention. Note value cannot exceed 1. Thus, only one sensitivity simulation performed.</td>
</tr>
<tr>
<td>Initial cultural difference</td>
<td>Dimnl</td>
<td>1.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of interactions for culture adoption</td>
<td>Interactions/culture</td>
<td>400</td>
<td></td>
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<tr>
<td>Technology integration assessment</td>
<td>Dimnl</td>
<td>0.458</td>
<td></td>
<td></td>
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<tr>
<td>B's value of preserving own culture</td>
<td>Dimnl</td>
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<td>28.5</td>
<td>1157</td>
<td>Decreased cultural difference between company A and B.</td>
</tr>
<tr>
<td>Initial cultural difference</td>
<td>Dimnl</td>
<td>0.77 (-30%)</td>
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<td></td>
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<td>Average number of interactions for culture adoption</td>
<td>Interactions/culture</td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial cultural difference</td>
<td>Dimnl</td>
<td>1.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of interactions for culture adoption</td>
<td>Interactions/culture</td>
<td>400</td>
<td></td>
<td></td>
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<tr>
<td>Technology integration assessment</td>
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<td></td>
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<tr>
<td>B's value of preserving own culture</td>
<td>Dimnl</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial cultural difference</td>
<td>Dimnl</td>
<td>1.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of interactions for culture adoption</td>
<td>Interactions/culture</td>
<td>280 (-30%)</td>
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<tr>
<td>Technology integration assessment</td>
<td>Dimnl</td>
<td>0.458</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B's value of preserving own culture</td>
<td>Dimnl</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial cultural difference</td>
<td>Dimnl</td>
<td>1.11</td>
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</tr>
<tr>
<td>Average number of interactions for culture adoption</td>
<td>Interactions/culture</td>
<td>520 (+30%)</td>
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<td></td>
</tr>
<tr>
<td>B's value of preserving own culture</td>
<td>Dimnl</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Initial cultural difference</td>
<td>Dimnl</td>
<td>1.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average number of interactions for culture adoption</td>
<td>Interactions/culture</td>
<td>400</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Technology integration assessment</td>
<td>Dimnl</td>
<td>0.320 (-30%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Decreased number of interactions for culture change.

Increased number of interactions for culture change.

Project does not finish

With a low technology assessment score, we cannot finish the project. This can be due to low maturity or too large impact in A.
Specific parameter values can change significantly the behavior of the model. We can clearly see how some parameters have greater effects than others. However, the model never produces an awkwardly significant change thus reducing the uncertainty in the behavior of the model itself. In regards to the socio-technical attributes and how they affect the outcome of the project, we note that it is the feedback loops and structure of the model that drive the behavior, and not the parameters themselves. The only simulation, which failed to reach equilibrium, relates to a low technology assessment for the case where company A was looking to integrate a low maturity technology. By integrating a low TRL into company “A” products in a highly coupled architecture, the project was unable to achieve completion. Although increasing staff and time might help, the simulation we will disregard this view as it lies outside the scope of this research.

For the purposes of the model analysis, we abstracted the variables of “Initial cultural difference” and “Technology integration assessment”. This allowed us to focus on the socio-technical aspects that drive the changes in the model as a whole. In a real-life scenario, the M&A management team could assess the impact of each cultural focus area and each technology integration challenge. These variables would then drive policies to reduce risk and cost.

Finally, we assessed periods, based on this model. Assuming that number of tasks drives costs we would need to establish a standard cost per task in order to assign it a dollar value. Clearly, it is possible to provide such an assessment. However, the model output is dependent on the quality of data available. An aspect for further research would be the fidelity and quality of the model outputs.
Chapter 7 Framework

This chapter presents a proposed model based M&A integration framework. Its purpose is to guide decision making for management and leadership teams in their assessment and definition of the most appropriate integration approach. This framework intends to be a tool for key M&A decision makers, who supported also with technology and business expertise, will be prepared to make more effective M&A decisions.

