DECISION MAKING AND COMMUNICATION PROCESS ASSESSMENT OF NASA USING THREE CHANGE REQUESTS FROM THE SPACE LAUNCH SYSTEM PROGRAM

by

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A THESIS

Submitted in partial fulfillment of the requirements

for the degree of Master of Science in Engineering

in

The Department of Industrial & Systems Engineering and Engineering

Management

to

The School of Graduate Studies

of

The University of Alabama in Huntsville

HUNTSVILLE, ALABAMA
2015

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ABSTRACT
The School of Graduate Studies
The University of Alabama in Huntsville

Degree <u>Master of Science in Engineering</u>   College/Dept. <u>Industrial & Systems Engineering and Engineering Management</u>

Name of Candidate <u>Karen Campbell Hicks</u>

Title <u>Decision Making and Communication Process Assessment of NASA Using Three Change Requests from the Space Launch System Program</u>

      This thesis investigated the communication and decision making process as part of the Systems Engineering practices at the NASA/Marshall Center to determine its level of effectiveness. Data was collected across three change requests to assess how decisions were made, how the decisions were communicated, and whether a process mattered in the formulation and dissemination of those decisions. Data results revealed the comprehensive decision making process for the technical change requests to be effective. Evidence revealed that the process was sufficiently tailored to accommodate the need of each individual technical change which promoted effective communication amongst the stakeholders in the formulation of the strategic decision recommendations elevated to upper management. However, data results also revealed the dissemination of the final decision and approval of the change requests from the higher organizational level down to all stakeholders was less effective. An establishment of a culmination meeting at the end of the change request decision process in which to close the communication loop with all entities would be beneficial.

Abstract Approval: Committee Chair   _____

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ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

1.1   The Marshall Center and the Future Rocket

The future of space travel is evolving as NASA designs the nation's next generation launch system that will provide the capability for human exploration missions beyond low-Earth orbit (i.e., to the moon, Mars and beyond). NASA's Marshall Space Flight Center (referred to hereafter as the Marshall Center) is leading the design, development and delivery of the most powerful rocket ever built – the Space Launch System or SLS. This advanced, heavy-lift vehicle will launch humans and robotic explorers deeper into the solar system than ever before.

This is not unfamiliar territory for NASA and the Marshall Center. The Marshall Center is an experienced developer and integrator of launch systems possessing the engineering capabilities to take hardware from concept to preliminary design to operation in space. Prior to the SLS Program, the Marshall Center was responsible for the design and development of the Ares I and Ares V launch vehicles within another national-level program called Constellation. The Marshall Center was an active participant in the first, successful dedicated vehicle and ground test flight of the Ares I-X rocket prior to the cancellation of the

Constellation Program. Similarities between the Constellation Program and SLS Program are:

➢ Share a primary goal of enabling human exploration beyond Low Earth Orbit (LEO)

➢ Share a common service intent with rockets under design to be the Space Shuttle's successor

➢ Share a distributed team approach across multiple NASA Centers

➢ Share a common charge to reconstitute systems engineering capacity within NASA's human spaceflight community to smoothly transition the human spaceflight workforce to the next generation of capabilities and to lay the foundation of a program that will be cost-effective and sustainable into the far future (Rhatigan, et al., 2011).

While large scale, distributed programs like Constellation afforded advantages such as accessibility to the entire Agency's technical depth, skills and expertise, best practices and approaches, and state-of-the-art NASA facilities and infrastructures across the nation, there were also some pivotal disadvantages (Constellation Lessons Learned, 2011). There was persistent political tension between what was most efficient for the Constellation Program versus what was best for a particular NASA Center to sustain or grow its current role. The large dispersed teams at ten NASA Centers led to unclear roles and responsibilities and exposed cultural differences. With each Center documenting Constellation requirements, procedures and processes – oftentimes duplicative and contradictory - the contractors had difficulty distinguishing final decisions

coming from the Agency, since direction could come from the program or the independent technical authority.

1.2   Lessons from Constellation

In 2011, NASA published an executive summary containing lessons learned collected from the aerospace workforce who contributed to the Constellation Program. From the key findings, the most difficult and most persistent challenges involved cost, schedule, and organization (Constellation Lessons Learned, 2011). While the NASA Agency is renowned for technical prowess, senior managers in flagship programs can be faced with multitude of non-technical challenges for which they have far less training or preparation. In this respect, using Constellation as a comparative and its lessons learned can provide invaluable sources of insight (Constellation Lessons Learned, 2011). For the purposes of this study, three major lessons learned pertaining to roles and responsibilities, decision-making, and communication are listed and analyzed as the basis for the research objectives within this study.

The clarity of RR&A for the Constellation Program was degraded by the combined effects of the wide distribution of program responsibilities via the "10 Healthy Centers" policy, the multi-decadal phasing of the program development, and the assumption of traditionally understood roles from the Space Shuttle heritage component development. There is no formula or checklist for clear RR&A in an Agency-wide flagship program, but RR&A can be improved by periodic functional examination, by either combining like tasks or separating functions by needs (Constellation Lessons Learned, 2011).

The clarity and effectiveness of the decision-making processes for the Constellation Program were driven by the same events as for the RR&A mentioned above. In spite of constant attention from senior management, the decision-making process remained a persistent issue that only marginally improved over time. In a program of this magnitude, attempts to balance timely decision-making at the appropriate levels, consider tactical viewpoints and clearly delineate accountability for execution, while keeping all stakeholders informed and included, often left someone dissatisfied. For any large scope, distributed program like Constellation, it is recommended to invest the time and energy to define a comprehensive strategic decision process that includes all affected parties. Project Planning is vitally important (Constellation Lessons Learned, 2011).

As mentioned previously, Constellation's widespread 10-Center team created a true communications challenge. While countless assessments and prevailing programmatic wisdom indicate a small, centrally located team is the most efficient way to build a complex element, Constellation did not have that luxury. Thus, this posed RR&A, decision-making and communication issues. The Constellation Program incorporated Information Technology (IT) tools and applications (telecom, WebEx, Integrated Collaborative Environment (ICE) portal, etc.) extensively to enhance the flow of information (Constellation Lessons Learned, 2011).

The vast aerospace industry as well as scientists and academics across the globe are watching NASA, tracking its progress in the development of the SLS

heavy-lift vehicle. Congress and the U.S. taxpayers are also closely observing its

progress and alignment with budget and schedule constraints. On the heels of the

abruptly cancelled Constellation Program in 2010, with not one, but two test

flights accomplished for the Ares I-X rocket and Orion crew vehicle,

NASA/Marshall Center must learn vital lessons from Constellation (and other

large-scale human spaceflight programs such as Apollo, Space Shuttle,

Shuttle/Mir and International Space Station (ISS)) and adequately apply them to

the management and development of the SLS Program.

1.3   Research Questions

Based on the nature of the responsibility and the watchful eye of the

nation on NASA in the development of the SLS launch vehicle, the following

questions will be researched and analyzed in this study:

➢ Is the SLS Program applying these lessons learned from the Constellation

  Program to its decision making and communication processes?

➢ Does the SLS Program balance timely decision making at appropriate levels?

➢ Does the SLS Program make strategic decisions and have a comprehensive

  decision process?

➢ How effective is the SLS Program at making decisions?

➢ Does a decision making process really matter?

➢ How are decisions made on the SLS Program?

➢ Are the decisions made by group consensus or directed by management?

➢ How is the communication flow within the program?

➢ Are all parties included in the decision making and communication process?

Consequently the resulting research objectives from the above questions are:

❖ Define strategic decisions

❖ Define the dimensions of strategic decision making

❖ Investigate how decisions are made

❖ Investigate the effectiveness of the strategic decision making process

❖ Determine if decision making process matters

❖ Assess communication flow within each objective listed

To thoroughly investigate and study the research objectives, the SLS Program Change Request (CR) change control process served as the surrogate for insight and data collection pertaining to decision making and communication patterns and processes.

CHAPTER II

LITERATURE REVIEW

2.1   Decision Definition

What is a decision? The Merriam-Webster dictionary (2014) defines a

decision as a determination arrived at after consideration. Mintzberg, et al. (1976)

defined a decision as a commitment to a future action. Decisions are assumed to

be clearly distinguishable and discrete events. Decision makers often can identify

discrete decision points and feel a sense of completion at making a decision.

However, decision boundaries are not always as clear as first thought [or

assumed], and there is not always agreement on what events are involved in a

given decision. Almost every decision involves a series of activities and choices

nested in choices of wider scope, rather than a single simple choice (Poole &

Hirokawa, 1996).

2.1.1   Strategic Decision Definition

One type of decision is a strategic decision. Strategic decisions express

adaptation to opportunities, threats, constraints, and other characteristics of the

environment (Papadakis, Lioukas, & Chambers, 1998). Strategic decisions have

been described as committing substantial resources, setting precedents and

creating waves of lesser decisions (Mintzberg, et al., 1976); as ill-structured, non-

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routine and complex (Schwenk, 1988); and as substantial, unusual and all-pervading (Hickson, et al., 1986). The significance of strategic decisions means that there is more at stake for those who stand to gain or lose from the decisions in terms of material or reputational consequences (Child, Elbanna, & Rodrigues, 2010).

2.1.2 Strategic Decision Schemes

Common decision making schemes with strategic decisions are consensus, majority vote, and decision by authority. Other methods include minority decision, where a subgroup decides, with or without the goodwill of the other group members; bargaining, arbitration, and compromise are also possibilities (Brilhart & Galanes, 1992; Gulley & Leathers, 1977; Jensen & Chilberg, 1991; Johnson & Johnson, 1987). When compared to uninstructed groups, consensus decision making produced better quality decisions but entailed more time (Hall & Watson, 1970; Nemiroff & King, 1975; Nemiroff *et.al.*, 1976).   Consensus is the best evidence of widespread commitment to a decision and without the commitment the decision has little chance of being effectively carried out. Moreover, the sometimes taxing process of working toward commitment yields not just commitment but better decisions (Nickols, 2005).

2.1.3   Strategic Decision Impact

By implication, strategic decisions are complex and involve a high degree of uncertainty (Mador, 2000). Strategic decisions, with important impact, attract the collective attention of more layers in an organizational hierarchy. This idea corroborated Dutton, et al. (1989), who argue that issues with great magnitude of

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impact imply high interconnectedness with other relevant issues. Therefore, such issues attract more collective attention and thus result in higher hierarchical decentralization and lateral communication (Papadakis, Lioukas, & Chambers, 1998). These results align with Dean and Sharfman (1993a) and Stein (1980), who suggest that the perceived magnitude of impact of a decision is among the strongest explanatory variables of decision making behavior, as decision makers act more comprehensive or rationally when a decision implies important consequences (Papadakis, Lioukas, & Chambers, 1998).

2.2 Decision Dimensions

As mentioned previously, a decision is a determination made after some consideration. Decision making is not a unitary event, but a complex social process involving the directing of attention, discovery, designing courses of action, evaluating alternatives and choosing among them (Simon 1965; Oliver & Roos, 2005). Two concepts – procedural rationality and politics – have clearly played central roles in the organizational decision making literature (Allison, 1971; Carter 1971; Cyert & March, 1963; Eisenhardt & Bourgeois, 1988; Eisenhardt & Zbaraki, 1992; Fredrickson & Iaquinto, 1989; Hart, 1992; March & Simon, 1958; Mintzberg, Raisinghani & Theoret, 1976; Pettigrew, 1973; Pfeffer, 1981; Dean & Sharfman, 1996). Substantial research by Dean and Sharfman (1993a) has demonstrated that procedural rationality and politics are distinct dimensions of the strategic decision making process.

2.2.1 Procedural Rationality Dimension

Procedural rationality is defined as the extent to which the decision process involves the collection of information relevant to the decision, and the reliance upon analysis of this information in making the choice (Dean & Sharfman, 1993b). Managers who conduct and rely upon analysis in making their choices – those who use more rational strategic processes – will be more likely to develop effective plans for reconciling their organizations with environmental reality. As Bourgeois and Eisenhardt (1988, 827) put it, rational processes allow people to "form theories regarding which strategies will succeed." Top managers who fail to systematically collect and analyze information about environmental trends and constraints will be much more likely to lead their organizations in nonviable strategic directions (Dean & Sharfman, 1996).

2.2.2 Political Dimension

Political behavior has long been recognized as an aspect of organizational decision making (Allison, 1971; Pettigrew, 1973). Since strategic decisions are made among people by people for people, they are a welter of action, interaction, and counteraction (Hickson, et al., 1986). An organization comprises distinct groups of people with different motivations for getting involved in decisions (Butler, 2002). The interplay of interests, conflict and power between individuals and groups means that the strategic decision making process can be characterized as political in nature (Wilson, 2003).

Two key ideas underlie the political dimension of decision making. First, people in organizations have differences in interests resulting from functional,

hierarchical, professional, and personal factors (Hickson, et al., 1986; Pettigrew, 1973). Second, people in organizations try to influence the outcomes of decisions so that their own interests will be served, and they do so by using a variety of political techniques (Pfeffer 1981; Dean & Sharfman, 1996). Hickson, et al. (1986) identify three main variables of political behavior or what they called 'politicality': 1) Intervention or the extent of external influence, 2) Imbalance or the degree of uneven influence and 3) Contention of objectives or the extent of disagreement over objectives. Disagreement over objectives tends to reduce support for what has to be done later in implementation and diverts attention from exploiting knowledge about how to do it. Disagreement also contributes to unfavorable conditions (Dean & Sharfman, 1996; Sharfman & Dean, 1997; Nutt, 1998; Eisenhardt & Bourgeois, 1989). The personality and style of the decision makers are important factors in the strategic decision making process. Some people have preference for data while others prefer to go with their gut; some are controlling, demanding and hoard information while others are inclusive, rely on and involve others. Conflict among the varying personalities and styles should be productively managed else conflict can be the detriment of the organization and the decision (Nickols, 2005).

At first, Hickson, et al. (1986) argued that effective decisions must be based on organizational goals. However, Dean and Sharfman (1996) later assessed that political decision processes are typically not oriented toward organizational goals, are unlikely to produce complete and accurate information, and do not focus on environmental constraints. Consequently, they concluded

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there exists a link between politics and unsuccessful decisions. Two years later,

Papadakis, Lioukas, & Chambers (1998) conducted research that found with

properly aligned tools, politics can have a positive influence on strategic decision

making. They (1998) found that formal planning systems appear to have a

positive influence on three aspects of the strategic decision making process:

comprehensiveness or rationality, lateral communication, and politicization (i.e.,

politics). Results indicate that formal planning influences the way in which

strategic decisions are taken and thus, to an extent, strategy itself. Indeed, by

influencing comprehensiveness, lateral communication, and political activities, a

formal planning system seems to act as a powerful input to the process of strategy

making (Papadakis, Lioukas, & Chambers, 1998). This is in line with theoretical

and normative speculations arguing that planning systems lead to more rational

decision making (Armstrong, 1982; Langley, 1988; Papadakis, Lioukas, &

Chambers, 1998), and results corroborate the prevailing view that formal planning

systems encourage both lateral communication and political behavior (Langley,

1988; Papadakis, Lioukas, & Chambers, 1998).

2.2.3   Complexity Dimension

An additional dimension of strategic decision processes not yet mentioned

is complexity. Papadakis, Lioukas, & Chambers (1998) determined this

dimensional factor associated more with the comprehensive or rationality aspect

in their study than with lateral communication and politics. Astley, et al. (1982)

argue that decision making may vary in terms of complexity and cleavage.

Complexity refers to the extent to which the topic (or decision to be made) is

intricate and may involve multiple considerations such as ambiguity, uncertainty, etc. and is likely to be greater in the case of innovative decisions. Cleavage, on the other hand (or politicality as it is labelled by Hickson, et al*., 1986*) involves the political dimension in decision making, for irrespective of complexity each topic is subject to the diverse (and often conflicting) view of various interests. Hickson, et al. (1986) also agree decision making may vary in terms of complexity. They suggest that decision complexity is caused by the extent to which the decision is unusual, the consequences that may stem from the decision, the extent to which it will set precedents for later decisions and the degree to which various interests and personnel become involved, both within and outside the organization (Hickson, et al., 1986; Rowe, 1989).

2.2.4 Strategic Planning Tools

Strategic planning models are designed to help organizations cope with rapid change to enhance an organization's long-term prospects. Strategic planning anticipates new trends to which the organization must adapt (Jarboe, 1996). Strategic planning models incorporate many of the elements of rational and creative models where rational models include data gathering, problem definition, solution generation, and solution evaluation and where creative models include components of classic, rational problem solving plus a social aspect with attention to arousing interest, motivation, belief in, and effort for the task (Jarboe, 1996). Strategic planning tools also place emphasis on assessment of the external and internal environments, increasing organizational learning, communication

between groups, and processes tailored to the organization as well as the situation at hand. (Jarboe, 1996).

2.2.5   Section Summation

A summation of the three dimensions of the strategic decision making process is illustrated in Figure 2.1. Each dimension has positive and negative attributes; however, through applying strategic planning tools, viable strategic decisions can be adequately determined. Strategic planning tools can be the structure for who is participating and how, the process planning for data collection and analysis, the proactive, bidirectional communication of participants within organization, and/or the use of problem solving tools such as conceptual maps, creative decision analysis tools and techniques based on the complexity and severity of the problem (Mador, 2000). The development and application of formal planning tools provide positive influence on comprehensiveness, communication, and cleavage aspects of viable strategic decisions within the decision making process.

Eisenhardt and Zbaracki (1992) say the strategic decision making process is best described as an 'interweaving' of both bounded rationality and political processes. More recent research emphasizes how executives make decisions using political processes in addition to rational procedures (Butler, 2002). Political behavior may shape the assumptions that feed into rational analysis, but rationality appears to be a superior dimension of strategic decision making because it alone, systematically and synthetically, leads to viable strategic choices

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and an overall effective decision making process (Eisenhardt, 1989). This is reflected in Figure 2.1.

STRATEGIC DECISION MAKING

3 Dimensions of SDM

Procedural Rationality

Aspects of Rationality

- Collect Data
- Analyze Data
- Investigate Trends
- Evaluate Constraints

Leads to...

Viable Strategic Decisions

Politics / Cleavage

Aspects of Politics

- Include Multiple & Differing Interests
- Influence Decisions with Personal Interests

Political Variables

- Extent of Influence
- Imbalance of Influence
- Contention over Objectives

Leads to...

Unsuccessful Strategic Decisions

Improved by...

Develop & Align Formal Planning Tools

Leads to...

Viable Strategic Decisions

Complexity

Aspects of Complexity

- Include Intricate Data
- Include Ambiguous Data
- Include Variety of Personnel
- Include varying consequences & risks

Leads to...

Unsuccessful Strategic Decisions

Improved by...

Develop & Align Formal Planning Tools

Leads to...

Viable Strategic Decisions

Figure 2.1 Dimensions of Decision Making

2.3   Decision Models

Strategic decision making is complex involving many conflicting interests and environmental agents, taking long periods of time to make, and plagued by numerous interruptions, delays, disruptions, etc. Despite the complexity and seemingly random variations that characterize the strategic decision making process, there is evidence to suggest the process follows certain standard patterns

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(Shrivastava, 1983). Shrivastava (1983) described these patterns by the following

four strategic decision making models:

- ➢ Managerial Autocracy Model

- ➢ Systemic Bureaucracy Model

- ➢ Adaptive Planning Model

- ➢ Political Expediency Model

Shrivastava's four models are described in terms of the six characteristics of

decision making as defined by research studies of Shrivastava and Grant in 1982.

The six characteristics are 1) problem familiarization and solution development,

2) number and level of people involved, 3) motivation, 4) types of analysis, 5)

role of organizational systems, and 6) environmental influences. These six

characteristics are illustrated pictorially in Figure 2.2 and further expanded in

Figure 2.3 (Shrivastava & Grant, 1982; Shrivastava, 1983).
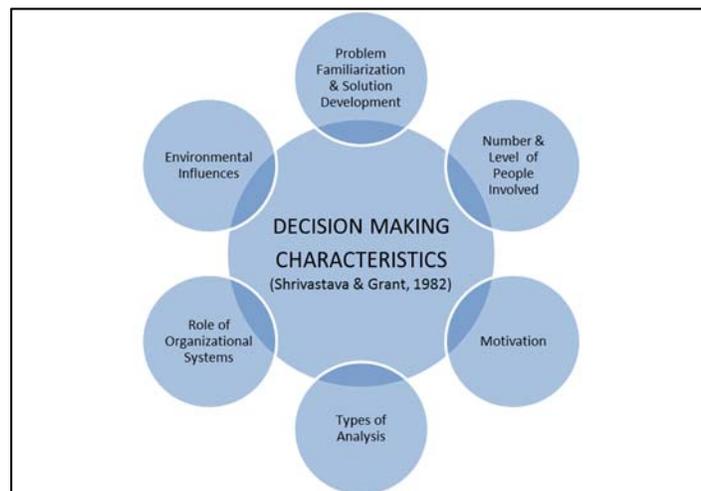
Figure 2.2 Decision Making Characteristics

2.3.1   Managerial Autocracy Model

The first model is the Managerial Autocracy Model (MAM). Within the

MAM, there is a single manager who is the key decision maker. A large amount

of power and authority rests with this single key manager who makes all strategic

decisions himself with technical assistance from several subordinates. Decision

making processes and outcomes are biased by the style and preferences of the

decision maker in charge and not by system tools, procedures, or accumulated

learning and experience of the organization (Shrivastava, 1983).

2.3.2   Systemic Bureaucracy Model

The second model is the Systemic Bureaucracy Model (SBM) where the

decision making process is oriented toward systems and procedures rather than

toward individuals and the individuals' experience or expertise. Information

flows in an erratic and impersonal manner with decisions made by using well-

established norm, rules, and regulations. Within the SBM model, well-defined

and documented stepwise procedures for handling all decisions are followed and

as long as procedures are followed the organization is happy, despite the decision

made (Shrivastava, 1983).

2.3.3   Adaptive Planning Model

The third model is the Adaptive Planning Model (APM). This model is a

practical version of systematic planning for viable strategic decision solutions

where plans are guidelines that are modified or deleted depending on the current

analysis of issues. Problem formulation occurs at the time of development of an

organizational plan that becomes the point of departure for strategic decision

making. Qualified experts systematically evaluate the technical merits of the

proposed alternatives in an effort to achieve efficient solutions to the problem

(Shrivastava, 1983).

