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ORGANIZATIONAL ASSESSMENT OF A FUTURE SURFACE FORCE DEVELOPMENT SQUADRON (SURFDEVRO

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THESIS

ORGANIZATIONAL ASSESSMENT OF A FUTURE SURFACE FORCE DEVELOPMENT SQUADRON (SURFDEVRON)

by

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To address an increasingly competitive security environment, the U.S. Navy surface force needs new or improved capabilities to attack, deceive, and defend against adversary ships, aircraft, missiles, submarines, and cyber and electronic attacks; and, it needs more agile acquisition practices that enable a rapid and iterative approach to improving performance. To deliver these capabilities, the Navy is exploring a SURFDEVRON (surface development squadron), similar in spirit to the submarine and aviation communities. This will serve as an interface between the research community (e.g., ONR, DARPA), other Navy warfare development commands (e.g., SMWDC), and the fleet; coordinate the at-sea testing of advanced technologies and their associated tactics, techniques, and procedures (TTP); and accelerate the integration of new technologies into the surface force. There are many options that exist that can facilitate the creation of a SURFDEVRON. This thesis explores some of those options and provides options that can be further explored in follow-up thesis projects.

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ORGANIZATIONAL ASSESSMENT OF A FUTURE SURFACE FORCE DEVELOPMENT SQUADRON (SURFDEVRON)

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ABSTRACT

To address an increasingly competitive security environment, the U.S. Navy surface force needs new or improved capabilities to attack, deceive, and defend against adversary ships, aircraft, missiles, submarines, and cyber and electronic attacks; and, it needs more agile acquisition practices that enable a rapid and iterative approach to improving performance. To deliver these capabilities, the Navy is exploring a SURFDEVRON (surface development squadron), similar in spirit to the submarine and aviation communities. This will serve as an interface between the research community (e.g., ONR, DARPA), other Navy warfare development commands (e.g., SMWDC), and the fleet; coordinate the at-sea testing of advanced technologies and their associated tactics, techniques, and procedures (TTP); and accelerate the integration of new technologies into the surface force. There are many options that exist that can facilitate the creation of a SURFDEVRON. This thesis explores some of those options and provides options that can be further explored in follow-up thesis projects.

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LIST OF ACRONYMS AND ABBREVIATIONS

CNO	Chief of Naval Operations
CO	Commanding Officer
COMOPTEVFOR	Commander Operational Test and Evaluation Force
DoD	Department of Defense
ISIC	Immediate superior in command
LCS	Littoral Combat Ship
LNO	Liaison Officer
MDUSV	Medium Unmanned Surface Vessel
O&M	Operations & maintenance
OPM	United States Office of Personnel Management
RDT&E	Research development testing & evaluation
SWDG	Surface Warfare Development Group
SMWDC	Surface Mine Warfare Development Center
SUBDEVRON	Submarine Development Squadron
SURFDEVRON	Surface Forces Development Squadron
TOC	Total Ownership Cost
TTP	Tactic, Technique and Procedure
UAS	Unmanned Aerial System
UWDC	Undersea Warfighting Development Center
VX-23	Air Test and Evaluation Squadron 23
ZRON	Zumwalt Squadron One

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I. INTRODUCTION

A. BACKGROUND

The U.S. Navy's Surface Development Squadron (SURFDEVRON) concept has been discussed by the Surface Warfare community more openly and is starting to see significant movement in the Navy's attempt to facilitate a more streamlined testing and acquisition process. Currently at the 4-Star decision level, it is being proposed that ZUMWALT Squadron ONE (ZRON) be transitioned into SURFDEVRON. The idea is that the ZUMWALTs, as well as the first four Littoral Combat Ships (LCS) and the SEAHUNTERs, are all still considered developmental platforms. The development command concept is a proven organizational strategy that adds flexibility in transitioning and integrating new platforms and varied systems into the fleet.

A previous thesis project made a case for the SURFDEVRON concept by highlighting several of the obstacles that the Research Development Testing and Evaluation (RDT&E) phase run into ultimately that slow down the acquisition process. (Boddiford & Byrd, 2018). While there are examples of steps being taken to attempt and speed up certain aspects of the acquisition process, while maintaining discipline, there do not appear to be supporting procedures for temporary systems for vessels afloat that are supporting the experimental process. The SURFDEVRON command structure and strategy will help bridge the gap between researchers, program managers and the force at sea.

The Chief of Naval Operations (CNO) has set the Navy on an aggressive ship and capability delivery timeline. In order to meet the anticipated needed pace to meet this demand, experimentation and warfare development organization and procedures should be reevaluated to ensure speedy, yet disciplined, material and technical solutions can be fostered and delivered. The SURFDEVRON concept is a step towards facilitating a structured, swift, disciplined approach. There remains, however, uncertainty regarding the resource requirements for establishing a successful development environment that is able to perform its mission in a sustainable and effective manner. This issue is complicated by the variety of options for scaling the level of development activities that the proposed

SURFDEVFRON would undertake. This thesis will present a cost estimation of the resource requirements for various proposed postures for the SURFDEVRON.

The cost of a SURFDEVRON staff will be examined, as well how best the organization can be structured. This thesis will describe proposed processes for the development activities that will be conducted within the development environment. The process map is then used to identify resource requirements and develop cost projections. Identifying an efficient process while maintaining relevant oversight will be important to determine what benefits this concept will have over the established way of conducting business. As the United States moves further into a period of major power competition, the United States Navy's innovation demands extensive cultural change in how the service conducts business (Murray, 1996).

B. PURPOSE OF RESEARCH

The demand for a development environment that serves the Surface Warfare community requires careful study and analysis. What is being discussed is how best to accomplish the missions, functions and tasks that SURFDEVRON will be assigned. SURFDEVRON has the potential to be the conduit between industry, researchers, training commands, other warfare development centers, as well as the rest of the fleet. It is important to analyze and simulate what configuration will be best suited for these tasks. When identifying what structure this organization will take, it may not be enough to emulate the structure of a traditional destroyer squadron staff structure; SURFDEVRON while still an operational squadron, has the additional mission of facilitating fleet experimentation.

The purpose of this research is to identify the personnel requirements associated with the activities conducted within a surface fleet development environment. There are a number of possible configurations to be considered. A platform for outside program developers to conduct their development activities. Provide other measurement and data collection/storage support for customers of the development environment. Data hosting to maintain a long-term memory of the various development activities conducted on the ship. As these are considered, the associated costs can also be examined with those respective configurations. With the SURFDEVRON being a new concept within the Surface Warfare community, there will be scrutiny and careful budgetary consideration; this thesis will explore ways to help mitigate those potential risks. This thesis will make use of a total ownership cost model to present a simulation of total ownership costs that decision-makers can make use of when considering future actions. The other purpose of this research is to try and identify an outline of how the development activities would work. In a concept of operations, data collection, proof of concept, etc., it is helpful to lay out possible frameworks that could facilitate an effective and efficient experimentation environment that will have a profound impact on the acquisition process.