This chapter seeks to address the following hypotheses:

- **H1:** A pre-merger model-based framework will increase the value creation process involved in a M&A transaction in the IT industry. If the M&A management team develops a model-based approach for the integration phase, the group will be able to manage decisions more effectively and reduce risk. By doing this, the overall value of the merger measured in time (schedule) and/or budget will increase.

- **H3:** The application of a model-based framework for mergers and acquisitions is appropriate in fast paced industries such as the commercial IT industry. However, even when overall value can be increased, the given approach might not fit the average requirements of all the industry.

Through the literature review presented in chapter 2, the data analysis and system dynamics model developed in chapter 5. We acquired a good understanding of the socio-technical aspects pertinent of a merger in the IT industry. While, our data is specific to an acquisition of a considerably smaller company B by company A we extend our understanding into a proposed framework which integrates the acquired knowledge base with a framework to be implemented and tested.

From the literature review, we extract the different types of strategic intents of a merger (Bower, 2001) as denoted in section 2.1. Based on these, we make assumptions that will drive the integration of the companies. The following table presents the each of the strategic intents and the assumptions made that will drive the framework. As mentioned, we will focus on strategic intents that are in the same country and within the same industry (IT).

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Strategic intent</th>
<th>TRL</th>
<th>Capabilities coupling level</th>
<th>Change propagation in A</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Overcapacity M&amp;A</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>S2</td>
<td>Product or Market extension</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>S3</td>
<td>M&amp;A as R&amp;D</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 5: Strategic intent assumptions
Description of each scenario:

- **S1**: the acquiring company increases its market share by acquiring its competitors. We are assuming that company A and B have very similar if not the same products in the market. This means that they possess: (a) commercial ready products (high TRL); (b) capabilities that will be highly coupled given the similarity (for instance, systems will be able to share the same technology stack), and finally, (c) the new capabilities will incite a high level of change propagation based on the same product architecture.

- **S2**: addition of product lines or markets by the acquisition or merge of a company. Again, we assume that company A and company B have similar products. However, company A does acquire company B because it is currently missing the product or offering demanded by the target market. This means that they offer (a) commercial ready products (high TRL), and also that (b) capabilities will be added to the product line but not integrated with the current products. Thus, we assume a medium coupling level. Finally, the assumption is that (c) change propagation in A will have medium impact. Given that the product is added but not integrated, some level of change propagation can be expected.

- **S3**: the acquiring company may not have the time or resources to develop new required capabilities. As a result, it may choose to merge with another company to inject such capabilities into its pipeline. This scenario can present the most challenges in the technology assessment. This is because (a) the TRL of the acquired capabilities is expected to be low, to the point that there is no clear understanding or a knowledge base in company A. Thus, we expect that (b) capabilities will be loosely coupled until the TRL level reaches a commercial ready state. Finally, (c) given the loose coupling, there will be no change propagation in A.

Based on the previous assumptions and strategic intents, we recommend the adoption of the model-based framework as follows:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Strategic intent</th>
<th>Model based Framework adoption recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Overcapacity M&amp;A</td>
<td>Yes</td>
</tr>
<tr>
<td>S2</td>
<td>Product or Market extension</td>
<td>Yes</td>
</tr>
<tr>
<td>S3</td>
<td>M&amp;A as R&amp;D</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 6: Model-based M&A framework recommendations

These recommendations are based on expected implementation challenges. Note that this is a recommendation, which we could ignore based on some of the potential promises of a model-based approach.
7.1 Challenges

A model-based merger approach requires not only technical system information and social company attributes but also requires infrastructure, processes, and management effort. Some potential challenges to consider include:

- Quality of the data to be analyzed and consumed by the model.
- Upfront investment to design, develop and implement a model-based approach.
- Building a team of employees with modeling and software skills.
- Process definition and adoption by the different M&A management teams.
- Team training on model-based processes and tools.