2.3.4   Political Expediency Model

The final model is the Political Expediency Model (PEM). This model

has several key decision makers or groups making decisions for personal gain,

protecting or advancing their own interests even at the cost of organizational

interests. While actual decision making is driven by interest group concerns,

problem formulation and solution development can follow organizationally

acceptable routines and procedures. Power is highly dispersed among

organizational managers, and despite process and procedures existing, managers

know how to circumvent the system to promote their own interests within the

PEM model (Shrivastava, 1983).

2.3.5   Section Summation

A summation of how the six decision making characteristics described in

2.3 correspond to each of the four decision models is listed in Figure 2.3

(Shrivastava & Grant, 1982; Shrivastava, 1983).

CHARACTERISTICS	MODELS			
	MAM	SBM	APM	PEM
Problem Familiarization / Solution Development	• Restricted number of problem / solution sets generated • One key manager develops solution with aid from assistants	• Proliferation of problem / solution sets generated • Procedures for disseminating & communicating problem / solution sets are well developed & followed	• Problem familiarization is almost nonexistent • Solution development revolves around modification of plans to accommodate changed conditions	• Multiple problem / solution sets are generated but one set is championed by the vested interest group • Solution development is influenced by individuals or vested interests
Number & Level of People Involved	• Usually one person • Decision made at top management level	• Tasks forces / committees of technically qualified personnel are involved in the decision making • Decisions made at middle & top management levels	• Several people form all levels of an org are involved in all phases of decision making • Decision made at middle or top management levels	• A coalition of individuals or a single individual • Decision made at top management level
Motivation	• To improve efficiency • To have a result-oriented process	• To satisfy procedural rationality • To fulfill written processes of organization	• To fulfill plans • To implement action over making decision	• To satisfy vested interests • To manipulate process to meet desires
Analysis / Evaluation	• Judgment or intuition of one key manager	• Evaluation is extensive, detailed, objective • Cost benefit analysis is emphasized	• Computational • Tech analysis and action planning are emphasized	• Bargaining , negotiations, and group consensus on legitimate analysis to be done
Role of Organization	• Few systematic roles used • Decision making is highly personalized by key manager	• Every activity is driven by bureaucracy • Communication and info sharing are predefined by org procedures	• Strategic planning and learning tools play key role	• Formal systems are side stepped • Personal knowledge of individuals widely used
Environmental Influences	• Very limited involvement of environmental agents	• Environmental influences shape the problem and solution	• Extensive negotiations with relevant environmental agents	• Environmental agents may be brought in/accepted to join coalitions

Figure 2.3 Summary of Decision Making Models (Shrivastava, 1983)

Strategic decision making can vary among organizations; however, understanding these models, that Shrivastava showed evidence of standard patterns, can help decision makers redefine the process within the organization to make the process more rational and efficient by identifying and reducing the influences of undesirable, non-rational variables. For instance, one way to improve decision making is to involve systematic participation by relevant members who can handle technical complexity, risks, environmental constraints, and effectively communicate information in which to achieve viable strategic

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decisions and implementation plans that yield solutions to problems (Shrivastava, 1983). Understanding the decision making models can help organizations effectively execute the strategic decision making process and make successful, viable strategic decisions.

2.4 Decision Determination

2.4.1 Tracing a Decision

Mintzberg and Waters (1990) quote a dissertation on decision making by Nicoladies (1960, 173):

> "It is evident on the basis of [my] analysis that an organizational decision is in reality a constellation or a galaxy of numerous individual decisions. Some of these decisions are "registered" in the book of the organizational activities, while others remain hidden in the inner sanctum of the human psyche. When and where a decision begins and ends is not always clear."

Decisions simply prove difficult to track down (Mintzberg & Waters, 1990). Defining the beginning and the end of a decision process is also difficult. Does a decision begin when the group states a goal or problem, when it first becomes aware of an issue, or when a single member recognizes a need? Does it end when the choice is made, after the implementation period, or when the group explicitly takes up another issue (Poole & Hirokawa, 1996)?

Do decisions precede actions? Can actions indeed trace back to the decisions made? Mintzberg and Waters (1990) argue that action can occur without commitment to act – as when a doctor strikes one's knee – and challenge readers to consider the following comment by an executive of one of the world's largest corporation in the 1990's before thinking this is a far cry from the behavior of formal organizations:

"We use an iterative process to make a series of tentative decisions on the way we think the market will go. As we get more data we modify these continuously. It is often difficult to say who decided something and when – or even who originated a decision…..I frequently don't know when a decision is made in General Motors. I don't remember being in a committee meeting when things came to a vote. Usually someone will simply summarize a developing position. Everyone else either nods or states his particular terms of consensus" (Quinn, 1980, 134).

Shift this into the more complex organizational setting where the commitment must be collective, and the problem of identifying decision magnifies enormously. Mintzberg and Waters (1990) say, given that an action was taken, and that broad support preceded it, the when and where consensus emerged must be found – for that must be the real 'point' of decision. In a bureaucratic society, citizens are expected to decide formally and receive approval before acting. However, not all organizations or all society are fully bureaucratic (Mintzberg & Waters, 1990).

2.4.2. Strategy for Making a Decision

So how are decisions made? Is there a particular flow or recurring strategy to decision making? Why are some decisions arrived at differently from others? Papadakis, Lioukas, and Chambers (1998) discovered the following strategic decision factors: perceived magnitude of impact, frequency, uncertainty, threat/crisis component and whether a decision emerges through discipline of the planning system of the firm, significantly influence the dimensions of the strategic decision making process, more than other environmental, organizational and managerial factors (Papadakis, Lioukas, & Chambers, 1998). Rowe (1989) argues that every decision is unique and can move along alternate routes depending upon the level of management involved and the stage at which they

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become involved. A number of studies extend the argument further, contending that the role of 'upper echelons' or 'top managers' or 'strategic leadership' is important enough to determine strategy content and process (Child, 1972; Hambrick & Mason, 1984; Miller & Toulouse, 1986; Papadakis, Lioukas, & Chambers, 1998). Studies from Astley, et al. (1982) and Hickson, et al. (1986) became known as the Bradford Studies focusing on the 'flow' of management decision making. As referenced earlier, Astley, et al. (1982) proposed a model which argues that decision making may vary in terms of complexity and cleavage (politics). They argue that particular combinations of problems and interests throw up particular processes and identify three main processes – sporadic, fluid and constricted – which can be linked with three types of subject matter – vortex, tractable and familiar – to form three 'ideal type' modes of decision making: vortex-sporadic, tractable-fluid and familiar-constricted (Hickson, et al., 1986; Rowe, 1989).

Integrating research findings on decision strategies from Thompson and Tuden (1964) and Thompson (1967) with Astley, et al. (1982) research, the matrix in Figure 2.4 is formed (Dean & Sharfman, 1996). This matrix provides insight for how decisions are determined.
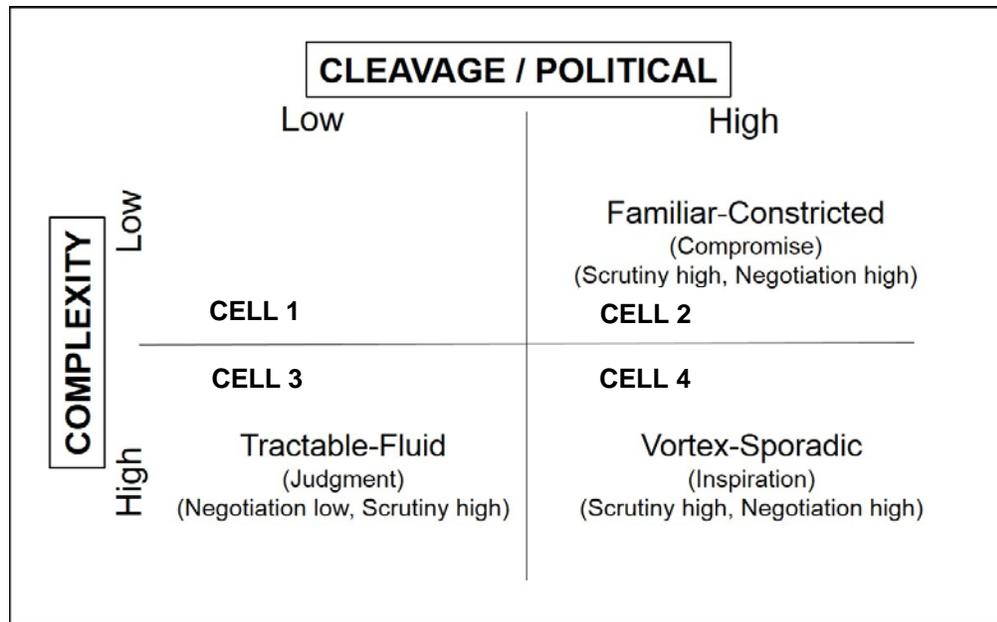
Figure 2.4 Decision Strategy Flow

2.4.2.1 Calculation Strategy

If complexity of the decision to be made is low and the political behavior of group is low, then decision strategy is a simple computational (calculation) procedure. This is depicted within cell 1 of Figure 2.4.

2.4.2.2 Inspiration Strategy

Vortex-sporadic decision making mode (i.e., cell 4) is high in both complexity and politics. This mode sucks everyone into swirls of activity and is likely to be protracted, running into disrupting delays and impediments. Controversial and complex vortex matters tend to be processed in sporadic ways (Miller, 2010). Decisions are likely to be taken to the highest level where only inspiration by top management can provide an answer for what the decision will be (Hickson, et al., 1986; Rowe, 1989). Thompson (1967) assesses that in cases of high uncertainty management acts in an inspirational manner by making obsolete any formal procedures and rules usually followed.

2.4.2.3 Judgment Strategy

Tractable-fluid decision making mode (i.e., cell 3) is where less complex and least political tractable matters tend to be process in fluid ways (Miller, 2010). If complexity surrounding a decision is high but exhibits low political agendas by the group, then the decision strategy is judgment when the group can collaborate as they scrutinize the details to reach understanding and an easily negotiated decision. The decision is typically non-controversial. The tractable-fluid decision making mode is more steadily paced that is formally channeled and speedy (Hickson, et al., 1986; Rowe, 1989).

2.4.2.4 Compromise Strategy

Familiar-constricted decision making mode (i.e., cell 2) is where familiar matters which are the least complex and of mid-level politicality follow constricted ways (Miller, 2010). If complexity is low and politics is high, then a compromise strategy through high levels of negotiating may apply (Hickson, et al., 1986; Rowe, 1989).

2.4.2.5 Decision Strategy Flow

The model in Figure 2.4 is an abstraction, and it is not suggested that all decisions fit neatly into it, but rather, that decisions will approximate to the different cells. The decision outcome is dependent on the complexity of the problems and the politics of the interests and, to a lesser extent, the nature of the organization (Hickson, et al., 1986, Rowe, 1989). Management will, presumably, try to present as many decisions as possible as matters for calculation (i.e., cell 1 of Figure 2.4), but if this is contested by the workforce or other managers,

allowing complexity and/or cleavage to increase, then decision strategies move to cells 2 and 3, or even to cell 4. The tension in the decision making process between cells 1 and 4 creates a major source of conflict within the organization and provides the political dimension (Rowe, 1989).

2.4.3   Section Summation

The aim of management therefore, is presumably to maximize the number of decisions where the outcome can (as far as possible) be accurately determined (i.e., calculation procedure in cell 1) and reduce dependency on compromise, judgment and, in particular, inspiration (Thompson & Tuden, 1964; Thompson, 1967; Astley, et al., 1982; Hickson, et al., 1986; Rowe, 1989). Management decision making may still be the 'science of muddling through' (Lindblom, 1959), but formal planning tool development may disentangle the muddle. The great appeal of the hybrid Thompson, Tuden and Astley matrix in Figure 2.4 is that it is both simple and fertile and a useful starting point for decision making analysis (Rowe, 1989).

2.5   Decision Effectiveness

Strategic decision effectiveness is defined as the extent to which a decision achieves the objectives established by management at the time it is made. Effectiveness as perceived by external constituencies may of course differ from management's perceptions (Friedlander & Pickle, 1968). Managers have the capacity to influence organizational outcomes through strategic choice (Dean & Sharfman, 1996). Assumptions: 1) Decision processes are related to strategic choices, and 2) The relationship between strategic decision making processes and

effectiveness is that choices relate to outcomes. These two assumptions are plausible which suggests it is reasonable to expect strategic decision making processes to influence strategic decision effectiveness (Dean & Sharfman, 1996).

2.5.1 Positive Influences

Does the success or effectiveness of strategic decisions depend on the steps managers use to make them (Hitt & Tyler, 1991)? This question is fundamental to organization theory, as strategic decision making is a key element of management-centered conceptions of organizations (Astley & Van de Ven, 1983; Dean & Sharfman, 1996). The concept of 'strategic choice' captures the extent to which the operating environment of the organization places limits around what managers can decide and how much autonomy they have in making those decisions (Child, 1972). Burgelman (1991, 252) argued that "an atmosphere in which strategic ideas can be freely championed and fully contested by anyone with relevant information….may be a key factor in…generating viable organizational strategies." Pfeffer and Salancik (1978, 266) argued that, for a decision to be successful, "Information about the environment and possible consequences of alternative actions must be acquired and processed". Therefore, in order for a decision process to result in an effective choice, it must be 1) oriented toward achieving appropriate organizational goals, 2) based on accurate information linking various alternatives to these goals, and 3) based on an appreciation and understanding of environmental constraints (Dean & Sharfman, 1996). Results of Paul Nutt's study (2005) of 376 strategic, non-routine decisions indicated that a rational, goal-oriented search approach tends to lead to more

successful outcomes. Hough and White (2003) in a simulated environment found

a positive relationship between rationality and decision quality and that this

relationship was contingent upon environmental dynamism (i.e., uncertainty)

(Goll & Rasheed, 1997).

The quality of information available to a group is one of the most

important determinants of successful group decision making (Kelley & Thibaut,

1969). Nooraie (2008) found that rationality mediated the relationship between

decision magnitude of impact and decision quality. Groups are more likely to

reach high-quality decisions when their decision making processes are

characterized by careful and painstaking examination and reexamination of the

information on which the choice is to be based (Janis & Mann, 1977). Dean and

Sharfman (1996, 389) note that "managers who collected information and used

analytical techniques made decisions that were more effective than those who did

not. Those who engaged in the use of power or pushed hidden agendas were less

effective than those who did not." They note that their study, despite using quite a

different methodology, shows "that some of the findings of Eisenhardt and

Bourgeois (1988) and Bourgeois and Eisenhardt (1988), extend beyond unstable

environments to include stable ones as well" (Dean & Sharfman 1996, 389;

Mador, 2000). Peter Senge (1990) observes groups are more likely to arrive at

high-quality decisions when they employ a rational, as opposed to a political,

logic in arriving at a final decision.

2.5.2 Negative Influences

Crucial to successful decision making and problem solving in groups is the extent to which members' interaction ensures that particular requirements of their tasks are being fulfilled. If they are not adequately addressed, the chances of the group's making a good decision or identifying an effective solution to a problem are diminished (Gouran & Hirokawa, 1996). As Irving Janis (1989) so aptly noted, however, decision making and problem solving are activities that groups frequently perform under the influence of powerful social influences that can and do interfere with the ability of participants to satisfy the essential requirements of a decision making or problem solving task. Janis (1989) identified three sources of negative influences that he called 'constraints': cognitive, affiliative, and egocentric. When any of these three constraints become dominant, the interests of effective decision making are apt to be ill served unless action is taken.

Janis (1989) relates cognitive constraints to perceived deficiencies in the resources (information, time, and skills necessary for performing the task) available to group members. When present, they lead to superficiality in the analysis of issues and alternatives a group may be considering. Affiliative constraints contribute to preoccupations with relationships and the well-being of the group (Janis, 1989). As a result, they can shift the focus of inquiry from making the best choice to the accommodation of differences in points of view. Janis (1989) also defined egocentric constraints as those deriving from the personal needs of the members (typically needs concerned with control). Such

constraints are productive of conflict, the culmination of which is often

acquiescence rather than informed choice (Janis 1989; Gouran & Hirokawa,

1996). If manipulation of data and secret communication exist, it could lead to

selective and biased disclosure of relevant information (Pettigrew, 1973) and give

rise to disappointing outcomes (Dean & Sharfman, 1996).

2.5.3   Section Summation

Although it is clear that group decision making performance is affected by

a variety of factors and influences, there are many who suggest that the quality of

communication that occurs as a group attempts to reach a collective decision may

well be the single most important influence on the decision making success or

failure (Hackman & Morris, 1975; Janis & Mann, 1977; McGrath, 1984;

Hirokawa, Erbert, & Hurst, 1996). When a group communicates the right

information at the right time in the right way, then the communication and the

decision making will be more effective (Eikenberry, 2005). The existence of

communication is necessary to measure the effectiveness of any decision (Hitt,

Miller, & Colella, 2006).

2.6   Communication

Social systems theory considers communication as the basic element of

any organization (Luhmann, 2000). Habermas (1998) finds that activities

between people need a certain amount of communication, which must be fulfilled

in order to coordinate actions effectively for the purpose of satisfying needs. In

organizations the act of fulfilling these needs is an effective problem solving

process, in other words, effective decision making (Habermas, 1998). Social

systems theory observes decision making as communication that opens future alternatives of action (Baraldi, 2013).

2.6.1   Communication is Vital

Communications is the instrument by which members of groups with varying degrees of success reach decisions and generate solutions to problems (Poole & Hirokawa, 1996). They found that communication constitutes decisions in at least two senses: 1) through communication the form and content of decisions are worked out, and 2) at a more fundamental level, decisions are social products embedded in "social reality". Communication processes are the primary means through which social realities, as experienced by participants, are created and sustained, and therefore are the prerequisites for making decision.

There are a variety of communication modes for decision making: face-to-face communication, written communication, audio communication, and electronically mediated audio/visual communication (Argyle & Cook, 1976; Hirokawa, Erbert, & Hurst, 1996). Results of investigations have been mixed, but the prevailing view is that less restrictive communicative modes tend to be associated with high-quality decisions than more restrictive modes (e.g., audio only) when more complex and difficult decision making tasks have been employed (Hiltz, Johnson, & Turoff, 1986; Hirokawa, Erbert, & Hurst, 1996). As the difficulty of a decision task increases, systematic face-to-face interaction tends to result in higher-quality outcomes (Hirokawa, 1988; Jarboe, 1988). Less restrictive mode, like face-to-face communication, provides group members with increased opportunity to exchange and utilize information in arriving at a solution

to the problem (McGrath, 1984). A study by Harper and Askling (1980) found that groups making high-quality decisions displayed higher-quality leadership, more open communication, and a higher proportion of active participants than did groups whose decision were judged to be of low quality.

2.6.2   Communication, Process and Decision Making Performance

Is group communication related to group decision making performance? Some contend that communication actually produces group decisions by creating and shaping the contexts with which those decisions are made and enacted (Hirokawa, Erbert, & Hurst, 1996). Hackman (1990) contends that group decision making performance is determined by three "enabling conditions": sufficient group effort, adequate knowledge and skills possessed by group members, and appropriate performance strategies, processes, and procedures employed in reaching a decision. Moreover, he suggests that these enabling conditions exert positive influence on group performance through the mediation of communication and interactions (Hackman, 1990). Habermas (1998) further surmises that social action and communicative practices are inherent parts of decision making process and performance.

Formal planning tools (i.e., planning models, procedures, building participant involvement, and promoting communication networks within the group) are social in intent with clear, task-related functions for the decision making process (Jarboe, 1996). The assumption behind involving people is that involvement increases the amount of information available to the group, increases commitment to the decision, improves dissemination of that decision, and

enhances commitment to group problem solving, thereby increasing the likelihood of quality thought throughout the process (Jarboe,1996). Procedures can also produce communicative behavior that produces outcomes (Jarboe, 1996).

Outcome measures in decision making are often associated with primary task activity such as the quality of solutions, the number of ideas, or the uniqueness of ideas. Although these [quality, number and uniqueness] are the most practical ways to assess outcomes in laboratory research, there is little doubt that the value of a decision depends on the confluence of subsequent events (Reagan & Rohrbaugh, 1990). Reagan and Rohrbaugh (1990, 21) further offer "any assessment of the effectiveness of decision making performance requires directing primary attention to the process itself, not only to subsequent outcomes." They studied various approaches to group decision making and discovered eight distinct criteria – adaptability, legitimacy, efficiency, goal centeredness, accountability, data based, participatory and supportability – to assess both process and decision effectiveness as communicated and conducted by a group (Reagan & Rohrbaugh, 1990). The eight criteria are summarized in the following questions by Reagan and Rohrbaugh (1990) as an evaluation of both decision making process and outcome effectiveness:

> ➢ From a rational perspective, was the decision making process conducted by the group goal-centered and the resulting decision efficient?

> ➢ From a political perspective, was the decision making process adaptable for the group and the resulting decision legitimate?

> ➢ From a consensual perspective, was the decision making process
>
> participatory by the group and the resulting decision supportable?
>
> ➢ From an empirical perspective, was the decision making process
>
> data-based and the resulting decision accountable?

2.6.3 Communicating Decisions

A decision is the commitment to a particular course of action (Mintzberg, et al., 1976), and the decision must be communicated clearly, coherently and convincingly (Nickols, 2005). One of the areas where the gap in decision making is widest is in communicating decisions. Decisions are made, but the communication of those decisions has shown to be ineffective or incomplete (Eikenberry, 2005). The following guidelines (Eikenberry, 2005; Busch 2012) help to successfully communicate decisions within an organization (and beyond):

> ➢ Determine who (i.e., one executive, individual managers or both)
>
> and when (i.e., sooner the better) the decision is communicated
>
> and how (i.e., email, team meeting, voicemail, newsletter, etc.)
>
> ➢ Clearly, correctly, and concisely communicate exactly what was
>
> decided and the rationale that led to the decision
>
> ➢ Clearly stipulate how the decision's effectiveness will be
>
> measured (i.e., communicating the measures for success is
>
> especially important to those who may disagree with the decision),
>
> and
>
> ➢ Understand communication is a two way process (i.e., a complete
>
> communication plan of transmission of message, receipt of

message and feedback on message ensures individuals have

received and understood the decision

The results of a communication study by Habermas in 1998 show that

both managers and employees found the best ways to communicate decisions

were in meetings, email, or face-to-face conversation. Usually the channel [of

communication] was chosen by the urgency of the message (Mykkanen, 2010);

however, the important aspect is that the decision is communicated.

