THE LITTORAL COMBAT SHIP: IS THE US NAVY ASSUMING TOO MUCH RISK?

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

JONATHAN C. RUSSELL, LCDR, USN
B.S., United States Naval Academy, Annapolis, Maryland, 1993

Fort Leavenworth, Kansas
2006

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **16 JUN 2006**	2. REPORT TYPE	3. DATES COVERED
4. TITLE AND SUBTITLE **Littoral combat ship: is the US Navy assuming too much risk?**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) **Jonathan Russell**		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **US Army Command and General Staff College,1 Reynolds Ave.,Fort Leavenworth,KS,66027-1352**		8. PERFORMING ORGANIZATION REPORT NUMBER **ATZL-SWD-GD**
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR’S ACRONYM(S) 11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT
The purpose of this research is to explore the current risks associated with the Littoral Combat Ship (LCS). There are several compelling reasons for the radical changes incorporated in the LCS design. A better understanding of the risks that the ship and crew will assume is vital to the proper use of this new platform and will help ensure the safety of both. This study does not advocate complete risk mitigation aboard the LCS, but strives to increase the overall risk awareness. The risk of combining so many new and untested elements on a single ship must be understood by all of those who are involved in its implementation. The arrival of the first LCS, projected to be operational in 2007, will represent a reduced manning concept designed from the ground up and the first of a new family of US naval combatants built to face the future maritime threats. With the proposed ship class of up to fifty-five ships, the US Navy needs to make sure that LCS is not assuming too much risk.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**1**	**79**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

Name of Candidate: Lieutenant Commander Jonathan C. Russell

Thesis Title: The Littoral Combat Ship: Is the US Navy Assuming Too Much Risk?

Approved by:

____, Thesis Committee Chair
Robert M. Brown, M.M.A.S.

____, Member
Phillip G. Pattee, M.M.A.S.

____, Member, Consulting Faculty
Ronald E. Cuny, Ph.D.

Accepted this 16th day of June 2006 by:

____, Director, Graduate Degree Programs
Robert F. Baumann, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

THE LITTORAL COMBAT SHIP: IS THE US NAVY ASSUMING TOO MUCH RISK?, by LCDR Jonathan C. Russell, 79 pages.

The purpose of this research is to explore the current risks associated with the Littoral Combat Ship (LCS). There are several compelling reasons for the radical changes incorporated in the LCS design. A better understanding of the risks that the ship and crew will assume is vital to the proper use of this new platform and will help ensure the safety of both. This study does not advocate complete risk mitigation aboard the LCS, but strives to increase the overall risk awareness. The risk of combining so many new and untested elements on a single ship must be understood by all of those who are involved in its implementation. The arrival of the first LCS, projected to be operational in 2007, will represent a reduced manning concept designed from the ground up and the first of a new family of US naval combatants built to face the future maritime threats. With the proposed ship class of up to fifty-five ships, the US Navy needs to make sure that LCS is not assuming too much risk.

ACKNOWLEDGMENTS

I would like to thank my committee chair Mr. Robert Brown, committee member Mr. Phillip Pattee, and consulting faculty Dr. Ronald Cuny for their help and expert advice throughout this project.

I would also like to thank the staff at the Combined Arms Research Library (CARL) for their excellent assistance with my research. Whether keeping me informed on the latest subject information or processing thesis permissions, CARL proved to be a valuable asset.

Finally, to my family, thank you for your continual support. Once again, I could not have done it without you.

TABLE OF CONTENTS

ACRONYMS

CO	Commanding Officer
CSG	Carrier Strike Group
DC	Damage Control
ESF	Expeditionary Strike Force
ESG	Expeditionary Strike Group
FRP	Fleet Response Plan
HCO	Human Capital Object
ISO	International Standards Organization
ISR	Intelligence, Surveillance and, Reconnaissance
KSA	Knowledge, Skills, and Abilities
LCS	Littoral Combat Ship
MEU	Marine Expeditionary Unit
MIO	Maritime Interception Operations
NPDC	Naval Personnel Development Command
POE	Projected Operational Environment
ROC	Required Operational Capability
SAG	Surface Action Group
SMD	Ship Manning Document

ILLUSTRATIONS

Page

TABLES

Page

CHAPTER 1

INTRODUCTION AND BACKGROUND

> Have we not ourselves much to blame for it in this exclusive devotion to the mechanical matters? Do we not hear, within and without, the scornful cry of disparagement that everything is done by machinery in these days, and that we are waxing old and decaying, ready to vanish away? Everything done by machinery! As if the subtlest and most comprehensive mind that ever wrought on this planet could devise a machine to meet the innumerable incidents of sea and naval war.
>
> Alfred T. Mahan, 1888

Introduction

On 2 June 2005 the US Navy began building the first Littoral Combat Ship (LCS), the USS *Freedom*. The LCS represents the first of a new family of surface combatants designed to face the challenges of the twenty-first century. The USS *Freedom* is the first ship of a class which the Navy envisions may grow to as many as fifty-five in number. This ship is designed to operate and fight in the congested littorals and carry out a wide range of mission tasks against a very unpredictable enemy. In addition, the LCS is designed with reduced manning from the ground up. As Navy planners make decisions today that will affect tomorrow's fleet, how the LCS is manned and the risks the ship will assume due to several other new design features are critical issues.