C. METHOD

This thesis will first review the history within the naval community in operating a similar development environment within the Trident Warrior program. Although the current scale of the Trident Warrior program is much larger than the near-term proposed activities for the SURFDEVRON, there is some overlap that can be analyzed to inform SURFDEVRON resource requirements. A literature review of complex contracts, products and uncertainty will present where possible fiscal obstacles may result in waste or cancellation. Reviewing the Trident Warrior tasks will provide insight on what administrative authorities would be helpful to SURFDEVRON to assist the development process.

A total ownership cost model will also be used to conduct a simulation of costs associated with the SURFDEVRON organization structure. Using payroll data for both active duty military and civilian DoD employees, ownership costs can be calculated for standing up the SURFDEVRON, as well as examining what life-cycle costs can look like. What the total ownership cost model provides is a look at acquisition costs, operational costs, maintenance costs, and replacements costs in order to calculate total annual operation and maintenance (O&M) costs. Taking the annual O&M costs, along with the nonrecurring acquisition and end of life-cycle costs allows the model to simulate total ownership costs given s specified life cycle. This model will be used to simulate organizational costs in this thesis; however, the applications for this model can extend to simulating costs for other projects within the developmental process.

D. SCOPE AND LIMITATIONS OF RESEARCH

Pay-chart data that will be used to help represent the cost of operating a development platform similar to the SURFDEVRON concept; there are too many specific cases for this thesis to account for all instances. Likewise, there are a vast number of ways that a squadron can be organized. This thesis will only explore a few configurations that may be more likely and recommend other configurations for possible future study. The focus of this thesis will be SURFDEVRON's organizational structure and interaction with the experimentation process and then its impact on the acquisition process. There are a number of experiments that can be conducted on a smaller scale and this thesis will recognize that smaller tests can be conducted within entities outside of the SURFDEVRON sphere of influence. SURFDEVRON will likely be engaged in more complex experimentation processes that will require particular conditions that only a SURFDEVRON platform can facilitate. This thesis will only be examining what the SURFDEVRON will support, and not necessarily what the rest of the surface fleet can support at large.

A significant factor limiting this thesis is that SURFDEVRON is still an evolving concept. While some missions, functions and tasks are being considered, it is entirely possible that, once SURFDEVRON is stood up and has started executing missions, those missions, functions and tasks may have changed or other tasks have been added. Similarly, the physical make-up of the squadron may change. A number of ships have already been considered to be a part of the squadron. This inherently lends a number of capabilities, limitations and requirements on the squadron staff. This configuration of ships can see significant changes in the future. This thesis will assume a specific configuration of ships for the consideration of organizational structure within the squadron. The configuration of the ships within the squadron should not affect the total ownership cost of the squadron staff with any significance in the model. This thesis's focus will be the organizational structure of the SURFDEVRON staff and not necessarily the ships within, although there will need to be some discussion regarding what ships are involved and what ships could or should be involved. Ultimately, there are a near infinite number of variables when considering the creation of SURFDEVRON. This thesis will attempt to capture the critical variables.

E. ORGANIZATION OF REPORT

This research is divided into the following chapters:

- Chapter I introduces the background surrounding the topic.
- Chapter II will review literature and research regarding the fleet experimentations process and the Navy acquisition process.
- Chapter III will present data gathered from our simulation.
- Chapter IV will discuss the various structures that SURFDEVRON can take and analyze the benefits and limitations of each and how they will affect the acquisition process.
- Chapter V will summarize findings and provide recommendations for future research in support of developing a SURFDEVRON.

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II. LITERATURE REVIEW

Before proceeding to identify specific organizational structures and determining appropriate authorization authorities, a review of past experimentations efforts such as Trident Warrior, a review of the risks of complex contracting, and examining other development and testing entities organizational structure will all establish a frame of reference to draw from when considering how SURFDEVRON can be structured.

A. TRIDENT WARRIOR

Before the question is asked, "Who should be on the SURFDEVRON staff," and "what positions should be included?" it would be important to first ask, "What are the required capabilities of a naval development environment?" Trident Warrior is an excellent case study for us to examine when exploring what kinds of experiments can conducted within the confines of a SURFDEVRON. Trident Warrior is an annual exercise, usually held in conjunction with another Navy exercise that brings scientists, engineers, and researchers to the fleet to conduct at-sea experimentation. The goal of Trident Warrior is to experiment and demonstrate warfighting systems in a near-realistic environment (Altbaum 2005).

Trident Warrior helps shed light on the various types of experimentation that exist: concept of operations, technology, technical, and network are some examples. Concept of operations is a set of experiments prepared and executed with the intent of trying to demonstrate smaller broken-up concepts of the larger effect, before putting it all together, or demonstrating a capability in a controlled and unrealistic environment to ensure the process executes as desired. Technology experimentation is the development of new physical capabilities as a sum of more technical theories that contribute to a new tactic, capability or procedure. Network experimentation involves putting a new element into an existing network to test compatibility (Altbaum 2005).

Trident Warrior also expresses the importance of understanding the purposes of the experiment and not getting lost with add-on objectives. It is important for leaders to understand and reflect on the intent of the experimentation. What is the expected value to the major line of effort? Are technical integration requirements met? Ultimately, what is the military utility of the experiment being conducted? These questions and more are relevant when leaders are evaluating how to distribute their limited resources in planning and executing the experimentation process.

There are different types of costs involved in an endeavor such as the Trident Warrior: cost of labor and cost of experimentation. SURFDEVRON can expect to incur costs directly supporting the experimentation process. How those costs are incurred and classified are important given the type of funding that the squadron will receive. SURFDEVRON will be considered an operational squadron, and it stands to reason that a large portion of its costs will be operational and maintenance related; this falls into the O&M category of DoD funds. O&M funds will be used specifically to address the needs of the ships, but will not be used to fund research and development costs that are traditionally met with R&D funding. What the experiences with Trident Warrior can lend to in the SURFDEVRON concept, is that the classification of expenses will need to be carefully accounted for to ensure the proper auditing of funds can take place and the command can be successfully held accountable to what it has been allocated and authorized to spend.

Time is also a major factor in the experimentation process. Trident Warrior's planning process accounted for nearly two years of planning. It would take two years to coordinate and arrange for execution of the exercise so that it could be conducted at sea or in the desired environment that the experimentation called for. The nature of experimentation as it stands now is very opportunistic and relies heavily on what the fleet can support given its already taxed ship operational schedule. An entity such as a SURFDEVRON can absolutely cut that time down by multiple factors, greatly accelerating the experimentation process while still maintaining a disciplined screening process (Altbaum 2005).