2.6.4 Section Summation

Substantial research has proven a direct link between communication,

decision making performance through process, and decision making effectiveness.

High quality decisions require communication for the adequate understanding of

the problem, the formulation of viable strategic solutions to the problem and the

effective implementation of those solutions to the problem. However, research in

the processes of decision making and the communication of those decisions

within the process is fairly new (Mykkanen, 2010). The outcomes of more

research in this realm could further benefit practical applications of decision

making and communicating decision within organizations, help organizations to

evaluate whether the decision making process is too lengthy and whether the

outcomes of the process reach the desired recipients, and help organizations

concentrate on using more coherent information in decision making to improve

organizational performance (Mykkanen, 2010).

2.7   Literature Review Conclusions

A resounding theme within the research literature is that strategic decisions are not routine, not well-structured, and not easily made due to a high degree of uncertainty associated with the problems to be solved, thus, rationality is necessary to achieve viable strategic decisions. Rationality is one of three dimensions associated with the strategic decision making process. Politics and complexity are also dimensions as presented previously in Figure 2.1 within section 2.2.5. Depending on the dimension evident, Figure 2.1 illustrates a path as guidance for how teams can reach viable strategic decisions. Of the three dimensions, the application of procedural rationality fosters team consensus and produces effective and better quality decisions; however, this method can be time-consuming. Research shows that the optimal decision making process includes open and continual communication among all decision makers in repetitive evaluations of collected data to determine strategic decisions that are rationally assessed against environmental trends and threats. Greater the perceived impact or implied consequences of the decisions to be made, greater the need for decision makers to act rationally. Since people are involved, complexity and political influences are seldom absent from problem solving and decision making. To offset conflicts arising from the complexity and uncertainty amongst varying personalities and interests of the decision makers and amongst the varying details, risks, and consequences stemming from the problems to be solved, a team can apply formal assessment techniques such as procedures, devil's advocacy, and dialectical inquiry that critique ideas or alternatives to drive out the best decisions.

Planning tools increase learning and communication within the team, enhance

assessment of environmental constraints, allow processes to be tailored to specific

organizational needs, and employ appropriate performance strategies to reach

viable strategic decisions. Team interaction and open communication are vital to

effective decision making where team involvement in making decisions increases

not only the commitment to and quality of the resulting decisions, but also

improves dissemination and execution of those resulting strategic decisions.

CHAPTER III

PROBLEM DEFINITION AND STATEMENT

3.1   Problem Definition

The most important task in any systems decision process is to identify and understand the problem which is informed by understanding the concerns, objectives and constraints of the stakeholders (Parnell, et al., 2011). Figure 3.1 below shows the three components that help define the problem space for this study. They are 1) identifying the problem, 2) understanding the stakeholders who are the individuals possessing a vested interest in the problem, and 3) determining the best research approach to tackle the identified problem. Each component will be further discussed in the following sections.
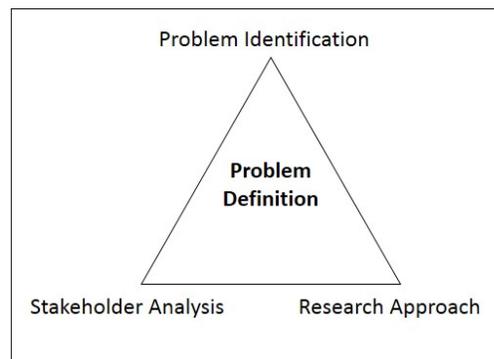
Figure 3.1 Definition of Problem Space (Parnell, et al., 2011)

3.1.1 Problem Identification

At a high level, this study aimed at understanding the communication and decision making process as part of the Systems Engineering practice at the NASA/Marshall Center. The SLS Program, managed by the Marshall Center, served as the test bed for analysis. To that end, three SLS Change Requests (CRs) flowing through the Configuration Management change control process provided the specific basis for the research and analysis.

The focus of this study was to understand the decision making process by tracking the three SLS CRs from initiation to official approval. To drive down to the crux of the problem for a thorough investigation and solution recommendation, the '5-Whys' technique (Goodwin and Wright, 2012) was applied.

1. Why understand the SLS the decision making process?
   - ✓ To understand how each CR was introduced, discussed, approved, and communicated within the decision making process

2. Why understand how each CR was introduced, discussed, approved, and communicated within the decision making process?
   - ✓ To understand key drivers leading to the decisions

3. Why understand the key drivers leading to the decisions?
   - ✓ To better understand if, how, and why the key drivers differed amongst the three CRs

4. Why understand if, how, and why the key drivers differed?

✓ Because the initial findings reflected that while all CRs were classified as Category 1 and successfully approved, each completed the process differently

5. While each CR was successfully approved, why did each CR complete the process differently?

✓ Not sure. Thus, this was the identified root problem around which the research and analysis was focused to better understanding the SLS communication and decision making process.

3.1.2 Stakeholder Analysis

Stakeholders play an important role in the decision process for any project. When approaching a decision, stakeholders typically have their own schemata and filtering criteria in which to apply solutions that meet their intermediate needs. Schemata (or mental models) are cognitive structures that represent one's general knowledge about a given concept or stimulus domain, including its attributes and the relations among those attributes (Oliver & Roos, 2005). Both the mental models and criterion are dependent on their disciplined area of expertise.

With this study, the stakeholders were no different. Each stakeholder had a vested interest, be it power, legitimacy, or an urgency, to influence, not only the decision making process, but also the review and processing direction for each CR studied. This section will identify the stakeholders and the level of influence each contributed to the study.

3.1.2.1 Stakeholder Identification

For this study, the individuals who could provide insight into the technical discussion patterns, approval processes, resulting decisions, factors influencing the resulting decisions, communication of the resulting decisions, and effectiveness of resulting decisions (i.e., implementation success) for the SLS CR processing were identified as stakeholders and reflected here.

1. Exploration Systems Development's (ESD) Cross Programs

    o Orion / Multi-Purpose Crew Vehicle (MPCV) Program

    o Space Launch System (SLS) Program

    o Ground Systems Development and Operations (GSDO) Program

2. SLS Program Office

    o SLS Program Managers

    o Stages Element Managers

    o Boosters Element Managers

    o Engines Element Managers

    o Spacecraft & Payload Integration Element Managers

    o Advanced Development Element Managers

3. SLS Chief Engineers Office

4. SLS Lead Systems Engineering Team

5. SLS Discipline Lead Engineers

6. SLS Element Discipline Lead Engineers

7. Change Request Change Package Engineer

8. SLS Configuration Management Office

o Configuration Management Manager

o Configuration Management Release Desk

3.1.2.2 Stakeholder Salience Definitions

To complete a stakeholder analysis for this study, the following definitions

were employed:

- Power – Made the final decision and responsible for overall budget and

  schedule resources

- Legitimacy – Had direct relationship to decision to be made

- Urgency – Had a critical need to find solution and/or critical claim to decision

  to be made
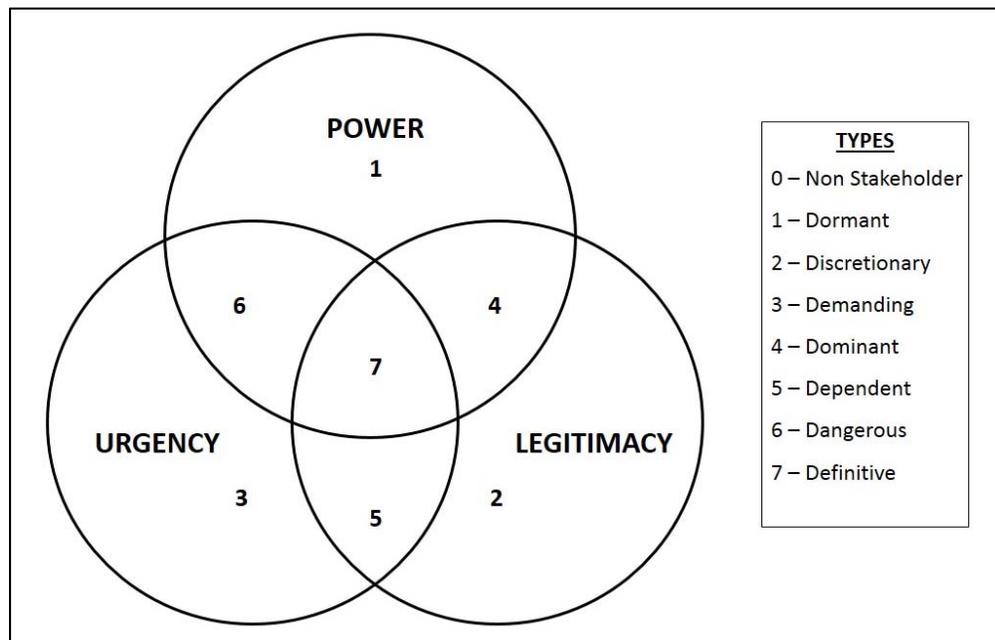
Figure 3.2 Stakeholder Salience Types (Parnell, et al., 2011)

Of the eight attributes classified for stakeholder saliency of influence
(Matty, 2010) reflected above, there were three specific types fulfilled by the
stakeholders within this study. Each of the three specific stakeholder type will be
discussed in the following sections.

3.1.2.3 Definitive Stakeholders

The Exploration Systems Development (ESD) division is responsible for
ensuring technical, cost, and schedule details across three Programs align with
agency, presidential, and legislative goals. The three Programs are reflected here
in Figure 3.3.
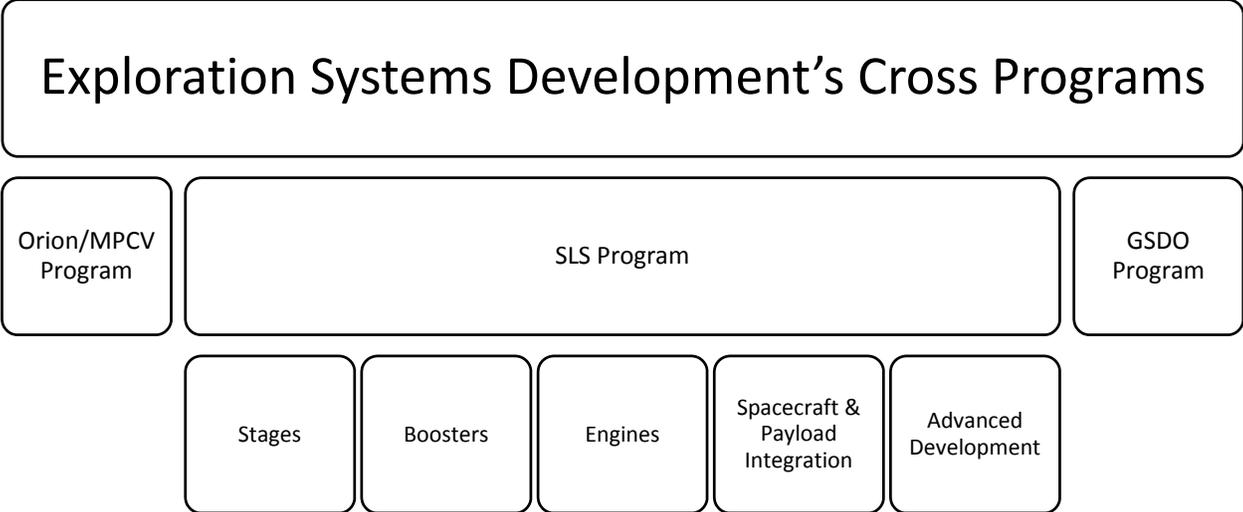
Figure 3.3 SLS Program Definitive Stakeholders

The Orion/MPCV Program, managed by Johnson Space Center (JSC),
develops the crew exploration vehicle that will carry the crew to space, provide
emergency abort capability, sustain the crew during space travel, and provide safe
re-entry. The SLS Program, managed by Marshall Space Flight Center (MSFC),
develops the heavy lift vehicle that will launch the crew vehicle, and eventually
other modules and cargo for specified missions. The GSDO Program, managed by

Kennedy Space Center (KSC), provides the ground systems, infrastructure, and services to perform ground processing, launch and recovery, as applicable, for the SLS and MPCV Programs. The Cross Programs, collectively, comprise a definitive stakeholder exhibiting power, legitimacy and urgency.

The SLS Program is a multi-element program which includes a Stages Element, Boosters Element, an Engines Element, a Spacecraft and Payload Integration Element and an Advanced Development Element as illustrated above in Figure 3.3. The SLS Program Manager leads the management, integration, and direction of all the SLS Element activities ensuring compliance and consistency with NASA Agency policy and priorities. All of the SLS Element Managers report to the SLS Program Manager regarding safety, schedule, performance, and cost details in the design and development of hardware and related systems of their respective Elements. The SLS Program Manger chairs the SLS Program Control Board (PCB) and is the decision authority for all SLS baseline changes. Consequently, The SLS Program Manager is a definitive stakeholder exhibiting power, legitimacy and urgency attributes. Specifically to the Change Request (CR) processing, the SLS Program Manager and SLS Element Managers depend on thorough reviews by subordinates/engineering discipline experts with concurrences and/or concerns with recommendations and forward plans presented at the PCB.

With respect to this study, both the Cross Programs and SLS Program Manager were highly salient, major stakeholders with direct access to budgetary and other programmatic resources. They were powerful and legitimate

stakeholders who considered all technical recommendations, suggestions and

options in relation to schedule and budget constraints to ultimately make the final

decisions.

3.1.2.4 Dependent Stakeholders

The majority of the dependent stakeholders discussed in this section are

specific engineering entities within the SLS Program itself and illustrated in

Figure 3.4.
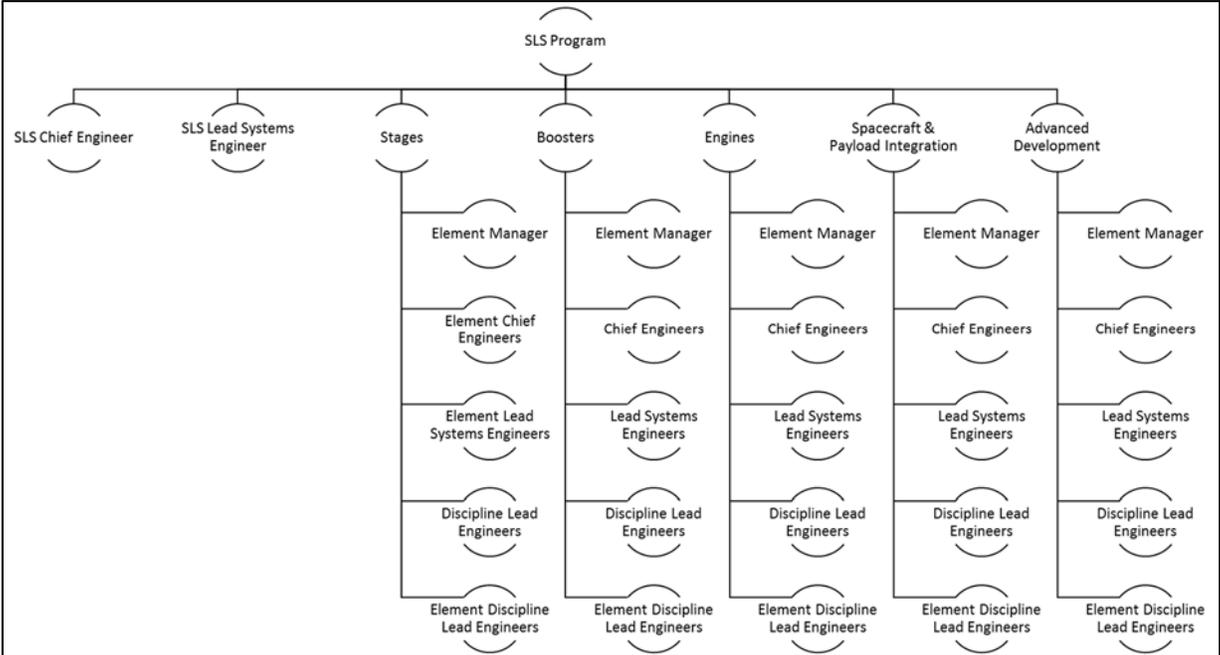
Figure 3.4 SLS Program Dependent Stakeholders

First, the SLS Chief Engineer (CE) executes Systems Engineering and

Integration (SE&I) at the SLS Program level. The CE is responsible for the

integrated SLS vehicle design and has a team of Chief Engineers distributed

across the Elements. These Element Chief Engineers (ECEs) ensure the technical

work at the Element levels meets the requirements of the integrated vehicle

design. The CE chairs the Chief Engineer Control Board (CECB) which serves as

the engineering authority for SLS Program baselines. The CECB also functions

as a technical pre-Board to the PCB where it reviews all changes within its

defined authority and makes recommendations on any engineering and safety

content seeking PCB final approval.

Next is the Lead Systems Engineer (LSE) who also has a team of System

Engineers distributed across the Elements. The LSE and the Element Lead

Systems Engineers (ELSEs) ensure the planning and production of all multi-

discipline deliverables for the SLS vehicle. The LSE also leads the change

management effort within engineering for the SLS Program.

The Discipline Lead Engineers (DLEs) are the single authoritative entity

for understanding, assessment, and recommendations related to their assigned

discipline for the entire vehicle. The DLEs are members of the CECB and are

responsible for ensuring all integration with other disciplines and the Elements is

achieved prior to seeking CE approval. DLEs are responsible for carrying any

dissenting opinions to the CECB.

The Element Discipline Lead Engineers (EDLEs) are technically

accountable to the ECEs regarding data provided by the Elements for use at the

vehicle level meets the needs of the vehicle and is technically adequate with

respect to their discipline scope.

The SLS CE, ECEs, LSE, ELSEs, DLEs and EDLEs were all dependent

stakeholders. This group of moderately salient stakeholders had a direct

relationship to the decisions under review. Overall, they had a critical need to

seek solutions or had decisions made with respect to issues applicable to their

areas of technical/discipline expertise. The engineers had some power in providing technical suggestions and/or recommendations for consideration at a Control Board but do not make the final decision.

Lastly of the dependent stakeholders is the CR Change Package Engineer (CPE); however, the CR CPE is not reflected on in Figure 3.3 because the CR CPE is an appointed position dependent on the technical expertise pertinent to a given proposed change. The CR CPE is responsible for the review and consolidation of comments from mandatory evaluators and the recommendation of a change disposition to the CECB and PCB. The CR CPE has a vested interest in the review of a CR and therefore categorized as a dependent stakeholder. As the CR shepherd, this moderately salient stakeholder has both a critical need and sense of urgency to obtain a thorough review, consensus, and a formal decision to the proposed technical change.

While these dependent stakeholders (i.e., CR CPE, SLS CE, SLS LSE and the collage of expert engineers) did not make the final decisions, they were, however, the more deeply involved stakeholders in the CR initiation, review, approval, and implementation process. Furthermore, these dependent stakeholders were also the more influential stakeholders in technical assessments and decision package recommendations typically presented to the SLS Program Manager for final approval at the PCB.

3.1.2.5 Discretionary Stakeholders

The SLS Receipt and Release Desk (R&RD) and Change Package Manager (CPM) are entities within the SLS Configuration Management (CM)

Office. The SLS R&RD is the authoritative point for all communication related to official CM products and serves as the official location for submittal of CRs. The CPM assists the CR CPE with the CR life-cycle process, from CR initiation to closure of the Control Board directive actions.

From the study, the CM Office was a discretionary stakeholder. This latent salient stakeholder had no power or critical need for a decision to be made on the CRs; however, the CM Office did exhibit legitimacy by ensuring the official release of CRs for review and support with the CR processing, if/as needed.

Figure 3.5 summarizes the saliency types of all the stakeholders associated with the decision making study.
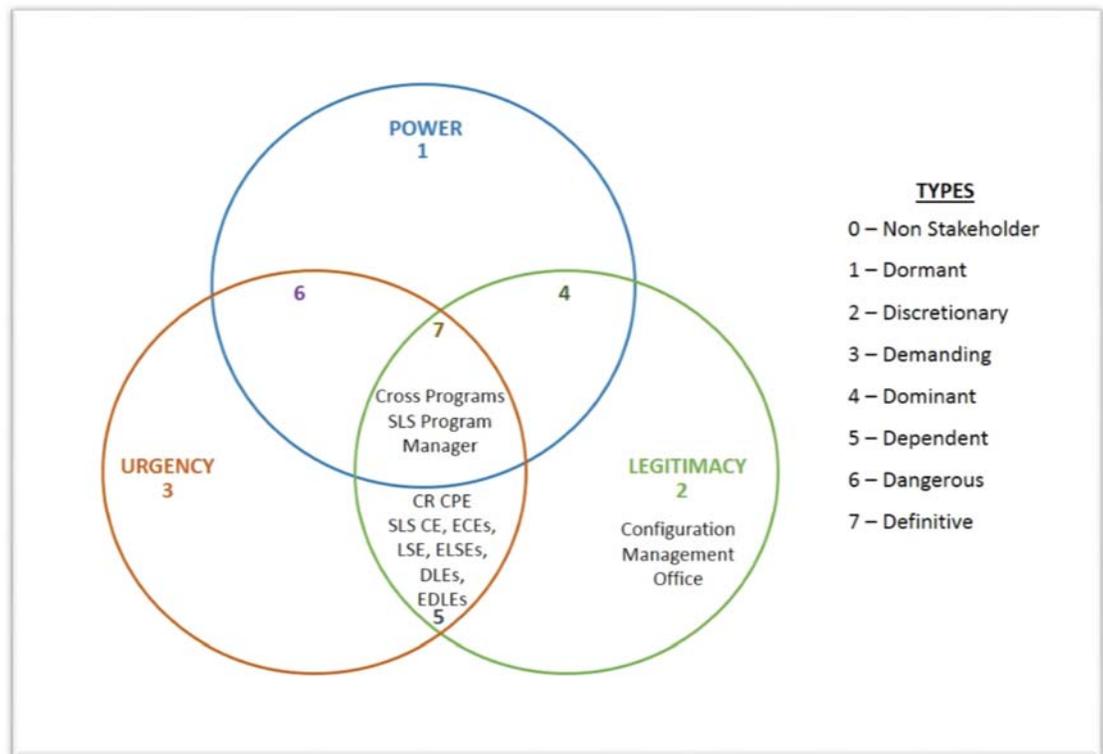
Figure 3.5 Stakeholder Analysis for the SLS Decision Making Study

3.1.3 Research Approach

For this study, a teaming approach was invoked to ensure the root problem was thoroughly researched, assessed, understood, and solved. The team was comprised of the thesis author and the SLS team members (i.e., stakeholders) who were personally involved in the reviews and decision making process for the three CRs. A survey was determined the better mechanism for data collection and analysis and thus employed. In addition to the survey, research and a better understanding of the formal SLS CM change control process was necessary to understand how and where the CR processing could have differed from the documented process. This entailed understanding the former CM change control process that included Tabletop reviews and the updated CM process that replaced Tabletop reviews with the Task Team review approach.

