A Systems-Theoretic Approach to Organizational Design and Analysis

by

Lauren E. Gutierrez

B.E. Electrical Engineering (2012)
Stevens Institute of Technology

M.S. Enterprise Program Management (2014)
Stevens Institute of Technology

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Authored by: Lauren E. Gutierrez
MIT System Design and Management Program
January 13, 2025

Certified by: Nancy G. Leveson
Jerome C. Hunsaker Professor in Aeronautics and Astronautics
Thesis Supervisor

Accepted by: Joan Rubin
Executive Director
MIT Systems Design and Management Program

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Abstract

A significant challenge for large organizations lies in organizational design, particularly for public sector bureaucracies and the largest of industry's private firms. Organizations tend to turn to organizational design improvements when facing effectiveness and efficiency issues. Unfortunately, these large organizations struggle with organizational design because of the sheer size and complexity of their organization which results in a fragmented and often times faulty approach to improving their organization. Organizations, at their core, are a special type of system or a set of components that operate or work together to achieve some common purpose. Organizations are purely social systems in that their elements are not technical or engineered.

Systems Theory provides a lens through which these types of social systems can be studied. Just like in engineered systems, an organization's emergent behavior is determined by its internal elements' complex interactions. Traditional organizational design and analysis methods focus on optimizing these internal elements in the hopes of re-integrating optimized elements in pursuit of organizational-level optimal behavior. Just like in traditional systems engineering, component-level optimization does not yield system-level optimal behavior.

This thesis codifies a systems-theoretic approach to organizational design and analysis using the language of Systems Theory and the semantics of Systems-Theoretic Accident Model and Processes. By extending traditional Systems-Theoretic Process Analysis (STPA), a tool for hazard analysis used primarily for engineered systems, this work refines STPA's concepts and terminology to be more accessible for analyzing social systems. Building off this extension, this thesis leverages a contemporary Department of Defense reorganization effort as a case study, illustrating Systems-Theoretic Organizational Design and Analysis (STAODA) as a tool to assess organizational design options.

Thesis Supervisor: Nancy G. Leveson
Title: J. C. Hunsaker Professor of Aeronautics and Astronautics

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Chapter 1: Introduction

The real secret of the greatness of the Romans was their genius for organization.

--James Mooney, Vice President, General Motors, 1931

Motivation

We live in a complex, ever-changing world. Read any newspaper, website, or television news report, and you will read (or hear) about how our fast-moving world is forcing organizations to change to remain relevant. Organizations must adapt to stay competitive; this is a fact of life and something we have most likely witnessed, participated in, or gone through.

Organizational transformation and change are unavoidable. As noted by organizational scholars Schlesinger et al., "over a period of 20 years, it is still possible for a company, even one that is not growing, to experience numerous changes in its business, product markets, competition, government regulations, available technologies, labor markets, and strategy. These changes are an inevitable product of its interaction with a world that is not static"[1]. Embracing this reality allows organizations to be proactive rather than reactive to unavoidable change.

And yet, although organizational change is ubiquitous, the dynamics and underlying processes of organizational change are understood in only rough, ill-defined ways [2]. If nothing else, experts agree on the sheer complexity of the situations at hand: "the managers and social scientists who create and study change situations find that organizational changes involve multiple sets of complex variables whose identity, interaction, and impact vary from situation to situation"[2].

Because organizations are constantly changing, organizational design is not straightforward; it typically involves "complex approaches, relationships, and processes"[2]. What makes organizational design and redesign challenging is the organizations themselves: the fact that they are complex, open social systems [1].

Organizations can most effectively be described as open social systems in the parlance of Systems Thinking; they are comprised of hierarchies of components that contain the human element [3], [4], [5]. Social systems, by definition of a system, pursue some purposeful activity, and their components exhibit interdependency; "changes in one part of the organization affect other parts," including system-level or organizational-level emergent properties [1]. Ultimately, organizations, like any system, function as complex, adaptive systems that pursue purposeful goals, exhibit

interdependence, have emergent properties, and strive for equilibrium in response to internal and external changes.

Given the dynamic nature of organizations, effective design and analysis practices are needed whenever organizational change is necessary. Organizational design "should be the result of a conscious problem-solving and planning process"[6]. Organizational design is a source of competitive advantage for organizations, and more importantly, "the way we organize and govern our companies and other institutions also affects how benefits, opportunities, and privileges are distributed in society. There is increasing evidence that it has direct effects on our health and personal well-being"[2].

Applying design to creating human social systems, such as organizations, increases the challenge tremendously [3]. A considerable amount of academic literature, models, and frameworks is available on how practitioners, managers, and leaders should design or redesign their organizations. These frameworks provide a solid foundation for understanding organizational dynamics and help managers think more broadly about their organizations.

Yet the organizational tools available tend to optimize select elements of an organization and prioritize implementation. They do not effectively capture or provide guidance on navigating the complexity of the design decisions and changes being made to the organization or the impact of the emergent properties of alternative designs.

The decomposition of organizations into elements is a reductionist approach. As organizations face more complexity due to dynamic operating environments, interconnectedness of stakeholders, and growing demands for increased performance, managing the complexity induced by these factors may be difficult for managers, especially during the design organization or the analysis of the implications of that design. For example, leaders within an organization may find it challenging to consider the entire organization and identify all interactions between departments, teams, and stakeholders if the number of elements and relationships exceeds their cognitive capacity [7].

These limitations are due to a lack of a true systems perspective of the organization and design process. By leveraging principles from systems theory, and a technique called System-Theoretic Process Analysis, organizational designers can develop a deeper understanding of organizational dynamics, such as interconnectedness and emergence. Leaders can design (or redesign) more effective and resilient organizations through this systematic approach. This thesis proposes a systems-theoretic process for organizational design and analysis, providing organizational leaders with a framework to navigate the complexities of organizational development.

1.1 Research Objectives and Approach

The objective of this thesis is to propose a systems-theoretic approach to organizational design and analysis, providing organizational leaders with a framework to navigate the complexities of organizational development. Specifically, this work will:

1. Identify organizational design and managerial language that aligns with the concepts of Systems Theory and allows organizational designers to effectively utilize a systems-theoretic approach to organizational design and analysis.
2. Develop a systems-theoretic technique for organizational design and analysis.
3. Demonstrate how a Systems-Theoretic Approach to Organizational Design and Analysis (STAODA) can be applied to a complex, real-world organization undergoing a large-scale effort to reorganize and transform itself for future competition.

This research can be categorized as hypothesis-generating because it will develop and propose a novel idea that can be later validated through a separate study [8].

1.2 Thesis Outline

Chapter 1 introduces the purpose and objectives of this study.

Chapter 2 is a literature review that provides an overview of what organizations are, the history of organizational design theory, what organizational design is, an analysis of three leading methods for the design and redesign of organizations, and a deep dive into systems theory and its theoretic approaches.

Chapter 3 focuses on extending STPA for organizational design and analysis. It will present the primary theoretical contribution of this thesis and will outline how STPA can be adapted to analyze and manage organizational design and analysis.

Chapter 4 is a demonstrative case study and applied analysis.

Chapter 5 concludes with a summary of key insights and conclusions from this analysis and suggestions for future research.

Chapter 2: Literature Review

Humans are social creatures. Humans have formed organizations since our species learned to reason, but organizations as we know them today have evolved significantly over the last several hundred years.

Organizations can be incredibly complex, and their management and design require art and science skills. The socio-technical nature of today's organizations introduces unique managerial, design, and structural challenges for new and existing organizations.

To better understand the challenges surrounding organizations and their management, this chapter explores the background and relevant literature that lay the foundation for today's state of the art in this focus area.

This chapter is structured in three main sections. The first section highlights what organizations are, organizational theory, and the theoretical underpinnings that have been broadly accepted as descriptive of complex organizations. The second section discusses organizational design and existing techniques academics and practitioners offer to design or analyze organizations. The final section of this review delves into Systems Theory. This section highlights the attributes of organizations as complex systems and provides an overview of systems-theoretic analysis or modeling techniques that have been developed and leveraged in other application domains.

2.1 Organizations and Organizational Theory

2.1.1 Organizations

So, what is an organization? There are several definitions in the literature about what an organization is. Edgar Schein, a leading researcher in the field of organizational behavior, said an organization "is the planned coordination of activities of a number of people for the achievement of some common, explicit purpose or goal, through division of labor and function, and through a hierarchy of authority and responsibility"[9], [10].

To Ralph Davis, a mid-century organizational theorist, "an organization is a group of people working together under a leader to accomplish an objective"[10], [11].

A modern organizational theorist, Richard Daft, offered that organizations "are social entities that are goal-directed, are designed as deliberately structured and coordinated activity systems, and are linked to the external environment"[12].

These three leading definitions vary in detail about what an organization is. Still, they agree that an organization involves a structured group of people working together toward a common goal.

The organization also has many synonyms, and this linguistic phenomenon highlights the ubiquitous nature of the concept in humans. Other terms for an organization include team, enterprise, union, group, coalition, corporation, association, federation, firm, and network. This thesis will use the word organization to clarify this important concept.

2.1.2 Organizational Theory

Organizational Theory is a transdisciplinary field that "encapsulates a range of perspectives from economics, psychology, and sociology [9]. Suter et al., organizational researchers, stated, "Organizational Theory focuses on the holistic examination of organizations, i.e., the study of organization from multiple viewpoints, using multiple methods and levels of analysis"[13]. More simply, it studies how organizations work and interact with their environment.

The breadth of organization theory makes it essential to understand and use because it is a way to see and think about organizations [12]. Herbert Simon, a leading organizational behavior theorist, "envisaged 'organization theory' as a broad category that included scientific management, industrial engineering, industrial psychology, the psychology of small groups, human-resources management, and strategy [14], [15]. By understanding and applying the various concepts of organizational theory, leaders can effectively analyze, design, or redesign their organizations to be more effective.

Organizational Theory did not develop until the late 19th century; it is a relatively new field of study because the need to study organizations was not needed until the Industrial Revolution began to change the world. Despite being relatively new, there have been four key periods of evolution since its inception; the theories, concepts, and frameworks developed during these times can be categorized as classical, neoclassical, modernist, and postmodern organizational theory. The subsequent subsections examine each of these eras.

2.1.2.1 Classical Organizational Theory

Classical organizational theory occurred between the late 19th and early 20th centuries. This period was brought on by the rise of the Industrial Revolution, which led to the seminal works of Frederick Taylor (scientific management), Max Weber (bureaucratic management), and Henri Fayol (administrative management). The key concepts of this era include efficiency, hierarchy, clear division of labor, and formal structures. The characteristics of the theories developed by these gentlemen are centered

around task specialization and standardization, hierarchical structures with clear lines of authority, and a focus on efficiency and control through formal rules and procedures. These three thought leaders and their pioneering theories laid the foundation for organizational theory, and many elements of their work are still in use today.

Fredrick Taylor, the father of scientific management, was responsible for developing scientific management, which focused on optimizing worker productivity and streamlining production processes through scientific analysis. Through scientific methods, "one best way" to do the work could be identified and exploited for the organization's benefit [16]. Taylor's "one best way" would have a lasting impact on organizational and management theory.

Max Weber, "who initiated the contemporary sociological study of bureaucracy, freed the word from pejorative connotations and stressed the essentiality of bureaucracy for the rational achievement of the aims of the organizations [17]. He "considered the organization of broader society. He looked at the structure of the organization and the control of member behavior" [17]. Weber's bureaucratic management focused on developing organizations in an objective and logical way, specifically with clear lines of authority, responsibility, and accountability.

Henri Fayol, a French engineer and manager in the mining industry, authored the book *General and Industrial Management* in 1919. Fayol outlined six key functions of management and fourteen management principles in his book. Fayol's work essentially established the field of administration management, which focuses on "the design and functioning of the organization as a whole" [12], [17]. The output of Fayol's work is still used in practice today.

2.1.2.2 Neoclassical Organizational Theory

The next critical time for organization theory was from the 1930s to the 1950s, known as the neoclassical era. The neoclassical era arose primarily because the classical era ignored the human worker or treated the human worker as a machine. This lack of acknowledgment of the impact of the human worker on the organization and the organization on the human worker gave way to the rise of the neoclassical era. American organizational theorist J.L. Bowditch claimed that "the neoclassical school of thought can be viewed as a critique of the classical doctrine" [16], [18], [19]. This is evident in the key concepts developed during this era: human relations, worker satisfaction, and informal structures.

A critical foundation of the neoclassical school of thought is the Hawthorne studies, led by Elton Mayo, F.J. Roethlisberger, and William J. Dickinson. In 1927, Mayo and his associates led a research study at the Chicago Western Electric Company's

Hawthorne Works site [20]. The focus of the studies was to understand behavior in the workplace specifically as it pertains to "style of leadership, working conditions and other organizational issues with employee output"[21], [22], [23]. The outcome of these experiments was the importance of the human element in the workplace. Especially the notion that treating workers well increases their motivation and ultimately benefits the organization's productivity.

The Hawthorne studies "underlined that the group dynamics and social makeup of an organization were an extremely crucial force either for or against higher productivity. This outcome caused the call for greater participation from the workers, greater trust and openness in the working environment, and great attention to teams and groups in the workplace [16]. The work of these experiments laid the foundation for human relations and understanding the impact of informal structures.

Another thought leader during this time was Mary Parker Follet, an American management scholar, social worker, and government consultant. Mary's contribution to the development of organization theory revolves around the idea that employees know their job best and, therefore, managers should leverage their worker's expertise to improve work processes and functions. Follett's idea directly challenged Frederick Taylor's scientific management theory and highlighted the importance of a humane side of organization and involving the worker [24]. Mary's work led to behavior management theory, which "refers to how managers ought to behave in motivating employees to become committed to achieving organizational goals and objectives" [24]. Her work contributed to the humanization of management and management practices.

Mary Parker Follett's work helped inspire some of Chester Barnard's ideas on the role of the executive in an organization, which he published in 1938 in *The Functions of the Executive*. Barnard, an American management theorist, believed that the role of an executive should be focused on developing and maintaining the organization's purpose, ensuring the organization was appropriately resourced, and tending to the organization's structure, roles, responsibilities, and relationships. It is evident in Barnard's work that he recognized that the role of executives was to nurture the organization specifically by recognizing it as a social system and focusing on effective communication and motivating employees [25].

2.1.2.3 Modern Organizational Theory

Just as the neoclassical era addressed the shortcomings of classical organization theory, the modern organization theory era has further developed and expanded upon neoclassical ideas, filling in the gaps and advancing the field even further. The timeframe of the modern movement of organization theory began around the mid-20th century and

lasted until approximately 2010. This period of the theory can be summarized in two words: integration and holistic-ness; "modern organization theory is an integration of valuable concepts of classical models with the social and behavioral sciences", "it is the study of the organization as a whole" [26], [27]. The dominant ideas which emerged were systems theory, contingency theory, bounded rationality, and socio-technical theory.

A primary idea during this era was that the organization is a system. The roots of this idea come from the notion that *all* aspects of the natural and social world can be described as systems. This concept, called General Systems Theory, is generally attributed to Viennese theoretical biologist Ludwig von Bertalanffy [28]. Von Bertalanffy's "ideas were based on the observation that societies contain groups, groups contain individuals, individuals are comprised of organs, organs of cells, cells of molecules, molecules of atoms, and so on. Von Bertalanffy considered each of these phenomena, which have their own dedicated science, to be a system, and he sought the laws and principles generic to all of them" [25].

He developed the concept of a "system" as an antidote to the limitations of individual disciplines in addressing complex social problems [13], [29]. Simply put, system theorists believe all systems, whether scientific, engineered, or social, all have the same basic elements, such as hierarchy and control. A more detailed review of Systems Theory will be provided in section 2.3. To understand systems theory pertaining to organizations and organization theory, Suter et al. stated, "the basic premise of systems theory is that organizations consist of multiple, interdependent parts that collectively form more than the sum of their parts. Interactions between parts of the system are seen as purposeful, boundaries are permeable, and cause and effect as dynamic, nonlinear process"[13]. This notion gave rise to the saying, "the sum is greater than its parts".

Another theory that arose in the 1960s that has shaped organization theory is contingency theory. Contingency theory arose out of the limitations of classical theory, specifically the fundamental idea championed by Frederick Taylor that science can be used to find the best way to organize work for organizations. The basic concept of contingency theory is that there is no one-size-fits-all approach to organizational design, and that organization's design must consider the circumstance and context in which it exists [24], [30]. Paul Lawrence and Jay Lorsch primarily led this theory's development.

Bounded rationality is another fundamental concept of organization theory developed during the mid-century by Herbert Simon and James March. This concept arose as a critique of the classical theories of scientific management and economics, which theorized that "a rational individual has unlimited cognitive capabilities, and his choice of behavior is focused on maximizing his own expected utility"[31], [32]. Simon, in his 1947 book entitled *Administrative Behavior: a Study of Decision-Making Processes in*

Administrative Organization, stated, "at the base of the real human behavior, there are three restrictions on cognition: incompleteness of information, difficulty in the anticipation of the consequences of future actions; and scarce knowledge of all possible human behaviors"[31], [33], [34]. In response to his findings, Simon developed the bounded rationality model with March's help.

Simon and March's work showed "that the design of the organization was a strategy to deal with both lack of information and the inability of actors to be able to absorb endless amounts of information"[35]. Their work created a comprehensive approach to understanding organizations and their problems, such as how to structure themselves, motivate and track employee performance, and adapt to changing market conditions.

Another critical theory that emerged was the socio-technical theory. This theory emerged in the 1960s over "the concern for the interaction between two organizational subsystems – social structure and technology" [25]. Eric Trist and Ken Bamforth established the theory through their work with the Tavistock Institute of Human Relations in the United Kingdom [25]. Their theory "aims to address problems associated with the introduction of new technologies in an organization"[13], [32]. It is focused on the intersection of an organization's social and technical aspects.

The main principles of this theory are: 1) how well members of an organization work together and how well they use the technical tools (processes and tools) that can affect the success of an organization, and 2) focusing on only one of these elements can negatively impact the overall performance of the organization.

2.1.2.4 Post-Modern Organizational Theory

While modern organization theory focuses on viewing organizations as a system and looking at those systems as a whole, the postmodern era, which is in its infancy, focuses on how organizations are understood and how organizations can reconcile complexity and ambiguity. This evolution of the theory began to emerge in the late 20th century, and the initial focus and development of the theory has been on power, identity, and how communication occurs within an organization.

While the modernist mentality on organizational theory relied heavily on control, order, and overall efficiency, the postmodern movement questions modern organizational design and theory tenets. Unlike the contemporary school of thinking, the "postmodern theory of organizational power demonstrates that we are empowered only through the actions of others"[36]. This construct insinuates that emphasizing power and influence should be abandoned in favor of concepts encouraging interdependence amongst stakeholders and members of today's organizations.

Understanding the evolution of organization theory helps the reader understand key tenets of the approaches employed in the recent past and today in organizational design. As evident in this historical review of the evolution of organization theory, it is essential to remember that organization theory lays the foundation for how to see, analyze, and understand an organization.

2.2 Organizational Design Methods

Having established the foundations of organizational theory, this review now examines the practical application of organizational design. The effective design of an organization is imperative to its overall performance and adaptability; therefore, it is important to review the basic concepts, key elements, and frameworks that been developed to support this process. The aim is to understand how these approaches are employed and how they both help and hinder organizations that are undergoing organizational design improvements.

2.2.1 What is Organizational Design and Why it Matters

Organizational design is about assembling elements, such as structure, people, and processes, to optimize the organization's operation efficiently and effectively. As noted by organizational theorists, Robert Burton and Borge Obel, "organization design is a systematic approach to aligning structures, processes, leadership, culture, people, practices, and metrics to enable organizations to achieve their mission and strategy"[37]. Effective organizational design matters because it directly impacts an organization's ability to meet its goals.

Without the right design, an organization's performance can be undermined; an improper design or "inappropriate attempts to introduce changes in organizational design also can be costly. They can disrupt a company's operations, generate resistance and hostility among employees" and lead to several other organizational problems [1]. "good" organizational design creates value for those taking part in the organization, and for those using the products and services of that organization"[38]. Fundamentally, organizational design is about creating the proper structure and internal environment that allows an organization to operate effectively, meet its goals, and remain competitive.

2.2.1.1 When Does Organizational Design Occur

There are two overarching times organizational design should be considered for an organization. The most obvious is when an organization is forming. The other time organizational design practices and methods are needed is when the organizational needs are not being met, resulting in the organization requiring reorganization or

redesign. Typically, this occurs when the "organization structure is out of alignment with the organization's needs" [12]. Leading indicators of structural deficiency are: decision-making is delayed or lacking in quality, the organization does not respond innovatively to a changing environment, employee performance declines, goals are not being met, and too much conflict is evident [12], [39], [40]. Organizations need to understand these leading indicators to address any organizational issues proactively.