The USS *Freedom* is part of the US Navy's transformation plan. Transformation is a defense-wide initiative that describes the military's need to be adequately prepared for the challenges of the twenty-first century. The US Navy's framework for transformation is "Sea Power 21" with its three components: Sea Strike, Sea Shield, and Sea Basing. These components provide the vision of how the US Navy will project offensive power, ensure global defense, and maintain the ability to operate at sea as a sovereign entity. Important elements to both naval transformation and the Sea Power 21 vision are the need to operate in the littorals, conduct network-centric operations, and utilize unmanned vehicles while operating with reduced personnel (Clark 2002, 34). The LCS is designed to support these elements with a reduced crew of highly trained sailors able to perform multiple tasks in several different mission areas. The success of the LCS will help determine how reduced manning as well as other design features will be implemented in future fleet designs like the next generation destroyer DD(X) and cruiser CG(X).

One of the key tenets of Sea Power 21 is the focus on the design of systems that will enable war-fighters to be more efficient decision-makers with fewer personnel. The need to lower the cost of operating a ship by reducing the overall crew size has become a top priority for the US Navy. Challenged by a decreasing defense budget, the US Navy realizes the importance of smart spending and the need to preserve its greatest asset--people. Operations and support costs, which include the cost of personnel, maintenance, consumables, and sustaining support, have remained relatively constant while the Navy's total operational budget has decreased. The cost of personnel alone comprises over 50 percent of the operations and support costs for a navy ship (Hinkle 2004, 4). The ability to reduce the operational cost of the fleet by lowering the number of sailors required aboard its ships has the potential to save these vital funds.

Along with budget constraints, the US Navy is getting smaller. Since the 1980s and the Reagan administration's goal of the 600-ship navy, a lot has changed. The United States is no longer racing to keep up with a large Soviet naval threat. The US Navy is building a smaller and more capable fleet, one that will face a less defined threat. However, with the current battle force of just over 280 ships, every ship will count. Of these 280 ships in the current force, barely a hundred are surface combatants to include cruisers, destroyers and frigates as well as various other war fighting ships. This number is the lowest since the late 1930s. However, the current vision is to build the fleet back to approximately 313 ships (Cavas 2005, 1). The LCS will play a large role in this expansion. Today's naval leadership suggests that the Navy should not fixate on the large numbers of the 1980s but focus on a smaller and more capable fleet. Those in support of the reduced manning concept believe that smaller and more capable crews, enabled with new technology and training, will be able to achieve mission success. However, decreasing the overall manning requirements to the lowest levels must be balanced with ship survivability and overall risk.

As the Navy builds a more efficient fleet, it finds itself with a wide range of missions and an increased operational tempo. The Fleet Response Plan (FRP) instituted in December 2003 gives the US Navy the ability to surge multiple ship formations in response to emergencies. Under the current FRP, Carrier Strike Groups (CSGs) and Expeditionary Strike Groups (ESGs) that have just returned from deployments will be on alert for a certain period for short-notice deployment. In addition, CSGs and ESGs approaching deployments will also be in surge windows prior to deploying. This increased operational tempo has put even greater strain on today's Navy. The ability to reduce the crew size required to man these strike groups has the potential to reduce the strain on the individual sailor and could also give the Navy more flexibility. Any added flexibility will depend on how the personnel removed from the ships are utilized. If the

Navy does not maintain end strength and reduces its overall numbers as a result of reduced manning, the individual sailor tempo (in the US Navy commonly referred to as personnel tempo or PERSTEMPO) will remain the same.

Along with the challenges of reduced budgets, fewer ships, and increased operational tempo, the US Navy faces a new and deadly threat. The bombing of the USS *Cole* (DDG-67) on 12 October 2000 was a clear reminder of how unpredictable the current threat is. As the Navy builds a new fleet it needs to make sure that its crews have the ability to properly protect their ships. The results of the USS *Cole* investigation produced several lessons learned. One of these lessons was that damage control efforts of the crew were instrumental in the survival of the ship.

Damage control (DC), the ability for the ship's crew to protect itself from fire and flooding, is a manpower intensive activity. A major conflagration is damage control at its worst. The Office of the Chief of Naval Operations through its Navy tactics, techniques, and procedures (NTTP) publications defines a major conflagration as:

> Damage of magnitude that cannot be readily handled by conventional DC organization; therefore, all-hands participation is required to save the ship. A major conflagration may also involve mass personnel casualties. It is imperative that command, control, and communications be established and maintained to effectively coordinate DC actions over a prolonged period of time. The inflicted damage must be brought under control immediately and simultaneously; combat systems must be kept in or returned to a state of battle readiness. (US DoN 2004b, 10-1)

As the Navy determines the reduced numbers required to man the LCS, the crew's ability to combat fire and flooding must be addressed. In the past, technology has been a major factor in helping reduce the demands on manpower; however, there are some functions that cannot be easily replaced by machine. For example, when electricity is not available during a casualty and automatic sensors, valves, and pumps are not functioning properly, manpower may be the only option available to save the ship.

Research Questions

The objective of this study is to evaluate the risks associated with the reduced manning design on the LCS. The primary question that the study addresses is: Is the US Navy assuming too much risk with reduced manning aboard the LCS?

