Architecting the Future U.S. Coast Guard Shore Infrastructure Logistics Enterprise

by

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Submitted to the System Design and Management Program
in partial fulfillment of the requirements for the degree of

Master of Science in Engineering and Management
at the
Massachusetts Institute of Technology

September 2016

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ABSTRACT

Just over a decade ago, the United States Coast Guard (USCG) initiated radical changes to its doctrine and business model for mission support. A series of "logistics centers" and "service centers" were established and were organized around four management cornerstones: Product Line Management, Configuration Management, Bi-level Maintenance, and Total Asset Visibility. For the organizational element responsible for logistics related to shore infrastructure (piers, runways, office buildings, etcetera), this meant transforming what were then called the "Maintenance and Logistics Command Shore Divisions" from a loose set of *regional project management* organizations to a *centrally managed asset management* organization known as the "Shore Infrastructure Logistics Center" (SILC). Now, seven years after this fundamental reorganization, several hurdles still obstruct the USCG shore infrastructure enterprise from fully achieving its strategic goals; there are also longstanding problems that the new enterprise structure has yet to overcome, as well as emerging challenges associated with higher standards, declining budgets, and environmental changes.

This thesis argues that the hurdles, persistent problems, and limited capabilities to handle emergent challenges are due to an incomplete and insufficient transformation effort, and that a systems approach to "architecting the enterprise" can position the SILC to most effectively manage the USCG shore infrastructure portfolio. To demonstrate the applicability and efficacy of a systems approach, this thesis applies the Architecting Innovative Enterprise Strategies (ARIES) Framework, developed by Nightingale and Rhodes. The seven step ARIES process reveals that the current "SILC 2.0" enterprise is a step in the right direction, but that a new enterprise architecture is required to align resources with levels of service so that the organization will be capable of affordably achieving strategic enterprise goals. Specifically, the process identifies key upstream transformation drivers, recommends a future enterprise architecture, and dictates an implementation approach that will most efficiently transform the enterprise. The findings not only illustrate the applicability and benefits of system architecting to the USCG shore infrastructure enterprise, but to the industries in which SILC operates.

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Acknowledgments

I would like to thank the U.S. Coast Guard for providing me numerous educational opportunities, culminating in this MIT SDM fellowship that is truly a great capstone to my formal professional development. Previous opportunities have enabled me to immediately apply what I have learned, and I look forward to bringing my newly acquired skills to the Coast Guard Acquisition Program. I have been fortunate to have many great mentors and shipmates throughout my Coast Guard career, and I hope their leadership and dedication are reflected in the level of analysis herein.

I would also like to express my sincere appreciation to the SDM staff and faculty, as well as my other professors and teaching assistants who all played a role in my understanding of the concepts and tools that enabled me to research and write this thesis. Most notably is my advisor, Dr. Donna Rhodes, who introduced me to a better way to transform an enterprise, and provided steady and prudent guidance throughout the process. I would also like to acknowledge Dr. Thomas Malone, Dr. Bruce Cameron, Dr. Oli de Weck, Dr. Bryan Moser and soon-to-be doctor John Helferich for so proficiently teaching me the skills specifically applicable to this project. The same thanks goes out to my fellow SDMers (and IDMers), past and present, who facilitated my comprehension and provided additional insights throughout the year.

This thesis would not have been nearly as accurate or robust without the voluntary assistance of the many subject matter experts who devoted their time to providing updates, discussing ideas, and reviewing my work. I hope this end product provides value in return for their very generous assistance.

Finally, I thank my family for their tremendous patience and support throughout this process. Though technically coming "back home" to New England, we did not get to visit with my dad and sister as much as initially expected. Most importantly, I express my sincerest appreciation to my wife, Clara, and my amazingly resilient children, Ana Lucia and Joe. I significantly "mis-underestimated" the demands and effects this program would have on us, and I will always be profoundly grateful for Clara's amazing foresight, clarity of thought, and plain hard work. It was her guiding hand and dedication that made this possible, and I learned more from her in this year than in all my years of formal education combined. Thank you Clara, Ana and Joe for your patience, understanding and unwavering love.

Table of Contents

List of Figures

List of Tables

Core Chapter Summaries

Chapter 1 – Introduction

Chapter 1 discusses the author's motivation for seeking a better way of managing the U.S. Coast Guard's (USCG's) shore asset portfolio, encompassing roughly forty-four thousand real property assets. It poses the thesis's central research question, "can system architecting be applied to an organizational element within a federal agency?", and discusses the associated sub-questions and factors by which to evaluate the answer to this question. It then introduces the "Architecting Innovative Enterprise Strategy" (ARIES) framework as the methodology for answering this question, citing that the outputs from system thinking techniques organized within the ARIES "process" will provide the evidence to support that answer.

Chapter 2 – Background

Chapter 2 discusses USCG and its organizational evolution over the past 20 years. It describes the Shore Infrastructure Logistics Center (SILC) and the current management framework (ISO 55000 – Asset Management) upon which the mission support business model for shore infrastructure (SI MSBM) is being modeled. arguing that the current architecture is insufficient to comply with the ISO 55000 asset management framework because the strategy and the organizational structure, among other architectural elements, are not aligned. It closes by outlining the system boundary conditions for the USCG shore infrastructure (SI) enterprise.

Chapter 3 - Literature Review and Research Methods

Chapter 3 reviews pertinent literature and provides a description of the research tactics used to generate this report. It outlines the key applicable theories and techniques from authors and researchers that built the underlying context for the application of "system architecting" to enterprises, and provides an interpretation of "architecting" an enterprise versus "designing" an organization. It ends by discussing how data was collected and analyzed to provide answers to the research question.

Chapter 4 – The ARIES Framework

This chapter provides an overview of the ARIES Framework. It discusses the ten elements of the framework, as well as the seven step process that is applied to the USCG shore infrastructure enterprise in Chapters 5 and 6. It also provides background information on several of the techniques used to assess the current SI enterprise architecture and develop concepts for future architectures.

Chapter 5 – The Problem Domain: ARIES Process Steps 1 – 3

Chapter 5 discusses the SILC's high level enterprise strategy and explores the problem definition phase of the ARIES Framework, applying the first three steps of the process: (1) Understand the Enterprise Landscape, (2) Perform Stakeholder Analysis and (3) Capture the Current Architecture. This chapter closes with a summary of the challenges the future architecture must address.

Chapter 6 – The Solution Domain: ARIES Steps 4 – 7

Chapter 6 transitions from the problem domain to the solution domain through ARIES Step 4, Create a Holistic Vision of the Future, and then develops that solution through the last three steps: (5) Generate Alternative Architectures, (6) Decide on the Future Architecture, and (7) Develop an Implementation Plan. This chapter provides SILC with a blueprint for building an Enterprise that is specifically suited to manage the complexity of the shore plant by expanding capabilities related to efficiency, resiliency, and sustainability through innovation, engaged leadership, and standard practices. Key features of this "blueprint" include an organizational structure that balances resources between asset management and project management based on prioritized functions, a focus on more flexible information technology, the adoption of a "looser hierarchy" for specific functions, and the pursuit of joint projects with DHS.

Chapter 7 – Conclusions and Framework Analysis

This chapter summarizes the answers to the research question and describes how system architecting and the techniques applied herein can contribute to the increased effectiveness of the SI enterprise, as well as to other organizations within the government/military or in real estate management. It discusses limitations of the thesis findings, contains recommendations for refinement to the ARIES Framework, and recommends potential future work to build off of this thesis.

List of Acronyms

Acronym	Definition
AC&I	Acquisition, Construction & Improvement
AFC	Allowance Fund Control
AIS	Asset Investment Strategy
ALM	Asset Line Manager
ARIES	Architecting Innovative Enterprise Strategy
BOD	Business Operations Division
C4IT	Command, Control, Communications, Computers and Information Technology
CASREP	Casualty Report
CCB	Configuration Control Board
CE	Civil Engineering
CEUs	Civil Engineering Units
CG-1	USCG Human Resource Directorate
CG-2	USCG Intelligence and Criminal Investigations Directorate
CG-4	USCG Engineering and Logistics Directorate
CG-43	USCG Office of Civil Engineering
CG-46	USCG Office of Energy Management
CG-47	USCG Office of Environmental Management
CG-6	USCG Assistant Commandant for C4IT
CG-7	USCG Assistant Commandant for Capability
CG-8	USCG Assistant Commandant for Resources
CG-9	USCG Assistant Commandant for Acquisition
COMDT	USCG Commandant
CONOPS	Concept of Operations
CSTO	Configuration Standards Technical Order
DCMS	Deputy Commandant for Mission Support
DCO	Deputy Commandant for Operations
DLM	Depot-Level Maintenance
EC&R	Environmental Compliance & Restoration
ECIP	Enterprise Common Ideation Platform (*used for internal USCG crowdsourcing*)
ECP	Engineering Change Proposal
E_o	Operational Effectiveness
ESD	Engineering Services Division

ETA	Engineering Technical Authority
FAM	Facility Asset Manager
FD&CC	Facilities Design and Construction Center
FE	Facility Engineer
FMB	Facilities Management Branch
FRMM	Financial Resource Management Manual
HCA	Head of Contract Activity (Also CG-91)
IT	Information Technology
KPI	Key Performance Indicator
MER	Marine Environmental Response
MIT	Massachusetts Institute of Technology
MLC	Maintenance and Logistics Command
MSBM	Mission Support Business Model
O&M	Operations & Maintenance
OE	Operating Expenses
OLM	Operational-Level Maintenance
OLO	Organizational-level Operations
PGTO	Process Guide Technical Order
PLM	Product Line Manager
POP	Planned Obligation Prioritization
RDTO	Requirements Directives Technical Order
SAM	Shore Asset Management
SDM	System Design and Management
SFRL	Shore Facilities Requirements List
SI	Shore Infrastructure
SILC	Shore Infrastructure Logistics Center
SI-MSBM	Shore Infrastructure Mission Support Business Model
SME	Subject Matter Expert
SOP	Standard Operating Procedure
TA	Technical Authority
TAV	Total Asset Visibility
TCTO	Time Critical Technical Order
TD	Technical Director
TRACEN	Training Center

Chapter 1 – Introduction

In 2009, the organizational entity responsible for the maintenance and management of all U.S. Coast Guard (USCG) shore Infrastructure[1], generally known as the USCG's Civil Engineering (CE) Program, radically transformed its organizational structure from one focused on regional project-management to one driven by enterprise-wide asset management. This shift was part of a larger organizational transformation that sought to standardize the delivery of logistics services throughout the Coast Guard applying what was called the "Four Cornerstones of Mission Support" of the "USCG Mission Support Business Model" (MSBM). This transformation is discussed in more detail in *Chapter 2 – Background*, and at least on paper, it was intended to fundamentally change the CE Program's approach to managing shore infrastructure. In reality, however, the transformation initially faced significant resistance within the CE Program, and the second iteration of the organizational structure was initiated before the first was fully implemented due to resource allocation and the idiosyncrasies of real property management.

The transformation focused on changes to the "field support" component of the CE Program, which came to be known as the Shore Infrastructure Logistics Center (SILC). But it made only minor changes to SILC's primary "policy and oversight" component at USCG Headquarters (HQ), known as CG-43. This resulted in an organizational misalignment between the new SILC organization and its relatively unchanged hierarchical superior, CG-43. Though seemingly insignificant, this misalignment led to redundancies, gaps, and misunderstandings that contributed both to the almost immediate internal rejection of the SILC 1.0 construct and to the slow adoption of the SILC 2.0 construct.

Though only tangentially impacted by SILC 1.0 as the Chief of Facility Engineering at the USCG Base in Portsmouth VA, I became fully immersed in the implementation of SILC 2.0 after being assigned as the SILC's Chief of Business Operations in the summer of 2011. Amongst a myriad of other responsibilities, I became the de facto lead for SILC 2.0 implementation and spent the next four years working to implement and acculturate a SILC 2.0 construct that was, at best, 35% designed and documented when I began. While the concept of "design-build" is common in the construction industry, it does not have the same advantages in organizational reconstruction because the complexities extend beyond just the technical to the social, cultural, and financial realms. A more apt analogy would be that of building an airplane while flying. I knew there had to be a better way.

[1] Examples of USCG shore facilities include piers, airfields, towers, office buildings, hangars, recreation and training facilities, barracks, family housing, and industrial facilities. SILC manages over 44K real property assets

1.1 Motivation

Despite significant progress in actually transforming the SILC into an asset-focused organization during my four-year tour of duty, there was still speculation, especially at higher levels, about a "SILC 3.0" to be implemented sometime by 2020. When I departed SILC for an educational opportunity at the Massachusetts Institute of Technology (MIT) in the summer of 2015, I too was frustrated that our results were "good", but not "great", and I wondered what a SILC 3.0 could look like and why USCG should go through yet another disruptive organizational change.

In addition to substantive issues in maintaining a complex portfolio of shore infrastructure, such as maintaining aging infrastructure in harsh coastal environments to support missions where human life is at stake, I noted the SILC faced perception challenges that limited its ability to compete for funding. Although "every mission begins and ends at a Coast Guard shore facility", [1] senior leadership appeared to view shore infrastructure as overhead and not as a mission enabler. This is not uncommon, as the National Resource Council noted that managers in both the public and private sectors tend to tacitly assume that facility maintenance cannot yield positive paybacks and can be delayed in favor of other initiatives. [2] The MSBM, particularly the cornerstone of total asset visibility (TAV), showed promise for helping the CE Program better articulate shore needs in terms of mission impact and long term cost effectiveness, but to date there has not been an appreciable change in perception. I wondered if a different organizational structure and strategy could allow the CE Program to make a better case.

Upon commencing MIT's System Design and Management (SDM) Program, and after taking time to reflect on my experience, I soon noted a number of things that I could have done better during the planning and implementation phases of SILC 2.0. More importantly, I began to acknowledge that the "enterprise asset management" approach that was central to SILC 2.0 was a step in the right direction, but would never be enough to overcome the persistent problems related to chronic under-funding of the USCG shore plant, nor would it enable the CE Program to overcome the emergent challenges associated with sea-level rise, increasingly complex building systems, and significantly higher accountability standards for real and personal property. I reached this conclusion upon realizing that the five-year "Strategic Plan" [3] I helped develop required activities and initiatives beyond the capabilities of the current organizational structure. In other words, there was a disconnect between most SILC goals and the SILC organization. This will be further discussed in Chapter 5 – ARIES Problem Domain.

I began to recognize that the "built environment", an industry term of art encompassing all buildings and structures, was a complex socio-technical system. I use the term "complex" based on the generally accepted system definition in that is "involves a large number of interacting elements, the interactions are non-linear and dynamic, the whole is greater than the sum of the parts, and the system elements evolve with one another." [4] The *management* of the built environment, especially within a government agency, was an even more complex socio-technical-economic system.

Given that the CE Program manages this complex "system of systems," it became apparent that in applying an asset-based approach, the CE Program was effectively attempting to fit a square peg in around hole. That is, a systems approach would more appropriately account for the social, political, and economic aspects of the shore infrastructure ecosystem. Indeed, my USCG predecessor in the SDM Program, Captain Chad Jacoby, explored how a systems approach may be applied to cutter maintenance, [5] and there are direct correlations to the maintenance of shore infrastructure.

A problem I encountered as a civil engineering project manager earlier in my career illustrated how a purely asset-focused approach could be insufficient. In the mid 2000s, the USCG acquired a highly capable class of surf boats that were slightly taller than the class of boats they replaced. While the upgrade was entirely defensible under an asset-based approach, it failed to account for the fact that the new boat could not fit through the doors of many boat maintenance facilities. Although the issue seems minor on its face, it ultimately required USCG to divert a portion of the limited shore maintenance funding to enlarge the door openings so that the new boats could undergo routine maintenance.

Fortunately, USCG has already taken an increasingly systems-thinking approach to acquisitions, and a civil engineering billet was created within the Acquisition Directorate (CG-9) to help ensure that shore infrastructure-related changes are identified and funded as part of acquisition deployment. In addition, many career civil engineers have been assigned to CG-9 programs, and the virtue of their experience has further ensured that shore-related costs and concerns are factored into the acquisition process for boats, cutters, aircraft, and communications systems.

However, while the CE billet was a deliberate architectural change to the CG-9 enterprise, the assignment of multiple civil engineers to CG-9 was likely due more to a need for proven project management experience than it was a calculated strategic initiative. In systems-thinking vernacular, the unexpected positive impacts to shore infrastructure resulting from the assignment of civil engineers to CG-9 is known as "emergence". Rather than simply reaping the benefits of such unanticipated "emergence," developing such benefits through the application of a systems-thinking frameworks may allow the CE Program to overcome some of the pervasive challenges the it has endured for decades. This thesis applies the systems-thinking skills honed in the SDM program to develop a blueprint for the USCG to meet the future challenges of managing its coastal "built environment" through an enterprise transformation process that aligns the enterprise value proposition with strategy and aligns all levels of the organization with that strategy.

1.2 The Research Question

This report seeks to answer the following research questions. The first represents the primary research question, while the next two are necessary to support the answer to the first:

1) *Can system architecting be applied to the USCG CE Program to develop an enterprise equipped to meet the complexities and uncertainties of future USCG shore infrastructure requirements?*
2) *What is the enterprise architecture that best positions the CE Program to achieve the strategic goals of the SILC 2016 Strategic Plan and the ISO 55000 Management Framework?*
3) *What is the best approach to implementing the recommended architecture?*

I researched several approaches[2] for answering these questions and determined that the "Architecting Innovative Enterprise Strategy" (ARIES) Framework would be the most effective. ARIES focuses on the drivers of organizational transformation and forces the person (or team) planning the transformation to apply systems thinking principles while employing a flexible suite of system architecting techniques. These techniques extend well beyond the flow charts and organizational charts central to the other methods considered. The ARIES methodology also provides ample evidence, in the form of artifacts produced through these techniques, as to whether the proposed enterprise architecture can enable innovation and ingrain the principles and practices of sustainability and resilience necessary in the future to manage complexity and reduce ambiguity associated with shore infrastructure management.

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[2] Other approaches considered include the U.S. Department of Defense Architecture Framework (DODAF), The U.K. Ministry of Defence Architecture Framework (MODAF), Generalised Enterprise Reference Architecture and Methodology (GERAM), the Integrated Architecture Framework (IAF) and Ownership, Business Processes, Applications, Systems, Hardware, and Infrastructure (OBASHI)

1.2.1 Research Question Factors

In order to properly answer the research questions, I developed a set of criteria to evaluate how well the evidence supports the proposed answers. Specifically, I identified the following factors to help illustrate whether the evidence logically supports the answers:

1. The concept of *Architecting the Enterprise* versus *Designing the Organizational* in the context of meeting future enterprise challenges.
2. The techniques used in the ARIES process that are the most insightful in either defining the problem or providing evidence that a concept can address a system of problems.
3. The importance of the implementation strategy and whether timing matters.
4. The successful aspects of ISO 55000, in terms of fostering innovation, sustainability, or resiliency, that may not be captured within the ARIES Framework.
5. The applicability of the ARIES Framework to the Construction/Facility Management Industry, other organizational entities within the USCG, and to Federal Agencies in general.

1.2.2 Objective and Focus

Assuming a general acceptance of the notion that shore infrastructure management is a complex system of systems, the objectives of this paper are to: (1) analyze how system-thinking approaches to developing an enterprise strategy can be used to identify or create opportunities for positive emergence; (2) apply a system architecting framework to the USCG Shore Infrastructure Program to develop an organization and enterprise strategy that optimizes USCG shore facilities as a mission enabler; and (3) recommend an implementation approach for the selected enterprise architecture, building on the lessons of my SILC 2.0 experience.

The focus in achieving these objectives is to enable the CE Program overcome the anticipated challenges associated with (1) the increase in complexity of the built environment (i.e. high electricity demand, sophisticated HVAC and IAQ systems, and complicated internal communication networks); (2) the increase in number and strictness of external mandates, particularly those associated with accountability (CFO Act) and sustainability; and (3) the anticipated decrease in budgets relative to inflation. These challenges require innovation at all levels and on many fronts, and they further require a deeper integration of principles related to sustainability and resiliency into SILC processes and the organizational construct itself. In summary, the focus is to architect the CE Program/SILC enterprise to minimize future ambiguity, manage complexity, and enhance creativity related to shore facilities.

Given the breadth of the research question, I "abstract", or group, many of the SI enterprise's organizational elements and processes at a level to deemed to best facilitate the identification and understanding of the key mechanisms, drivers, or outputs of a given aspect of the enterprise's form or function. By documenting the SI enterprise through such abstraction, I reveal systemic issues that can be addressed through the architecting process.

1.3 Proviso

The views expressed in this article are those of the author and do not reflect official policy or the position of the U.S. Coast Guard, the Department of Homeland Security, or the U.S. Government.

Chapter 2 – Background

"At all times an Armed Force, a regulatory agency, a humanitarian service, a federal law enforcement agency, and a member of the intelligence community, the Coast Guard is responsible for the safety, security, and stewardship of the Nation's waters. The Coast Guard employs broad authorities and capabilities, leverages expansive partnerships and projects effective and persistent presence to ensure the most vital national interests in the maritime operating environment are met."

- U.S. Coast Guard 2016 Posture Statement

ARIES presumes that knowledgeable leaders within the organization will be part of the architecting team, and therefore the target audience will inherently understand a wealth of corporate knowledge related to the enterprise. This is not the case for this academic thesis, and thus a concise background overview is necessary to facilitate an outsider's comprehension of the analytical evidence produced by the ARIES tools and techniques. The intent is to enhance the analysis described in ARIES Step 3, Capturing the Existing Architecture, by providing pertinent architectural and organizational context in this "background" discussion so that the findings in ARIES Step 3 can succinctly dissect problem areas in the existing architecture. To that end, Chapter 2 explains the current architecture in general, while Chapter 5 analyzes specific aspects and problems relevant to a holistic vision of the future.

2.1 The U.S. Coast Guard Culture

The United States Coast Guard is America's oldest continuous maritime service. Founded in 1790 by Secretary of the Treasury Alexander Hamilton as the "Revenue Marine", the service was renamed the U.S. Coast Guard in 1915 when the Revenue Cutter Service merged with the U.S. Life Saving Service. In the years that followed, the U.S. Lighthouse Service, the Steamboat Inspection Service, and the U.S. Bureau of Navigation were absorbed into USCG, expanding the service's responsibilities to the 11 statutory missions shown in the Venn diagram in Figure 1. [6] This diverse mission set has created an extremely flexible and resilient organizational culture,[3] which has enabled USCG to build a reputation for finding ways to "do more with less".

[3] The Author's assertion that the USCG is culturally flexible and resilient is supported by Sheffi [20] in Chapter 14

Figure 1: Integration of the USCG's 11 Statutory Missions (*Source: USCG Publication 1*) [6]

Inherent within this culture is a fervent sense of stewardship. Not only are Coast Guardsmen bound by law to enforce sustainability-related practices through their *Marine Environmental Protection* and *Living Marine Resources* missions, they embody stewardship in all operations. These stewardship-related missions and the reputation for resiliency and efficiency places a higher standard on how the USCG conducts operations. This higher standard extends to the USCG "mission support community", which includes engineering and logistics, personnel support, Information technology, and acquisitions. While the stewardship ethos is strong within the USCG support community, this community is arguably under-resourced in comparison to Department of Defense standards and National Resource Council recommendations. [2] USCG support units are staffed for compliance, but it is difficult for them to exceed applicable government/industry standards, particularly in terms of sustainability and resiliency.

To accomplish its diverse mission set, the USCG needs naval and air assets (boats, cutters, planes, and helicopters), the electronic systems for command and control, and the shore facilities from which all assets and missions are launched, coordinated, and recovered. The organizations that support these four asset types are collectively known as the "logistics" segment of the USCG's "mission support" community. This community is commanded by the Deputy Commandant for Mission Support (DCMS), and all logistical support activities are executed through "logistics centers" respective to each asset type: naval (surface forces), air (aviation), communications (C4IT), and facilities (shore infrastructure). The logistics centers are relatively new and evolved through three major organizational transformations over the past twenty years.

2.2 Recent USCG Organizational Evolution

The first of these aforementioned transformations, known as *Streamlining* (1996), was driven by a congressional mandate to cut costs and personnel. *Streamlining* redistributed logistical resources within regions and instituted organizational changes that transformed the USCG's logistics construct from a primarily geographic structure to a product-category structure. The second major change, known as *"Sectorization"* (2004), combined offices into unified regional "sectors," in response to technological advances in asset capability and changing stakeholder requirements. Each *Sector* covered a larger geographic domain than their predecessor components (Groups and Marine Safety Offices), and Sector Commanders had greater discretion and responsibility. The third major transformation, known as *Modernization* (2008), sought to fill the gaps and eliminate redundancies left in the wake of *Streamlining*, better align logistics services with the operational *Sector* organization, and create a consistent logistics delivery system across all mission support domains (i.e. Civil, Naval & Aviation Engineering, C4IT, Health Services, Personnel Services, and Legal Services).

The current high-level organization for logistics is depicted in Figure 2. It shows that the relevant chain of command for this report extends from DCMS to the Assistant Commandant for Engineering and Logistics (CG-4), to the CE Program (CG-43, omitted in this diagram as a component of CG-4), to the SILC. DCMS and the other "3-Star" organizational elements, the Deputy Commandant for Operations (DCO) and the Atlantic and Pacific Area Commanders, represent the executive level at which most major logistics decisions (i.e. funding and spend plans) are approved or adjudicated. That said, logistic center commanders often have significant discretion in the execution of their responsibilities.

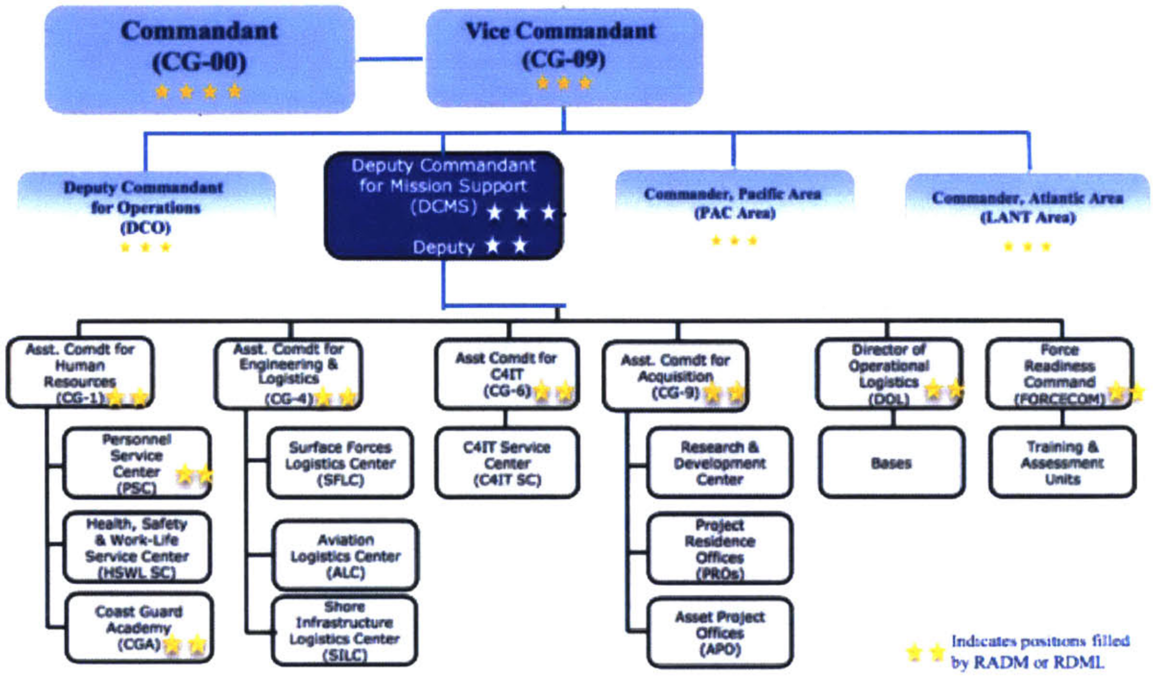


Figure 2: High Level USCG Logistics Organizational Chart (*Source: adapted from U.S. Coast Guard*)

2.3 The Shore Infrastructure Logistics Center (SILC)

The Logistics Transformation (*Modernization*) dictated the creation of product-oriented "logistics centers" and "service centers" (LC/SC) to replace two geographically bifurcated "Maintenance and Logistics Commands". USCG's CE Program (CG-43) became the direct superior unit to SILC. The SILC's purpose is to enable USCG missions by efficiently managing USCG's extensive real property inventory by performing all manner of services thereunto related. The function of "efficiently" managing real property is governed by the four high-level cornerstone principles of the MSBM: product line management (PLM), total asset visibility, configuration management, and bi-level maintenance.

Prior to *Modernization*, shore infrastructure management and stewardship activities were performed inconsistently across the enterprise with minimal knowledge-sharing among the geographically distributed units. The organization managed projects well, but it was debatable whether they were managing the "right" projects. The original "modernized" structure, called *SILC 1.0,* attempted to remedy these problems, but the structure emulated the Aviation Logistics Center (ALC) structure too closely and proved ineffective. *SILC 2.0* accounted for the realities and uniqueness of managing a huge, non-standard, real property inventory that was governed by a different section of the Federal

Acquisition Regulations (FAR) than the other LC/SC's. In the process of integrating the four cornerstones of the MSBM, the SILC transformed from a regionally-based, project-focused enterprise to an Enterprise-based, asset-focused enterprise. This transformation was accomplished by carving out a segment of the organization to focus on "asset management" (the product lines) while retaining its legacy "project management" segment (the regional execution branches). SILC 2.0 also included the creation of functional "shared services" that supported both asset and project management activities, in addition to providing some direct support to customers.

Though SILC 2.0 is still in its infancy, there is growing pressure to better navigate regulation and federal budgeting processes, to expand capabilities in enterprise knowledge, planning, and execution, and to embed sustainability and resiliency into both the organizational fiber of the SILC *and* all USCG shore infrastructure.

2.3.1 The SILC's Organization Design

SILC 2.0 encompasses all four of the key organizational dimensions discussed by Kates and Galbraith—function, product, geography, and customer. [7] Product and customer are combined since product and asset lines are defined by both the purpose and beneficiary (aka the "customer") of the facility. The structural dimensions are discussed further in section 3.1.4.

2.3.1.1 Product/Customer

Figure 3: Overview of the five product lines and their respective asset Line icons in SILC (*Source: USCG SILC*)

SILC's product lines are currently divided into facilities for (1) tactical operations, (2) strategic operations, (3) mission support, (4) mission readiness, and (5) waterways operations. Within each of these product lines, products are further segregated into "asset lines" for span of control. Figure 3 shows the asset line icons for each product line. The asset lines are further categorized into "asset classes" by their specific function or purpose, such as piers, office buildings, or communication towers. While each asset class may have a variety of beneficiaries, the asset lines were designated so as to roughly align with a particular organizational element(s) from which operational and/or support requirements are dictated. The alignment of product and asset lines to their primary organizational customers is shown in Table 1:

Table 1: Product & Customer Alignment

Product Line	Asset Line	Customers that drive requirements	Higher Level Customer Org Element
Tactical Operations	Waterfront Facilities	CG-7, SFLC	DCO, DCMS
	Aviation Facilities	CG-7, ALC	
	Shore Operations	CG-7, SFLC	
Strategic Operations	C4IT Infrastructure	CG-7, CG-6, C4IT SC	DCO/LANT/PAC, DCMS
	Sector/District	CG-2, CG-6, CG-7, Districts, C4IT SC	
Mission Support	Industrial Facilities	SFLC	DCMS
	Civil Works	SILC	
	Base Support	DOL	
Mission Readiness	Housing	CG-1	DCMS
	Training Facilities	FORCECOM	
	Community Services	CG-1	
Waterway Operations	Fixed & Floating Aids to Navigation	CG-NAV	DCO, LANT, PAC
	MER, Signal Power & Equipment	CG-NAV, SFLC	

The general responsibilities within the product line construct are depicted in Figure 4. Note that Facility Engineers (FEs), to include Sector Engineering Officers (EOs), are not part of the product line hierarchy, but they provide critical information to the Asset Line Management Branch Chiefs and Product Line Managers. Not shown, but equally important to information gathering, are the regional Facility Asset Managers (FAMS), who identify and track maintenance needs and help coordinate depot services for their respective geographic area of responsibility. While FEs, EOs and FAMS are part of the geographic hierarchy and not the product hierarchy, there are clearly matrixed responsibilities.

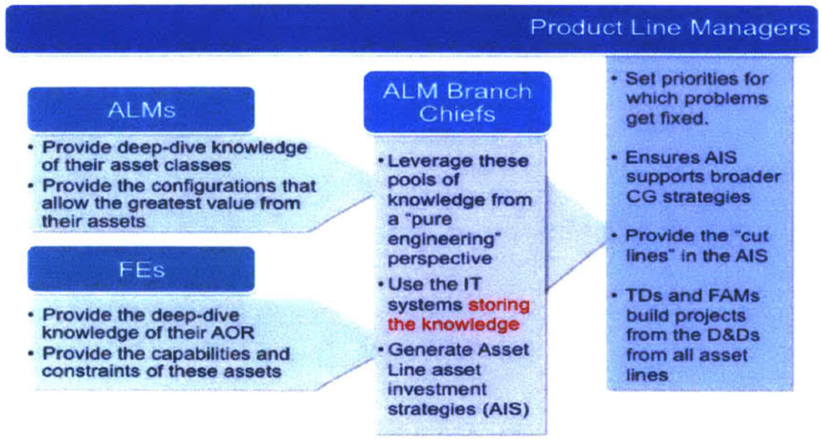


Figure 4: Responsibilities within the product/customer dimension (*Source: USCG SILC*)

2.3.1.2 Function

Like many federal government entities, SILC's primary functional activities are driven by "appropriation funding codes," that are defined by the Department of Homeland Security (DHS) and the USCG through the Financial Resource Management Manual (FRMM). [8] SILC's main "colors of money," as they are colloquially called, are AC&I, EC&R, AFC-43, AFC-36 and AFC-30. Table 2 describes each code along with the primary functional organizational element. Note that engineering/project management functions are divided into recapitalization and "bi-level maintenance" (defined as "depot level maintenance" (DLM) and "organizational level maintenance" (OLM)). While there is a notional alignment of AFC-43 to DLM and AFC-30 to OLM, there are key differences based on FRMM language which confound a direct alignment. Environmental service functions align with EC&R, but these functions are integral to the execution of all other funding codes as well. AFC-36 is primarily related to Aids to Navigation (ATON) inventory and supply chain management (SCM) functions. While SILC's SCM functions are currently targeted to a single product line and funding code, it is anticipated that further opportunities to integrate SCM functions with other funding codes will arise in the future. There are several other SILC functions that cross AFC boundaries, including accounting, administration, capital planning, contracting, information services, energy management, and real property management. Many of these functions are performed by organizational elements currently called "shared services".

Table 2: AFC Code Descriptions and Responsible Org Elements

Code	Description and primary associated activity	SILC sub-unit/division responsible for execution
AC&I	Acquisition, Construction and Improvement: Intended for **recapitalization** of existing facilities or to build **new capabilities**. Multi-year funds for projects >$750K. Projects are typically executed via design-build contracts.	Facility Design and Construction Center (FDCC)
EC&R	Environmental Compliance and Restoration: intended for projects related to **environmental clean-up** and processes to ensure **compliance** with environmental law and regulations.	SILC Environmental Management Division (EMD)
AFC-43	Operating Expense (OE) funds intended for non-recurring repair projects (typically **depot level maintenance**) between $5k and $750K. Projects are typically executed via design-bid-build contracts.	SILC Civil Engineering Units (CEU's), specifically the regional execution branches
AFC-36	OE funds for **central accounts,** specifically used by the SILC to purchase buoys and fund leases arranged through the General Service Agency (GSA).	Waterways Product Line & SILC Engineering Services Division Real Property Branch
AFC-30 & AFC-34	OE funds intended for recurring operations and maintenance (typically **organizational level maintenance**) less than $5K. Projects under this code are typically completed in-house. Also includes vehicles and energy payments.	SILC Facility Management Branch oversee, but local units outside SILC Chain of Command manage

The funding streams, like many of the functions, are interdependent. A failure to promptly spend on AFC-30 on minor issues today could result in the need for a larger AFC-43 or AC&I expenditure when the infrastructure deteriorates further tomorrow. Perversely, because AFC-43 and AFC-30/34 are managed by different entities, there is a tendency for operational units to wait for facilities to degrade to the level that AFC-43 is required, so that they can spend AFC-30 on other priorities. Figure 5 highlights the functional complexity related to these funding streams and the current shortfalls. Chapter 5 will examine the sources of these shortfalls while Chapter 6 proposes concepts to resolve these issues.