2.2.2 Key Concepts of Organizational Design

Regardless of who is designing an organization, the design effort focuses on making the organization the best it can be in the context of its environment to meet its goals. While many organizational design methods and frameworks exist, fundamental concepts must be understood and considered regardless of the framework used to aid the design efforts. These concepts include organizational design dimensions and the basic parts and types of organizations.

2.2.2.1 Organizational Design Dimensions

One of the first elements anyone trying to design or redesign an organization should look at is the dimensions of the organization. Two types of dimensions should be considered: the structural dimension and the contextual dimension. These two dimensions provide essential information about the organization, allowing designers to evaluate and understand the organization [12]. Figure 1 shows how the dimensions are interdependent.

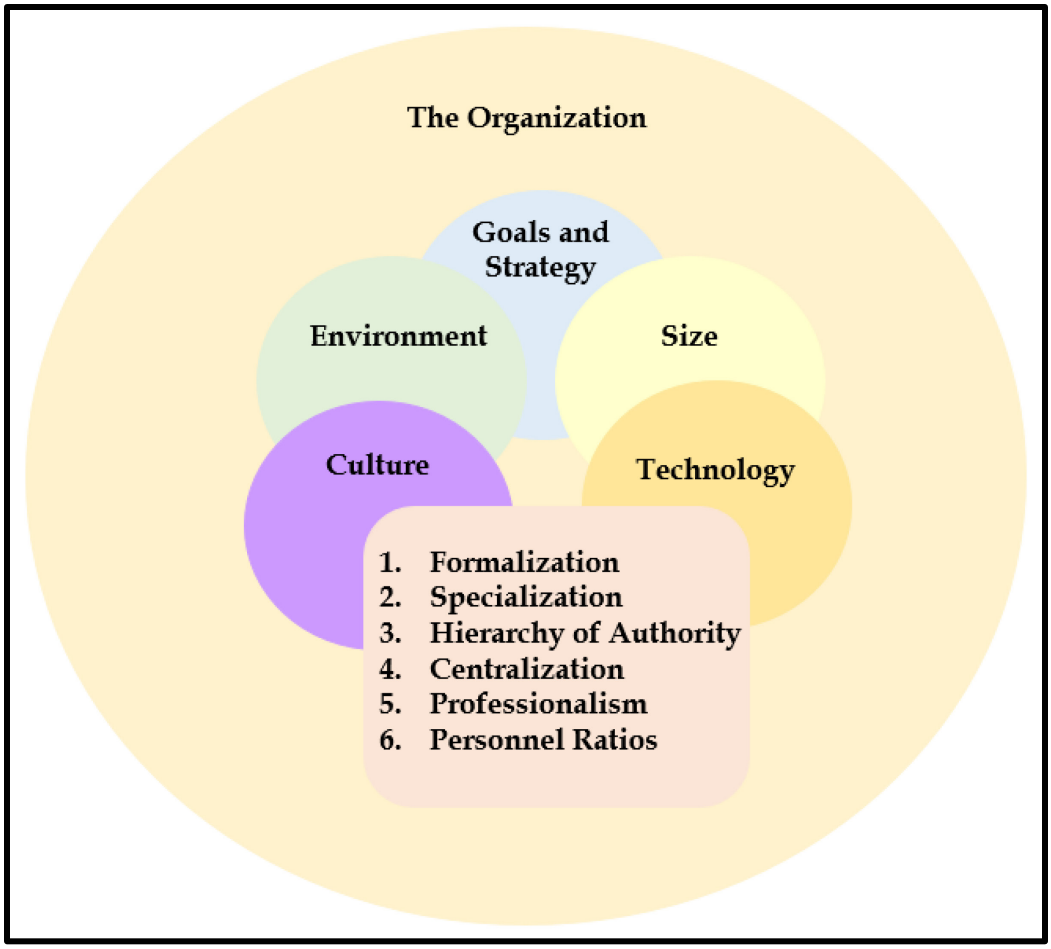


Figure 1: Contextual & Structural Dimensions of Organization Design [12].

The structural dimension refers to the internal characteristics of an organization. The elements of the structural dimension are formalization, specialization, hierarchy of authority, centralization, professionalism, and personnel ratios. The definitions of these elements are captured below in Table 1.

Table 1: Elements of Structural Dimension

Elements of Structural Dimension	
Element	**Definition**
Formalization	The extent to which organizations document their rules, procedures, and standards
Specialization	The degree to which work is divided into separate job
Hierarchy of Authority	Who reports to whom and the span of control for each manager
Centralization	How much decision-making authority is distributed amongst an organization's members
Professionalism	The level of formal education and/or training employees have
Personnel Ratios	The proportion of employees assigned to different departments and functions of the organization
	Sources: [12], [41], [42], [43]

The contextual dimension describes the organization in a broader context. The elements of the contextual dimension are size, technology, environment, and goals. The definitions of these elements are captured below in Table 2.

Table 2: Elements of Contextual Dimension

Elements of Contextual Dimension	
Element	**Definition**
Size	Typically measured by the number of employees in an organization.
Technology	The technology used by the organization (tools, techniques, and actions) to meet its goals.
Environment	The elements outside the boundary of the organization that can affect all or part of the organization.
Goals and Strategy	The purpose and attributes of the organization that set the organization apart from other organizations.
Culture	The values, beliefs, norms, and behaviors shared by the members of the organization
Personnel Ratio	The proportion of employees assigned to different departments and functions of the organization.
Source: [12]	

The elements of structure and context for an organization are interwoven together; affecting one can have ripple effects on other elements. It is important to understand these elements before design because they "provide a basis for measuring and analyzing characteristics that cannot be seen by the casual observer, and they reveal significant information about the organization"[12]. By understanding these dimensions, organizational designers, leaders, and managers can develop an effective design that allows the organization to fulfill its goals.

2.2.2.2 Organizational Structure Design Considerations

When designing an organization, a key part is focused on developing the organizational structure. This focus on the structure is critical because structure directly impacts an organization's ability to function effectively and accomplish its goals. It is

important to consider the structure's vertical or horizontal nature because these types of structuring fundamentally determine how an organization's authority, roles, and decision-making are defined. Each structure exhibits its own characteristics and tends to support specific organization types and operating environments.

A vertical structure, which is the oldest of the two forms since it has direct ties to how organizations were shaped and managed since the Industrial Revolution and allows organizations to optimize for efficiency, is described by having a tall structure. The vertical nature of this structure is because there are typically multiple layers of management. Additionally, a vertical structure has a clear chain of command, centralized decision-making, and a communication flow that normally flows up and down the organizational hierarchy. In a vertical structure, roles and responsibilities are known to all employees. This type of structure lends itself to organizations striving for efficiency, uniformity, and control. Organizations with a vertical structure typically operate in a stable environment where variability is rare or manageable. Examples of organizations with vertical structures are militaries, governmental agencies, and mass production agencies.

Vertical structures thrive in stable environments, "however, in a rapidly changing environment, the hierarchy becomes overloaded. Top executives are not able to respond rapidly enough to problems or opportunities"[12]. Other drawbacks to this type of structure are slowness to adopt change, slow communication, decision-making, and the potential for bureaucratic inefficiencies.

A horizontal structure, otherwise known as a flat structure, is a relatively new type that only emerged in the late 20th century when a shift began from industrial manufacturing to service and knowledge-based industries. Service and knowledge-based organizations are not mass-production industrial organizations; therefore, they do not necessarily need to exhibit tight control of their organization to ensure efficiency.

A horizontal structure usually has fewer management layers and decentralized decision-making, meaning employees have more capability and ability to make decisions without excessive approval. Additionally, the work involves cross-functional knowledge from its employees. It leads to organizations that allow teams to form from within and have a wide variety of knowledge and experience.

The benefits of a horizontal structure for an organization are their ability to adapt to change as needed to fit their operational environments, faster communication, easier collaboration, and innovation. Horizontal structures are best for organizations that value innovation, exist in fluid operating environments, and are smaller in scale.

The drawbacks to a horizontal structure are that roles and responsibilities may not be as clearly defined as in a vertical structure, which can create ambiguity for all those involved, and it can be challenging to scale these types of organizations.

It is worth noting that in today's evolving and complex world, many organizations exhibit a combination of both structures. This combination certainly can help an organization achieve the best aspects of each structure. Still, it does induce greater complexity for an organization and requires the right leadership and organizational culture to manage and maintain effectively.

2.2.2.2.1 Organizational Structure and Information Flow

Another critical aspect of an organization's structural design is information flow. According to Daft, "organization design should facilitate the communication among employees and departments that is necessary to accomplish the organization's overall task"[12]. Information needs to flow vertically and horizontally in an organization.

Vertical information flow or linkages "coordinate activities between the top and bottom of an organization and are designed primarily for control of the organization"[12]. These linkages are established through a chain of command, rules, plans, and reporting systems.

Horizontal information flow or linkages "refers to communication and coordination horizontally across organizational departments. Horizontal communication overcomes barriers between departments and provides opportunities for coordination among employees to achieve" organizational goals [12]. The mechanisms to support horizontal information linkages are cross-functional information systems that all members of the organization can use, direct contact between managers of different departments, the establishment of liaison roles within each department whose responsibility is to ensure communication and coordination between departments, and the use of an integrator which can be a member or department outside of the other departments whose responsibility is coordination amongst multiple departments [12].

Information flow is crucial to any organization; if the information flow does not match the information needs of the organization, then "people either will have too little information or will spend time processing information that is not vital to their tasks, thus reducing effectiveness"[12], [44]. Most organizations today establish vertical and horizontal information linkages and combine the abovementioned mechanisms to achieve effective communication, coordination, and collaboration.

While the selection of structure and all the other elements addressed in this entire section is essential to consider while designing or redesigning an organization, "the most important decision that managers make about structural design is to find the right

balance between vertical control and horizontal coordination, depending on the needs of the organization" [1]. Striking the right balance and finding the structure and elements that fit the organization's needs is imperative during the design process; otherwise, the organization will not be able to efficiently or effectively meet its goals.

2.2.3 Leading Organizational Design Methods

After outlining the fundamental concepts of organizational design, it is time to explore the leading models that guide the practical application of designing (or redesigning) an organization. Utilizing organizational design models is important because they provide a structured approach to helping people understand how an organization functions and how it could operate in the future. Models are simplify complex ideas, making it easier for everyone in the organization to understand, discuss, and design together [45].

Numerous organizational design models exist, providing leaders and managers guidance and processes for designing or redesigning their organizations. The following section examines three notable methods: Galbraith's Star Model, McKinsey 7-S, and the Burke-Litwin Model.

These three models have been selected because of their comprehensive approaches to organizational design; they represent different perspectives of organizational design and are still utilized today.

2.2.3.1 Galbraith's Star Model

Jay Galbraith was a leading scholar in the field of organization design and was the first to map organization strategy against structures, information-processing functions, reward systems, and people practices through his development of his Star Model in his 1977 book, *Organization Design* [46].

Galbraith's Star Model provides a way to think holistically about the five components of organizational design. According to Galbraith, the five components are strategy, structure, processes, rewards, and people. His framework is displayed graphically as a star because the interconnecting lines highlight the importance of the five components, their interdependence, and how they must be aligned to enable an organization's best performance [46]. Galbraith's Star Model is shown below in Figure 2.

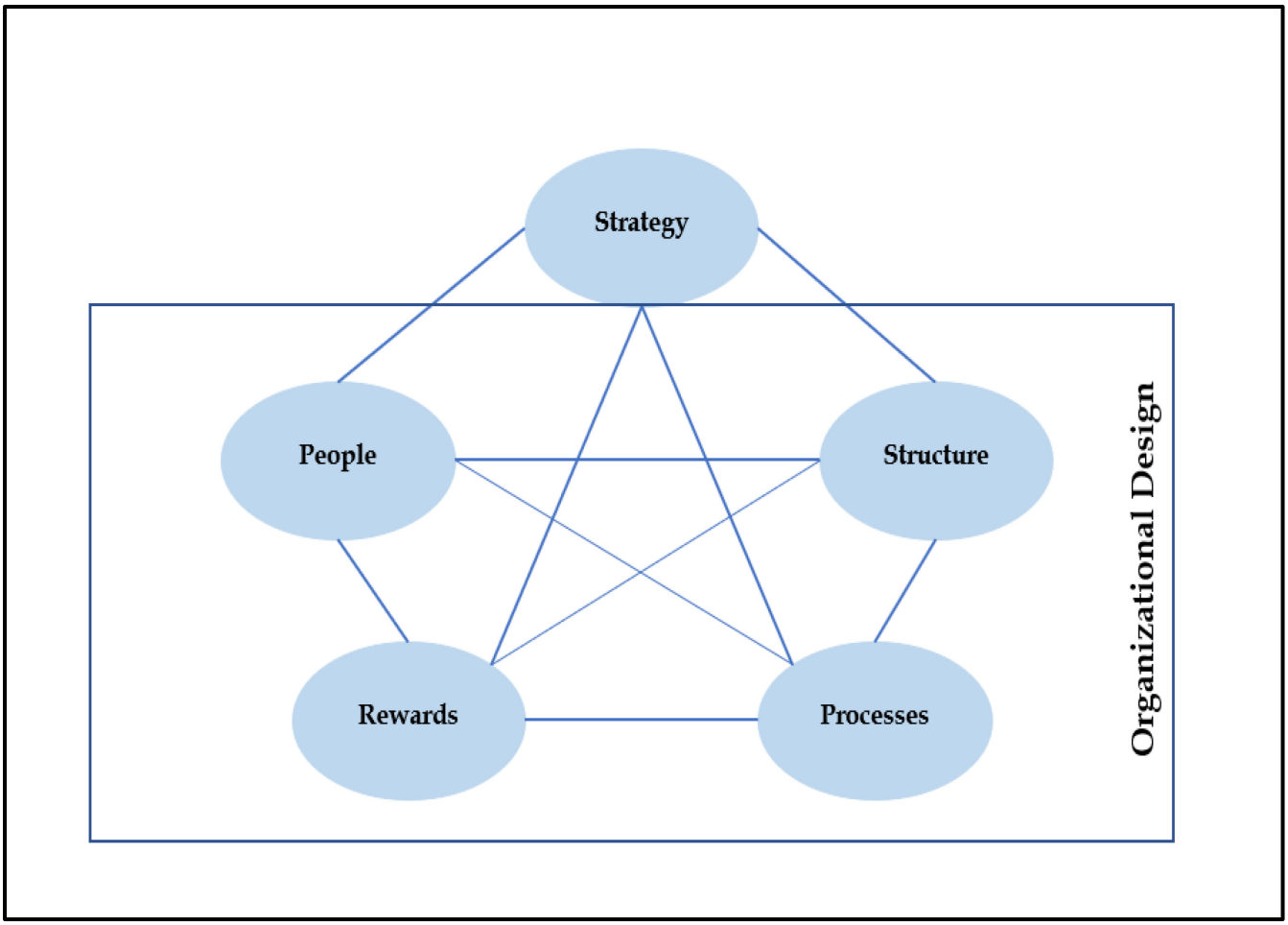


Figure 2: Galbraith's Star Model [46], [47]

Strategy informs the direction of the organization from what the organization produces or provides, what markets they are in, and how the organization will be profitable.

Structure comprises the locus of power and where decisions are made.

Processes determine information flow. Vertical and horizontal information flows determine how information flows up and down the chain of command and across the organization.

Reward systems help motivate members to perform to reach the organization's goals.

People policies, otherwise known as human resource policies, establish guidance and standards for the management of organizational members.

Galbraith believed these five components were crucial to organizational design. He observed that too much emphasis was being placed on organizational structure during the design. Although he recognized the importance of structure, it was not the only element organizations should concern themselves with during the design process. It is important to note that Galbraith believed there is no "one size fits all" to organizational design, and each organization needs to build a design that works best for them.

2.2.3.1.1 Galbraith's Star Model Theoretical Background

Herbert Simon, James March, Paul Lawrence, and Jay Lorsch strongly influenced Galbraith's work. Simon and March's work on bounded rationality, which showed "there are limits to rational thinking in organizations and these limits have important consequences," shaped a lot of Galbraith's work, including the Star Model [46]. The Star Model accounts for bounded rationality through the structure and process components. Structure and process are interwoven and affect managers' and leaders' ability to make effective decisions for the organization; organizations should structure themselves in a way that helps decision-makers make informed decisions since these members have cognitive limits.

Galbraith's Star Model framework also draws upon contingency theory and the work done by Lawrence and Lorsch. He draws on contingency theory when he states that in *Designing Organizations*, "there is no "one size fits all" organizational design, and the design selected should be the one that best matches the strategy [47].

2.2.3.1.2 Galbraith's Star Model Application

The Star Model is a tool and blueprint for leaders and managers designing an organization. By using this model, organizations can take a holistic approach to their design process and ensure they are aligning their organization in a way that allows them to maintain top performance. The Star Model can be used to address a variety of issues or opportunities for an organization. It is typically used during organizational restructuring to aid in change management, and it can address and improve an organization's performance [48].

2.2.3.1.3 Galbraith's Star Model Strengths, Limitations, and Critiques

The strengths of Galbraith's Star Model are its comprehensiveness through the five components that need to be considered and aligned to develop an organization that can perform well. The Star Model can be applied to any organization, regardless of size or industry [48]. Additionally, the model is practical; it offers a clear and actionable framework for organizations.

Although the Star Model is comprehensive, it has some limitations worth highlighting. The first limitation is its lack of acknowledgment of how culture impacts the organizational design process and how it should be considered within the model. Another difficulty is that there is a lack of information on what constitutes alignment of the five components and how designers know if they have effectively aligned them.

The issues organizations face today are complex; the model comes across as an oversimplification, and everything boils down to those five elements. Perhaps it is simply the passage of time, but those elements do not seem enough for today's organizations. Additionally, there is a lack of consideration for how the environment should shape the design process.

Finally, the model and literature on the model come across as relatively static. While Galbraith draws upon contingency theory for his model, information on when and how to re-evaluate the organizational design is lacking.

2.2.3.2 McKinsey 7-S Model

In the late 1970s, Tom Peters and Robert Waterman, two consultants at McKinsey & Company, a highly regarded management consulting company, developed the 7-S model. They created this model after working with several clients and consulting on their organizational problems. Peters and Waterman found that many of the organizational design solutions available to them and their clients only focused on structure and strategy when dealing with organizational issues. They found that this limited focus never allowed organizations to completely solve their problems or set them up entirely for success.

The 7-S Model is "a conceptual framework useful in diagnosing the causes of organizational malaise and in formulating programs for improvement"[49], [50]. Peters and Waterman believed "that effective organizational change is really the relationship between structure, strategy, systems, style, skills, staff," and superordinate goals [50]. These 7-Ss are what constitute their framework. The McKinsey 7-S Model is shown below in Figure 3.