B. COMPLEX CONTRACTING

The operation of a development environment may require efforts to mitigate the risks associated with complex contracting. Complex contracting is when there is uncertainty about the product in the exchange, or when complex products are involved. "Unlike simple products, the cost, quality, and quantity parameters of complex products cannot be easily defined or verified, leaving buyers and sellers unable to clearly and completely define exchange terms" (Bajari and Tadelis 2001). It is likely that SURFDEVRON will be dealing a lot in contracts that are with parties still testing and evaluating a product. This makes it difficult to value a contract.

With experimentation and testing there is a factor of uncertainty that will always be present. Ideally before SURFDEVRON is approached for participation in the experimentation process, there will already be a significant portion of research and development completed by the originating entity, to mitigate uncertainty. The other primary means of reducing uncertainty in a product would be producing the product and taking advantage of learning curves. That appears to be impractical for this concept, as SURFDEVRON is meant to help facilitate the experimentation process of the acquisition process (Brown and Van Slyke 2009).

Due to ship schedules the experimentation process at sea is forced to be opportunistic and affords limited opportunities to test products before the Navy decides it wants to enter into a contract regarding said item. This leads to a scenario within complex contracting where the navy buys into a product or capability while there is still a significant degree of uncertainty and finds itself locked-in to a contract that may not be as beneficial to the Navy. SURFDEVRON can minimize losses due to the lock-in problem by being the premier experimentation/demonstration facilitation entity for the surface Navy. This scenario still leads to behavior that can be classified as a win-win for both the Navy and the manufacturer. The Navy gets to test and evaluate a potential product, helping influence development of a higher quality product, and the contractor still secures the contract with the Navy for potentially greater gains (Brown and Van Slyke 2009).

Contract timing can also be influenced by the proper implementation of a SURFDEVRON. History is rife with examples of contracts that were intended for a specific amount of time, only to be extended and have associated costs multiplied several times over what was agreed upon initially. As mentioned, the Navy's current experimentation process is limited at sea. Having a dedicated squadron facilitate experimentation, demonstration, and rapid feedback will certainly provide benefits in the form of contracts that are more accurately executed. While SURFDEVRON, by its intended function, helps the contracting process's timeliness, it may wish to consider the need to have procurement and contract management professionals in managerial positions of the squadron. SURFDEVRON will be involved in contracts that could be considered complex, and having contracting specialists available to the staff will help mitigate the risks due to such contracts (Brown and Kim 2012).

An additional source of contract complexity may arise from the variation in the scope of service that the SURFDEVRON would provide to its potential customers. The scope of activities may include simple acting as a platform for development equipment, providing human subjects for developmental procedures and practices, and other maintenance and data collection activities in support of the development work. As the scope of activities increases, the design of the contract agreement may become more complex and it may require additional contract language to ensure compliance with law and ethical standards (Brien and Hine 2015). Ensuring the execution of the development mission is in compliance with fiscal law, human subjects regulations and other ethical standards would require additional monitoring activities and structures within contract agreements.

C. SIMILAR ORGANIZATIONS

Before stepping up to the drawing board and throwing an organizational chart together, it would be beneficial to review what other communities have had success with. Specifically, within the naval aviation community and the submarine warfare community there exists developmental squadrons whose mission is to facilitate experimentation and to develop tactics techniques and procedures. Looking at VX-23 and SUBDEVRON's structure helps establish what those communities find to work and try to see if any of those lessons can be carried over into the development of a SURFDEVRON.

The mission of VX-23 "is to support the RDT&E of fixed-wing tactical aircraft by providing aircraft and pilot assets, maintenance services, safety oversight, and facility support for these efforts" (Hammerer J. 2017). From the mission statement there are already parallels in that can be draw to what a SURFDEVRON aims to do. “AIRTEVRONs collaborate with Program Offices and the Commander Operational Test and Evaluation Force (COMOPTEVFOR) to conduct developmental and operational testing of new aircraft capabilities” (Hammerer J. 2017). The manning and aircraft consists of:

- ~45 officers (Navy, Marine Corps and foreign nationals)
- 90 enlisted (Navy and Marine Corps)
- 45 civil service
- 965 contractor employees directly involved with aircraft maintenance
- 44 aircraft

It would be a mistake to think that a SURFDEVRON should attempt to employ such a large number of contractors, but it bears keeping in mind that the nature of the surface warfare community and the naval aviation community shape what is possible or even economically feasible. A SURFDEVRON consisting of DDGs, LCSs, MDUSVs will all have their own ships company, which would mean that there would be no need to employ such a large contractor force for the purpose of ship operation. What is worth noting is the relationship between the squadron and the program offices, as well as COMOPTEVFOR. Such a relationship should be mirrored within the SURFDEVRON structure and entities such as SWDG and SMWDC.

SUBDEVRON appears to provide a more realistic picture of what SURFDEVRON could look like on paper. SUBDEVRON has “a small number of dedicated ships and crews that are well experienced in areas of tactical development. Its association with the Undersea Warfighting Development Center (UWDC) for the purpose of developing tactics leverages the resources of a much larger and more capable organization” (Hammerer J. 2017). This speaks very much in line with what is currently envisioned for SURFDEVRON. However, there is a warning to be kept in mind: SURFDEVRON is still an operational squadron that will be tasked outside of just RDT&E facilitation and the staff will still be responsible for the obligations of the material upkeep and personnel leadership of the ships within the squadron (Hammerer J. 2017). This can divide attention and commanders may consume a fair amount of time trying to oversee everything; they run the risk of detracting too much from focusing on RDT&E facilitation.

To mitigate this risk, it would stand to reason that SURFDEVRON leaders will need to leverage much support from entities like the Surface Warfare Development Group (SWDG), and the Naval Surface and Mine Warfighting Development Center (SMWDC), as well as their own ISIC. Cooperation and coordination will be key in order to effectively cover down on supporting the ships within the squadrons' material needs, developing TTPs and facilitating fleet experimentation. Leadership will be challenged similarly to that of standard DESRON tasks that periodically need attention, but SURFDEVRON has the added task of having to find a work-flow balance between ensuring the operational readiness of the squadron and providing platforms for RDT&E opportunities.

D. CONCLUSION

Trident Warrior provides an excellent example of what kind of tasks that a SURFDEVRON can look to support. It would benefit SURFDEVRON leadership to review what type of experimentation takes place during Trident Warrior and examine how they could help facilitate such efforts in the future. Trident Warrior can also help identify what kind of other leadership roles may be helpful within the SURFDEVRON organization, namely some form of a 'science adviser' with a research background who can help Navy leadership within the squadron may not be as familiar with the experimentation process.