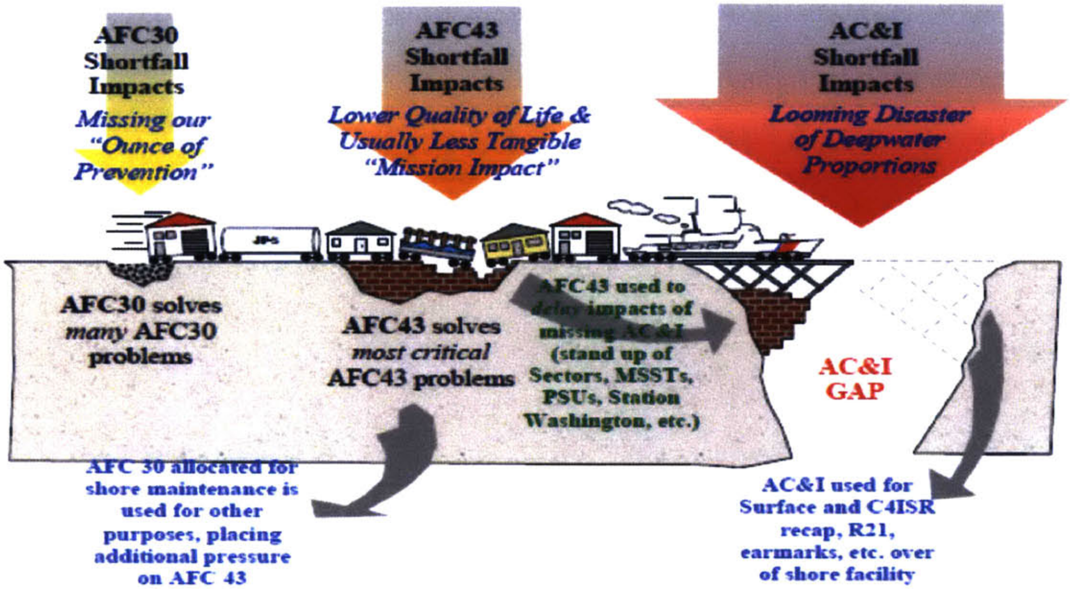


Figure 5: Types of Funding and Impacts of Shortfalls (*Source: USCG SILC*) [9]

2.3.1.3 Geography

The nature of the built environment dictates that SILC's activities differ depending on where shore infrastructures are located. Each CEU in Cleveland, Providence, Miami, Oakland, Juneau, and Honolulu caters to the specialized condition within those regions. The geographical dimension is essential to understanding local building codes and standards (e.g., termite protection standards in the southeast or limited construction times in Alaska), unique climate concerns (e.g., seismic risk in one area versus hurricane risk in another), and local suppliers. Given the impact that such regional differences can have on the resiliency of infrastructure, as well as the size of typical USCG maintenance projects, past practice has been to utilize regional contractors for the physical construction work.

2.3.2 SILC's Current Organizational Hierarchy

The organizational dimensions of SILC are linked within the matrixed hierarchy shown in Figure 6. The "dotted line" linkages common in some matrix organizational charts are not shown to highlight the functional chain of command that has both regional and product/customer dimensions within each Civil Engineering Unit (CEU). Note that the Commanding Officer of the four largest CEUs is also the product line manager. This "dual hat" has had some positive emergence in regards to the exposure of MSBM concepts to regional execution branch employees. It has also enabled the CE Program to retain the coveted "Commanding Officer" positions that were eliminated within other logistic center hierarchies. The concept of "command" is sacred within the military and has tremendous cultural significance. The negative emergence is that the responsibilities and demands of the Commanding Officer "hat" often trump the product line needs. This is a classic example of the "tyranny of the present", where immediate, short-term issues prevent long-term forethought. This issue is analyzed further in Chapter 5.

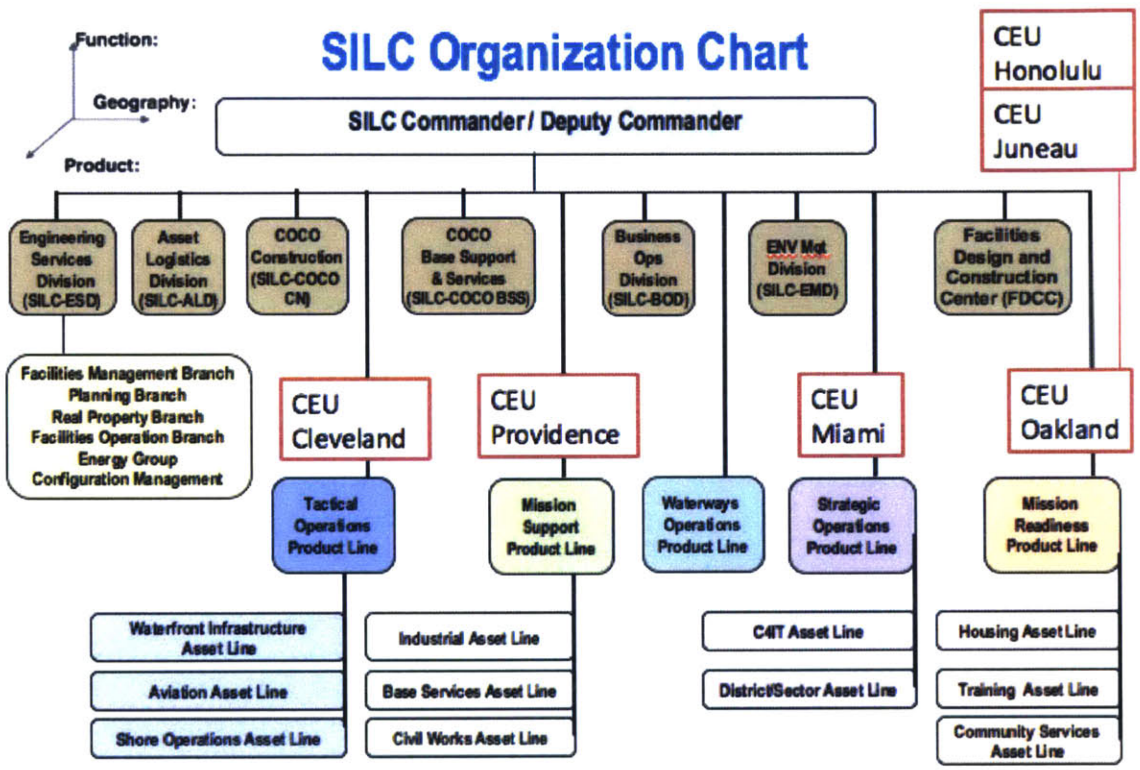


Figure 6: Current SILC Organizational Chart (*Source: Adapted from USCG SILC*)

2.4 Shore Infrastructure Enterprise Components Outside the SILC Organizational Structure

As noted above, there are several organizational entities that are critical to a functional shore infrastructure system, but that fall outside of the SILC's command hierarchy. The downstream organizational elements are Facility Engineers, Engineering Officers, and Engineering Petty Officers. They are primarily responsible for the "operations and maintenance" (O&M) of each of the over 400 geographically dispersed USCG shore installation sites. O&M is an industry term encompassing the wide variety of activities necessary for the daily functionality of the built environment. The USCG has subcategorized O&M to OLM and organizational level operations (OLO). This sub-categorization has organizational benefits, but has created some confusion, overlap, and gaps amongst localities. The inter-relationships of organizational elements within and external to the SILC's hierarchical chain of command are shown in Figure 7.

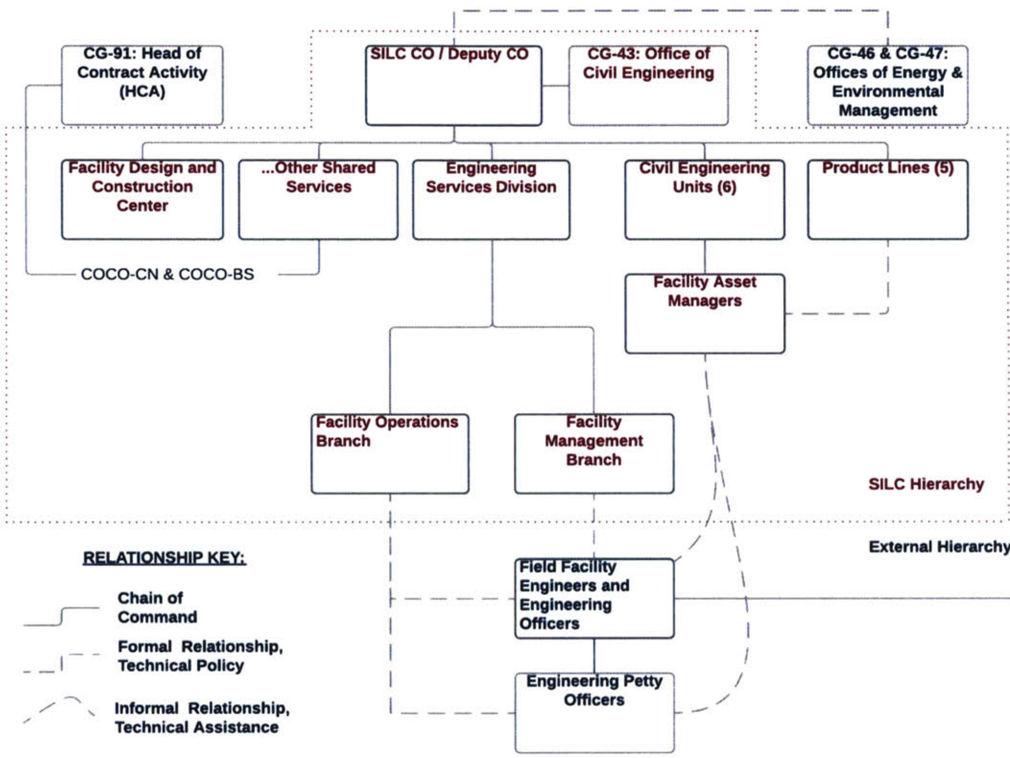


Figure 7: Current Relationships of SILC and Non-SILC Organizational Entities Responsible for SI Maintenance

The upstream organizational elements include the acquisition program (CG-9), the energy program (CG-46), and the environmental program (CG-47). CG-46 and CG-47 provide policy, advocacy, and strategic direction to functional elements of SILC. The "Chiefs of Contracting Office" functions within SILC shared services for construction and base services (COCO-CN and COCO-BS) actually work directly for the Head of Contracting Activity (HCA) in CG-9 to avoid potential conflicts of interest and better comply with acquisition law. Despite not working in the SILC Hierarchy, the COCOs have been responsive to SILC needs and have demonstrated that the organization can perform functional responsibilities without direct chain of command oversight.

2.5 ISO 55000 – Asset Management

In October 2014, SILC contracted the engineering consulting firm Jacobs [10] to analyze how the SI MSBM aligned with what appeared to be an ideal framework upon which to model the new enterprise asset focus. They developed two reports on the subject, including one with a series of recommendations that are discussed further in Chapter 6 of this report. The section below contains an excerpt of the ISO 55000 framework from the first Jacobs report, posted with permission. It is followed by the thesis author's analysis of the ISO relative to the management of the SI enterprise.

2.5.1 Jacobs Overview of ISO 55000 and its alignment with the SILC MSBM [11]

ISO released three documents on January 15, 2014 establishing a universal, international framework for asset management systems as follows:

- ISO 55000 Asset Management – Overview, Principles and Terminology
- ISO 55001 Asset Management – Management Systems – Requirements
- ISO 55002 Asset Management – Management Systems – Guidelines for the Application of ISO 55001

ISO defines an asset as an item, thing, or entity that has potential or actual value to an organization. ISO asset management standards have been written to apply to tangible assets (e.g. equipment, property, inventory, infrastructure, IT, human resources, etc.) and intangible assets (e.g. leases, options, brands, digital assets, intellectual property, legal rights, reputation, and agreements). Simply, asset management helps organizations better achieve strategic goals and objectives while realizing greater value from their assets. The tactical objective of the standard is to implement the fundamentals and requirements that enable an SI-MSBM. The organizational context for an asset management system is shown in Figure 8.

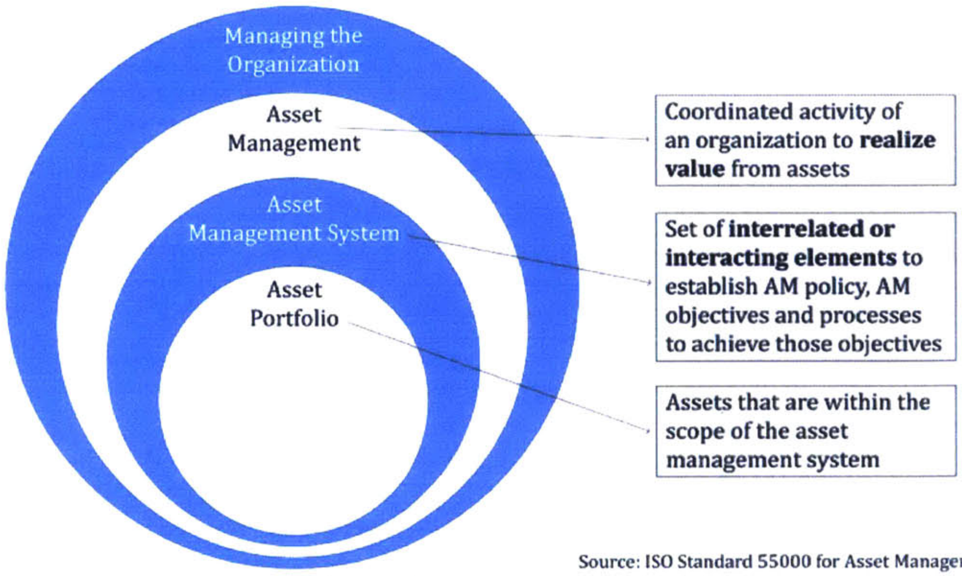


Figure 8: ISO 55000 Visualization (*Source: ISO Standard 55000 for Asset Management*)

A principal objective of the standard is to unlock strategic thinking capabilities to best align mission, budgets, and asset performance in order to achieve desired organizational goals and objectives.

ISO stated asset management fundamentals are:

- **Value:** asset management does not focus on the asset itself, but on the value the asset can provide to the organization.
- **Alignment:** asset management translates organizational objectives into technical and financial decisions, plans and activities.
- **Leadership:** asset management seeks to enable leadership and organizational commitment at all levels to help realize value enabled by assets.
- **Assurance:** asset management gives assurance that assets will fulfill their required purpose.

2.5.2 Independent Analysis of ISO 55000

Given the Jacobs overview, the ISO 55000 Asset Management Framework is not just focused on "managing assets", but is actually a systems approach to managing the "value of assets". It provides guidance for a system to manage people, processes, and tools in order to deliver the capabilities necessary for an organization's mission. ISO 55000 is a logical model by which the product lines should operate, and there are broad applications to other aspects of the larger SI enterprise, particularly the integration of configuration management and risk management. The ISO 55000 framework is well suited for many of the concepts related to decentralization, creativity, and flexibility discussed in the literature review in Chapter 3.

The SI MSBM is currently being modified to represent the "Asset Management System" depicted in Figure 8. It will therefore encompass many of the broad ISO 55000 principles while adhering to the four cornerstones in a manner applicable to the distinctive characteristics of SI. SILC 2.0 was designed prior to the promulgation of ISO 55000, and the Jacobs report identified numerous gaps between the existing SI MSBM doctrine and ISO principles. Regardless of any gaps, the SILC has not fully acculturated the existing model as the current enterprise is still largely focused on asset management through tactical project management. This is likely because the bulk of personnel are still assigned project management roles, and key metrics, i.e. AFC-43 spend down, are still project-management-centric. Therefore, a gap exists between doctrine and current organizational performance.

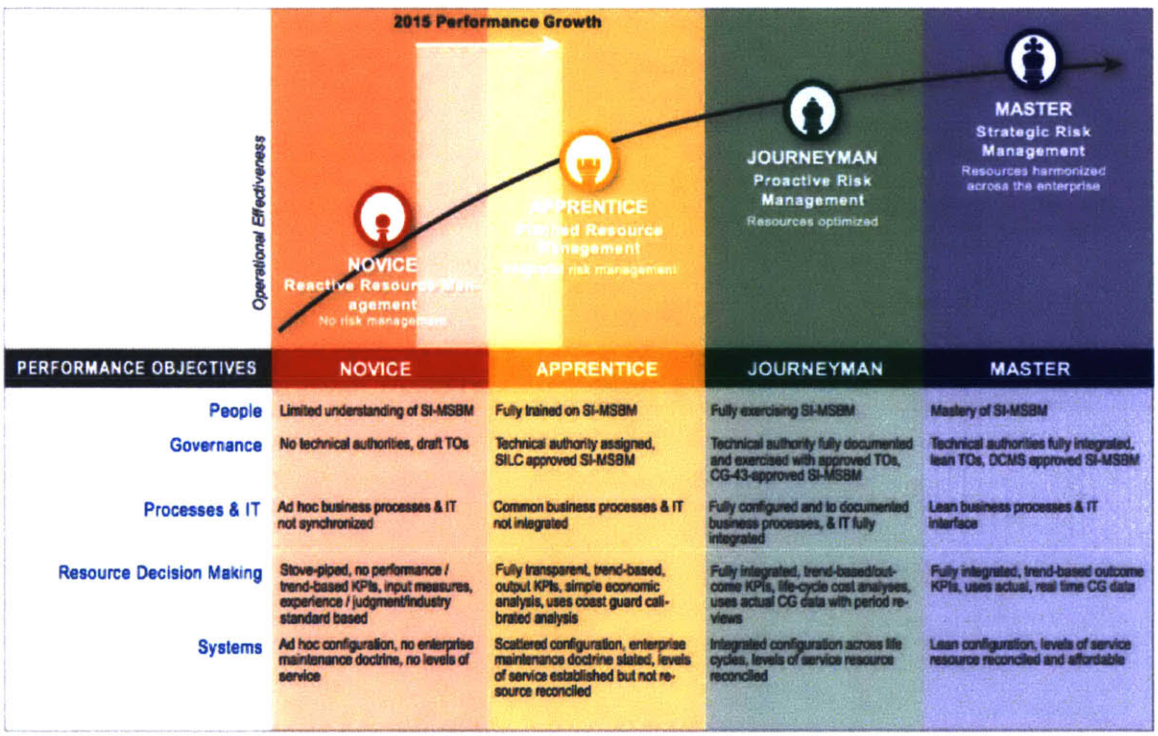


Figure 9: SI MSBM Maturity Continuum [1]

The measure used to gauge the level of acculturation and the achievement of desired capabilities is the "maturity continuum" shown in Figure 9. At the end of fiscal year 2015, the SILC had moved from the novice stage to the apprentice stage. This was a very positive result, but this thesis argues that the SILC 2.0 construct is insufficient to progress much further, particularly in the "systems" dimension, because the current architecture does not enable the flexibility or innovation required for resources and levels of service to be reconciled. A different organizational construct along with functions and resources aligned with the enterprise strategy is needed to reach the "master" performance level.

It is expected that ISO 55000 will remain the framework for *managing* the future enterprise, but a different approach is needed for *architecting* the organization and its future strategy. The new SI MSBM (aka the "asset management system"), the enterprise strategy directing this system, and the organizational structure should be comprehensively architected together in order for the SILC to deliver more value to stakeholders. Ensuring that the SILC and the CE Program are properly organized and a coherent enterprise strategy is devised to make that happen is at the heart of this research effort. While the ISO 55000 framework considers the broader ecosystem in which the enterprise assets operate, it offers neither guidance nor a rubric for constructing an organization to best operate the asset management system within that ecosystem. Note that in Figure 8, the activity "Managing the Organization" is outside the "Asset Management" activity, indicating that asset management is viewed as a subsystem of the larger enterprise ecosystem.

2.6 System Boundary and Assumptions

Thus far, this thesis has used "CE Program" to describe the command and control hierarchy responsible for shore maintenance and management and "SILC" to describe generally the organizational element that actually performs the work (either with in-house resources or via contract). Section 2.4 introduced broader members of the shore infrastructure management community that exist outside the boundaries of the SILC organizational hierarchy, but are critical to the stewardship of the USCG shore plant. This broader community of downstream and applicable upstream actors, including CG-43 and SILC, will heretofore be called the "SI enterprise". As noted in the introduction, the failure to align CG-43 organizationally with what became the SILC 2.0 organization has created redundancies, gaps, and other inefficiencies. The lack of formal alignment between the SILC and the non-SILC members of the SI enterprise, as will be discussed in Chapter 5, has created similar problems as well as counter-productive incentives. Therefore, the system boundary for ARIES analysis includes the entire SI enterprise.

In terms of a boundary related to the scope of services, this thesis focuses on the high-level maintenance functions (capital, depot, and organizational), product line management, and Shared services at the divisional level. Analysis may go deeper into the organization to decompose the problems inherent in the current architecture, and some recommendations may include details, but most will remain at the high level. It is assumed that greater detail will be applied to the recommended architecture and implementation plan during the USCG organizational change process. Finally, because the MSBM Seven-step model shown in Figure 10 is intentionally broad and can be applied to almost every SI enterprise activity, this report will not explore a new process model, but may recommend high level processes that fit within the MSBM process model boundary.

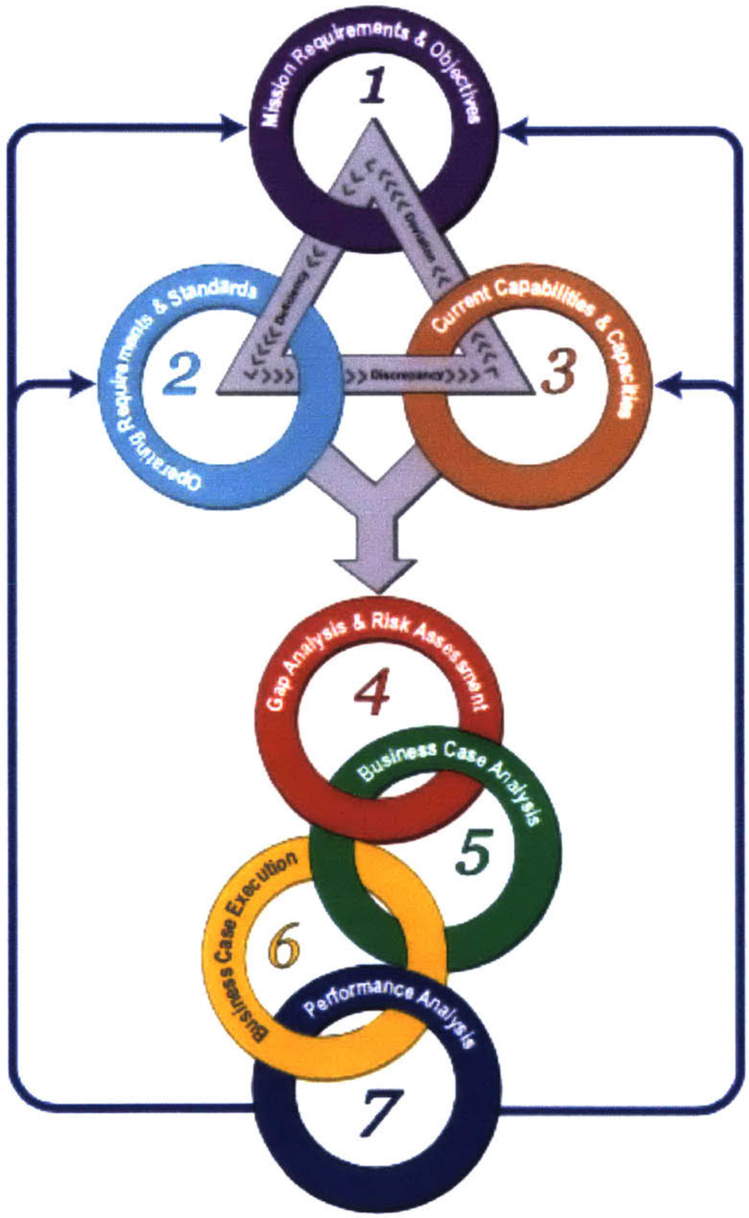


Figure 10: MSBM Seven Step Process Model (*Source: USCG SILC)*

Chapter 3 – Literature Review and Research Methods

This Chapter reviews the theories and findings applicable to "architecting an enterprise" in books, journals and websites, and then discusses how key aspects of the literature were applied to the SI enterprise using system thinking, subject matter experts and the author's project work at MIT.

3.1 Literature Review

This section is organized by author to demonstrate key independent findings as well as common threads of their research and or theories. This section closes with a discussion of *designing an organization* vs. *architecting an enterprise* to explain why architecting is hypothesized to provide a higher probably of future success for the SI enterprise.

3.1.1 Eberhardt Rechtin and Mark Maier

Rechtin is considered the "father of systems architecting" and produced two books relevant to this thesis, "*Systems Architecting: Creating and Building Complex Systems*" with Mark Maier, and "*Systems Architecting of Organizations: Why Eagles Don't Swim*". The relevant aspects of his work include [12]:

- Defining a *system Architect* as "a specialist in reducing complexity, uncertainty, and ambiguity to workable concepts", whose responsibility is "to bring structure in the form of systems to an inherently ill-structured, unbounded world of human needs, technology, economics, politics, engineering, and industrial practice"
- In complex enterprises, almost everything is connected to everything else
- The greatest leverage, risk, dangers, and opportunities in a complex enterprise are in the interfaces and the interrelationships
- Architectural Analysis is "not restricted to the high level"; the architect may go deep in order to discover what brings the most value to the client
- Stable intermediate forms: "complex systems will develop and evolve within an overall architecture much more rapidly if there are stable intermediate forms"
- Relationships among the elements of the enterprise give it its added value

- The importance of heuristics: "systems architects draw on inductive reasoning and heuristics to develop a systems concept (vs. traditional engineering's use of deductive reasoning, analytical tools, and mathematics)"
- Useful heuristics have the five characteristics listed below. The outputs of the heuristics (techniques) discussed in chapter 4 and exercised in chapters 5 and 6 meet these characteristics.
    1. It must make sense in the original context.
    2. Its sensibility or meaning should apply beyond its original context.
    3. It should be easy to rationalize.
    4. Its opposite should seem foolish.
    5. The heuristic's lesson should be time tested.

3.1.2 William Rouse

Rouse has produced numerous works on enterprises as systems and enterprise transformations through his work with the Tennenbaum Institute at the Georgia Institute of Technology. His book, "Enterprises as Systems: Essential Challenges and Approaches to Transformation" and "*Enterprise Transformation: Understanding and Enabling Fundamental Change*" [13], is directly applicable to this thesis because it addresses the drivers of transformation and the challenges from technical, behavioral and social perspectives. It examines several case studies that demonstrate the practical application of many of the transformation principles introduced, including enterprises as systems, transformational leadership, and cultural change. This work supports the entering argument that the USCG SI enterprise is a complex system and that a systems thinking approach to transformation has advantages over traditional methods.

3.1.3 Gareth Morgan

Morgan uses metaphors to describe organizations in "*Images of Organization*" [14]. Morgan introduces two applicable principles. The first is the "principle of minimum critical specification", where "if a system is to have the freedom to self-organize, it must possess a certain degree of 'space' or autonomy that allows appropriate innovation to occur". This suggests that an enterprise should only be defined to a level absolutely necessary to launch a particular initiative. The second principle to s to "build the whole into the parts", which consists of the following four components [12]:

1. Corporate DNA – vision, values, and sense of purpose that binds every individual to understand and absorb the mission and challenge of whole enterprise
2. Networked Intelligence – information can be accessed from multiple points of view, creating opportunities for full participation of individuals
3. Holographic Structure – design of structure that can grow large while staying small (fractal nature)
4. Holistic Teams and Diversified Roles -- job design defines work holistically, cross-training, basic unit is work team

3.1.4 Amy Kates and Jay Galbraith

Kates and Galbraith introduce the "Star Model" in *Designing Your Organization* as a decision-making framework for organization design. According to the authors, "its basic premise is simple but powerful: different strategies require different organizations to execute them." [7] Figure 11 describes each point of the star. The Star Model emphasizes the importance of looking at the organization as a system, but does so in the context of "complementary systems theory". "The notion of complementarity holds that design choices work as coherent systems and that the application of one practice will influence the results of a corresponding practice—whether positive or negative". [7] This indicates the star model takes a systems approach to the organizational design after the strategy has been established, but does not comprehensively help define that strategy.

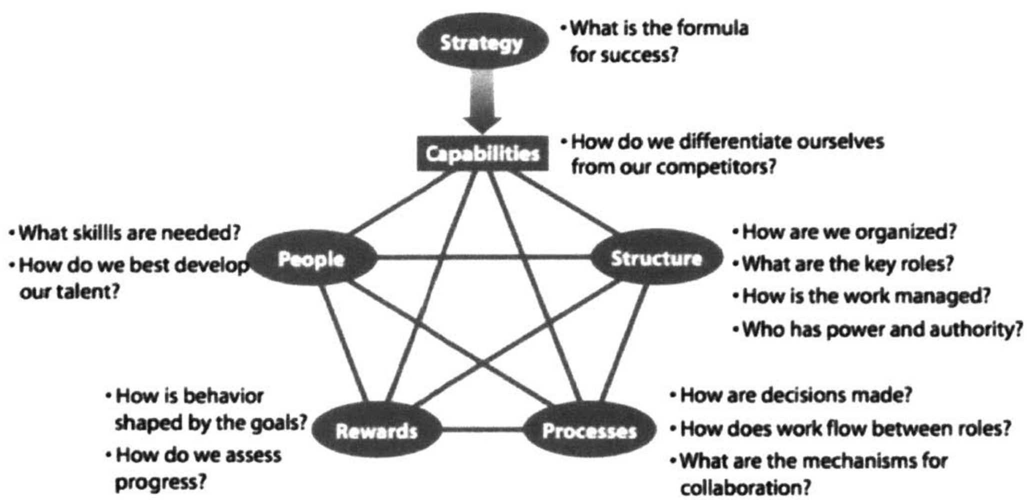


Figure 11: The Star Model for Organizational Design (*Source: Kates and Galbraith*)

Kates and Galbraith also state that "Complex business models cannot be executed with simple organizations". This idea supports the concepts discussed in Section 4.3.1 Cynefin Framework, where simple and complex contexts require different courses of action. Related to the complexity concept is the stated importance of alignment within the model. Kates and Galbraith describe alignment as each point on the star supporting strategy. Their discussion on the four primary structural dimensions—function, product, geography, and customer—is especially relevant as a component in describing the current and potential future architectures. The chosen structure determines communication channels, thus the speed at which members can innovate and execute on some dimensions versus others. [7]

Another relevant concept is that of "lateral connections", which Kates and Galbraith argue can be used to bridge barriers within an organizational structure. They provide the "continuum" in Figure 12 to show that, in general, stronger connections require more effort, thought and time. For example, matrices depend heavily on a culture of informal sharing, as well as an efficient means of sharing that information. It can be argued that the SI enterprise has the culture of sharing but lacks the means. Kates and Galbraith provide an excellent discussion of centralization vs decentralization, and their analysis strongly supports the SILC 2.0 imperatives of centralizing around total asset visibility and the other MSBM cornerstones. Their research also provides excellent considerations for designing for innovation. These concepts will be applied in Chapter 6.

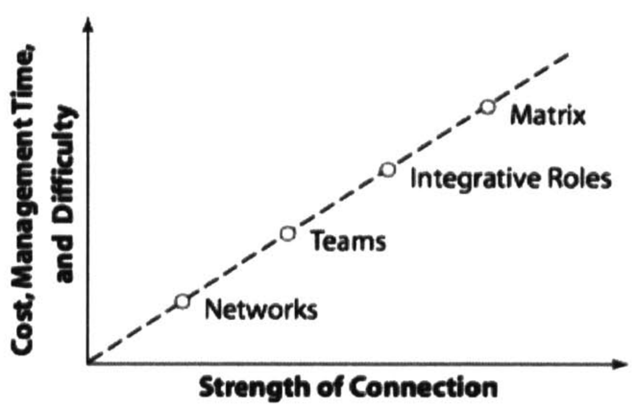


Figure 12: Continuum of Lateral Connections (*Source: Kates and Galbraith, Figure 1.7*)

Kates and Galbraith also list a number of principles for design, the most relevant being Ashby's "principle of requisite variety", which states: "When the variety or complexity of the environment exceeds the capacity of a system (or enterprise), the environment will dominate and ultimately destroy that system". This articulates the importance of understanding the external environment and the enterprise's capacity to manage the complexity therein.

3.1.5 Thomas Malone

Malone's Book, *The Future of Work*, and his related MIT course materials for MIT course 15.320: Strategic Organizational Design, make the case that the decreasing cost of communication enables more distributed decision making due to the increased accessibility of information. This, in turn, leads to progressively more decentralized organizations that engender greater innovation and flexibility. [15] He also suggests that a management model of "coordinate and cultivate", a superset of "command and control", which opens a broader range of alternatives and provides the ability to flex "back and forth on the decentralization continuum as the situation demands". [15] The theory that decentralized decision making within organizations yields innovation will be used as a basis for potential architectural concepts. This includes the "principles for cultivating organizations" [15]: (1) harness people's natural tendencies, (2) let a thousand flowers bloom, (3) encourage cross-fertilization, and (4) improvise.

Table 3: Strengths and Weaknesses of Typical Organizational Structures

Structure	Strengths	Weaknesses	Bottom Line Responsibility	Notes
Functional	Economies of Scale w/in funtional Departments In-depth knowledge and skill development Enables organizations to accomplish Functional goals Best with only a few products	Less innovation & slow response time to enviromental Changes May cause decisions to pile on top; heirarchy overload Poor horizontal coordination among departments	CEO - The functions have metrics but no real bottom line Functional Groups may have competing incentives	The reason for less innovation is that each product idea needs to go thru several layers of approval
Divisional (Product, Geography, Customer, Market)	Suited to fast Change and Innovation in an unstable environment Higher cliet satisfaction because product responisblity and contact points are clear Easier to adapt to differences in products, regions, clients Decentralizes decision-making	Eliminates economies of scale in funcional departments Duplication of resources and poor coordination across departments Less in-depth completence and technical specialization Integration and standardization across divisions (products, regions, etc) more difficult	Each Division VP, "easier to be the CEO"	Divisional Stuctures enable innovaiton and better customer, but typically cost more due to redundancies
Matrix	Achieves coordination to meet dual demands Flexible sharing of human resources across divisions Suited to complexdecisions and rapidly changing environments Opportunity for both functional and divisional skill development	Dual authority can be frustratig and confusing participants need good interpersonal skills and extensive Time-consuming: frequent meetings and conflict resolution sessions Requires great effort to maintain power balance		Hybrid of any two above. Can allow for the "best of both worlds" but can be confusing and susceptible to unintended imbalances of power w/in the matrix
Front-Back Organization	An alternative way (in addition to a Matrix) to optimize on multiple dimensions at once (e.g. products, functions, customers, regions) Often suited for large, complex organizations No one has 2 bosses, as it is a separate hierarchy	Very complex to manage (needs top-down management from CEO and executive Committee combined with lateral coordination throughout organization "No one has the authority to do what they have to do"		Back-end units = products & functions Front-end units = customers and regions

Sources: Malone, Thomas. Organizational Design Basics, Class Notes
Duncan, Robert. "What is the right organizational structure? Decision tree analysis provides the answer". *Organizational Dynamics (Winter 1979) p. 429*
Daft, Richard L. Essentials of Organization Theory and Design (Cincinati, OH, South Western), 2001 pp 42-47

Malone also catalogued strengths and weaknesses of various organizational structures. Table 3 was adapted from Dr. Malone's class notes, and will be useful in identifying and evaluating existing and alternative architectures in Chapters 5 and 6 of this report.

3.1.6 Andersen and Jonsson

Andersen and Jonsson offer a potential counter-point to the theme above that organizational structure impacts organizational "effectiveness". They surveyed over 300 manufacturing companies in Sweden and found weak correlations between structure and effectiveness, as measured by profitability and growth. They concluded that "suggestions or arguments in favor of changing the organization structure cannot be assessed without due consideration of the functioning of the organization that is assumed to be the consequence of the new design. It is how the organization functions that may affect the degree of goal attainment and success, not the structure." [16] They go on to recommend that by "acknowledging that form does not determine function, theorists and managers can look for and properly assess new organization structure alternatives before implementing them." [16] In other words, while they do not completely discount the positive impact that organizational structure can have, they caution that any structural changes must only come after considering the organizational functions and evaluating alternative organizational structures. This concept of fully understanding organizational functions and evaluating alternatives *before* making any changes (or even designing any changes) was a key impetus behind the work by Nightingale and Rhodes.

3.1.7 Deborah Nightingale and Donna Rhodes

Nightingale and Rhodes, in *Architecting the Future Enterprise*, found that many of the existing frameworks for enterprise transformation focused on what to do *after* a future architecture has been decided (or during what they call the "design phase"). They argue that treating the new architecture as a simple point decision, vice a significant decision analysis problem, ignores the very important processes of generating possibilities and methodically selecting the right architecture. They also noted a tendency for organizations to jump right to a solution without carefully considering the problem. To address these issues, they created the ARIES Framework, which is discussed thoroughly in Chapter 4, and exercised in Chapters 5 and 6. ARIES is targeted at the early concept phase, upstream from the design phase, and focuses on what triggers an organization to undertake a transformation.

3.1.8 Designing an Organization vs. Architecting an Enterprise

Organizational design is "the deliberate process of configuring structures, processes, reward systems, and people practices to create an effective organization capable of achieving the business strategy". [7] *Architecting the enterprise* is "effectively generating options for the future, evaluating these options, and selecting the future architecture, before enterprise change commences." [17] The primary difference, as articulated by Nightingale and Rhodes, is that design is what happens after the architectural decision is made, while architecting is what goes in to making the decision in the context of the enterprise's ecosystem. From this perspective, "architecting" and "designing" can be said to have areas of distinct focus, and areas of overlap. This perception is common, but is not universally accepted in the literature, as displayed by Emes et al. in Figure 13. In this case, "systems engineering" is taken to be a proxy for "organizational design" as defined above. Note that the perspectives range from architecting and design are "completely independent activities" to them "being the same thing". This thesis favors the concept in "*Figure 18. SE as an activity that overlaps with SA*" in Figure 13.