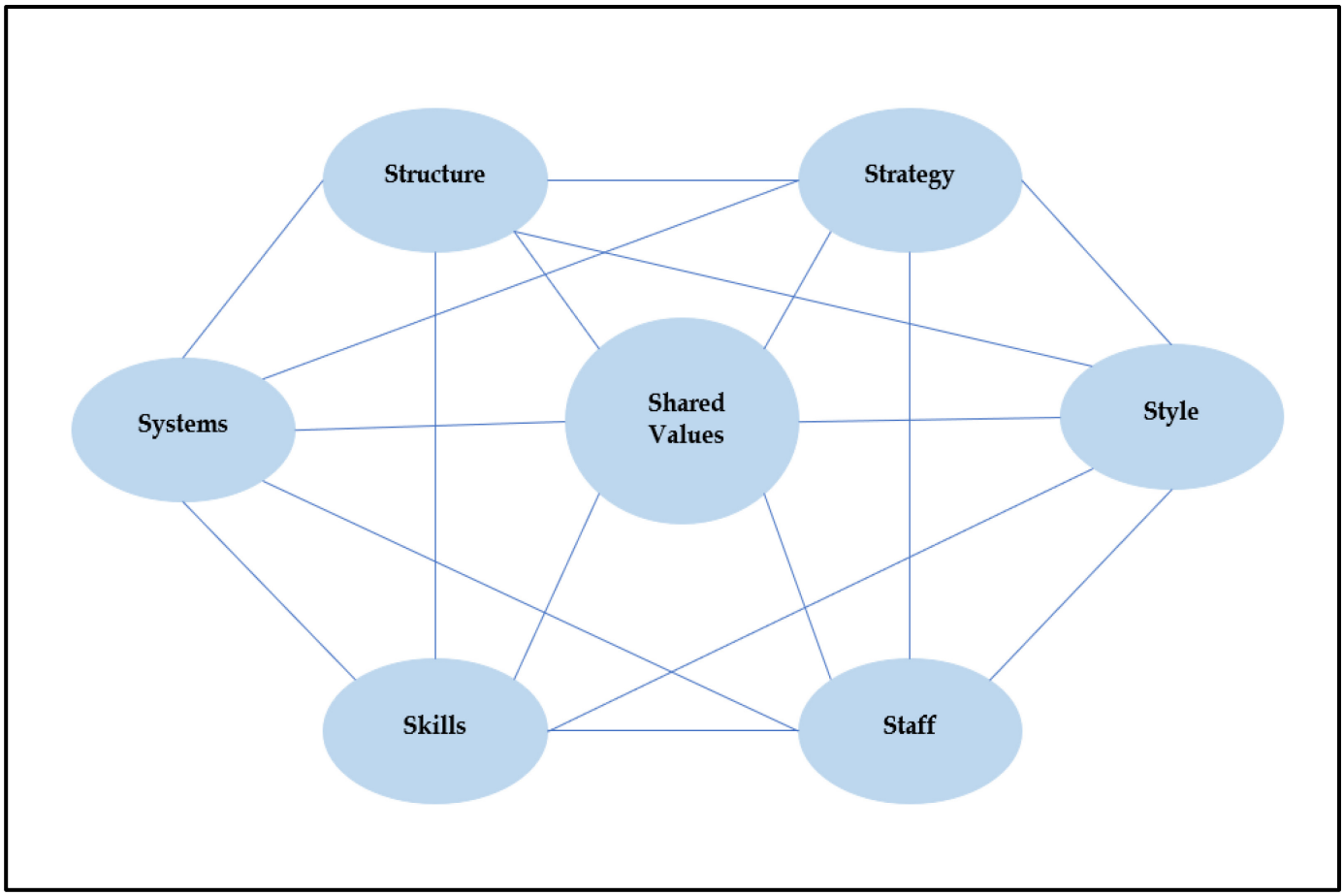


Figure 3: McKinsey 7-S Model [51]

Structure is an organization's ability to focus on the elements of the organization's design that are most important to the future growth of the organization [49].

Strategy is any set of plans that guide how the organization should respond to (or anticipates) changes to its operating environment.

Systems are the processes and procedures that organizations use to accomplish their work.

Style is the "tangible evidence of what management considers important by the way it collectively spends time and attention and uses symbolic behavior. It is not what management says is important; it is the way management behaves"[51].

Skills are an organization's capabilities, and these should not be confused with individual member skills and expertise.

Staff are the members of the organization.

Shared Values are the "guiding concepts—a set of values and aspirations, often unwritten, that go beyond the conventional formal statement of corporate objectives. They are the broad notions of future direction the top management team wants to infuse throughout the organization"[50]. Another term Peters and Waterman use to explain shared values is superordinate goals.

Three less apparent elements of their framework, which are only evident in the graphical depiction, are the seven elements together, the diagram itself, and the shape of the diagram. The seven elements together are intended to convey multiplicity and the notion that there are several "factors that influence an organization's ability to change and its proper mode of change"[50]. They believed that the seven elements must be in unison with each other for the organization's design to succeed.

In addition, the diagram symbolizes the interconnectedness of the elements and the idea that they must all be addressed in the organizational design process. Another less obvious element is the shape of the diagram. This is significant because it highlights that there is no specific starting point and that all elements must be addressed together.

2.2.3.2.1 McKinsey 7-S Model Theoretical Background

Although this model was not produced within academia, Peters and Waterman were still influenced by several aspects of organizational theory when they developed their 7-S Model. Peters and Waterman drew on the work of Chester Barnard. Barnard's work focused on how management is a social skill and how it is the manager's responsibility to ensure that the workers are focused on the organization's goals [35]. This aspect of organizational theory shows up in the 7-S Model through the style element, which is about how management influences the workforce, specifically through their behavior.

Additionally, based on Peters and Waterman's assertion, "organization effectiveness stems from the interaction of several factors—some not especially obvious and some under-analyzed"[50]. It is clear they were influenced by systems theory and the idea that the system is greater than the sum of its parts; in this case, the organization is the system, and its parts are the seven elements; only when those seven elements are aligned, will the organization function in an optimal way.

2.2.3.2.2 McKinsey 7-S Model Application

Peters and Waterman believed their model would help diagnose and solve organizational problems. It is also a framework that allows organizations to take a holistic approach to addressing organizational design issues, and it can be used when developing organizational designs.

Peters and Waterman acknowledge that organizations can take two primary approaches when applying their model. Organizations can take a systematic and thoughtful approach and use the model in great detail, or they can take a more high-level approach. They were so confident in their framework that they suggested a "checklist" approach to the model would have powerful effects for an organization and it would allow leaders "to understand how organizations really operate" and even allow them "to design a truly comprehensive change program" [51].

2.2.3.2.3 McKinsey 7-S Model Strengths, Limitations and Critiques

A strength of the McKinsey 7-S Model, and what sets it apart from Galbraith's Star Model, is its recognition of culture. Waterman explains that "the 7-S Framework is saying that culture is at least a function of seven variables"[50]. Although it is not explicitly its own element, culture can be teased out from the "soft" elements: style, skills, staff, and shared values. Another strength of the model is its attempt to force the organization to look at itself through various elements. The seven aspects of the model allow leaders and managers to take a broader perspective of their organization.

Although the McKinsey 7-S model strives to be comprehensive, there are limitations to its application and practicality. The first limitation is that "there are no external factors" involved in the model; the emphasis is on internal elements only [52]. As noted previously, the environment plays a crucial role in an organization's performance; a lack of a clear acknowledgment of it in the model is concerning.

Despite the model's relatively simple visual, many parameters need to be considered, such as the seven factors, the interconnectedness, and the lack of a clear starting point. These elements can make using the model difficult and even overwhelm the user due to all the things they need to consider as they design or redesign their organization.

Finally, the model does not provide guidance on routine or continuous adaptation. Perhaps this shortcoming further highlights the lack of consideration for the organization's operating environment, but whether it is today or the late 1970s, the world is constantly changing, and operating environments are becoming less and less predictable. Not considering how to continually scan and adjust an organization based on external factors is another limitation of the model.

2.2.3.3 Burke-Litwin Model

In 1992, W. Warner Burke and George H. Litwin published their seminal work entitled *A Causal Model of Organizational Performance and Change*; in this paper, they put forth their model of organizational function and organizational change. The goal of their model was "to provide a causal framework that encompasses both the *what* and the *how*—

what organizational dimensions are key to successful change and how these dimensions should be linked causally to achieve the change goals"[53]. The Burke-Litwin Model is shown below in Figure 4.

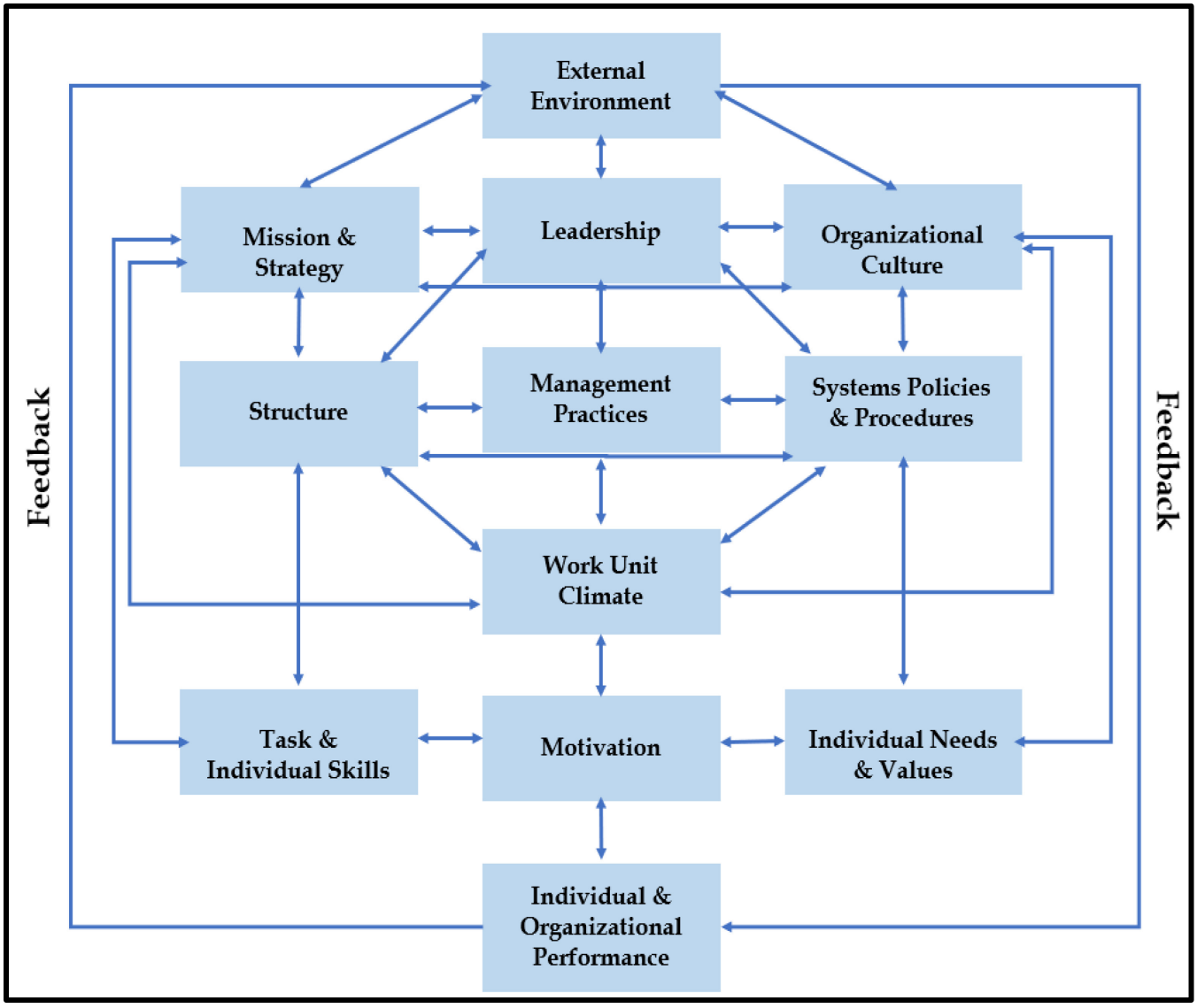


Figure 4: Burke-Litwin Model [53]

As evident in Figure 4, this model is complex. Burke and Litwin recognized this and claimed that although the model is "complex to depict and describe, it is still an oversimplification" [53]. Figure 4 shows the key factors that Burke and Litwin theorized to influence an organization's behavior and how they interact with each other to drive change.

Before delving further into the model's details, it is important to highlight two primary concepts that shape it. The Burke-Litwin model shows "two distinct sets of organizational dynamics. One set is primarily associated with the transactional level of human behavior or the everyday interactions and exchanges that create the climate of the organization. The second set of dynamics is concerned with processes of human transformation, amounting to sudden 'leaps' in behavior" [53]. Burke and Litwin indicated that the transactional level of change is handled by management, and the transformational level is led by leadership [53]. It is important to note, that Burke and Litwin considered leadership to be the executive level positions of an organization who were responsible for overall direction of the organization and management to be the lower levels responsible for the day-to-day operations.

The transactional factors are structure, management practices, systems (policies and procedures), work unit climate, task and individual skills, motivation, individual needs and values, and individual and organizational performance.

- Structure is how the organization is organized.
- Management practices are the reoccurring actions and decisions made to ensure the organization achieves its goals.
- Systems are the policies and procedures that should be followed to support the organization in achieving its goals.
- Climate is the mood and atmosphere of the organization and how it influences employee behavior and interactions.
- Task requirements and individual skills/abilities are the skills, knowledge, and behavior needed to accomplish employees' jobs.
- Individual needs and values are the personal factors that influence an employee's actions.
- Motivation is the drive and willingness to contribute to the organization's mission and goal accomplishment.
- Individual and organizational performance results from how well an employee or the organization is doing.

The transformational factors are the external environment, mission and strategy, leadership, and organizational culture.

- The external environment is the outside factors that impact the performance of an organization.
- Mission and strategy represent the purpose and plans to direct the organization.
- Leadership are the top-level executives who provide direction to the organization.

- Culture is considered the organization's written and unwritten rules, values, and principles.

Another element that needs to be addressed is the use of arrows. These arrows highlight essential linkages between the elements and, more importantly, demonstrate the open system principle, which is the idea that the environment influences the organization and that a feedback loop exists between the two.

Burke and Litwin believed that by displaying their model in this manner, they could make "a statement about organizational change. Organizational change, especially an overhaul of the company business strategy, stems more from the environmental impact than from any other factor" [53]. Additionally, they believed that the transformation factors had more impact than the transactional factors.

2.2.3.3.1 Burke-Litwin Model Theoretical Background

The Burke-Litwin Model draws on two primary aspects of organizational theory: systems theory and contingency theory. The model takes a systems theory approach by recognizing the environment and how the organization responds to it or more simply put as feedback and control. The model emphasizes the twelve elements and their alignment to optimize organizational performance. This approach draws from contingency theory and the work of Lawrence and Lorsch, which is precisely the idea that the organization must match the conditions the environment creates.

2.2.3.3.2 Burke-Litwin Model Application

The Burke-Litwin model "is a best-known and most influential model for looking at the role of organizational climate in business performance" for an organization [54], [55]. The Burke-Litwin model can also be used to design or redesign an organization, guide change management, diagnose problems, and assess performance improvement opportunities.

Burke and Litwin posit that their model could be used in parts: (a) if an organization wants to undergo a significant change, it should focus on "the top transformational boxes" and its associated elements for that change [53] and (b) if an organization wants to address internal processes and efficiencies, it should focus on the lower level of the model and use the transactional elements to guide the process. Finally, the model can be used as a whole to help leadership and management undergo a complete transformation of an organization.

2.2.3.3.3 Burke-Litwin Model Strengths, Limitations and Critiques

The strengths of the Burke-Litwin Model are its comprehensiveness, flexibility to be used in parts or as a whole, and recognition of the causal relationships that occur during organizational design or redesign. Martins and Coetzee noted that two strengths of the model are the recognition of the relationship between the internal organization and its external environment and that it differentiates the role of transformational and transactional dynamics in the organization. Additionally, some have lauded the model for being "more than merely descriptive and congruent; it serves as a guide not only for organizational diagnosis but also for planned, managed organizational change[56].

A significant limitation and critique of the Burke-Litwin Model is its complexity and the amount of elements and considerations that must be made while using it [54]. The twelve elements and the arrows could overwhelm practitioners and even lead to a misapplication of the model. Despite recognizing the importance of the environment, some have taken issue with how the environment is shown in the model. Spangenberg and Theron stated, "this positioning may create the impression that the external environment controls organizational leaders"[57]. Finally, the model is static and does not provide any guidance on how organizations can use it if they exist in unstable environments.

2.2.3.4 Organizational Models Comparison

The Galbraith's Star Model, the McKinsey 7-S Model, and the Burke-Litwin Model are commonly used models for designing or redesigning organizations. While each model is distinct and has its unique approach, they all share common organizational design principles.

The similarities between the three models are that they emphasize several elements at play when it comes to organizational design and redesign; they all recognize that these elements need to be aligned for organizational effectiveness. All three models are agnostic to the type of organization to which it can be applied and when it can be applied.

Key differences amongst the models are the number of elements recognized in each model; Galbraith's Star Model has five components, McKinsey 7-S Model has seven components, and Burke-Litwin has twelve components. Although they all can be used for organizational design and redesign, their focuses are nuanced. Galbraith's Star Model is focused on aligning strategy with the other elements, McKinsey's 7-S Model is focused on internal alignment of the organization, and Burke-Litwin is focused on assessing and managing organizational change through transformational and transactional views.

While all these models help develop organizational design options, they are insufficient for our ever-changing and complex world. All three models draw on systems theory and thinking in their approach, yet a closer analysis reveals that they fall short of applying true systems theory principles. These three models primarily take a reductionist approach; through their elements, such as structure, strategy, and motivation, they break an organization down into low-level components without recognizing the complexity of these interdependencies at the organizational level. Their emphasis on elements results in an isolated focus instead of a holistic look at the organization, as systems theory requires, which leads to an incomplete understanding of the organization.

Additionally, these models do not account for nonlinear interactions and emergent properties that occur in complex systems like organizations; these models are static and fail to truly capture the dynamic nature of organizations. Their application reflects a component-based view rather than an actual systems theory perspective.

A more nuanced systems theoretic lens is needed to design and redesign organizations. The following section expands in much greater detail on Systems Theory and various systems-theoretic approaches for system analysis.

2.3 Systems Theory

Systems Theory has been developed in the last half-century to enable insight and analysis into increasingly complex systems. Specifically, it allows the understanding of systems that exhibit organized complexity, which is "too complex for complete analysis and too organized for statistics" [58], [59]. Complex systems can be natural, engineered, or social systems like an organization. Common examples include the following: the ecosystem of a river, the Lockheed Martin F-35 Lightning II Supersonic Stealth Strike Fighter, and the Federal Food and Drug Administration.

According to Gerald Weinberg, author of the seminal book *An Introduction into General Systems Thinking,* systems that exhibit organized complexity demand more holistic analysis techniques [58]. This need for holistic analysis stems from the idea that some system properties, such as safety, effectiveness, and efficiency, can only be fully understood by considering all aspects of the system. These properties emerge from how the different parts of the system interact; therefore, systems that exhibit organized complexity should be viewed and analyzed as a whole and not decomposed into separate parts for analysis [59], [60]. Systems Theory provides a framework for understanding complex systems, specifically focusing on a holistic understanding of the dynamic relationships that drive system-level properties.

The two main principles of Systems theory are as follows: 1) emergence and hierarchy and 2) communication and control [5]. Emergence and hierarchy as a principle

means that a system can be viewed in hierarchical levels, with each subsequent higher level exhibiting increasing complexity. The concept of emergence means that the behaviors and properties inherent to a single level of complexity within a system cannot be analyzed below that level of abstraction. Communication and control imply that any higher level within a system can apply controls to lower levels within the system. This concept of implementing control constraints on behavior at the lower level affects changes in that lower level's emergent behavior. These two principles apply to any technical or even purely social system. In addition to these two principles, several foundational concepts within Systems Theory exist. These are summarized below in Table 3.

Table 3: Systems Theory Concepts

Systems Theory Concepts	
Concept	**Explanation**
System	A set of components that act together as a whole to achieve some common goal, objective, or end [61].
Hierarchical Levels	These are the layers of organization within a system. The higher the level, the more complexity it exhibits.
Component	These are the elements that make up a system. In an engineered system, this could be the body of an aircraft, its electrical system, and its engine. In a social system like an organization, these could be an organization's individuals, groups, or departments.
Boundary	What separates a system from its environment [62]. A boundary can be physical, conceptual, or both.
Environment	Everything outside the system's boundary.
Open Systems	These systems interact with the environment and adapt to external changes to maintain equilibrium.
Inputs, Processes, Outputs	The flow of resources and information into a system which is then processed through some action and produces output such as results or products.
Feedback	A circular process into which the output of a system is fed back into a system, which allows the systems to adapt and respond to changes as necessary.
Holism	The idea is that the system must be studied as a whole, not decomposed and analyzed as separate parts.
Sources: [59], [62], [63]	

Systems Theory provides guiding principles for understanding and analyzing complex systems. Systems Theory and its emphasis on focusing on the system as a whole is a significant paradigm shift from other theories. As a theory, it enables analysis and synthesis holistically instead of component-by-component optimization. These foundational tenets can be applied to help with organizational design and analysis.

2.3.1 Systems Theory and Organizational Design

There is a significant body of knowledge surrounding the topic of organizational design, and there are plenty of frameworks offered to organizations underdoing design or redesign. Yet despite the myriad of information and processes available for organizations to leverage when they need to design or redesign themselves, "organizational design initiatives often fail to achieve their objectives because they trivialize the concept" [64]. Too often, the resources available and used by organizations offer a mechanistic and reductionist approach to understanding their organization and aiding in design efforts, resulting in organizational changes that focus more on organizational chart changes than real systematic improvements to the organization.