Making room for contracting specialist positions within the squadron can help mitigate the risks of complex contracting. This paper's focus is not necessarily to make the case that the existence of a SURFDEVRON will mitigate the Navy's risk of complex contracts for larger acquisitions, but more so. To help mitigate complex contracting risks for the type of activities that SURFDEVRON will be involved in executing. Either it will be important for SURFDEVRON to have its own comptroller or some form of agreement with its ISIC and their comptroller for direct support, so that the squadron can mitigate its own risk of navigating complex contracting.

Reviewing what other organizations are currently doing also provides valuable insight. The relationship between SUBDEVRON and the program offices seems to be a link that will directly contribute to the overall effectiveness of the squadron. SUBDEVRONs structure appears to be the more practical approach for modeling SURFDEVRON around, with the emphasis being on a smaller number of ships so that commanders can effectively divide their time between material upkeep, and operational readiness, as well as warfare development and experimentation. Like these organizations, there is an opportunity to make use of liaison officers from the development organization to attach to partners within the development process. These opportunities will afford clearer lines of communications between the development organizations staff as well as the entity they are partnered with.

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III. DATA

During the search for relevant cost data from entities like Trident Warrior, specific cost data could not be found relating directly to the individuals executing the experimentation process. To supplement the Total Ownership Cost model that will be showcased in this chapter, salary data from OPM's 2019 salary chart regarding GS level employees was used to show an estimate of what costs could look like if civilian employees were brought onboard SURFDEVRON. While this substitution will likely present an inaccurate look at what costs will look like in reality, it still demonstrates the purpose of such a model when more accurate data can be accessed.

Before examining what the model can demonstrate, it would be beneficial to provide some insight into what kind of structures can be considered within the SURFDEVRON structure. The SURFDEVRON staff will likely function traditionally within their own organization, as many other staff organizations do. However, this squadron serves a unique purpose and as a result will have unique relationships and interactions, notably with entities such as SMWDC and SWDG, among others.

A. SURFDEVRON STRUCTURE

1. Matrix Organization

A matrix organization lends itself to an organization that finds itself needing its members to fulfill multiple roles and functions. For instance, there could be a structure in place where either military or civilian members of SURFDEVRON would not only report to the commanding officer of SURFDEVRON, but also report to a leader over at SMWDC. While this structure allows a fair degree of crossflow among organizations, it could also be stressful for members who have several authority figures they need to report to. This type of organization can leverage the use of liaison officers to facilitate communications between organizations involved in this structure.

2. Parallel Organization

Parallel organizational structures imply that there are essentially two staffs. In the case of SURFDEVRON there could be a ship staff and an experimentation staff. This would reduce the workload on staff members, since they will have a smaller degree of responsibility compared to a matrix organization. The drawback will be that the organization will likely have to employ more individuals than may be initially desirable. It may be practical to start with another organizational structure and then phase into a parallel structure as the organization matures and grows. This organization structure is best utilized once an operational department and an experimentation department.

3. Hybrid Organization

The hybrid organization can be tailored to what leadership wants from it. This very well may be the way that SURFDEVRON gets started, as the organization will be a little smaller than what leadership would probably desire, when compared to its end state. A hybrid organization can take elements of a parallel organization and a matrix organization that it finds that best suited for its environment. A hybrid organization can also include those outside entities that the organization may interact with during the development process, i.e., having a liaison officer or similar program office representative. What matters is that the organization has a shared objective with unity of effort. While a developmental organization is in this hybrid configuration, the use of liaison officers can help facilitate effective communications with development partners.

B. IMPACT OF SQUADRON STRUCTURE

There are different ways to examine how the structure of the squadron will impact a number of factors. There are also different metrics to consider and take into account when determining the performance of the squadron. What is its capacity to carry out the operational upkeep for the ships within the squadron? Is the staff able to effectively carry out normal immediate superior in command (ISIC) functions? Is the staff and the squadron able to facilitate the execution of various types of experimentation? What kind and how many partnerships is SURFDEVRON able to effectively maintain with its staff structure?

Ultimately, what does this staff structure cost? Using the total ownership cost model developed by Dr. Jonathan Mun, there are five different systems that this thesis examined:

- System A: ZRONs current staffing
- System B: ZRONs desired staffing for SURFDEVRON
- System C: SURFDEVRON staffing with additional civilian leadership
- System D: Phase I of phased approach
- System E: Phase II of phased approach

System A represents ZRON's current staffing, which affords a staff that can function as an ISIC to the squadron, but will lack dedicated resources to facilitate development operations proficiently. Where it may struggle is when the added tasks are introduced to the system. These kinds of tasks will include interactions with entities like SMWDC, various program offices, and research institutions. When the experimentation process starts, this staff may also struggle due to the knowledge gap in facilitating the experimentation process. While staff members will likely not be expected to know nuances of conducting experimentation, there will be a need for leadership to understand what supporting roles will be needed to effectively conduct the different experimentation types.

System B represents ZRON's desired staffing as they transition into becoming SURFDEVRON. The added military personnel would afford a significant increase in the staff's knowledge base that it can leverage when interacting with outside entities that wish to do business with the squadron. The added billets for Weapons Tactics Instructors (WTIs) and a possible civilian equivalent will allow the staff and WTIs to embark together to assist in the direct facilitation of experimentation underway and provide valuable insight as a direct result of their qualifications. The added civilian personnel in System B are in positions that deal with financial management. With dedicated financial managers, the risk of misuse and waste of funds is decreased.

System C represents everything mentioned in system B, with the addition of a senior civilian leader. This senior leadership position would be designated for a science adviser. Their main task would be to assist the CO filter through all the proposals that SURFDEVRON is likely to receive. The CO of the squadron will already be executing a number of functions in the capacity of ISIC for all ships within SURFDEVRON, which is where their expertise is best leveraged. The CO of SURFDEVRON may not always have the most knowledge when it comes to deciding which experimentation initiatives to pursue. There will likely be guidance from a higher authority in a number of cases, and it is possible that there will be permissions extended to the CO to approve other experimentation efforts. This is where a science adviser's role can be best leveraged - someone who has extensive experience in the experimentation process and is also familiar with the platforms capabilities within the squadron. This position will assist the CO in filtering out and prioritizing projects and use of resources towards which efforts provide the best value for the squadron and the Navy as a whole.

System D and E represent a phased approach to standing up SURFDEVRON. It is unlikely that SURFDEVRON will be stood up with all requested and desired billets approved upon its inception. It is most likely that the current ZRON will transition to be SURFDEVRON with possible additions to the staff permitted over time. What system D and E show is what a phased approach would look like financially. System D shows the starting staff configuration as SURFDEVRON goes through the early stages of its life cycle and starts to establish itself as an operational squadron. As the SUFDEVRON's responsibilities and work volume increases, it will likely require its manning and capabilities to be similarly increased to meet said need. System E shows what phase II manning increase could look like.