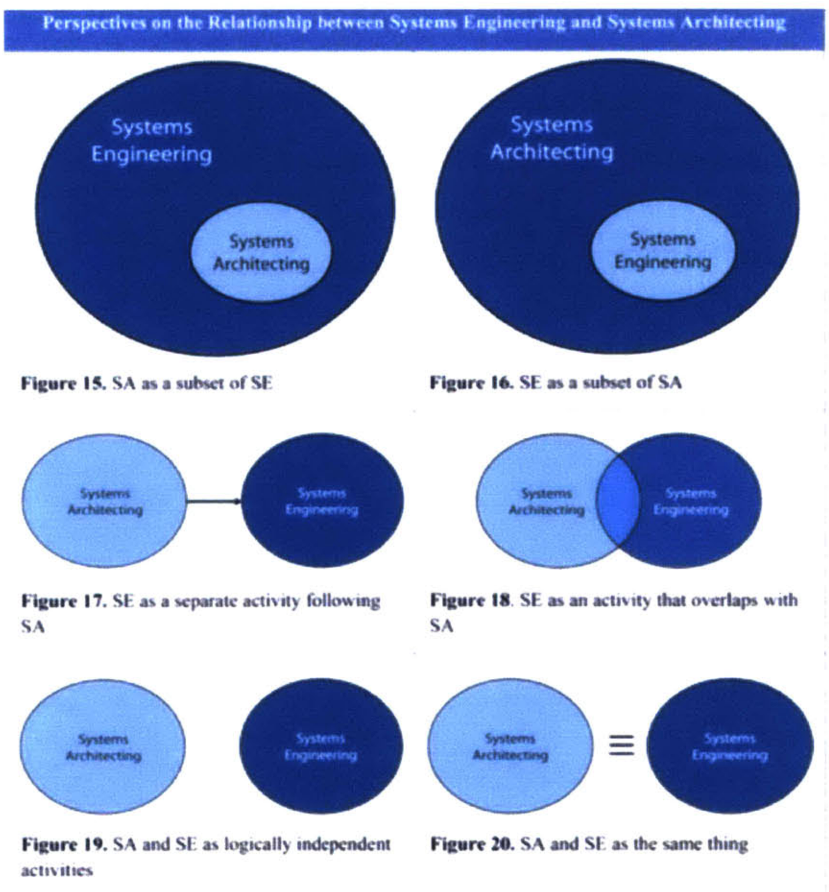


Figure 13: Range of Perspectives Defining System Architecting & System Engineering (*Source: Emes et al., Table IV*)

A comparison of elements within the Star model (designing the organization) and ARIES (Architecting) helps to illustrate the "areas of distinct focus" and "overlap". Whereas the Star Model focuses on 5 elements and the alignment of 4 of those to a fifth (strategy), ARIES encompasses ten elements and what is referred to as "entanglement" amongst combinations of the elements. It is the consideration of this entanglement as a driver of transformation that makes architecting an "upstream" activity in comparison to the complementary considerations in the Star Model that are employed after the strategy is decided upon. Another way of stating this distinction is that *architecting,* by asking the question "what *should* we be doing?", results in solution-neutral concepts for building architectural alternatives, while *designing* more specifically describes the architecture and strategy already selected. Andersen and Jonsson's arguments that function has a greater influence on effectiveness than form also adds credence to the notion that analyzing functions prior to establishing the strategy and the organizational construct helps protect against the common failure modes referenced in Chapter 4. The overlap occurs when the downstream analysis of elements like people or processes leads to changes in the strategy. Also, as discussed in Chapter 6, the line between "architectural" decisions and "design" decisions can be blurry in the enterprise context.

3.1.9 Summary of Literature Review

Organizational Structure can help an enterprise achieve its strategy, but achieving the strategy does not always equate to effectiveness. To be effective, the strategy and organizational structure (including resource allocation) must be developed in the context of the enterprise ecosystem and the changing landscape therein. Most important is identifying the functions that create the most value with respect to the enterprise mission. The architecting process enables these functions to be identified through heuristic analysis and solution neutral concepts. System architecting principles applied to the enterprise furthermore enable the strategy and structure come to focus through the deliberate application of multiple perspectives and implementation through stable intermediate forms. This systems approach to decision making helps, in Rectin's words, to reduce complexity, ambiguity and uncertainty into workable concepts, as well as to direct focus to interfaces and interrelationships, where the greatest risks and opportunities lie. Once these architectural decisions are made, there are numerous approaches to organizational design that can be employed to manage the details. At the intersection of architecting and designing are Malone's concepts related to the "coordinate and cultivate" approach, particularly in terms in architecting for innovation.

3.2 Research Methods

In exercising the ARIES framework, a number of "systems thinking" tools and techniques were employed. Most of these tools are well documented in academia, and were populated with data extracted from correspondence with subject matter experts (SMEs), personal experience, publically available USCG publications or websites, and USCG SILC documentation used with permission. In addition, the author participated in several projects and assignments during the course of the SDM program in which the SI enterprise architecture was analyzed.

3.2.1 Systems Thinking Approach

The specific tools and techniques used to analyze data are described and/or demonstrated in chapters 4, 5 and 6. Techniques with larger outputs are included in the Appendices. The application of these tools were iterative, and several tools were updated throughout several stages of the ARIES process. The iterations between tools ensured completeness of data used for each individual technique, while also promoting consistency and a holistic analysis. The evolution of the data used in a technique through multiple steps in the process enabled the progression of thought.

3.2.2 Correspondence with Subject Matter Experts

Throughout the year, a number of subject matter experts (SMEs) contributed to this work through general correspondence and review of specific chapters and artifacts of this thesis report. The five main themes of the correspondence were: (1) How is SILC 2.0 currently working for your domain? (2) What are the biggest challenges you see for your domain? (3) What are your proposed strategic solutions to address these challenges? (4) Does the work to date on this thesis accurately reflect current conditions? (5) Are the conclusions and recommendations of this thesis reasonable and feasible?

The SME's were selected to optimize face-to-face interaction based on travel schedules and proximity to MIT. Due to the rotational nature of USCG job assignments, these SME's are not geographically beholden to a single area, and therefore provided a diverse set of opinions despite their current geographic proximity. SME correspondence with geographically distant SME's was conducted with email, phone and video conference. Table 4 lists the subject matter experts consulted, as well as their topic or area of expertise relative to this thesis. Per the proviso in Section 1.3, the findings and conclusions of this thesis do not represent the opinions of the SMEs.

Table 4: List of Subject Matter Experts Consulted

#	Subject Matter Expert	Topic/Area
1	Dr. Paula Loomis, Acting Director of CG-43	Policy
2	Mr. Fred Sommer, Deputy Division Chief, SILC Engineering Services	All Aspects
3	CDR Andrew Brown, Executive Officer, USCG Base Boston	OLM, DLM & Customer
4	LCDR Greg McLamb, Facility Engineer, USCG Base Boston	OLM & Customer
5	CAPT Matthew Lake, Prospective Commanding Officer, USCG Yard	Budget
6	LCDR Michael Cost, Executive Officer, CEU Providence	OLM, DLM, PLM
7	CDR Michael Roschel, Mission Support Product Line Manager	DLM, OLM, PLM/ALM
8	Mr. Alfred Jacobs, Technical Director, CEU Providence REB	DLM
9	Ms. Carissa Vlahovich, Asset Line Integration Contract Project Manager, Jacobs	PLM/ALM & Shared Services
10	Mr. Jack Dempsey, Principal, Jacobs	ISO 55000, policy, enterprise strategy

3.2.3 MIT SDM Projects

The following class projects helped advance thought and provide inputs for the techniques and analysis herein. Table 5 lists the class, project/assignment, team members (in addition to the thesis author, if applicable), and the contribution to this thesis.

Table 5: MIT Projects/Assignments Contributing to this Thesis

MIT Course	Project	Team members	Contribution
ESD.412: Foundations of SDM II	OS8	N/A	Mapping of architecture to strategy, technology, regulation and marketing
ESD.38: System Architecture Applied to Enterprises	Term Project	Karl Gantner	ARIES techniques applied to the organizational entities responsible for Organizational Level Maintenance
ESD.38: System Architecture Applied to Enterprises	Personal Paper	N/A	Application of Proctor and Gamble experience to SILC for the development of alternative concepts
15.320: Strategic Organizational Design	Term Project	Carolina Aguilar, Zach Green, Carolyn Fu, Naoki Matsunaga	Causal loop diagrams, structure analysis & development of alternative concepts, specifically concepts for innovation
15.878: Capstone for Sustainability	Term Project	N/A	Sustainability aspects, particularly the Embedding Project evaluation
ESD.754J: Data Mining	Term Project	N/A	Applicability of data visualization and other analysis techniques

Chapter 4 – The ARIES Framework

This Chapter explores the basics of the ARIES Framework, so that Chapter 5 can focus on the analysis. "The ARIES framework evolved from the knowledge and experience of enterprise leaders, enterprise researchers, and architecting teams in over 100 diverse real-world projects", and is based on three foundational concepts [17]:

- *Architecting*: the act of creating a "blueprint" for the enterprise to follow to achieve its desired transformation vision.
- *Innovative*: means being forward-looking so that the enterprise evolves to stay ahead of changes in its ecosystem that may impact its ability to survive and to thrive.
- *Enterprise Strategy:* the overarching strategy that is a determinant of success of an enterprise in delivering value to stakeholders while pulling from and contributing to its own ecosystem.

4.1 The Elements

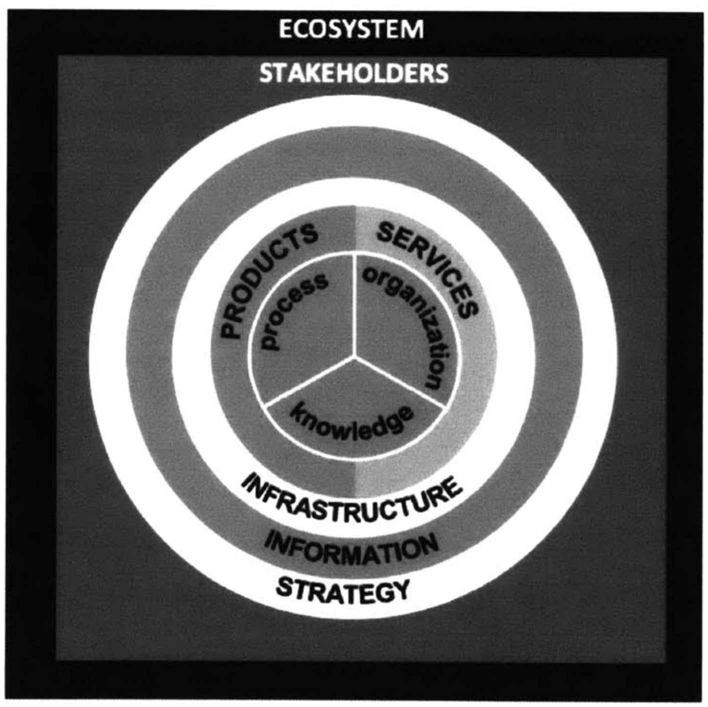


Figure 14: The Ten Elements of the ARIES Framework (*Source: Nightingale and Rhodes, Figure 2.1, p 15*)

The ten elements shown in Figure 14 represent a way to see the whole enterprise through its parts. Ecosystem and Stakeholders are specifically examined in steps 1 and 2 of the ARIES Process discussed in Section 4.2. The remaining eight elements are called the "view" elements because they enable one to look into the enterprise from different angles. The different-but-interrelated views are the mechanism to: (1) isolate unique areas of focus or concern (e.g., process); (2) reduce complexity to help understand a whole enterprise; and (3) help provide unique perspectives to address the needs of the enterprise's diverse stakeholders. The "view elements" are defined in Table 6, along with SI enterprise examples.

Table 6: View Element Descriptions and SI Enterprise Examples

Element	Description [17]	SI Enterprise Examples
Strategy	The enterprise vision, strategic goals, business model, and enterprise-level metrics	MSBM, 5-yr Strategic Plan, Annual Report, operational effectiveness
Information	Information the enterprise requires to perform its mission and operate effectively	Asset condition & functionality, mission impacts of failure, costs
Infrastructure	Enterprise systems and information technology, communications tech, & physical facilities that enable enterprise performances	Real Property (RP) Assets "as-is" in terms of function & condition, Shore Asset Mgt IT Sys (SAM)
Products	Products the enterprise acquires, markets, develops, manufactures or develops	RP *after* acquisition, maintenance & construction projects
Services	Offerings derived from enterprise knowledge, skills & competencies that deliver value to stakeholders, including support of products	Accounting, contracting, project mgt, engineering, capital planning energy mgt, enviro compliance
Process	Core, leadership, lifecycle, & enabling processes by which the enterprise creates value	MSBM 7-step process, process guide technical orders (PGTO's)
Organization	Culture, organizational structure, & underlying social network of the enterprise	Dual hat PLM/CEU CO, mil/civ mix, 3D matrix org, OLM by others
Knowledge	Competencies, explicit & tacit knowledge, & intellectual property resident in & generated by the enterprise	Multidisciplinary engineering skill, regional expertise, asset line specialization

The elements can be further analyzed by an "anatomical" evaluation of its (1) *structure*: arrangement and relationships of parts; (2) *behavior*: how things work or function; (3) *artifacts*: documentation and objective evidence; (4) *measures*: metrics and analytics; and (5) *periodicity*: frequencies and cycles. Nightingale and Rhodes stress that the elements must be analyzed collectively rather than just individually. They note it is difficult to see the whole enterprise without examining it through the parts (elements), and one must recognize that the simple sum of these elements does not equal the whole enterprise. To accentuate this point, they explain that relationships, dependencies and tensions exist across each element, causing observations to change when several elements are examined together, vice each one in isolation. These interactions cause the elements to become "entangled", and the nature of this entanglement differs among enterprises.

4.2 The Process

The process model defines seven sequential activities, shown in Figure 15. The first three steps focus on defining the issues that need (or are desired) to be addressed through transformation. Each step in this "problem domain" will be demonstrated in Chapter 5. The final four steps enable the development of concepts and alternatives that solve or mitigate the issues identified in the problem domain, including an approach for implementing the selected concepts. The steps in this "solution domain" are exercised in Chapter 6.

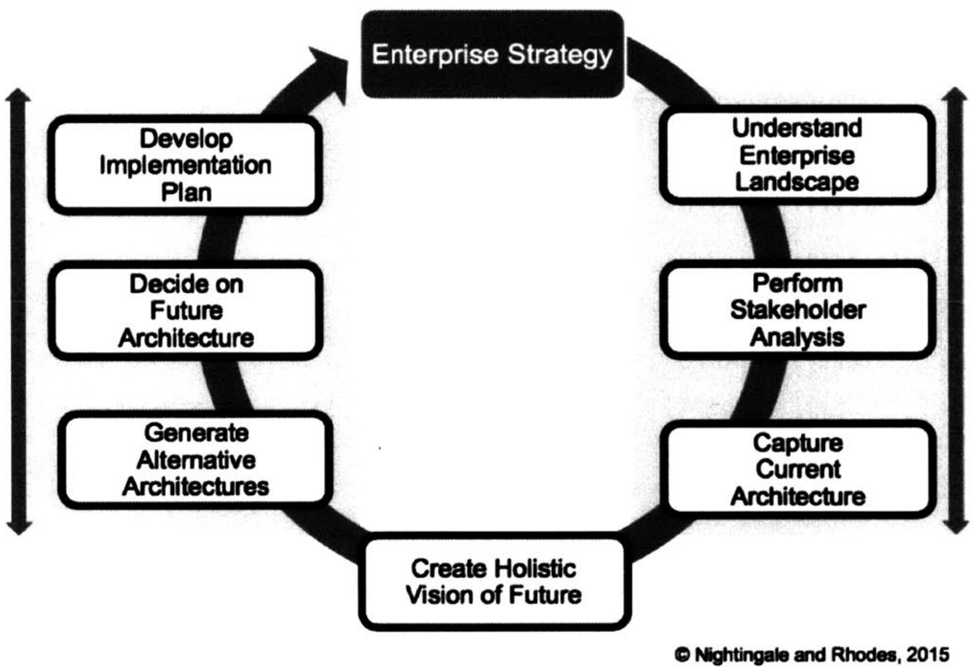


Figure 15: ARIES Process Model (*Source: Nightingale and Rhodes, p 15*)

4.3 The Techniques

ARIES suggests, but does not mandate a number of heuristics through which to answer the questions posed within each step of the framework process. Some techniques are simply tabular representations of questions and answers. Others are either more complicated tools, not yet well known outside academic circles, that require the practitioners to be trained in the use of the technique. The techniques that fall into this latter category will be discussed in the sub-sections below.

4.3.1 Cynefin Framework

Cynefin (pronounced ku-*nev*-in) is the Welsh word literally translated as “habitat”, but more closely stands for the multiple affiliations and “factors in our environment that influence us in ways we can never understand.” [4]. The Framework is useful in contextualizing a situation so that leaders can take appropriate action. The four main contexts can be divided into “ordered” and “unordered”, while the fifth, disorder, applies when one of the other contexts is not dominant. Note that “unordered” does not mean lack of order, “but a different kind of order, one not often considered but just as legitimate in its own way.” [18] Per Figure 16, the ordered domains include the “simple” (or “known”) and “complicated” (or “knowable”). Unordered domains are “complex” and “chaotic”. Descriptions of each context are listed in Figure 17. “Cynefin [is] a *sense-making* framework, which means that its value is not so much in logical arguments or empirical verifications as in its effect on the decision-making capabilities of those who use it...it gives decision makers powerful new constructs that they can use to make sense of a wide range of unspecified problems. It also helps people to break out of old ways of thinking and to consider intractable problems in new ways.” [18] The Cynefin framework has numerous applications, but is used in this thesis to illustrate how the landscape may require organizational flexibility to operate in each of the domains, sometimes in all four simultaneously.

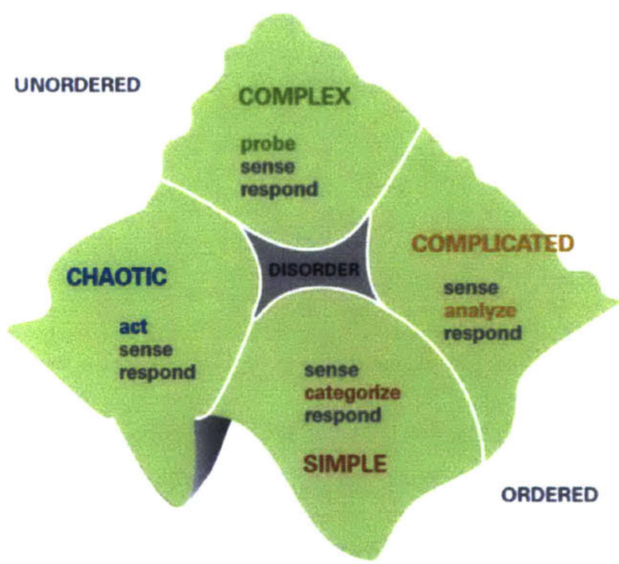


Figure 16: Cynefin Framework - Contexts and the Leader's Approach (*Source: Snowden & Boone* [4])

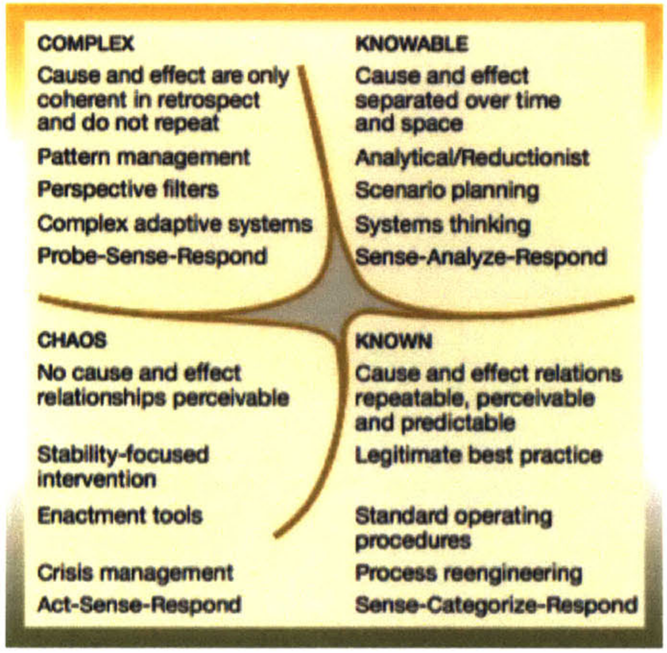


Figure 17: Cynefin Framework w/ Descriptions of Each Context (*Source: Kurtz & Snowden* [18])

4.3.2 Stakeholder Value Network (SVN) and Dependency Structure Matrix (DSM)

Stakeholder value networks (also called SV mapping) are an effective method of comparing multiple needs across multiple stakeholder groups. Why a network? Interactions surrounding facility management are decentralized, interconnected, and interdependent, and thus a network representation enables a more holistic way of thinking about the problems and opportunities within an ecosystem. Networks can be analyzed mathematically and qualitatively.

The SVN can easily be converted into a Dependency (also called "Design") Structure Matrix (DSM) to visually understand the strength and alignment of stakeholder interactions. A DSM is an "n by n" matrix, where the axes are identical. Typically, only the y-axis is fully labeled, and the diagonal is blocked out. The power of the DSM is that it can be reordered, or "partitioned", through simple algorithms to identify the most effective groupings (called "clusters") by minimizing the interactions above the diagonal. "DSMWeb" [19] and Eppinger's "DSM Methods and Applications" [20] are two recommended guides for the detailed understanding and use of DSMs. Figure 18 shows the basic clustering concept in terms of "tasks", but for this thesis, "stakeholders" can be substituted for tasks. The sample DSM shows that stakeholders A, B, and C can be addressed independently and sequentially. Stakeholders D and E should be coordinated with in parallel. Stakeholders G, H, and I are tightly coupled due to the interactions above the diagonal, and therefore should be addressed as a group. DSMs have a wide range of application and can be used for processes, products, stakeholders and organizational elements.

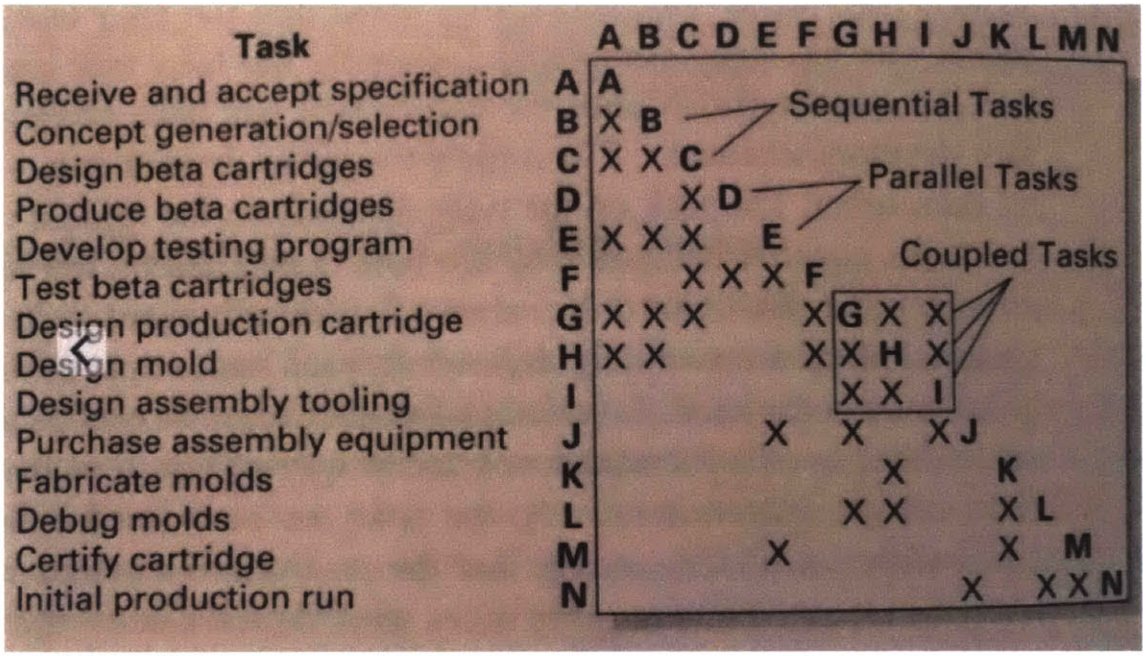
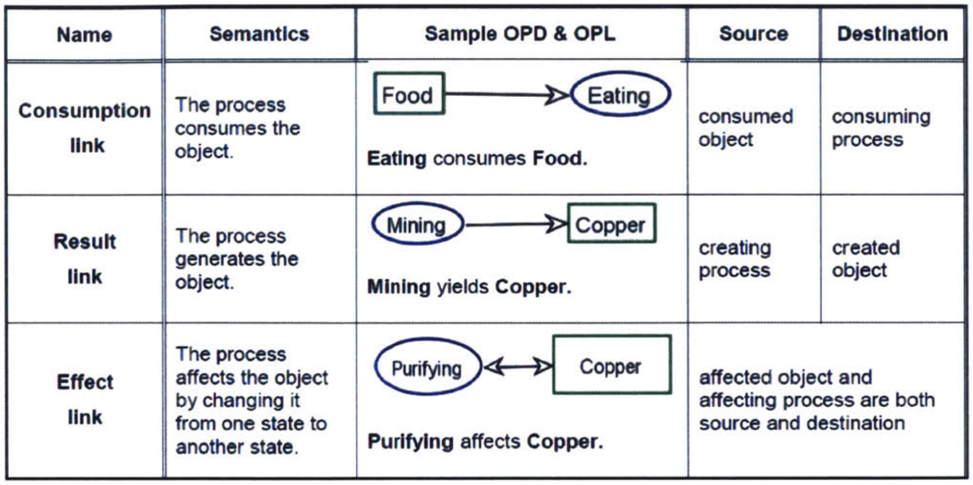


Figure 18: Sample DSM for General Explanation (Source: Ulrich and Eppinger, 2008) [21]

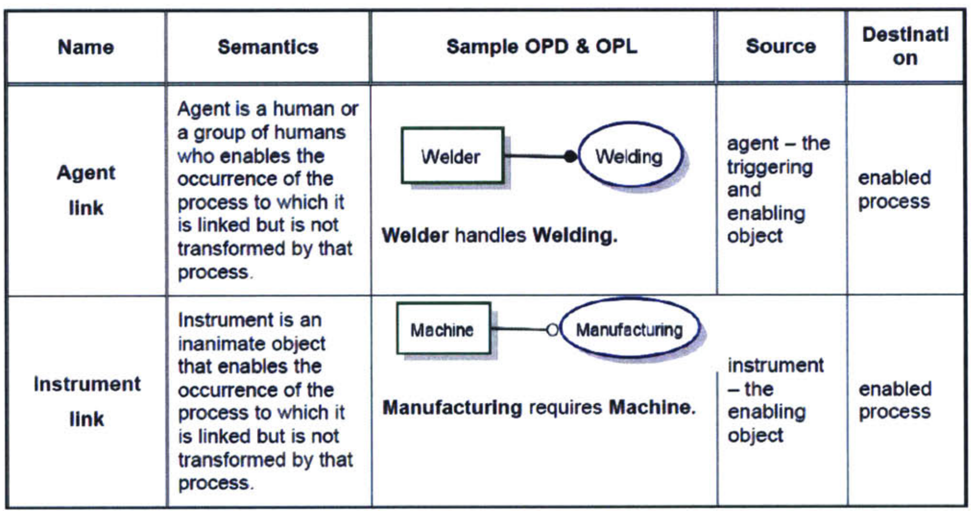
4.3.3 Object Process Methodology (OPM)

OPM is a conceptual modeling language and methodology for capturing knowledge and designing systems, and was recently codified in ISO 19450. The application of OPM ranges from simple assemblies of elemental components to complex, multidisciplinary, dynamic systems. [22] In this thesis, OPM is used to help graphically define the existing architecture in terms of "objects", "processes" and "links". Objects are elements of form that include operands (objects that are transformed by a process) and agents/instruments (human/inanimate objects that trigger or enable a process). Objects are represented by boxes and processes are represented by ovals. Links signify the relationships between objects and processes, and are represented as shown in Figure 19 and Figure 20. This list of links represents only those applicable to the OPM diagrams presented herein.



Name	Semantics	Sample OPD & OPL	Source	Destination
Consumption link	The process consumes the object.	Food → Eating **Eating** consumes **Food.**	consumed object	consuming process
Result link	The process generates the object.	Mining → Copper **Mining** yields **Copper.**	creating process	created object
Effect link	The process affects the object by changing it from one state to another state.	Purifying ↔ Copper **Purifying** affects **Copper.**	affected object and affecting process are both source and destination	

Figure 19: OPM Transforming Links (Source: Snhot, https://commons.wikimedia.org/wiki/File:OPM_Transforming_Links.png)



Name	Semantics	Sample OPD & OPL	Source	Destinati on
Agent link	Agent is a human or a group of humans who enables the occurrence of the process to which it is linked but is not transformed by that process.	Welder —● Welding **Welder** handles **Welding.**	agent – the triggering and enabling object	enabled process
Instrument link	Instrument is an inanimate object that enables the occurrence of the process to which it is linked but is not transformed by that process.	Machine —○ Manufacturing **Manufacturing** requires **Machine.**	instrument – the enabling object	enabled process

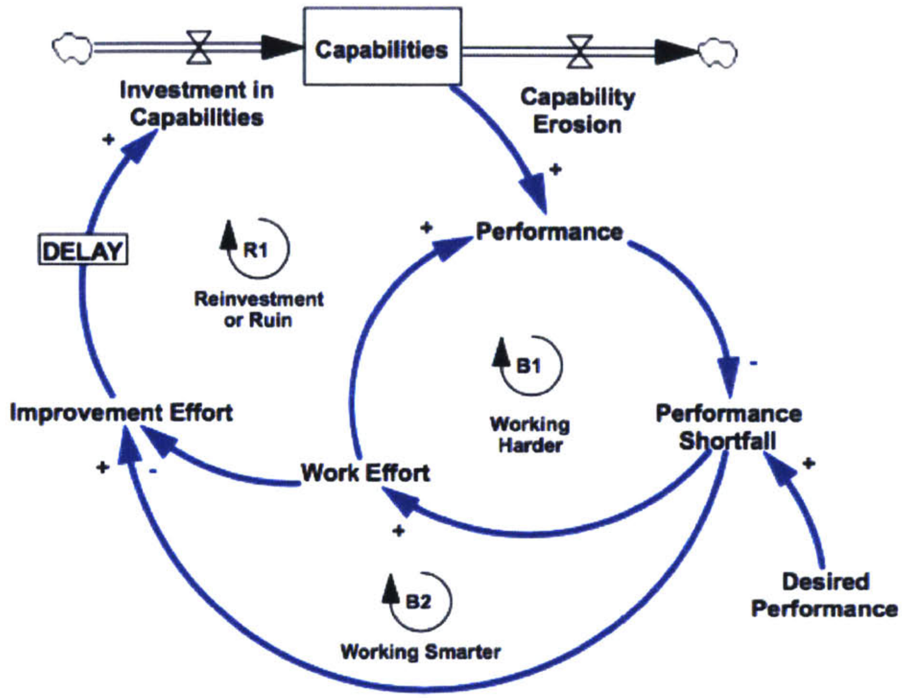
Figure 20: OPM Enabling Links (Source: Snhot, https://commons.wikimedia.org/wiki/File:OPM_Enabling_Links.png)

4.3.4 Causal Loop Diagrams and System Dynamic Models

System dynamics models, including causal loop diagrams and stock and flow diagrams, are thoroughly explained by Sterman in *Business Dynamics* [23], and are the subject of numerous articles and presentations publically available online. Causal loop diagrams are a graphical way of representing system feedback structure. Arrows from one variable to another have signs indicating whether the source variable causes an increase or decrease in the destination variable. A loop occurs when a series of two or more variables link back to a source variable. Loops can be either "balancing" or "reinforcing", and are designated by a capital "B" or "R" surrounded by a small arrow loop. Balancing means there are offsetting effects amongst the variables while reinforcing means that the relative increase or decrease of the effect, compared to what it would have been without the interaction, is bolstered. Per its name, all links in a causal loop "must represent what is believed to be causation and not just correlation because the diagram's intent is to model the structure and not behavior". [23]

Stock and flow diagrams represent the movement of an entity from one state to another. Stocks are accumulations, such as inventory of parts, number of people employed, operational hours for a cutter, and the backlog of maintenance projects. Flows are the mechanisms that control rate at which the stock moves from one state to another. Parts inventories can be altered by the inflow of purchases and the outflow of consumption. An employee stock can change based on the rate of hiring versus the rate of departure/transfer. Maintenance backlogs can be increased by the rate of maintenance requirements (i.e. how fast things are breaking) and decreased by the maintenance completion rate. Stocks are represented by boxes, and flows are represented by arrows with a valve symbol. Stocks external to the system boundary are depicted by clouds. The combination of causal loop diagrams and stock/flow diagrams can be used to model the dynamics of a given system, as depicted in Figure 21.

This particular model was chosen for illustrative purposes because it highlights a concept called the "capability trap", which will be further described in Chapter 5 as a fundamental problem facing the SI enterprise. The capability trap model shows that the stock of capabilities, generically speaking, is decreased by erosion and increased through investment. The larger the stock of capabilities, the higher the applicable level of performance. Performance increases will cause a decrease in performance shortfalls. Managers address performance shortfalls by increasing the level of work, or increasing the improvement effort. An increase in the amount of work effort typically leads to immediate increases in performance. This is noted by the balancing loop called "working harder". Improvement efforts lead to an increase in investment in opportunities, but that is only realized after a delay in time for the improvements to take effect. This is represented by the "working smarter" balancing loop. The delay in the improvement effort is described by Sterman as the "worse before better" effect. This is what sets the "trap", as managers tend to respond to the initial negative performance indicators by prematurely abandoning the improvement efforts.



Signs ('+' or '–') at arrowheads indicate the polarity of causal relationships: a '+' denotes that an increase in the independent variable causes the dependent variable to increase, ceteris paribus (and a decrease causes a decrease); formally, $X \xrightarrow{+} Y \Leftrightarrow \partial Y/\partial X > 0$. Similarly, a '–' indicates that an increase in the independent variable causes the dependent variable to decrease; that is, $X \xrightarrow{-} Y \Leftrightarrow \partial Y/\partial X < 0$. Boxes represent stocks; arrows with valves represent flows. A stock accumulates the difference between its inflows and outflows, e.g., $\text{Capabilities}(t) = \int[\text{Investment in Capabilities}(s) - \text{Capability Erosion}(s)]ds + \text{Capabilities}(t_0)$. See Sterman 2000.

Figure 21: System Dynamics Model of the "Capability Trap" (Source: Lyneis and Sterman, 2015) [24]

4.3.5 The Embedding Project Framework for Sustainability

The Embedding Project is an online resource for transforming business models from "*treating sustainability as an add-on* to *making sustainability the way they do business*." Figure 22 depicts the entire framework in what is called the "Embedding Wheel". The wheel is an interactive visualization that "outlines a portfolio of 60 business practices that help companies embed sustainability." [25] The website also contains a survey tool to evaluate the current state for each "pathway" on the wheel for a given enterprise.

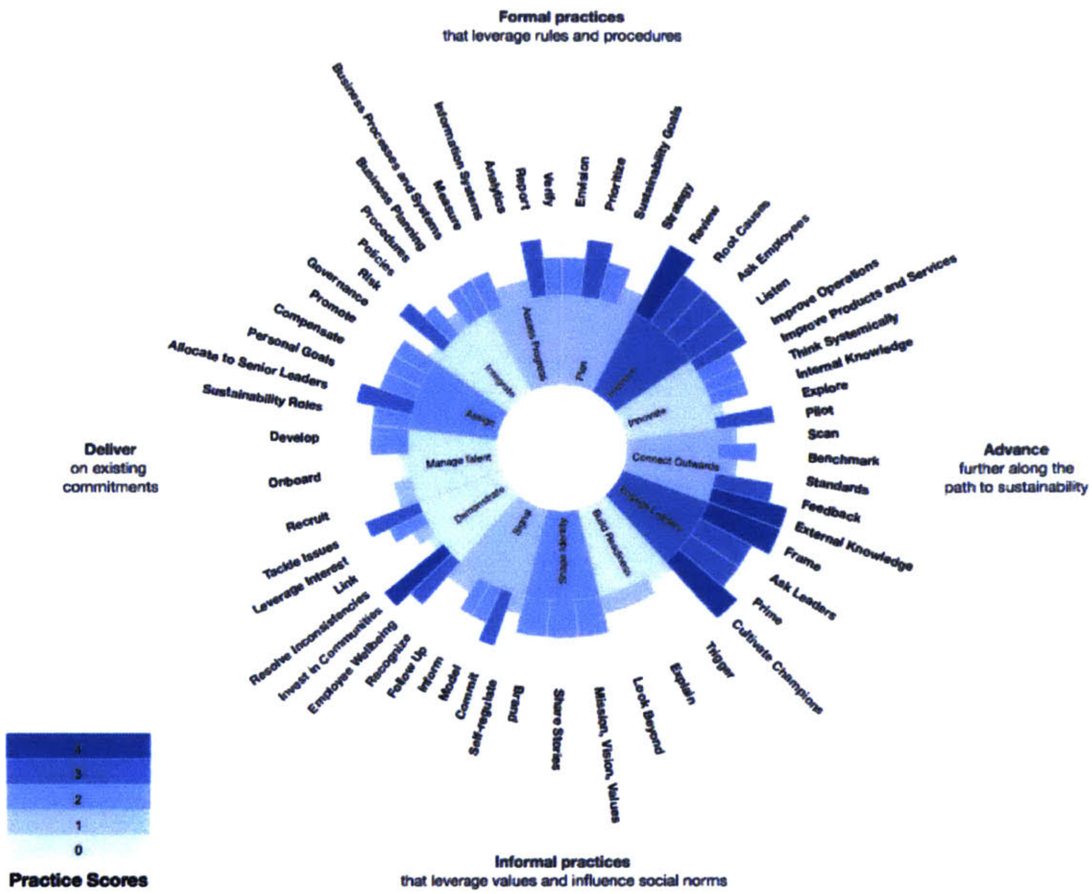


Figure 22: Embedding Wheel w/ Sample Data for Illustrative Purposes (*Source: The Embedding Project* [25])

4.4 Failure Modes and the Seven Imperatives

Five common failure modes identified by Nightingale and Rhodes are listed in Table 7.