7.2 Opportunities

The formalized application of modeling to support the strategic intent of the merger can span through multiple teams and phases. Whilst several qualities of a good model, if present, may achieve greater results, a model-based approach, gathers information from different disciplines into one integrated model or collection of models, designed to provide a single source of truth. The model(s) is helpful to generate different views directed at different stakeholders so they may access the information, notably to answer multiple questions and to address multiple stakeholder concerns. This provides several unique advantages:

- Enhances Communication
- Improves Productivity
- Improves Quality
- Supports Integration
- Manages Complexity
- Facilitates Reusability

This model also offers the benefit of clarifying potential opportunities. An important task that will affect the benefits of a model-based approach is the scope of the model itself. This scope should answer the following questions, including what explicitly lies outside the boundary of the model-based effort:

- Which behaviors of the socio-technical system the model will capture? Which behaviors will not be captured?
- Which social and technical aspects and/or attributes of the company will be modeled? Which will not be reflected?
- Which parts of organization will contribute to model development? Which will not be expected to participate?
7.3 Definition

For the definition of the framework, we adopt the industry best practices reviews in Chapter 2 and integrate an iterative model-based approach into the standard merger phases.

The organization of this framework includes three phases: (i) pre-merger, (ii) integration and (iii) post-merger. Furthermore, each phase is broken down into main stages. The pre-merger phase focuses on leveraging the information and integration strategy to both assess the use of a model-based framework and to perform data analysis. The outputs are then used by the integration phase to iteratively develop, assess (instantiate) the model and finally to refine the data in order to improve the quality and fidelity of the model with the goal of achieving model credibility. It is expected that the model will have a low fidelity in the initial stages. However, this data can be useful to guide the planning, risk management and definition of the post-merger operating model. As the execution stage progresses, we expect the model to provide a higher fidelity output and to guide the management team. There are two main definitions to keep in mind.

- **Model fidelity**: we refer to fidelity as the quality of the models output. In essence, to what degree does the model actually represent the real-world socio-technical system. Note that a very high fidelity might incur in additional and unnecessary development costs. In contrast, low fidelity might lead to poor decisions or overconfidence.
- **Model credibility**: refers to whether the output of the model is trusted by the M&A management team and leadership have in the model's output to make decisions based upon it.
The iterative process in which the model evolves and increases both fidelity and credibility across time may be represented as follows:

![Model iteration cycle](image)

**Figure 16: Model iteration cycle**

Finally, the post-merger phase includes a model critique by the management team. This critical review and assessment of the whole model has the purpose of (a) evaluating the current state and achievements of the model, and (b) verifying and validating the final state of the model after completing the iterative update cycle. This critique should result in a structure analysis, which includes the limitations and strengths of the model. Afterwards, the model management stage ensures that the model is maintained and is kept available for other potential M&A transactions within the organization. This ensures that a good model is be created in a way that makes it reusable beyond the initial M&A transaction for which it was created. A modular approach is one possible solution. However, each organization will treat its model differently.

Preliminary results indicate that actively adopting a model-based framework can lead to additional value creation in the merger even though the model and framework developed in this research was based on historical data. For instance, our model instantiation demonstrates that placing resources to increase collaboration, mentoring and training could have had a significant impact in the transfer of capabilities. Additionally, adopting policies to avoid integration fatigue could have maintained productivity and quality of work.
The following list depicts real-life actions per focus area that could have addressed some of the challenges faced:

1. Collaboration
   - Develop training for IBM teams working with acquisitions. Focus teams on listening skills, collaboration and inclusiveness.
   - Assign integration team resources that have broad set of skills and can adapt to new acquired members.

2. Orientation
   - Design and implement an IBM acquisition community with key links, welcome material and helpful tips.
   - Host a set of lunch and learns to allow for expanded Q&A sessions

3. Functional training
   - Document IBM processes clearly.
   - Focus on staged, end-to-end operational and tool training including training on emergency and escalating processes.