C. TOTAL OWNERSHIP COSTS

While the information used in the model is general pay information pulled from 2019 pay grade tables, it still represents a simulation of how staff structure and organization will affect the costs of standing up and maintaining a SURFDEVRON. What this model can do for leadership is help evaluate costs of investments, whether they be investments in personnel, material or technology. The total ownership cost model accounts for acquisition costs, operational costs, maintenance costs, and replacements costs. These costs accumulate into total acquisition costs and total annual operational and maintenance costs. Of note, is that regardless of the manning of SURFDEVRON, the military personnel would still be getting paid and even assigned to another squadron. What this model helps show is an opportunity cost. While these officers and sailors could be assigned elsewhere, the benefit they provide at SURFDEVRON represents a greater investment vice being stationed elsewhere.

What this model would benefit from in its effort to calculate the total ownership cost of a SURFDEVRON would be:

- Type of analysts
- Type of specialists
- What amount of time staff members would be dedicated to certain functions
- Total cost of installation (i.e., weld, training)
- Contracting costs

What this model can do is take recurring costs, such as the operational costs, maintenance costs, and replacement costs in order to calculate a total annual O&M cost. This model also has the capacity to factor in nonrecurring costs to include, bid specifications development, proposal evaluation, data collection, data analysis, contracts development, program planning, hardware purchases, administrative costs, asset management, in-house training for staff, product maintenance, software/hardware upgrades, and energy costs. The model also includes inputs for end of life-cycle costs that are nonrecurring to include, administrative costs, asset management, vendor contract procurement, staging, sanitizing, testing, follow-up support, recycling and disposal fees. These data points were not available for the purpose of this thesis so the data produced in the model within this thesis represents a simulation of data just factoring in the cost of staff pay requirements.

The total ownership cost model, shown in Figure 1, whose data can be found in the appendix, showed that System A had total annual operational and maintenance (O&M) cost of $218,084.80, which if cash flows are extended out for a 20-year life cycle equals $5,042,920.32. The total ownership cost model showed that System B had total annual O&M cost of $774,712.40, which if cash flows are extended out for a 20-year life cycle equals $17,914,191.64. The total ownership cost model showed that System C had total annual O&M cost of $942,020.40, which if cash flows are extended out for a 20-year life cycle equals $21,782,966.13. The total ownership cost model showed that System D & E when factored together in such a way that for simulation purposes: System D exists for five years and then System E goes into effect for the follow-on 15 years, had total annual O&M cost of $1,313,479.20, which if cash flows are extended out for a 20-year life cycle equals $17,628,768.99.

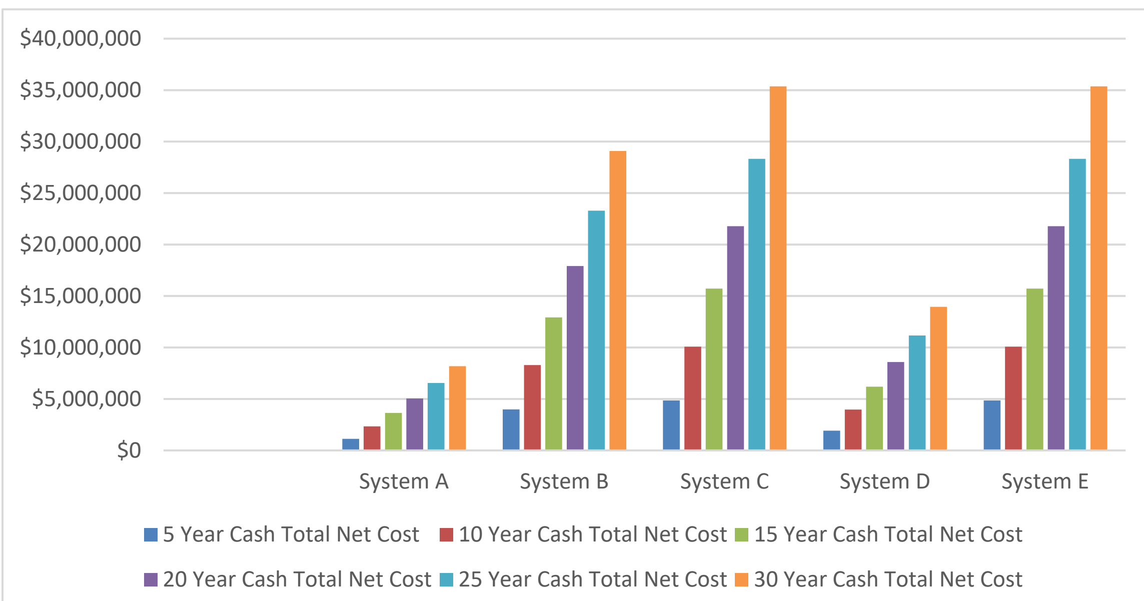

Figure 1. Total Net Life-Cycle Cost

Given the results from the model, it can be said that implementing a phased approach, demonstrated by System D & E, would provide the best value for the navy as it stands up SURFDEVRON. By phasing in costs and expanding the organization over an extended period of time, the Navy can save some opportunity cost as SURFDEVRON matures from a new operational squadron into the premier experimentation and developmental squadron. Conversely, opting for a swifter course of action such as immediately moving to a system like C or E would require larger amounts of resources initially. The payoff is that SURFDEVRON would be able to support all its function areas immediately and accelerate the acquisition and development process.

D. CONCLUSION

The data here suggests that there are options when implementing the structural organization of SURFDEVRON. There does not appear to be one specific way to start it up. Rather, first it should be determined what type of activity is expected of it and what volume of those activities is expected upon inception. If the expectation is for the squadron staff to fulfill the role of ISIC for the new ZUMWALTs, a number of LCSs and MDUSVs, then assigning a traditional DESRON staff will satisfy that effort. So far as it is understood now, however, SURFDEVRON will be the premier surface warfare organization to conduct experimentation, demonstration and other warfare development. In this case it is more financially viable to phase in growth of the SURFDEVRON staff as the organization forms and matures into a proficient developmental squadron.

In the future, the TOC model can be used extensively to help decision makers simulate costs in an effort to make more informed decisions. However, to make the most use of this model, there needs to be careful collection of vast amounts of cost data mentioned in this chapter. The more data inputted regarding the recurring and nonrecurring costs, the more informative the simulation will be.