To focus the research, any 'known', 'partially known' and 'unknown' details were determined. The 'known' details (or details with documented results) were:

- The Marshall Center had governing /guidance procedures/policies (NASA Procedural Requirements (NPRs), Marshall Procedural Requirements (MPRs), Handbooks, etc.) for program/project management and execution, safety and mission assurance, systems engineering, and technical design and standards.
- The SLS Program had a formal Configuration Management (CM) Plan that defined CM requirements, process and procedures for the control of SLS technical and programmatic documentation.

- A CR, affecting a SLS baseline, followed the CM change control process for disposition and approval at the SLS PCB.

- All three CRs were classified as Category 1 which meant the CRs referenced the SLS Program baseline and required a rigorous control via an established and standardized CM process utilizing configuration control boards such the SLS PCB for official approval, control board directive actions, and concurrence sheets (SLS CM Plan, 2013).

- All three CRs were successfully approved and implemented.

  o CR53

    - Originated: July 2012

    - Approved: October 2012

  o CR70

    - Originated: October 2012

    - Put Back: January 2013

    - Re-Released: February 2013

    - Approved: April 2013

  o CR82

    - Originated: October 2012

    - Approved: December 2012

- All three CRs were processed and approved via different paths.

  o CR53

    - No Tabletop reviews held

    - No Form 4511 signed

- Approving Board: PCB

  o CR70

    - Series of Tabletop reviews held

    - Processed through CECB and put-back at PCB

    - CM process updated

    - Task Team review held

    - CR re-released

    - Approving Board: PCB

  o CR82

    - No Tabletop reviews

    - Form 4511 signed by LSE only

    - Approving Board: Joint PCB with JSC

- With all three CRs, discipline representatives were involved in the review
  process along with CM representatives. So technical expertise was available
  to aid CR technical processing, and CM expertise was available to aid CR
  change control processing.

The 'partially known' details (or details with partial data available) were:

- With the time difference equaling six months to a year between CR review
  and survey input, the survey data provided by the stakeholders was at best
  memory recall with exact details not remembered very well. The survey
  respondents did their best to recall data and provide the best answer they
  could recall from memory.

The 'unknown' details (or details certain to have no data or knowledge of) were:

- The specific survey respondents' names were unknown, and the linkages between the specific respondents and their survey inputs were unknown. Consequently, clarifying information could not be obtained after the survey responses were submitted.

3.1.3.1 Problem Statement

The desired outcome of this study was to better understand the decision making and communication process within the SE practices at the Marshall Center and have an understanding of the level of its effectiveness. On the surface, there appeared from the root problem identified earlier (in 3.1.1) to exist some potential inefficiencies. To accomplish the desired outcome, a teaming approach of the thesis author and participating SLS members through anonymous survey inputs collaborated using the SLS CR change control process as a surrogate to determine whether resource and communication efficiencies existed that would make the exercised decision making process more effective. A lesson learned from the Constellation reflected a less than stellar and ineffective strategic decision making process existed for the program. With respect to decision making and communication, this study investigated whether the SLS Program management had learned from Constellation and was sufficiently implementing recommendations from the abruptly cancelled program.

3.1.3.2 Focused Research Questions

To accomplish the objectives of the problem statement, the following research questions served as the specific investigation focus:

- How did the process differ for each CR?

- Why did the process differ?

- What were the key drivers for the differences in CR processing?

- What were the benefits and/or drawbacks with the differences in the CR processing?

- Were the same resources expended for each CR or efficiently minimized?

- Did those involved in the CR processing feel their contribution was value added to the decision making and approval of the technical change?

- What strongly influenced the decisions?

- How were technical reviews, technical recommendations, resulting decisions and action plans communicated? Were they well-defined, well-structured, well-vetted and/or well-communicated?

CHAPTER IV

METHODOLOGY

A five step approach was formulated in developing the methodology to address the research questions for this study. The five steps were 1) determine the strategic decision and communication specific characteristics of the CRs under investigation, 2) develop an instrument that will capture the necessary information to better understand the decision and communication specific characteristics, 3) identify sample population for data collection, 4) administer data collection instrument, and 5) analyze collected data.

4.1   CR Decision and Communication Characteristics

Based on the literature review, the following list of characteristics were consistent with the strategic decision making and communication processes. As the first step of the study's methodology, this list was evaluated for commonality with the three SLS CR decisions.

- Comprehensive with significant impact as a whole and on long-term performance
- Time intensive
- Significant commitment of resources
- Shared effort - not an isolated, unitary event

- Complex social and communicative process

- Uncertainty

- Dynamically evolvable

- Solutions based on bounded rationality, insight, perceived magnitude of impact and inspiration

- Adaptable to opportunities, threats, constraints and environmental factors

- Influenced by politics

- Precedent setting

- Create waves of lesser decisions

- Non-routine and unusual

Table 4.1 reflects the decisions for each of the three SLS CRs as well as the decision process flow for each CR.

Table 4.1 SLS CR Decisions

CR	SLSL CR DECISION	RESOURCES	STAKEHOLDERS	PROCESS FLOW	DURATION
CR53	Implement Flight Termination System (FTS) architecture option 10A into the SLS vehicle baseline	Cost Schedule Mass	PM, CE, LSE, CSO, Stages, Booster & Payload Element Management, all DLEs all EDLEs, and GSDO & MPCV Programs	Routine technical CR released per CE direction, no Table Top review, no signed Form 4511, CECB approval, and then PCB approval	3 months
CR70	Update the Data Requirements List (DRL) with the latest Data Requirement Description (DRD) changes needed to reflect the baseline version. The update is required to support SLS Preliminary Design Review (PDR) planning.	Cost Schedule Manpower	PM, CE, LSE, CSO, all Elements, all DLEs, all EDLEs, and GSDO Program	Routine programmatic CR released, 5 Table Top reviews, CECB approval, PCB puts back the CR due to cost impacts, CM process updated, Task Team reviews & signs Form 4511, CR re-released, CECB approval & then PCB approval	6 months
CR82	Implement Core Stage Forward Skirt umbilical with the independent Vehicle Stabilization System (VSS)	Cost Schedule Mass	PM, CE, LSE, CSO, Core Element, Structure & Environments DLE, Test DLE, and GSDO Program	Urgent technical CR released, no Table top review, Form 4511 signed by LSE only, no CECB or PCB, approved @ JPCB	2 months

These CR decisions appear to be strategic, aligning with several of the characteristics listed above. Significant resources such as cost, schedule,

manpower, and vehicle mass were substantial evaluation factors. While the SLS PM was the final decision authority, the PM could not complete the engineering assessment alone. Oftentimes, the engineering change was complex requiring collaboration and technical expertise from many stakeholders. Table 4.1 illustrated the breadth of technical expertise that was necessary for a comprehensive assessment of not only the feasibility of the technical change, but also of the impacts the change had on resources, vehicle design, mission success, safety, etc. This assessment plus the analysis of how to mitigate and/or manage risks appeared to be time consuming especially when the change entailed much uncertainty or ambiguity. While a shared and highly communicative effort among the organizational teams determined decisions that were weighed against threats, constraints, and environmental factors, it undoubtedly also evoked political influences with potential negative contributions to the decision making process. To offset this, the team applied assessment techniques such as devil's advocacy and dialectical inquiry that critiqued ideas or alternatives to drive out the best decisions.

4.2   Research Method Development

Step two was to develop an instrument to capture the necessary information to better understand the strategic decision and communication characteristics. This entailed determining the best research method to collect the data and developing the mechanism to be thorough, succinct, and user-friendly.

4.2.1 Research Method Selection

One method considered to obtain information was through face-to-face, one-on-one interviews. However, with hectic schedules filled with detailed technical design work on the SLS launch vehicle and individual Element (i.e., Boosters, Stages, Spacecraft/Payload, Engines) design reviews and deadlines looming, interviews were not a viable option. Consequently, the better approach to gathering data was a web-based survey. This type of survey afforded an anonymous, user-friendly environment for easy access and easy submittal for the participants. The research need, goals, and planned data collection method were presented to the SLS CE office and approved to proceed.

4.2.2 Survey Instrument Development

A software package called SurveyGizmo was first researched and found adequate for survey development, administration, data collection, and data analysis. SurveyGizmo also met the anonymous and user-friendly environment criteria. The goal was for a survey to be quick and easy for the respondents to complete, but also direct enough to evoke respondents to provide information of their perceived notions and understanding of the communication flow and decision making practices specifically for SLS engineering change request processing.

The survey was designed to be succinct for respondents to give quick answers. Comment sections were also available allowing respondents to be as verbose as desired to provide any information they wanted.

Construction of the specific survey questions centered on the existing philosophy of the SLS CR change control process.   Three primary areas of exploration (i.e., process, problem identification, and success) were defined within the survey. The breakdown of the different type of questions per area are listed in the next sections.

4.2.2.1 Process Oriented Questions

These survey questions were focused on the mechanics of the SLS CR change control processing. In theory, the CR was generated by an entity (i.e., person or group) that requested a technical or programmatic change and then shepherded the CR through a series of events (i.e., official release of CR, formal review period for comments to the CR, discussions of comment dispositions and/or potential impacts, and notification of CR approval). The intent of the survey questions was to gain insight into the respondents' knowledge of the CR change process and to determine if the process was effectively practiced.

- Who (person or group) generated the CR?

- How were you notified of the CR for assessment?

- Were you involved in the discussion of any impacts stemming from the dis-positioned comments from the review of the CR? Explain.

- How were you notified of the Table Top or Task Team Review for this CR?

- When did the decision / approval of the CR officially get to you (approximate month and year) or Never?

4.2.2.2 Problem Identification Questions

The problem identification questions focused on identifying gaps or issues (underlying or blatant) which the respondents personally experienced or witnessed during the CR decision formulation. The intent was to not only pinpoint and understand the problem, but also to assess for potential recommendation for improvement or efficiency to SLS Program management and/or SE&I technical authority.

- What was your motivation in reviewing the CR?

- Would the assessment have benefited from additional expertise or input? If yes, what expertise would have improved the CR assessment?

- Do you feel you had adequate time and/or CR related materials to perform an assessment of this CR? If no, what hindered your review?

- Do you think your comments were assessed adequately in the Table Top or Task Team Review process? Explain.

- If you did not fully understand the CR decision and its implementation plan, what would have aided your understanding?

- Were there any gaps in communication during the CR review? If yes, what were they?

- Were there cost or schedule impacts due to communication glitches during the CR review? If yes, what were they?

4.2.2.3 Success Oriented Questions

The success oriented questions focused on identifying successes and/or positive tenets of the decision making and communication process the

respondents experienced or witnessed. It was important that the active

participants in the CR process shared technical expertise for strategic decision

making. They also needed to feel their concerns were heard and that they were

viewed as a knowledgeable contributing member of the team. The intent of these

questions was to determine the respondents' level of involvement in decision

making, determine the level of awareness and agreement with the resulting

decision, and to understand the respondents' perspective of the decision making

process effectiveness.

- Do you believe you provided a needed contribution to the CR assessment?

- How do you feel your comments were received and dis-positioned?

- Do you think your comments were assessed adequately in the Table Top
  or Task Team Review process? Explain.

- Did you fully understand the CR decision and its implementation plan?

- To what degree did you agree with the CR decision?

- From your perspective, were your concerns with the CR dealt with
  effectively?

- From your perspective, how would you describe the decision process with
  respect to the CR?

Each of the three CR surveys contained these same types of questions with the

header of the survey serving as the distinguishing factor between them. The

survey content was vetted through SLS and approved.

4.3 Sample Population Identification

Step three was to identify the population of individuals most involved with each CR's decision making and communication process. The technical scope, urgency, resources, and population varied for each CR. Participant data were collected from two primary sources: 1) the original email notification of the CR issuance from the SLS CM Release Desk, and 2) the consolidated matrices of reviewer comments for each CR. The official notification of a CR's release came in the form of an email from the SLS CM office with a pre-coordinated, pre-approved distribution list of multi-layer managers (LSE, CSO, ECEs, and DLEs). These managers participated in the CR change control process, and they could notify members of their teams either verbally or by the forwarded SLS CM email, requesting their participation in the CR review also. Any one that provided comments to the CR CPE were captured in a consolidated matrix for formal review and disposition. Therefore, these two primary sources were selected for a comprehensive list of participants for each CR. The list of names compiled for each CR was vetted through SLS technical authority management and approved. This list of names served as the population for each CR and ranged from 13 individuals to 118.

4.4 Survey Administration

With an approved research request, survey, and population from the SLS Program, the next step was to administer the surveys. Official notification of the survey originated as an email from the SLS CE Office and included the secured participant distribution list and a link to the web-based CR survey. The

participants were encouraged to support and provide as valid and candid information as possible.

4.5   Data Collection

All data were collected in one round of structured, anonymous surveys with SLS engineers, managers, and administrative support who were actively involved in making the decisions under study. The survey statistics for each CR were:

- CR 53 – Flight Termination System (FTS) Architecture Option 10A

  - Survey Population: 44

  - Survey Responses: 8 (per SurveyGizmo)

  - Survey Success: 18%

- CR 70 – Data Requirements List Update

  - Survey population: 118

  - Survey responses: 38 (per SurveyGizmo)

  - Survey Success: 32%

- CR 82 – Core Stage Forward Skirt Umbilical

  - Survey population: 13

  - Survey responses: 5   (per SurveyGizmo)

    - 6 submits of survey

    - 1 removal of indeterminate submittal[+]

  - Survey Success: 38%

[+]The data in this survey submittal could not be rationalized. Vague and conflicting answers were consistently provided throughout the survey input. With

an anonymous survey, an inability to contact the individual for clarification, and

an inability to rationalize the contradicting answers, the decision was made to

remove the indeterminate submittal from analysis.

4.6   Human Subject Testing

To ensure the ethical treatment of human subjects, the following

conditions were met within this study: 1) anonymity was stated and guaranteed

for the participants, 2) data would be reported collectively per CR, 3) participating

organization gave consent, and 4) every participant was over 19 years of age.

Due to an oversight, the Institute Review Board (IRB) approval was not pursued.

CHAPTER V

DATA RESULTS AND ANALYSIS

Data results for the three areas of exploration (i.e., process, problem identification, and success) are presented and analyzed within this chapter. First, observed discrepancies in the data and how those discrepancies were handled will be explained followed by the presentation of the survey data results and analyses. A summary of the main findings and key decision drivers determined from the study conclude the chapter.

5.1   Observed Data Discrepancies

Two data discrepancies were observed in the survey results. Each of these discrepancies will be briefly explained to provide a better understanding of how the discrepancy data was assessed within the data analyses presented and discussed throughout this chapter.

5.1.1   'Other' Category Discrepancy

When the survey was originally launched, a glitch was discovered where respondents could not submit the survey if a couple of questions were left blank. The issue was quickly rectified, and the survey re-launched. However, in a few occurrences of the early data submittals, the 'Other' data field captured benign

verbiage, such as "The survey required a response in this block." as one example. This data was compiled and included in the complete data set of survey results in this study; however, the erroneous data did not carry any weight or provide any value in the final data analysis of the results for the overall study. Consequently, if there was no justification given or additional explanation for the 'Other' category of responses in this data analysis write-up, it was because it was related to the few occurrences of these benign answers received.

5.1.2 Percentages >100% Discrepancy

The respondents were asked to "Check One" for an answer to the questions in the survey; however, the respondents would, in a few occurrences, check two or three answers for a question. An example of such an occurrence was with survey question: How were you notified of this CR for assessment? Options available were "Direct email from CM", "Email from DLE/EDLE", "Verbal from DLE/EDLE", and "Other". The respondents were asked to select one; however, a few respondents checked multiple answers. Furthermore, SurveyGizmo would count the number of answers given for each answer and divide that by the total number of respondents for the question. Consequently, in these instances of multiple answers given, the total percentage resulted in a value greater than 100. Nine out of 27 questions across all three CRs resulted in multiple answers given and percentages exceeding 100%. In each case, the percentages were normalized for analysis and were denoted with an asterisk in the title of the data results within this chapter.

5.2   Definition of 75% Delineator

Poole and Van de Ven (2010) surmised that process research is all about

finding temporal patterns, and the forms of the representation contributes

significantly to pattern recognition. In an empirical study of decision making

processes, Poole and Roth (1989) developed a three-tier, phasic timeline that

tracks the task functions and the working relationships of a group to the

percentage of the discussion the group has at various phases of decision making.

They determined that the 75% marking on the timeline denoted the optimal level

of participation and communication amongst the decision makers for the

formulation and realization of strategic decision solutions. Consequently, a value

of 75% was selected as a delineator in the assessment of process effectiveness.

This 75% delineator was utilized in the evaluation of the frequency that the

desired selectable answers to the survey questions were chosen by the CR

respondents. The reasoning was the more often a desired answers was selected,

the more effective the respondents found the process to be.

5.3   Process Results and Analysis

There were nine process-oriented questions pertaining to the three CRs.

The results will be discussed in the following sections.

5.3.1   Results per Question

Q1: Who (person or group) generated the CR?

- CR 53

- 88% (representing 7 out 8 respondents) answered a combination of EV72 and/or Flight System Safety Working Group which was consistent with the originating organization listed on the CR
- 22% of respondents answered with a broader entity such as System Engineering / SLS Systems Engineering & Integration (SE&I)
- CR 70
  - 47% (18 out of 38 respondents) answered a combination of EE12 and/or Configuration Management Office which was consistent with the originating organization listed on the CR
  - 11% (4 of 38 respondents) identified other organizations they thought were the originator
    - QD02
    - Change Package Manager
  - 8% of the respondents could not recall an originator
    - Do not know
    - Don't have time to go look this up
    - Unknown
  - Lastly, like earlier with CR53, 34% of the respondents (13 of the 38) answered with a broader entity such as SLS System Engineering as the originator
    - Level II SE&I
    - SLS SEI Management
- CR 82

- 80% (4 out of 5 respondents) answered a combination of EV74 and/or SLS Vehicle Integration which was consistent with the originator organization listed on the CR

- 20% representing a single respondent thought the Core Stage element originated the change request

Across all three CRs under study, an average of 72% of the respondents had a decent understanding and awareness of what organization and/or individual originated the change request and to whom they provided comments.

Q2: How were you notified of this CR for assessment?

	Direct Email from CM	Email from DLE/EDLE	Verbal from DLE/EDLE	Other
▨ CR 53	60%	0%	10%	30%
⊠ CR 70	57%	10%	0%	33%
▦ CR 82	83%	0%	17%	0%
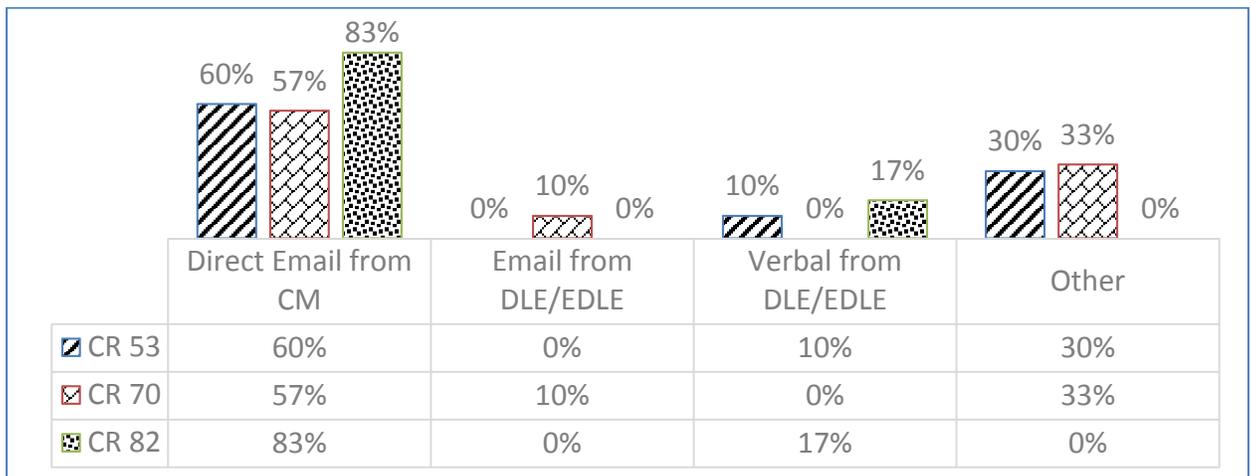
Figure 5.1 Summation of SLS CR Survey Question 2 Results*

An average of 67% of the respondents indicated they were identified as mandatory reviewers of the change request via the original distribution email from the SLS CM Release Desk. This initial contact from the SLS CM Release Desk was typically and appropriately formal. This percentage indicated the right technical disciplines were researched and identified early for review of the engineering change. An additional 12% were notified less formally via email or

verbal request from a manager-type to review the change request. The final 21% were notified by 'Other' means such as:

- Email from DLE agent

- Verbal from a LSE

- Email from office SLS and/or MPCV CM support

- Verbal from a FTS Trade Team representative

- Not notified

Q5: Do you believe you provided a needed contribution to the CR assessment?