Secondary questions include the following:

1. What level of risk is the US Navy assuming with the LCS reduced manning design?

2. Will the LCS be able to conduct damage control and repair in a mass conflagration environment and save the ship?

3. Will the multiple tasked "hybrid sailor" have sufficient skills and training to compensate for the reduced crew size aboard the LCS?

4. Will the LCS be able to maintain mission capability and accomplish the mission in the littorals while operating independently?

5. Will the rapid acquisition timeline of the LCS allow follow-on designs to benefit from the initial Flight 0 prototypes?

Significance of the Study

This thesis examines the potential risks associated with the reduced manning design aboard the new LCS. As the US Navy plans to build as many as fifty-five of these ships, it is very important that the risks associated with the LCS design be fully understood and minimized. Furthermore, other future Navy ship designs may also benefit from this research.

The study is organized into four subsequent chapters: chapter 2 presents the literature used in this study to research the primary and secondary questions; chapter 3 presents the research methodology used to analyze the data; chapter 4 contains the study's analysis; and chapter 5 summarizes the results of the study, provides a conclusion, and closes with recommendations for further study.

Background

Leveraging technology to reduce the crew size is not a new concept. Commercial maritime industry has been using reduced manning to cut cost for years. A 100,000-ton merchant ship going to sea with a crew of only thirty is not uncommon. The US Navy has also seen crew reduction in its recent past. An 8000-ton World War II cruiser typically had a crew of 800 to 1,500 sailors compared to a modern-day Arleigh Burke-class destroyer of comparable size with only 326 sailors (Klain 1999, 66). Most of these gains occurred due to the advances in the engineering plant. The rise of gas turbine technology and the ability to monitor ship spaces remotely greatly reduced the crew required to operate the plant. The gas turbine engine was incorporated into the design of the Spruance (DD-963) class destroyer and Oliver Hazard Perry (FFG-7) class frigate. Several critics insisted that the design changes, resulting in such large crew reduction, would never work. However, history has proven the gas turbine to be more reliable than the steam plant ships of the 1950s and 1960s (Klain 1999, 66).

The US Navy conducted its first "Smart Ship" experiment aboard the guided-missile cruiser USS *Yorktown* (CG-48) in 1997. The goal of Smart Ship was to see how minor crew reductions aboard an operational ship would affect its ability to accomplish all required tasks. The experiment successfully reduced the workload and manpower requirements while enhancing combat readiness and improving the crew’s quality of life. The results further indicated that the use of cost-effective commercial technology as well as policy and procedural changes allowed crewmembers to focus more on their war fighting and professional skills, instead of repetitive tasks. The Smart Ship experiment allowed USS *Yorktown* to achieve incremental manning reductions. The ship’s crew further realized that greater changes in reduced manning would require complete platform and systems integrated design (Schank 2005, 109).

In a further effort to reduce required crew size without affecting performance, the US Navy began two experiments in 2002, one on east coast, which included six surface ships, a submarine, and a strike fighter squadron. The West Coast experiment was called the “Optimal Manning Experiment” and included the USS *Mobile Bay* (CG-53) and USS *Milius* (DDG-69). The USS *Mobile Bay* crew shrank to 308 sailors after 34 billets were cut and the USS *Milius*, after cutting 53 billets, reduced the enlisted crew to 237 (Wise 2003, 16). Again through the use of new technologies, procedures, and policies, the ships’ crews were able to reduce manning by 34 and 53 enlisted sailors, respectively. Their success centered on the innovative use of personnel to accomplish shipboard tasks. Remote monitoring through the use of additional video cameras, increased use of distance support, which is the ability to contact technicians ashore when troubleshooting equipment at sea, and the use of specialized ashore-based teams to conduct preventative maintenance, played an important role in manning reductions.

The East Coast experiment, called the "The Fleet Manning Experiment" included the destroyer USS *Mahan* (DDG-72), the cruiser USS *Monterey* (CG-61), the aircraft carrier USS *George Washington* (CVN-73), the amphibious assault ship USS *Nassau* (LHA-4), the submarine USS *Oklahoma City* (SSN-723), and Strike Fighter Squadron 34. The commanding officers were asked to identify warfare requirements, to match people to the requirements, and then to deploy with their results. Results from the units involved were mixed:

- *Mahan*-cut 18 sailors, enlisted crew 286
- *Monterey*-detached 30 sailors, enlisted crew 295
- *George Washington*-added 48 sailors, enlisted crew 3,045
- *Nassau*-cut 26 sailors, enlisted crew 1,016
- *Oklahoma City*-added 1 sailor, enlisted crew 130
- *VFA-34*-added 16, total squadron 218. (Wise 2003, 18, emphasis mine)

These experiments illustrate the path that the US Navy has taken to help determine the minimal number of sailors needed to accomplish unit tasking and the ability to integrate these tasks with the assigned personnel. As a result, several new and innovative approaches to better utilize personnel were discovered. Finally, by reducing the menial jobs required of the crew such as preservation and maintenance through aggressive outsourcing to the private sector, there were fewer requirements on the crew, further allowing its reduction.

The LCS concept began in 1998 when the US Navy started looking at designs for a small and fast surface combatant. The study, named "Streetfighter," was conducted at the Naval War College. Vice Admiral Arthur Cebrowski, who became the president of the college that same year, led the study in an effort to find new naval concepts for fighting in the heavily defended littorals. Admiral Cebrowski is also known for his help in developing the concept of network-centric warfare and as a leader in naval transformation (O'Rourke 2005, 21).