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IV. DISCUSSION AND ANALYSIS

A. SURFDEVRON EXPERIMENTATION PROCESS

There has been much thought and discussion around how the experimentation process should function once SURFDEVRON becomes involved. Another part of that discussion is at what point does SURFDEVRON become involved? Easy answers to the latter part range from being approached by a developmental command such as SMWDC to direct guidance from higher headquarters, to pursuing a particular initiative. However, there will likely be a number of other entities that wish to conduct business with SURFDEVRON. Squadron leadership would benefit from having a standardized set of procedures and criteria before accepting contracts and initiating the experimentation process.

Part of that process should take into consideration giving the Commodore of the squadron specific permissions to initiate partnerships. To what extent and other restrictions may be the topic of other research, but in order to fulfill the purpose of SURFDEVRON to cut down the time it takes to plan, initiate, execute, collect and reassess the experimentation process, the Commodore and the rest of the squadron should be empowered to pursue non-traditional partnerships. Allowing specific, carefully thought out, permissions to the Commodore will assist in that goal. Should this be the case, it will also be important that the Commodore have the necessary supporting staff to assist them to make the right partnerships and to execute those partnerships within the letter of the law. Delegating down permissions certainly introduces risk, but that risk can be mitigated given that the proper structure is put into place.

As it currently stands, the experimentation process is a 12–18 month planning process that attempts to align with fleet exercises for at-sea experimentation. SMWDC entered into a partnership to conduct testing of unmanned aerial systems (UAS) alongside a surface combatant, it took six months to identify test objectives. Another three months to identify which ship would be the test ship and then 11 more months until installation and testing was conducted. Six months after the test, the report was released. What

SURFDEVRON can bring to the equation is a dedicated team that can accelerate partnership discussion: identifying test objectives, having dedicated platforms for at-sea experimentation and as this process is repeated, the squadron staff will become more proficient as learning occurs (SURFDEVRON Decision Brief).

What the surface warfare community is lacking is timely feedback that can provide impactful value on the experimentation process. The experimentation process, similarly the acquisition process, starts by identifying a capability gap after analyzing our fleet capability as well as the capability of adversaries. Once the capability gap is identified, the cycle moves into development to determine how to minimize the delta in capability, this part of the process is where most of the time is invested. SURFDEVRON will be that timely impactful feedback loop in the development process. Being directly involved in the development process will rapidly cut down on time, costs, and increase capability feedback and open up opportunities for more iterations of experimentation to further develop capabilities (SURFDEVRON Decision Brief).

B. IDEAL SURFDEVRON STRUCTURE

SURFDEVRON will have three lines of effort:

- Be an effective ISIC
- Medium/Large USV transition and operation into the fleet
- Developmental Operations

With this in mind, careful consideration needs to be given to what kinds of positions are critical to these mission areas. The first line of effort can be met by installing a traditional DESRON staff, this group can see to the operational needs of the squadron and can be their first line of support. It should be noted though that the ships in this squadron are largely unique to this squadron, the ZUMWALT class is still being tested and maturing as a platform, same can be said for the first iterations of the LCS classes that would be assigned to SURFDEVRON. The MDUSVs are an interesting addition to the squadron, they will likely require a more specialized staff that understands the platform and can better assist them in their operations. (CAPT Adams P-CO, SURFDEVRON, personal conversation)

As the squadron starts to become involved in the developmental mission, it will become necessary to employ financial mangers on the SURFDEVRON staff. There is a fair amount of risk if the proper monitoring of funds is not cared for. There is a difference between operations and maintenance (O&M) funds and research and development (R&D) funds, notably how that money can be spent and what it can be spent on matters. SURFDEVRON needs to ensure that they are spending their allocation of money appropriately and in accordance with the letter of the law. Having financial managers on staff helps reduce this risk. Should it be decided that the squadron will not have their own financial managers, then a memorandum of agreement should be in place with SURFDEVRONs ISIC for direct support from their comptroller or equivalent financial management support. One of SURFDEVRONs greatest risks will come from misuse of appropriations funds, and should be carefully mitigated.

As the volume of developmental work increases it will require more attention in order to ensure that the right projects are being taken on and given the appropriate amount of attention. A senior level squadron leader whose task would primarily be being the subject matter expert on experimentation management. Experimentation management is not a skill set inherently present within the surface warfare officer community, while there are skills that can be learned on the path to SURFDEVRON leadership, having an experienced leader who can be the liaison between the academic community and the command organization will be value added. This position would be meant to help delegate some attention from the CO, while the CO is ultimately responsible for being cognizant of all squadron activities, this science advisor position is meant to be a screen that can help the CO make informed decisions.

Should budgetary constraint not allow for the allocation of a science advisor position, SURFDEVRON should consider an agreement with another developmental warfare organization (i.e., SMWDC) to have LNOs placed within SURFDEVRON to assist in any developmental warfare efforts. If LNOs cannot be placed within SURFDEVRON then perhaps SURFDEVRON can explore placing an LNO in a partner developmental warfare organization. In some form or another there should be some dedication within the staff organization for facilitating and understanding the relationships and expectations of the experimental and developmental community.

What the TOC model has shown is that, in the interest of being fiscally minded, it would be most cost efficient to conduct a phased approach to standing up the SURFDEVRON. Starting with a smaller organization that will expand over time as other criteria are met and the volume of work expands, then bring on additional staff to form the larger more ideal state for SURFDEVRON. Despite the fact that the TOC model used in this report is examining just organizational structure considerations, there is more opportunity to use the TOC model to evaluate future costs. Users of this model can input: acquisition costs, operational costs, maintenance costs, replacement costs that are recurring. That information can be paired with nonrecurring acquisition and end of life-cycle costs in order to determine total ownership costs throughout the projects life cycle. This data can simulate those costs and provide valuable information to decision makers so that they can make more informed decisions regarding the projects and partnerships SURFDEVRON is looking to enter into.

C. CONCLUSION

The experimentation process within the surface warfare community has an opportunity to invest in its future. Several organizations have been stood up within the surface warfare community to assist in accelerating the development process within the experimentation cycle. The availability of at-sea platforms however have been a limiting factor that has made current experimentation planning to be more opportunistic. The creation of an empowered and capable SURFDEVRON can reduce a cycle that historically can take years and reduce it to a matter of months or weeks, given the proper conditions. With new initiatives however, there is certainly an amount of risk, specifically when it comes to matters of financial audit and operational safety. It is important to minimize this risk by ensuring that the proper checks are put in place. These checks can take the form of financial managers within the organization or parallel to it. With the accelerated experimentation process, safety needs to be carefully considered, WTIs and other relevant

SMEs need to insert themselves into those discussions about operational safety. As the organization grows, its work volume will grow and the CO will be challenged to maintain their priority of being the ISIC to the members of the squadron and also being a decision maker establishing partnerships in the realm of the experimentation process. Having a science advisor, a senior leadership position for a civilian academic, assist in screening these partnership opportunities so that the CO can make informed decisions. Finally, the TOC model can be used for more than evaluating staff structure; it can be a powerful cost-simulating tool for decision makers across a wide variety of experimentation and developmental efforts.