	No. Didn't need to contribute & had no comment	Yes
CR 53	25%	75%
CR 70	11%	89%
CR 82	20%	80%
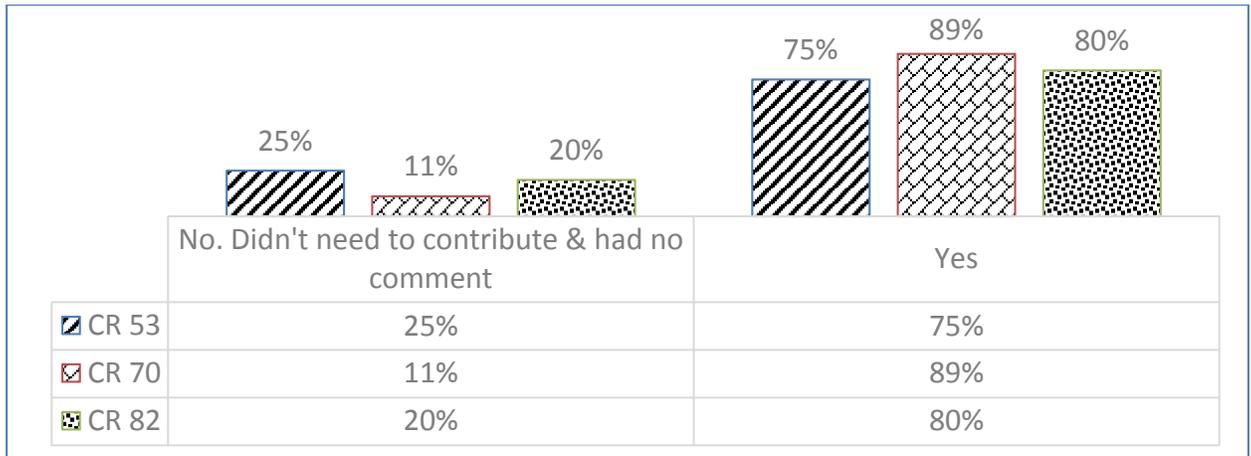
Figure 5.2 Summation of SLS CR Survey Question 5 Results*

Considering all three CRs, 75-90% of respondents felt they provided a necessary and beneficial contribution to the CR reviews.

Q6: Would the assessment have benefited from additional expertise or input?

	No	Yes
CR 53	100%	0%
CR 70	83%	17%
CR 82	80%	20%
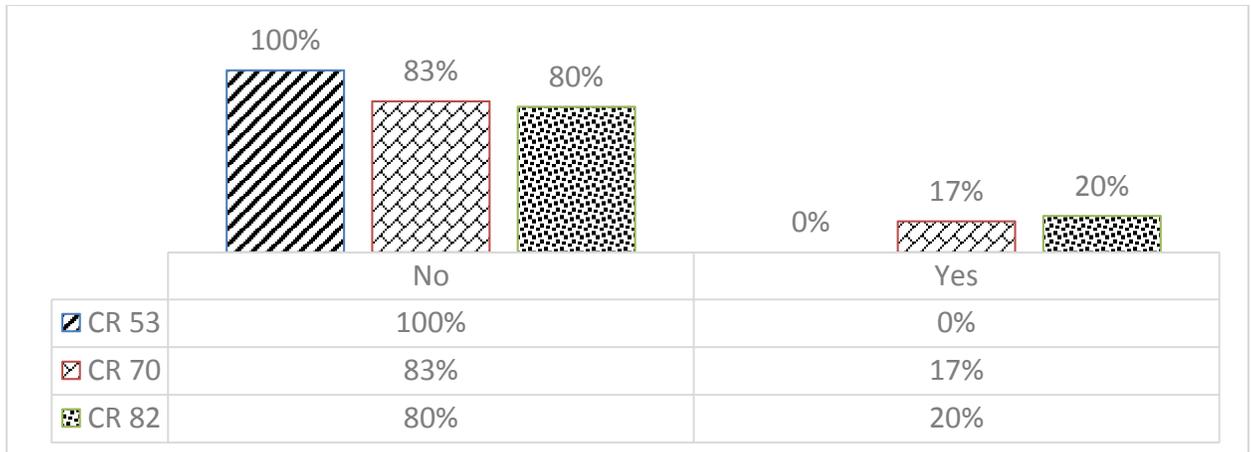
Figure 5.3 Summation of SLS CR Survey Question 6 Results*

By the input of "no additional expertise needed" from an average of 88% of the survey respondents, it appeared the process proved effective in including the right expertise to review, rationalize, and discuss impacts, risks, and workable solutions of the CRs. For the other 12%, most of the comments received suggested that lack of resources (time, budget) were the reason additional expertise would have helped.

Q11: Were you involved in the discussion of any impacts stemming from the dis-positioned comments from the review of the CR? If not, please explain.

	No, not al all	Yes, informally (i.e., through DLE, EDLE, etc.)	Yes, formally via direct Table Top / Task Team / Control Board Review(s)
CR 53	25%	38%	38%
CR 70	22%	34%	44%
CR 82	0%	20%	80%
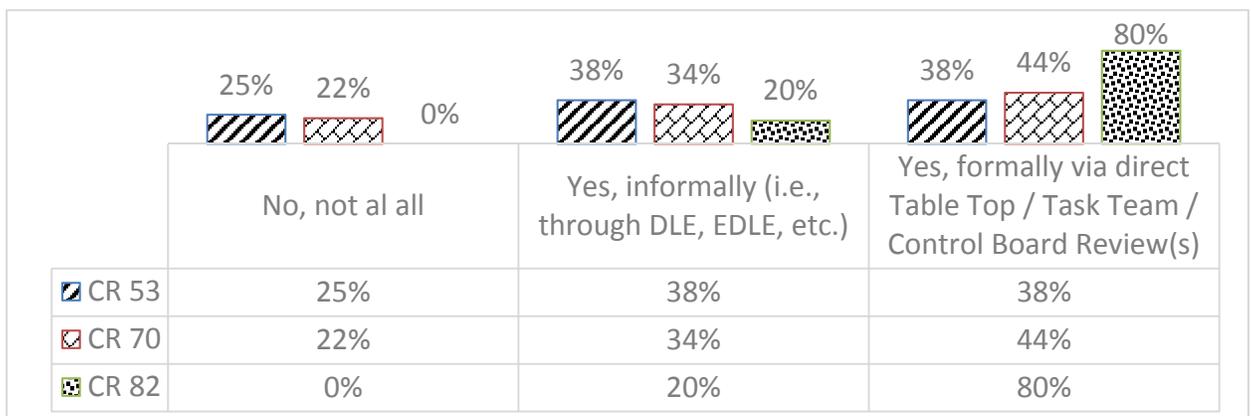
Figure 5.4 Summation of SLS CR Survey Question 11 Results*

The majority (>80%) of the respondents were actively involved, formally or informally, in the CR decision assessments and deliberations regarding the magnitude of risks and consequences of those risks. While most of the respondents were involved in potential impact discussions and resolution plans, there were a minority of respondents who were not involved. The following question provided insight into respondent exclusion from potential impact discussions.

Q12: Why were respondents not involved in impact discussions?

- Reviewer oversight or Reviewer unaware of impacts or discussions regarding them
    - Without my knowledge, a decision was made to eliminate a [Data Requirements Description/Definition] DRD that affected the document within my responsibility.
    - Email communication [was] used for dispositions. Minimal info as to impacts and little info as to big picture effects.
    - Just focused on the disposition of my comments via email. I was not involved in any group discussion.
- Either had no comments or had non-trivial editorial comments
    - I did not have any comments nor did anyone from my organization. CR53 was a well-vetted change prior to the CR release.
    - Comment was "editorial", no discussion required.
- Reviewer only involved at CECB level

- Outside of the CR presentation to the CECB, I was not involved in any discussion of comments.

Q13: If you were involved in impact discussions, how were you notified of the Table Top or Task Team Review for this CR?

	Direct email to review	Email from DLE / EDLE to review	Verbal from DLE / EDLE to review	Other
CR 53	43%	28%	15%	15%
CR 70	40%	28%	12%	20%
CR 82	67%	17%	17%	0%
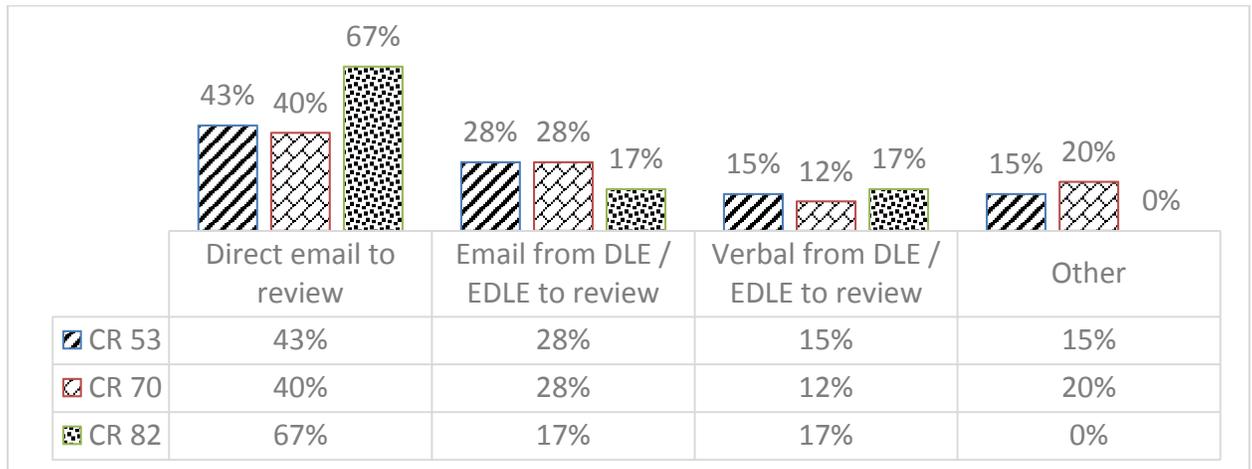
Figure 5.5 Summation of SLS CR Survey Question 13 Results*

Verbal and/or written (i.e., email) notifications from the CR CPE and/or SLS discipline management were the dominate methods practiced when notifying the respondents of CR discussions regarding impacts, consequences, and workarounds. The notification and communication at this stage in the process was more informal and appeared appropriate. An average of 12% of respondents was notified of CR discussions by other methods as described in the follow-on question.

Q14: What were 'Other' means of review notification?

- Email from task team representative from within home organization

- I was involved in control board reviews, not table tops.

- I was notified by the document owner, LSE and through the formal Booster CM process.

- I was involved in a division assessment of the impact. The division management assessed the scope and provided a cost impact. Coordinated with my management and not directly to the CR.

Q17: When did the decision / approval of the CR officially get to you (approximate month and year) or Never?

	Calendar Timeframe	Control Board Reference	Don't Know	Never	Repository Update	Receive Office Notice
CR 53	50%	25%	13%	0%	13%	0%
CR 70	30%	35%	11%	16%	0%	8%
CR 82	40%	40%	0%	0%	20%	0%
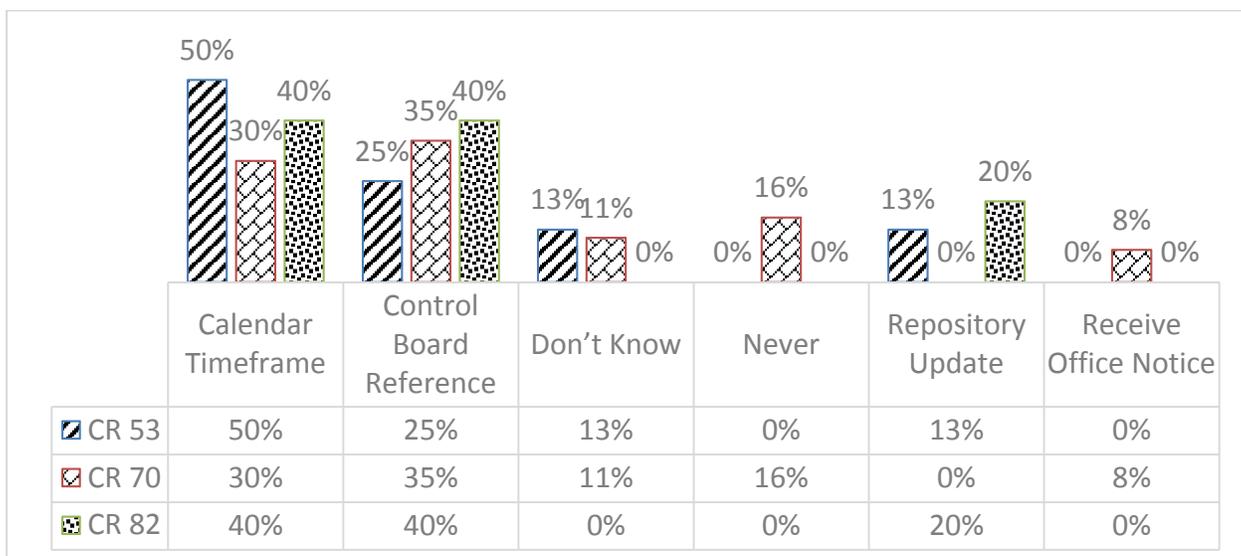
Figure 5.6 Summation of SLS CR Survey Question 17 Results

It appears all respondents were aware of the approval of the CRs with the exception of 6 respondents (i.e., 16%) on CR70 who were never notified of the decision or approval of CR70. With respect to the calendar timeframe inputs, the accuracy in answering was dependent on the respondents' memory. The inputs ranged over 2-6 month intervals for each CR. One thought on the variance in the timeframe answers was that the respondents may have been involved in the PCB where the CR was final approved and gave that date as a reference. Other

respondents may have given another date based on the official receipt of the final

approved document with all changes and decisions incorporated. Depending on

the magnitude of comments, the document update and release could have taken a

few months post PCB approval.

5.3.2   CR Process Analysis

All the answers submitted by the survey respondents with respect to the

process-oriented questions have been detailed earlier in this chapter. This section

will attempt to determine the effectiveness of the CR change control process by

evaluating the desired answers selectable for the process-oriented questions

against the survey results from the respondents' answers across all three CRs.

When analyzing the change control process, the desired choices were identified as

receiving official notifications of the change and of meetings and/or discussions

about the change and possessing a good understanding of who initiated the

change, its purpose, reviewer expectations, and time constraints for review,

decision formulation, and CR approval. Table 5.1 lists these desired answers and

the resulting percentages for each CR.

Table 5.1 Desired Selectable Answers for Process

Desired Selectable Answers	CR53	CR70	CR82
Received official CM notification email	60%	57%	83%
Understood who originated the CR and why	88%	47%	80%
Provided a needed contribution to the CR decision	75%	89%	80%
Felt adequately involved in impact discussions	76%	78%	100%
Felt adequately involved in formal reviews	71%	68%	84%
Knew when the CR was approved	88%	73%	100%

The CR results for the desired process related questions ranged from a lowest value of 47% to a highest value of 100%. Evaluation of the three CR results with a 75% delineator revealed that the CR82 respondents observed no process inefficiencies, the CR53 respondents observed a few, and the CR70 respondents observed the most inefficiencies in the processing of the DRL update. The CR53 results ranged from 60% to 88% for the desired process-oriented questions with results falling below the 75% delineator in the notification of the vehicle flight software architecture change and Table Top Reviews. The CR70 process related results ranged from 47% to 89% with percentages falling below 75% in understanding the CR origination and purpose as well as in the notification of the CR, team reviews, and resulting CR approval. Improvements within the communication realm of the process are suggested, especially when 16% of the CR70 respondents were unaware of the official approval of the CR on which they participated. The results reflecting CR70 as having the most process inefficiencies appear logical since the baseline SLS CR change control process was revamped during that CR review.

5.4 Problem Identification Results and Analysis

There were eleven problem identification questions pertaining to the three CRs. The results will be discussed in the following sections.

5.4.1 Results per Question

Q4: What was your motivation in reviewing the CR?

- CR53

    o To establish a FTS architecture for SLS

- - Participated in the decisional process for the FTS architecture, which resulted in having this CR be generated

    - Gain knowledge of the Flight Termination System (FTS)

  o Ensure consistency among Cross-Programs and other activities

    - Making sure it has the appropriate considerations relative to ground operation activities

    - To assess that the change was consistent with trade study results and an agreed to option

    - Understand if impact to crew vehicle was acceptable

    - Ensure the specific Flight Termination Architecture definition that is required to be represented in the SLS technical baseline is documented in the appropriate interface control document.

  o Safety

    - Concern that FTS implementation could lead to a safety risk and a future redesign to mitigate the safety risk. Architecture seemed to be driven by a view to simplify a design (i.e., remove components) rather than a full integrated stack systems view.

- CR70

  o Mandatory Evaluator

    - DLE role

    - It's part of my job

  o Accuracy of technical / discipline-specific data in DRL

- Responsible for the development of several documents affected by this CR / Motivated to ensure the accuracy of the data in the DRL / This document affects my work / To ensure that my input to the document was correctly implemented / Ensure the documents under my functional team were accurately captured in terms of content and delivery milestones.

- We needed to review the CR to ensure that our organizations [Data Requirements Description/Definition] DRDs were correctly represented and that there were no impacts to our organization relative to other DRDs

- The DRL is like the Rosetta Stone for all the pertinent information regarding products generated by one discipline and products generated by other disciplines in which there are many stakeholders. Need to assure program integration between the vehicle and ground services occurs smoothly / Reviewing content relative to ground operations deliverables / Having the necessary documentation properly identified and baselined.

- CR was related to the SLS DRL which directly effects the SPIO Element by defining data products required from payload integration team.

- Review for correctness from the standpoint of Integrated Avionics and Software (IAS)

- o Align with Agency, Center and Cross Program requirements

    - Ensure the program had the correct deliverables identified in order to comply with Agency and Center requirements for the development of the program.

    - This was a Cross Program change request that could impact another Program or ESD

    - To ensure DRL would adequately address changes to category 1 and 2 documentation associated with verification and validation needs across all programs.

  - o Deliverables alignment and document flow to external entities

    - It directly impacted deliverables from the element office(s) and external entities with potential for cost impact / Assure alignment between L2 expectations for data deliveries from the elements / Interested from perspective of proper classification of documents for proper flow down to external entities

- CR82

  - o Assigned as a mandatory reviewer

    - Part of the job

  - o Accuracy of technical / discipline-specific data

    - Document owner

  - o Ensure consistency among Cross-Programs and other activities

    - Minimize operational and interface impacts between the vehicle and ground operations

Q6: Would the assessment have benefited from additional expertise or input?

	No	Yes
CR 53	100%	0%
CR 70	83%	17%
CR 82	80%	20%
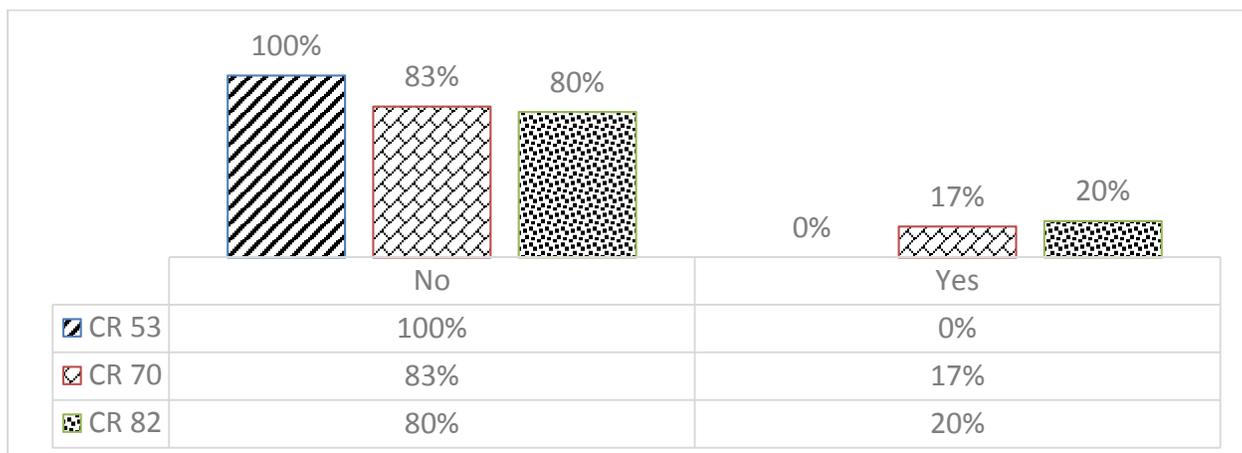
Figure 5.7 Summation of SLS CR Survey Question 6 Results*

Between 80 and 100% of the respondents believed the technical assessment they provided was sufficient.

Q7: If yes, what expertise would have improved the CR assessment?

- Objective independent assessment presented to the Cross-Program tech authorities

- Vice identifying specific expertise, respondents tried to justify why certain expertise was not included

    o Unclear scope

        ▪ Unsure if individual knew if all documents were necessary [on CR 70]

    o Limited resources

        ▪ There are limited amount of resources to review all CRs, each organization tries to place those with the most expertise on the

CR; however, there is a lack of planning of CRs to ensure that

SMEs are not overburdened with CR reviews. (CR70)

- Additional expertise is always needed but that need has to be

balanced with the cost of managing excessive input. I believe

the balance achieved for this revision was reasonable. (CR 70)

Q8: Do you feel you had adequate time and/or readily available CR related

materials to perform an assessment of this CR?

	No	Yes
CR 53	0%	100%
CR 70	16%	84%
CR 82	20%	80%
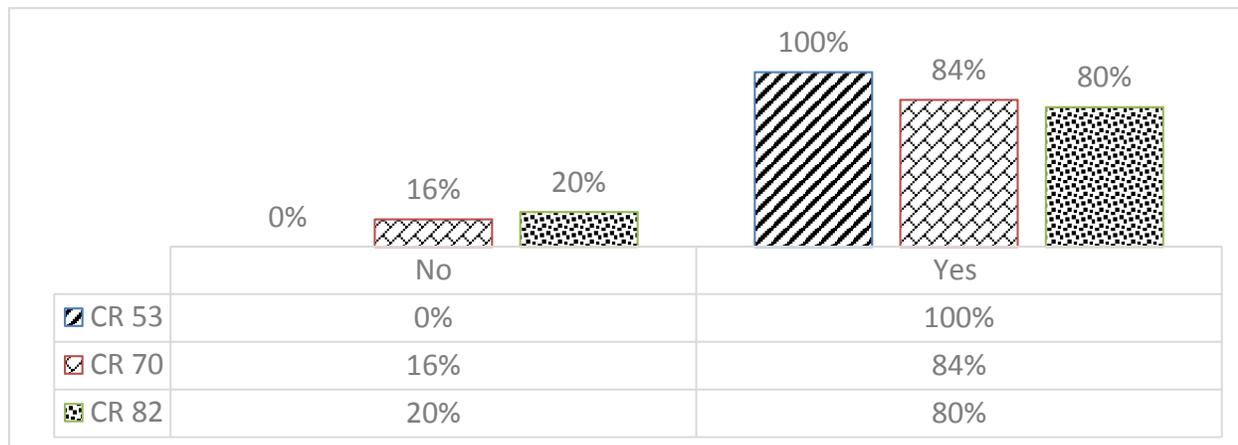
Figure 5.8 Summation of SLS CR Survey Question 8 Results

The data showed that the majority of the respondents felt they had adequate time

and resources available for the review of each CR; however, there were a few

concerns as explained in the following question.