Table 7: Common Failure Modes (Source: Adapted from Nightingale and Rhodes, p3-6)

	Architecting Failure	Application to current USCG SI Enterprise
1.	When in doubt, reorganize	Many enterprises use reorganizations to deal with short term challenges. This can be counterproductive if done in isolation of the other elements
2.	Forgetting Stakeholders	Enterprises often assume they understand stakeholder needs and do not consult them as part of the transformation effort, or they may fail to include stakeholders such as employees
3.	It's all about technology	Technology is often assumed to be the central, if not the only, factor in the transformation effort without due consideration of other critical aspects
4.	Silo Effects	Enterprises often optimize only one aspect, either an enterprise element or a specific function, in isolation of others
5.	IT will solve everything	IT solutions are often pursued without due consideration of enterprise strategic imperatives and organizational factors

The seven architecting imperatives and their respective justifications are listed in Table 8. These imperatives help further justify why an architecting approach makes sense for the SI enterprise. These imperatives should be revisited prior to the actual implementation process.

Table 8: Architecting Imperatives and their Respective Justifications

	Imperative	Reasons to apply this imperative to USCG SI Enterprise [17, pp. 139-145]
1.	Make Architecting the initial activity in the transformation process	• Expands space for innovation to occur • Increases opportunities for effective communication among stakeholders • Helps mitigate risk & to identify future opportunities • Increases the probability of selecting the "right" architecture by generating alternatives before jumping to a solution
2.	Develop a Comprehensive understanding of the enterprise landscape	• Understanding the potential impact of uncertainties in landscape factors enables better decisions in choosing architecture fit for the future • Landscape is always changing, and architects must remain current • Rarely does one person have a comprehensive view, so a devoted effort can avoid false assumptions
3.	Understand what stakeholders value and how that may change in the future	• Provides insights as to what changes must be made to deliver value • Invokes dialogue needed to make difficult strategic decisions • Enables value gaps & anticipated value shifts to be discerned
4.	Use multiple perspectives to see the whole enterprise	• Complex enterprises can only be seen through a parts perspective • Using the ARIES ten elements collectively, these "lenses" enable parts to be seen in the context of the whole • Enables an understanding of the interfaces and interrelationships of the elements, which can often be used as leverage points for transformation
5.	Create an architecting team suited to the transformation challenge	• Every transformation is unique, and decisions must be made under conditions of uncertainty and with incomplete knowledge • Diverse teams who can think beyond their given silos can enable the best opportunity to view the enterprise holistically
6.	Engage all levels of leadership in the transformation effort	• Architecting emanates from highest levels of the enterprise & is dictated by strategic considerations • Empirical data shows transformations fail when leaders at all levels do not facilitate access to information required by the architecting team • Enables focus on the right objectives, allocation of appropriate resources, access to external stakeholders, and glimpses into future direction
7.	Architect for the enterprise's changing world	• Forward looking perspective is needed to design an enterprise suitable for the envisioned future • Enables anticipation of probable changes, as well as accommodation of unanticipated changes

Chapter 5 – The Problem Domain: ARIES Process Steps 1-3

"If I had only an hour to solve a problem, I would spend fifty-five minutes on the problem and five minutes on the solution"

- Albert Einstein

Though the Problem Domain consists of only three major steps, it requires the abundance of time for analysis. Per the opening Einstein quote, such attention to problem definition greatly facilitated the process steps and the techniques used in the solution domain.

5.1 Understand the Enterprise Landscape

Building on the overview presented in Chapter 2, this section analyzes the SI enterprise's core values, strategic imperatives, required capabilities and key landscape challenges to identify the drivers for transformation. Given the ecosystem boundary conditions defined in Chapter 2, the techniques used here examine the enterprise's core values while defining the strategic imperatives and internal landscape. Heuristics are used to analyze and visualize the key landscape factors presenting challenges to the current architecture and to define the capabilities required to meet those challenges. The SI enterprise is then analyzed in the context of the Cynefin framework to demonstrate why the current architecture may not be sufficient to address aspects of the landscape that are "unordered". Finally, the landscape is summarized in terms of key ARIES Framework "consideration factors".

5.1.1 Technique 1: Core Values, Strategic Imperatives and the Internal Landscape

The Coast Guard's Core values of "Honor, Respect and Devotion to Duty" have been so codified since 1994 and reflect the core principles upon which the Service has stood for over 226 years. These values will continue to stand the test of time and support many positive "soft properties", particularly the emergent value of the "stewardship culture", which is especially strong within the SI enterprise. Other positive emergent properties stemming from these core values are trust, loyalty and ethical conduct. While not a direct driver of transformation for the SI enterprise, the core values form the foundation for the DCMS vision to provide "excellent and sustainable support for all Coast Guard missions" [26]. To achieve this vision, the SI enterprise must pursue and embody a set of forward-looking "strategic imperatives" that can be logically induced from each strategic priority listed in SILC's

5-year strategic plan. Table 9 shows that, while the SI enterprise's strategic imperatives are aligned with the core values and vision, the current organizational resources and/or capabilities are not. This analysis supports the earlier assertion that the existing organizational structure is not properly aligned with strategic priorities, particularly in terms of reconciling the desired levels of service with resources.

Table 9: Strategic Priorities, Imperatives and Existing Capabilities

Strategic Priority [3]	Strategic Imperative	Organizational Element [3]	Analysis of Current Resources and Capabilities to Achieve Objectives Related to Strategic Priorities
Optimize Shore Portfolio	Sustainability through innovation & Standard Service Delivery	ESD, RMB, BOD & ALD	Resources & capabilities exist for the execution of the related initiatives, but not to effectively overcome internal & external perception obstacles
Mature OLM Program	Sustainability through innovation	Facility Management Branch (FMB)	Temporarily resourced through contracts; limited capabilities due to organizational hierarchical structure & OLM visibility
Enhance & Leverage IT	Efficiency through innovation and Std Service Delivery	Business Operations Division (BOD)	Org element created in SILC 2.0 provides some capabilities, but it is under resourced & not billeted for critical skill sets. Temporary contracts are making only minimal progress.
Strategically Manage AC&I Program	Sustainability through innovation & Standard Service Delivery	Engineering Services Division (ESD) & FDCC	Resources and capabilities exist, but there has been little success in articulating SI needs, especially given the Shore Facility Requirements List (SFRL) lags requirements.
Acculturate MSBM	Standard Service Delivery	Shared Service Divisions	Understanding of MSBM varies widely between Divisions; Temporarily resourced through contracts
Promote Value of Shore Infrastructure	Engaged Leadership & Standard Service Delivery	ESD & BOD	Resources and capabilities are insufficient – this contributes to the lack of success in articulating SI needs within the USCG and via external reports
Cultivate Workforce Competencies	Engaged Leadership	BOD & Other Shared Service Divisions	Severely under resourced and limited organizational capability
Improve Contingency Prep/Response	Resilience through Engaged Leadership & Std Service Delivery	ESD & Other Shared Service Divisions	Under resourced and limited capabilities due to IT constraints & coordination issues with USCG entities outside of the SI enterprise
Lead Enviro & Energy Stewardship	Sustainability through innovation & Standard Service Delivery	Environmental Mgmt Division (EMD)	Capabilities & resources are not strategically allocated, nor are capabilities consistent across the enterprise, particularly at small units
Sustain CFO Act Compliance	Sustainability through innovation & Standard Service Delivery	Real Property Branch (RPB) & Asset Log Division (ALD)	Capabilities exist but resources are insufficient given the work backlog, despite huge expenses for temporary contracts that have now expired. SILC has defined the need for 20 additional billets.

Presents challenges to achieving SILC objectives
Is neutral to achieving SILC objectives
Facilitates or presents opportunities for achieving SILC objectives

5.1.2 Technique 2: Landscape Factor Analysis & Fishbone Diagram

The full landscape factor analysis is in Appendix A. The fishbone diagram in Figure 23 is an effective way to visualize the key challenges from the landscape factor analysis. These techniques are used to further condense landscape challenges into three categories: (1) *Resource constraints* (money and billets) due to ambiguity and/or the inability to effectively articulate needs in comparison to operational and competing logistical resource demands; (2) *Knowledge and capability gaps* due to frequent military personnel transfers, the growing number of civilian employee retirements, and an allocation of skills based on antiquated requirements; these gaps are compounded by lethargic human resource (HR) and SILC information technology (IT) systems; (3) *Increasingly stringent standards* and higher expectations with respect to the sustainability, resiliency and accountability of shore infrastructure. This includes Executive Orders and OMB guidance for energy/water intensity reduction, facility footprint reduction and standards for the efficient use of real property. [27]

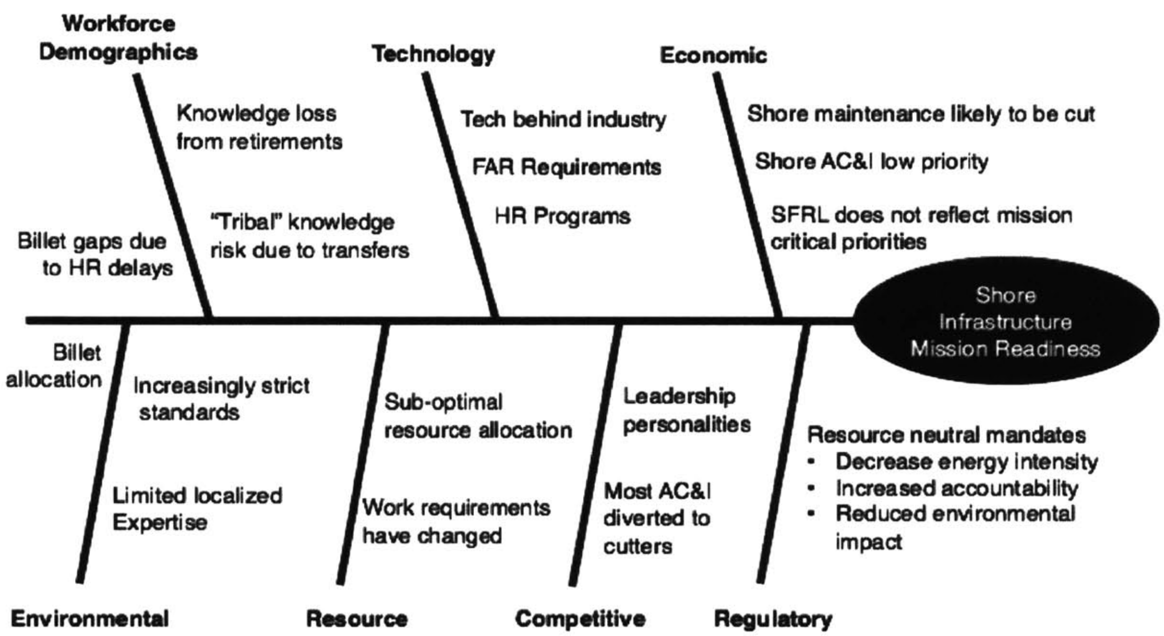


Figure 23: Fishbone Diagram of Landscape Factor Analysis

The USCG's landscape challenges are consistent with findings from a recent GAO report (the USCG was one of the agencies studied) which noted that "despite successes, the agencies continue to face long-standing challenges with excess and underutilized property and maintenance and repair backlogs due to a complex disposal process, competing stakeholder interests, and limited funding". [28]

5.1.3 Technique 3: Enterprise Capability Analysis

Table 10: SI Enterprise Capability Definitions and Analysis

-ility	Definition Applicable to SI Enterprise	Analysis
Adaptability	Ability to sustain value delivery by transforming to respond to changes in its ecosystem	Med: There was considerable resistance to change by some, but many championed the new org and the MSBM. All project mgmt goals met during the transformation process
Agility	Ability to shift rapidly from one strategy to another to sustain enterprise value delivery	High: Successful examples include CFO Audit efforts, Superstorm Sandy recovery & support of the Deepwater Horizon oil spill response
Competitive-ness	Ability to deliver SI products and services that provide **perceived** value to stakeholders, equal to or greater than that of the other logistics centers competing for funds	Low: Operative word in the definition is "perceived" value. SI enterprise must do more to change perceptions of shore infrastructure from that of overhead to that of mission enabler
Evolvability	Capacity of the SI enterprise to transform by leveraging successful features of the current EAM architecture	High: Though "change weary" from the on-going transformation, key leaders are becoming more amenable to gradual changes if part of a larger plan
Effectiveness	Ability of the SI enterprise to maintain facilities at the appropriate "Operational Effectiveness" level (Eo)	Med: Technical capabilities exist and ALMs have defined Eo targets, but the necessary TAV is a work in progress
Resiliency	The ability of the SI enterprise to design resilience into all facilities to enable USCG operational units to recover quickly from disruptive events	Med: Resilience has become a major factor in all new construction, and a growing factor in maintenance activities.
Responsive-ness	Ability to respond in a timely & effective way to emergent stakeholder needs, threats & opportunities, including SI casualty reports & asset configuration change requests	Med: Very responsive to SI causalities, but there are considerable differences in interpretation as to what constitutes an SI casualty. Configuration change process is in its infancy
Robustness	Ability to sustain consistent value delivery in spite of changes and perturbations in the ecosystem	High: SILC has persevered through hiring freezes, budget cuts, external mandates & government shutdowns
Scalability	Ability to expand or contract the SI enterprise in order sustain value delivery	High: The underlying military chain of command culture is built for such expansion & contraction through short-term resource reallocations & contracts
Sustainability	Capacity of the SI enterprise AND its assets to endure over time as related to economic, environmental and/or social dimensions	Med: SILC has led sustainability in CG, but it has been mainly driven by grass-roots efforts; sustainability must be embedded into activities vice add-on

Table 10, adapted from Nightingale and Rhodes [17, p. 38], shows the necessary capabilities for the SI enterprise to satisfy the strategic imperatives and priorities above. The analysis column evaluates the current enterprise using a "high-medium-low" scale to describe the degree of alignment with the desired capability. The analysis finds the SI enterprise has opportunities to improve competitiveness, effectiveness (specifically TAV), resiliency, responsiveness (in terms of standardizing what does and does not warrant immediate response), and sustainability. Given the high agility and "evolvability", in comparison to adaptability, the SI enterprise is better suited for a gradual transformation process than another major upheaval of radical change.

5.1.4 Technique 4: Cynefin Framework for Landscape Context

The SI enterprise has traditionally operated in the "complicated" domain. This domain requires classic engineering problem solving skills and SILC 2.0 is well suited for challenges in this domain. Many SI projects and initiatives exist in the complicated domain, but an increasing amount of challenges now fall (or can fall) into the "complex" domain. Per the Cynefin Framework, an organization operating in the complex domain must grant leaders the flexibility to "probe, sense and respond" by "creating environments that allow patterns to emerge, increasing levels of interaction and communication", and innovating ideas. [4] In addition, the SI enterprise faces situations in the "chaotic" domain when responding to and recovering from contingency events such as hurricanes, earthquakes, and events of National Significance, such as a major oil spill or a mass over-sea migration of Foreign Nationals to the U.S. Some facility casualty scenarios, such as a fire, can also be chaotic.

Understanding the context in which SI activities and situations fall enables the proper response. The enterprise architecture can either facilitate or hamper the ability for leaders to understand and respond properly. Leaders in an enterprise designed to focus on only one domain, for example "complicated", may not be able to ever properly make sense of complex issues, and may even make "simple" problems more complicated than they need to be. An example of this latter category could be the common practice of developing full plans and specification details for relatively mundane projects such as replacing roof coverings in-kind. Table 11 plots a sampling of SI enterprise activities in their most applicable domain. This illustrates that managing the built environment within a government agency routinely involves situations with aspects or activities falling into all four domains.

Table 11: "Typical" Domains of Selected SI Activities

Complex • Developing Sustainable Asset Investment Strategies • Budgeting Process • Project Management in Politically or Environmentally Sensitive Areas • Project Prioritization • OLM management across commands • Gov't owned housing management *Probe, Sense, Respond*	**Complicated (or "knowable")** • Multi-disciplinary Design Engineering • Establishing Process Guides • Most Contracting Actions • New Construction where Requirements have been vetted • Utility Asset Line Management *Sense, Analyze, respond*
Chaotic • Hurricane Response & Recovery • Events of National Significance • Critical Facility System Failures • Wartime Operation Facility Support *Act, Sense, Respond*	**Simple (or "known)** • Preventive Maintenance • Record keeping • Property Accountability • Most Base Support Activities *Sense, Categorize, Respond*

5.1.5 Summary of Enterprise Landscape

The USCG core values are aligned with the strategic imperatives of improving the efficiency, sustainability and resilience of USCG SI through innovation, standard practices and engaged leadership, but the current resources are insufficient and are not optimally distributed to meet strategic objectives. The primary challenges facing the SI enterprise are resource constraints, knowledge and capability gaps, and increasingly stringent regulatory and operating requirements. The pace of change for factors involving resources and requirements are either unpredictable or quickening, which indicates the SI enterprise cannot be complacent. The key SI enterprise capabilities needing improvement are resiliency, competitiveness, effectiveness, responsiveness, and sustainability. The SI enterprise is better suited for "evolutionary" architectural changes over time vice "revolutionary" changes all at once. Finally, the SI enterprise operates in both the ordered and unordered Cynefin contextual domains, and therefore must have the enterprise knowledge for understanding each context and the organizational flexibility to respond appropriately. The findings above reveal the primary drivers for transformation as (1) the quest for improvement, (2) competitive and economic forces related to limited funding, (3) workforce factors, such as morale capabilities, and (4) the natural evolution of the organization.

5.2 Perform Stakeholder Analysis

This section analyzes the diverse set of stakeholders identified in the landscape analysis to gain an understanding of what value the SI enterprise provides to stakeholders and the USCG as a whole, as well as what the SI enterprise may value from those stakeholders. Understanding this value exchange is crucial to identifying the functions around which an enterprise strategy should be developed. The interactions and dependencies among stakeholders are investigated and visualized. This section also evaluates the relative importance of stakeholders, as well as the relative importance of each of the ARIES "view elements" to these stakeholders.

5.2.1 Technique 5: Stakeholder RASCI Analysis

Jacobs worked with asset line managers (ALMS) to identify key stakeholders and their roles related to key asset line functions. An example of their analysis for the Shore Operations Asset Line, called a RASCI Matrix, is shown in Figure 24. The name is based on five roles a stakeholder can perform with respect to a task: Responsible, Accountable, Supports, Consulted and Informed. Definitions for each role are provided in the postscript of Figure 24. The RASCI is a proven tool for clarifying and communicating expectations. The 12 charts produced by Jacobs and the ALMs provided a comprehensive list of over 50 unique stakeholder groups. The RASCI analysis helped identify commonalities amongst groups and the nature of the interactions between these stakeholders.

Key Stake Holder Analysis (Shore Operations Asset Line)											
Key Stakeholder	Identify with RASCI code:* R - Responsible; A - Approver; S- Supports; C - Consulted; I - Informed										Information provided (Focus on physical and functional baseline status, budgeting, prioritization, allocation)
	Standards	Project Prioritization	Capital & Depot Program Mgmt	Assess Physical Baseline	Preventative Maintenance Stds & Oversight	Technical Authority/SME Coordinator	Management & Sustained Portfolio Data Requirements	Configuration Audit Mgmt	Funds Management	Training	
Base		S	S	S	S					S	Needs and conditions of units, maintenance requirements, local maintenance execution, assistance with data calls
CEU Execution Sections	S	S	S	S	S	C			S	S	Regional project oversight, engineering of proposed configuration standards and projects. FAMs can be used to gather data used by the Shore Operations asset line
Districts		S	S		S						Needs and conditions of units, maintenance requirements
Facility Asset Managers (FAMs)	C	S	S	R	R	C	I	C	I	I	Provide input for the prioritization of projects for their assigned area of operation (AOR). Responsible for knowing the condition and configuration of the real property assets that exist in their AOR
Facility Design and Construction Center (FD&CC)	S		S								Liason for AC&I project management and development
Facility Engineer	C	S	S	R	R	C	I	C	S	C	Needs and conditions of units, maintenance requirements, local maintenance execution, data call gatherer
Health, Safety & Work-Life (HSWL)	S					S					Coordinate for hazmat, safety issues and safety requirements of assets
Office of Civil Engineering (CG-43)	I	A	A			C			A		Establish policy that is used to establish configuration standards. Oversees the shore maintenance program CG wide
Operations Systems Center (OSC)	C					C					Communications and technical capabilities and requirements that need to be taken into account when drafting TOs for assets
Sectors		S	S	S	S						Current systems in place, report problems to become projects for prioritization needs, configurations. Provide assistance with data calls for their AOR units
Shore Infrastructure Logistics Command (SILC)	A	S	C	R	R	R	A	C	R	A	Policy, manage national AFC43 funds, manage business model implementation, coordinate CCB for TO approval
Shore Operations Asset Line Manager	R	R	S	S	R	R	R	R	S	S	Equipment specific information, develop configuration standards, future center of excellence and one-stop-shop for Shore Operations assets
Small Boat Units		I	I	S	I					I	Current systems in place, report problems and needs to become project, report conditions of unit, executes maintenance tasks
Surface Forces Logistics Center (SFLC)	S			S		C					Ship/boat types and their configurations, future facility needs, overall surface asset policy
TACOPS Product Line Manager	R	R	S	S	A	A	R	R	A	A	Directly responsible for the product line at the CEU Level

* RASCI codes defined:
R - Responsible – Those who do the work (typically only one Responsible per task)
A - Approver – The one ultimately accountable for the deliverable or task (must have only one Approver per task)
S - Supports – Those who provide resources, information, expertise or other assistance in completing of the task
C - Consulted – Those whose opinions are sought (two-way communications)
I - Informed – Those who are kept up-to-date on progress (one-way communication)

Figure 24: RASCI Analysis for Shore Operations Asset Line (*Source: Jacobs AL Stakeholder Report, Unpublished*)

5.2.2 Technique 6: Stakeholder View Element Analysis

The RASCI analysis was very useful for ensuring all stakeholders were considered, particularly those who may be unique to a specific asset line. However, analyzing 50 stakeholders is laborious and there are diminishing returns in dividing stakeholders too discretely. To more efficiently analyze stakeholder requirements, unit types were grouped based on their place on a continuum of proximity to mission execution (the proverbial “pointy end of the spear”). As depicted in Figure 25, abstracting stakeholders based on commonality of needs/values along the continuum yielded nine main groups –

the seven USCG entities shown, plus the American Public and Congress/Office of Management and Budget (OMB).

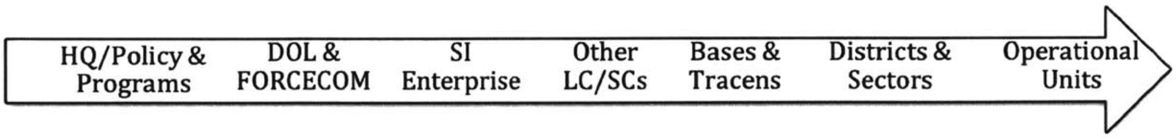


Figure 25: "Spear" Diagram Showing USCG Stakeholder Abstractions Along Mission Execution Continuum

These abstracted groups were then evaluated against the ARIES "view elements" to determine which elements will be most critical for future value delivery. Table 12 shows that information, infrastructure and product (as previously defined in Table 6) hold the most importance amongst stakeholders. While the sum of the view elements does NOT constitute a whole view of the enterprise, it is interesting to note that, outside of the SI enterprise itself, Bases/Training Centers and Operational Units appear to the hold the highest interest in SI enterprise activities. This makes sense given that these units typically have local "landlord" responsibilities at a given site and depend directly on the wide variety of assets types maintained and managed by the SI enterprise. In contrast, the other unit-types typically operate primarily out of office spaces as "tenants" at a given site.

Table 12: Stakeholder/View Element Analysis

Importance of Views from each stakholder (H-high (3 pts), M-medium (2 pts), L-low (1 pt)

Stakeholder	Strategy	Information	Infrastructure	Process	Product	Services	Organization	Knowledge	Score:
USCG HQ Programs	H	H	M	L	M	L	H	M	17
DOL / FORCECOM	H	L	M	H	M	M	M	H	18
SI Enterprise	H	H	H	H	H	H	H	H	24
Other Logistics & Service Centers (LC/SCs)	M	M	M	H	M	M	M	L	16
Training Centers & Bases	M	H	H	M	H	H	M	M	20
Districts & Sectors	M	H	M	M	M	M	L	M	16
Operational Units	L	H	H	M	H	H	M	M	19
American Public	L	M	M	L	M	L	L	M	12
Congress & OMB	M	H	M	L	L	L	L	M	13
Score:	19	23	21	18	20	18	17	19	

The recent GAO report on federal real property transparency further highlights the importance of the information element. According to the report, "Officials from the Coast Guard, which reported 79 percent of the buildings had no repair needs, stated that they have not surveyed the condition of all of their buildings." [28] This statement indicates a disconnect between information shared within the SI enterprise and the information shared outside the USCG. Such a disconnect could have significant budget scoring implications and therefore should be a major emphasis of the architecting effort.

5.2.3 Technique 7: Stakeholder Value Exchange and Value Map

A value exchange for each stakeholder identified the values expected by and contributed to the SI enterprise. An excerpt of this analysis is shown in Table 13.

Table 13: Excerpt from Stakeholder Value Exchange for Operational Units and HQ Programs

Stakeholder Value Exchange Data Collection

Value expected from SILC	Stakeholder	Value contributed to SILC
O&M Guidance & Training	Operational Units (Cutters, Aids to Navigation Teams, Boat and Air Stations)	Performance of OLM and OLO
Depot Needs Prioritization		Reporting of OLM & OLO
Environmental Guidance		Feedback on SILC Products & Services
Real Property Services		Reporting of facilty discrepancies or deficiencies
Depot Project Management		On-site observation of contractors
Shore Energy Management Capability		Project Design review feedack
Single Point of Contact for Facility Issues		Management of "Self-Help" projects
Responsiveness to Shore Casualties		
O&M Tracking System		
Stewardship of Tax Dollars	HQ Level Programs (DCMS, CG-4, CG-9, CG-43, CG-46 & CG-47)	Funding allocation
Implementaton of Policy		Policy Direction & Support
Cost Implicatons of Requirements		Clear Capability Requirements for SI
Timely, Accurate Information for External Reports and Strategic Decisions		Clear Descriptions of Information Needed

The values expected from the SI enterprise were then rated in terms of importance and quality of delivery for each stakeholder. An excerpt for operational units is shown in Table 14.

Table 14: Value Exchange Assessment for Operational Units

Value expected from enterprise	How Important is this Value?	How well is Enterprise Delivering?
O&M Guidance & Training	5	3
Depot Needs Prioritization	4	3
Environmental Guidance	4	3
Real Property Services	3	4
Depot Project Management	4	5
Shore Energy Management Capability	3	4
Single Point of Contact for Facility Issues	4	4
Responsiveness to Shore Casualties	5	4
O&M Tracking System	4	2

This data was plotted for each stakeholder in Figure 26 to visualize the key focus areas. The value map represents a "trade space" to help enterprise architects determine which value shifts will be most important over time, and where they should focus their efforts. As highlighted in red, O&M tracking represents an area to focus upon because it is an important value is not being delivered at the desired service level. O&M training, casualty responsiveness and depot prioritization deserve more attention given their importance, while shore energy management, real property and depot project management are all currently being performed at levels commensurate with the relative importance assigned by operational units.

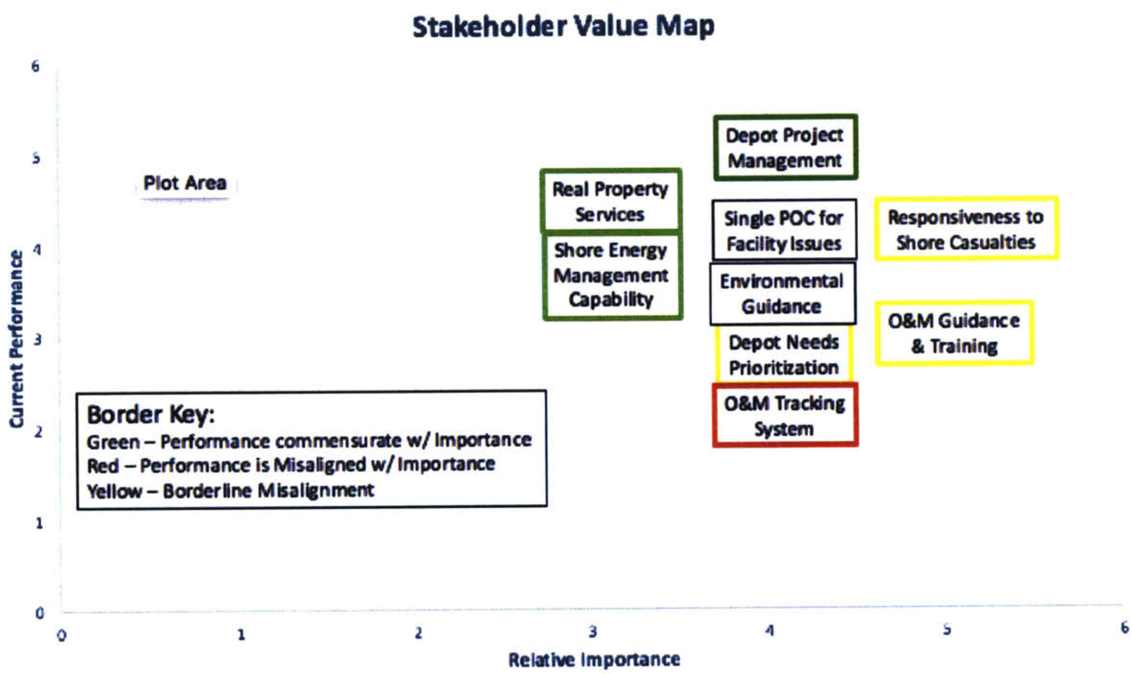


Figure 26: Stakeholder Value Exchange Map

5.2.4 Technique 8: Stakeholder Value Network (SVN)

A Stakeholder Value Network (SVN) shows the type and strength of interactions amongst stakeholders, and can be very useful in understanding the interfaces that must be managed in order to deliver value. Figure 27 shows the SVN for the abstracted stakeholder groups. The types of units that typically have "landlord" responsibilities for a given site are outlined in purple. These include (1) bases and Training Centers (TRACENS), which are typically large installations with a dedicated shore maintenance staff, and (2) operational units, especially air stations and boat stations which are medium to small size installations with collateral shore maintenance staffs. Some sectors may also have landlord responsibilities, but that is not shown at this level of abstraction since sectors and districts are being viewed as operational command and control entities. Landlord responsibilities in the context of this SVN are to perform organizational level maintenance (OLM/OLO) and to manage the local needs of tenant units, if applicable. Key observations are summarized below:

First, the minor OLO/OLM interaction (thin blue line) from operational units is indicative of the shore maintenance staffing (or lack thereof) and a host of other issues, like training deficiencies, high turnover due to military transfers and competing priorities. Next, the major information exchange between Bases/TRACENS and the SI enterprise is due to dedicated shore staffing and performance reporting chains for FE's under the matrix hierarchy. Given the importance of information determined via the element analysis in Table 12, the minor information exchanges from the SI enterprise to other external stakeholders should be upgraded to major exchanges through a better O&M IT tracking system. Third, there is no exchange of financial resources for goods or services, so market forces that might motivate entities to perform O&M are not at play. The bulk of funds allocated via the budget model for OLO/OLM are distributed at the discretion of the sectors and base commands, not per the needs determined by SILC. This unique for the SILC as the other LC/SCs have funds that cannot be "taxed" by field commands. Such "taxes" vary by region and negatively impact SI O&M capabilities. The "self-help" funding provided by the SI enterprise is for specific projects, and constitutes a very small percentage of the overall maintenance need. Finally, even in this very simplified view, landlord units have a host of interactions which tend to draw attention away from landlord responsibilities.

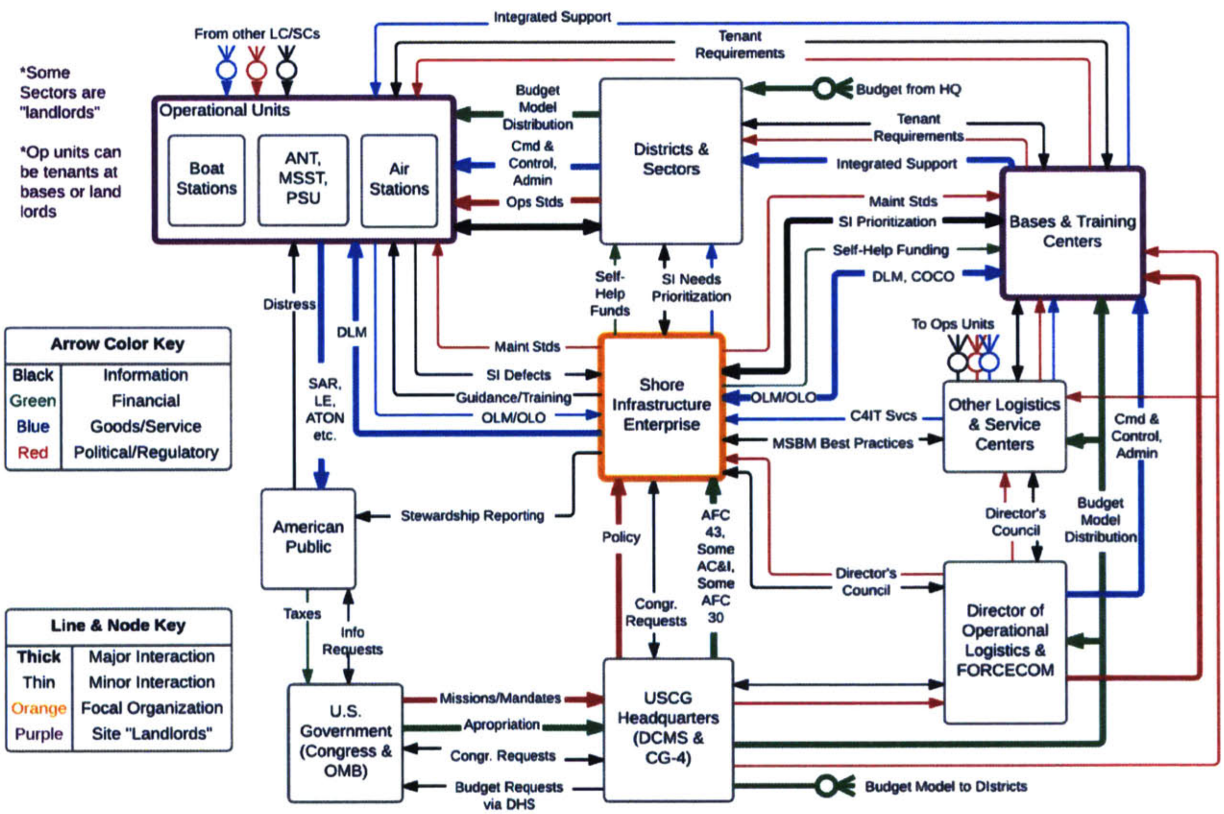


Figure 27: Simplified SVN for SI Enterprise

5.2.5 Technique 9: Dependency Structure Matrix (DSM)

A DSM can be very useful in identifying key groupings of stakeholders based on the interactions shown in the SVN. Figure 28 shows these interactions in a matrix format, using the same color coding for the nature of the interaction (i.e. green for financial, red for policy, black for information and blue for products/services). Like the SVN, this is not a comprehensive listing as only interactions relevant to the SI enterprise are analyzed. However, the DSM does show some of the informational dependencies that were purposely omitted (for clarity) from the SVN.

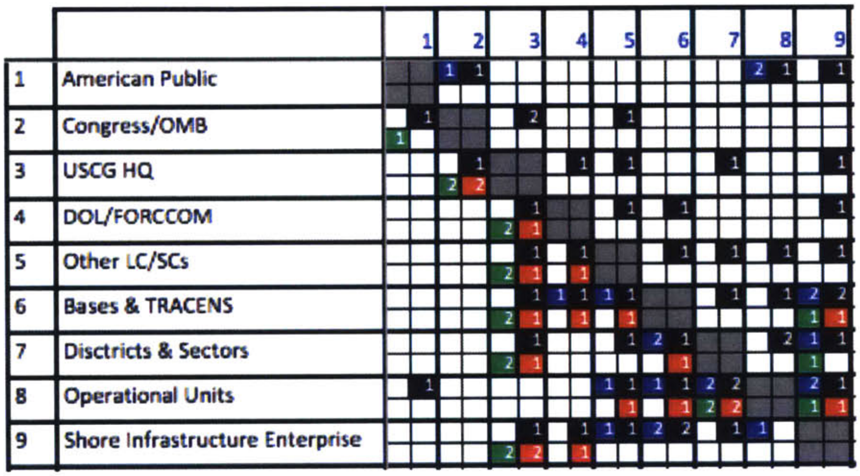


Figure 28: Initial Dependency Structure Matrix for Shore-Related Activities

This initial DSM was essentially ordered from the "back of the spear" to the "pointy end", with the exception of the focal organization, which was listed last. The partitioned DSM in Figure 29 shows the mathematical groupings of stakeholders based on the total strength of the interaction. Though a more detailed breakdown would provide better granularity, this high level partition reveals several interesting concepts:

First, when addressing issues with the public and/or Congress (aggregated in the red box as "constituents"), it is important not only for the applicable HQ entities to be involved, but for the local Base if the issue is localized, and/or the other LC/SCs if it involves funding or policy issues. In the latter case, a united front would likely improve the quality of the interaction. Next, establishing that united front would take the collective interaction of the "logistics" (blue box) and "integration" (purple boxes) stakeholders. Third, the applicable LC/SCs should also be involved in coordination with the "Ops" grouping shown in the green box. This makes intuitive sense given the inextricability of the shore facilities and other operations support platforms (i.e. communication systems need towers, boats need docks, etc). Finally, the "integration" grouping reinforces the important coupling of Bases and the SI enterprise, especially through the "FE Outside the Fence line" initiative and the normal interactions coordinated by SILC's Facility Management Branch. The partitioned DSM also indicates that there may be benefits for the SILC to have tighter organizational ties with organizational elements within headquarters due to the shared ubiquity of their interactions related to SI activities. While SILC 2.0 currently has FAMs to manage the interfaces with "OPS", and the ALMs to interface with "Logistics", the interfaces with HQ (specifically budget programming and external relations) and "constituents" has historically been situationally based. The SI enterprise, and by extension the USCG's mission readiness, could benefit from an organizational element specifically focused on such stakeholder engagement. This concept reinforces the argument that the SI enterprise boundary must include the applicable HQ and OLM entities.