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V. CONCLUSION AND RECOMMENDATIONS

The creation of new classes of ships, and the development of unmanned surface vessels have offered an opportunity to the surface warfare community to form a unique squadron that can serve as an operational unit that can also be the premier at-sea testing entity. To do this however, that squadron needs to be led by a specialized team that realizes it owes responsibility to the ships and her crews and then also the responsibility of providing services for experimentation and warfare development. At present there is an opportunity to vastly improve the way our surface navy conducts warfare development, and according to the CNOs latest *Design for Maintaining Maritime Superiority* (Richardson 2018), there is a call to "increase the rate of technological creation and adoption," SURFDEVRON can be the catalyst for technology and tactics development.

This thesis set out to explore strategies for how a SURFDEVRON could be stood up, looking at historical examples from other warfare communities and looking at the number of examples that they employ. The lesson to be pulled away is that careful consideration needs to be given to how partnerships are formed with entities outside of the DoD and how relationships within the DoD are established. The structure of the SURFDEVRON organization will largely help determine what kind of outside support is going to be needed, for example; if constraints do not allow for financial managers within the organization, then there should be some form of memorandum of agreement with SURFDEVRONs ISIC for direct financial services support.

The fundamental reason for the careful consideration of staff organization is that SURFDEVRON will be a different kind of squadron. While it will have all the responsibilities of a traditional squadron, that it needs to provide for the operational sustainment of the ships within their charge. The squadron will also be responsible for facilitation experimentation and warfare development, this will be done by either partnering with members of industry, academia or other warfare development centers within the DoD. To accomplish these lines of effort, SUFDEVRON will need to have an array of staff members whose skillset can be leveraged to support the ships and crews within the squadron and support partnerships within the warfare development process.

Based off the findings of the research conducted in this thesis, the following recommendations are provided for action and future research.

Because of SURFDEVRON's unique mission to support the facilitation of the experimental process, it can be anticipated that funding for SURFDEVRON will be scrutinized. There will need to be an understanding established regarding how funds can be used and how they cannot be used so that allocation violations are not performed. Misuse of funds and audit risk is a factor that can be mitigated to good extent by employing the use of financial managers who are familiar with the DoD finance regulations.

The CO of SURFDEVRON will benefit from leveraging the support of a science advisor whose role will be to help screen potential initiatives from the academic community as well as projects involved with industry. Although the support of a senior advisor to the CO will be beneficial, SURFDEVRON's organization will also largely benefit from the support of additional civilian employees who specialize in experimentation management. These staff members will work alongside their military counterparts so that swift communication can take place and feedback from collected data can be quickly acted on before the next iteration of experimentation.

Future research would benefit from careful record keeping regarding labor-hours and dollar figures used in individual experimentation efforts and warfare development activities. This thesis originally set out to find what costs would be associated with the DoD for their part in the experimentation and development process. In the search for relevant data to analyze, it was found that the particular data being sought after was not readily available. It is recommended that cost data be collected as well as labor hours collected for the purpose of conducting research and analysis on costs associated with SURFDEVRON and the services they are providing to support the experimentation and development process.

APPENDIX

Select Uncertainty Range: Use Small +/- 5% Range

Name: System A | *Discount Rate:* 3.00% | *Economic Life:* 20 Years

Notes: SURFDEVRON existing staff

Annual Growth or Decline Curve: 1.50%

Categories	Number of Units per System	Number of Platforms	Acquisition Cost (Unit)	%	Operational Costs (Unit) Per Year	%	Maintenance (Unit) Per Year	%	Replacement (Unit) Per Year	%	Total Acquisition Cost	%	Total Annual O&M	%
Grand Total			**$0.00**		**$136,546.30**		**$0.00**		**$0.00**		**$0.00**		**$218,084.80**	
DEVRON Staff	**12**	**34**	**$0.00**	**0.0%**	**$136,546.30**	**100.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$218,084.80**	**100.0%**
O6	1	1	$0.00	0.0%	$10,841.40	7.9%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$10,841.40	5.0%
O5	1	0	$0.00	0.0%	$8,230.80	6.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%
O4	1	3	$0.00	0.0%	$7,596.30	5.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$22,788.90	10.4%
O3	1	0	$0.00	0.0%	$5,671.50	4.2%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%
E9	1	1	$0.00	0.0%	$6,470.70	4.7%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$6,470.70	3.0%
E8	1	4	$0.00	0.0%	$5,232.30	3.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$20,929.20	9.6%
E7	1	3	$0.00	0.0%	$4,482.60	3.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$13,447.80	6.2%
E6	1	8	$0.00	0.0%	$3,543.30	2.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$28,346.40	13.0%
E5	1	12	$0.00	0.0%	$3,001.50	2.2%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$36,018.00	16.5%
E4	1	1	$0.00	0.0%	$2,555.40	1.9%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$2,555.40	1.2%
E3	1	0	$0.00	0.0%	$2,233.50	1.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%
GS13	1	1	$0.00	0.0%	$76,687.00	56.2%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$76,687.00	35.2%

Select Uncertainty Range: Use Small +/- 5% Range

Name: System B | *Discount Rate:* 3.00% | *Economic Life:* 20 Years

Notes: SURFDEVRON desired staff

Annual Growth or Decline Curve: 1.50%

Categories	Number of Units per System	Number of Platforms	Acquisition Cost (Unit)	%	Operational Costs (Unit) Per Year	%	Maintenance (Unit) Per Year	%	Replacement (Unit) Per Year	%	Total Acquisition Cost	%	Total Annual O&M	%
Grand Total			**$0.00**		**$136,546.30**		**$0.00**		**$0.00**		**$0.00**		**$774,712.40**	
DEVRON Staff	**12**	**84**	**$0.00**	**0.0%**	**$136,546.30**	**100.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$774,712.40**	**100.0%**
O6	1	1	$0.00	0.0%	$10,841.40	7.9%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$10,841.40	1.4%
O5	1	3	$0.00	0.0%	$8,230.80	6.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$24,692.40	3.2%
O4	1	11	$0.00	0.0%	$7,596.30	5.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$83,559.30	10.8%
O3	1	13	$0.00	0.0%	$5,671.50	4.2%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$73,729.50	9.5%
E9	1	2	$0.00	0.0%	$6,470.70	4.7%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$12,941.40	1.7%
E8	1	9	$0.00	0.0%	$5,232.30	3.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$47,090.70	6.1%
E7	1	9	$0.00	0.0%	$4,482.60	3.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$40,343.40	5.2%
E6	1	14	$0.00	0.0%	$3,543.30	2.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$49,606.20	6.4%
E5	1	12	$0.00	0.0%	$3,001.50	2.2%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$36,018.00	4.6%
E4	1	4	$0.00	0.0%	$2,555.40	1.9%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$10,221.60	1.3%
E3	1	1	$0.00	0.0%	$2,233.50	1.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$2,233.50	0.3%
GS13	1	5	$0.00	0.0%	$76,687.00	56.2%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$383,435.00	49.5%