Q9: If no, what hindered your review?

- Unclear change purpose or intent

  o CR 82 was an urgent CR when it came out. The

  information/background about it was very confusing. Real

  understanding of the thrust arrived when CR was explained at the

  board.

- Insufficient time / Workload

    o Needed more time to fully review this document

    o Heavy review load including other CRs and documents

    o While the review period for this CR (70) was sufficient for one CR of
      this magnitude, this CR was not the only one under review. That is the
      price of a tight schedule; multiple changes being reviewed
      simultaneously by the same experts. We do the best we can, and
      request extensions when we feel we cannot accomplish an appropriate
      review. But there's never enough time to do it all.

    o Preparation for internal milestone review. CM system had a number of
      changes in the system to review.

Q15: Do you think your comments were assessed adequately in the Table Top or

Task Team Review process?

	No	Yes
CR 53	33%	67%
CR 70	3%	97%
CR 82	0%	100%
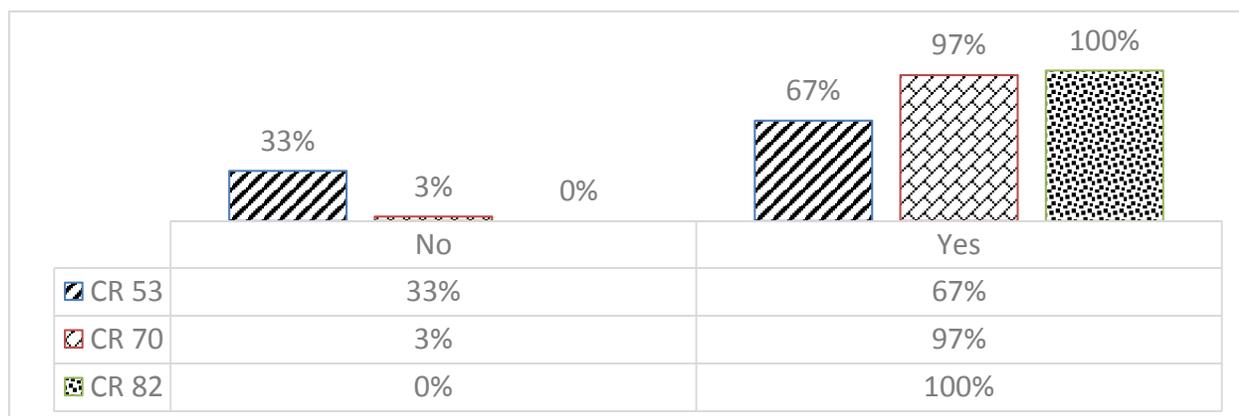
Figure 5.9 Summation of SLS CR Survey Question 15 Results*

The data showed the majority of the respondents across all 3 CRs thought their

comments were adequately assessed. The explanation of the 33% dissension was

explained in the follow-on question.

Q16: If no, please explain.

- The future implications [of FTS option 10A] were not given much consideration. The future configurations [were] not viewed as design considerations.

    o I felt the solution was workable but we did not adequately consider future implications or risk in operational scenarios.

Q18: Did you fully understand the CR decision and its implementation plan? If not, what would have aided your understanding?

	No	Yes
CR 53	0%	100%
CR 70	8%	92%
CR 82	20%	80%
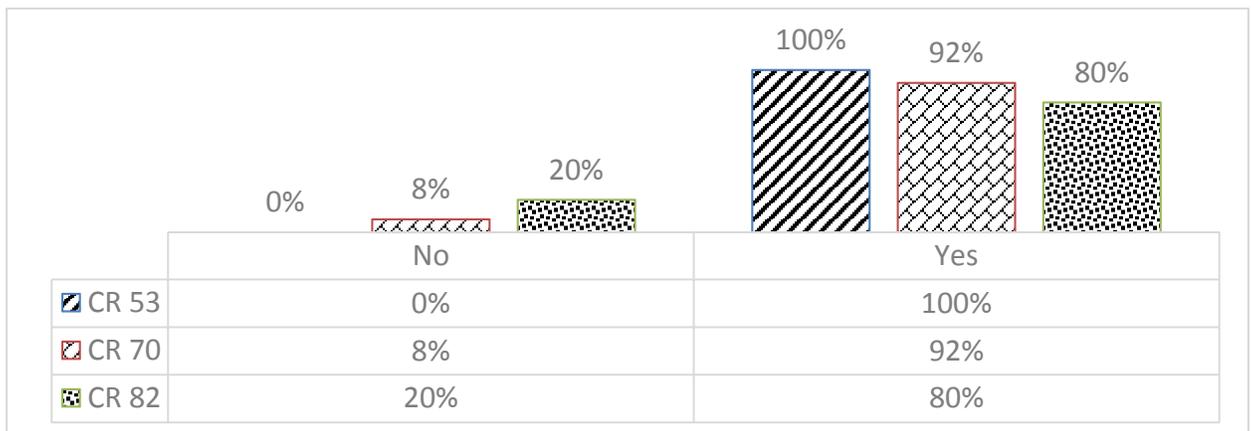
Figure 5.10 Summation of SLS CR Survey Question 18 Results

Across each of the 3 CRs, 80-100% of the respondents understood the resulting decisions and the implementation plans for the decisions. Issues that impacted understanding were listed in the next question.

Q19: If not, what would have aided your understanding?

- A better big picture understanding of intent of CR [70] and what problems it was solving.

- We were plowing new ground with what it meant to execute a hard T-0 design -- that design is still in work after all these months. (CR 82)

Q22: Were there any gaps in communication during the CR review?

	No	Yes, minor	Yes, major
CR 53	100%	0%	0%
CR 70	74%	18%	8%
CR 82	60%	20%	20%
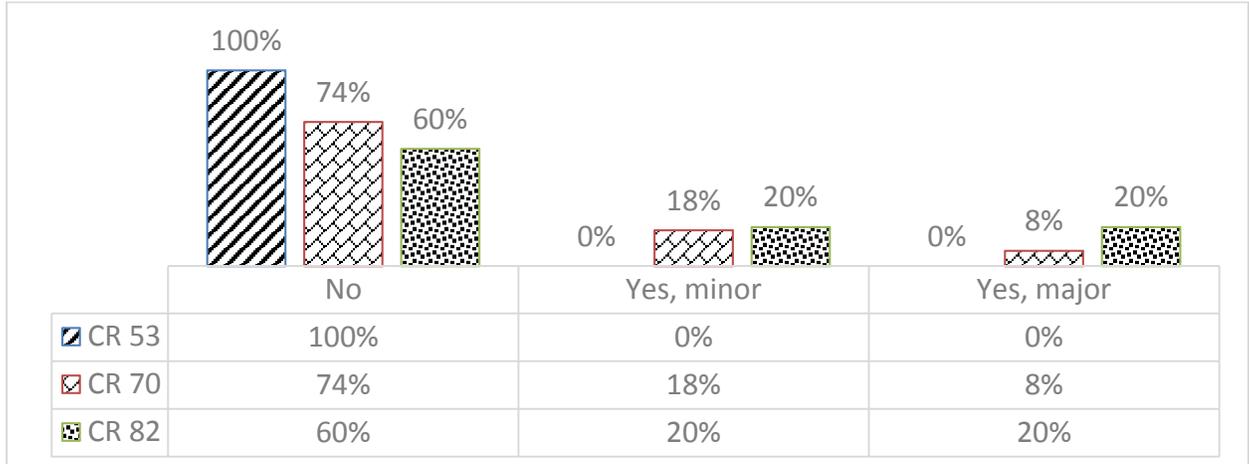
Figure 5.11 Summation of SLS CR Survey Question 22 Results

On average, 78% of the respondents experienced no communication issues, 13% experienced minor communication gaps, and 9% of the respondents saw major issues in communication. The next question addressed the major and minor communication issues identified by 22% of the survey respondents.

Q23: If yes, what were they?

- Unclear cost impacts
    - Lack of understanding life cycle cost impacts
    - Cost assessment was not performed until the CR was out for formal review. Several significant cost impacts had to be worked out through the board process.
    - Some entities "piled on" with cost impacts at the PCB meeting instead of writing the cost impacts down formally through comments.

- o Unclear cost impacts from some parties in the days leading up to the boards which resulted in "piling on" a bit at the board meetings. This was minor, though.

- Unclear deliverables schedule

  - o Updates required inputs to be scheduled per the SLS-SCHE-164 [document] which did not accompany the CR. No communication as to how the scheduling of deliveries would be handled.

- Unclear SLS Task Team Review Process

  - o The SLS Task Team review is a bit confusing to most outside organizations - who participates, how are they chosen, how are they notified. Also sometimes a gap in closing the loop with CR reviewers/commenters

- Unclear content / scope of change

  - o This CR [70] was release in 2012 and then re-released in 2013 as R1. There was some question as to what was retained in the comments from R0 review to R1 - just caused additional review of the R1 version.

- Unrealistic review process for substantial changes

  - o The method of doing changes of this importance and magnitude is broken. The DRL is a document that should be given mandated undivided attention though it is just one of many priorities when it is worked as part of an existing program. The magnitude of the change

and the method of review of the changes and inputs from the various

commenters created a communication nightmare.

- Unclear purpose

    o [CR 82] was an urgent CR whose intent was not well communicated.

      Couldn't figure out the thrust of the change via the email notification

      alone.

- Difficult integration across 3 programs

    o Getting to an integrated Cross-Program objective story was difficult to

      achieve as some entities were already ahead in their work and any

      vehicle changes resulted in significant SLS cost impacts; essentially

      put the onus on one Program to comply with the vehicle-focused

      [Vehicle Stability System] VSS design.

Q24: Were there cost or schedule impacts due to communication glitches during

the CR review?

	No	Yes
◪ CR 53	88%	12%
◪ CR 70	87%	13%
◪ CR 82	80%	20%
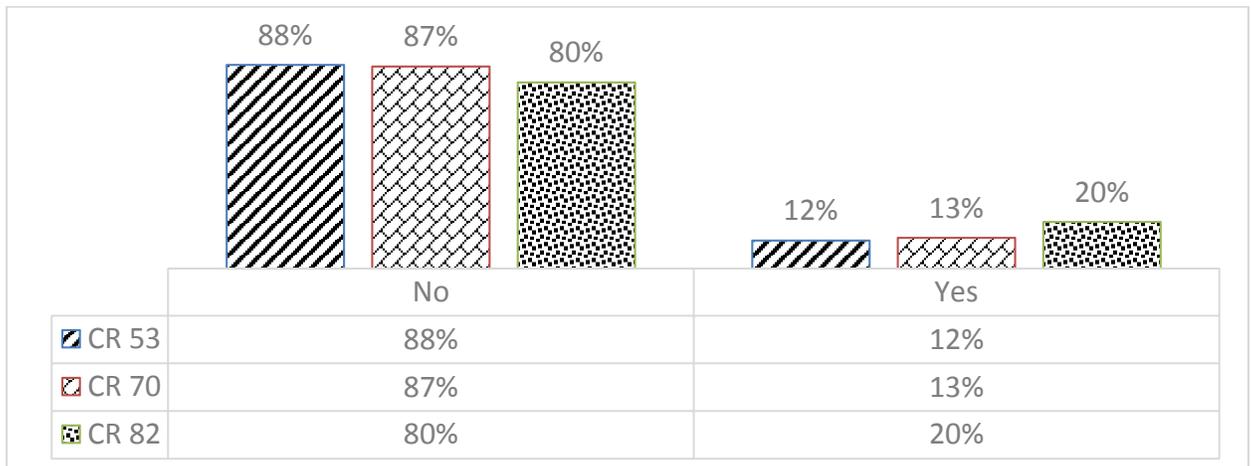
Figure 5.12 Summation of SLS CR Survey Question 24 Results

From the previous question, an average of 78% of total survey respondents

reported no communication issues, while 22% reported experiencing

communication gaps and identified them. An interesting data point here was that

previously, the CR53 respondents reported no communication gaps during the

review; however, in this question, one out of the eight CR53 respondents felt

there were resource impacts to cost or schedule and related them to

communication gaps. Therefore, it was difficult to conclude that any cost or

schedule impacts relate directly back to the 22% that recognized communication

issues during the CR processing. However, strictly assessing the data as

presented here, 80-88% of respondents, across all 3 CRs, who recognized

communication issues, did not see those impacting substantial resources such as

cost and schedule. The 12-20% of those respondents that did see cost or schedule

impacts due to ineffective communication provided specific examples as reflected

in the next question.

Q25: If yes [there were cost or schedule impacts], what were they?

- Time / Schedule
    - The CR [70] had to be delayed multiple times due to its size and
      complexity.
    - The amount of time needed to work through the [CR 70] Rev D
      impacts took valuable time that would have otherwise been used on
      other tasks. This created stress on the employees attempting to meet
      dates that were being pushed hard to keep the program, or Level II

schedule on track, without concern for the schedule impact to the element.

- Cost
    - o Unsure cost impacts were fully vetted by the design solution at the time of the PCB. (CR 53)
    - o Getting to an integrated Cross-Program objective story was difficult to achieve as some entities were already out ahead in their work and any vehicle changes resulted in significant SLS cost impacts. (CR 82)
- Cost and Schedule
    - o Lack of understanding life cycle cost impacts of missed design influence decisions resulting in schedule delays. (CR 70)

5.4.2   CR Problem Identification Analysis

All the answers submitted by the survey respondents with respect to the problem identification questions were detailed in 5.4.1. An analysis of the effectiveness of the CR change control process by analyzing whether blatant and/or underlying problems were evident will be discussed in this section. Specifically, an assessment of how the desired answers selectable for the problem identification questions performed against the survey inputs from the respondents' answers across all three CRs will be evaluated. What are desired choices when attempting to identify and rectify problems arising during the decision making process of the three CRs in study? Those were identified as participant motivation to review and ensure compliance, correct expertise identified for assessment, adequate time for review, adequate information accessible for review,

adequate bidirectional participatory discussion of technical inputs and risk

mitigation and/or management, and finally, understanding the resulting decision.

Table 5.2 lists these desired answers selectable and the resulting percentages for

each CR.

Table 5.2 Desired Selectable Answers for Problem Identification

Desired Selectable Answers	CR53	CR70	CR82
Motivated for technical accuracy and compliance among Cross Program	100%	80%	60%
Needed no additional expertise	100%	83%	80%
Adequate time for review	100%	84%	80%
Adequate assessment from review	67%	97%	100%
Understood decision	100%	92%	80%
No communication gaps	100%	74%	60%
Observed no cost/schedule impacts	88%	87%	80%

The CR results for the desired problem identification questions ranged

from a lowest value of 60% to a highest value of 100%. Evaluation of the three

CR results with a 75% delineator revealed that the CRs were collectively above

average for having adequate expertise and review periods assigned for CR

evaluation, for identifying and/or mitigating impacts to budget or schedule, and

for possessing a team consensus in the understanding of the resulting decisions.

While most of the CR results favored the desired answers, there were, however, a

few problems identified by each CR during the review, communication, and

decision making process. The CR53 results showed a 67% rating for the

assessment of comments during the Table Top Review process, CR70 narrowly

missed the delineator mark with a 74% rating on communication, and the CR82

results were 60% both in motivation and communication. Specifics of these process hindrances were:

- Adequate Assessment
    - CR53 respondents understood the resulting decision for the FTS architecture and considered the software upgrade workable, but one respondent felt future implications with the upgrade were not been adequately assessed.
- Communication Gaps:
    - CR53 identified no communication issues while twelve CR70 respondents and two CR82 respondents identified communication ambiguities with cost, schedule, review iterations, task team roles and responsibilities, and the integration process across the three Cross Programs.
- Motivation:
    - All of the CR53 respondents identified technical considerations and coordination strategies with the Cross Program entities to establish a viable and safe FTS architecture as the motivation for the CR processing. Twenty-eight out of thirty-five respondents on CR70 revealed similar motivation strategies. For CR82, three respondents shared a desire for technical accuracy and compliance across the Cross Programs whereas two respondents commented their motivation was "part of the job" which may or may not have been a positive motivator.

Legitimate problems were identified during the processing of the three

CRs under study. Despite these problematic issues, the respondents reviewed,

debated, and rationalized the decisional information as necessary to reach

consensual decisions and programmatic approvals of the CRs. Overall, the

decision making and communication within the CR processing was above

average; however, based on the respondents' feedback, there exist areas of

improvement within the SLS CR change control process to be addressed and

refined.

5.5   Success Results and Analysis

There were nine success-oriented questions pertaining to the three CRs.

The results will be discussed in the following sections.

5.5.1   Results per Question

Q5: Do you believe you provided a needed contribution to the CR assessment?

	No. Didn't need to contribute & had no comment	Yes
CR 53	25%	75%
CR 70	11%	89%
CR 82	20%	80%
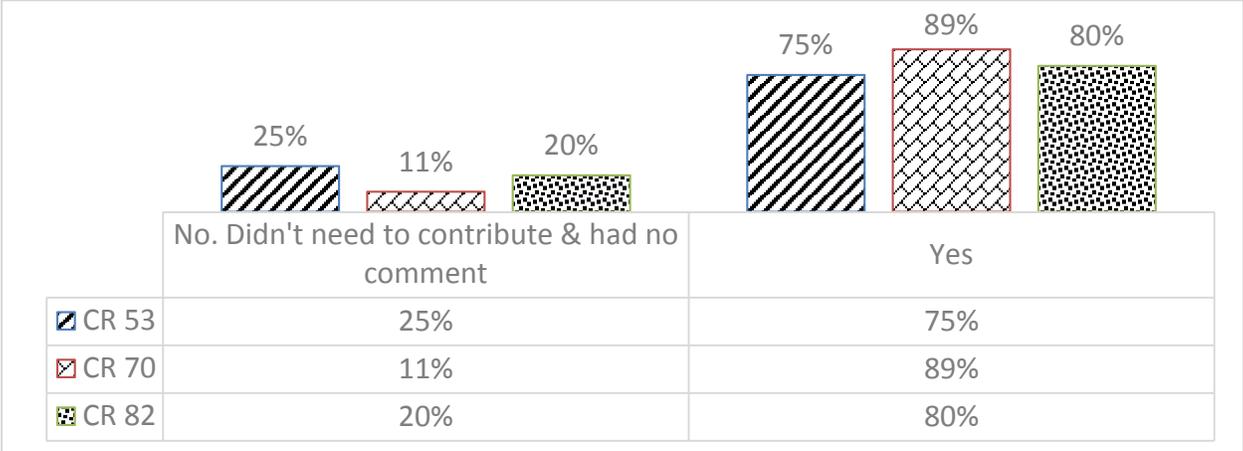
Figure 5.13 Summation of SLS CR Survey Question 5 Results*

Greater than 75% of the respondents across the three CRs felt they provided a

necessary and beneficial contribution to the CR reviews.

Q10: If your answer to Question 5 was 'Yes', how do you feel your comments were received and dis-positioned?

	Well. Lots of discussion to make my comments understood.	Fair. Minimal communication (mainly via email).	Poor. My comments were ignored or dismissed.
CR 53	60%	40%	0%
CR 70	65%	35%	0%
CR 82	60%	40%	0%
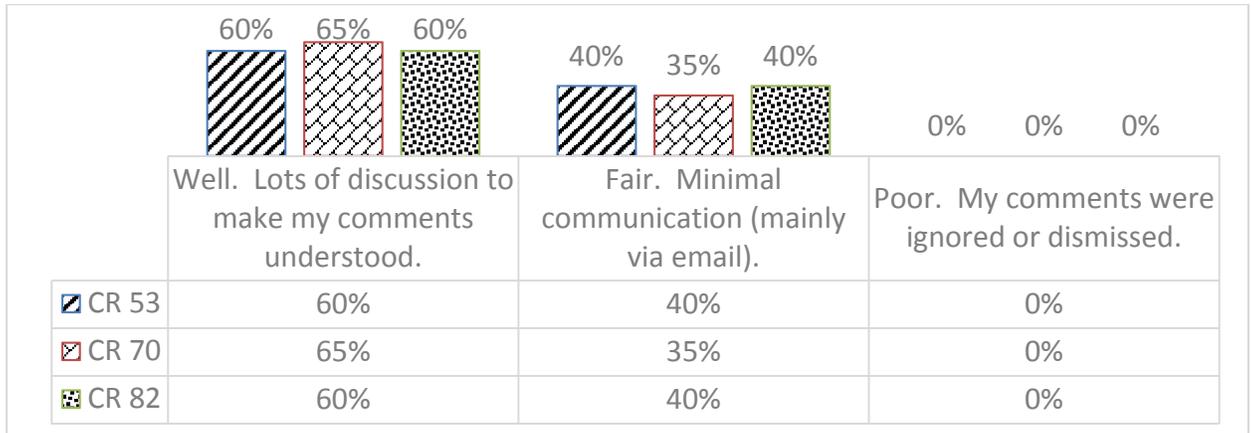
Figure 5.14 Summation of SLS CR Survey Question 10 Results

All of the respondents felt their comments were adequately received and assessed.

Q15: Do you think your comments were assessed adequately in the Table Top or Task Team Review process?