4. Mentoring
   - Assign peer advisors to incoming employees.
   - Assign transitional career mentors that focus on future opportunities, managing your career and leveraging internal tools.

5. Management
   - Procure M&A and functional teams to validate resource requirements pre-merger to secure additional funding as required.
   - Define organization & management structure during early stages of the integration.
   - Define newly acquired talent growth plan within IBM.

The previous bullet points provide a real world scenario where modeling based on the acquired information could have provided actions aimed at reducing risk and increasing success. However, one question remains. Can this framework be adopted in the fast-paced IT industry? Based on the challenges posed in section 7.1, it might be difficult for all M&A transactions to adopt this approach. This stems from the fact that there is no consensus in this M&A processes. However, company A in this case should assess the framework and decide if the opportunities and value are worth the initial effort and investment. In general, large IT companies that undergo several acquisitions each year should take into serious consideration adopting a model-based approach. The reusability factor should be considered and targeted as a goal of the initiative especially when an initial upfront investment is involved.
Chapter 8  Conclusion

M&A transactions continue to grow each year. Given the rapid changing and highly competitive environment we are very likely to encounter more and more of these transactions in the technology industry, involving companies dedicated to the manufacturing or development of hardware and software. Each transaction, merger or acquisition, clearly presents dynamic socio-technical behavior is challenging to the management team. Still, the literature review presented in chapter 2 observes many references to the cultural challenges but none of them relate to customary practices in the industry. The nature of the socio-technical attributes makes these real life projects hard to address even though cultural issues are opportunities for improvement.

Considering the above, this thesis has provided an overview of M&A transactions in the IT industry. We have included both the technical and social perspectives in chapters 5 and 6 with the intent to provide decision makers and/or management team the opportunities and challenges they might face before embarking on the journey of an acquisition or merger. This thesis also proposes a M&A IT model based integration framework in chapter 7, which guides the M&A team in deciding and defining policies to address socio-technical risks and challenges in order to increase the probability of success for achieving the target synergies within the proposed time and cost.

At the end, Section 8.1 summarizes the key findings in the Chapters with respect to the three research questions RQ 1 – 3 which are the motives behind the development of this thesis. Section 8.2 highlights the significance of this thesis and recommends future areas of work.

8.1 Research Questions and Findings

RQ1: Main cultural and technical factors that drive rework

Chapter 2 addresses a part of the first research question. In the literature review, we find that integration fatigue and interdependency are the main factors driving rework during the integration phase. Additionally, based on the qualitative data analysis performed in chapter 4, we found five main factors that were pertinent to the acquisitions made by IBM.

1. Collaboration
2. Orientation
3. Functional training
4. Mentoring
5. Management
Interestingly we can conclude that, based on the areas and the data acquired, even without a model-based approach a thorough due-diligence process should be able to encapsulate gaps in these areas before the integration phase. However, while these are in fact integrated to the model, they cannot be extrapolated to other acquisitions until further research is performed on an extended set of data.

**RQ1.1: Rework generated by these factors**

In Chapter 5 we develop and instantiate a system dynamics model that simulates the impact of the socio-technical factors to the acquisition. The results documented in chapter 6 provide an overview of how each factor impacts both time and effort required for the integration. While the parameter sensitivity analysis isolates each factor, we can clearly conclude that the change in rework (total cumulative effort) is dependent on cultural differences and technology assessment. An important consideration is that a low technology assessment, meaning low maturity and high coupling can impede completion of the project.

The findings of RQ1.1 provide a high level overview for management and leadership to assess the feasibility, based on time and resources, of the M&A IT integration. Finally, a static method could be developed if the organization opts to not invest in a model-based approach.