The organizational design and analysis field can benefit from the principles of Systems Theory. Organizations are social systems, and the principles underlying any complex system are in play for this specific kind of system. Systems Theory allows organizational designers to develop a deeper understanding of the complex interactions within and around an organization, leading to improved decision-making and long-term success. As noted by Fremont Kast, a former professor of Business Administration at the University of Washington, "Systems Theory seems to provide a relief from the limitations of more mechanistic approaches and a rationale for rejecting "principles" based on relatively "closed-systems" thinking" [63]. [63]. Organizations can use the principles of Systems Theory to help manage complexity, particularly during times of introspection and redesign. Systems Theory can be a lens through which an organization can more holistically and comprehensively organize and resource itself better to achieve its mission, vision, and goals.

According to Nancy Leveson, a leading systems theory expert at the Massachusetts Institute of Technology, "using a systems theoretic approach, organizations are understood as interrelated components that are kept in a state of dynamic equilibrium by feedback loops of information and control. The goal is to satisfy the organization goals while satisfying cost, safety, and other general organizational constraints" [65]. A systems theoretic approach to organizational design and analysis allows designers to focus on relationship dynamics within the organization's components (teams, departments, divisions, etc.) and the external environment. Furthermore, it enables organizational designers to identify and address the root causes of problems

rather than simply treating symptoms. This approach allows organizational design and analysis to move beyond superficial structural changes, such as updating organizational charts, to implementing purposeful, systemic changes.

Additionally, a Systems theory-inspired approach to organizational design and analysis would highlight the importance of feedback loops and their criticality in enabling an organization to achieve its goals. Feedback mechanisms allow organizations to adapt to change in their environment, ensuring alignment with the organization's aims. The ability to holistically analyze the entire organization as a system will enable leaders to make more informed decisions that account for the complexity inherent to their organization.

Within the literature, there are several examples of systems-theoretic approaches for analysis of engineered systems. While an organization is a social system, Systems Theory and its principles are applicable to natural, engineered and social systems. It is worth highlighting, one specific and popular systems-theoretic approach that is routinely applied to engineered systems which is the Systems-Theoretic Process Analysis (STPA) technique. Although this technique is intended for analysis of safety in engineered systems, there are many parallels that can be made and used in a systems-theoretic approach for organizational design. The following section provides a brief explanation of this technique.

2.3.1.1 Systems-Theoretic Process Analysis

STPA is an example of a systems-theoretic framework that can be applied to help solve real-world problems. STPA enables the analysis of engineered systems holistically, treating the safety engineering problem as a system-level control problem. While traditional frameworks for safety analysis focused on component reliability, STPA leverages Systems Theory to holistically analyze a system to examine the emergent property of safety. Just like STPA enables a system-level analysis for engineered systems, Systems Theory-inspired tools can enable organizational-level analyses focused on organizational effectiveness and efficiency, which this thesis explores in later chapters.

STPA is an analysis technique that relies on Systems Theory for its theoretical foundations and the principles of Systems-Theoretic Accident Model and Processes (STAMP) for its semantics. The *STPA Handbook* describes the STPA technique in four steps, as shown in Figure 5. Third, the analyst explores the concept of unsafe control within the hierarchical control structure from the second step. Finally, the last step of the analysis examines causal scenarios that result in unsafe control actions that lead to

system-level hazards that cause the losses that are most concerning to system stakeholders.

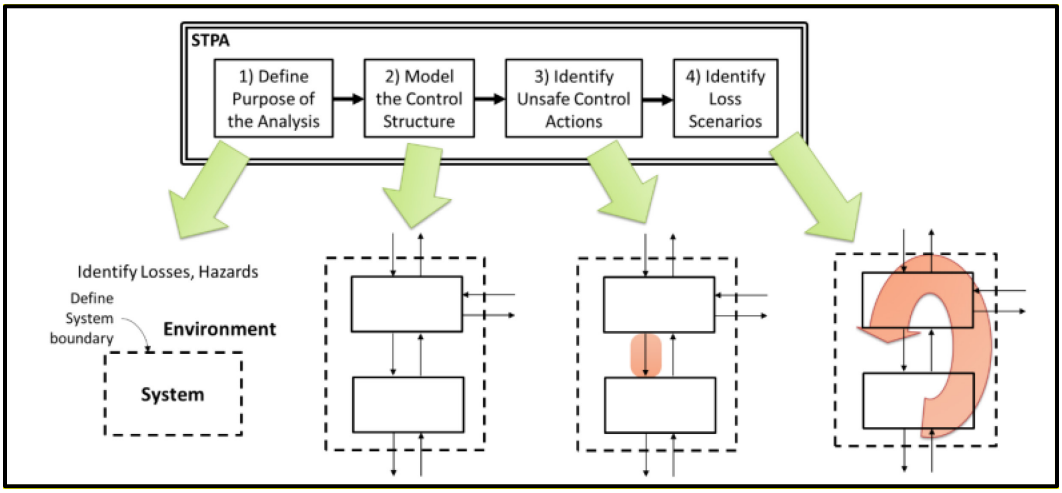


Figure 5: STPA Technique [66]

STAMP and STPA have been successfully extended previously to examine additional emergent properties like cybersecurity for engineered systems. STPA has also been extended to apply to specific genres of engineered systems. Finally, STAMP has been extended to model early concepts for complex systems. These extensions highlight the flexibility of systems-theoretic frameworks and methodologies to inform the analysis of complex systems, and this brief overview of these extensions foreshadows the applicability of Systems Theory for organizational design and analysis.

2.4 Summary

This literature review explored the foundations of organizational theory, showcasing how it has developed over time to address the growing complexities organizations face. From classical foundations emphasizing efficiency and structure to neoclassical and modern advancements incorporating human relations and systems thinking. Finally, it culminates in the current evolution of organizational theory, which is focused on postmodern perspectives. Although still relatively new, the postmodern movement is focused on reconciling ambiguity, complexity, and power dynamics within today's modern organizations. Together, these developments highlight the growth of organizational theory and how understanding organizations and their design is still an evolving field.

Additionally, three organizational design methods were explored. These methods were Galbraith's Star Model, McKinsey 7-S Model, and the Burke-Litwin Model. Although these models are helpful whenever an organization sets out to design or redesign itself, several limitations exist. These models all take a reductionist approach, breaking an organization into elements without fully addressing the dynamic interactions and emergent properties, such as effectiveness and efficiency, which are inherent to complex systems like today's organizations. Furthermore, these models are static, which limits their utility in rapidly changing environments. These limitations illustrate the necessity for a more nuanced, systems-theoretic approach to organizational design and analysis, one that addresses the dynamic nature and adaptability needed by modern organizations.

A systems-theoretic approach would offer a robust framework for organizational design and analysis because its foundation is rooted in Systems Theory. Systems Theory and its principles, such as emergence, hierarchy, and feedback loops, lay the groundwork for a holistic analysis of any complex system, including a social system like a modern-day organization. Notably, the technique STPA, which was initially developed for engineered systems, shows applicability as a framework from which to draw for applying systems-theoretic principles to organizational design and analysis. This exploration sets the stage for the next section, which investigates how a systems-theoretic approach can be used for organizational design and analysis.

Chapter 3: STPA for Organizational and Social Analysis

While most of the literature on STPA revolves around its usage and application to engineered systems, Leveson briefly touched on the use of STPA for organizations and social systems in the *STPA Handbook*, a guidebook for those wanting to apply STPA to a real-world system. The approach she outlined, which is examined below, was an initial example of how STPA could be adapted for organizational and social analysis. This chapter explores this initial demonstration of STPA to organizations and how STPA can be extended for organizational design and analysis.

3.1 Overview of STPA for Organizational and Social Analysis

Leveson's exploratory application of STPA for an organization (or social system) is a five-step process, reference Figure 6. This process focused on analyzing an organization and determining where improvements can be made for an organization to meet its goals. Specifically, she assessed a company's systems engineering effectiveness from the perspective of its ability to deliver products on time, on budget, and to the satisfaction of its customers.

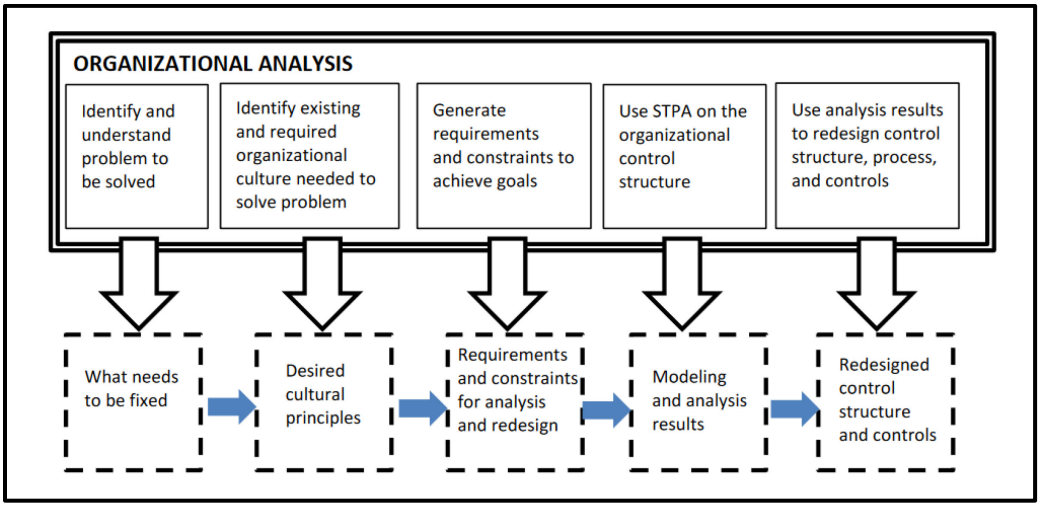


Figure 6: STPA for Organizational and Social Analysis Process [68].

Per Leveson, the outputs of this approach are:

1. The organizational problems that need to be solved (the goals of the analysis)
2. The organizational culture required to achieve the goals
3. Requirements and constraints for the organizational structure
4. STPA analysis of the organizational structure

The analysis results can be used to design or improve the organizational structure, identify risks and leading indicators of risks, and design or (redesign) the risk management process [66].

3.1.1 STPA for Organizational and Social Analysis

The first step, as outlined in Chapter 5 of the *STPA Handbook*, is problem identification and understanding. The handbook recommends conducting interviews with stakeholders and key personnel to capture a broad understanding of the problem(s) from different perspectives. These interviews also provide an opportunity to understand the organization's culture better.

Step two is focused on identifying existing and desired organizational cultural elements necessary to address the problem(s) determined in step one. This is important because effective change cannot be made in an organization without addressing its culture. Actual change cannot occur without the organization and, more importantly, its members embodying a culture that supports the change.

As noted, the identification of the desired culture occurs during the interviews. Leveson recommends asking interviewees "what cultural changes they think are needed in their organization?" [66]. Once identified, these elements can be synthesized with the concerns captured in the interviews and restated as cultural principles. Determining and ultimately integrating the cultural principles into the organization's design is important to alleviate the identified issues.

It is essential to highlight that this part of the process may seem straightforward, but it requires significant time and investment, especially when identifying the desired cultural principles. The desired principles cannot simply be a list; they must be socialized, and buy-in must occur amongst an organization's leadership team and members. Fundamentally, step two is about generating the crucial conversations that need to happen about where the current culture of an organization is, where it needs to go, and how it will get there.

Step three entails defining requirements and constraints to achieve the goals that will support the redesign of the organization. These requirements are created from the

problems identified in the interview process and the desired cultural principles the organization wants to adopt.

Step four involves modeling the organization's control structure. The primary goal of this step is "to identify where the identified requirements are currently implemented (if at all), or at least where responsibility is assigned for these activities, and to determine why the concerns identified in (step 1) are not already being adequately addressed and the requirements implemented" [66].

Once the organization's control structure is established, hazard analysis can occur. It is important to highlight that a control structure should not be confused with an organizational chart; a control structure describes the organization using control loops, controlled processes, hierarchy, authority, accountability, and responsibility. The modeling of the organization into a control structure can start with a high-level of abstraction and then be refined as needed for analysis.

It is helpful to use a hierarchical control structure model for this analysis; reference Figure 7 below for a basic control loop structure adapted for organizational purposes.

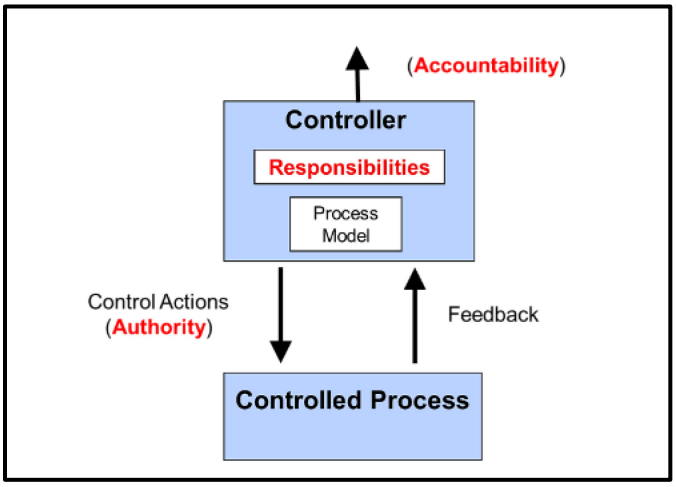


Figure 7: Basic Organizational Control Loop [66]

Each problem identified earlier should be examined through the control structure during this part of the process. This examination will allow managers to understand what changes may need to be made to the control structure. Typical issues identified during this part of the process include multiple people controlling the same process or having the same overlapping responsibility, lack of appropriate or independent oversight of decision-making, or missing feedback paths [66].

As Leveson noted, applying a complete STPA causal analysis on the control structure or, at a minimum, a specific portion of it may be helpful. This analysis technique can generate substantial information and potential causes as to why a particular goal is not being met; once this list of factors is created, it can be helpful to initiate a study to determine the operative cause and determine what changes are needed [66]. The strength of the STPA modeling technique on the organization's control structure is that it helps generate conversation without requiring a complicated process or model; it helps identify where issues may be resolved and reduce the likelihood of missing critical causal factors.

Finally, step five involves using the organizational control structure analysis to inform the organizational redesign, specifically regarding the organization's structure, processes, and controls. The information from step four's analysis is also recommended to establish a risk management program for the organization. In this context, a risk management program is centered on identifying organizational behaviors or leading indicators that indicate when an organization's product, services, or behavior are deviating from an organization's goals. A risk management program specific to an organization's behavior allows corrective action to be taken before any detrimental effects impact the organization's goals.

3.2 Assessment of STPA for Organizational and Social Analysis

Now that an exemplary approach to how STPA can be applied to organizational and social analysis has been outlined, the following section explores its strengths and limitations.

There are several strengths in Leveson's suggested approach to applying STPA to organizational and social analysis. The most obvious strength is its systematic approach to analyzing an organization. It considers problem identification, organizational culture, formal structure, and processes. Recognition of these factors is crucial for any organization undergoing design analysis through a systems-theoretic lens because, from this perspective of systems theory, practitioners can inquire about the function of culture and hierarchy together instead of neglecting one or the other as is found in other organizational theories and frameworks such as the ones analyzed in Chapter 2 of this work [67]. It is important to note that recognizing these factors does not constitute a decomposition of the social system, nor should they be treated independently.

Another strength of this approach is its emphasis on the value and importance of organizational stakeholders and key personnel. It recommends that members of the organization should be interviewed to gain a deeper understanding of the organization, the problem(s) needing to be solved, and the identification of factors contributing to these

issues. Member involvement and analysis of their perspectives are crucial to capture because they allow the organization's leadership to hone in on their organization and understand how it is functioning. While it may seem counterintuitive to "zoom-in" when taking a systems-level approach to organizational and social analysis, it is imperative for those making organizational changes to understand a variety of members' thoughts and perceptions because these insights can help leaders to proactively understand the organizational behavior and emergence which could result from their decisions. Considering stakeholders' perspectives at varied levels of responsibility within an organization, the organizational model can be refined to capture critical details while effectively applying abstraction.

A final strength of STPA for organizational and social analysis is its focus on identifying requirements and constraints. This approach focuses on considering the requirements and constraints for the analysis and the design as a whole. Typically, analytical constraints are seldom considered in applied organizational design frameworks. Leveson's approach is the opposite: constraints bound the analysis to consider only pertinent components of an organization. This is a parallel to the application of abstraction for engineered systems, a successful modeling and analytical technique that evaluates and presents only the most critical, pertinent information at the appropriate level of granularity to answer the questions the analysis is trying to answer.

While this initial example of how STPA could be used for organizational and social analysis has several key strengths and offers crucial insights into organizational issues, its effectiveness in the context of social and organizational science is hindered by its technical language. STPA was initially developed for systems safety analysis in engineered systems; its terminology and concepts are deeply rooted in Systems Theory and may be unfamiliar to those without a technical background. To fully leverage and benefit from the application of STPA in a social and organizational context, it would be essential to align STPA's technical language with organizational design, making it more relatable to social scientists, organizational leaders, and practitioners. Failure to reframe the terminology for social and organizational contexts could create a barrier to adopting the technique or, worse, lead to a misapplication of the technique, resulting in a failed organizational change or transformation.

The following section will identify how the Systems Theory concepts and terminology can be tailored to create a better understanding and seamless adoption of the method and how it can be extended for organizational design and analysis.

3.3 A Systems-Theoretic Approach to Organizational Design and Analysis

Leveson's initial demonstration of how STPA could be used in organizational and social systems has created a solid foundation for future use in this context. However, two key enhancements are needed for STPA to be effective and utilized for organizational design and analysis. Specifically, the STPA terminology should be aligned with the parlance of organizational theory and design. In addition, the STPA process should be extended for use in the context of organizational design and analysis to allow for practical application and adoption by organizational researchers, leaders, managers, and practitioners. The following two subsections explore how Systems Theory terminology and STPA concepts can be revised along with establishing a systems-theoretic approach to organizational design and analysis (STAODA).

3.3.1 Systems-Theoretic Process Analysis Terminology for Organizational Design and Analysis

The technical language of STPA can sometimes be a challenge for social scientists and non-technical individuals wanting to apply STPA to purely social systems. For this reason, different terminology is needed to perform such an analysis.

Using the principles of Systems Theory, the reference terminology for applying STPA to a purely social system can be considered through the lens of authority, accountability, and responsibility. While there are numerous definitions of these terms in the literature, the simplest means to understand them are:

- Authority means an individual or entity's power *to act*
- Accountability means an individual or entity's *answerability for actions and/or outcomes* [68]
- Responsibility is an individual or entity's obligation *to perform a task (or meet a goal) at an agreed upon standard* [68], [69]

Authority, accountability, and responsibility are crucial to the functionality and success of any organization, regardless of its size, type, or formal structure, because "central to all organizations is the concept of division of labor"[70]. These three elements define where and how tasks are assigned. They ultimately create a framework for decision-making to ensure alignment between organizational behavior and its goals.

STPA is a technique underpinned by the theoretical constructs of Systems Theory. It uses safety constraints, hierarchical control structures, and process models to guide system analysis. In this thesis, STPA for organizational design and analysis extends the

STPA technique to consider organizational effectiveness and efficiency as emergent properties only exhibited at the organizational level. This is akin to the whole being greater than the sum of its parts in Systems Theory. In a purely social system, the emergence of organizational effectiveness and efficiency could be modeled and analyzed using a vocabulary specific to organizations or organizational systems.

Utilizing the principles of Systems Theory, a constraint can be a condition, rule, or limitation that affects the behavior or performance of a system. A constraint is enforced by a controller inside of a system. This concept stems from the construct of emergence and hierarchy from Systems Theory. The idea of a system constraint applies to social systems and is a mechanism to control the system.

The next aspect of Systems Theory that applies to organizational systems that are purely social is the hierarchical control structure. Framing the problem of system-level emergence as a control-theoretic problem, the designer can model a system using a control structure. This control structure contains controllers, control loops, feedback, controlled processes, and a process model. A process model is a controller's understanding of the current operating state of a given controlled process. For a human operator, this process model can be described with a mental model.

Modeling a system as a whole using Systems Theory and its hierarchical control structure is critical to any analysis because it enables the systems thinker to consider the system-level emergent behavior using a control problem. At the same time, a systems-level analysis from the perspective of Systems Theory often uncovers the complex interactions within a system that ultimately drive emergent behavior. This holistic approach provides a deeper understanding of how the various components of a system and their interactions shape a system's behavior, allowing for a deeper understanding of the system and ultimately, developing more effective solutions.