	No	Yes
CR 53	33%	67%
CR 70	3%	97%
CR 82	0%	100%
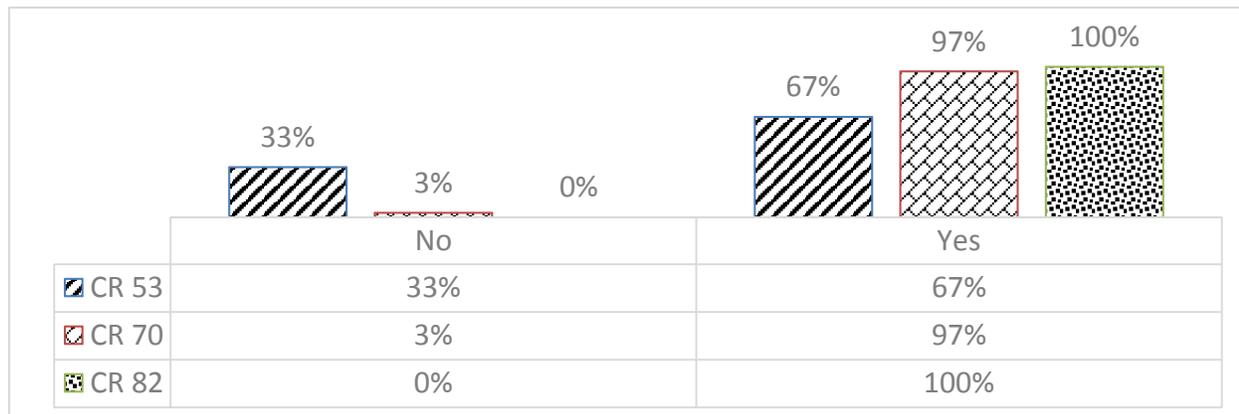
Figure 5.15 Summation of SLS CR Survey Question 15 Results*

Between 67% and 100% of the respondents across the three CRs felt their comments were adequately assessed during the Table Top or Task Team Review meetings. The one exception in CR53 was explained in the following question.

Q16: If no, please explain.

- The future implications [of FTS option 10A] were not given much

   consideration. The future configurations [were] not viewed as design

   considerations.

   o   Solution was workable but did not adequately consider future

       implications or risk in operational scenarios.

Q18: Did you fully understand the CR decision and its implementation plan? If

not, what would have aided your understanding?

	No	Yes
CR 53	0%	100%
CR 70	8%	92%
CR 82	20%	80%
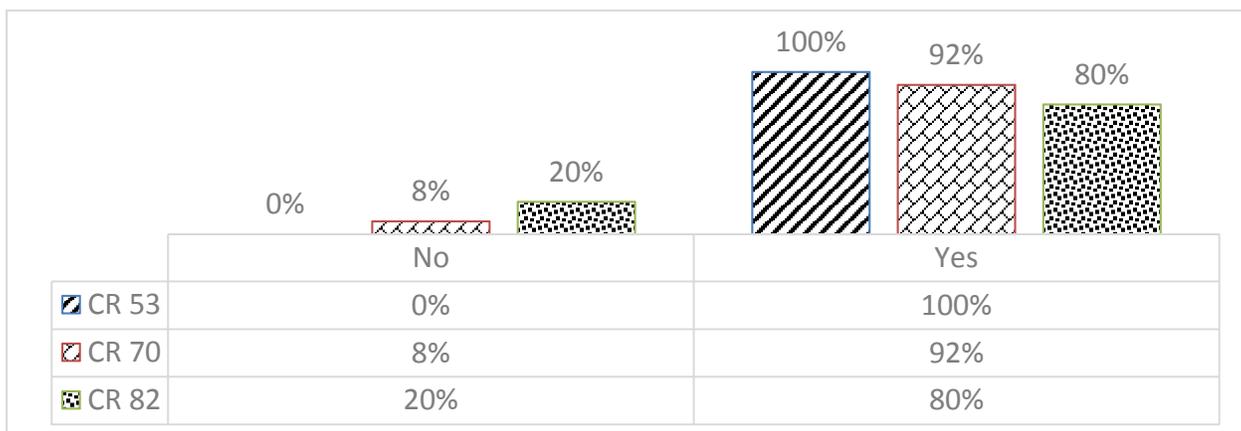
Figure 5.16 Summation of SLS CR Survey Question 18 Results

Between 80% and 100% of respondents across the CRs understood the resulting

decisions and corresponding implementation plans. Issues that impacted the

understanding of CR70 and CR82 decisions were explained in the next question.

Q19: If not, what would have aided your understanding?

- A better big picture understanding of intent of CR [70] and what problems it

   was solving.

- We were plowing new ground with what it meant to execute a hard T-0 design

   -- that design is still in work after all these months. (CR 82)

Q20: To what degree did you agree with the decision?

	Not at all (0%)	Disagreed but understood rationale (30%)	Ambivalent and workable (50%)	Moderately agree (80%)	Completely agree (100%)
CR 53	0%	13%	25%	13%	50%
CR 70	0%	0%	13%	28%	59%
CR 82	0%	0%	0%	40%	60%
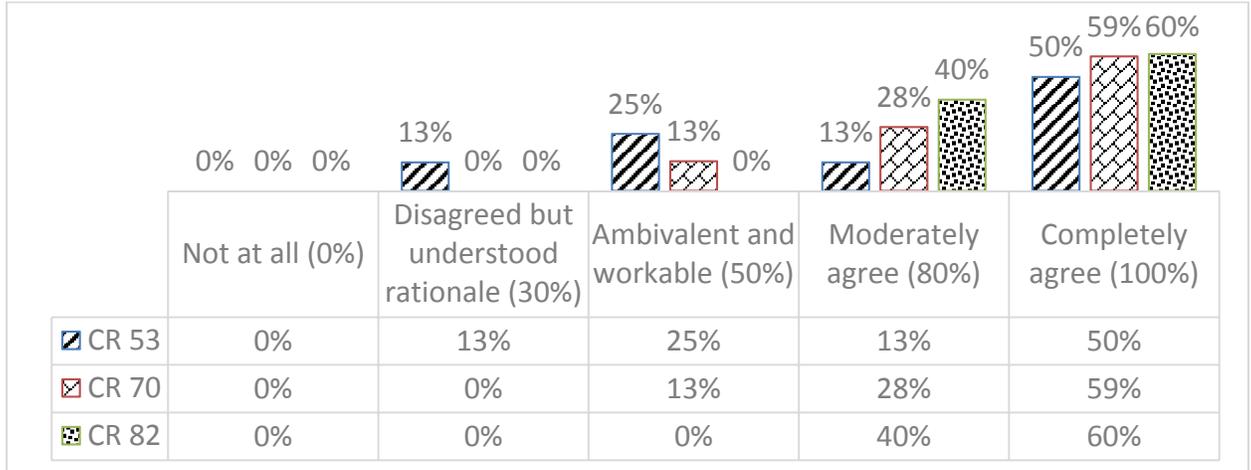
Figure 5.17 Summation of SLS CR Survey Question 20 Results*

The majority of the survey respondents found the resulting decisions to be agreeable and workable. The 13% dissenting opinion for CR53 came from a respondent who disagreed with the FTS architecture decision but understood the rationale for the decision. The respondent commented:

- While the option selected had some benefits, the other option was less complex, [had] no interfaces to deal with, and reduced the mass on the Core Stage.

Q26: From your perspective, were your concerns with this CR dealt with effectively?
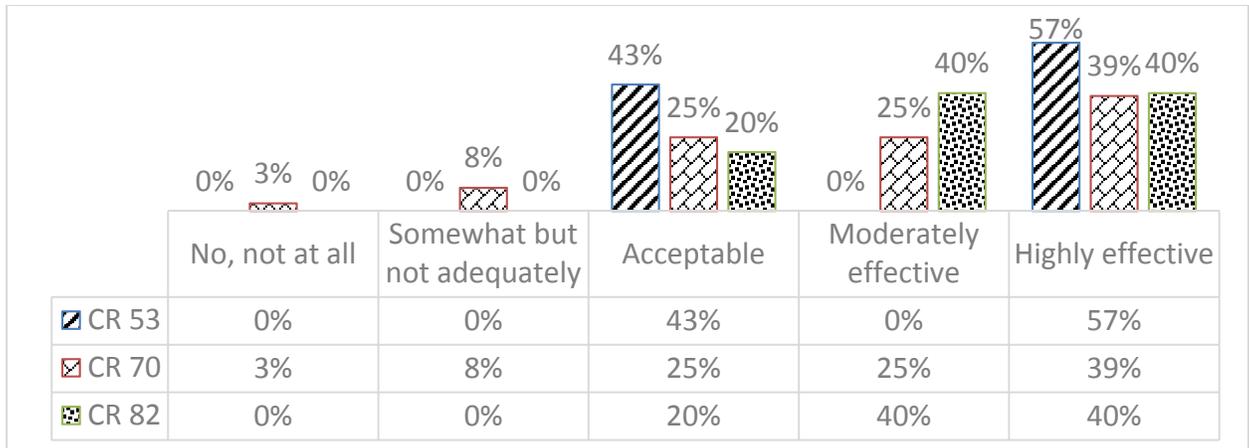
Figure 5.18 Summation of SLS CR Survey Question 26 Results*

	No, not at all	Somewhat but not adequately	Acceptable	Moderately effective	Highly effective
CR 53	0%	0%	43%	0%	57%
CR 70	3%	8%	25%	25%	39%
CR 82	0%	0%	20%	40%	40%

Among the three CRs under study, the majority of the respondents commented that they felt their inputs to the CR change process and their contributions to the resulting decisions were adequately and effectively handled. However, there were a few dissensions with respect to CR70. One respondent answered this question with "No, not at all" and added a comment that the respondent did not review the CR. Therefore for assessment purposes, no review of the CR equated to no concerns with the processing of the CR. For the next category of "Somewhat but not adequately", a couple of CR70 respondents provided the following comments to explain why they felt this answer was appropriate with respect to their inputs to the CR:

- One of my comments was rejected due to the elimination of [Data Requirements Description/Definition] DRD without my knowledge.
- Cost swept under the rug, as they have been for other changes. Level II requirements drove cost that the elements had to find a way to make happen with no additional money.

Q27: From your perspective, how would you describe the decision process with respect to this CR?

	Very difficult and/or frustrating and not effective	Difficult and somewhat effective	Effective but inefficient	Sufficiently effective and somewhat inefficient	Highly effective and very efficient
CR 53	0%	0%	22%	56%	22%
CR 70	3%	5%	23%	52%	17%
CR 82	20%	0%	20%	60%	0%
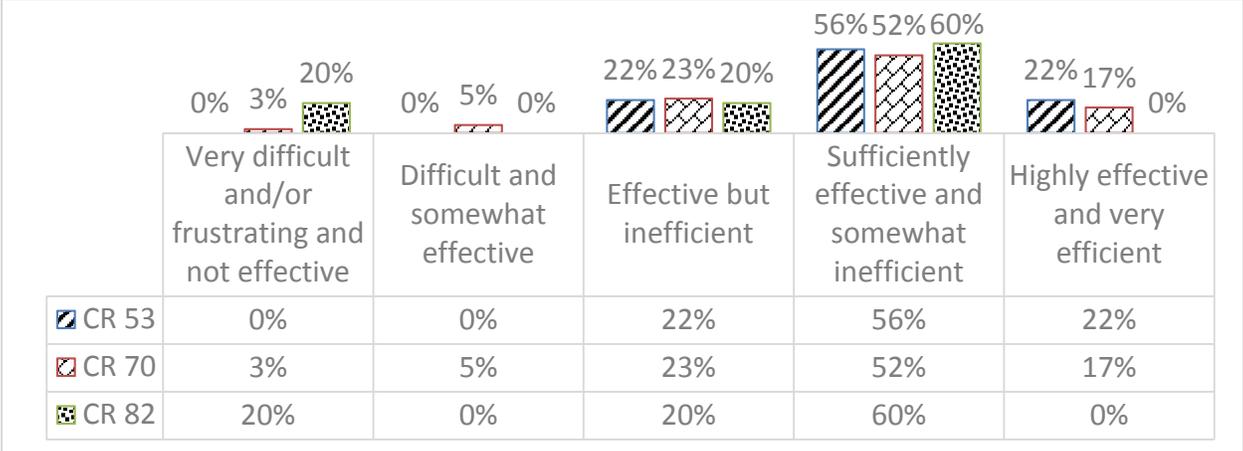
Figure 5.19 Summation of SLS CR Survey Question 27 Results*

An averaged majority of 91% across all three CRs observed the decision process to be effective. This percentage broke down to: 22% of all respondents viewed the decision process as effective but inefficient, 56% viewed the decision process as sufficiently effective and somewhat inefficient, and 13% of the respondents viewed the decision process as highly effective and very efficient. For the other end of the spectrum, an average of 9% of the survey respondents found the process to be difficult, specifically expressing the decision process to be very difficult, frustrating, and ineffective. The following data addressed the difficult and ineffective process examples identified by the survey respondents.

- CR Review Process
  - o The CR and Table Top process is long and time consuming. There are areas that can be eliminated and improved. (CR 82)

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- o The perseverance of the professionals that we had working the product was the only reason the CR [70] made it through the process at all. In other words, the process did not help, the work got done (mostly) in spite of the process.

  o Never given enough time to review any CRs. (CR 70)

- CR Scope / Content

  o The most inefficient part, in my opinion, was caused by people adding documents to their scope without updating the DRL. This happened before the CR [70] was sent out for review. Granted, it is a by-product of the phase of program we were in, and things have tightened down since that time.

  o Inefficient because there were so many changes associated with this CR [70] it was difficult to keep up with understanding changes provided by other commenters.

- CR Cost Impacts

  o This CR [70] had to be withdrawn and re-released (as SLS-00070R1) due to cost impacts from various entities. The process worked, but it might have been more efficient had cost impacts been addressed during the task team process.

  o Hard to present an objective story because of out of synch schedules. Any design changes were major cost impacts to the Program. (CR82)

5.5.2 CR Success Analysis

All the answers submitted by the survey respondents with respect to the success-oriented questions were detailed in 5.5.1. An analysis of the success of the overall decision making and communication practices exercised within the CR change control process will be discussed in this section. As conducted on the previous survey assessments for the process and problem identification questions, an evaluation of how the desired answers selectable for the success-oriented questions performed against the actual survey answers from the respondents across all three CRs will be analyzed. The desired choices for the success-oriented questions were identified as those where the respondents felt they made a necessary and valuable contribution to the review and resulting decision, where their comments and contributions were acknowledged and adequately assessed, where they understood and agreed with the resulting decision, and lastly, where they exhibited a high degree of confidence in the effectiveness of the decision making process. These desired answers selectable and the resulting percentages for each CR for that answer are listed in Table 5.3.

Table 5.3 Desired Selectable Answers for Success

Desired Selectable Answers	CR53	CR70	CR82
Provided needed contribution to CR assessment	75%	89%	80%
Adequate comment disposition	100%	100%	100%
Adequate assessment from review	67%	97%	100%
Understood decision	100%	92%	80%
Moderately agreed to completely agreed with decision	63%	87%	100%
CR concerns acceptably to highly effectively assessed	100%	89%	100%
Sufficiently to highly effective decision making process	78%	69%	60%

The CR results for the desired success-oriented questions ranged from a lowest value of 60% to a highest value of 100%. Evaluation of the three CR results with a 75% delineator revealed that the CRs were collectively above average for having respondents who felt they provided a needed contribution to the CR assessments, felt their comments were assessed highly effectively, and understood the resulting decisions. A majority of the CR results favored a desired success (i.e., >75%) indicating positive influences of success for the decision making process; however, there were four less desirable occurrences in comment assessment, decision agreement, and decision making process effectiveness. Respondents for CR70 and CR82 showed higher percentages of satisfaction in how their comments were assessed during team reviews and in agreement with the resulting decision than the CR53 respondents where the CR53 results were 67% and 63%, respectively. In the case of decision agreement, the CR53 respondent moderately agreed with the decision but completely understood the rationale and thereby supported the resulting decision. Despite the CR53 less desirable results for comment assessment and decision agreement, the CR53 respondents ranked the overall decision making process as sufficiently to highly effective and yielded the highest ranking amongst the three CRs. This data result seemed illogical since CR70 and CR82 had exceeded the 75% delineator in all the desired areas except this one decision making process effectiveness descriptor that yielded percentages of 69% and 60%, respectively. While the SLS CR change control process worked and decisions were made, there were, however, observed

scope, ambiguity, and resource issues that hindered the overall decision making and communication process as reflected in these recorded comments:

- If disciplines would have done a due diligence and understood the affordability tenant upfront this [DRL] would have been a better product.

- This [CR70] was a large, difficult CR to deal with because of its scope. But, given that scope, I feel the actual CR process itself worked fairly well. Cost impacts were generated which were dis-positioned at the boards. Ultimately the CR was re-scoped due to a board decision to not absorb the original costs. It would have been better to work changes in scope (such as new documents, etc.) with decision-makers earlier, instead of waiting until this CR, but considering that this did not happen the CR process itself did what it was supposed to do.

- Any changes [for CR82] were major cost impacts to the Program.

Despite the observed hindrances, the level of respondent knowledge, skill, and involvement applied to the technical evaluations, discussions, and decisions proved to be sufficiently effective as reflected in the survey results.

5.6   Summation of Main Findings

The data results across all three CRs under study revealed that all comments from the CR respondents were adequately acknowledged and assessed. The data results showed that an average greater than 80% of the CR respondents were not only actively involved in the CR deliberations concerning the technical changes including risks and consequences of those risks, but they also felt they made necessary contributions to the resulting decisions. Additionally, an average

greater than 90% of the CR respondents said that they not only fully understood both the CR decisions and the implementation plans, but they also agreed with the decisions. While the majority of the respondents felt involved in the reviews and formulation of the consensual decisions, there were less than 20% of the respondents who voiced not being involved in impact discussions or aware of the official approval of the CRs.

When the CR respondents were asked to describe the decision process, an average of 96% of the respondents across all three CRs described the decision making process as effective. Nine percent, however, observed the process as difficult and ineffective stating inefficiencies in the time allocations and the SMEs assignments to the review of CRs. With respect to communication within the decision making process, an average of 78% of the CR respondents did not experience or observe any issues in communication. Fifteen percent of the 22% who confirmed experiencing communication issues said those issues resulted in cost impacts due in large part to the inability of entities to perform cost assessments correctly or consistently for the technical changes under review. Communication proved effective in the formulation of decision recommendations to be provided to and approved by the final decision authority; however, the communication of the final decision and approved CR back down the hierarchy was less effective.

Assessment of the CR data results identified four areas of process improvement. These include the official notification of CR review and CR final approval, the definition of the CR scope and/or purpose, and the inclusion of all

reviewers in all facets of the CR process. While 67% of the respondents said they
were on the official email from the CM Release Desk, if it had not been for
informal emails and verbal requests from other parties, the CRs would not have
received adequate reviews. Similarly, the notification of the CR final approval
was inefficient because 16% of the respondents said they never received official
notification the CRs were approved. Unclear scopes and/or expectations for the
technical review within the CRs were recurring comments from the respondents.
And lastly, less than 20% of the respondents, who had no comments or non-trivial
comments such as editorials, were not involved in review meetings where impacts
were discussed.

5.7   Key Decision Drivers

The respondents ranked attributes such as design/performance, cost,
schedule and risk in priority (top, second, third, lowest or not considered).
Weights were then applied to achieve an overall score.

Attribute Rank	Weight
Top Priority	4
2nd Priority	3
3rd Priority	2
Lowest Priority	1
Not Considered	0

The overall score per weighted attribute per CR was then normalized to
find the percentage breakdown for the attributes per CR. From Figure 5.20, it
appears cost followed closely by design/performance were the decision drivers for

the FTS architecture change in CR53. Design followed closely by cost and schedule were the decision drivers for CR70's baseline update to the list of all data requirements required for the SLS Program. Finally, design and cost tied for the decision drivers for the change to the Core Stage forward skirt umbilical in CR82. Across all three CRs under study, the resulting key drivers were design/performance and cost for making the final decisions.
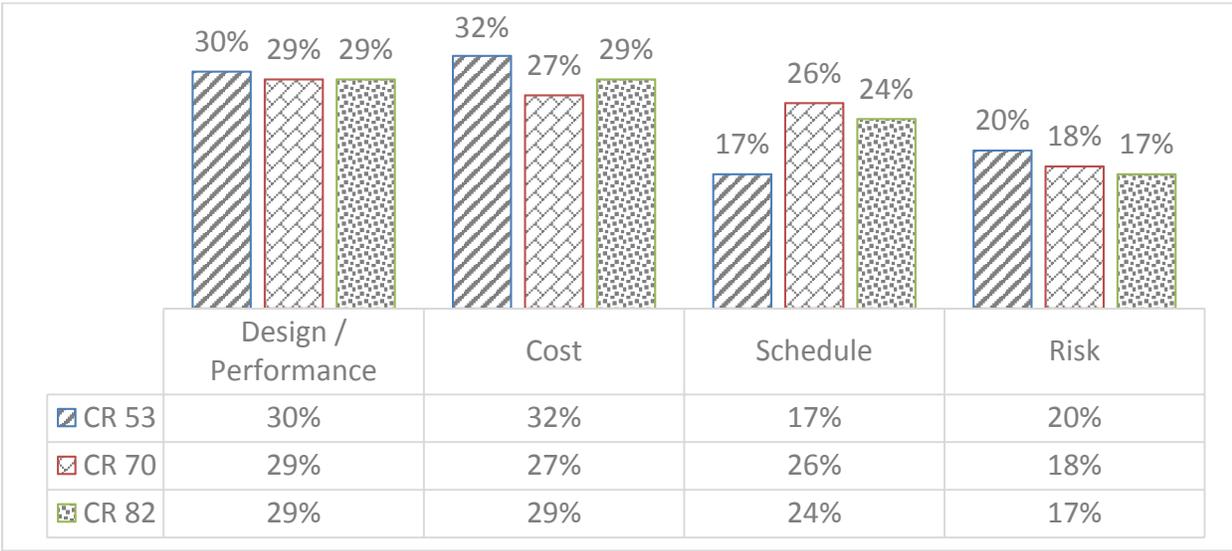
	Design / Performance	Cost	Schedule	Risk
CR 53	30%	32%	17%	20%
CR 70	29%	27%	26%	18%
CR 82	29%	29%	24%	17%

Figure 5.20 Key Driver Results for SLS CR Decisions

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

6.1   Conclusions

Evidence from the study of three decisions within the SLS CR change

control process suggested that SLS Program has consciously reviewed and

applied lessons learned from previous large-scale programs to the execution of the

SLS Program. Specific evidence findings of and recommendations for the SLS

decision making and communication processes will be discussed in this chapter.

6.1.1   Constellation Lessons Learned

Evidence suggested the SLS Program applied the lessons learned from the

Constellation Program to its decision making and communication processes. The

ESD within NASA Headquarters was accountable for ensuring that integration

was executed effectively, efficiently, and affordably across the three Cross

Programs. Specifically for the SLS Program, the program's Configuration

Management and Data Management (CM/DM) repository provided insight into

the program-level documentation that defined how the SLS Program would

implement Cross Program and internal technical integration from design,

development, design analysis, test, and certification (SLS Integration Plan, 2013)

to systems engineering and integration roles, responsibilities, and processes

specific to the integrated launch vehicle design and implementation (SLS Systems

Engineering Management Plan, 2013).