**RQ2: Inclusion of socio-technical factors in a dynamic model**

Chapter 5 presents a fully developed model that includes integration fatigue and component interdependency. However, in chapter 7 we present a framework to guide an organization to adopt and implement a model-based approach. This does not mandate a specific implementation of the dynamic model. In support of this research, the literature review and chapter 3 present a strong case for system dynamics as an implementation tool. The decision of how to build a dynamic model is left open within the framework presented. However, this thesis and previous research reviewed in chapter 2 provide specific use cases of how dynamic models can increase value creation by pinpointing specific feedback loops. Based on these findings, a series of policies can be developed and implemented while understanding their expected impact. In contrast, a static model will output the end state of the integration without providing insights into the complex patterns driving the socio-technical outcomes of the merger.

**RQ3: Leveraging model outputs to implement a risk mitigation strategy**

The model-based framework presented in chapter 7 leverages current best practices of phases and stages of a merger and includes the use of a dynamic model that evolves with the project. Specifically, section 7.1 delineates the risk mitigation strategies that management could have implemented to address each focus area faced during the merger.
8.2 Significance and Future areas of work

This thesis is aimed at providing the decision maker and leadership team with sufficient knowledge to appreciate, consider and implement a model-based M&A integration framework into their merger or acquisition operations. While this thesis does not break ground in terms of M&A modeling, the consolidation of literature into a framework provides an initial proposal for both academia and industry that could be continued in the future.

In the same way, although this thesis proposes a framework based on industry best practices and model driven development, it does not propose any significant advancements in management frameworks. Rather, it derives from previous research and literature in the context of mergers and acquisitions. That said, the qualitative analysis of the acquisition data provides concrete insights into some of the cultural challenges faced during the IT integration phase. Additionally, we can see the value of applying a model-based approach based on the model outputs in chapters 6 and 7.

Finally, there are three areas of future work to advance further this research. First, we could propose the application of the M&A model-based integration framework in an active manner by assessing and implementing pre-mergers or with access to data that enriches research of such scenarios. Secondly, we could also suggest expanding on methods and tools to extract and assess both cultural and technological gaps between companies A and B. This can include both quantitative and qualitative models. Third, we recommend extracting and validating social and technological attributes to provide a better understanding of the socio-technical aspects of a merger.
Appendix A: Interview data

Question 1: What worked well and was helpful?

- Face to face meetings
- Allow to use BAU processes in interim
- HR process
- Early training
- Acquisition Leadership
- Using IBM resources
- IBM Personnel

Question 2: What didn't work well? What was confusing?

- Acronyms
- Date changes
- Lack of flexibility
- Quick pace of integration
- Culture shock
- Brand didn't understand the business
- Lack of face to face
- Forced to use the IBM way / no sensitivity
- Roles/responsibilities
- Lack of SME connection / collaboration / communication
- Creating / understanding processes / training
- Overwhelmed / time mgmt issues
Question 3: What could have been done better?

- Big picture
- Slow pace of culture change
- Communication
- Provide roles/responsibilities
- More functional training
- Explain IBM processes
- Assign a mentor
- Slow the pace of training
- More ISC training
- Put more value on the acquired input/contribution
- Explain 'why' the IBM way
- More face to face
- Assign appropriate SME
- More straight talk/be realistic
- Slow the integration pace
- More functional training

Question 4: How have you adapted to working in IBM?

- More formal
- Less travel/difficult approvals
- More matrixed environment
- More multitasking
- Need to be more self-sufficient
- Adapting well
- More separation of duties
- More silo'd
- Role significantly changed
- Working across time zones
- Working from home
- Building people network
- Working more hours
- More beaucracy slows work
- Learning IBM culture/processes/tools
- More conference calls/impersonal communications
Question 5: What would you have liked to see and/or better understand?

- More straight talk / honesty
- More sensitivity to acquired team
- Job rotations
- Better staff resource analysis
- Address the malcontented employees
- Roles/responsibility clarity
- Better assistance in finding information
- IBM Big picture training
- Have a functional mentor / SME connection
- Improved process / functional training

Question 6: How did your expectations map to how things turned out?