Using the language of Systems Theory, a crucial foundation for STPA's application to organizational design and analysis, is the basic control structure depicted in Figure 7, which shows how the managerial elements of accountability, responsibility, and authority map to a control loop.

This basic organizational control loop shows the relationship between authority, accountability, and responsibility within a given system's control structure. It highlights the interconnectedness of these three roles in a control system and how they must all work together to manage the organization effectively. More specifically, the controller is responsible for managing the system and ensuring the controlled process operates as intended; effective management depends on them fulfilling their obligations by properly exercising authority and accountability. It is important to note that accountability flows upward from the controller to a higher-level entity, which indicates the controller's

obligation to explain its decisions and outcomes. Additionally, the controller issues a control action, otherwise known as authority, to a controlled process (or task). This allows for actions to be taken to achieve a desired outcome. The outcome is communicated through feedback to the controller. The creation of this loop enables the controller to respond as appropriate based on the feedback received.

These terms and the key components of Systems Theory are fundamental building blocks for analyzing social systems using STPA. Because a systems-theoretic lens provides the analyst with a comprehensive view of an organization, the analysis can consider the organization, its components, and the internal relationships beyond those just involved in its formal structure and organization chart.

To make STPA more accessible and applicable for organizational design and analysis, the following terminology is proposed in Table 4. Unlike STPA for engineered systems, this vernacular is focused on organizations as social systems and their emergent properties.

STPA Terminology for Organizational Design and Analysis	
Terminology	**Rationale**
Undesired Organizational Behavior – actions (or inaction) that prevents an organization from meeting its identified goals.	In line with Systems Theory, this emphasizes the importance of understanding the emergent behavior of the organization which arises from interactions within the system. It focuses on identifying the actions (or inactions) that could cause an organization to not meet its goals. Example: Inability to deliver capability/product
Undesired Organizational States – A system state or set of conditions that, together with specific internal or external factors, will significantly impact the organization and ultimately lead to undesired organizational behavior.	This terminology and definition highlight the emergent nature that can occur in an organization. In line with Systems Theory, this definition recognizes that these states result not from a singular cause but from complex interactions between the components and environment of an organization. Example: Incorrect priorities
Constraints – a organizational-level constraint specifies system conditions or behaviors that need to be satisfied to prevent undesired organizational behavior.	Constraints serve as a guide to shaping organizational behavior to ensure alignment with desired goals. Example: The organization must not exceed its operating budget for this fiscal year.
Organizational Control Structure – this is the part of the hierarchical control that models the organization's structure. It identifies formal relationships such as responsibility, authority, accountability, decision-making exercised within the organization, and any associated feedback loops.	Organizational control structures are essential because they model the systematic relationships of the organization [71]. The model enables a holistic analysis of the organization and helps ensure the organizational structure is structured to support the organization's goals. It is essential to highlight that an organizational control structure is *not* an organization chart.
Inadequate Control Action – a control action (decision, directive, mandate, etc.) that, in a particular organizational context and conditions, will lead to an undesired organizational state.	In the context of organizations, the most basic control structure depicts the standard management requirements of responsibility, authority, and accountability. The control action (authority) is implemented by the controller (management/leadership) on the appropriate entity, which executes a controlled process. Just like in engineered systems, organizations require the proper application of authority to control for emergence at the organizational level. Example: Not providing clear priorities, requirements, or sufficient resources
Causal Scenario – describes the causal factors that lead to inadequate control action(s) and undesired organizational states.	Identifying scenarios that could lead to undesired organizational states is critical because it helps organizational leaders and/or designers identify, understand, and mitigate the complex dynamics that can contribute to these conditions. This terminology emphasizes the need to analyze both the outcomes and actions that lead to those scenarios.

Table 4: STPA Terminology for Organizational Design and Analysis

This calibration of the language of Systems Theory closes the divide between Systems Theory and language traditionally used in organizational analysis. This alignment enables designers and analysts to treat and model organizational effectiveness and efficiency as emergent properties. Additionally, modeling the organization through a control-theoretic approach supports the application of STPA to social systems by strategically focusing on the hierarchical control structure and intricate relationships within an organization. This terminology allows the organizational design analyst to leverage Systems Theory as a practical tool as part of a forward-looking framework for organizational design and analysis.

3.3.2 Extending STPA for Organizational Design and Analysis

Now that the STPA terminology has been defined for use in organizational design and analysis, the process for applying STPA to an organization is outlined below. The goal of applying STPA to an organization is twofold; it is intended to aid in analyzing and selecting organizational designs whenever an organization is establishing its structure, processes, and controls or when an organization is developing new organizational design(s) due to reorganization or transformation.

The extension proposed in this approach is to use STPA for general emergent properties for a social organization. Following an analysis rooted in Systems Theory, the analyst can analyze a social system while treating organizational-level success, effectiveness, and efficiency as a control problem.

This section details this process, proposing a novel framework for a systems-theoretic approach to organizational design and analysis (STAODA) as an upfront tool for organizations to use when assessing and selecting organizational designs, agency composition, or reorganization options.

3.3.2.1 System Theoretic Approach to Organizational Design and Analysis

For STPA to be applied to a social system, specifically in the context of organizational design and analysis, the following framework is proposed and detailed below in Figure 8.

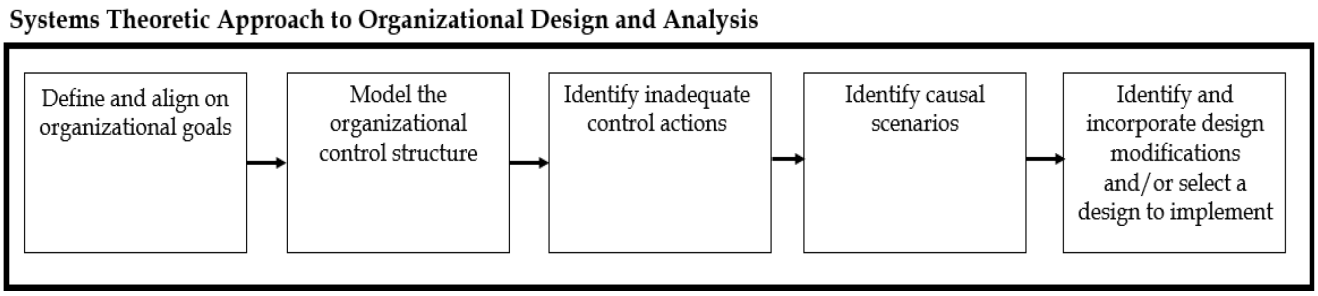


Figure 8: Systems Theoretic Approach to Organizational Design and Analysis

Figure 8 depicts a five-step process in a linear sequence; it is important to recognize that this approach will most likely not be executed linearly. Each step will likely inform and refine previous steps in the application, making it an inherently iterative process.

3.3.2.1.1 Step 1: Define and Align on Organizational Goals

The first step of the process, as shown in Figure 8, is to define and align on organizational goals. Fundamentally, this step focuses on identifying the organization's emergent properties that are of the highest interest to organizational leaders and stakeholders. Examples of emergent properties an organization may seek to improve are effectiveness and efficiency. The first step of this process requires organizational leaders to explicitly explore, identify, and enumerate the goals of the organizational design activity.

This first step is critical to any organization or system undergoing change because it sets the stage for the rest of the process. As noted by Russell Ackoff, a leader in systems thinking, "leaders that undertake to redesign their organizations, frequently encounter problems that are best described as "messes" – problems that are difficult to solve because of incomplete, contradictory, and/or changing requirements"(or goals) [70], [72]. Goal establishment, understanding, and synchronized mental models across the organization's stakeholders are critical because design decisions will be made on the common understanding of the problem(s) the organization is trying to address and goals they are trying to achieve. Clarification of the problem and goal establishment can have a profound impact on the success of the both the impending design process and future organization. As emphasized earlier in this work, effective organizational design directly impacts the success of an organization moving forward, and effective design decisions cannot be made without a proper understanding of the problem and shared goals of the key stakeholders in the organization.

Goal identification and understanding across key stakeholders is a step commonly missed in today's leading organizational design and analysis methods. If recognized, the due diligence around this particular step is typically scant on how to approach it. To help

clarify the goals and establish a clear understanding of them amongst organizational stakeholders, the following sub-steps should be followed:

1. Identify the organization and the organizational boundary under analysis.
2. Identify the undesired organizational behavior the organization seeks to prevent and/or address.
3. Identify undesired organizational states leading to undesired behavior.
4. Identify organizational constraints necessary to prevent undesired organizational behavior and achieve its goals.

The first sub-step is to define the organization and its associated boundary. In terms of the organizational design, this could be as simple as the entire organization or perhaps a specific segment. Concerning the boundary, a helpful way to establish this is to consider what parts of the organization the organizational leaders have some control over. It is essential to identify the organization and its boundaries to make clear what is being included and what is not. This step helps support the rest of the process, which focuses on identification of undesired organizational behavior and undesired organizational states.

The next sub-step is focused on identifying the undesired organizational behavior the organization seeks to prevent and/or address through its reorganization. Undesired behavior refers to the action (or inactions) the organization seeks to prevent (or address), in order to achieve its identified goals. In organizations or other social systems, undesired organizational behavior could be inefficiency/inefficacy, inability to deliver product/capability, or even complacency. Depending on the situation, multiple undesired organizational behaviors could be identified; in this case, they should be ranked and prioritized. To avoid confusion with the next step which is focused on identification of undesired organizational states, it is important to highlight the difference between behavior and state. Behavior are actions of a system over time, while state refers to the condition of system [73].

Once undesired organizational behaviors are identified, the next step is to define the undesired organizational states that may lead to these behaviors. An undesired organizational state is a system state or set of conditions that, together with specific internal or external factors, will significantly impact the organization and lead to undesired organizational behavior. Undesired organizational states arise from inadequate control over the behavior of the organization. This lack of control can stem from actions or inactions that ultimately are in conflict with the organization's goals and performance [74]. Examples of undesired organizational states in organizations include ineffective communication, incorrect priorities, institutional lethargy/inertia, lack of

accountability, inequality amongst departments, lack of trust, inappropriate divisions of labor and/or resources, high employee turnover, low morale, lack of resources, [74], [75], [76], [77]. Note that this list is not exhaustive; it does capture common undesired organizational states that can occur in any organization or social system.

Multiple undesired organizational states can be identified, and all states should be traced back to a particular undesired behavior. An undesired organizational state can contribute to more than one behavior. Ultimately, undesired organizational states are conditions that organizational leaders should want to prevent from occurring.

Finally, the constraints of the organization should be identified. Constraints are specific system conditions that need to be satisfied to prevent undesired organizational states and thus prevent undesired behavior. Constraint identification is important because they represent the goals for organizational controls. Just like for undesired organizational states, there should be traceability of the constraints identified back to the undesired organizational state(s) and undesired organizational behavior(s). Examples of generic constraints are: an organization must not exceed its operating budget for a given fiscal year, an organization must not exceed a particular size, and an organization must review and update priorities on a yearly basis.

3.3.2.1.2 Step 2: Model the Organizational Control Structure

The next step is to model the organizational design as an organizational control structure. An organizational control model depicts the hierarchical control structure of the organization and identifies explicitly formal relationships such as responsibility, authority, and accountability exercised within the organization, along with any associated feedback loops. As highlighted by Leveson, "an effective control structure will enforce constraints on the behavior of the overall system" [66]. This model captures the control loops and dynamic relationships within the organization and allows for a holistic analysis of the organization. It is worth highlighting that an organizational control structure is not equivalent to an organization chart; official reporting lines that are a cornerstone of an organization chart are not necessarily symbolic of an organization's actual working relationships and formal structure [70].

Modeling the organizational control structure provides an informative way to understand the organization and drive a more systematic discussion of the organization and the pending changes that will be implemented. Also, it offers another opportunity to synchronize mental models of organizational leadership and key stakeholders on how the organization functions; it is way too common for leaders and stakeholders to have very different ideas on how a given organization functions and gaining alignment on how the organization functions is critical for progressing through the rest of the process.

The development of the organizational control structure should be accomplished through the lens of the authority, accountability, and responsibility assigned to the various entities or roles within the varying levels of the organization. This lens is imperative because it ultimately showcases where and how decision-making occurs within an organization. Once the organizational control structure is established, it can be examined to determine if the assigned authority, accountability, and responsibility will address the problem and goals identified in Step 1 of this process. The power of the organizational control structure through the lens of authority, accountability, and responsibility is that it allows for discussion and analysis of how those three elements are applied in the context of a control loop to various organizational entities. Reference Section 3.3.1 and Figure 7 for more detailed information on modeling the organizational control structure through the basic management requirements of responsibility, authority, and accountability. If the analysis performed before an organization exists, then the necessary responsibilities, authority, and accountability will be identified in the design process and the alternative analyzed using STAODA.

It is recommended that abstraction is used during this step. This enables the modeler to focus on only the critical, most relevant information for a large organization. Abstraction is a tool to help manage complexity, and in this application, the analyst can address complex organizational challenges. STAODA performed on the high-level abstraction of an organizational control structure can be used to identify the requirements for more detailed levels of design that follow during the initial organizational design process.

3.3.2.1.3 Step 3: Identify Inadequate Control Actions

Once the organizational control structure is modeled, the next step is identifying inadequate control actions. As defined in Table 4, an inadequate control action (decision, directive, mandate, etc.) that, in a particular organizational context and condition, will lead to an undesired organizational state. Building off Step 2, the control actions are defined by the authority assigned by the controller, which could be the manager, leader, or organizational unit.

When identifying inadequate control actions, four types must be considered, although they may not all apply to a particular control action. The four types are:

1. Not providing the control action leads to an undesired organizational state
2. Providing the control action leads to an undesired organizational state
3. Incorrect Timing/order of the control action leads to an undesired organizational state

4. Stopping the control action too soon or applying it too long leads to an undesired organizational state

All the inadequate control actions identified should be traced to an undesired organizational state. This step is important because it uncovers weaknesses in the authority, accountability, responsibility, and decision-making capability assigned to different levels, entities, and roles of the organization. By addressing these issues, organizations can strengthen their control structure, processes, and controls to eliminate or mitigate the risk of undesired organizational behavior and enhance their effectiveness.

3.3.2.1.4 Step 4: Identify Causal Scenarios

The next step is identifying causal scenarios leading to undesired organizational states. As defined in Table 4, this step identifies the causal factors that can lead to inadequate control actions and undesired organizational states. During this portion of the analysis, the following primary questions can drive discussion and evaluation:

1. Why would an inadequate control action occur?
2. Why would control actions (authority) be improperly executed or not executed, leading to undesired organizational states?

The significance of this step is allowing leadership, managers, organizational consultants, and practitioners an opportunity to zoom in on the system and determine how undesired organizational states leads to undesired organizational behavior. This step enhances their understanding from a system level, bridges the gap between undesired organizational states and control actions, and can uncover issues with control actions on the organizational design.

3.3.2.1.5 Step 5: Identify and Incorporate Design Modifications and/or Design Selection

Given the information generated through Steps 1 – 4, organizational leaders and designers now have significant data about their organizational design(s). This step focuses on targeted improvements in the organizational design to address identified weaknesses and enhance the design's overall effectiveness. The information developed through Steps 1-4 allows them to make informed decisions about what happens next. Decision makers can use the information captured through the STPA analysis to modify the organizational design, as necessary, based on information from Steps 3 and 4, or they could choose to continue with the design as it is.

Depending on the situation, it is highly recommended that an organization contemplating a reorganization develop multiple organizational designs to be evaluated

through this process. This process would allow organizational leaders to consider various design options and give them a broader decision space to select the ideal design to address their issues. Finally, it is worth noting that no design is a complete solution to the organizational problem being addressed. The organizational design solution is simply a formulation of a way to address the issue the organization is trying to address and meet its stated goals.

Once a design is selected for implementation, it is highly recommended that organizational leaders develop a plan for implementing the organizational changes. Various frameworks and processes are available on how organizations can implement their organizational changes. A popular resource is John Kotter's, a leading expert on organizational change 8-Step Change Model.

This system-theoretic process for organizational design and analysis is top-down and enables the analyst to consider the entirety of the organization. Using holism and Systems Theory, the analysis can focus on the complex interactions among organizational elements that drive high-level organizational behaviors. Unlike other organizational design methods that employ a reductionist approach to optimize parts of the organization and do not offer a mechanism to assess potential designs, a systems-theoretic approach to organizational design and analysis (STAODA) enables both a holistic analysis and an opportunity to evaluate design alternatives for an organization.

Chapter 4: Application of a Systems-Theoretic Approach to Organizational Design and Analysis

This chapter steps the reader through an application of a Systems-Theoretic Approach to Organizational Design and Analysis on a representative case study. This chapter aims to demonstrate the application of STPA and its extension for organizational design and analysis on a real-world applied problem set.

This chapter presents two main sections: an introduction to the case study and the application of STAODA. As part of the case study, the author has chosen to evaluate the organizational changes inside the United States Air Force announced earlier in the calendar year 2024. These changes were announced by the Secretary of the Air Force, Frank Kendall, as part of an initiative to "Re-Optimize" the Air Force for Great Power Competition.

This case study was selected because it presents a large-scale effort to reorganize and transform a complex, sociotechnical organizational system; this initiative is focused on structural and capability realignment to address fragmented decision-making, optimize readiness, and improve integration across the enterprise. This case study offers an applicable opportunity to explore how STAODA can be applied in the design and reorganization of an existing organization and in identifying high-level organizational risks and control actions needed to manage the complex interdependencies that drive resultant emergent behaviors. Finally, this case study offers a timely and contemporary example of organizational transformation within a real-world context.

4.1 Background on the United States Air Force and its Reoptimization for Great Power Competition

Since the end of the Cold War in 1991 and that infamous day on September 11, 2001, the United States military has been structured and operating in a manner to meet the demands of a post-Cold War and post-9/11 environment, which has primarily been focused on counter-terrorism and counter-insurgency operations. These operations occurred in asymmetric operating environments where the USAF had significant strength, power, and competitive advantage over its enemies.

While the United States military services did not significantly withdraw their presence and focus from the Middle East until August 2021, a shift has occurred in the

world's geopolitical landscape for the last decade. The 2022 United States National Security Strategy notes that "the post-Cold War era is definitively over, and a competition is underway between the major powers to shape what comes next."; those major powers are the People's Republic of China (PRC or China) and the Russian Federation (Russia) [78], [79]. Per an August 2024 congressional report for the United States Congress, " the emergence over the past decade of intensified U.S. competition with the PRC and Russia—often referred to as great power competition (GPC) or strategic competition—has profoundly changed the conversation about U.S. defense issues"[79]. This shift from a post-Cold War era which experienced "reduced levels of overt political, ideological, and military competition among major states" has led the United States military services to begin a significant transformation in how they operate, organize, train, and equip their members to effectively deter challengers like China and Russia [79].

The direction to modernize the US military "so it is equipped for the era of strategic competition with major powers while maintaining the capability to disrupt the terrorist threat to the homeland" was formalized in the 2022 National Security Strategy[78]. All the services are undergoing significant change at this moment, the Department of the Air Force (DAF) has defined their effort as "Reoptimizing for Great Power Competition". It is worth noting that the Department of the Air Force oversees two military services: the United States Air Force (USAF) and the United States Space Force (USSF). While the reoptimization effort spans the entire DAF, this research will focus on the Air Force-specific portion of the plan.

This effort to reoptimize the DAF was initiated on September 5, 2023, when the Secretary of the United States Air Force, the Honorable Frank Kendall, released a memorandum stating it was time to "address the need for broader and more comprehensive change through the Department of the Air Force"; it was clear to him and his leadership team that the Air Force was "not optimized for great power competition"[80]. Secretary Kendall established a central planning effort and challenged its members to analyze and develop initial plans for reoptimization within five months; he wanted to announce the planned changes for the service by February 2024 at the Air Force Association Warfare Symposium and begin the implementation phase as soon as possible due to the urgency of the great power competition has created.

As planned, in February 2024, Secretary Kendall and other key leaders outlined the plan for reoptimizing the Air Force. This plan "unveiled sweeping plans for reshaping, refocusing, and reoptimizing the Air Force and Space Force to ensure continued supremacy in their respective domains while better posturing the services to deter, and if necessary, prevail in the era of Great Power Competition"[81].

The plan to reoptimize the service involves specific changes in four key areas and twenty-four key decisions; these will be explained in further detail in section 4.1.2. Figure 9 captures the four key areas for reoptimization below.



Figure 9: Reoptimizing for Great Power Competition [82].