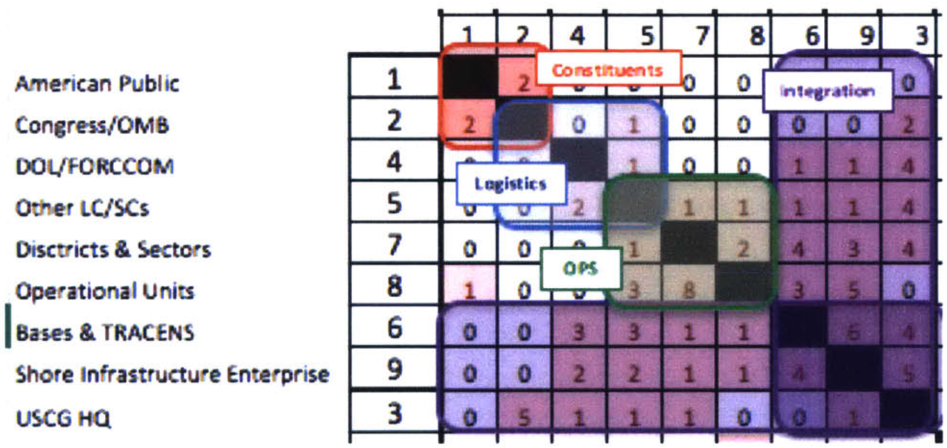


Figure 29: Partitioned DSM Showing High Level Groups

DSMs can also help in identifying more efficient groupings of internal stakeholders. A divisional breakdown of stakeholders within the SI enterprise could be analyzed according to the frequency of interaction amongst elements, denoted by a number. The higher the number, the more frequent the interaction. A partitioning analysis would be very helpful in the design phase of the future enterprise because it would identify efficient groupings of the organizational sub-elements.

5.2.6 Summary of Stakeholder Analysis

The stakeholder analysis techniques above all indicate that operational units and bases/TRACENs are the stakeholders most important to the SI enterprise, followed closely by organizational elements at USCG HQ. The importance of these three stakeholders is not likely to change appreciably over time, but the "FE outside the fence line" initiative, where FE's from Bases/TRACENs become a more integral extension of the SI enterprise to operational units, may change the dynamics of the value exchange amongst these stakeholders. In addition, it seems that the relative importance of the other LC/SCs will also increase over time, particularly given the interactions shown in the partitioned DSM, where other LC/SCs are coupled with the "constituent" stakeholders and "Ops" stakeholders. A more detailed SVN and DSM analysis that disaggregates the individual LCs and individual HQ organizational elements would provide more specific insights.

The current gaps in stakeholder value delivery in terms of importance vs. performance are primarily related to O&M issues. Several initiatives are already underway to address this gap[4], and architectural considerations will be applied to these issues later in this report. As the SI enterprise continues to focus on this area, other values are likely to become more important over time, and current performance standards will increase commensurately. Given that recent Executive Orders and legislation have mandated stricter sustainability and accountability standards, values related to environmental guidance, energy management and real property accountability will most likely become more important, and the required level of service will increase. This too will be an architectural consideration discussed in Chapter 6.

In terms of designing future value delivery, the view elements of *information*, *infrastructure* and *product* will be critical. Improving the IT infrastructure and the delivery of informational value will demand very close coordination with the C4IT SC in order to get the SI enterprise's IT systems aligned with TAV goals. As determined in the ecosystem analysis, physical infrastructure improvements will be increasingly measured in terms of facility efficiency (right facility in the right place at the right time), sustainability, and resiliency. The Product and Service elements can be improved through engaged leadership, innovation, and standardized services that are centered on the stakeholder values discussed above. One advantage the SI enterprise has in this regard is that many officers rotate between jobs within most of the stakeholder communities. Officers with this cross-stakeholder experience should be part of the future architecting team to ensure stakeholders values are properly represented. In cases where a stakeholder may be under-represented, the architecting team should recruit a representative from that community.

[4] Most notably the "Equipment Enrollment" initiative to address O&M tracking system issues and "FE Outside the Fence Line" to address training issues.

5.3 Capture Current Architecture

This section begins with a retrospective look at the development of the SILC 2.0 architecture and uses several techniques to describe that architecture from different perspectives. It then looks at the current system dynamics within the SILC 2.0 architecture to identify some of the challenges that may need to be addressed as part of the architecting effort.

5.3.1 Technique 10: Architectural Decision Analysis

Revisiting and analyzing the architectural decisions made during the last transformation can provide useful insights into the current architecture. "Architectural decisions" are a subset of design decisions that are most impactful because they relate form-to-function mapping, encode key-tradeoffs and often strongly determine costs. [29, p. 197]

Table 15: Architectural Parameter Analysis of SILC 2.0

Parameter	SILC 2.0 Analysis
# of architectures w/in the internal ecosystem	Five. Three for SI product delivery: *Capital construction, depot repair, and local operations & maintenance (O&M).* The key distinctions amongst the architectures are funding stream, workforce organization (national, regional, or local) and execution vehicle (Design-build, design-bid-build, in-house). Two architectures for integration: *Product Lines* and *Shared Services*
# of potential configurations	At least a dozen. Over the past 30 years, the USCG has used three different configurations for SI service delivery. There are also numerous variations amongst the other Armed Services and private industry
Architectural documentation	The architecture was released internally through a series of "technical orders". The Technical Orders govern the form and function of the respective sub-components, and also map form to function. It is currently disjointed, but a Technical Order hierarchy has been developed & a configuration manager is in place to manage documentation
Architectural Approval process	The SILC 2.0 approval process took over two years due to internal sensitivities related to billet changes. Organizational change approval requires concurrence from several HQ programs. Lower level changes, such as to Technical Orders, are made through the Configuration Control Board.
Transformation driver	The architectures prior to SILC 1.0/2.0 were stove-piped; despite working on the same real property portfolio, the organizational "agents" did not coordinate efforts and instead focused on their specific functions. For example, the depot maintenance agents (CEUs) focused on executing the projects best for their region, vice focusing on the assets that posed most risk to mission. The new architecture sought to integrate the existing architectures by prioritizing needs and controlling the flow of funding

The full analysis for SILC 2.0, based on questions from an SDM assignment, is provided in Appendix B. Complementary to the architectural decisions, Table 15 provides additional analysis to bring the SILC 2.0 architecture into better focus. Interestingly, the themes behind the reasons for many of these decisions can be categorized as being related to resources, knowledge gaps, and mandates from higher echelons. These are exactly the same underlying issues identified in Section 5.1.2. The problems look different, but at their core, they are still the same problems. One very important difference is that the SILC 2.0 decisions were made in *acknowledgement* of those problems, while the methodologies used in this thesis to architect the future enterprise seek decisions that *address* those problems.

5.3.2 Technique 11: Data Mining and Visualization

A number of data mining and statistical tools are available for understanding the current architecture and/or the major causes of the key problems. This thesis uses parallel plots to highlight flaws in the budget distribution model and resource allocation models that should be addressed when developing concepts for future architectures. The parallel plots in Figure 30 show that civil works assets (underground utilities, water treatment plants, etc.) have very high plant replacement values (PRV) in comparison to their square footage. This is in contrast to Base Support Facilities (which include warehouses and temporary shelters) which primarily have larger spatial areas that are relatively inexpensive to rebuild. This shows that the current methods of using PRV as the basis to allocate depot repair funding and square footage to allocate local maintenance funding can create imbalanced resource support amongst asset lines. While parametric funding models are relatively easy and repeatable, they are susceptible to this type of imbalance. The current SILC 2.0 architecture has enabled budget "studies", but a different architecture is necessary to ensure that the SI enterprise can translate data mining and visualizations into better decision making with respect to resource allocation.

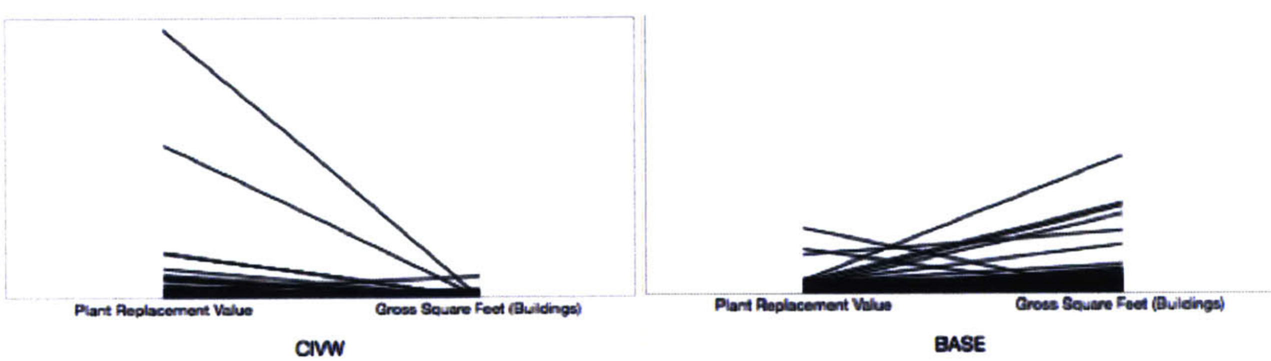


Figure 30: Parallel Plots of Civil Works and Base Asset Lines

5.3.3 Technique 12: Object Process Methodology (OPM)

Figure 31 uses object process methodology to diagram the current SILC 2.0 architecture by mapping form to function. Shared services were omitted for clarity since those functions are integral to the value and support processes shown. Omission does not imply that shared services agents are less important in the value chain, just that a greater level of decomposition is necessary to separate out those integrated functions and agents.

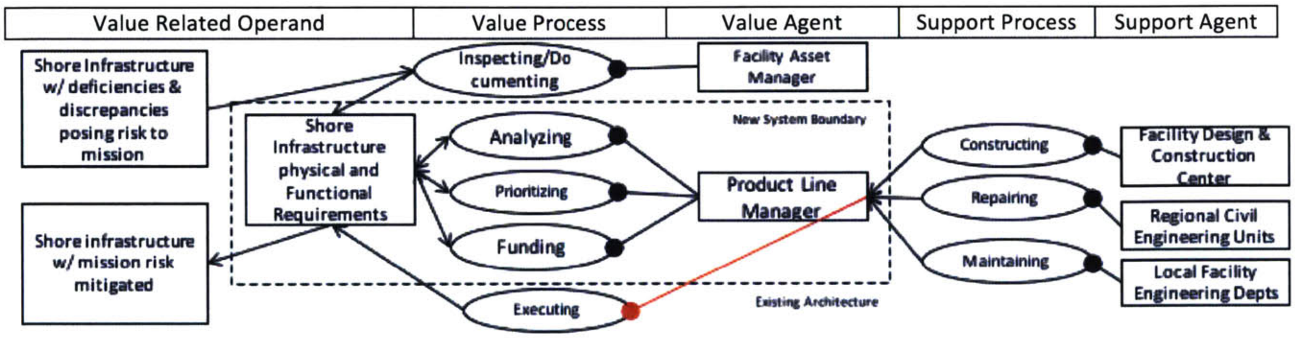


Figure 31: OPM Diagram of Existing Architecture

The value related operand is the *real property asset capable of enabling CG missions*. The value related process is *managing the life-cycle* of an asset portfolio by analyzing the discrepancies (condition-related problems) and deficiencies (function-related problems), prioritizing needs based on mission risk, then allocating funding to address the needs. The supporting processes of new construction, major repair, O&M and divestiture are integrated and directed by the PLM to address mission critical requirements. Divestiture, though a critical life-cycle activity, is not explicitly shown in this diagram because there are not yet comprehensive divestiture plans for each product line[5], and because divestitures have political elements outside direct control of the SILC. The confluence of supporting processes is represented by the connector to the value process of "executing", signifying that the PLM is accountable for execution, though the supporting agents actually do the work. The value agents are the Facility Asset Managers (FAMs) and Product Line managers (PLMs), while the supporting agents are Facility Design and Construction Center (FDCC – for new construction), the regional Civil Engineering Units (CEUs – for major repair and divestiture) and the local Facility Engineer Departments (FED – for O&M), including the Engineering Officers and Engineering Petty Officers at operational units.

[5] There are regional divestiture plans, but they currently lack the comprehensive enterprise viewpoint that product lines could provide. The one exception (and the perfect example of how valuable such a plan could be) is the owned-housing divestiture plan.

The FAM, PLM, FDCC, CEUs, and FEDs are all elements of form. The functions include the processes that transform CG facilities from a state of posing mission risk to a state where risks are mitigated. The red line represents the integration of the three formerly independent processes executed within the construct of pre-existing architectures. The other lines map form and function.

The SILC 2.0 architecture was modeled, in-part, after the ALC and SFLC, as mandated by DCMS for a standard approach to logistical support. The "new system boundary" in Figure 31 depicts the architectural changes brought by SILC 2.0. The organizational elements outside this boundary remained structurally intact and retained their "command" positions, where applicable. Retention of these field commands (the CEUs and FDCC) was a significant departure from ALC and SFLC architecture, and created some initial consternation within the mission support community. The functional breakdown within the product lines constituted a significant cultural shift for the SI enterprise, and the organization is still stabilizing/normalizing. The form breakdown became stable once the SILC 2.0 organizational changes were approved and positions within the product lines were filled.

Figure 31 highlights the disconnect between SILC 2.0 "strategy" and SILC 2.0 "structure". The strategy places the processes of documenting, analyzing, prioritizing and funding SI requirements as the "value functions", i.e. the functions that deliver the highest value to stakeholders. These functions map to FAMs and PLMs, which constitute less than 10% of the billet count within the formal structure of the SI enterprise. The value function of executing, which is supported by the legacy formal construct of the FDCC, CEUs and FE/EOs, maps to the largest cache of resources. In fact, elements within the CEUs (a "supporting agent") still perform a large part of the "analyzing" and "prioritizing" processes due to regional idiosyncrasies and limited PL resources. From this perspective, one could argue that the "tail is wagging the dog", and that the "executing" process has far more downstream influence than the strategy (as documented in the SI MSBM RDTO) dictates. A key architectural question is whether the functions in Figure 31 truly represent the value that the SI enterprise is expected to deliver, and to what level of service, and in what priority. Architectural decisions related to form should be made accordingly.

5.3.4 Technique 13: Mapping Architecture to Strategy, Regulation, Marketing & Technology

In addition to mapping form to function, another way to represent the current architecture is to map it to strategy, regulation, marketing and technology. A detailed analysis, using a framework adapted from an ESD.412 opportunity set, is provided in Appendix C, and is summarized below.

5.3.4.1 Strategy

Strategy is integral to the enterprise architecture and helped drive many of the changes brought by SILC 2.0, most notably the creation of the product lines and a single command structure accountable for the performance of the shore plant. Unfortunately, many other elements of the current architecture do not align with the strategy, including the current organization and infrastructure. While other LC/SC's have clearly defined their scope of services, SILC has become a "catch all" for many of the functions that do not fit neatly into one category. A key issue in developing the future architecture is therefore to determine which functions the SI enterprise must prioritize to overcome continued resource constraints.

5.3.4.2 Regulation

Regulatory compliance has become increasingly central to all SILC products and services. Though technically exempt from most local building codes as a federal entity, the SILC has made it policy to follow those codes unless it would impede mission readiness. Key "product" related regulations include the Americans with Disabilities Act (ADA) for building accessibility and the Chief Financial Officer (CFO) Act for real property accountability, as well as numerous laws and executive orders relative to sustainability, energy management, safety and environmental compliance. For example, SILC internally requires that every maintenance and repair project include CFO Act documentation to ensure any capitalized improvements to a facility are recorded in the USCG's core accounting system. The SILC's enterprise architecture has business units dedicated to environmental and health/safety compliance, and SILC 2.0 created new billets dedicated to energy and real property accountability.

Since the SILC operates in a mature industry with "grandfather clause" allowances, regulations are more incremental than disruptive, and can be forecast relatively easily. To stay ahead of potential regulation, SILC employees attend professional conferences, affinity group meetings, and training sessions. Due to limited funding and production demands, typically only one person per unit will attend with the expectation they will share what they've learned. Unfortunately, SILC lacks the mechanism to effectively track and transfer such knowledge to ensure full dissemination.

5.3.4.3 Marketing

The SILC does not engage in traditional "marketing", as would a private full-service real property management company, but it does perform traditional inbound and outbound marketing functions.

Given a relatively fixed customer base, the inbound function of *identifying* specific operational customers is performed by the regional Facility Asset Manager (FAM). The FAM also has responsibilities related to outbound marketing functions, and especially the *communications* function. SILC's customers are *segmented* by geography (to align with the regional operational command structure) and by facility purpose (to align with the HQ Programs with logistical responsibility e.g. aviation, industrial, medical, aids to navigation) in the form of "Asset Lines". *Customer identification* for these customers is performed by Asset Line Managers (ALMs). ALMs also perform outbound marketing functions, with greater emphasis on *product, cost*, and *distribution*. Though the SILC has no *competition* for its product/services, it does compete with other logistics centers for funding. ALMs and SILCs Business Operations Division work with counterparts at the other LC/SCs to understand their metrics and initiatives so that the SILC can better articulate SI needs during the budget planning process.

The decision to have two groups (FAMs and ALMs) performing both inbound and outbound marketing functions, but with different points of emphasis, requires close coordination between the two groups. This adds complexity for the SILC, but reduces complexity for customers and external stakeholders. Regional operators have cross-functional needs in a given geographical area while programmatic managers have enterprise-wide needs related to a narrow function. This reflects the natural tension between operations and stewardship, and the SILC's current "marketing" architecture helps balance those potentially competing needs.

5.3.4.4 Technology

Technology is primarily acquired by the USCG via a centralized acquisition program. For products with low technology readiness levels, the USCG has a Research and Development Center that falls within the Acquisition Program umbrella. As an Armed Service, the USCG "piggybacks" on many Department of Defense technologies. The SILC looks to the Army Corps of Engineers Research Laboratory (CERL) for technologies relative to the built environment for the armed forces. CERL has a relationship with the University of Illinois, where many USCG officers attend graduate school for civil engineering. SILC also uses technology and processes from the National Renewable Energy Laboratory for sustainability related issues. There are opportunities for a greater degree of partnership with these entities and others, but the SI enterprise has not yet capitalized on them.

The USCG acquisition program has a very structured process for implementing and integrating acquired technology. This includes an Acquisition Program Office (APO), which performs some system architecting functions, as well as integrating with the USCG training command to establish training programs and doctrine. The SILC is the one exception with respect to technology acquisition due to the highly non-standardized nature and variation of the shore plant. Instead of an APO, the Facilities Design and Construction Center (FDCC) performs many of those functions. Increasingly, FDCC is installing very complex mechanical and electrical systems to meet sustainability goals. Unfortunately, these systems have initially been more difficult to maintain. Closer integration with the Asset Line Managers, CEUs and O&M sub-units would help ensure that the systems selected are congruent with the maintenance staff capabilities.

SILC is also becoming increasingly dependent on computer added design and calculation tools. Due to increasingly strict cyber security standards, much of this software has to be run on "stand-alone" computers as the certification and accreditation process can be arduous. Even when these commercial-off-the-shelf applications are approved for the network, updates and configuration changes can be equally time and resource intensive.

5.3.4.5 Mapping Summary

The Strategic factors clearly have the strongest inter-relationship with architecture and, as identified by several other techniques, the SI enterprise's current architecture is not aligned with its strategy on several fronts. Regulation will have an increasingly greater inter-relationship with architecture. The weakest interrelationship with architecture is technology. This is partially due to the nature of the industry and that of a government/military agency, but the SILC could benefit greatly by working to increase this inter-relationship when developing concepts for the future architecture.

5.3.5 Technique 14: The X-Matrix

The X-matrix highlights strengths and weaknesses amongst strategic objectives and key processes, as compared to enterprise metrics and stakeholder values. The intersecting quadrants represent potential interactions between a column and a row. Each potential interaction was evaluated by asking a specific question for the given quadrant, and indicating whether the interaction was strong (blue), weak (yellow) or no-existent (white/blank). The question for the upper left quadrant was "Is this objective measured by this metric?". The upper right question was "Is this stakeholder value represented by this strategic objective?". The lower right quadrant asked "Does this process contribute to delivery of this stakeholder value?" The lower left quadrant asks "does this metric, measure this process?" The numbers on the outside of the grid indicate numbers of weak, strong, and total interactions for their respective row or column.

Figure 32 indicates that current metrics are weakly correlated to strategic objectives. Note that there does not appear to by any SILC metrics related to managing workforce competencies. Even the metric that has been regarded as "primary" for the SI enterprise, "AFC 43 spend down", is weakly aligned with strategic objectives. Conversely, strategic objectives represent stakeholder values relatively well. The notable exception is the stakeholder value of maximum allowable space. Given that the "National Strategy for the Efficient Use of Real Property" [27] mandates reduction of the real property footprint, the SI enterprise must manage stakeholder expectations related to space allowances based on this new paradigm, which unfortunately put SI requirements in conflict with a fairly emotional stakeholder value, where most stakeholders passionately feel they need *more* space.

Key processes also seem relatively well aligned with stakeholder values. The potential exceptions are real property accountability and shore funding management, but one could argue that these processes indirectly support many of the other stakeholder values. The metrics again appear to be not well aligned, but at least every process has a key metric with the exception of vehicle management, which is a relatively new SI enterprise function. Establishing better metrics is a key component of the TAV cornerstone, and SILC has started down that path with the composite metric of Operational Effectiveness (Eo). An enterprise architecting effort would help in aligning metrics by clarifying the key processes and strategic values in relation to how they provide value to the stakeholders. The metrics should then focus on that value proposition.

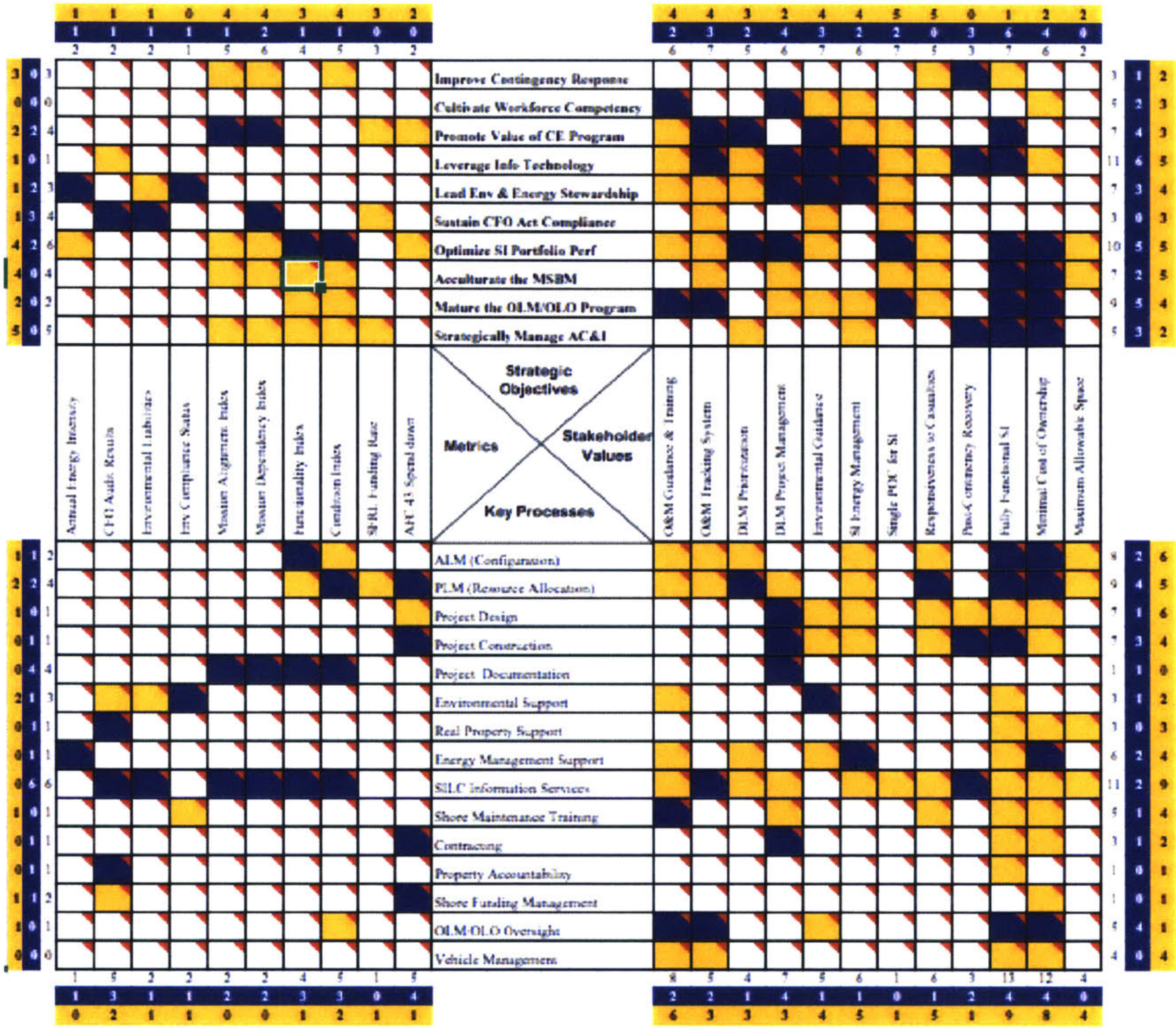


Figure 32: X-Matrix for SI Enterprise Current Architecture

5.3.6 Technique 15: SWOT Analysis

The analysis of strengths, weaknesses, opportunities and threats (SWOT) shown in Table 16 highlights that the quality of people/culture, strong project management skills and asset management skills being developed through the SI MSBM are strengths upon which the future enterprise should capitalize. The weaknesses involve interfaces with external USCG organizational elements (Human Resources system and IT systems), as well as the ability to train/guide USCG engineers outside of the SILC chain of command in facility O&M practices. The lack of TAV due to unreliable data and metrics also contributes to weaknesses in articulating the value SI and the SI enterprise brings to mission execution.

Table 16: SWOT Analysis for Existing Architecture

Strength	Weakness

• People and "can-do" culture
• Process Guides & Configuration Standards
• Public image
• Champions for USCG in Congress
• Growing asset management skills
• MSBM process & ISO 55000 principles
• Project management skills
• Desirable work climate (compared to other Federal Agencies, per surveys)
	• HR System
	  o Unresponsive
	  o No career ladders
	• IT Systems
	  o Changes are slow & costly
	  o Users lack confidence
	• Internal SI training capabilities
	• Articulating shore asset value to mission
	• Lack of reliable data & metrics

Opportunity	**Threat**
• DHS Facility Management or more explicit alignment w/ DHS stewardship goals • Partnerships w/ other gov't agencies (i.e. NOAA, NPS, CBP, FEMA, DOD) • Adoption of new technologies related to communications, information management and construction efficiency and resiliency • Divestiture of installations no longer critical due to improvements in USCG operational capabilities (i.e. longer range boats/aircraft) • Strategic outsourcing contracts based on function in addition to region.	• Federal deficit & effect on annual budgets • Internal USCG power struggles • Competitive Sourcing of commercially available SI enterprise activities • Unfunded Mandates and increasingly strict regulations related to accountability and sustainability • Cyber Security restrictions • Perception of facilities as overhead • Sea-level rise & other vulnerabilities

The primary opportunities include building relationships outside the USCG with government agencies that have shared goals and interests related to SI. For example, DHS has management goals related to sustainability that can be met through SI projects. Joint projects within the department may incentivize departmental investment. This may help offset some of the AC&I funding deficit. However, an organizational tendency to closely control external interactions with DHS maybe an obstacle to such collaboration unless an official mechanism was put in place to monitor the interaction. New technologies may also help achieve facility goals with lower life cycle costs, but the common (mis)perception of facilities representing only overhead may prevent the initial investment necessary to avail this technology. Similarly, advances in technology for operational assets have already made some USCG shore installations redundant, but there are external political pressures to keep them operational. A partnership with the operations community to document a comprehensive plan for divesting such facilities may have a huge impact in overcoming the single biggest threat (arguably) to the health of USCG SI - the expected decreases in annual budgets due to federal budget deficits.

5.3.7 Technique 16: Causal Loop Diagram for Current Architecture

SILC is an artificial exception to the model for decentralization presented by Malone (as discussed in chapter 3). In that model, new information technologies are credited with lowering costs of communication, which increases accessibility of information. This empowers more individuals to participate in decision making, engendering progressively more decentralized organizations that enable greater innovation and flexibility. Within SILC, as in much of the USCG, costs of communication are artificially high due to constraints such as cybersecurity, regulations, bureaucracy, and human resource inefficiencies. These intervene at various parts of the model, as shown in Figure 33.

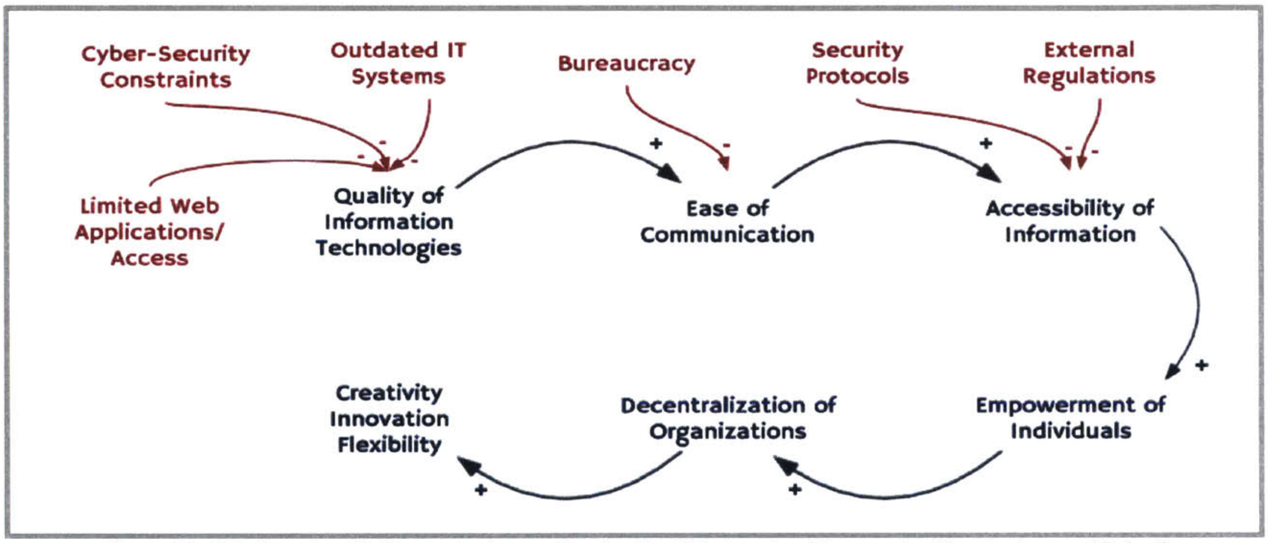


Figure 33: CLD Showing Challenges to Innovation for the SI Enterprise (*Source: Aguilar et al., unpublished*)

5.3.8 Technique 17: System Dynamics Models for Current Architecture

Lyneis and Sterman adapted the "Capability Trap" model (introduced in chapter 3) to facility maintenance on the MIT campus, as shown in the simplified model in Figure 34. Here, "capabilities" was replaced by "defects" while "work effort" and "improvement effort" were replaced by "Reactive Repair" and "Proactive Maintenance", respectively. A Collateral Damage loop was also added to reflect the additional defects created before the initial problem, say, a leaky roof, is reported and protective measures can be enacted. This model is representative of USCG facilities in many ways, and the "investment or ruin" loop helps to explain why the stock of facility defects continues to grow despite better attention to maintenance under SILC 2.0. The investments in the "equipment enrollment" and "FE outside the fence line" initiatives have shown promise, but greater investment is needed.

Figure 4: Feedback structure governing defect creation and elimination.
The model represents every building separately. Building systems and the stocks of defects associated with them are disaggregated into six categories: exterior structures, interior structures, plumbing, electrical, HVAC, and other.

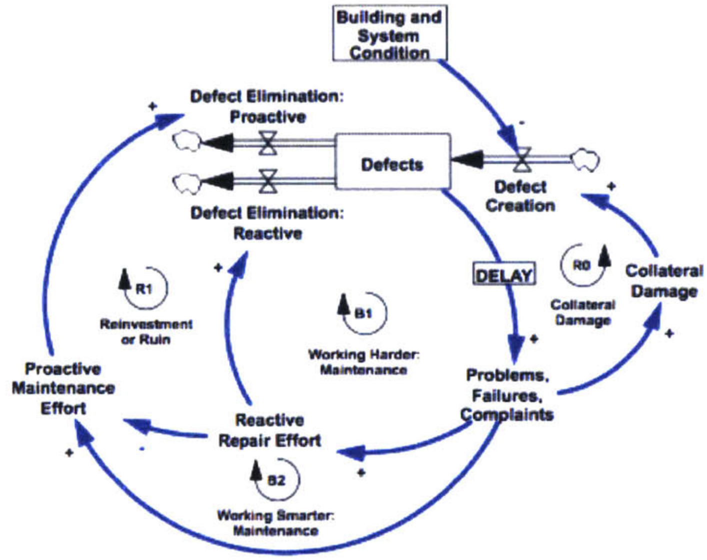


Figure 34: Capability Trap Model Adapted to Facility Maintenance (*Source: Lyneis and Sterman, 2015*)

Lyneis and Sterman expanded the model, shown in Figure 35, to include sustainability factors ("energy efficiency investment") as well as the regular need for recapitalization ("investment in renewal"). Without these investments, costs for facility O&M and energy will continue to increase over time. This model was used to simulate the effects of several strategies at MIT. The results of these simulations, along with a concerted lobby effort and other factors, helped MIT decision makers select a strategy to overcome the capability trap. A system dynamics model, similar to Figure 35 using USCG specific data, could be used to simulate how costs might increase over time (given certain assumptions) if the current funding levels remain the same. Such a model may help senior decision makers enact policies that could counter these increases through very fast simple-payback periods. Note that Lyneis and Sterman suggest three general policies that can make positive changes – "efficiency programs", "renewal programs", and "proactive maintenance programs". These are italicized and denoted with green arrows in Figure 35.

Figure 5. Interacting Capabilities: Expanding the boundary of the model

Endogenously accounting for building and system condition, energy efficiency, operating costs and financial pressure creates new capability trap feedbacks. The three main policies for improvement are shown in italics, including programs to improve maintenance, to renew buildings and systems, and to improve energy efficiency.

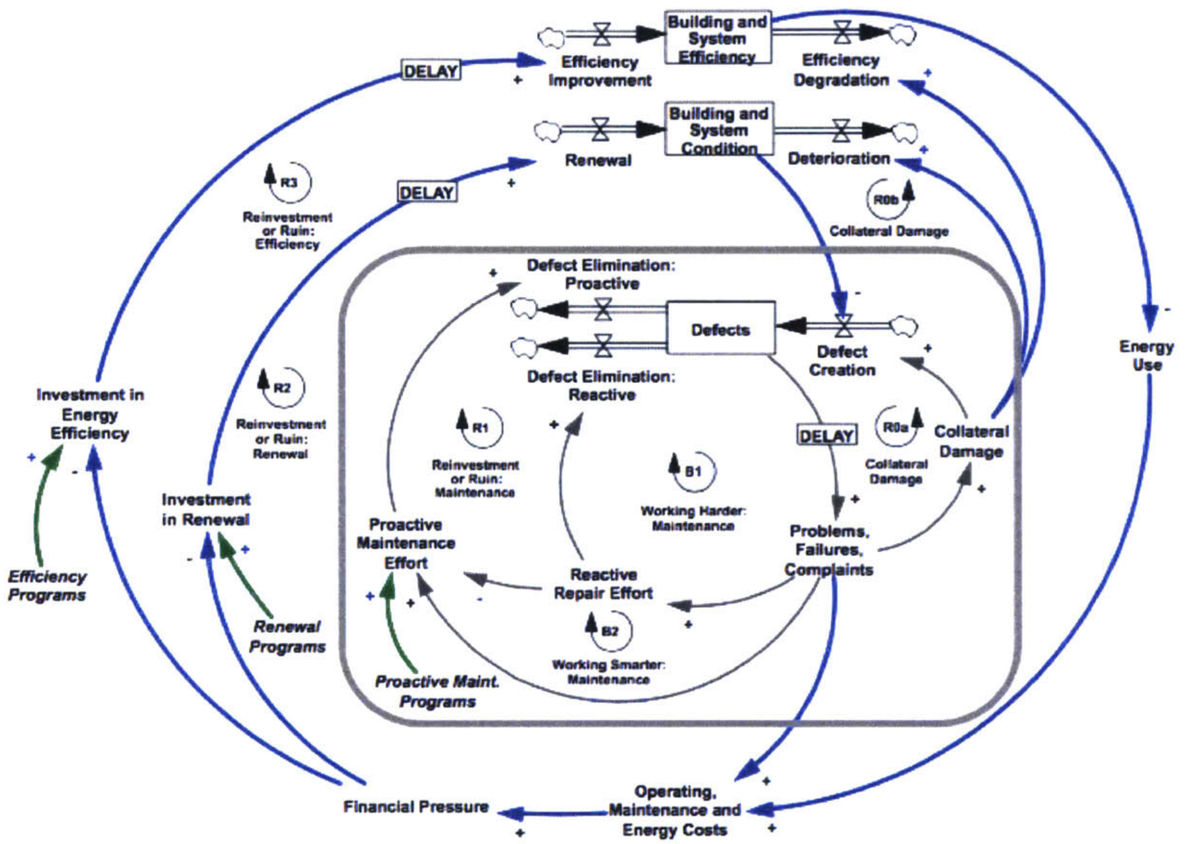


Figure 35: Expanded Capability Trap Model (*Source: Lyneis and Sterman, 2015*)

Two of the three improvement policies, *proactive maintenance programs* and *efficiency programs*, are directly related with OLM. While there are currently initiatives underway to enact these policies, it is debatable as to whether they can be achieved *and* sustained because OLM functions are buried deep in the organization in terms of visibility to the SILC Commander. Figure 36 depicts this current "visibility inequality" compared to DLM and recapitalization. Given that the Lyneis and Sterman models illustrate that the maxim of "an ounce of prevention is worth a pound of cure" is applicable to facility maintenance, greater visibility of OLM and OLO at higher organizational levels would likely garner greater enterprise attention to proactive maintenance and efficiency programs.