The SLS decisions under study were strategic with deliberations among a

group to reach a consensual recommendation presented forward to SLS Program

Management for final approval. The communication appeared to have been better

executed within the SLS Program than on Constellation; however, the SLS

communication process still needs improvement within the overall decision

making process.

6.1.2   SLS Decision Making Effectiveness

The SLS Program aimed to balance timely decision making at the

appropriate levels within the CR change control process. Before discussing the

SLS decision making effectiveness, evidence of how the SLS process aligned

with the plethora of research from decision theory experts such as Hickson, Dean,

Sharfman, Papadakis, Thompson, Reagan, and Shrivastava will be discussed.

6.1.2.1 SLS Decision Making Dimensions

The three dimensions of strategic decision making (i.e., procedural

rationality, politics, and complexity) were evident in the CR decision study.

Kelley & Thibaut (1969) theorized that the quality of information available to

decision makers is one of the most important determinants of successful decision

making. Evidence of procedural rationality relies upon analysis of this

information relevant to the decision in making a choice (Dean & Sharfman,

1993b). Survey results showed that all the respondents had readily available

material for review; however, the review time was an issue. The deficiency of

adequate time to review is considered by Janis (1989) to be a negative influence that can lead to decision analysis issues. Fortunately, this cognitive constraint was not dominate, per the survey results, and did not appear to have hindered the decision making process. Survey results also showed that all the respondents contributed necessary CR comments with no comments being ignored but rather all effectively assessed. Much review and discussion went into the comment dispositions and the analyses of impacts, risks, and constraints to arrive at the viable strategic decision recommendations presented to the PM for final approval of each CR.

Each of the Cross Programs (SLS, Orion, GSDO) across three NASA Centers (MSFC, JSC, KSC) comprised its own specific processes, its own groups of experts with varying motivations for involvement in the CR review, and its own idiosyncrasies factoring into decision making. Consequently, politics was introduced. An example of political imbalance of influence from the survey results was "getting to an integrated Cross-Program objective story was difficult to achieve as some entities were already out ahead in their work and any vehicle changes resulted in significant SLS cost impacts; essentially put the onus on one Program to comply with the vehicle-focused [Vehicle Stability System] VSS design." An example of political contention over objectives was "cost impacts were not fully vetted by this design solution at the time of the PCB." Another example, "the method of doing changes to the DRL should be given mandated undivided attention…suggestions of how this should work...the document owner should be knowledgeable enough to make the decisions on changes to be

made…then the document should be updated….provided…with changes highlighted…and with a meeting to go through the document in a scheduled order so commenters can attend when areas they are interested in are discussed. The Table Top method of going through the spreadsheet one comment at a time was a waste."

Evidence of complexity included a confusing or unclear scope, intricate or ambiguous data, and diverse or conflicting views, interests, and/or opinions among the decision makers. All of these complexity issues were evident in the survey results. For instance, one survey respondent cited, "a better big picture…of intent of DRL CR [70] and what problems it was solving" would have aided understanding. Another cited, "[CR 82] was an urgent CR whose intent was not well communicated…couldn't figure out the thrust of the change via the email notification alone." There were also examples of intricate or ambiguous data cited. For instance, "we were plowing new ground with what it meant to execute a hard T-0 design…with that design…still in work after all these months." Other respondents cited examples from "several significant cost impacts had to be worked out through the board process" to "CR [70] had to be delayed multiple times due to its size and complexity…it was released…and then re-released…as R1…there was some question as to what was retained in the comments from R0 review to R1" to "the amount of time needed to work through the [CR 70] Rev D impacts took valuable time that would have otherwise been used on other tasks." Lastly, survey examples of complexity stemming from diverse or conflicting views and/or opinions were "unclear cost impacts from

some parties in the days leading up to the boards…resulted in "piling on" at the board meetings" to "the SLS Task Team review is…confusing to most outside organizations…[understanding] who participates, how are they chosen, how are they notified."

Analysis of the evidence showed all three dimensions of strategic decision making present in the assessments of the three SLS CRs. Politics and complexity were evident in the multi-disciplined grouping of personnel with diverse skills, mental models, and motivations evaluating each CR's intricate and sometimes unclear data. Application of decision tools fostered the rational processing to reach consensual decisions.

6.1.2.2 SLS Decision Making Model

Evidence suggested that the SLS Program decision making process tracked to a hybrid managerial autocracy and adaptive planning decision making model. From the managerial autocracy model perspective, a large amount of power and authority rested with the single key manager (i.e., SLS PM) who made all SLS strategic decisions himself with technical assistance from several subordinates (Shrivastava, 1983); however, the SLS PM did not bias the style and preferences for reaching the decision or stifle the use of system tools, procedures, and/or experience of the SLS organization in providing the necessary technical assistance. From the adaptive planning model perspective, plans were viewed as guidelines that were modified depending on the current analysis of issues. Specific to the CRs, each one differed in technicality. One CR was software related, another hardware related, and another pertained to documentation.

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Qualified SLS discipline experts systematically evaluated the technical merits of each proposed change in an effort to achieve efficient and adaptable solutions to the problem each CR presented (Shrivastava, 1983). Evidence suggested that the SLS CR change control processing "involved systematic participation by relevant members who could handle the technical complexity, evaluating risks and environmental constraints, and effectively communicate information in which to achieve viable strategic decisions and implementation plans that yielded solutions to problems" (Shrivastava, 1983). Each CR reached final approval by the SLS PM implying the SLS PM agreed with the decision recommendations provided by the technical disciplines. Based on this analysis, the SLS Program decision making process appeared to pattern a hybrid managerial autocracy and adaptive planning decision making model.

6.1.2.3 SLS Decision Making Strategy

Evidence suggested that the decisions under study were traceable to a judgment decision strategy employing the tractable-fluid decision making mode. The survey results showed that the right disciplines were identified and included at the appropriate levels/phases of the process. One respondent cited, "additional expertise is always needed, but that need has to be balanced with the cost of managing excessive input…the balance achieved for this revision was reasonable." Another cited, "while the review period for this CR was sufficient for one CR of this magnitude, this CR was not the only one under review...that is the price of a tight schedule…multiple changes being reviewed simultaneously by the same experts…do the best we can…request extensions when…cannot

accomplish an appropriate review…there's never enough time to do it all."

Results also showed that all of the comments received were acknowledged with the vast majority of the comments adequately dis-positioned. The survey results reflected a couple of exceptions: "One of my comments was rejected due to the elimination of DRD [Data Requirements Description] without my knowledge." and "Cost swept under the rug, just as...for other changes…Level II requirements drove cost that the Elements had to find a way to make happen with no additional money." Similar results were evident for the process effectiveness in that the majority of the survey respondents thought the overall process was effective with a couple of exceptions. Respondents perceiving the process as difficult, very frustrating, and ineffective cited, "[It is] hard to present an objective story because of out of synch schedules…design changes were major cost impacts." and "…the magnitude of change and the importance of the document created an environment where there was frustration at many levels…perseverance of the professionals…working the product was the only reason the CR [70] made it through the process." The vast majority understood and agreed with the resulting decisions. One respondent who did not agree with the resulting decision cited, "While the option selected had some benefits…the other option was less complex, no interfaces to deal with, and reduced the mass." This respondent did not agree with the decision but understood the rationale in which to support the decision made. Evidence further revealed a medium-to-high level of complexity and politics across the three CRs. One respondent cited communication issues stemming from "cost impacts not fully vetted within the CR review." Complexity

of the large, complicated CR [70] made communication a struggle resulting in cost, schedule and workload impacts. A corresponding survey comment cited, "A large, difficult CR to deal with because of its scope…people are overloaded, schedule is tough, decisions are hard, and everyone's not going to be happy in the end…but…given that scope…the actual CR process itself worked fairly well." Also political comments reflecting an imbalance of influence and contention over objectives made the politics within the decision making process high. Consequently, analysis of the evidence suggested the common decision making strategy for the three CRs approximates to the tractable-fluid decision mode where the CR reviewers collaborated and scrutinized the details to reach understanding and negotiated the resulting decisions (i.e., a judgment strategy).

6.1.2.4 SLS Decision Making Effectiveness

Evidence suggested that the decision making within the CR change control process worked well from five perspectives: participatory identification, review notification, reviewer involvement, input assessment, and decision formulation. Survey evidence revealed the appropriate competencies were indeed identified as necessary participants in the CR reviews, and those individuals felt they were adequately notified of the reviews and in turn provided essential [or valuable] inputs to the CR reviews, impact discussions, and the decision recommendations that were presented to the final decision authority. Survey results further revealed that all received comments were effectively assessed, that all of the participating individuals understood the resulting CR decisions with the majority of them

(>80%) agreeing with the decisions, and lastly that they considered the overall decision making process to be effective and efficient.

While each CR completed its approval process differently, evidence suggested that the SLS decision making process was less process dependent than typical systems engineers might expect. The variation in CR approval process appeared to have not impacted the overall decision making process and success of each CR; instead, the tailored approach, as opposed to a standard process rigor, was appropriate for each CR. As long as the process matched the needs of the decision makers and an effort was made to get all needed individuals involved, different processes appear to be used effectively.

Evidence from the CR study suggested the SLS Program was sufficiently effective at making strategic decisions via a comprehensive decision making process. As a guideline, a decision making process matters; however, a process that is adaptable to a project's needs (i.e., size, complexity, risk posture) is ideal. Of all the survey responses, only one commenter disagreed with this premise citing, "the process did not help, the work got done in spite of the process." The NASA Systems Engineering Handbook (2007) specifies an evaluation be made to determine the magnitude of the change required, and then the process be tailored to address the issues appropriately. This approach promoted effectiveness to the process as opposed to brainlessly following a process just to follow a process. However, with any leniencies provided in a process, attention to thorough review, communication, and execution of the negotiated, tailored process must always be consciously exercised.

Evidence showed a variation in formality within the SLS decision making process. The initial contact with all the stakeholders was generally formal with a 10% to 17% amount of informality. More informality was evident in the notification and communication at the Table Top / Task Team review level where informality ranged between 17% and 32%. It seemed more appropriate for this review level to be less formal. One observation was that the communication of notification at this review level appeared to be less inclusive (depending on the comments). For instance, if reviewers had no comments or had minor comments such as editorials, then the reviewers were not always part of the discussions on comment dispositions. This raised a flag indicating a potential communication issue since approximately 25% were not involved in discussions of any impacts stemming from the dis-positioned comments from the CR reviews. Some respondents with no comments would not be included in the discussion, therefore, missing a decision and/or impact discussions leading to the formulation of a decision.

The overall process differed for each CR. One difference was in the array of individuals with varying levels of knowledge, skills, interests, and workload tasks assigned as reviewers. Secondly, the CR subject matter, data products, control boards (i.e., CECB, PCB, JICB), and review periods varied amongst the CRs due to project time constraints and other dependencies. Lastly, the process differed with the institution of the new Task Team review concept for one CR under study. In each case, the same decision making process was referenced for

technical guidance but tailored to the specific CR need and decision maker expertise.

Evidence showed that the same resources were expended for the three CRs under study. A respondent shared, "Each organization tries to place those with the most expertise on the CRs." Additionally, most of the survey comments suggested that lack of resources such as time and budget were the reason additional expertise would have helped in the CR reviews. One respondent commented that "there were always too many CRs in the system with too little time to complete as one would like". Other comments such as: "SMEs are…overburdened with CR reviews", "multiple changes…reviewed simultaneously by the same experts", and "never enough time to do it all" served as a result of the overwhelming workload of many CRs in general, not due to a specific CR.

Evidence showed cost and design/performance strongly influenced the decisions. Those involved in the CR processing felt their contribution was value added to the decision making and approval of the technical change. The survey results revealed no more than 25% had no need to contribute. It appeared the SLS Program would rather commit a type II error (i.e., asking a few more people to comment who do not have a comment to make) than a type I error (i.e., that is failing to ask someone who might have an appropriate comment).

All comments received during the CR reviews were deemed acceptably dis-positioned. Most CR participants completely or moderately agreed with the resulting decisions. In the case of CR53 there was one person who, while

understanding the rationale for the decisions, thought there was a better alternative that was less complex, cheaper in the long run to operate, and was afraid the decision made was a short term and not the best long term decision. No one disagreed completely.

The Reagan and Rohrbaugh (1990) study was referenced for the evaluation of the decision making process and the resultant decisions from the process to determine whether the SLS decision making process was goal-centered, adaptable, participatory, and data-based. The SLS decision making process was adaptable and participatory; however, the process was not consistently goal-centered or data-based across the CRs under study. When reviewers did not know or understand the scope or intent of CR in review, then the process was not adequately goal-centered. Similarly, when the magnitude of the change was too much to process within a defined time constraint, then the process was not adequately data-based. Were the resulting decisions efficient, legitimate, supportable, and accountable? Evidence showed that no one completely disagreed with the resulting decisions; therefore, the decisions were considered efficient, legitimate, supportable, and accountable since procedural rationality was applied to logically produce a necessary effect for each CR change.

6.1.3 SLS Communication Effectiveness

Hackman (1990) theorized that three "enabling conditions" (i.e., sufficient group effort, adequate knowledge and skills possessed by group members, and appropriate performance in decision making strategies) exert positive influence on

group performance through the mediation of communication and interactions. Eikenberry (2005) theorized that individuals communicate the right information at the right time in the right way to make an effective decision. Habermas (1998) theorized that communication between people must be fulfilled to coordinate actions effectively for the purpose of satisfying needs and employing an effective decision making process. The question was, did the SLS disciplines meet these communication guidelines for effective decision making? Evidence suggested the CR reviews and resulting decisions appear to be well-vetted, understood by all, and agreed to by the majority of the CR reviewers. The decisions seemed to also be well-communicated to the Program Manager for approval; however, the dissemination of the CR approvals were not so well-communicated to the stakeholders and/or organizations. It was a disturbing result that 16% never officially received notification of the approved CRs. The decision making process needs improvement for proper dissemination of decisions.

Table Top and Task Team reviews were the mode of communication for the CR processing. These reviews were face to face meetings with audio (i.e., teleconference) interactions. Per McGrath (1984), this hybrid mode is less restrictive on communication and provides increased opportunity to exchange and utilize information in arriving at solutions / decisions. Jarboe (1996) theorized that group involvement in decision making increases the amount of information available to the group, increases commitment to the decision, improves dissemination of that decision, and increases the quality thought throughout the process. While evidence suggested the decision making process to be effective,

the communication was not a total positive influence in the process. Evidence

revealed 16% of the survey respondents never officially learned of the approved

CR decisions, indicating a communication gap within the process.

Communication within the decision formulation and determination appeared

adequate with the dissemination of the resulting decision lacking. This result

aligned with Eikenberry (2005) who theorized the widest gap in decision making

to be in communicating decisions.

The Constellation Program comprised a 10-Center team. Communication

was a documented challenge for that program. The SLS Program spans a smaller

grouping of integration efforts across 3-Centers; however, with respect to the CR

processing and decision making, communication exhibited challenges to the

Program. Evidence suggested that the decision making process was inefficient in

resource (i.e., time and workload) allocations and in communicating decisions.

6.2   Recommendations

The overall assessment of decision-making and communication as

evidenced by analysis of these 3 CRs was positive. The SLS Program has

improved and incorporated lessons learned from recent past programs. There are,

however, a few recommendations to be made which would further strengthen a

successful decision-making and communication process.

There is a need to include all involved parties in the discussion of the

comments. The mere fact that an individual did not have a comment was reason to

exclude the individual from the comment discussion. On the surface this seems

appropriate; however, there were respondents who mentioned that changes were

made to a CR during discussion of a comment which were not known to those not included in the discussion. Involving all parties requires additional resources up front but may solve issues in the long term.

The effectiveness of the decision process was hindered by the difference between NASA's schedule and external entities' schedules. A decision making approach that has NASA schedules more in synch its counterparts' schedules would facilitate needed changes and quick responses.

There were multiple comments about the workload within and across CRs. The time and resources to review, understand, and completely assess all the CRs was extremely limited. It was clear the SMEs felt the pressure to respond quickly and thoroughly but acknowledged that this had the risk of overlooking a problem or implementing a conservative answer and/or comment. Faster is not always better.

Approximately 20% of the respondents never officially learned of the approved CR decisions. Inefficient communication resulted in cost and schedule impacts. Based on the communication issues, an establishment of a culmination meeting at the end of the CR decision process to close the communication loop would be beneficial.

There were concerns about individuals' understanding, skill, and timing of life cycle cost assessments. There is a need to train Cross Program personnel on how and when to perform cost and schedule impact assessments within a review.

6.3   Thesis Research Contribution

The culmination of this thesis research will contribute to the body of knowledge by providing a better understanding of the decision making process within the Systems Engineering discipline. Formal Systems Engineering processes are documented, but the informal implementation of Systems Engineering are not fully understood. While this thesis focused on the formal and informal interactions and practices employed by the NASA Marshall Center to investigate, collaborate, and negotiate viable strategic decisions within the SLS Program, the knowledge and implementation of decision making and communications captured within the thesis can be effectively applied to Systems Engineering practices within any type of organization (i.e., government, cooperate, academia, etc.).

APPENDIX A

SURVEY ADMINISTRATION

Subject: Decision Analysis Survey

On behalf of Garry Lyles, your completion of the Decision Analysis Survey below is greatly appreciated.

The University of Alabama in Huntsville is following 3 different Change Requests to understand SLS decision making processes. One way to gather information to aide this effort is by studying how each of these 3 CRs was introduced, discussed, approved and then communicated. We would like to survey those involved in each of these CRs to better understand the discussion patterns, the approval process and the resulting decision, and communication of that decision. This is not a critique of the decision making process, but a study to determine key drivers in decision making. We are trying to identify aspects that strongly influenced the decisions made and those aspects which are more flexible. The survey should take between 4 and 7 minutes to complete.

It has been placed on Survey Gizmo to protect anonymity. No names will be used in the reporting of the data or conclusions. Please take a few minutes to complete the survey at the link below for CR00070 or forward to your delegate for this CR as appropriate.

For Questions please contact: Karen Hicks at kch0039@uah.edu or Dawn Utley at utleyd@uah.edu.

The survey can be found at the following link:
http://www.surveygizmo.com/s3/1349312/SYSTEMS-ENGINEERING-PROCESSES-SURVEY-SLS-DECISION-PROCESS-FOR-CR-SLS-00070

Some of you may receive more than one survey based in your participation in the review of the CRs selected for the survey. If so, please fill out a separate survey for each CR in which you were involved.

SURVEY INSTRUMENT

	Change Request (CR) SLS-00XX Review				
1	Who (person or group) generated the CR?				
2	How were you notified of this CR for assessment? (Check one.)	☐ Direct email to review	☐ Email from DLE / EDLE to review	☐ Verbal from DLE / EDLE to review	☐ Other
3	If 'Other' checked above, please elaborate.				
4	What was your motivation in reviewing this CR?				
5	Do you believe you provided a needed contribution to the CR assessment? (Check one.)	☐ No. I did not need to contribute to this CR and had no comments.		☐ Yes	
6	Would the assessment have benefited from additional expertise or input? (Check one.)	☐ No		☐ Yes	
7	If 'Yes' above, what expertise would have improved the CR assessment?				
8	Do you feel you had adequate time and/or readily available CR related materials to perform an assessment of this CR? (Check one.)	☐ No		☐ Yes	
9	If 'No' above, what hindered your review?				
10	If your answer to Question 5 was 'No', then skip to Question 11; otherwise, how do you feel your comments were received and dispositioned? (Check one.)	☐ Well. Lots of discussion to make my comments understood	☐ Fair. Minimal communication (mainly via email)	☐ Poor. My comments were ignored or dismissed	
11	Were you involved in the discussion of any impacts stemming from the dispositioned comments from the review of the CR? (Check one.)	☐ No, not at all	☐ Yes, informally (i.e., through DLE, EDLE, LSE, CE, etc.)	☐ Yes, formally via direct Table Top / Task Team / Control Board Review(s)	
12	If 'No', please explain. Then skip to Question 17.				
13	If 'Yes' in Question 11, how were you notified of the Tabletop or Task Team Review for this CR? (Check one.)	☐ Direct email to review	☐ Email from DLE / EDLE to review	☐ Verbal from DLE / EDLE to review	☐ Other
14	If 'Other' checked above, please provide info.				
15	Do you think your comments were assessed adequately in the Tabletop or Task Team Review process? (Check one.)	☐ No		☐ Yes	
16	If 'No' above, please explain.				
17	When did the decision / approval of the CR officially get to you (approximate mm, yy) or NEVER?				

18	Did you fully understand the CR decision and its implementation plan? (Check one.)	☐ No		☐ Yes	
19	If 'No' above, what would have aided your understanding?				

20	To what degree did you agree with the decision? (Check one and provide any comments.)					
	☐ Not at all (0%)	☐ Disagreed but understood rationale (30%)	☐ Ambivalent and workable (50%)	☐ Moderately agree (80%)	☐ Completely agree (100%)	Comments?

21	In your opinion how were the following attributes used in making the final decision of this CR? Rank the attributes. (where 0=Not Considered, 1=Top Priority, 2=Second Priority, etc in a pull-down menu).				
	Click to select a rank Design/Performance	Click to select a rank Cost	Click to select a rank Schedule	Click to select a rank Risk	Click to select a rank Other: _____

Communication

22	Were there any gaps in communication during the CR review? (Check one.)	☐ No	☐ Yes, minor	☐ Yes, major
23	If 'Yes', what were they?			
24	Were there cost or schedule impacts due to communication glitches during the CR review? (Check one.)	☐ No	☐ Yes, minor	☐ Yes, major
25	If 'Yes', what were they?			

Overall Assessment of the CR Decision-Making Process

26	From your perspective, were your concerns with this CR dealt with effectively? (Check one and provide any comments.)					
	☐ No, not at all	☐ Somewhat but not adequately	☐ Acceptable	☐ Moderately effective	☐ Highly effective	Comments?

27	From your perspective, how would you describe the decision process with respect to this CR? (Check one and provide any comments.)					
	☐ Very difficult and/or frustrating and not effective	☐ Difficult and somewhat effective	☐ Effective but inefficient	☐ Sufficiently effective and somewhat inefficient	☐ Highly effective and very efficient	Comments?

28	If you have anything you would like to share about this CR review, please do so here.	

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