From a high-level perspective, the goal of reoptimization is to "separate readiness and modernization functions, unify requirements development, streamline acquisitions and build deployable units—all with a focus on "integration"[83]. This effort fundamentally changes how the DAF, specifically the Air Force, is structured and operated.

4.1.1 Why Reoptimization and Why Now

As mentioned in the previous section, the Department of the Air Force is reoptimizing due to the Great Power Competition. Per the Frequently Asked Questions, for Reoptimizing for Great Power Competition, "the Department of the Air Force is facing a significant, dangerous shift in the strategic security environment," and it "must reoptimize to pivot from supporting post-9/11 conflicts and demands to deterring, if

necessary, winning, conflicts in an era of Great Power Competition"[84]. After almost two decades in the Middle East, the United States of America and its military services must evolve; the geopolitics of the world have changed along with the strategic security environment; if the Air Force does not adjust its priorities and strategies, it will not be able to deter or win conflicts in this new era effectively.

4.1.2 Key Areas and Objectives of Reoptimization

The Reoptimization for Great Power Competition revolves around four key areas: developing people, generating readiness, projecting power, and developing capabilities. Across these four areas are twenty-four objectives; sixteen objectives are tied explicitly to the Air Force, five pertain to the Space Force, and three are specific to the DAF [85]. Figure 10 and Figure 11 captures the four key areas and their respective objectives below.

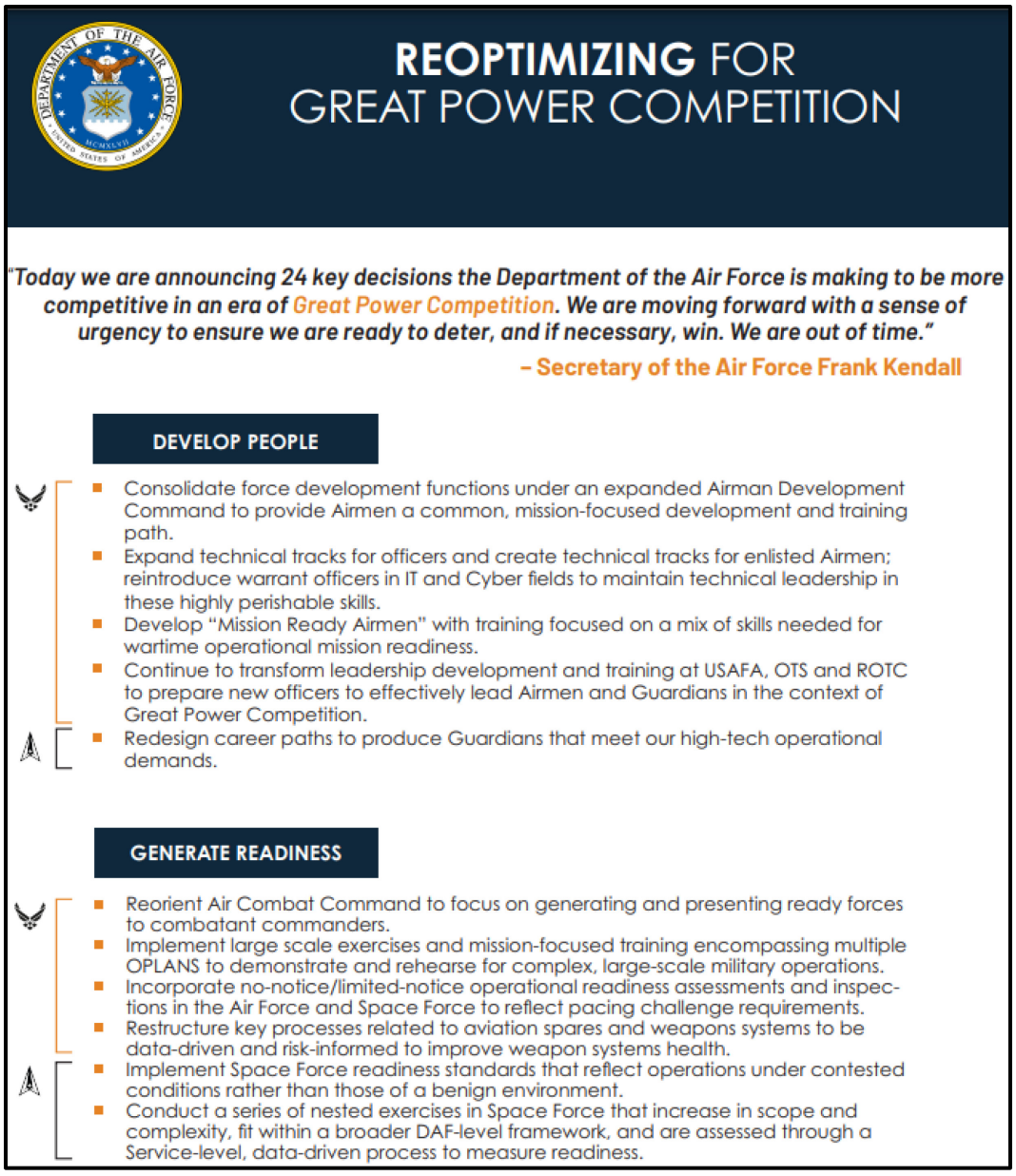


Figure 10: Reoptimization Key Areas and Objectives Part 1 [85].

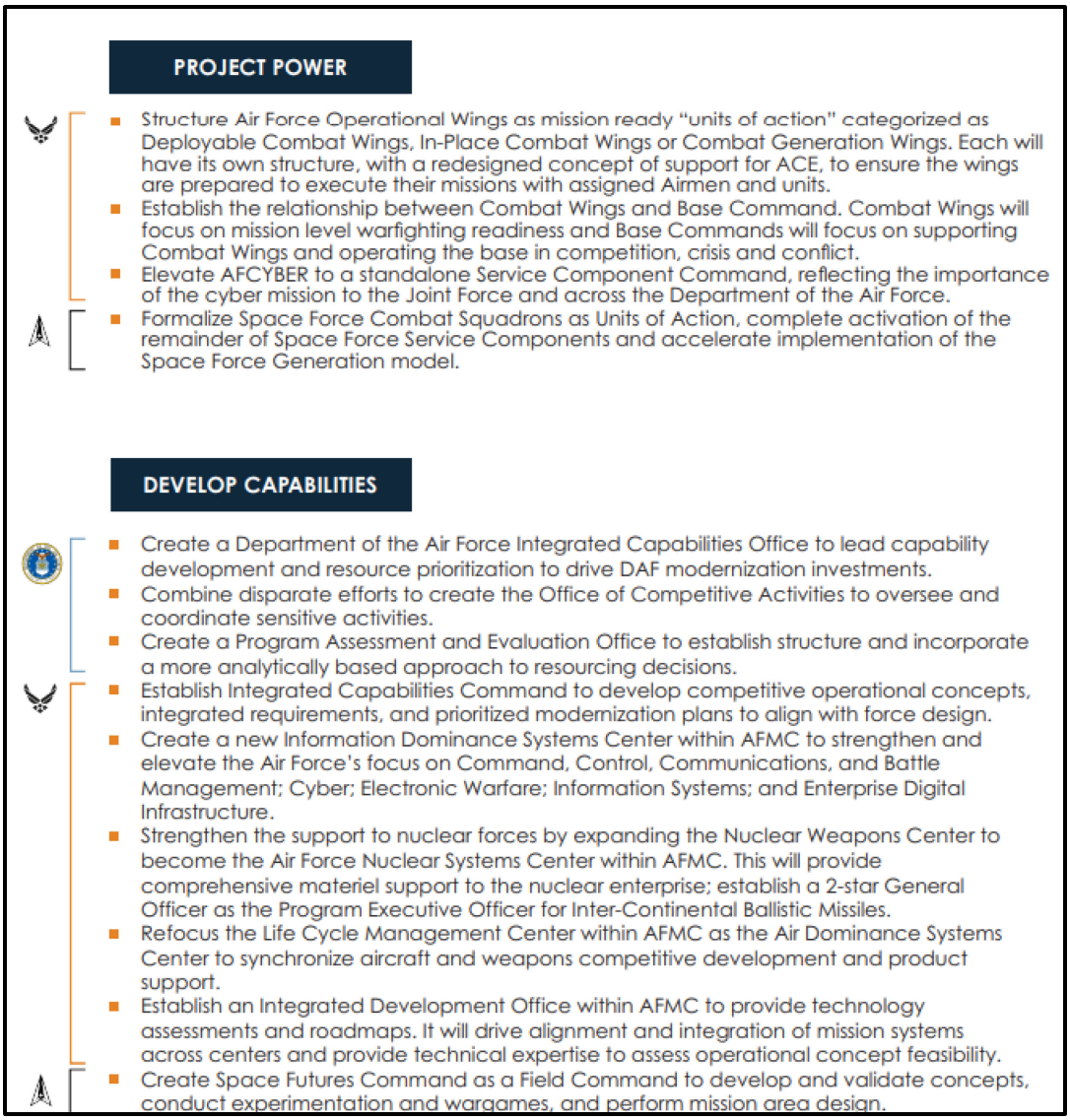


Figure 11: Reoptimization Key Areas and Objectives Part 2 [85].

Develop People is focused personnel and requires a "unified effort to attract, retain, and nurture the talent and specialized skills demanded by the emerging strategic landscape"[86]. This effort involves five objectives focused on overhauling personnel-related matters and ensuring that all Airmen (and Guardians) are optimized for the Great Power Competition.

Generate Readiness is an initiative focused on how the Air Force generates and prepares its fighting forces for conflict. It requires "realigning from functional readiness to mission readiness, prioritizing mission-focused assessments and inspections, and

enhancing mission support effectiveness"[86]. There are six key objectives for this, and it is assumed that these changes will ensure the Air Force is better postured for any conflict.

Project Power involves restructuring the Air Force's fighting forces, specifically its operational wings and commands. This portion of the effort will help ensure that the Air Force is postured to more effectively and efficiently support Combatant Commanders [86]. Four different objectives make up this focus area.

Develop Capabilities is by far the largest key area for change; it comprises nine different objectives spanning the DAF, USAF, and USSF, with the most objectives called out for the Air Force. Specifically, the Air Force aims to optimize its "capability development pipeline through an enterprise-wide integrated force design"[86]. This entails establishing a single authoritative entity focused on identifying and prioritizing future operational capabilities, drive cross-platform mission systems integration and capability development, establish focused acquisition Systems Centers for effective portfolio and life cycle management, and establish relevant Secretariat offices which inform Department of the Air Force senior leaders on enterprise decisions"[86]. More simply put, the Air Force needs to improve its ability to develop effective and timely technologies and capabilities for its fighting forces, and the envisioned end state involves several new offices at varying levels in the command structure to ensure the Air Force is making informed data-based decisions to inform their investments.

Without going into the granular detail of all twenty-four objectives, it is clear from this summary overview of the four key areas for change that this is not a simple reorganization of the DAF and its services; especially for the Air Force this reoptimization plan goes beyond basic organization structure changes and involves distinct changes to the structure, processes, decision making, and culture.

4.1.3 Implications Across the Department of the Air Force

With this background information in mind, these previous sections seek to convey the complexity of the Department of the Air Force as an organization and the shifting sands underneath it. Service-level organizations within the United States Department of Defense are immense and highly complex, and any departure from an accepted status quo, no matter how big or small, tends to introduce organizational tension.

The previous sections of this chapter served as a backdrop for the second half of this chapter, where systems-theoretic approach to organizational design and analysis technique is demonstrated in this case study and its associated organizational challenges. This reoptimization effort is a colossal undertaking, and this brief introduction to the problem space is not exhaustive.

Compared to how the Department of the Air Force has been organized for the previous 33 years, this transformation involves a slew of complicated changes: structural changes, personnel changes, process changes, and decision-making authorities. While these changes are explicitly mentioned in publicly available materials, DAF leadership is likely also attentive to another focus area for change: organizational culture.

Any organizational transformation or re-architecting effort of this size is doomed to fail unless its proponents have the desired end state in mind before any decisions or requirements are created. These 24 key decisions for Great Power Competition seem to be focused shifts in organizational roles and responsibilities in response to key symptoms of the problems with today's force structure, as opposed to new controllers in an otherwise complex system intended to help the organization better achieve the desired emergent properties.

For organizations that execute at this scale, change is never easy. Effecting a single change can take months or even years, let alone a series of decisions that affect both the interactions amongst teams of teams and the individuals who serve in the Department of the Air Force.

While this description of the case study might sound like these decisions and proposed changes are met by the author with a healthy dose of skepticism, the legislative branch of the U.S. government is also concerned with the direction of this reoptimization effort. The reoptimization plan calls out such momentous change that it has caught the attention of the United States Congress.

Since these announcements, Congress has requested special reporting from the Department's leadership at least 30 days before any organizational change is formalized. Not only is the DAF leadership pounding the pavement in full force to convince its workforce that this is the right thing to do to achieve capability for the warfighter and deterrence for the taxpayer, but they also are staring down the barrel of multiple Congressional inquiries.

Congress is demanding advanced reporting for the following key questions before any real action by the DAF :

1. How does the change differ from the status quo? [87]
2. How each phase of the change will be implemented and what each phase will cost? [87]
3. Any new "offices, commands, or centers" to be established? [87]
4. Any impacts to military and civilian positions, itemized by location? [87]
5. The programmatic impacts of such decisions [87]

Given the scope of the proposed organizational changes, the political pressures involved, and the complexity of the Department of the Air Force as an organization, this case study is a treasure trove of challenges with potential solutions for organizational design research, ripe with opportunities to advance the state of the art.

That being said, because of the limited scope of this thesis, the analysis presented in the second half of this chapter presents an analysis of the proposed reorganization design efforts affecting the development, deployment, and sustainment of warfighting capabilities through acquisitions channels inside of the U.S. Air Force; specifically, it will focus on the objective and decisions called out in the key area of Developing Capabilities, as seen in Figure 12 below. Even after paring down the scope to examine research questions related to USAF acquisitions, this case study on the Reoptimization for Great Power Competition is sufficient to demonstrate this thesis' contribution to the body of knowledge.

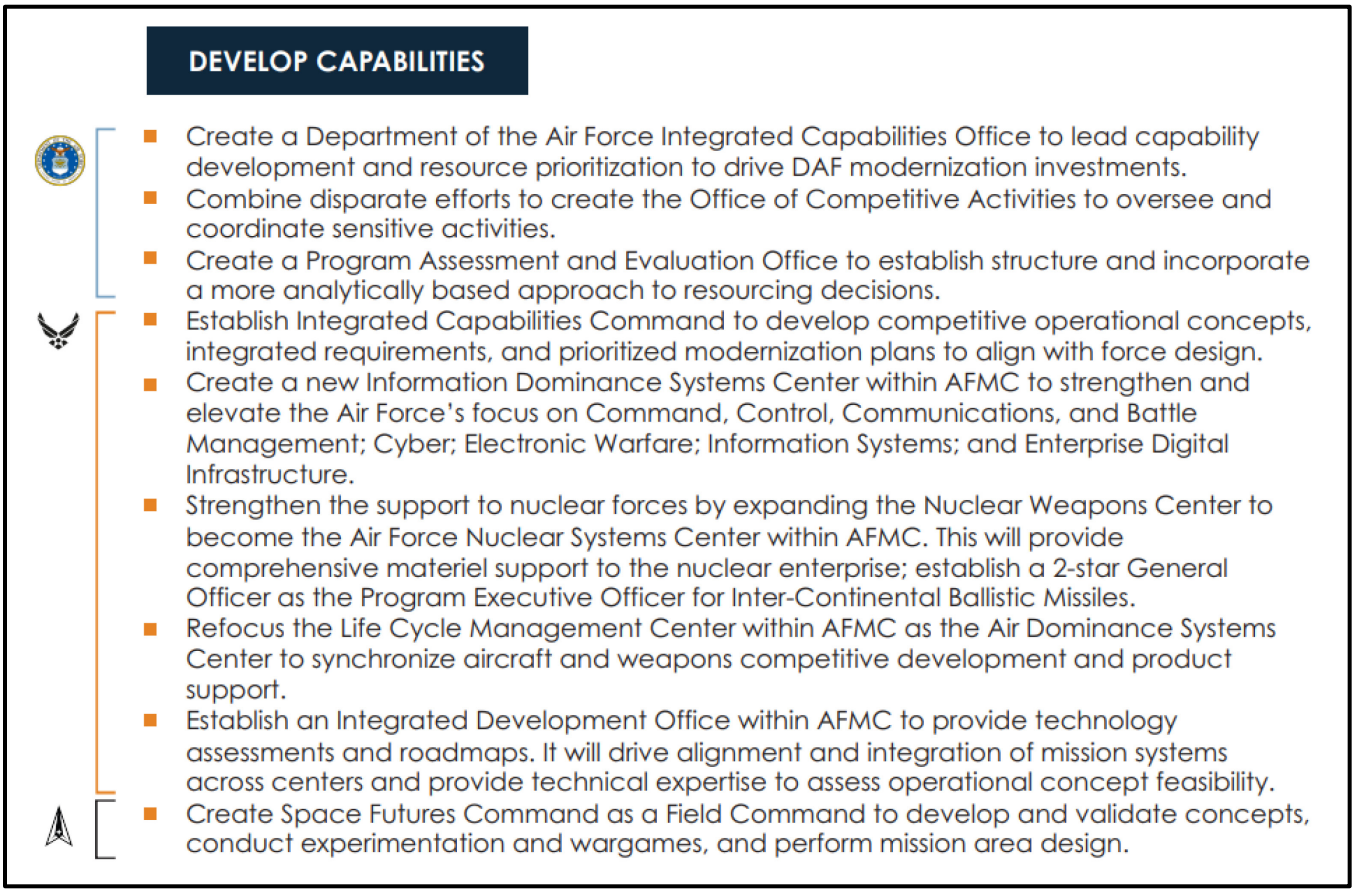


Figure 12: Developing Capabilities Key Decisions

4.2 STAODA in Practice: Reoptimizing for Great Power Competition

Over the last two years, the United States of America and its military services have been hard at work developing new strategies and priorities for the changing geopolitical and security landscape occurring throughout the world. Military services, like the United States Air Force, have feverishly been developing plans to revamp itself, specifically making significant changes to how it is organized, structured, manned, and prepared for conflict. The Air Force has coined this massive reorganization as its "Reoptimization," through this effort, it will be better prepared for future competition and the high-end fight.

The Air Force's Reoptimization Plan has been underway since September 2023, and this effort was accentuated in February 2024 with a high-level explanation of the planned changes the Air Force intends to make. While time is always of the essence, it is impressive, if not mind-boggling, that a massive bureaucratic and complex organization like the United States Air Force has managed to develop a plan, in approximately five months, to undergo one of the most significant reorganizations in its seventy-seven-year history. Since February 2024, various Air Force entities have been working to fill in the finer details of the plan and make portions of it a reality.

In pursuit of this reorganization effort, the Air Force went from a call to action to setting up new organizations with names like the Integrated Capabilities Command and the Integrated Capabilities Office in less than a year. These are only a few examples of the organizational changes the Air Force plans to implement. The speed at which these organizational changes are being made and enacted is striking, considering the sheer size and complexity of the Air Force. In the coming months and years, observing how these changes impact the greater Air Force organization and what emerges at an organizational level due to this reorganization will be interesting.

Given the complexity of the Air Force, lack of guidance on organizational design in Air Force Policy Directive (AFPD) 38-1, *Manpower and Organization*, and Air Force Instruction (AFI) 38-101, *Manpower and Organization*, and a reductionist approach to the Reoptimization Plan through diluting this reorganization into four key areas with twenty-four key decisions, it is safe to say that this massive reorganization would benefit from a systems-theoretic lens and analysis.

The following five subsections demonstrate how a systems-theoretic approach could benefit the Air Force's Reoptimization Plan. Specifically, it will focus on reoptimization design efforts affecting the development, deployment, and sustainment of warfighting capabilities through acquisition channels inside of the U.S. Air Force,

particularly the objectives and decisions in the key area of Developing Capabilities, as seen in Figure 12. This application of the systems-theoretic approach to organizational design and analysis (STAODA), as shown in Figure 8 and described in section 3.3.2.1, seeks to demonstrate the utility of the framework and a list of areas that reoptimization architects and designers should consider as they continue to refine and implement the design.

The data used in this application of STAODA will be generalized due to limited publicly available data and resources on the Air Force's Reoptimization Plan. This analysis is based on publicly available sources.