The LCS not only represents a new class of ships but also a completely different approach to war fighting. The LCS will have a modular mission capability that will allow the ship to reconfigure its mission focus on short notice. Fleet or operational commanders will be able to select from mission areas which include mine countermeasures, antisurface warfare, and shallow-water antisubmarine warfare allowing increased flexibility in a dynamic threat environment. These "plug-and-fight" mission capabilities will complement inherent ship capabilities which support maritime interception operations (MIO), intelligence, surveillance, and reconnaissance (ISR), homeland defense, special operations, and logistics support. Appendix A provides a complete list of the LCS's focused and inherent mission capabilities.

In May 2004, the Department of the Navy awarded Lockheed Martin and General Dynamics--Bath Iron Works individual contracts to build two LCSs each. The USS *Freedom* represents the Lockheed Martin design which is currently being built at Marinette Marine, Marinette, Wisconsin, with an expected delivery to the US Navy in early 2007. The General Dynamics design (LCS-2), in production at Austal USA shipyards in Mobile, Alabama, will be delivered to the Navy in the fall of 2007. Each design will be dramatically different in an effort to give the Navy the best possible options for the design of the remaining fleet. Lockheed Martin's design will center around a steel monohull while the General Dynamics design will focus on an all-aluminum trimaran. Both of the proposed design drawings are shown in figure 1.

Figure 1. Lockheed Martin and General Dynamics LCS Designs
Source: Lockheed Martin and General Dynamics LCS Designs, Peoships Littoral Combat Ship [database on-line]; available from http://peoships.crane.navy.mil; Internet; accessed on 14 March 2006.

Both LCS designs will be relatively small with a displacement between 1,000-4,000 tons compared to current ship designs--Arleigh Burke-class destroyer, approximately 9,000 tons, and the Oliver Hazard Perry Class Frigate, approximately 4,000 tons. The reduced displacement and new hull design will give the LCS a maximum draft of only twenty feet allowing for greater shallow-water operations capability. The LCS will also be fast, capable of speeds of between 40 to 50 knots. With a focus on the littoral environment, the LCS will be deployed as part of a large group (CSG or ESG) or tasked to conduct independent operations.

In addition to new war-fighting capabilities, the LCS will change the way the Navy thinks about development and acquisition timelines. The LCS program will support the rapid delivery of two development phases called “Flights.” The first four ships will be Flight 0, followed quickly by the Flight 1 design. Development phases are not new to the Navy, but the short period of time between development and acquisition is unique. The development of the Arleigh Burke-class destroyer took over a decade before the first ship was delivered. In contrast, the LCS will have its first Flight 0, the USS *Freedom* (LCS-1), only five years after the official start of the LCS program.

As the US Navy continues to pursue the design features of the new LCS, incorporating individual tasks and finding innovative ways to reduce crew manning, recognizing the risk that will be assumed with these reductions will be essential to the success of its future fleet.

Assumptions

An initial assumption made during this study is that the US Navy will continue to pursue reduced manning. In addition, the US Navy will continue to pursue advanced technology systems that will support current and future ship designs.

Definitions of Terms

The following is a list of terms and phrases that are used throughout this thesis:

Carrier Strike Group (CSG). A CSG is an independent deployable group of US Navy ships which typically include one aircraft carrier and approximately six surface combatants made up of cruisers, destroyers and frigates, one or two attack submarines, and one or two supply ships.

Expeditionary Strike Group (ESG). An ESG is an independent deployable group of US Navy ships which typically include three amphibious ships capable of embarking a Marine Expeditionary Unit (MEU), and one to three surface combatants and one to two attack submarines. The main difference between the CSG and the ESG is the fact that the latter is centered on amphibious capability and Marine support vice the aircraft carrier.

Future US Navy Cruiser (CG(X)). CG(X) is the third member of the future "family of ships." This multi-mission capable cruiser will focus on air dominance.

Future US Navy Destroyer (DD(X)). DD(X) is the centerpiece of the US Navy's future family of ships. This destroyer is designed with multiple warfare capabilities with a focus on land attack, robust self-defense, and stealth technologies, as well as a reduced crew design.

LCS Seaframe. The core platform of the LCS; the naval equivalent of an airframe.

Major Conflagration. A major conflagration at sea is a large shipboard fire which often results in personnel causalities. This fire can be caused by several different events to include internal fires and explosions from weapons handling mishaps or large fuel spills which result in fire, as well as external attack from missiles, torpedoes, and mines.

Reduced Manning. Reduced manning can be referred to as minimum manning or optimal manning. Optimal manning is the fewest number of crew members required to man a ship while taking into consideration the use of technology and human factors. Minimal manning is calculated based on associated ship workload and may not include additional factors. For this reason, minimal manning often refers to the lowest possible crew limit.

Ship's Manning Document (SMD). The SMD is a document that identifies the manpower requirements for a US Navy ship. Manpower requirements are based on several criteria which include the Required Operational Capabilities (ROC), the Ship's characteristics, as well as other inputs.

Five Vector Model (5VM). The 5VM is a career-planning tool for sailors that focuses on five separate areas: professional development, personal development, leadership, certifications and qualifications, and performance.