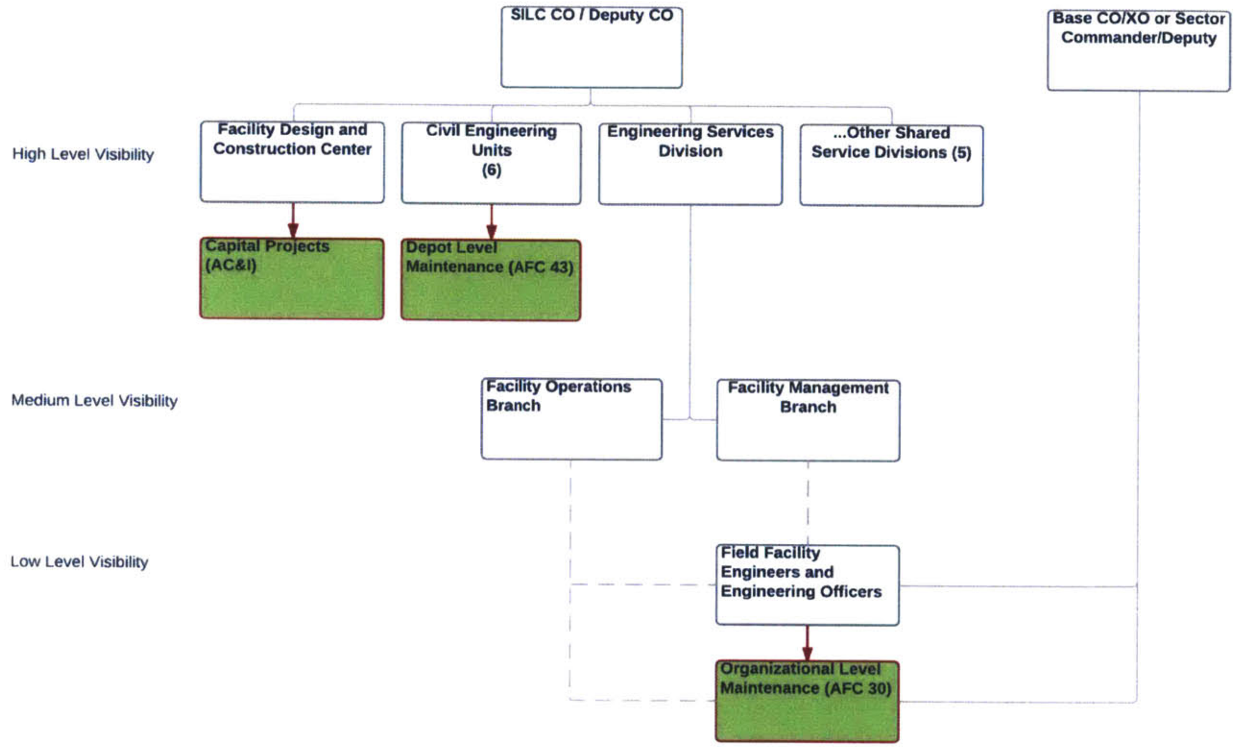


Figure 36: Visibility Challenges for O-Level Maintenance

The third improvement policy shown in Figure 35, *investment in renewal*, is directly related to AC&I. While there is no visibility inequality within the SILC for shore AC&I, there is arguably a lack of visibility for DHS and Congress, since the AC&I budget requests contain only project titles and locations, with little detail on the criticality of the project. Given the Coast Guard's Mission, better visibility of shore requirements at the highest level likely will not change the fact that cutters, boats and planes will always take priority in austere budget environments. However, at the DHS level and above, stewardship and other factors associated with shore maintenance may have more importance, and are more directly related to Departmental and OPM goals. Elevating visibility of USCG AC&I Shore needs to the DHS decision-maker level may enable funding from other sources. System dynamics models may help in articulating this need by showing the anticipated effects of various scenarios.

5.3.9 Technique 18: Embedding Project Pathway Analysis specific to sustainability

While the *efficiency programs* suggested in Figure 35 have a strong OLM component, they are equally applicable to the DLM and recapitalization programs. Current SI enterprise sustainability initiatives, including efficiency programs, can arguably be considered an "in addition to" activity pursued primarily through grass roots efforts. The exception is AC&I construction, where all new facilities have been designed to LEED Silver standards for several years. Unfortunately, this represents a very small portion on the USCG SI portfolio, so there are many opportunities to do more. The impetus to take a more systemic approach is the USCG's Operational Sustainability Performance Plan [30], which has nine goals. The "stakeholder" column Figure 4 lists the program directors at USCG Headquarters. SILC is the field implementation organization for CG-43, and to a large extent CG-46 and CG-47. SILC also performs acquisition functions and maintains data centers, and thus supports goals for which CG-9 and CG-6 is responsible. The SILC therefore supports or is directly responsible for every USCG sustainability goal.

OSPP Section 2 –Performance Goals*	Stakeholders	Stakeholders Description
GOAL 1: Scope 1 & 2 GHG Reduction/ Scope 3 GHG Reduction	CG-46, CG-43	Assistant Commandant for Engineering and Logistics (Energy Management, Civil Engineering)
Federal Employee Travel	CG-1 (CHRO)	Assistant Commandant for Human Resources
Contracted Waste Disposal	CG-43	Assistant Commandant for Engineering and Logistics (Civil Engineering)
Electricity T&D Losses	CG-46	Assistant Commandant for Engineering and Logistics (Energy Management)
GOAL 2: Sustainable Buildings	CG-43, CG-46	Assistant Commandant for Engineering and Logistics (Civil Engineering, Energy Management)
GOAL 3: Fleet Management	CG-43	Assistant Commandant for Engineering and Logistics (Civil Engineering - Vehicle Program)
GOAL 4: Water Use Efficiency and Management		
Water Conservation	CG-46, CG-43	Assistant Commandant for Engineering and Logistics (Energy Management, Civil Engineering)
Storm Water Runoff	CG-43	Assistant Commandant for Engineering and Logistics (Civil Engineering)
GOAL 5: Pollution Prevention and Waste Reduction	CG-43, CG-47	Assistant Commandant for Engineering and Logistics (Civil Engineering, Environmental Management)
GOAL 6: Sustainable Acquisition	CG-9 (CPO)**	Assistant Commandant for Acquisition
GOAL 7: Electronic Stewardship and Data Centers	CG-6 (CIO)	Assistant Commandant for Command, Control, Communications, Computers and IT
GOAL 8: Renewable Energy	CG-46, CG-43	Assistant Commandant for Engineering and Logistics (Energy Management, Civil Engineering)
GOAL 9: Climate Change Resilience	CG-DCO, CG-4	Deputy Commandant for Operations, Assistant Commandant for Engineering and Logistics

Figure 37: USCG Operational Sustainability Performance Plan Goals and Stakeholders (*Source: USCG*)

The Embedding Project (EP) was chosen from a plethora of sustainability frameworks because it appeared to have a built-in training program that could be cost effective. An initial assessment using an

Embedding Project survey[6] revealed that the SILC was relatively strong in several categories, which is not surprising given the culture of stewardship. The assessment also revealed the SILC needs to improve in the categories of *Innovation*, *integration* and *Assessing Progress*. This too was unsurprising given the preceding discussion on challenges within the current SI architecture. The *Innovation* pathway includes "semi-formal practices that leverage a combination of rules and values that influence social norms" [25]. Innovation is essentially the key to "working smarter" (as shown in Figure 34) and will help the SI enterprise escape the capability trap. *Integration* and *Assess Progress* are pathways defined as "formal practices that leverage rules and procedures" that can help SILC "deliver on existing commitments" [25].

5.3.9.1 Innovate Pathway

Table 17: Innovation Pathway Resources and Relevance to SILC 2.0

Practice	Training Resources	Relevance to SILC
Improve Operations	• A guide to traceability • Global water tool	The SILC does not actively manage its supply chain as most materials are available commercially. Sustainable SCM is an opportunity SILC has not yet explored. The water tool is very applicable for facility managers across the USCG.
Improve Products and Services	• Bio-mimicry action Model behavior • Okala EcoDesign Wheel	These are very applicable design apps that can inspire designers to think creatively and sustainably during the conceptual phase.
Think Systemically	• Whole systems and lifecycle thinking • Got a wicked problem? • Building a language of systems change	The entire SILC organization would benefit greatly from systems thinking. Too often, designs are too focused on independent components rather than the interfaces
Internal Knowledge	• Designing effective knowledge networks	SILC has a very weak knowledge management system and the network approach could be the most effective way to improve internal knowledge related to sustainability
Explore	• Surprising habits of original thinkers	There is a definite aversion to risk inherent in both government and A/E/C industry. This tool may help SILC engineers try new approaches
Pilot	• Three big ideas for designing innovations to work at scale	This tool can help better institutionalize the good grassroots efforts

The "Innovate" pathway has six practices and 17 training resources. The training resources are online tools, typically in the form of video presentation or an interactive webpage, to help with learning or implementing the given topic. Table 17 shows these practices and their applicability to the SILC. The

[6] Informal assessment was conducted by author based on 23 years of experience in the USCG

training resources could help create a dialogue within design teams to ensure that sustainability concepts, products and processes are used to help define the problem and evaluate solution alternatives. At this time, it does not appear that these resources are being used by the USCG, and it is uncertain if they would be accessible through the USCG network.

5.3.9.2 Integrate Pathway

While the SILC has demonstrated success through a network of grass roots sustainability initiatives, sustainability is not integrated into all aspects of SILC's daily activities. The "Integrate" pathway is intended to help organizations institutionalize sustainability. SILC currently has no systemic way of tracking sustainability projects, nor are there documented procedures in support of policies. The misalignment of organizational structure between SILC and HQ entities also shows room for improvement in practices related to governance. In addition, a general aversion to risk has prevented the use of new technologies without a thorough risk assessment.

Table 18: Integrate Pathway Resources and Relevance to SILC 2.0

Practice	Training Resources	Relevance to SILC
Business processes and systems	• Triple bottom line & structured decision making	This tool is relevant to the SILC programming and prioritization processes, and can help improve tracking of sustainable projects
Business Planning	• None yet	This would be applicable to SILC product and asset line managers as they build their 5 year asset investment strategies
Procedures	• None Yet	This would be very applicable to SILCs Process Guide and Configuration Management development
Policies	• None yet	This would be very applicable to SILCs Requirements Directives development
Risk	• Risk assessment tool • Water risk monetizer	There is a definite aversion to risk inherent in both government and A/E/C industry. This tool may help SILC engineers try new approaches
Governance	• Sustainability in the boardroom • CERES roadmap for sustainability	This practice would be useful for Product Lines and their interaction with CG-43

5.3.9.3 Assess Progress Pathway

One aspect of USCG culture not yet discussed is the "firefighting hero" rewards system that is prevalent throughout all military services due to the nature of their work in chaotic environments. SILC employees therefore have the tendency to move directly onto the next project without ever fully taking a fix on where they are and where they are going. This is especially true when it comes to capturing, storing, analyzing, reporting and validating sustainability data. The "Assess Progress" pathway may help SILC move away from a primarily reactive and ad hoc organization with respect to sustainability to one that takes the time to collect and analyze data for more strategic decision making.

Table 19: Assess Progress Pathway Resources and Relevance to SILC 2.0

Practice	Training Resources	Relevance to SILC
Verify	• External assurance of sustainability reporting	This tool may be useful to CG-46 as they prepare the annual reports. It may help inform what data SILC should collect
Report	• A starter's guide to sustainability reporting	Same as above
Analytics	• The beauty of data visualization • Simplifying complexity	This would be very helpful to the SILC environmental Management Division and the Energy Managers as a way to inform and call others to action
Information Systems	• Indicators and information systems for sustainable development	This would help the SILC's Business and Information Services branch draft IT requirements and select software to track sustainability efforts & results
Measure	• Water footprint network • Greenhouse gas protocol • Science based targets	There is a definite aversion to risk inherent in both government and A/E/C industry. This tool may help SILC engineers try new approaches

5.3.9.4 Sustainability Analysis Summary

The USCG continues to meet the industry standards for sustainability, but there are opportunities in the logistics support arena, particularly with respect to shore infrastructure, for making changes that would enable the USCG to set the standards, rather than to just comply. The USCG culture of stewardship is a natural driver for many employees to go beyond the statutory requirements related to sustainable practices, but culture alone is not enough to overcome the socio-technical challenges related to age, past practices and the current budget process. The online training resources offered through the Embedding Project are a great starting point for creating a common dialogue and standardizing a common internal definition of what "sustainability" really means for the SI enterprise.

5.3.10 Summary of Current Architecture

The analyses above can be summarized through a comparison of the view elements, shown in Table 20. These findings can be further synthesized as follows: The current architecture has an asset-focused management strategy but is still largely organized and resourced for project management. This has resulted in a paradox where the SILC delivers high quality products and services, yet the overall shore infrastructure readiness is declining and the SI enterprise's ability to manage information and knowledge remains insufficient.

Table 20: Summary of Current Architecture Through ARIES View Elements

Element	Summary of Findings Though the Perspective of Each View Element
Strategy	Strategy is guided by ISO 55000 principles and is aligned with stakeholder values; organizational structure, resource allocation & metrics are not yet aligned with strategy.
Information	SI enterprise has initiatives in progress to improve collection and dissemination of information, but there are many gaps due to inadequate IT systems and data management practices that are often deferred due to other priorities. GAO report indicates disparity between information shared internally vs. externally.
Infrastructure	The Annual report gauges overall infrastructure condition as a "C", and Eo values are based on incomplete information. IT infrastructure has improved but still needs significant improvement to achieve TAV and enable data-driven decisions.
Products	SILC has met DLM spend down requirements, but there are few reliable metrics related to efficiency and quality of products. Eo and other KPI show promise, but do not yet have universal understanding or acceptance. FDCC products meet sustainability goals through LEED, but there are too few of these products to move the bar for the enterprise. OLM products vary widely, and there are still major variances in DLM practices across regions.
Services	SILC offers a wide and flexible array of services; metrics are very limited and quality is difficult to discern. Anecdotal evidence indicates inconsistency across enterprise. Limits of services are not well defined, so SILC has tended to become the "catch-all" for responsibilities not performed by other LC/SCs.
Process	The 7-step SI MSBM process is gaining traction and process documentation is improving. Refinements to POP processes have anecdotally better aligned project selection with mission need. OLM budget allocation processes have been studied, but the processes have not been updated.
Organization	SILC 2.0 appears to have many of the organizational elements necessary for strategic imperatives, but the number, allocation and skills of the resources assigned to those elements has resulted in an imbalance.
Knowledge	Corporate expertise is being lost retirements and transfers due to insufficient knowledge management practices. HR system exacerbates problems as delays in filling billets puts pressure on already limited staffs, thus reducing time for training and managing knowledge transfers.

Chapter 6 – The Solution Domain

"The measure of success is not whether you have a tough problem to deal with, but whether it is the same problem you had the last year"

- John Foster Dulles, Former Secretary of State

Secretary Dulles's quote seems to be reflected by GAOs recent assertion that problems related to federal real property management have not improved since it was listed as a high risk area in 2003. [28] It seems that no matter what changes have been made, the chronic problems of insufficient resources (as compared to industry benchmarks) [2] and misaligned project programming priorities have persisted.[7] The solution domain seeks to architect an enterprise strategy and structure to solve or mitigate these pervasive problems.

6.1 Create a Holistic Vision of the Future

The SILC's published vision statement is to "Collaboratively anticipate mission requirements and provide optimal lifecycle stewardship of CG Shore Infrastructure through innovative, sustainable, and affordable solutions". To achieve this vision, the problem domain analysis in Chapter 5 highlighted that the SI enterprise needs to align its strategy, functions and organizational form to (1) better manage the complexity of the built environment within the confines of regulation and the federal budgeting process, (2) expand capabilities in terms of enterprise knowledge, planning and execution and (3) embed sustainability and resiliency into the organizational fiber in order to meet mandates, prepare/adapt shore infrastructure for storms and sea level rise, and reduce energy costs.

The alignment of strategy, function and form must occur within the bounds of the MSBM principles, the strategic imperatives discussed in Chapter 5, and in keeping with the traditions and culture of the USCG. Though a military service with due reverence to the chain of command, the USCG has demonstrated a unique amenability (amongst government agencies) to delegating important decisions to the lowest levels. This was most notably demonstrated during the USCG response to hurricane Katrina. [31]

[7] Benchmarks include annually allocating 2-4% of the planned replacement value (PRV) for maintenance, yet the USCG has averaged closer to 1%. "Misaligned priorities" refer to the author's anecdotal experience of projects constituting "wants" being prioritized and funded over projects representing maintenance "needs".

6.1.1 Technique 19: Vignettes

Vignettes are stories "from the future" that describe the envisioned results. They can be written from the perspective of a view element and/or a stakeholder, and can examine the interrelationships amongst stakeholders and elements. The vignettes below represent desired stories five years from now.

6.1.1.1 Strategic Element Based Vignettes

Recapitalization (AC&I): CG SILC has successfully articulated the direct operational link of specific shore assets to operations, and congress has allocated $300M per year for the next 5 years to rebuild USCG waterfronts and underground utility systems, as well as to perform seismic retrofits where required. Annual AC&I allocations will return to a steady-state, inflation adjusted $200M per year thereafter. Congress has also agreed to follow the recommendations of the USCG facility closure and consolidation plan in order to ensure the USCG has the right facilities in the right places for mission requirements while expeditiously divesting underutilized real property.

Depot Maintenance (AFC43): The USCG Commandant has pledged that future AFC 43 allocations will match the industry standard 2% of Planned Replacement Value in order to overcome the estimated $76M annual gap between funding and requirements. The decision was based on the SILC's proven its ability, though metrics linked to mission requirements, to consistently select and deliver the most critical shore projects.

Organizational Level Maintenance (AFC 30): Total Asset Visibility and the SILC's proactive Organizational-Level Operations and Maintenance programs (OLO and OLM, respectively) have built a culture of proactive shore maintenance at operational facilities. Records show that 95% of the OLM/OLO funding distributed to field units is now spent on shore maintenance, up from less than 25% just five years ago. The "zero-based" budget allocation process has also greatly incentivized units to view their facilities as mission enablers and to take ownership of those facilities.

Sustainability: The USCG has once again exceeded sustainability performance goals thanks to dramatic reductions in shore energy/water consumption, waste generation, and underutilized facilities. The SILC's leadership in systemically embedding sustainability principles and practices within all activities is being emulated by the other LC/SCs. SILC credits its "total cost of ownership" dashboard with helping customers and stakeholders understand their sustainability profile compared with similar units, and that it was this transparency that led to innovation and self-correcting behavior in the field.

Budget Processes: The recent announcements from Congress and the USCG to increase shore funding come as a direct result of SILC's relentless pursuit of total asset visibility and the analysis and visualizations of the resultant data. The SILCs strategic partnerships with other DHS agencies were also a major driver as the SILC clearly demonstrated the rapid payback and savings generated from sustainability-related joint projects.

Product Line Management: The PLM structure has matured to where over 70% of investment decisions are made via each product line's "asset investment strategy". The remaining 30% are left to local decision makers to enable flexibility and innovation, while PLMs remain informed and can provide input. Capital, depot, and organizational level products and services are coordinated throughout the enterprise. The "hand-off" process from depot and capital projects has become seamless from the landlord's viewpoint due to the requirement for contractors to provide flat files of all newly installed equipment information so that the data can be directly uploaded into the SI enterprise IT system.

6.1.1.2 Stakeholder Based Vignettes

Shore Station EPO: I am motivated to focus on proactive shore maintenance because I do not have the time or funding to deal with facility casualties. My maintenance scheduling and tracking system is easy to use and gives me real-time data on the status of all facility equipment and components. I also use this system to monitor and reduce energy consumption, and the cost savings are added to my budget to help fund other energy conservation measures. The SILC's OLM/OLO training program, which is a mix of onsite, online and C-school offerings, has greatly enhanced the knowledge and capabilities of my engineering staff.

Big 4 (DCMS, DCO, LANT, PAC) Representative: I look forward the annual SI strategic planning process. No longer do we spend two days picking projects; we spend only a few hours reviewing the SILC generated investment program for the next year and spend the remainder of the time updating mission impact and mission dependency metric criteria at the asset class level, evaluating the Operational Effectiveness (Eo) relativity scale[8], and discussing strategic priorities for the next one to five years. The SILC's annual report and the more detailed product line "portfolio reports" provide ample data and analysis for consideration against other spending priorities.

[8] This is a color-coded graph template that sets "targeted" levels of performance for various asset classes. The scale is built on the premise that SILC is willing to accept lower levels of performance for assets with low impact to mission if they were to fail.

6.1.2 Technique 20: Causal Loop Diagrams for Future Vision

Figure 33 from Chapter 5 is used as a basis for identifying concepts, or "exogenous variables", that can positively affect the variables that lead to increased creativity, innovation and flexibility, despite the aforementioned challenges to quality IT systems. Per the literature review and problem domain analysis, there are five concepts that can help achieve these end goals/capabilities: standardization, coordination, transparency, consolidation, and outsourcing. Some of these concepts appear contradictory to the goals. How can standardization breed flexibility or creativity? Malone answers this question by stating this is "a surprising paradox of decentralized coordination: rigid standards in the right parts of a system can enable much more flexibility and decentralization in other parts of the system." [15] The dynamics as to where these concepts interact are shown in Figure 38. Fully resolving this paradox requires addressing the fundamental tension between innovation and the security of USCG assets and information, which in turn requires close coordination with the C4IT SC. This should not delay efforts to activate the downstream "levers" shown in Figure 38, such as to identify the "right" parts of the system to standardize or to continue building transparency using the IT systems currently available.

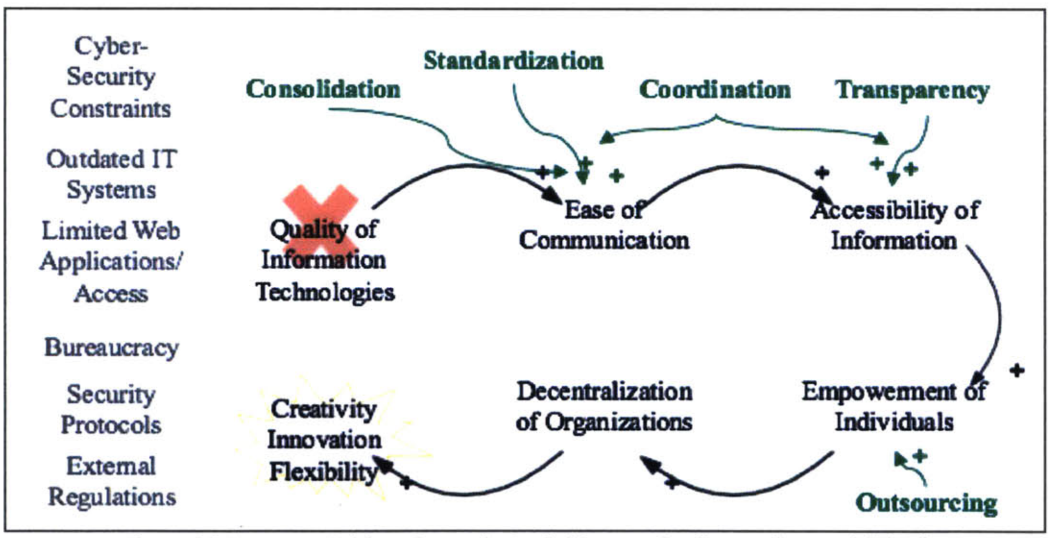


Figure 38: Levers to Achieve Strategic Goals (*Source: Aguilar et al., unpublished)*

6.1.3 Technique 21: Generate Table of Architectural Decisions

Per the background and analysis in Chapters 2 and 5, several architectural questions still remain: (1) What should be the SI enterprise's role in "organizational level operations" (the "O" in O&M)? (2) As the owner of roughly 80% of the Department of Homeland Security's infrastructure, should the SI enterprise seek to administer all DHS facilities? (3) Should the Product Line Management structure established in SILC 2.0 remain distributed or should it be centralized? These and other necessary architectural decisions are listed in Table 21 along with three potential options for each. The list is not prioritized, nor is it sequential, as most decisions can be made independent of each other.

Table 21: Architectural Decisions and Potential Options

ID	Decision	Option 1	Option 2	Option 3
1	Prioritized functions (for resources)	PLM centered functions dominate	Balanced functional priorities	Execution dominates
2	Scope outside of USCG (I.e. DHS)	Combine with and lead DHS Program	Pursue joint projects	Remain USCG only
3	PLM construct	Consolidate PLs in Norfolk; Retain Regional CEUs	Split from CEU but remain geographically distributed	Retain Dual Hat PLM and CEU CO
4	OLO scope	Integrate fully with OLM at Base/Tracen level	Clear interfaces bx OLM and OLO staff	Maintain status quo as separate entities
5	OLM authority	Direct command and control of OLM staffs	Coordinate and cultivate under existing structure	Elevate to Division level for parity
6	Funding control	Control via conversion (i.e. change AFC 30 to 43)	Control through budget policy (no taxes)	Maintain existing parametric model
7	Construction mgt, condition assessment and design functions	Retain these as core SI enterprise functions; resource it accordingly	Retain a subset as core functions; Specify others to outsource/suspend	Outsource or dis-continue most of the related sub-functions
8	Workforce competency development	Invest in robust program with central coordination; include CGA & CE postgrads	Invest in more training but allow regional management	Establish career ladders and rotation options for civilians
9	Management framework	Expand adoption of ISO 55000 principles	Seek another framework	Retain ISO 55000 but do not expand
10	Contingency response role	Retain as a core function, invest in IT & work w/ DOL and HQ to improve process	Retain as a core function, wait for DOL guidance	Retain oversight but outsource damage assessment teams
11	IT Infrastructure	Focus on improving systems on CG network	Shift to Software as Service or FEDRamp	Better utilize the existing systems

6.2 Generate Alternative Architectures

Three alternative architectures were developed using the ideation techniques described below. Many of the concepts generated are more likely applicable to the "designing" process versus this "architecting" exercise, but such design ideas did help shape some architectural decisions. The development of alternatives required several iterations so each alternative addressed the architectural decisions listed in Table 21, was viable, and was differentiated. While some concepts were applicable to all alternatives, each was assigned to the alternative of best fit to allow for evaluation.

6.2.1 Technique 22: Four-Step Ideation

The goal of the Ideation process is to develop concepts that can later be consolidated into alternative architectures. A summary of the approach and the key findings are shown in Table 22.

Table 22: Four-Step Ideation Process

Step	Process [17]	Result/Findings
1	Generate Ideas	Brainstorming yielded a number of ideas summarized in 5.2.1.1
2	Learn From Experience	Concepts from evaluating case studies are discussed in 5.2.1.2
3	Ask For Suggestions	Working with two project teams focused on innovation and managing complexity yielded the concepts discussed in 5.2.1.3
4	Think of Extreme Enterprises	Contemplating extreme concepts yielded ideas to (1) completely loosen the hierarchy below the Division officer level and (2) to outsource all depot design and O-Level Maintenance, making the SI enterprise almost exclusively a facility management/Construction management enterprise with very limited in-house production.

6.2.1.1 Brainstorming to Generate Ideas

The 15.320 and ESD.38 project teams brainstormed a number of suggestions based on literature research, USCG SILC documentation, MIT coursework, and team experience. These concepts were then categorized into the five categories introduced earlier in Figure 38: standardization, transparency, coordination, consolidation and outsourcing. These categories are aligned with the MSBM and were, to varying degrees, integrated into the SILC 2.0 architecture. This reinforces the entering argument that SILC 2.0 was a step in the right direction theoretically, but that it did not go far enough in the actual implementation. Table 23 describes these categories in terms of specific concept recommendations that can be included in the alternatives. Like the initiatives listed in SILC's existing Strategic Plan, many of these concepts will require a responsible organizational entity or resource that currently does not exist, is under-staffed or has other competing responsibilities.

Table 23: Categorized Concepts Generated through Brainstorming

Recommendation Category	Specific Concepts
Standardization	* Formally define use of Operational Effectiveness Metric (E_o) * Create "feedback/bid process" for validating or improving E_o scores * Standardize at component level (i.e. HVAC for an asset class), not facility level * Simplify IT Systems to increase use and reliability * Align funding allocation codes with bi-level maintenance definitions * Establish knowledge management system
Transparency	* Create a common operating picture of readiness (expand SAGE dashboard) * Establish video based knowledge sharing (SILC YouTube)
Coordination	* Cross-training across functional, geographic and product-focus groups * Strengthen collaboration with USCG Congressional Liaisons * Establish a SILC "budget market" for Product Line Managers to negotiate for project funding in advance of "fallout funding" so projects can be ready
Consolidation	* Place all OLO/OLM staffs under one chain of command *Consolidate all PLM staffs w/ SILC command in Norfolk for economies of scale
Outsourcing	*Use regional contracts for field commands w/ under-resourced maintenance staffs *Direct specific design functions to always be outsourced, i.e. fire protection *Outsource damage assessments and condition assessments

6.2.1.2 Learn from Experience

Four Case Studies were analyzed to generate concepts that could be applicable to the SILC. The cases, the applicability, and the resultant concepts are summarized in Table 24:

Table 24: Concepts Derived Through Experience (Case Studies)

Case	Applicability	Resultant Concepts
Proctor and Gamble "Organization 2005"	Economies of scale, managing complexity & product innovation	Front-Back organizational structure (*supporting* elements are not *subordinate* elements)
Proctor and Gamble "Connect and Develop"	Innovation through external partnerships	Connect and Develop concept tailored for SILC – using dedicated POCs to liaise w/ other LC/SCs, DHS, DoD, & local Universities
Jones Lang LaSalle	Construction & real estate industry, managing complexity, disruptive transformations	Organizational elements to balance the needs of the top tier customers while not forgetting lower tier customers; incremental vs. disruptive change
IDEO	Innovation, "OpenIDEO" for crowdsourcing	Inspiration→ideation→implementation, Expanding USCG Crowdsourcing tool
Valve Software	Innovation	Self-forming project teams, peer ranking systems, whole family engagement; crowdsourcing to hire talent

6.2.1.3 Ask for Suggestions

Two external entities were consulted for ideas, Jacobs and the Office for Space Launch for the National Reconnaissance Office. Jacobs was contracted to analyze the SILC's current management framework and its alignment with ISO 55000. Jacobs recommended "organizational, doctrinal, strategy, and procedural changes to optimize the SI-MSBM while leveraging industry best practices". [31] The four "future state" recommendations are: (1) Define the SI MSBM scope, (2) Establish Organizational Manuals, (3) Establish configuration control over shore infrastructure, and (4) commission a strategic asset management plan. They go on to recommend a number of "tactical" recommendations that are summarized in Table 25. These are similar to the concepts developed independently above.

Table 25: Summary of Jacobs Tactical Recommendations (Source: Jacobs and USCG)

Tactical Recommendation	Description
Strategic communications	Dedicate resources to articulate value of Shore facilities and SI enterprise
Management reviews	Periodically evaluate unit performance to ensure accountability for SI objectives
Requirements development	Dedicate resources within CG-43 and SILC-ESD to coordinate requirements from CG-7 and Asset Line Managers, respectively, iaw steps 1 and 2 of the SI MSBM
Key performance Indicators	Dedicate resources to obtaining, processing, storing, and using relevant, responsive, timely, accurate, and affordable data to calculate and use KPIs
Requirement-based budget	Base budgets on acceptable thresholds for shore infrastructure performance
Asset Management Plans	Develop plans for each asset line to instruct annual project prioritization
Configuration Control Boards (CCBs)	Commission a SI CCB at the HQ level to vet DCO requirements, manage interfaces with other programs, and provide quality assurance for lower-level CCB products
Internal Audits	Establish audit program to determine if systems and assets are working in accordance with approved processes and standards
IT Requirements	Document a "Mission Needs Statement" and a "Concept of Operations" for IT as legacy IT systems likely will not support future SI enterprise requirements
Functional Baseline	Evaluate methods to establish and maintain a "should be" baseline for SI
Physical Baseline	Improve techniques for collecting, tracking & reporting the "as-is" baseline for SI
Competency Development	Engage FORCECOM and/or CG-1 to determine strategic human capital planning requirements, tools, and techniques to improve training and accession planning

The Office for Space Launch had three facilities with independent maintenance staffs, funding streams, and budget request processes. This made it very difficult to provide a long-term plan that would benefit all three sites, particularly in the budget planning and execution process. This situation was very similar to the USCG's pre-SILC 2.0 construct. To overcome these obstacles, the Launch Support

Division consolidated staff functions and funding under a single management framework, while retaining the existing command structure. They also created a full-time equivalent position to liaise directly with the budget staff, vice the multiple people previously involved. The division then developed a comprehensive planning process with a 20-year outlook vice the existing two-year planning cycle. This plan is now reviewed quarterly, along with the publication of "strip charts" that detail the maintenance needs of the facilities. The condition information is provided by a third party contractor that uses a budgeting tool for O&M. While the outsourcing of this function is relatively expensive (SILC performs this with in-house resources), the findings are readily accepted and the frequency of inspection is not pre-empted by project management concerns or other competing priorities. The Launch Support Division's holistic approach, now in its thirteenth year, has streamlined communication and coordination with decision makers and has positioned infrastructure projects to better compete with other initiatives.

6.2.2 Technique 23: Devise Alternatives

The concepts converged into three alternative architectures through an iterative process of down selection and logically grouping options from Table 21. Each alternative was named based on its key strategic emphasis to facilitate comparison. The paragraphs below describe key features of each alternative, display a rough organizational construct, and list the strengths, weaknesses, opportunities and threats (SWOT) for each to indicate its viability. Though not explicitly shown, each alternative assumes commensurate changes at the respective HQ level (CG-43, 46 & 47) to ensure alignment.

6.2.2.1 Alternative 1: Harmonize

Alternative 1 focuses on balancing functions and resources to align with strategic goals, while recognizing the assessment, design and construction management functions are critical to building the required knowledge to properly perform product line management functions. It realigns SI service delivery, product Line management and shared services into a "front-back" org structure as interdependent organizations. OLM is relocated to a top level of the SI Hierarchy to ensure proper visibility, and the "front-end" organization can harmonize efforts while building project management expertise. If designed properly, this structure enables cross-organizational collaboration at appropriate levels without requiring laborious chain of command approvals. Product lines will no longer be stripped of resources for short term production goals and will continue to expand the ISO 55000 framework.