Select Uncertainty Range: Use Small +/- 5% Range

Name: System C | *Discount Rate:* 3.00% | *Economic Life:* 20 Years

Notes: SURFDEVRON desired staff with additional science advisor role

Annual Growth or Decline Curve: 1.50%

Categories	Number of Units per System	Number of Platforms	Acquisition Cost (Unit)	%	Operational Costs (Unit) Per Year	%	Maintenance (Unit) Per Year	%	Replacement (Unit) Per Year	%	Total Acquisition Cost	%	Total Annual O&M	%
Grand Total			**$0.00**		**$227,167.30**		**$0.00**		**$0.00**		**$0.00**		**$942,020.40**	
DEVRON Staff	**12**	**85**	**$0.00**	**0.0%**	**$227,167.30**	**100.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$942,020.40**	**100.0%**
O6	1	1	$0.00	0.0%	$10,841.40	4.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$10,841.40	1.2%
O5	1	3	$0.00	0.0%	$8,230.80	3.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$24,692.40	2.6%
O4	1	11	$0.00	0.0%	$7,596.30	3.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$83,559.30	8.9%
O3	1	13	$0.00	0.0%	$5,671.50	2.5%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$73,729.50	7.8%
E9	1	2	$0.00	0.0%	$6,470.70	2.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$12,941.40	1.4%
E8	1	9	$0.00	0.0%	$5,232.30	2.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$47,090.70	5.0%
E7	1	9	$0.00	0.0%	$4,482.60	2.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$40,343.40	4.3%
E6	1	14	$0.00	0.0%	$3,543.30	1.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$49,606.20	5.3%
E5	1	12	$0.00	0.0%	$3,001.50	1.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$36,018.00	3.8%
E4	1	4	$0.00	0.0%	$2,555.40	1.1%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$10,221.60	1.1%
E3	1	1	$0.00	0.0%	$2,233.50	1.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$2,233.50	0.2%
GS13	1	6	$0.00	0.0%	$76,687.00	33.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$460,122.00	48.8%
GS14	1	1	$0.00	0.0%	$90,621.00	39.9%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$90,621.00	9.6%

Select Uncertainty Range: Use Small +/- 5% Range

Name: **System D** *Discount Rate:* 3.00% *Economic Life:* 5 Years

Notes: Phase I of phased approach, starting with military staff and minimal civilian staff

Annual Growth or Decline Curve: 1.50%

Categories	Number of Units per System	Number of Platforms	Acquisition Cost (Unit)	%	Operational Costs (Unit) Per Year	%	Maintenance (Unit) Per Year	%	Replacement (Unit) Per Year	%	Total Acquisition Cost	%	Total Annual O&M	%
Grand Total			**$0.00**		**$227,167.30**		**$0.00**		**$0.00**		**$0.00**		**$371,458.80**	
DEVRON Staff	**12**	**36**	**$0.00**	**0.0%**	**$227,167.30**	**100.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$371,458.80**	**100.0%**
O6	1	1	$0.00	0.0%	$10,841.40	4.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$10,841.40	2.9%
O5	1	0	$0.00	0.0%	$8,230.80	3.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%
O4	1	3	$0.00	0.0%	$7,596.30	3.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$22,788.90	6.1%
O3	1	0	$0.00	0.0%	$5,671.50	2.5%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%
E9	1	1	$0.00	0.0%	$6,470.70	2.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$6,470.70	1.7%
E8	1	4	$0.00	0.0%	$5,232.30	2.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$20,929.20	5.6%
E7	1	3	$0.00	0.0%	$4,482.60	2.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$13,447.80	3.6%
E6	1	8	$0.00	0.0%	$3,543.30	1.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$28,346.40	7.6%
E5	1	12	$0.00	0.0%	$3,001.50	1.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$36,018.00	9.7%
E4	1	1	$0.00	0.0%	$2,555.40	1.1%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$2,555.40	0.7%
E3	1	0	$0.00	0.0%	$2,233.50	1.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%
GS13	1	3	$0.00	0.0%	$76,687.00	33.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$230,061.00	61.9%
GS14	0	0	$0.00	0.0%	$90,621.00	39.9%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%

Select Uncertainty Range: Use Small +/- 5% Range

Name: **System E** *Discount Rate:* 3.00% *Economic Life:* 15 Years

Notes: Pase II of phased approach, adding remaining staff from system C

Annual Growth or Decline Curve: 1.50%

Categories	Number of Units per System	Number of Platforms	Acquisition Cost (Unit)	%	Operational Costs (Unit) Per Year	%	Maintenance (Unit) Per Year	%	Replacement (Unit) Per Year	%	Total Acquisition Cost	%	Total Annual O&M	%
Grand Total			**$0.00**		**$227,167.30**		**$0.00**		**$0.00**		**$0.00**		**$942,020.40**	
DEVRON Staff	**12**	**85**	**$0.00**	**0.0%**	**$227,167.30**	**100.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$0.00**	**0.0%**	**$942,020.40**	**100.0%**
O6	1	1	$0.00	0.0%	$10,841.40	4.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$10,841.40	1.2%
O5	1	3	$0.00	0.0%	$8,230.80	3.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$24,692.40	2.6%
O4	1	11	$0.00	0.0%	$7,596.30	3.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$83,559.30	8.9%
O3	1	13	$0.00	0.0%	$5,671.50	2.5%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$73,729.50	7.8%
E9	1	2	$0.00	0.0%	$6,470.70	2.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$12,941.40	1.4%
E8	1	9	$0.00	0.0%	$5,232.30	2.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$47,090.70	5.0%
E7	1	9	$0.00	0.0%	$4,482.60	2.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$40,343.40	4.3%
E6	1	14	$0.00	0.0%	$3,543.30	1.6%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$49,606.20	5.3%
E5	1	12	$0.00	0.0%	$3,001.50	1.3%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$36,018.00	3.8%
E4	1	4	$0.00	0.0%	$2,555.40	1.1%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$10,221.60	1.1%
E3	1	1	$0.00	0.0%	$2,233.50	1.0%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$2,233.50	0.2%
GS13	1	6	$0.00	0.0%	$76,687.00	33.8%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$460,122.00	48.8%
GS14	1	1	$0.00	0.0%	$90,621.00	39.9%	$0.00	0.0%	$0.00	0.0%	$0.00	0.0%	$90,621.00	9.6%

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