Limitations

The study does not discuss reduced manning on all US Navy platforms and will limit its focus to the current Arleigh Burke-class destroyer and the LCS. There are many factors aboard ship that have a direct effect on reduced manning; however, due to the limited time available to conduct this research, the areas mentioned in this thesis' primary and secondary questions are this study's primary focus. Furthermore, specific discussion of technologies to be utilized aboard the LCS is limited in scope due to the available information and sensitivities involved in the ongoing design competition between Lockheed Martin and General Dynamics.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the literature as it relates to this study's primary research question: Is the US Navy assuming too much risk with reduced manning aboard the LCS? The literature review is organized around each the following secondary questions: (1) What level of risk is the Navy assuming with the LCS reduced manning design? (2) Will the LCS be able to conduct damage control and repair in a mass conflagration environment and save the ship? (3) Will the multiple tasked "hybrid sailor" have sufficient skills and training to compensate for the reduced crew size aboard the LCS? (4) Will the LCS be able to maintain mission capability and accomplish the mission in the littorals while operating independently? and (5) Will the rapid acquisition timeline of the LCS allow follow-on designs to benefit from the initial Flight 0 prototypes?

In order to fully understand the current issues of reduced manning in the US Navy and the potential effects and risks associated with the reduced manning design aboard the LCS, several types of documents were reviewed. Numerous magazine and journal articles have been written on the subject of reduced manning and they can be divided into two basic groups of thought--those who fully welcome and support the new design and those who question a naval combatant's ability to accomplish its mission with such a design. In addition, there are several studies and reports concerning the feasibility of reduced manning aboard the LCS.

Studies on reduced manning for the future destroyer DD(X) program and the current Arleigh Burke-class destroyer were also reviewed. Even though the LCS is a very different platform in both physical design and mission, the challenges of reduced manning facing the DD(X) and the testing already conducted aboard Arleigh Burke-class destroyers provide insight into potential challenges for the LCS program. Government documents also illustrate the current strategy and concept of operations for LCS, as well as many of the current issues and concerns of US Congress on the performance and acquisition of the LCS program. In addition, a review of shipboard firefighting doctrine helped establish the current requirements and tasks that the Navy uses to combat shipboard fires. Documents supporting two naval ship incidents were also reviewed to support the vignettes used in this study.

Level of Risk

It is important to understand the Navy's current doctrine to fully appreciate the significance of the LCS. The role the LCS will play as well as the risks it will assume is defined through doctrine. "Sea Power 21" was introduced by the Chief of Naval Operations in 2001 and establishes the guiding principles for the Navy's future:

> To realize the opportunities and navigate the challenges ahead, we must have a clear vision of how our Navy will organize, integrate, and transform. "Sea Power 21" is that vision. It will align our efforts, accelerate our progress, and realize the potential of our people. "Sea Power 21" will guide our Navy as we defend our nation and defeat our enemies in the uncertain century before us. (Clark 2002, 33)

Sea Power 21 is a change from the US Navy's blue-water doctrine, which focused on the deep water battle, to an increased focus on the littoral environment. The LCS is designed to support all three of the Sea Power 21 pillars: Sea Strike, Sea Shield, and Sea Basing.

Figure 2. Sea Power 21
Source: Vern Clark, "Sea Power 21: Projecting Decisive Joint Capabilities," *United States Naval Institute Proceedings* 128, no. 10:33, reprinted with permission; Copyright © (2002) U.S. Naval Institute/www.usni.org.

The LCS will directly support Sea Strike which is the ability to project offensive power through the direct support of the Marine Corps and Special Operations Forces units. Sea Shield will also be supported through the employment of focused and inherent mission capabilities and limited self-defense. In addition, the LCS will protect US allies and friends and will be able to support sea-based theater and strategic defense against ballistic missiles. Finally, Sea Basing, which refers to the Navy's ability to operate at sea as a sovereign entity without concerns of access and political constraints, will be part of the LCS's list of capabilities. These three pillars will be molded together by what the Navy calls ForceNet which will integrate warriors, sensors, command and control, platforms, and weapons into a networked, distributed combat force (Clark 2002, 34).

In addition, the LCS will be completely involved in the three supporting organizational processes called Sea Trial, Sea Warrior, and Sea Enterprise which are defined as follows:

- Sea Trial   Delivering innovation and rapid technology development to the fleet
- Sea Warrior   Investing in Sailors and ensuring they are properly trained and utilized
- Sea Enterprise   Substituting technology for manpower to achieve war-fighting effectiveness at the best cost (Clark 2002, 39-40)

The LCS is designed to support these initiatives and increase the development of enhanced war-fighting capabilities for the fleet. Providing rapid technology, training US Navy sailors to achieve reduced manning and replacing sailors with technology to reduce cost are all part of the new vision. How the LCS adjusts to these dramatic changes will determine its success as well as the success of other future ship designs.

In line with Sea Power 21, the US Navy released the *Littoral Combat Ship Concept of Operations* in December 2004. This document provides insight into how the US Navy plans to use the LCS in future operations. Understanding how the LCS will be employed and the operational environment it will face will help determine the potential risks. As mentioned in chapter 1, the LCS will have inherent capabilities that will complement mission-focused capabilities. This design is intended to reduce the overall cost of the LCS as well as allow a smaller crew to operate the ship's core systems and capabilities (US DoN 2004a, ii). The actual manning numbers will be dependant upon what mission package an LCS has installed. Individual mission packages will be sized to fit into a twenty-foot International Standards Organization (ISO) container and can be pre-positioned or shipped to any location in the world (US DoN 2004a, v). This will allow the LCS to reconfigure in homeport or in theater and may cause a short-notice change in required manning. Manning numbers, which are closely tied to mission assignments, will present challenges for the LCS crew.