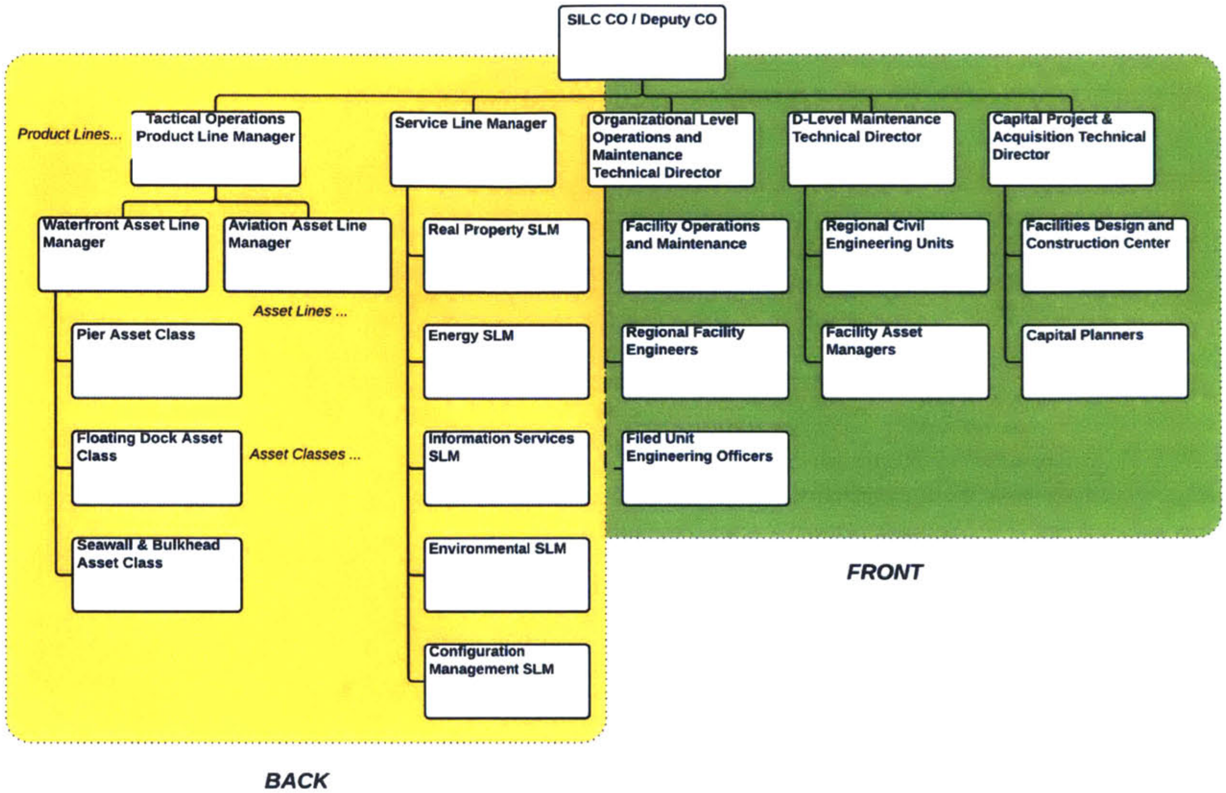


Figure 39: Alternative 1: Harmonize Organizational Chart

Table 26: SWOT for Alternative 1: Harmonize

Strength • Proper visibility for OLM • Builds strong project management AND product management competencies • Clear chains of command • Enables greater focus on respective core competencies vice "jacks of all trades" being spread too thin due to too much variation	**Weakness** • Disruptive structural change • Cultural challenges • Complex • Limited opportunities for cross training
Opportunity • Increased ability to specialize and learn • Better mission focus • Potential to better take on joint DHS projects	**Threat** • More susceptible to internal power struggles • Inadequate interface development and management could negate strengths • May create new stovepipes and rollback advances towards a systems approach to asset management

6.2.2.2 Alternative 2: Consolidate

Alternative 2 establishes dedicated chains of command for asset management and all facility maintenance. Product Lines are consolidated in a single geographic location for economies of scale and to enhance collaboration. OLM resources currently controlled by others are moved to Facilities Management Branch (FMB) to ensure greater accountability for O&M functions.

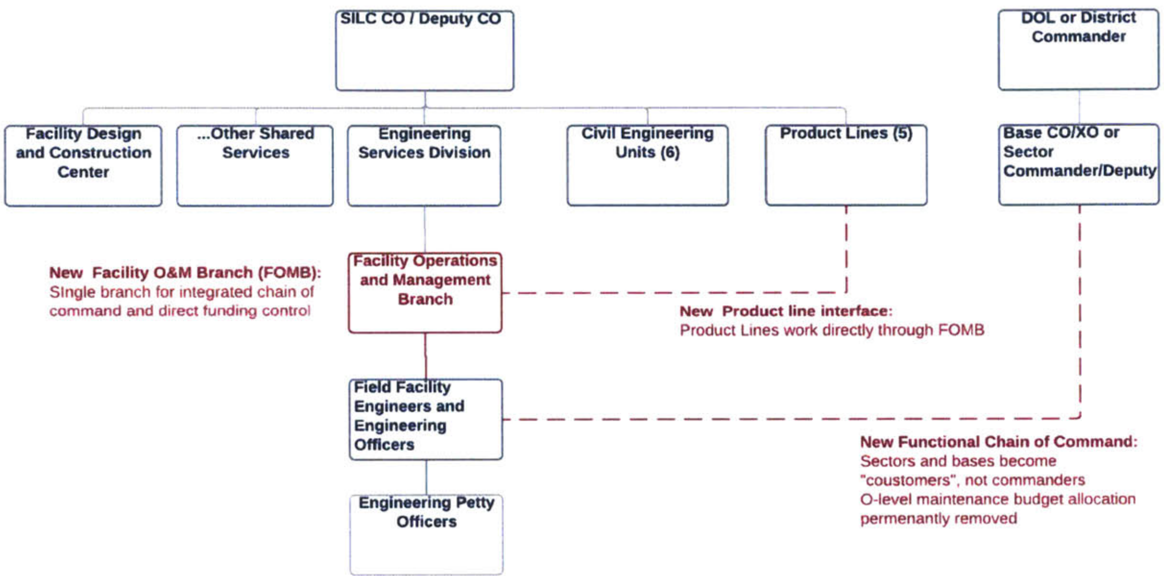


Figure 40: Alternative 2: Consolidate Organizational Chart

Table 27: SWOT for Alternative 2 : Consolidate

Strength • Economies of scale by consolidating maintenance and PLM activities • Economies of scale created by merging OLO and OLM functions • Field maintenance staffs are not pulled away for other unit priorities • All SI maintenance funding is used only for SI maintenance	**Weakness** • Disruptive structural changes • Cultural resistance • Since this is expected to be a resource neutral transformation, there will be some efficiencies lost by operational units
Opportunity • Increased ability for specialization and knowledge management • Dedicated OLM/OLO staffs can prevent progressive damage and improve long-standing data deficiencies • Operational units can focus on operations and not logistics	**Threat** • Internal USCG power struggles, particularly for resources that were formerly dual hat • Perceived loss of flexibility and utility since customers no longer have control; may lead to lost sense of ownership amongst operational units

6.2.2.3 Alternative 3: Integrate and Open

Alternative 3 integrates DHS facility management into the SI enterprise and loosens the hierarchy at the branch level to provide more open communication and innovation. Strategically outsourcing the majority of the maintenance, design and construction management functions enables resources to focus on asset management. To facilitate the required contract management requirements, FAMs will be reassigned to the SILC, yet remain geographically distributed. SI enterprise personnel will transform from "maintainers" to dedicated "asset managers" and system architects.

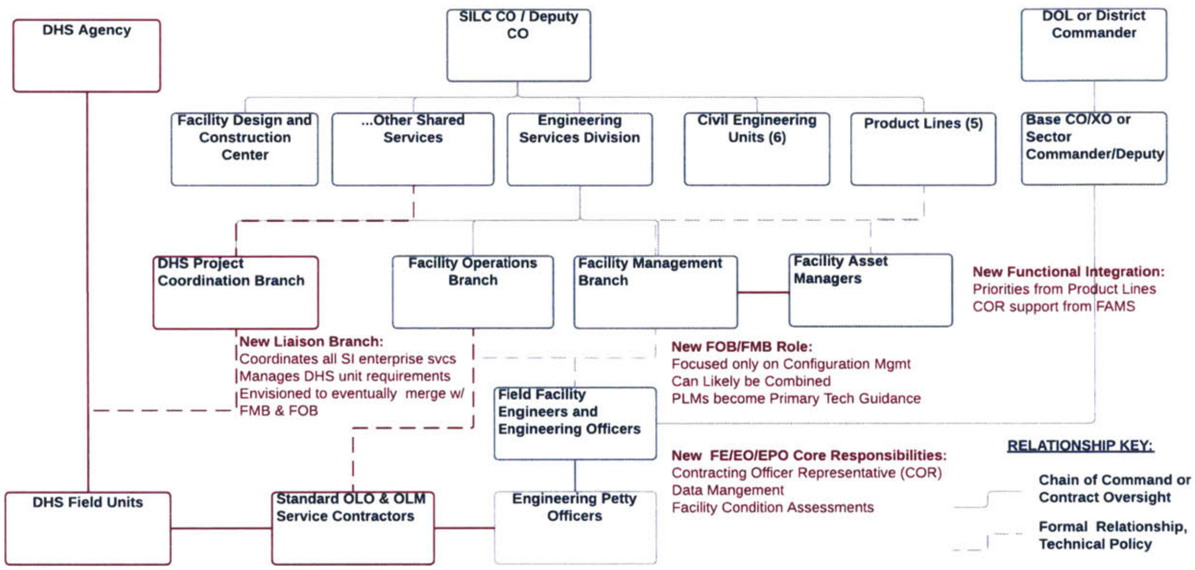


Figure 41: Alternative 3: Integrate and Open Organizational

Table 28: SWOT for Alternative 3: Integrate and Open

Strength	**Weakness**
• Reduce OLM work overload • All maintenance performed by trained journeymen or master tradesmen • Improved asset management expertise • Better discrepancy data for DLM • Economies of scale w/ other DHS agencies	• More expensive in short-term • Risky because readiness is dependent upon contractors • Cultural incongruities with other DHS agencies
Opportunity	**Threat**
• Leverage and improve project contract management expertise • Potential for increased funding & staff to perform maintenance for other DHS entities • Greater potential for capital project funding	• Inability to control contractor costs • Limited contractors in some locations • Loss of design & maintenance competency • Loss of organizational flexibility and performance capability in a contingency

6.3 Decide on Future Architecture

The first step in selecting a future architecture is to compare the alternatives side-by-side to understand the architectural differences. Evaluation criteria are then established based on stakeholder values, ecosystem factors, and the deficiencies noted in the evaluation of the existing architecture. The alternatives are then tested through future proofing for viability before being evaluated against the established criteria using a Pugh Analysis.

6.3.1 Technique 24: Compare Alternatives using Architectural Decision Table

Each alternative is defined in terms of architectural decisions in Table 29.

Table 29: Comparison of Architectural Decisions for Each Alternative

ID	Decision	Alt 1: Harmonize	Alt 2: Consolidate	Alt 3: Integrate
1	Prioritized functions (for resources)	Balanced functional priorities	Balanced functional priorities	PLM centered functions dominate
2	Scope outside of USCG (I.e. DHS)	Pursue joint projects	USCG Only	Combine with and lead DHS Program
3	PLM construct	Split from CEU but remain geographically distributed	Consolidate PLs at SILC; Retain Regional CEUs	Split from CEU but remain geographically distributed
4	OLO scope	Clear interfaces bx OLM and OLO staff	Integrate fully with OLM at Base/TRACEN level	Clear interfaces bx OLM and OLO staff
5	OLM authority	Elevate to Division level for parity	Direct command and control of OLM staffs	Coordinate & cultivate under existing structure
6	Funding control	Control via conversion (change AFC 30 to 43)	Control through budget policy (no taxes)	Control via conversion (change AFC 30 to 43)
7	Construction mgt, cond. assessment & design functions	Retain these as core SI enterprise functions; resource it accordingly	Retain a subset as core functions; Specify others to outsource/suspend	Outsource or dis-continue most of the related sub-functions
8	Workforce competency development	Invest in more training but allow regional management	Invest in robust program w/ central coordination; incl. CGA & CE postgrads	Establish career ladders and rotation options for civilians
9	Management framework	Retain & gradually expand ISO 55000	Expand adoption of ISO 55000 principles	ISO 55000; consider other frameworks
10	Contingency response role	Retain as a core function, wait for DOL guidance as not resourced to lead	Retain as a core function, invest in IT & work w/ DOL to improve process	Retain oversight but outsource damage assessment teams
11	IT Infrastructure	Shift to Software as Service or FEDRamp	Focus on improving systems on CG network	Shift to Software as Service or FEDRamp

6.3.2 Technique 25: Establish Evaluation Criteria

Nightingale and Rhodes advise that evaluation criteria should minimize inherent biases, address long term perspectives, account for stakeholder needs, be consistently understood by all evaluation team members and have full support of senior leadership. [12] All desired capabilities, view elements, and stakeholder values were considered and discussed with SMEs, and were down-selected based on the deficiencies noted in the problem domain analysis. Table 30 lists the selected criteria along with definitions for each for standard application.

Table 30: Evaluation Criteria Definitions

Evaluation Criteria	Definition for Evaluation Purposes
Affordability	Degree that current service levels be maintained or improved at existing funding levels
Cultural Acceptance	Degree that the SI enterprise personnel & USCG senior leadership will support the alternative during the implementation process
Information	How well the alternative can improve tracking, analysis and dissemination of data in order to consistently articulate SI requirements & performance to key decision makers
Innovation	Degree to which the architecture fosters innovation via the levers in Figure 38
Mission Readiness	How well the architecture will improve the product and infrastructure elements
Strategy Alignment	Degree that the architecture will enable strategic goals to be achieved in a timely manner
Sustainability & Resilience	How well the alternative enables the SI enterprise to embed sustainability and resiliency practices into all products and services

6.3.3 Technique 26: Future Proofing

Future proofing is an activity to gauge how robust or adaptable to unexpected or extreme changes the alternative will be over time. While the analysis to this point focused on the "most likely" future, the future proofing technique evaluates how the alternative might respond under different scenarios. The goal is not to use extremes or scenarios as evaluation criteria, but to test each alternative to ensure the key concepts are viable under a broad range of future changes. The USCG Evergreen program is a type of future proofing process that is used for developing and testing the USCG's grand strategy every four years to coincide with ascension of a new Commandant. The 2016 Evergreen Program has developed four future scenarios [32] that are used to future proof the three alternative architectures. The primary driver for the SI enterprise in each scenario is the anticipated funding impact. The effects on each alternative by the budget scenarios is summarized in Table 31.

Table 31: Future Proofing Using 2016 USCG Evergreen "Alternative Futures"

Alt Future: Budget impact	**Alt 1: Harmonize**	**Alt 2: Consolidate**	**Alt 3: Integrate**
Band of Brothers: Slight improvement	Minimal positive impact	Slight improvement of service capability	Expected positive impact on contract costs due to high cooperation w/ industry
Cybergeddon: Significant Improvement	Slight opportunity to improve product, but risks due to off-network software systems	Major opportunity to improve product & IT infrastructure on USCG network	Neutral or even negative due to market effects on contracts and IT systems off USCG network
Rise of the Geeks: Flat	Opportunities to improve IT infrastructure and TAV	Minimal impact	Opportunities to improve IT infrastructure and TAV
Hedgehog: Declining	Opportunities for DHS funding of sustainability projects; Competitive sourcing risk of front end organization	High risk due lack of external partnerships; Competitive sourcing risk since design/construction is commercially available	Contract costs expected to level or decline, so low cost and competitive sourcing risk; opportunities for DHS funded projects

The analysis reveals that all three alternatives are viable, yet some concepts place greater risk on the enterprise. This includes decisions related to the IT infrastructure, outsourcing functions, and retaining commercially available functions as core competencies. Further analysis, such as an "upside-downside" table, should be conducted to evaluate if the risks are worth potential rewards. The most volatile alternative is "consolidate", which can be impacted by both the positives and negatives of isolating and insulating the SI enterprise from other commands and agencies

6.3.4 Technique 27: Pugh Analysis

The Pugh analysis in Table 32 enables side-by-side comparisons of alternatives against the current state architecture as better (+1), worse (-1) or the same (0). The results are not summed in aggregate, but by category so the pros can be weighed against the cons. The best value for each category is shaded in green, the worst in red, and the middle in yellow.

The "Harmonize" alternative (#1) is expected to result in improvements over the status quo against most criteria. The front-back structure, the splitting of product lines from CEUs, and the external outreach for DHS projects may create some cultural resistance, while the elevation of OLM and greater independence of ALMs may offset some of this resistance. The "Integrate and Open" alternative (#3) was especially strong in innovation due to its highly distributed architecture. It was also strong in sustainability and resiliency due to the close ties with DHS. The distributed architecture and close ties to

DHS are weaknesses when it comes to cultural acceptance, but that should not dissuade the SI enterprise from trying to work these concepts into the Harmonize architecture because of their high potential upsides. The contract costs, in addition to retaining staff as asset managers and contracting officer representatives, make this less affordable initially, but the long term savings due to proper OLM and better contract oversight make this a neutral factor. The "Consolidate" alternative (#2) offered the fewest gains over the current state because the single SI chain of command will likely have limited interface management capabilities and too much consolidation and standardization in places that can *stifle* innovation, particularly if the IT systems remain constrained by the current processes.

Table 32: Pugh Analysis

Eval Criteria	Current State	Alt 1: Harmonize	Alt 2: Consolidate	Alt 3: Integrate
Affordability	0	1	1	0
Cultural Acceptance	0	0	0	-1
Information	0	1	1	1
Innovation	0	1	-1	1
Mission Readiness	0	1	1	1
Strategy	0	1	0	1
Sustainability & Resiliency	0	1	0	1
Number Better	0	6	3	5
Number Worse	0	0	1	1
Number Same	7	1	3	3

Per the analyzes above, the preferred architecture to implement is *Alternative 1: Harmonize, with the limited adoption of the strategic outsourcing and looser hierarchy concepts from Alternative 3.* This "Harmonize Plus" architecture will allow the SI enterprise to better balance its workforce and focus on the systems-thinking, asset management goals developed through the ISO 55000 Framework. Special attention must be paid to interface management, specifically when (1) PLMs apply the "connect and develop" concept to stakeholders external to USCG, (2) ALMs and FAMs provide the interface between the interdependent product lines, regional execution organizations, and shared service divisions, and (3) FAMs and ALMs manage the interfaces with internal USCG customers.

The fact that no alternatives were rated to be better (+1) in the "cultural acceptance" category is unsurprising given the general resistance to change within the government. Addressing this tendency is major a factor in the implementation planning discussed in the next section.

6.4 Develop the Implementation Plan Approach

The goal of the implementation plan is to provide just enough detail to enable implementation without over-constraining the implementation team. The implementation plan "serves as the basis for the next stage of transformation, involving detailed implementation planning and resourcing". [17] The key tasks in developing this plan include (1) ensuring alignment of processes and measures with the new architecture via an updated X-matrix, (2) establishing the executive owner of the transformation plan, (3) identifying the key transformation team members and change agents, (4) deciding whether the plan should be structured in phases for stability, and (5) identifying the mechanisms and frequency of communication. [17]

Per the analysis in section *5.3.5 Technique 14: The X-Matrix*, metrics require the most attention. Fortunately, SILC is actively working to institutionalize "key performance indicators" (KPI) for infrastructure and products, including the pinnacle metric of Operational Effectiveness (E_o). SILC is also developing KPI for services, which will be crucial for better understanding the true value and performance of those activities. The key processes in the X-matrix should also be revised to match the priorities of the new architecture to ensure they have greater alignment with measures and stakeholder values than the status quo. The "owner" of this activity and the implementation plan itself should be the SILC Deputy Commander to convey the utmost importance of the transformation effort and the ultimate goals. The criticality of executive ownership is discussed further in section 6.4.2. The key transformation team members should be the Business Operations Division Chief and Engineering Services Division Deputy. They will coordinate the participation of a robust group of representatives from each division of the proposed new architecture.

Given the very disruptive SILC 2.0 transformation and the difficulties in relocating encumbered billets, a phased approach to implementing the "Harmonize Plus" architecture would work best. The ISO 55000 management framework has already started the SI enterprise on the path towards "systems management" of the USCG's complex built environment. In a sense, SILC 2.0 can be viewed as what Rectin called a "stable intermediate form" in the transformation of an enterprise that managed SI as series of independent projects to one that manages SI as a system of systems. The Harmonize Plus architecture provides a clearer view of that desired end-state and the implantation plan provides the shortest path to that end state. The following sections describe a mechanism for communicating the new architecture, as well as a process for planning the phased implementation.

6.4.1 Technique 28: Organization Element Anatomy Comparison

An "anatomical" analysis of each view element effectively articulates the changes to be brought by the new architecture, and can be a useful communication tool. Table 33 shows the anatomy of the organization element for the current and future architectures.

Table 33: Organizational Element Anatomy Comparison of "As-is" and "To-Be" Architectures

Anatomy	As-is Architecture	To-be Architecture
Structure	• 3 Dimensional Matrix • Product line management and regional execution (design/construction project management) are in tension • OLM visibility buried deep in organizational hierarchy • Insufficient administrative support	• Front-Back • Interdependent product lines and regional execution • OLM visibility on par with DLM and recapitalization • Executive Officer (XO) and administrative functions properly resourced
Behavior	• Asset line resources often diverted to meet regional execution requirements • Spend down is the ultimate measure of success for organizational units • Sustainability & Resiliency are assumed to be the responsibility of other org elements • Project team composition for projects specific initiatives are directed by senior management or a branch supervisor	• Temporal regional execution needs are met through outsourcing so ALs remain focused on long-term planning and analysis • E_o is the ultimate measure of success • Sustainability & Resiliency are embedded into the fabric of all organizational elements • Communities of practice and a more flexible hierarchy at the branch level enables staff opportunities to self-form teams and work on more projects that interest them
Artifacts	• Completed SAM work orders, pulled from SI IT systems via cumbersome reports • Collections of plans and as-built drawings with no "drawings of record" • AL Portfolio reports and annual reports manually arranged by contractor	• Dashboard of work order completion rates by unit and asset class • Drawings of record updated with each project and properly catalogued • Org elements can readily produce reports from user friendly
Measures	• Preventive and corrective maintenance completed	• PM and CM completion rates • Depot projects generated through OLM
Periodicity	• OLM is often deferred for a myriad of reasons without consequence in part due to the current organizational construct	• Higher visibility of OLM enforces strict adherence to preventive maintenance schedules

6.4.2 Technique 29: Kotter's Eight Step Process in Tandem with the Architecting Imperatives

The Architecting imperatives introduced in Table 8 are useful in structuring the implementation plan. These imperatives can be augmented by a more detailed organizational change process devised by Kotter. [33] The Kotter process is aligned with the imperatives in Table 34.

Table 34: Architectural Imperatives & Kotters 8-Step Process applied to "Harmonize" implementation

	Imperative	Kotter 8 Step Process	Recommendations
1.	Make Architecting the initial activity in the transformation process		• Use this thesis as a starting point for a formal architecting effort
2.	Develop a Comprehensive understanding of the enterprise landscape		• Validate, update and expand Section 5.1
3.	Understand what stakeholders value and how that may change in the future		• Validate, update and expand Section 5.2
4.	Use multiple perspectives to see the whole enterprise	1. Establish a sense of urgency	• Validate, update and expand Section 5.3 • Make SILC Deputy Commander the face of the transformation effort • Focus on the drivers of change at each staff meeting to establish urgency
5.	Create an architecting team suited to the transformation challenge	2. Form a powerful guiding coalition 3. Create a strategic vision	• Use SILC CCB & existing "communities of practice" to shape the vision & the new architecture • Engage counterparts from other LC/SCs and DHS agency infrastructure managers • Employ crowdsourcing via the USCG "ECIP Connect" & external sites like "Innocentive" • Create core team representing all internal stakeholder groups; enlist volunteers as ad hoc members to shape specific aspects
6.	Engage all levels of leadership in the transformation effort	4. Communicate the vision 5. Empower others to act on the vision 6. Plan for and celebrate short-term wins	• Embed vision into all SILC documents (i.e. annual report, portfolio reports, asset management plans) • Ensure transformation phases are coordinated w/ CG-43, CG-46, CG-47 & CG-9, as applicable • Publish performance incentives (i.e. "on-the-spot cash" or time off awards for champions of change • Use the "Product Line Academy" construct to engage middle managers at branch level • Send SILC Deputy to each unit to hold "town hall" discussions to communicate vision, allows cynics to vent, and to celebrate success to date • Use "view element anatomies" to help describe and explain new architecture • Invest in change management tools, such as "ChangePro" simulations to help remove the uncertainty that leads to resistance to change
7.	Architect for the enterprise's changing world	7. Consolidate improvements and produce more change 8. Institutionalize new approaches	• Validate, update and expand techniques and analysis introduced in Chapter 6 • Document successes in all SILC documents • Require the new architecture to be a consideration in the hiring process and personnel training plan • Employ Cynefin's "probe-sense-respond" approach for incremental change in the complex domain

Note that Kotter focuses primarily on the "downstream" issues after the transformation decision is made, illustrating another example of architecting versus designing. This "design" detail helps generate a more robust set of concepts to facilitate implementation planning, and was therefore included within the architecting process.

6.5 Summary of the Future Enterprise Architecture

Recall from section 5.1 that the primary drivers for transformation were (1) the quest for improvement, (2) competitive and economic forces related to limited funding, (3) workforce factors, such as the knowledge loss to retirements and transfers, and (4) the natural evolution of the organization. The "Harmonize Plus" architecture is summarized below in terms of these drivers.

Balancing resources with the prioritization of functions creates major improvement opportunities for the SI enterprise. Product Line management staffs are increased and hierarchically separated from regional execution. This enables critical mid- and long-term planning to occur unfettered by the "tyranny of present" spurned from short-term execution demands or disproportionate regional influences. Importantly, the PLM staff will remain connected to the execution staffs, via continued collocation, to ensure their plans, standards and expectations remain grounded in reality. While the execution staffs may again feel "cheated" by the transfer of resources, the combination of clear standards and a looser hierarchy (i.e. the CEU's will have more organizational autonomy) will stir innovation and create efficiencies that will balance the workload with resources.

The expectations of continued funding shortfalls will most clearly be addressed by strategically pursuing joint projects with other DHS agencies, as well as "connecting and developing" ideas and technologies from other external entities that can reduce the cost of business. Strategic outsourcing of specific design and construction activities during the first quarter of each fiscal year, in addition to the regional "indefinite delivery" contracts, will enable a more balanced spend down pattern and allow in-house designers to focus on projects that are aligned with their core competencies. Meeting spend down goals earlier in the fiscal year helps guard against mid-year reallocations and improves the odds of obtaining additional funds, if they become available. The fully dedicated PLM staffs will also better articulate SI value through improved data integrity and analysis.

Workforce factors related to knowledge management will be addressed by exploring IT systems on cyber security-compliant servers outside the USCG network that can be more responsive to SI enterprise needs. There will still be considerable interaction with the C4IT SC, but the SI enterprise would be able to use market competition to determine the most cost effective solutions rather than depending on third party contractors that may not have expertise in the commercial software used. The centrally planned, but locally executed training plan will improve workforce capabilities in alignment with strategic goals. Central planning enables economy of scale and focused capability attainment, while local execution, including feedback and request processes, ensures higher quality of training. Expanded use of online training will result in more training opportunities at lower costs per course. Looser hierarchies will provide the workforce with greater opportunities for cross-training and to work on projects for which they are passionate. Such variety of work and self-determination has been shown to increase employee morale, productivity, and retention rates.

The natural evolution of the SI enterprise is depicted in Figure 42. The focus on enterprise asset management in SILC 2.0 was an important cultural paradigm shift, but the organization, resource allocation, and short term priorities are misaligned with the strategy being developed through the ISO 55000 management framework, which espouses a systems approach on managing the "value" of the asset. The "Harmonize Plus" architecture recognizes that the legacy competencies of engineering and construction project management are still crucial to managing asset value, and thus retains those functions, albeit in a smaller capacity, focused on well-defined levels of service aligned with resources. The front-back organization structure enables product line management, execution, and shared services to be viewed as sub-systems within the larger enterprise system.

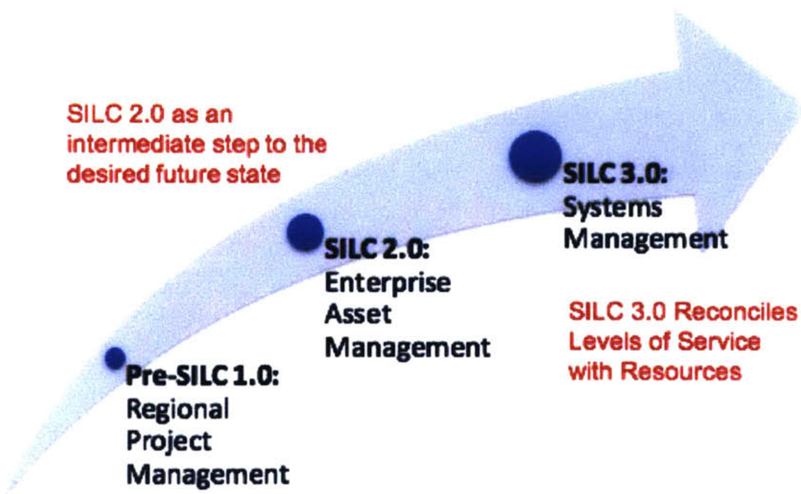


Figure 42: Evolution of the SI Enterprise

Chapter 7 – Conclusion and Future Work Recommendations

This chapter answers the research questions, examines the benefits and limitations of the thesis findings and the ARIES framework used, and discusses opportunities for future work based on this thesis.

7.1 Research Questions Revisited

1) *Can system architecting be applied to the USCG CE Program to develop an enterprise equipped to meet the complexities and uncertainties of future USCG shore infrastructure requirements?*

Yes. The application of systems architecting to enterprises, specifically to manage complexity and reduce ambiguity, is strongly supported by the literature review in Chapter 3, and the specific application to the SI enterprise is clearly exhibited in Chapters 5 and 6. Each technique either revealed new insights or confirmed and reinforced findings from previous tools. The process logically examined the problem domain so that concepts could be generated to specifically address transformation drivers. This comprehensive "upstream" analysis of the drivers is what differentiates system architecting methods from traditional organizational design techniques. This is examined further in Table 35, which addresses each of the "factors" introduced in section 1.2.1 to support the answers to these research questions. The "elements" of the ARIES Framework enables a holistic view of the enterprise from many perspectives, which reduces the chances of falling victim to the common transformation failure modes.

Table 35: Research Question Factor Analysis

ID	Factor	Discussion
1	The concept of *Architecting the Enterprise* versus *Designing the Organization*	Section 3.1.8 argues that *architecting* is unique from *designing*, yet there is overlap. Architecting provides upstream analysis to understand the drivers of transformation, making it the logical 1st step in a transformation effort
2	The most Insightful tools for applying the ARIES process	Architectural decision table, Cynefin framework, X-matrix, OPM diagram, SVN development, DSM & system dynamics models
3	The importance of the implementation strategy and whether timing matters	A poor implementation can completely undermine the benefits of a great architecture. Timing always matters, and should be factored into the implementation plan to avoid the common pitfalls of transformation efforts
4	The successful aspects of ISO 55000 that may not be captured in ARIES Framework	The ISO 55000 framework employs similar systems thinking principals, but has a very different purpose from ARIES. In this respect, ISO 55000 can be complementary to ARIES, particularly in terms of setting the strategic vision and generating concepts for a future architecture, per Table 25
5	The applicability of the ARIES Framework in SI-related industries and government	ARIES clearly has broader applicability to the industries in which the SI enterprise operates. The techniques are not industry-specific, and therefore enable an architect to delve into an appropriate level of detail on various enterprise elements. The architecting team of course must have applicable industry expertise to use the tools effectively

2) *What is the enterprise architecture that best positions the CE Program to achieve the strategic goals of the SILC 2016 Strategic Plan and the ISO 55000 Management Framework?*

The "Harmonize Plus" architecture addresses the transformation drivers and the strategic imperatives for efficiency, sustainability and resiliency (for both the SI enterprise and the infrastructure itself) through engaged leadership, standard practices and innovation. The architecture is defined in terms of architectural decisions in Table 29, the organizational element anatomy in Table 33, and the annotated organizational chart in Figure 43 depicting the "plus" attributes included from the "Integrate and Open" alternative. The architecture specifically addresses the three persistent challenges to the SI enterprise: (1) Resource constraints – by prioritizing functions and defining levels of service, outsourcing and divesting specified activities that require specialization or deliver low value, and partnering with DHS agencies for joint projects; (2) Knowledge and capability gaps – by strategically pursuing alternative delivery of IT systems, creating and investing annual training plans based on projected gaps and strategic goals, and providing more organizational flexibility at the branch level; and (3) Increasingly stringent regulatory and operating requirements – by creating interdependent organizations (front facing and customer facing) that can focus on fewer specific responsibilities, with clear delineations of responsibility for developing and executing specific compliance processes and standards. The training program and improved IT infrastructure will also mitigate this challenge.

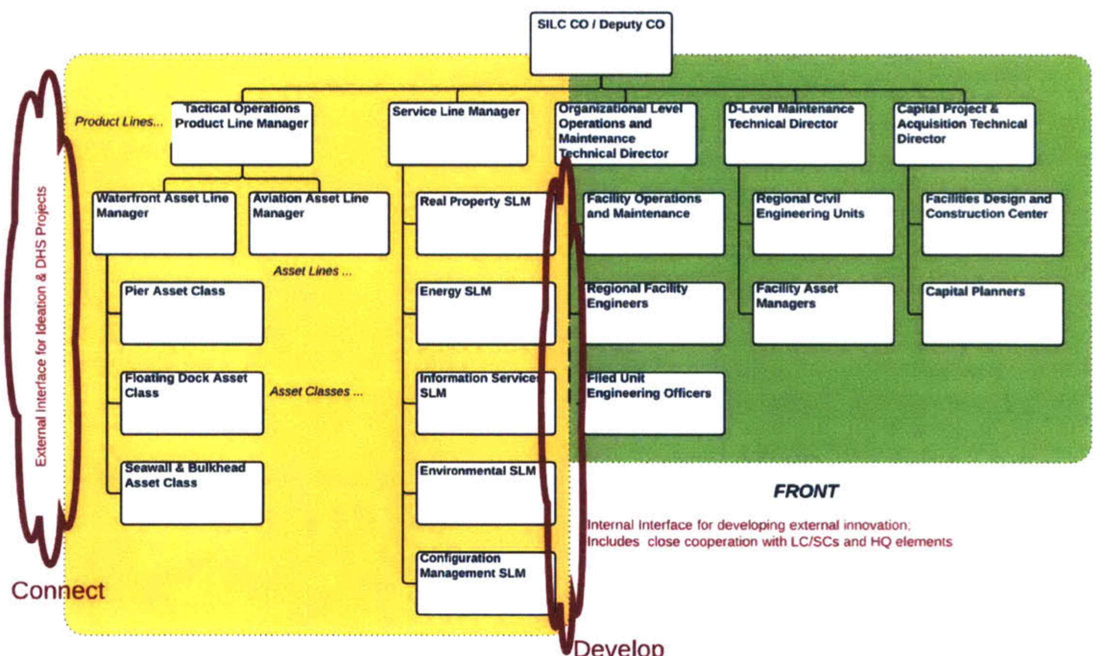


Figure 43: "Harmonize Plus" Conceptual Organization Chart

3) What is the best approach to implementing the recommended architecture?

An incremental approach adhering to the seven architecting imperatives and Kotter's eight step process, as shown in Table 34, is the approach that best balances the need for change with structural stability. Since the SI enterprise is already progressing towards managing USCG SI as a complex system of systems by adopting the ISO 55000 management framework, a "probe-sense-respond" approach, as suggested by the Cynefin framework, would help avoid the extended period of uncertainty experienced during the SILC 2.0 transformation. This approach would likely include developing a series of resource proposals, then sequentially submitting them upon making adjustments based on the emergent properties observed after the previous resource proposal was approved and implemented.

7.2 ARIES Framework Benefits

The system architecting approach applied to enterprises through the ARIES framework provides a logical, organized approach to dissecting enterprise challenges and transformation drivers, and then generating and evaluating new concepts to form a "blueprint" for the envisioned future enterprise. The ARIES process adheres to "Miller's Law", which states that the average person can manage seven things at a time, plus or minus two. [30] During the SILC 2.0 implementation, leaders were managing well over ten aspects at a time because SILC was attempting to define, design, and execute simultaneously. This significantly diluted the effectiveness of the transformation process because the leaders could not focus and therefore could not perform any of their initiatives as well as they otherwise could. ARIES minimizes the organizational tendency to jump immediately to solutions before defining the problem, and offers a series of artifacts that be used to articulate *why* a transformation decision should be made. Generating this blueprint before all else greatly facilitates and focuses the subsequent design and implementation phases of the transformation.

Another benefit is that the ARIES Framework provides flexibility to the architecting team by suggesting, but not dictating, the techniques used for analysis. Per Table 35, some techniques provided greater insights for the SI enterprise, but a different enterprise would likely find other techniques more valuable depending on their circumstance and the architecting team's ability to understand and employ the techniques. In addition, the "consideration factors" tabulated to summarize each ARIES process step in "*Architecting the Future Enterprise*" served as useful checklist in summarizing the findings from the techniques used in each step.

The "Harmonize Plus" architecture for the USCG SI enterprise is an excellent illustrative example of the aforementioned benefits. The problem definition developed in steps one through three formed the foundation for generating concepts that truly addressed transformation drivers and long standing problems. The evaluation process enabled critical analysis of these concepts against criteria that measured impacts of these concepts on strategic goals and capabilities. Reanalyzing the selected alternative and integrating favorable concepts from other alternatives made the final recommended architecture even more responsive to transformation drivers and enterprise challenges. Sections 7.2.1 and 7.2.2 offer an analogical view of the benefits that ARIES and the resultant "Harmonize Plus" architecture may bring, along with a specific observation as to why the ARIES process can be easily translated and understood by military organizations.

7.2.1 Analogy of System Architecting and the SI Enterprise Transformation to the Culinary Arts

System Architecting can be analogized to planning a dinner at home. There are plenty of recipes to choose from, and if the chef had unlimited funds and were starting with an empty pantry, any recipe could be used to "design" a meal. However, most families, like enterprises, have an existing inventory of food, tools (i.e. utensils, plates) and capabilities (i.e. number of appliances). There may also be key stakeholders, like growing children, whose tastes and appetites have evolved. The architecting process enables the chef to systematically *evaluate the landscape* (i.e. Are there guests coming? Is there new information that certain foods are more/less healthy than previously believed? Are prices for certain foods changing in relation to others?), *analyze stakeholders* (i.e. Are there allergies? Is anyone dieting?) and *inventory the kitchen, refrigerator and pantry* (i.e. is any food about to expire? How many serving sets are available?) before generating dinner ideas. One would expect the concepts jumping into the chef's mind at this point to be far more focused than if he or she had just thumbed through the recipe book. But architecting does not stop there. The problem domain has enabled the chef to envision a future meal better attuned to the ecosystem, but the solution domain enables a systematic approach of vetting those concepts to select the best alternative. It is only after the selection of the dinner "architecture" (i.e. maximum use of ingredients on-hand, a suite of appliances & utensils suitable for stakeholder favorites, and a doctrine that can flexibly accommodate food allergies), that the chef should consult the cook book as part of the implementation plan.