- Took longer than expected
- Networking less than expected
- More meetings than expected
- As expected
- Better than expected
- Difficult to integrate to large company
- Met expectations
- IBM systems/process/tools more difficult than expected
- Role different than expected
Question 7: What would be some good ways to assist onboarding during integration?

- Help with navigating IBM data
- SME connections
- Face to face training
- Time management help
- Assign career mentor
- Improve communication / big picture info
- Roles / responsibility clarity
- Improve functional training / more individual training

Question 8: Compare your initial impressions and how they evolved overtime

- Building relationships
- Processes slowed the work pace
- IBM is complex
- Change was difficult
- Continuing to learn IBM processes
- As expected
Question 9: What would you like to teach IBM?

- Use plain English
- Lessons learned
- Cultivate breadth in roles
- Sensitivity training
- Identify the quality employees
- Straight talk / open honest communication
- Consider using acquired company processes
- Listen to the people / Learn from them
- Consolidate / Improve IBM processes / tools
Knowledge Gap Areas: Did you get enough information on?
Question 10: IBM Mission, role & strategy

Yes 28%
No 40%
Not enough / Not early enough 32%

Question 11: How IBM is organized

Yes 36%
No 32%
Not enough / Not early enough 32%
Question 12: IBM Management systems

28% 40%
32%

- Yes
- No
Not enough / Not early enough

Question 13: IBM processes and tools

12% 60%
28%

- Yes
- No
Not enough / Not early enough
Question 14: IBM Portal, communities, webcasts

- Yes: 56%
- No: 36%
- Not enough / Not early enough: 8%

Question 15: Navigating within IBM

- Yes: 20%
- No: 52%
- Not enough / Not early enough: 28%
Question 16: Building a network within IBM

- Yes
- No
- Not enough / Not early enough

28% of respondents answered 'Yes', and 44% answered 'No'.

Question 17: How to get things done in IBM

- Yes
- No
- Not enough / Not early enough

32% of respondents answered 'Yes', and 40% answered 'No'.

44% of respondents answered 'No'.

Not enough / Not early enough

32% of respondents answered 'Yes', and 28% answered 'No'.

28% of respondents answered 'No'.

Not enough / Not early enough
Question 18: Operating in the IBM Matrix; who to involve, who to inform, how to make it work?

- Yes
- No
- Not enough / Not early enough

Question 19: Self Service approach

- Yes
- No
- Not enough / Not early enough
Question 20: What didn't work well? What was confusing?

- 4% Yes
- 56% No
- Not enough / Not early enough
Appendix B: Full model views

Capabilities view
Schedule

Social attributes
Technology infusion

Normalized B
Capability TRL

Normalized capabilities
coupling level

Capabilities
coupling level

Normalized change
propagation in A

Change
propagation in A

Sensitivity of Fraction Correct to Cultural Difference

Effect of Cultural Difference on Fraction Correct

Reference Cultural Difference

Table for Effect of Cultural Difference on Fraction Correct

Effect of Technology Integration on Fraction Correct

Technology integration assessment

Reference Technology Integration

Table for Effect of Technology Integration on Fraction Correct

Sensitivity of Fraction Correct to Technology Integration

Fraction of work correct

Normal Fraction of Work Correct
Integration fatigue

- Identified capabilities are B
- Cumulative effort
- Overrun on initial work estimate
- Expected productivity
- Initial time estimate of integration
- Effect of greater effort than expected on fatigue
- Normal fatigue
- Indicated integration fatigue
- Change in fatigue
- Time to change fatigue
- Project finished

- Expected completion date
- Pressure to accelerate the transfer of capabilities
- Effect of schedule pressure on fatigue
- Effect of fatigue on productivity
Appendix C: Framework view
Bibliography