The LCS may deploy as part of a Carrier Strike Group, Expeditionary Strike Group, Surface Action Group, or independently. Regardless of who it deploys with, the LCS is by design dependant on ships in company to provide the defensive capability it lacks. The US Navy's intent is for the future destroyer (DD(X)) or future cruiser (CG(X)) to provide this capability when in company with the LCS. The future DD(X) with its proposed advanced gun system and land attack capability and the CG(X) with its air dominance capability provide the perfect complement to the LCS. The LCS may also operate with other ships of its class, ideally with each ship configured for a different mission in order to provide greater collective capabilities. However, when assigned to operate independently, the LCS will assume additional risks due to its lack of offensive capability against a large missile-armed surface ship (US GAO 2005, 3). Regardless, the LCS will be required to operate in the littorals where there is sufficient threat from mines, submarines, and small boat swarm attack.

The Navy Warfare Development Command, who was instrumental in the development of the LCS Concept of Operations, summarized how the LCS will increase its survivability through several factors:

> The LCS force and individual platforms become less susceptible to detection and less vulnerable to attack through the employment of:
>
> - Agility (high speed in a variety of sea conditions and missions)

- Speed: In ASW [antisubmarine warfare], speed would allow LCS to cut off an enemy submarine's avenues of approach, and would help in evading sub-fired torpedoes. Against airborne threats, it would allow LCS to more rapidly skirt an aircraft's search window and improve the effectiveness of anti-ship cruise missile countermeasures. Tactical speed benefits also would include faster wide-baselining for ESM [electronic support measures] and quicker combat search and rescue response.
- Off board combat systems and on board sensors and weapons
- Area maneuver by the large numbers of both the LCS force and its off board sensors and weapons
- Powerful networking to power projection assets for increased awareness
- Signature management
- Force dispersal (decreases risk averseness in high threat regions)

> In addition to an LCS division's dispersion and maneuver, their operations in the complex and cluttered littoral environment will further serve to mitigate risk. (DoN 2003a, 8, emphasis mine)

Based on these factors the LCS will rely heavily on its speed, agility, reduced signature (the ability for the ship to decrease radar detection through structural design and the use of radar absorbing material), and sensors to maintain situational awareness. The LCS is built to avoid conflict by evading a threat at high speed. The littoral environment, even without increased surface vessel traffic, will pose additional navigational challenges which may prevent the LCS from having the ability to fully utilize its speed advantage.

Several Congressional Research Service (CRS) reports have addressed the LCS and reduced manning. Ronald O’Rourke, a specialist in National Defense, is the leading voice to Congress on the LCS and other US Navy ship programs. In these reports, O’Rourke expresses concern that the US Navy did not conduct enough research on the LCS prior to building its first prototype:

> Absent a formal study, they [LCS critics] could argue, the Navy has not, for example, shown why it would be necessary or preferable to send a small and potentially vulnerable manned ship into heavily defended littoral waters to deploy helicopters or UVs [unmanned vehicles] when helicopters or UVs could be launched from larger ships operating further offshore. . . . The Administration, LCS critics could argue, is being proposed on the basis of “analysis by assertion.”

> They can argue that while it may be acceptable to build one or a few ship as operational prototypes without first having analytically validated the cost-effectiveness of the effort, it is quite another thing to propose a potentially 55-ship program costing billions of dollars without first examining through rigorous analysis whether this would be the most cost-effective approach. (O'Rourke 2006, 4, emphasis mine)

It can be argued that the "Streetfighter" project of 1999-2001 was part of that research due to the similarities of its littoral focus. The Streetfighter, which was first revealed to the public in 1999, came under heavy debate due to questions about overseas sustainability and payload constraints. Also, due to the small size of the LCS, ship survivability and ability to survive a substantial weapon hit are also a concern (O'Rourke 2005, 21).

The United States Government Accountability Office (GAO) also expressed similar concerns for the LCS program in a report that it released in March 2005. The GAO's primary concern was that the US Navy has not fully analyzed the larger surface combat threat to LCS operations. The fact that the LCS, in accordance with its concept of operations, will operate independently will require a thorough understanding of the threats that it will face. The potential threat of a large combatant, armed with medium caliber guns, torpedoes, and anti-ship missiles needs to be fully addressed (GAO 2005, 16). Taking this threat into consideration is critical in determining the ship's survivability and the risks that it will assume in the littorals.

Key to the LCS's reduced manning plan is the ability to limit the necessary work required from the sailors. The LCS maintenance strategy builds on the Surface Force maintenance initiative called "Shipmain" which focuses on process improvement of the fleet maintenance system. In addition, the Fleet Response Plan (FRP) and the increased demand on fleet readiness have required the Navy to look for a smarter way to maintain its ships. As a result, the LCS core crew and mission package personnel will only perform routine maintenance to include visual inspections and basic servicing actions (US DoN 2004a, ix). Private contractors will provide maximum support in order to minimize the workload of the crew. This will be a cultural change for the US Navy since commanding officers are accustomed to having more control over their ships. Relying heavily on several private contractors to ensure the readiness and ability of their ship to meet mission tasking will be a challenge. Commanding officers, who have overall responsibility for their ship, will have to work with multiple contractors in order to prepare their ships for sea.