4.2.1 Step 1: Define and Align on Organizational Goals

The first step of STAODA is to define and align on organizational goals. During this step, the following information is identified:

- Identify the organization and its organizational boundaries under analysis
- Identify the undesired organizational behavior the organization seeks to prevent and/or address.
- Identify undesired organizational states leading to undesired behavior.
- Identify organizational constraints necessary to prevent undesired organizational behavior and achieve its goals.

4.2.1.1 Step 1.1: Organization and Organizational Boundary Identification

The entire Air Force is subject to the Reoptimization Plan, as depicted in Figure 13. The Department of the Air Force and its two services, the United States Air Force and the United States Space Force are all reoptimizing in some capacity.

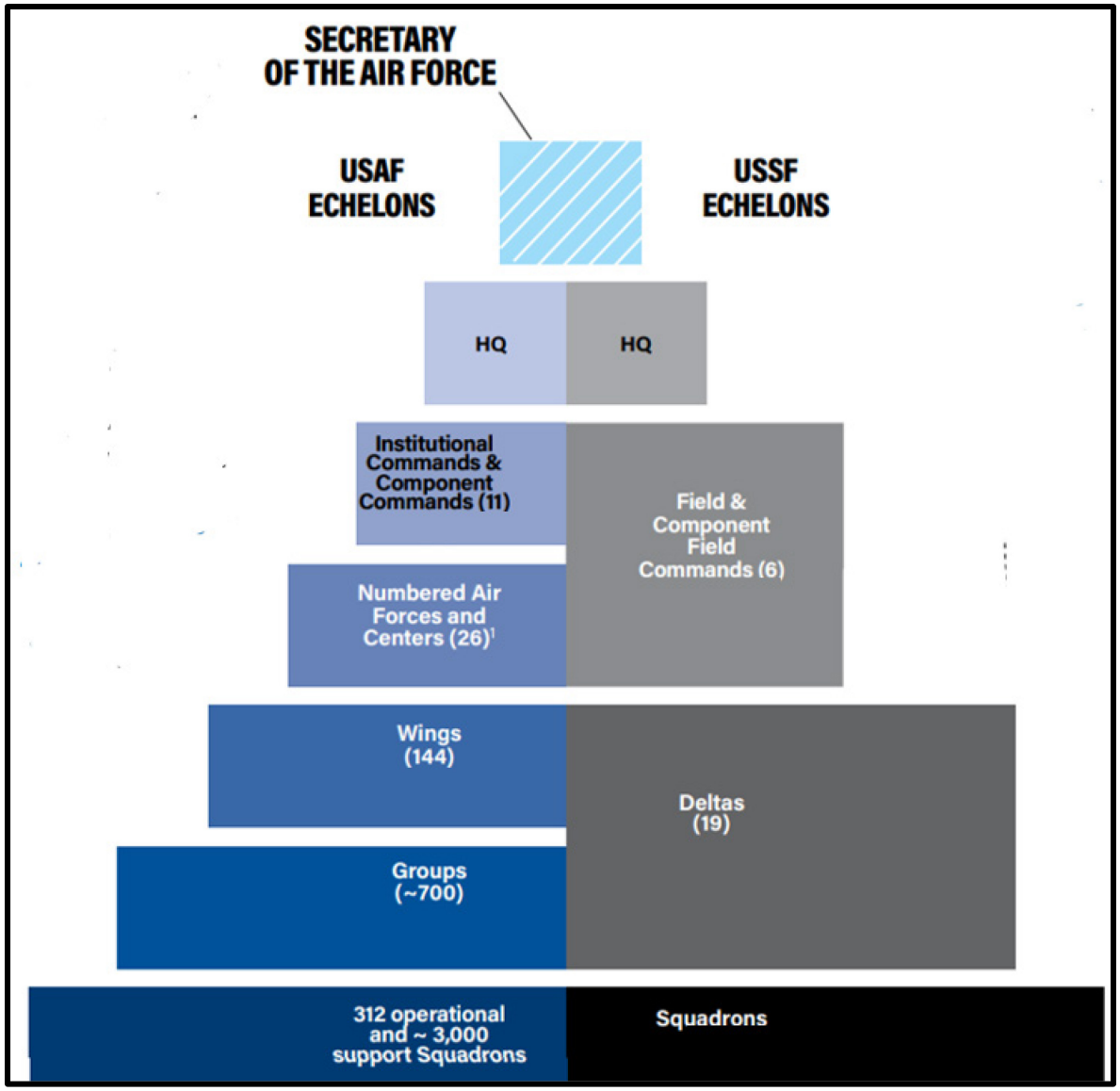


Figure 13: An Abstract Illustration of the Air Force [88].

A high-level organization chart that captures all the new offices, commands, and renamed organizations as a result of the Reoptimization Plan, specifically for the Air Force, is depicted in Figure 14. This organizational chart is current as of September 2024.

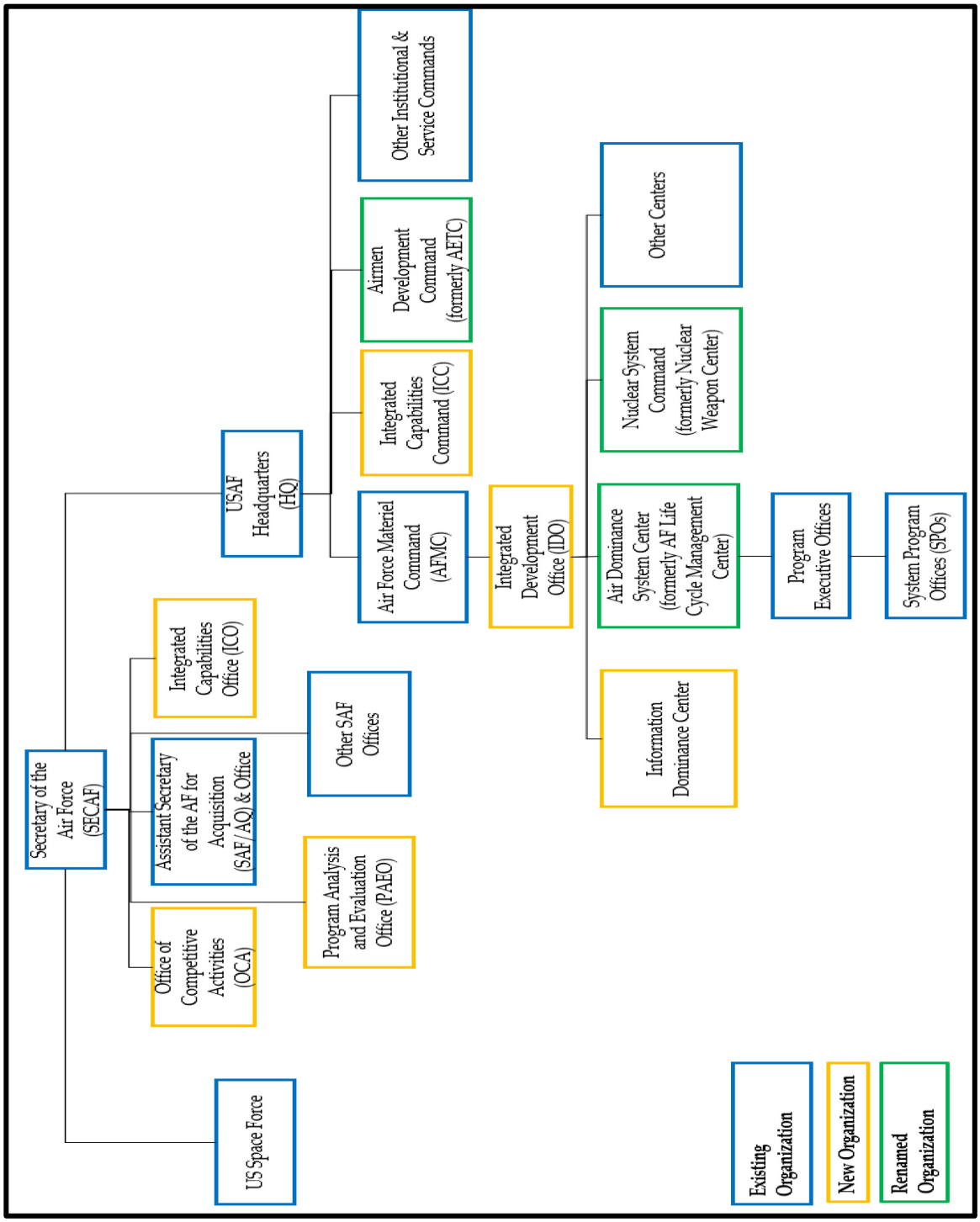


Figure 14: Air Force Reoptimization Organizational Chart

This analysis will specifically focus on the Air Force acquisition system as it pertains to the Air Force Materiel Command (AFMC), the newly established Integrated Capabilities Command, and other offices, as shown in Figure 15 below. This organizational chart captures the reoptimization changes to the Air Force acquisition system and its boundary under analysis.

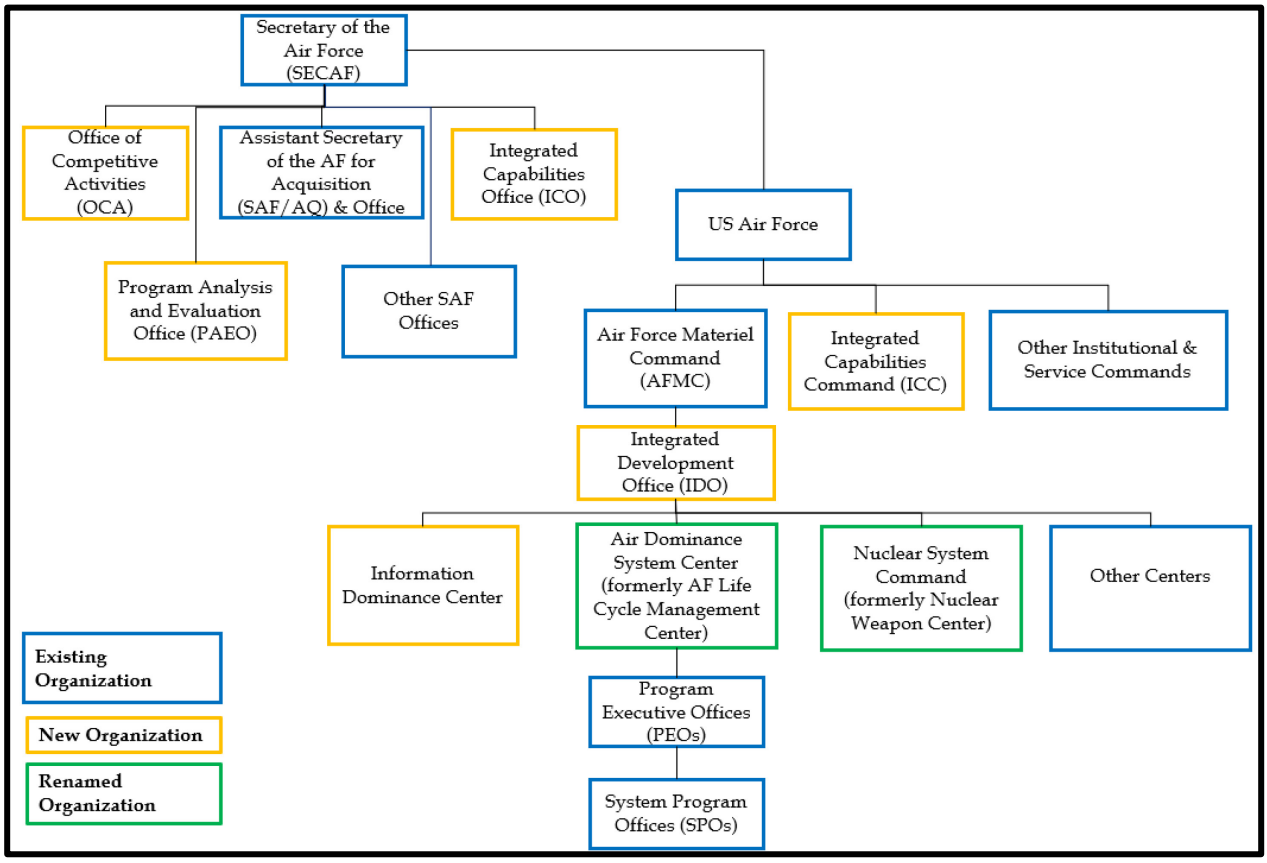


Figure 15: Air Force Acquisition System Organizational Chart

4.2.1.2 Step 1.2: Undesired Organizational Behavior

Identification of undesired organizational behavior (UOB) focuses on identifying behavior that would prevent the Air Force acquisition system from reaching its goals or even behavior the Air Force leadership seeks to prevent within the system. Given the purpose of the Air Force and its acquisition system, the following behaviors would be deemed unacceptable. In addition, these undesired organizational behaviors align with what the Air Force seeks to prevent through Reoptimization.

Table 5: Undesired Organizational Behavior

UOB ID	Undesired Organizational Behavior Description
UOB-1	Inefficacy/Ineffectiveness
UOB-2	Combat capability not delivered within cost, schedule, and performance requirements.
UOB-3	Strategic Policy Mismatch with National Objectives
UOB-4	Complacency

4.2.1.3 Step 1.3: Undesired Organizational States

As defined in Table 4, an undesired organizational state (UOS) is a system state or set of conditions that, together with specific internal or external factors, will significantly impact the organization and will lead to undesired organizational behavior. The undesired organizational states for the Air Force acquisition system are listed in Table 6. These states are listed in no particular order.

Table 6: Undesired Organizational States

UOS ID	Undesired Organizational State Description	UOB Link
UOS-1	Duplication of effort	UOB-1
UOS-2	Incorrect or ineffective priorities	UOB-1, UOB-3
UOS-3	Inadequate technology for operational/combat needs	UOB-2, UOB-3, UOB-4
UOS-4	Organizational misfit for technology development	UOB-3, UOB-4
UOS-5	Poor Talent Management	UOB-1, UOB-4
UOS-6	Procurement/Financial Mismatch	UOB-1, UOB-2, UOB-3, UOB-4
UOS-7	Institutional Inertia	UOB-1, UOB-4

4.2.1.4 Step 1.4: Organizational Constraints

Next, the organizational constraints are identified. These constraints are intended to help prevent undesired organizational states from occurring and thus prevent undesired organizational behavior. Ultimately, constraints are meant to help the

organization achieve its goals. The constraints the Air Force must take into account for this reorganization are provided below in Table 7.

Table 7: Organizational Constraints

Constraint ID	Organizational Constraint Description	UOS Link
C-1	In accordance with Headquarters Air Force Mission Directive 1-10, the Air Force acquisition system will manage resources effectively [89].	UOS-1, UOS-5, UOS-6
C-2	In accordance with Department of Defense Directive 5000.01, *The Defense Acquisition System,* the Air Force acquisition system will provide air, space, and cyber capabilities for combatant commanders [90].	UOS-2, UOS-3, UOS-4
C-3	In accordance with Headquarters Air Force Mission Directive 1-10, the Air Force acquisition system will provide research, development, modernization, and sustainment of air, space, and cyber capabilities [89].	UOS-1, UOS-2, UOS-3, UOS-4
C-4	In accordance with Department of Defense Instruction 5000.66, *Defense Acquisition Workforce, Training, Experience, and Career Development Program*, the Air Force acquisition system will provide training and administration to acquisition personnel [91].	UOS-5
C-5	The Air Force acquisition system will follow the manning and organization instructions as provided by AFPD 38-1, AFI 38-101, and AFI38-101_AFMCSUP as required .	UOS-4, UOS-5

Sub-steps 1-4 provide a solid foundation for which goals can be established. In this case, the overarching goals of the Reoptimization Plan for the acquisition system are and their associated undesired organizational behavior and undesired organizational states are as follows:

- Provide competitive capabilities for the warfighter in order to deter, and as necessary, win any conflicts that arise from the Great Power Competition. (UOB 2-4, UOS 3, 7)
- Develop, maintain, and sustain a competitive pipeline of weapon system programs (UOB 2-4, UOS 1-4)

- Consolidate roles, responsibilities, and acquisition focused work from current Major Commands into the Integrated Capabilities Command (UOB 1-3, UOS 1-3, 7).
- Develop a unified and skill Air Force acquisition workforce that can adapt, and respond to emerging global challenges. (UOB-4, UOS-5).

4.2.2 Step 2: Model the Organizational Control Structure

In the next step of STAODA, the organizational control structure is modeled. As discussed in Chapter 3, section 3.3.1, and Section 3.3.2.1.2, this is a hierarchical control structure of the organization and should be accomplished through the lens of accountability, authority, and responsibility. It can be helpful to start with the highest level of an organizational control structure and then develop more detailed ones as necessary. In this instance, a high-level yet basic control structure of the Air Force acquisition system is shown in Figure 16. This control structure is highly abstract and intended to provide only a basic overview of the Air Force acquisition organizational system.

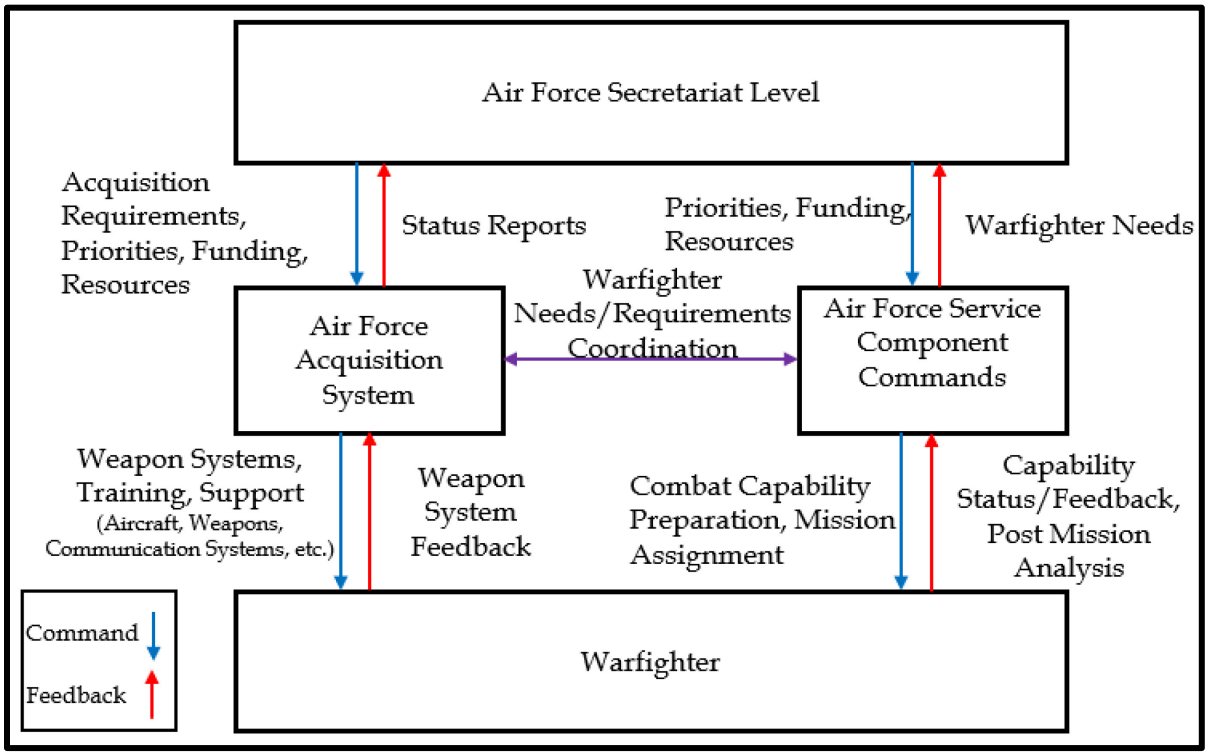


Figure 16: Basic Air Force Acquisition System Control Structure

While this control structure models a basic view of the Air Force acquisition system, it does highlight the complexity of the greater organization and managing the acquisition system in such a large organization like the Air Force. In addition, this model of the Air Force acquisition system through a control-theoretic lens is significantly different than Figure 15, which was the organizational chart of the Air Force acquisition system. The control structure in Figure 16 focuses on control and feedback between key components and their control relationships with each other; it effectively captures the basic control and feedback dynamics required to meet the warfighter's needs. The importance of the control structure is to showcase the control relationship between components, something that is not sufficiently captured in an organizational chart. While this control structure is helpful in understanding at the highest level how the acquisition organizational system works, it is not sufficient to continue the analysis since it does not capture the details required for the Develop Capabilities initiatives outlined in the Reoptimization Plan. A more detailed control structure is shown below in Figure 17.