Similarly, a dinner analogy helps explain the evolution of the SI enterprise architecture. The regional project management-focused architecture prior to SILC 2.0 was like slices of watermelon for an appetizer. The seeds of asset management were present, but some pieces (i.e. CEUs) had more seeds (i.e. local practices and grass roots champions) than others, and rarely were those seeds systemically cultivated to make more watermelon (i.e. more funding for more projects). SILC 2.0 is analogous to a salad as the second course of the dinner, where project managers and asset managers were mixed together like lettuce and tomato, and the shared services were sprinkled in like dressing to provide consistency. This "consistency" was superficial, as the lettuce and tomato were still wholly independent (not interdependent), and there was no true management of the interfaces. The salad provided a requisite variety that more closely matched the complexity of the immediate environment, but the stakeholders are anxiously awaiting the main course, which has been ordered to be sustainable, resilient and efficient at a reasonable cost. To manage the complexity of the main course, the SI enterprise must again transform to an entrée like a meatloaf or a stew, which retains the core ingredients, but from the deliberate and coordinated interfaces of those ingredients (where the flavors become intertwined) emerges a complex yet delicious taste that satisfies the hungry stakeholders for a price they can afford.

7.2.2 Why Systems Architecting Works for Military Enterprises

The ARIES process is directly translatable to a proven process of strategic planning for war, as presented by Michael Handel in "*Masters of War*" [34] and shown in Appendix D, because it centers on the importance of the "nature of the enterprise and its ecosystem" much like Clausewitz emphasized understanding the "nature of the war". Table 36 compares the key components of each process. In addition to the direct component relationships, the iteration shown in Appendix D likewise mirrors the iteration between steps when exercising the ARIES processes and techniques.

Table 36: Comparison of ARIES to Military Strategic Planning Process

ARIES Process Step	Strategic Planning and the Nature of War
Understand the Landscape	Strategic Environment; Policy & State Objectives
Perform Stakeholder Analysis	The Enemy, Including his Doctrine and Technology
Capture the Current Architecture	Understanding the Nature of War & Industrial Complex
Create a Holistic Vision of the Future	Identifying a Comparative Strategic/Military Advantage
Generate Alternative Architectures	Developing an Optimal Strategy
Decide on Future Architecture	
Develop the Implementation Plan	Development of a Suitable Operational Doctrine

7.3 Analysis and Limitations

The intent of this thesis was to determine if system architecting could be applied to the SI enterprise to provide value that was worth the effort. Chapters 5 and 6 clearly demonstrated the valuable insights that could be obtained by architecting, but the findings and recommendations should not be accepted without a validation and expansion of the techniques used. Likewise, the ARIES process itself may have limitations and constraints that must be understood prior to starting the process.

7.3.1 Limitations of the Thesis Findings

This thesis was limited by time and access to a more robust set of stakeholders. Time constraints limited the breadth and depth of analysis provided within each tool, especially in terms of relating concepts back the literature in order to help further support arguments for the concepts included in the selected architecture. Time also impacted accessibility to stakeholders external to the SI enterprise. The statements used in the stakeholder analysis were based on notes from interviews and discussions conducted before the author began the SDM program one year ago. These inputs were subject to the author's interpretation and may not be reflective of current sentiments, as the SILC has matured over the past year. Efforts were taken to minimize these effects through communications with SMEs, but more timely and penetrating stakeholder analysis can be improved upon in future work. In addition, while SME support was very helpful, the bulk of the analysis was conducted by the author alone, and so conclusions and recommendations are subject to the author's biases without the benefit of an architecting team to provide broader perspectives.

The selection of the preferred alternative was also limited by the evaluation technique chosen. The Pugh analysis was chosen as a tradeoff between the level of "confidence" that the outcome truly represents the best alternative and the level of effort required to determine that outcome. According to Cropsey (2008) [12], Pugh requires a relatively low amount of effort, but has a commensurately low level of confidence. Other evaluation methods, such as "Quality Function Design (QFD)", "Modified Decision Matrix" or "Multi-Attribute Utility" would likely have provided greater confidence that the "Harmonize Plus" alternative best positioned the SI enterprise for future success.

7.3.2 Recommendations for ARIES Framework improvement

Several of the most insightful techniques are complicated and require training and experience, and others can be very time consuming. The framework should remain non-prescriptive as to which techniques must be used, but it could benefit by providing a larger list of applicable techniques, along with recommendations as to when certain tools are better than others. Architecting can be more of an art than a science, and this can be difficult for some engineers, author included, who prefer being able to calculate "right" answers. A list of "standards" that list the conditions under which each technique is best applied would likely make engineers more comfortable when employing the ARIES process. Paraphrasing Malone's "paradox of standards", this could be an example of applying standards in the "right" parts of the framework to enable much more flexibility in other areas. [15]

7.4 Future work

This thesis lays the foundation for several future opportunities to expand the techniques available within the ARIES framework and to improve the USCG SI enterprise architecture. Future work relative to the framework includes the aforementioned annotated list of techniques and the exploration of how tools like Cynefin and system theoretical accident modeling and processes (STAMP) can be applied to the generation and evaluation of alternative architectures. Exploring potential actions to change or better manage the "Cynefin context" of certain activities may offer another ideation opportunity. For example, the concepts shown in Figure 44 relative to managing OLM present a process for generating ideas by considering changes for the activities judged to be complex. STAMP has been shown to be applicable to USCG operations in several theses by USCG officers in the SDM program, and shows potential as a method to evaluate whether a proposed architecture has appropriate safety control mechanisms. In STAMP, "safety is viewed as a *control problem*, and accidents occur when component failures, external disturbances, and/or dysfunctional interactions among system components are not adequately handled." [35] Applying STAMP as part of the evaluation process may help identify potential safety hazards inherent in an alternative architecture and aid in architectural decisions relative to the process. STAMP may also have application for the SI enterprise during the AC&I planning process.

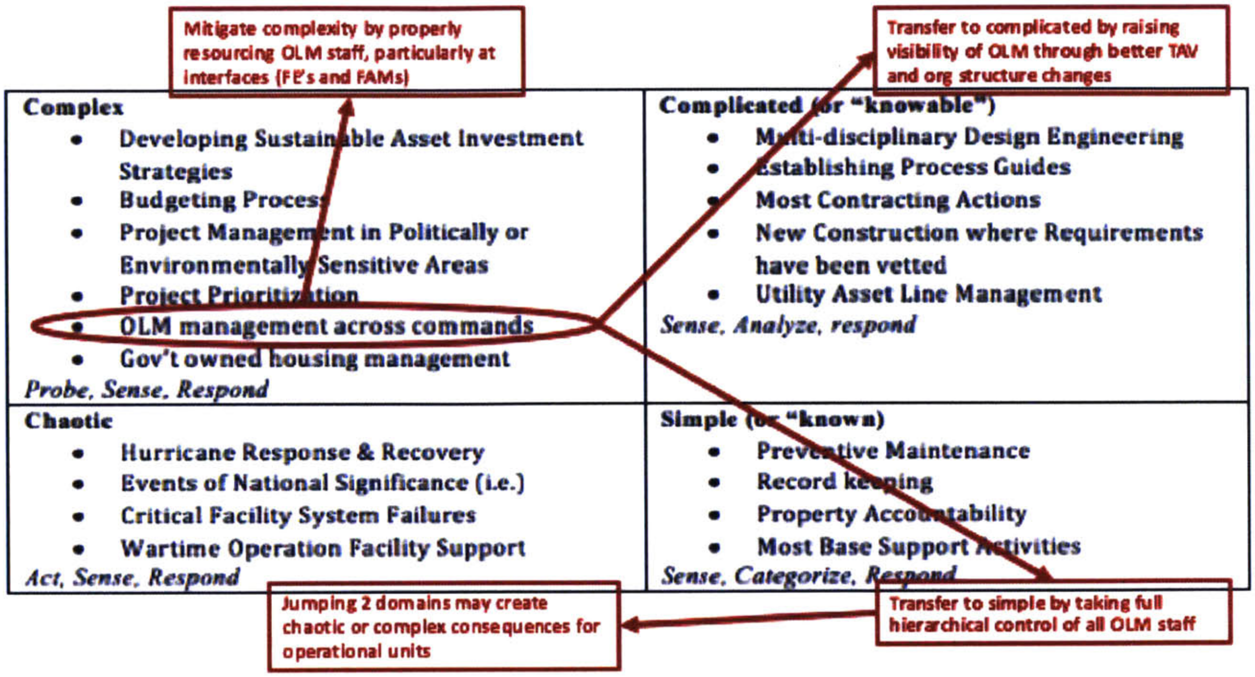


Figure 44: Ideation using methods to shift among Cynefin Domains

Potential future initiatives by the USCG SI enterprise begin with the recommendations listed in Table 34. This list can be expanded to include:

- Adopt, customize and build upon the system dynamics models developed by Lyneis and Sterman relative to facility maintenance, and those developed by Jacoby relative to USCG budget processes for boat and cutter maintenance, as shown in Figure 45 [5]. These models can greatly assist SILC in articulating shore maintenance needs and impacts.

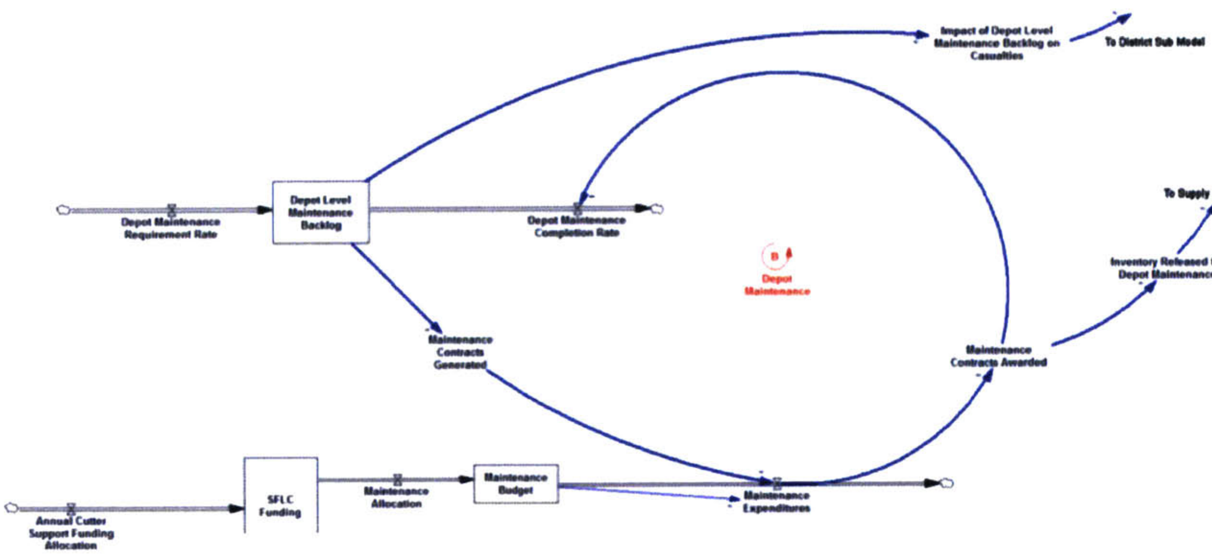


Figure 45: SFLC DLM Feedback Loop (Source: Jacoby, p38)

- Expand the OPM model of the new architecture to specify interface functions and provide a greater degrees of granularity so shared services can be analyzed.
- Use the other techniques demonstrated in the ARIES process to assist in the design, implementation and steady state operations of the future SI enterprise. This includes developing a DSM to identify functional teams, and data mining techniques to better understand and visualize the impact of strategic initiatives.
- Thoroughly evaluate other enterprises by expanding the scope of the "learn from experience" technique while generating alternative architectures. The analysis shown in Table 24 only scratches the surface, as enterprises like Disney World have proven resiliency programs for their infrastructure that the USCG should consider. The SI enterprise could affordably accomplish this by directing USCG Academy projects and Civil Engineering Program graduate school projects.
- Related to the above, better leveraging the existing USCG education programs in general can greatly advance SI enterprise goals. Not only will valuable and pertinent research be conducted at little additional cost, the officers can lead initiatives related to their research upon reintegrating to the SI enterprise.
- One specific area to study is the range and depth of DHS partnership opportunities. This may include partnering with FEMA and the Survivability and Vulnerability Information Analysis Center (SURVIAC), an analytical entity within the Defense Technical Information Center (DTIC) [36] to increase the visibility and perceived credibility of the Shore Infrastructure Vulnerability Assessment currently being developed within the SI enterprise.

Appendix A: Landscape Factor Analysis

Part 1 of 2

Context Factor	Description as Relevant to USCG CE Program	Level of Change in the Environment	Pace of Change in the Environment	to USCG CE Program
Economic	Funding levels are critical for maintaining the shore plant. CG43 estimates there is a $3B funding gap for AC&I and Depot Maintenance is funded at roughly 50% below Industrey Averages	Relatively stable: Annual appropriations for OE to funds follow trends of the overall federal budget. Often based on the prior year budget	Unpredictable: Annual changes are aligned with budget cycle. However, unplanned, off-cycle cuts (i.e. sequestration) or supplemental bills (i.e. post hurricane funding) can completely alter spending plans	Shore maintence funding is more likely to be cut than surface or aviation during off-cycle; Shore AC&I has been low priority
Market	The Market includes Facility O&M, A/E, Construction, Real Estate, Capital Planning, Environmental and contracting Services	These industries are fairly stable, and there is ample private sector capacity to outsource	These markets change with the general economy	In booming economies, gov't contracts are more expensive; we get better deals and service when economy is slow
Socio-political	Operational/mission focus is paramount both internally w/in USCG and from the publics perspective	Stable: Mission focus will not change, but there may be small changes on how leaders see the role	There has been a slow recognition of the importance of logistics, but that has not yet extended to shore facilities	Shore facilities are still seen as overhead, vice mission enablers - change has not
Technology	Technology can include new construction materials and procedures, energy conservation as well as IT systems for planinng, tracking and recording	Technology within the industry has advanced dramatically	New materials and IT capabilities, particularly mobile capability, are changing rapidly	Due to Cyber Security limitations, FAR, and HR programs, CE Program is
Workforce Demographics	Current CE workforce is primarily civilian (GS-5 through GS-15) with about 20% Active Duty military (O2 through O6)	A large portion of the Civilian workforce will retire over the next five years	HR system is painfully slow. It is unlikely employees can be hired at the expected rate of retirement	Billet gaps due to retirements already exist; large amount of corporate

Orange	Presents challenges to achieving SILC objectives
Yellow	Is neutral to achieving SILC objectives
White	Facilitates or presents opportunities for achieving SILC objectives

Part 2 of 2

Context Factor	Description as Relevant to USCG CE Program	Level of Change in the Environment	Pace of Change in the Environment	to USCG CE Program
Policy	DCMS Policy to align with MSBM four cornerstones	After period of significant upheaval, policy related organizational structure is stable	Should remain stable, though new administration may force changes	There are boundaries the enterprise must stay within, but they are fairly broad and SILC
Regulatory	This includes CFO Act (Real Property Accountability), EISA (Energy reductions), NEPA (Environemntal), and FRPC (square foot reductions)	Multiple mandates to increase accountability, decrease energy intensity, reduce environmental impact and reduce shore	Most mandates are active NOW	CE program is keeping up, but these "resource neutral" mandates have affected productivity and quality
Competitive	"Competitors" for funding include ALC, SFLC and C4IT SC. DOL can be seen as a competitor for resources for O-Level O&M	Most AC&I has been diverted to multi-year program to recapitalize the USCG cutter fleet, along with upgrades	Every 2-4 years there seems to be some sort of upheaval...usually commensurate with the transfer of leadership	Leadership personalities (i.e. at the DOL and other LC's) can impact SILC's ability to achieve
Resource	Does SILC have the right mix of skills?	Work requirements have changed - increased technological skill is	Requirements changes are faster than HR system can keep up	Magnitude and pace of change has left SILC with sub-optimal
Environmental	High expectations for stewardship as environmental protection is a USCG Misison	Standards wil continue to increase	Increase is expected to be gradual	We have numerous specialized billets for environmental compliance, but workload is not

Orange	Presents challenges to achieving SILC objectives
Yellow	Is neutral to achieving SILC objectives
(none)	Facilitates or presents opportunities for achieving SILC objectives

Adapted from Rhodes, Donna. Lecture 3 - The Enterprise Landscape. Systems Architecting Applied to Enterprises. MIT. March 1, 2016.

Appendix B: Analysis of Architectural Decisions for SILC 2.0

	Question	Description	Decision and reason
1	How will we subdivide shore infrastructure into "product Lines"?	The new business model was based on standard platforms (i.e. a class of cutter or a type of aircraft. Shore Infrastructure did not have similar standardization.	Decision: Subdivide by the primary function of the building or structure. For span of control, further sub-divide into "asset lines". For example, the Waterfront Structure Asset Line falls within the Tactical Operations Product Line Other options: Break down by unit type (air stations, marine safety units, boat stations) Reason: The unit type option would have created too much overlap and provided disproportionate influence to tactical unit commanders. The functional breakdown was more logical (like functions had similar requirements and similar mission criticality) and aligned with high level programs at HQ (i.e aids to navigation, aviation)
2	How do we populate the Product Line staffs?	This was "resource neutral" so we had to create PL and AL manager positions from existing billets	Decision: Convert billets from design teams at the Civil Engineering Units Other options: outsourcing, converting other positions Reason: The skill requirements of the ALM/PLM most closely aligned with those in the design teams. Funding was scarce so outsourcing was not really an option and would not have worked for the long-term
3	How do we define responsibilities and interfaces with Facility Asset Managers (FAMs)?	The breadth and spread of CG infrastructure, combined with limited facility expertise amongst tenants & operators, required a FAM as their primary POC. The pure MSBM had customers contact the PLMs directly.	Decision: Retain the FAMs as regional POCs to continue customer outreach, but redefine their responsibilities to report facility issues directly to the respective ALM, vice their chain of command, and to make data management a higher priority since ALMs would depend on this data Other options: Attempt to follow the pure model and absorb the FAMs into the PL org Reason: The complexity of the organization and geographic spread was too much for a PL. Much of the outreach dealt with issues outside the specific responsibilities of the PL. It was therefore better to allow PLMs to focus on core competencies while FAMs maintained customer outreach.

4	How do we define responsibilities and interfaces with The CEU's?	The CEUs were autonomous, regional, project-focused organizations. The new business model most directly impacted their form and some of their processes	Decision: Establish Product Lines at each CEU, making the Commanding Officer responsible for both PL responsibilities enterprise wide Other options: Central all PLMs, Keep CEUs separate Reason: There was much internal resistance to change. The only way to make the change happen in a reasonable time frame and to make it permanent was to embed the PLMs into the CEU. This created other tensions, but these were minor tradeoffs compared to the benefits of better integration. The decision was facilitated by the fact that the billets were already at that location.
5	How will the PLMs primarily make their decisions?	It not only funding government can support entrepreneurship education.	Decision: By analyzing data provided by the FAMs, using tools developed by a new branch called "information services" Other options: PLMs travelling all over creation to gather information on their assets Reason: Data holds the key to better facility decision making. We had been collecting data for years, but it was grossly underutilized. As part of the new architecture, an entity dedicated to managing data systems and services was created so PLMs could use this data to understand trends.

Appendix C: Mapping Architecture to Strategy, Regulation, Marketing and Technology

Table 1 of 5: Corporate Strategy

Strategic Level	Corporate Strategy	Impact of Strategy on Architecture
Stakeholder Annual Report	[*long term goal*] Collaboratively anticipate mission requirements & provide optimal lifecycle stewardship of CG Shore Infrastructure through innovative, sustainable, and affordable solutions	The architecture had to adjust to promote collaboration with operational partners. To this end, the roles and responsibilities of Facility Asset Managers (FAMs) and Asset Line Managers (ALMs) were redefined and realigned within the enterprise architecture
Executive Management	Align Contingency Response/Recovery/Reconstitution processes w/ emerging changes to reporting and funding request requirements [*to address opportunities and threats related to post storm funding*]	Evolving policy and requirements changes from DHS and USCG HQ will drive architectural changes to the SILCs pre and post hurricane organization and processes, specifically the forward deployed damage assessment teams and the SILC incident command post
Business Unit	[*The Business Operations Division's Information Services Branch (ISB)*] Progressively address IT system deficiencies, improve user interfaces and standardize data management processes. This is known as the information management strategy (IMS)	The Info management strategy drove the creation of new full time equivalent (FTE) positions and a reallocation of roles w/in the ISB to collect and document requirements, implement system changes, and provide data management training. The architecture of this business unit will likely continue to incrementally evolve as the strategy matures
Functional	[*product development*] Standardize equipment maintenance and data management practices enterprise- wide through a contracted effort augmented by designated USCG personal at every field unit. This is known as the "equipment enrollment" (EE) strategy	[context: equipment maintenance and management processes varied widely across and even w/in regions, resulting in inconsistent product performance and an inability to track trends because of inconsistent or nonexistent data structure]. The EE strategy will fundamentally change the data infrastructure in the SILC asset management IT system (linked to the Info management strategy outputs above) and standardize organizational processes across 500 field units. The process changes will require some units to change their maintenance organizational structure.

Table 2 of 5: Strategy

Strength of Impact	**Impact *of* Architecture**	**Strategy Factor**	**Strategy Description**	**Impact *on* Architecture**	**Strength of Impact**
HIGH – If SILC architecture is not aligned w/ the USCG operational architecture, facilities may fail to enable certain ops	The architecture, as defined by an org manual and a series of technical orders, determines how well the SILC can understand and meet operational requirements.	Long-term objectives (SF1)	Enable CG operations (i.e. launching boats & aircraft in support of CG missions of search & rescue, law enforcement, marine environmental protection, national defense, etc) through lifecycle management and stewardship of shore infrastructure.	"Enabling" CG operations shifts the focus of the SILC business model from merely a facility caretaker to more integral player in the broader CG context ("every CG mission begins & ends at a shore station"). This drives changes to the categorization of products and services to align w/ the ops they support both geographically & functionally	HIGH – the emphasis on ops/mission drove recent org changes to align Product lines w/ senior operational & program echelons
HIGH – existing architectures did not enable optimal delivery of services	The divergent existing architectures amongst logistics centers (e.g aviation, C4IT, surface forces (naval), personnel) drove the Commandant (CG CEO) to mandate a standard model so that all logistics services could be accessed in a standard & repeatable fashion	Action programs (SF2)	Integrate the USCG mission support business model (MSBM) "four cornerstones" (product line mgt, bi-level maintenance, configuration mgt, & total asset visibility) into all aspects of SILC activities	The four cornerstones became the central theme around which the SILC mobilized. The integration was used to define how lifecycle management and stewardship would enable CG operations. This was directly related to the long term goal of enabling ops & fundamentally changed the way SILC would plan & deliver products	HIGH - This greatly influenced the details of the org changes mentioned above in SF1.
HIGH – Senior CG leadership now has 1 POC w/ whom to prioritize resource allocation (vice 6)	With an architecture based on the four cornerstones in place, SILC resource allocation prioritization in collaboration w/ senior leadership is now possible	Resource allocation priorities (SF3)	Incrementally re-engineer the resource allocation model to be based on senior CG operational & program echelons vice the priorities of lower level unit commanders	This will strengthen the "product line management" component (per SF2) of the enterprise architecture by empowering PL mgrs to direct allocation of resources vice the legacy model of geographic distribution	MED – the architecture is in place, but the doctrine will be modified

Strength of Impact	Impact *of* Architecture	Strategy Factor	Strategy Description	Impact *on* Architecture	Strength of Impact
HIGH - limited resources dictate the extent of the "full service" business; if no procurement staff, no proc. business line	The architecture can either enable or prevent this strategy. There is another CG command trying to absorb some of the SILC resources & the final decision will determine the future viability of this strategy	Selects the business the firm is in or should be in (SF4)	Establish SILC as a full service real property management organization (vice an Architect/Engineer/Construction (A/E/C) org). This is very closely related w/ SF5, but there is some policy ambiguity wrt procurement business functions	Requires business units & functions beyond traditional A/E/C competencies, including real property specialists, accounting & procurement specialists (which currently exist in the SILC org)	LOW – Affects some of the details of the architecture, but does not result in significant changes
LOW – SILC was created to execute this strategy	Given the top-down mandate, the architecture was driven by strategy	Defines the business scope (Products, Markets, Geography) (SF5)	Provide shore facilities & related services to ALL CG units and programs worldwide. Highly related to SF4 w/ less policy ambiguity	This "strategy" is more or less mandated by CG policy	HIGH – SILC architecture was pre-designed for this strategy
HIGH – frustrations w/external constraints allows current architecture to drive competency strategy	HR system sits largely outside SILC control and the architecture is very difficult to change in terms of core competency development, so strategies are heavily based on the existing strategy	Aimed at developing the core competencies (SF6)	Hire "fully qualified" civilian workforce & use advanced education program to develop military officers	Strategy reflects deficiencies in HR system & SILC budget which prevents development of a career ladder or a comprehensive competency development program.	LOW – change can be made iteratively
MED – care must be taken to account for bias	Existing Architecture can create biases or pre-dispositions in the analysis, or limit innovation in the strategic planning process	Assesses opportunities and threats in the environment, and strengths and weaknesses of the organization (SF7)	Develop five year strategic plan augmented by annual business plan to include SWOT & related analyses	Strategic analysis may uncover deficiencies or imbalances that can be mitigated by architectural changes	MED – often iterative or focused on a specific function or business line

Table 3 of 5: Regulatory

Strength of Impact	**Impact *of* Architecture**	**Regulatory Factor**	**Approach**	**Impact *on* Architecture**	**Strength of Impact**
HIGH – good architecture enables forward leaning practices	SILCs centralized management (due to org structure & doctrine) & local delivery of regulatory mgmt (due to resource allocation) enables this approach. To date, the SILC has largely been able to absorb most unfunded regulatory reqm'ts	Regulatory compliance (RF1)	Establish standard Processes to meet or exceed the letter & spirit (intent) of regs, w/ particular emphasis on documentation	Has necessitated the creation of specialist positions in certain locations and has added processes that extend product delivery times	MED – The extra work & specialist positions counter the added work due to a violation
HIGH – good architecture enables forward leaning practices	Existing architecture enables professional interactions, which makes this approach viable. If compliance was not considered in the architecture, we would be chasing our tail vice looking fwd	Anticipated regulation (RF2)	Leverage professional societies, journals, conferences & CG reputation to plan for anticipated regulation	This has most recently led to creation of functional units to meet the expectation of increasingly stringent energy & CFO Act requirements	MED –Existing architecture needs some re-balancing to meet anticipated regs
MED – SILC Architecture predisposes an affinity to using standards	SILC does not have resources to develop our own standards or innovate beyond standards. Existing architecture has driven conclusion that following standards = better stewardship	Standards (RF3)	Adopt industry standards wherever possible (e.g. Universal bldg. codes, ASHRAE standards, Uniformat, Omniclass, etc)	Enterprise architecture is designed around the vast array of proven standards for the built environment. This is also reflective of the fact we are in a mature industry	LOW – changes in standards are typically very incremental & can be addressed on a project basis
MED – Military culture & architecture predisposes a thorough approach to liability	Technical orders (per SF1) are written with product liability in mind, and the architecture facilitates internal reviews	Product liability (RF4)	Employ thorough review process for each project to validate compliance with internal procedures	Reinforces the need for the hierarchical structure common in military organizations	LOW – hierarchical Architecture more due to military than to an approach

Table 4 of 5: Marketing

Strength of Impact	**Impact *of* Architecture**	**Marketing Factor**	**Approach**	**Impact *on* Architecture**	**Strength of Impact**
HIGH – SILC structure made this approach intuitive	Existing Architecture & the resource neutral (could not add FTE despite adding responsibilities) constraint of SF2 drove the redefinition of ALM & FAM responsibilities	Customer and stakeholder needs analysis (MF1)	ALMs perform formal analysis w/ regional inputs from FAMs	Established organizational entities dedicated to stakeholder	MED – deep impact for a narrow portion of the architecture
MED – driven more by strategy factors	By virtue of customer org structure, market segmentation was fairly straightforward	Market segmentation (MF2)	"Market" is segmented both functionally & geographically to align w/ senior echelon customers	This approach influenced details of the architecture driven by the SF2	MED – driven more by strategy factors
LOW – SILC structure does not appreciably change size	Architecture was originally designed with size of shore plant as a factor	Market size & penetration (MF3)	This is relatively fixed. ALMs analyze as part of annual reporting process	Total number of assets, or complexity of assets may impact relative sizes of AL staff, but do not require substantial arch changes	LOW – market size does not change
MED – SILC structure facilitates analysis	Per SF2, reasonable commonality amongst LCs facilitates understanding of budget requirements by senior decision makers	Competitive analysis (MF4)	Business Ops Division conducts competitive analysis based on interaction w/ other LCs & ALM inputs	Org changes at other LCs may influence in-kind changes to SILC architecture	LOW – this would not be the driving factor
LOW – mature industry	Dedicated ALMs may help drive some innovation in addition to standardized processes (yes, innovation can coexist w/ standardization as long as stds are not overly prescriptive	Product and service function, features (MF5)	Mostly set by CG policy, bldg. codes & related standards, but ALMs do establish CG configuration standards were there are unique CG assets (i.e. Aids to Navigation) or ambiguous or conflicting standards (i.e. physical security)	Impacts some processes but no organizational impacts	LOW – mature industry
MED – SILC org also facilitates data collections	An architecture well aligned with the operational customers org can greatly facilitate the approach of prioritizing work and	Product and service Pricing (MF6)	The "price" for our customers typically comes in the form of opportunity cost, i.e. we can do Project A or Project B. ALMs & FAMs present customers with	May impact distribution of work amongst regional design units, but does not affect architecture	LOW – project issue

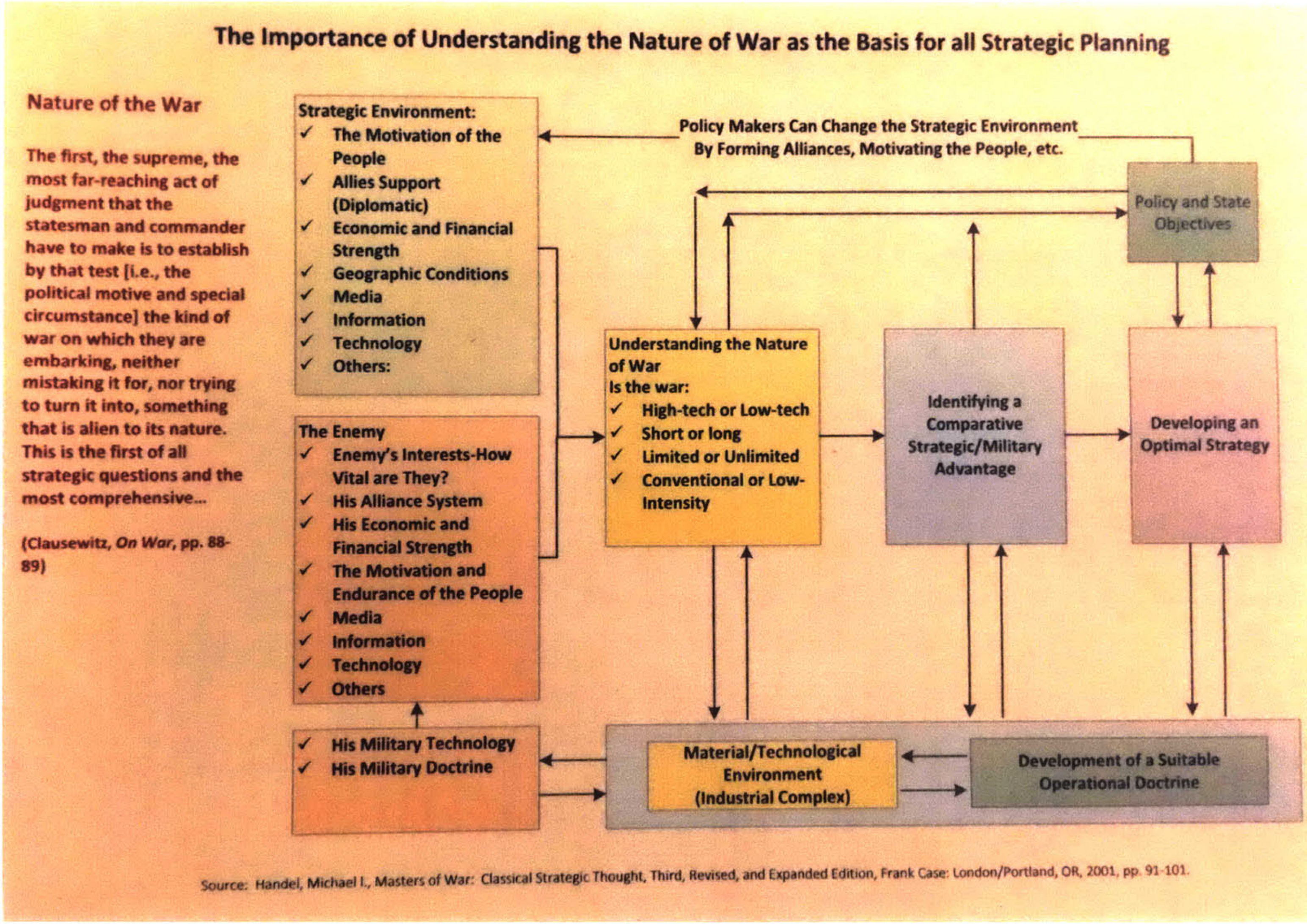
Strength of Impact	Impact *of* Architecture	Marketing Factor	Approach	Impact *on* Architecture	Strength of Impact
that feeds the metrics used for prioritizing projects	securing customer buy-in		recommended project priorities based on two composite metrics that account for operational relevance & a stewardship factor		
HIGH – facilitates customer under-standing	Existing architecture, driven by SF3, enables this approach	Communications and differentiation plan (MF7)	ALMs communicate plans via published "programs" for each fiscal year. FAMs personally communicate specific impacts of each AL plan to their respective customers	Approach is intended to reduce complexity for customers per SF3, and therefore the SILC architecture is a bit more complex	LOW – approach driven by Strategy
MED – architecture has some influence on the specific approach	Architecture enables centralized decision making with local project execution	Distribution channels (MF8)	For USCG, this translates to the "place" were resources are allocated. SILC is moving away from a formulaic regional distribution system to an allocation system driven by enterprise-wide operational needs	This approach changes processes but not architecture	LOW – architecture is largely unaffected

Table 5 of 5: Technology

Strength of Impact	Impact *of* Architecture	Technology Factor	Approach	Impact *on* Architecture	Strength of Impact
MED – no org unit to validate initial assess-ments	The existing hierarchical structure provides appropriate oversight for product specific technology planning. There is room for improvement when it comes to sharing project or product specific technology	Technology planning and assessment (TF1)	ALMs, design engineers, planners, civil architects, construction project managers, environmental specialists and the ISB seek out tech for their respective products, services and processes, then submit a proposal through the Business Ops division and Engineering Services division for assessment planning (if enterprise wide) or implement directly to their project if the spec is product or process specific	The need for a structured technology planning & assessment process for enterprise-wide proposals affected how the BOD and ESD were structured.	MED- narrow impact to 2 divisions
LOW – does not really promote transfer or infusion	The existing hierarchical structure provides appropriate oversight for product specific technology infusion	Technology transfer and infusion into products (TF2)	Often ad hoc for product specific infusion. Enterprise infusion follows the process established by SILC BOD and ESD	Can impact product architecture (i.e. lighter or more durable materials) but not enterprise architecture	High – for product arch, not enterprise arch
MED – there could be better ways to organize to achieve competitive advantage	Existing architecture enables this approach	Technology strategy as a competitive advantage (TF3)	The most relevant technology to competitive advantage is our IT system for using data to better articulate budget requirements for senior decision makers. The approach is to use IT systems to calculate meaningful metrics and visualizations to connect facility maintenance needs with mission needs	Great IT systems are of little value if not used properly, so the IMS discussed in #2 (business unit strategy) includes architectural changes necessary to ensure data integrity	MED – wide reaching but shallow impact to org
LOW – neutral impact	Existing architecture neither promotes nor hinders our ability to plan for the future, though the resources capable of doing so are usually trapped in the tyranny of the present	Architecting system to deal with future technology advances (TF4)	A joke in our industry is: "aside from computer aided drafting, steel & mechanical winches, technology in construction has not advanced since the pyramids". As a government agency, we are even less inclined to plan for future advances for our products. The exceptions are related to energy	Capability improvements to operational platforms (i.e. range improvements to radio comms, aircrafts and ships) reduce the need for future shore infrastructure. This could impact architecture but political	LOW – slow rate of advance in industry, political issues

Strength of Impact	Impact *of* Architecture	Technology Factor	Approach	Impact *on* Architecture	Strength of Impact
			conservation and projected capability improvements to operational platforms.	issues regarding the closure of CG facilities cloud our ability to architect the future (though I will attempt to do so in my SDM Thesis)	
MED – N/A but there is compatibilit y	The architecture reflects our info security culture and would be nicely suited to managing IP if applicable	Intellectual property and its strategy (TF5)	The SILC does not have technology IP, but we do deal with very sensitive information related to national security.	Information security is ingrained in the culture and reflected in our architecture	LOW – N/A

Appendix D: Graphical Representation of Military Strategic Planning



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