Damage Control and Mass Conflagration

There is no greater danger to a ship's survivability than fires and flooding. How a ship fights fires and flooding will become even more important on a ship with reduced manning. Proper utilization of every person aboard is important in order to prevent the worst form of damage--a mass conflagration. Navy technical manuals and warfare publications provide valuable information on techniques and procedures used to combat fires at sea.

Existing naval doctrine for fighting shipboard fires is located in naval ships' technical manuals (NSTM) and naval warfare publications (NWP). NSTM 555, Volume 1, *Surface Ship Firefighting*, provides the basic procedures for fighting fires on naval vessels. Even though NSTM 555 does not specifically address reduced manning it provides the organizational approach to fighting fires and the positions required. This provides a basis for comparison when looking at the LCS approach to fighting fires with reduced manning. NSTM 555 also provides the appropriate background on basic classification of fires and the recommended equipment and procedures to use when combating each type.

NWP 3-20.31, *Surface Ship Survivability*, clearly relates damage control to ship survivability. This publication provides procedures and guidance on how to prevent, combat and restore from shipboard damage. It is important to understand the complexities of combat at sea and the effect of a mass conflagration on a reduced manning crew. NWP 3-20.31 helps to identify many of the hazards that sailors will face to include the need for rapid power restoration, the effects of shock hazards due to weapon impacts, and personnel protection against chemical, biological and radiological (CBR) attack. A mass conflagration environment will require all hands to be highly trained in multiple areas in order to accommodate any loss in crew caused by internal or external damage to the ship.

Crew training has always played a very important role in a crew's ability to protect a ship during a fire at sea. How the crew reacts to the emergency often is a result of extensive training and preparation. The US Navy understands the importance of training and is developing a new sailor training program to support the reduced manning concept aboard the LCS.

Hybrid Sailor

The sailors of the USS *Freedom* are already training even though their ship is still being built; this is typical for a US Navy ship during its construction phase prior to commissioning. The sailors that will man the first LCS will be cross-trained in order to support the reduced manning requirements of the ship. Sailors will attend schools that were previously considered to be outside of their designated fields. These new cross-trained sailors are being called the Navy’s first “hybrid sailors.” This new training plan directly supports “Sea Power 21” and is part of the Sea Warrior initiative.

The Navy has been making significant changes to the way it trains its sailors since July 2001 when Chief of Naval Operations Admiral Vern Clark launched Task Force EXCEL – Excellence Through Commitment to Education (Harris 2005, 46). Several tools were created in an effort to balance the training requirement of the fleet with the career training needs of the individual sailor. Today sailors utilize a career planning tool called the Five Vector Model (5VM) which focuses on five areas of sailor development: professional development, personal development, leadership, certifications and qualifications, and performance. This tool allows sailors to see what they have accomplished, similar to a résumé, and what they should focus on for future personal and professional growth.

The Naval Personnel Development Command (NPDC), which was established in 2003 to carry out the CNO’s Task Force EXCEL vision, is in charge of the Navy’s education and training program. In 2004, NPDC tasked four of its learning centers with the development of the LCS’s Learning Center of Excellence program. The Center for Surface Combat Systems, Naval Engineering, Service Support and Information Dominance are all working to define the skills necessary for the LCS sailor (Henson 2005, 1). The Navy is using Human Capital Objects (HCOs) to help determine the required skills for the LCS sailors using a process that aligns work requirements with job positions. Furthermore, the Navy has determined that SkillsNET’s technology, developed by a skills assessment firm, will be the tool to develop these HCOs. SkillsNET will be used to drive all training, education and proficiency requirements for all officers and enlisted sailors in the Navy community (SkillsNET Corporation 2006). This new technology uses the five concentration areas of the Five Vector Model to develop what the company calls "skill objects."

> The company collects workforce data, including individual skills gap information, to define the workforce and its parameters, not just in an occupational sense but in the broader application of knowledge skills, resources, and other items that encompass the performance of an occupational skill. The information is all put together in a "skill object." (Henson 2005, 47)