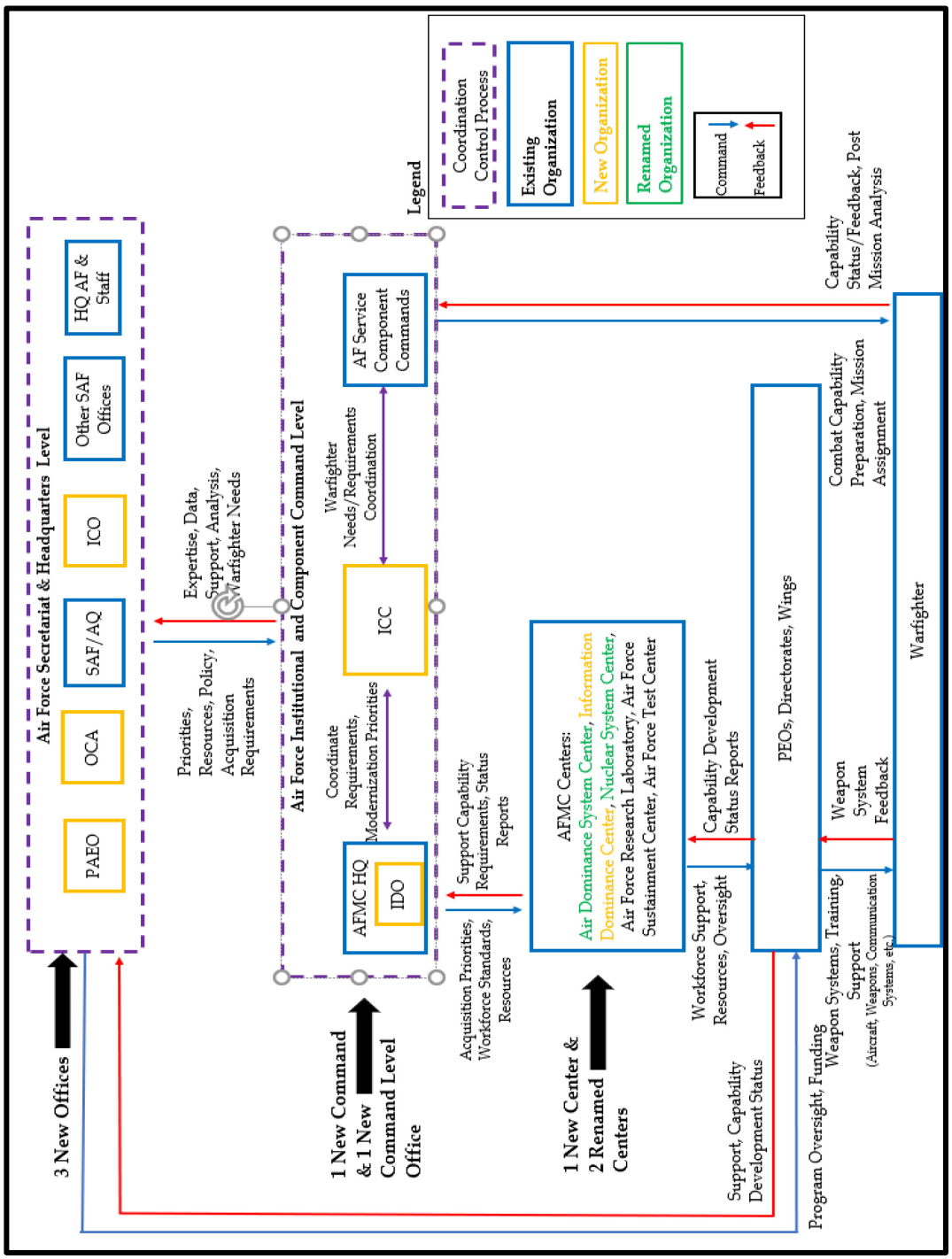


Figure 17: Detailed Air Force Acquisition System Organizational Control Structure [89], [92], [93], [94], [95]

This organizational control structure of the Air Force acquisition system highlights the hierarchical and functional interactions between its various components, providing insight into the complexity of the organization. The Reoptimization Plan establishes several new components in the overall organization which require greater horizontal and vertical coordination amongst the components. Additionally, at this time, there seem to be overlapping responsibilities amongst various elements and competing control loops, which can make prioritization and accomplishment of work difficult. Ultimately, the key point shown in this organizational structure is the intricate relationships and processes required to support the acquisition system.

4.2.3 Step 3: Identify Inadequate Control Actions

The next step is to identify inadequate control actions (ICA), which are control actions that, in a particular context and condition, will lead to undesired organizational states for the organization. For brevity, this analysis will focus on analyzing the control actions of the most impactful controllers in the acquisition system. While a real-world analysis using this technique style can delve into further depths for clarity and conciseness, this analysis will only provide the details about these control actions sufficiently to illustrate the technique. The analysis of the control actions is captured in Table 8. Each ICA is traceable to one or more of the undesired organizational states identified in Table 6.

Table 8: Identification of Inadequate Control Actions

Identify Inadequate Control Actions (ICA)					
Controller	**Control Action**	**Not Providing Causes Undesired Organizational State (Condition 1)**	**Providing Causes Undesired Organizational State (Condition 2)**	**Incorrect Timing/order of the control action (Condition 3)**	**The control action is stopped too soon, applied too long (Condition 4)**
AF Secretariat & HQ Level	Priorities, Resources, Policy, Acquisition Requirements	ICA-1: AF Secretariat & HQ Level does not provide priorities, resources, policy, and acquisition requirements to AF Institutional & Component Commands when institutional priorities need to be adjusted to support National Defense objectives [UOS-2, UOS-4, UOS-5]	ICA-2: AF Secretariat & HQ Level provides priorities, resources, policy, and acquisition requirements that do not align with the institutional budget for the fiscal year [UOS-6]	N/A	ICA-3: AF Secretariat & HQ Level maintains a list of priorities, resources, policies, and acquisition requirements for too long leading to misalignment with emergent National Defense objectives [UOS-2, UOS-3]
AFMC HQ & IDO	Acquisition Priorities, Workforce Standards, Resources	ICA-4: AFMC HQ & IDO do not provide acquisition priorities, workforce standards, and resources when institutional priorities have changed [UOS2, UOS-3, UOS-4 UOS-6,]	ICA-5: AFMC HQ & IDO provides acquisition priorities, workforce standards, and resources that do not align with National Defense objectives [UOS-2, UOS-3, UOS-4, UOS-5]	ICA-6: AFMC HQ & IDO provides acquisition priorities, workforce standards, and resources too late to support combat capability development for operational needs [UOS-3, UOS-6]	N/A
PEOs, Directorates, Wings	Weapon Systems, Training, Support	ICA-7: PEOs, Directorates, & Wings do not provide weapon systems, training, and support because the capability is not ready for deployment [UOS-2]	ICA-8: PEOs, Directorates, & Wings provide weapon systems, training, and support that do not align with actual warfighters needs [UOS-3]	ICA-9: PEOs, Directorates, & Wings provide weapon systems, training, support too late to address warfighter/operational needs [UOS-3]	ICA-10: PEOs, Directorates, & Wings provide weapon systems, training, support for too long, resulting in ineffective weapons systems for the warfighter to use [UOS-3]

Now that inadequate control actions have been identified, requirements can be derived to shape the controller's behavior and help it prevent undesired organizational states and, ultimately, undesired organizational behavior from occurring. The derived requirements for each controller are provided in Table 9, Table 10, and Table 11. It is recommended that derived requirements for each control action be developed. For conciseness, only prioritized control actions will be analyzed during this portion. The prioritization was based on control actions that are the most impactful to the acquisitional organizational system. Each ICA is linked to an undesired organizational state from Table 6.

Table 9: AF Secretariat & HQ Level Derived Requirements

AF Secretariat & HQ Level		
Control Action	**ICAs**	**Derived Requirements (Cond1-Cond5) are from Table 8**
Priorities	ICA-1: AF Secretariat & HQ Level does not provide priorities to AF Institutional & Component Commands when institutional priorities need to be adjusted to support National Defense objectives [UOS-2, UOS-4]	Con1: AF Secretariat & HQ Level shall ensure priorities are aligned with National Defense objectives and communicated appropriately
	ICA-2: AF Secretariat & HQ Level provides priorities to AF Institutional & Component Commands that do not align with the institutional budget for the fiscal year [UOS-6]	Cond2: AF Secretariat & HQ Level shall have a streamlined process to coordinate priorities with the AF budgeting office
	ICA-3: AF Secretariat & HQ Level maintains a list of priorities too long due to misalignment with emergent National Defense objectives [UOS-2, UOS-3]	Cond4: AF Secretariat & HQ Level must ensure there is a process in place to address emergent National Objectives and their impact on current Air Force priorities

Table 10: AFMC & IDO Derived Requirements

AFMC & IDO		
Control Action	**ICAs**	**Derived Requirements (Cond1-Cond5) are from Table 8**
Acquisition Priorities	ICA-4: AFMC HQ & IDO do not provide acquisition priorities when institutional priorities have changed [UOS-2, UOS-3, UOS-4 UOS-6,]	Cond1: AFMC & IDO shall ensure acquisition priorities are aligned with intuitional priorities
	ICA-5: AFMC HQ & IDO provides acquisition priorities that do not align with National Defense objectives [UOS-2, UOS-3, UOS-4]	Cond2: AFMC HQ & IDO must ensure there is a process in place to verify and validate acquisition priorities to ensure their alignment with National Defense objectives
	ICA-6: AFMC HQ & IDO provides acquisition priorities too late to support combat capability development for operational needs [UOS-3, UOS-6]	Cond3: AFMC HQ & IDO must ensure there is a process in place to coordinate and support combat capability development that aligns with operational needs

Table 11: PEOs, Directorates & Wings Derived Requirements

PEOs, Directorates, Wings		
Control Action	**ICAs**	**Derived Requirements (Cond1-Cond5) are from Table 8**
Weapon System	ICA-7: PEOs, Directorates, and Wings does not provide weapon system because the capability is not ready for deployment [UOS-2]	Cond1: PEOs, Directorates, and Wings must provide the status of weapon system development regularly.
	ICA-8: PEOs, Directorates, and Wings provide a weapon system that do not align with actual warfighters needs [UOS-3]	Cond2: PEOs, Directorates, and Wings must ensure there is a process in place to capture and understand warfighter needs
	ICA-9: PEOs, Directorates, and Wings provide weapon systems too late to address warfighter/operational needs [UOS-3]	Cond3: PEOs, Directorates, and Wings shall develop a process for urgent warfighter/operational needs development.
	ICA-10: PEOs, Directorates, and Wings provide weapon systems for too long, resulting in ineffective weapons systems for the warfighter to use [UOS-3]	Cond4: PEOs, Directorates, and Wings must ensure there is a process that prioritizes weapon system modernization

4.2.4 Step 4: Identify Causal Scenarios

This next step is focused on the development of causal scenarios. This step aims to identify and understand how inadequate control actions could arise and contribute to undesired organizational states. Drawing from the *STPA Handbook,* two questions that should be considered during causal scenario development are:

- Why would an inadequate control action occur?
- Why would control actions be improperly executed, not executed, or lead to an undesired organizational state?

The root causes of undesired organizational behavior can be identified through the development of these scenarios, along with the specific conditions or interactions with the organization that contribute to them. While working through the specific details of each causal scenario may seem obvious to some, the importance of taking the time to discuss and document causal scenarios is they point to flaws in the organizational design and provide actionable area for improvement in the design. Table 12, shown below, captures the causal scenarios for the Air Force acquisition system.

Table 12: Causal Scenarios

Causal Scenarios			
Causal ID#	**Causal Scenario**	**ICA Condition**	**UOS #**
Controller: AF Secretariat & HQ Level			
1	External and/or internal stakeholders insist on maintaining certain priorities, regardless of their relevance to current National Defense objectives.	ICA-1.Cond1	UOS-2, UOS-4
2	The AF Secretariat & HQ Level have too many support offices involved with coordinating priorities, resulting in schedule delays in updating the budget.	ICA-2.Cond2	UOS-6
3	External political considerations or internal bureaucratic delays make updating priorities challenging.	ICA-3.Cond4	UOS-2, UOS, 3
Controller: AFMC & IDO			
4	Competing priorities and responsibilities within AFMC HW & IDO result in delays in addressing intuitional priority changes and their impact on acquisition priorities.	ICA-4.Cond1	UOS-2, UOS-3, UOS-4, UOS-6
5	Conflicting directives from multiple higher-level authorities result in misaligned acquisition priorities.	ICA-5.Cond2	UOS-2, UOS-3, UOS-4
6	Lengthy bureaucratic coordination and approval processes within the acquisition system delay updating acquisition priorities in a timely manner.	ICA-6.Cond3	UOS-3, UOS-6
Controller: PEOs, Directorates, & Wings			
7	Weapon system requirements were poorly defined to the defense contractor resulting in several design changes and schedule delays.	ICA-7.Cond1	UOS-2
8	There is too much focus on introducing high-end, cutting-edge technology instead of focusing on the practical needs and requirements of the warfighter.	ICA-8.Cond2	UOS-3
9	Excessive bureaucracy in the acquisition process delays combat delivery to the warfighter.	ICA-9.Cond3	UOS-3
10	Air Force organizational culture resists developing and transitioning to newer systems, resulting in chronic reliance on outdated priorities.	ICA-10.Cond4	UOS-3

These scenarios describe the causal factors that can lead to inadequate control actions and undesired organizational states. The importance of this part of the process is to understand why a controller would act in a way that is not adequate. In large, complex

organizations, even if no one is purposefully trying to cause inefficiency or ineffectiveness, members (or offices) can make decisions that cause undesired organizational states.

It is evident from these causal scenarios that some of the reoptimization changes may induce emergent behavior that the Air Force would not want to occur such as ineffectiveness due to amount of additional levels of leadership and coordination needed amongst AFMC HQ & IDO and the other institutional and component commands, which results in a delay of acquisition priorities to the AFMC Centers, and PEOs, ultimately resulting in delayed weapon system delivery to the warfighter (Causal ID #6). While many of these new offices are intended to help change the way the Air Force does business, they also add more complexity to this large bureaucratic organization; is adding more complexity necessary if the goal is to *reoptimize* the Air Force? There is little debate that the Air Force acquisition organizational system would benefit from further improvements, but change for the sake of change is likely unhelpful.

Based on this initial analysis, these reoptimization changes will create overlapping responsibilities while assigning new responsibilities to organizational elements that struggle to meet today's requirements. Additionally, there is a clear emphasis on offices intended to integrate and coordinate, but the mechanisms to subvert or break down existing stovepipes have not been fully addressed in this reorganization. Ultimately, these changes may not result in the emergent behavior that the Air Force leadership had initially intended, particularly if the overarching goals were to enable a more effective, nimble, and efficient Department of the Air Force.

4.2.5 Step 5: Identify and Incorporate Design Modifications and/or Select a Design to Implement

The final step is focused on identifying and incorporating changes to the organizational design based on the information generated in Steps 1 -4. General design improvements that can be made include introducing new feedback loops, new control actions, altering control actions, or even revising the information a controller has to influence its process model. While it is recommended that organizational designers and leaders make the necessary changes based on the information that emerged through the analysis, they could choose to implement the organizational design as is despite the output of the analysis. While this is not advisable, it is ultimately up to organizational leaders to decide what to do next.

If the organization chooses to incorporate design modifications, it is highly encouraged to iterate and re-run the analysis on the updated organizational design.

While this may seem time-consuming, it can help the organization verify and validate that its updated design is what it wants to implement going forward.

In the context of the USAF Reoptimization Plan, the first four steps of this process inform the following recommendations:

Causal Scenarios 1, 4, and 8 deal explicitly with misalignment. Whether it is between priorities, authority, or coordination amongst organizational elements, a systemic source of inefficacy in this organizational structure is the misalignment of authority, accountability, and responsibility. These insights from the analysis tie directly back to the ICC, AFMC HQ, the SAF and HQ levels. Based on these insights, the Air Force should determine whether these elements have been appropriately aligned and whether overlap or redundancy can be eliminated.

Controllers within the control structure are overburdened with responsibilities. Even using abstraction, it is difficult to model and synthesize the responsibilities and bureaucracy required for organizational success. This systemic insight is related to many of the controllers in this control structure, and it was derived specifically from Causal Scenarios 2, 3, 4, 5, and 9. The Air Force should prioritize streamlining responsibilities in light of the inevitable bureaucracy required to implement them.

Air Force organizational elements have a hard time pursuing relevant priorities. This is indicated in Causal Scenarios 1, 5, and 7. A lack of prioritization indicates disagreement inside an organization surrounding the organization's actual goals. This analysis suggests that the Air Force should implement a clear and concise mechanism for communicating these priorities and feedback and accountability methods to ensure these priorities persist at lower echelons within the organization.

Several causal scenarios deal with the tactics, techniques, and procedures that must be successfully executed to produce combat capabilities for America's warfighters. These include Causal Scenarios 8 and 10. Managing defense contractors as part of the larger defense industrial base and targeting the appropriate development activities for new systems is a requirement in this business. The Air Force should immediately introduce authorities for lower-level controllers to pursue newer systems that align with today's priorities while guaranteeing practical acquisition efforts to meet the warfighter's needs.

The paradox of the Reoptimization Plan implies that the Air Force was previously optimized for some purpose. While no organizational design activity can promise optimal organizational behaviors and the desired emergence, a design solution that follows these recommendations grounded in Systems Theory is a step in the right direction.

Chapter 5: Conclusion

This research proposed a Systems-Theoretic Approach to Organizational Design and Analysis as a novel framework to address the complexities of organizational design. This framework leverages the principles of Systems Theory to address the complexity that modern organizations face when designing and reorganizing themselves. By integrating systems thinking, control theory, and practical organizational knowledge, this technique gives organizational designers, organizational leaders, and practitioners an actionable approach to navigating and managing the dynamic challenges modern organizations face today.

5.1 Contributions

The contributions of this thesis provide advanced organizational design and analysis through a systems-theoretic lens, providing novel insights and a practical framework to improve the organizational design process.

One significant contribution is the integrated Systems Theory with organizational design and analysis terminology, bridging the gap between the two fields. This integration makes Systems Theory and STPA more practical for organizational designers to leverage. The terminology proposed makes the parlance of Systems Theory more accessible and applicable for non-technical people, social scientist, and organizational leaders and managers.

Another key contribution is the development of a novel, systems-theoretic framework for organizational design and analysis. This framework extends STPA for use in general organizational design and social systems. The importance of this process to organizational design and analysis is that it promotes and enables a system-theoretic view of the organization. It encourages focus on the organization as a whole and considers how emergent behaviors can arise from organizational design concepts, something that is usually lacking in other organizational design and analysis models.

Finally, this thesis demonstrated the application of the Systems-Theoretic Approach to Organizational Design and Analysis in a real-world organization. Specifically, the framework was applied to the United States Air Force's Reoptimization Plan. Using this framework on the Reoptimization Plan showcases its utility in a large-scale, complex organization. It identifies areas of concern and reconsideration for the organizational design changes the Air Force plans to make in its acquisition system.

These contributions enhance the state of the art in organizational design and analysis while extending STPA to a new area of usage. Through this work, organizations now have a robust and comprehensive framework for designing, redesigning, and analyzing their organizations. This approach gives organizational leaders the tools to address the complex challenges organizations face when designing new structures, processes, and controls.

5.2 Limitations and Future Work

There are a few limitations of this work that should be addressed. The first limitation is the fact that this work generates hypotheses and does not include any validation of the STAODA methods across multiple organizations or industries. Another limitation is the use of a single-use case study that is limited to only the publicly available data on the Air Force's Reoptimization Plan. While there is a lot of information available through public resources, it would have been more informative to have specific information aside from generalized and abstracted information on the finer details of the plan. Finally, the proposed method does not provide any guidance on how to analyze coordination amongst the components in the organization.

In line with the limitations, future work includes applying STAODA to various organization types and industries. While application on a massive, complex, bureaucratic organization like the Air Force is practical, this type of organization lends itself to the analysis and a control theoretic view of the organization because it emphasizes a hierarchical structure and heavily uses authority, responsibility, and accountability. Future research should explore STAODA's applicability to other diverse organizational structures, such as a flat, decentralized organization. Applying STAODA to different organizational structures would further demonstrate its utility and versatility.

Another area for future work is enhancing STAODA to incorporate the work of Dr. Andrew Kopeikin, which is focused on assessing teaming or coordination between controllers. Kopeikin's work on STPA teaming is foundational for focusing on disparate teams working together within a traditional engineered system. Applying some of this to STAODA might benefit organizations that rely on and leverage high degrees of coordination between its components.

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