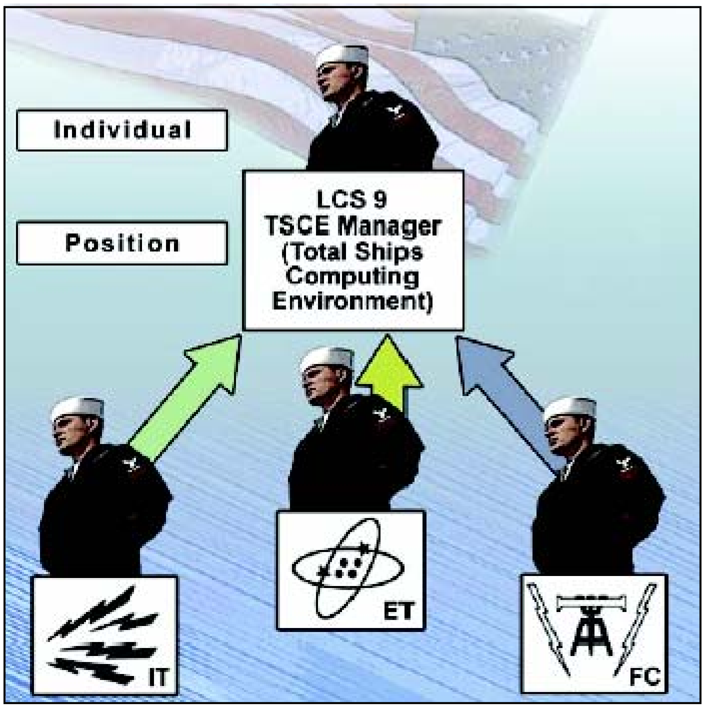

Figure 3. LCS Hybrid Sailor Skill Objects
Source: "Sea Warrior: A True Revolution in Training," *CHIPS Magazine*, October-December 2005, 10.

Knowing what skills will be required on the LCS by using skill objects is the first step but the next step is determining who receives the training. Vice Admiral J. Kevin

Moran, Commander, Naval Education and Training Command, explains the challenges of training the new LCS sailor:

> Under the old way, we would deliver all IT [Information Systems Technicians] SkillObjects to ITs; we would deliver all jet mechanic SkillObjects to jet mechanics. In the future, we will be delivering IT SkillObjects not only to ITs, but to other ratings in order to better fit an individual for a position. Since we are more effectively utilizing our manpower, we can then optimally man our units. This is the concept we are using right now to prepare the crew for the Littoral Combat Ship (CHIPS 2005, 9, emphasis mine).

Figure 3 provides an example of three different sailors with different specialties or ratings, (Information Systems Technicians (IT), Electronics Technician (ET), and a Fire Controlman (FC)) obtaining the necessary cross training to obtain the skills required to man the new LCS position of Total Ship Computing Environment manager. As the US Navy mans the first LCS with cross trained sailors the value of the individual sailor becomes even more critical to the ship's success. Having better trained sailors with multiple skills is by itself a smarter use of manpower; however, when crew size is reduced as a result, the individual sailor becomes more critical to the ship's mission capability.

Watch Stations and Manning Documents

The Navy's Ship Manning Document (SMD) presents the manpower requirements for the LCS. SMD's often rely heavily on the ships Required Operational Capability (ROC) and Projected Operational Environment (POE) to help determine the required manning. The ROC provides a detailed definition of a particular unit's mission statement and the POE describes the specific operating environment in which the unit is expected to operate. Presently, the LCS does not have a ROC and POE and the LCS concept of operations is the only document available that describes the mission and anticipated operating environment for the LCS.

Furthermore, the USS *Freedom* is still in the process of finalizing their Ship Manning Document. I obtained and reviewed its draft copy. The current proposed crew size for LCS-1 is forty personnel. A detailed billet analysis by Naval Sea Systems Command (NAVSEA) is still in progress which consists of reviewing each individual billet assigned to the LCS focusing on the following areas: tasks identified for each individual, workload required by each individual, knowledge, skills, and abilities (KSAs) of each individual, and training required.

Rapid Acquisition Timeline

Based on the rapid acquisition timeline of the Flight 0 ships, there may not be sufficient time to incorporate new design features learned from the Flight 0 models prior to Flight 1 model delivery. In a 2005 report to congress, the United States Government Accountability Office expressed concern about the immature technologies present in the LCS design and their effect on the acquisition timeline:

> Immature technologies increase risk that some systems will not perform as expected and may require additional time and funding to develop. The impact of delaying technology is less capability for the Flight 0 ships and less information for the Flight 1 ship design. (GAO 2005, 4)

Similar to immature technology concerns, having enough time between Flight designs is critical to LCS manning. The LCS has two different manning requirements--a core crew which mans the ship without the mission package, referred to as the “seaframe” on the LCS, and the crew required to man the individual mission packages. Core seaframe manning should remain relatively constant; however, total crew numbers will fluctuate based on installed mission packages. If it is determined that additional manning is required based on Flight 0 operational testing, there may not be sufficient time to incorporate this design change in follow-on Flights. The LCS program presents rapid employment of technology and basic manning methods which are new to the Navy. Many of the risks associated with the LCS program are discussed in greater detail in chapter 4.

Finally, several articles and reports on the incidents involving the USS *Stark* and the USS *Cole* were reviewed. Both ships were involved in major damage control efforts: USS *Stark* was struck by two Exocet missiles and the USS *Cole* attacked by shipborne suicide bombers.

Very little has been written about the USS *Stark* incident with the exception of Levinson and Edward's book, *Missile Inbound: The Attack on the Stark in the Persian Gulf*. This book provided a detailed account of the events leading up to and during the attack. As a result of numerous interviews conducted by the authors, this book provides a great deal of information about the crew's reaction to a mass conflagration. In addition, the investigation report submitted to US Congress in 1987 was also reviewed.

Concerning the USS *Cole* attack, the US Department of Defense Commission Report published in 2001, was reviewed which provided several lessons learned from the incident. However, other articles describing the details of the attack proved more valuable in understanding the crew's reaction to the incident and how their innovative actions played a large role in saving the ship.

This chapter provides an overview of the available literature on the US Navy's reduced manning program and presents many of the issues and concerns that directly affect the LCS. Chapter 3 provides the methodology that this study uses to help determine the potential risks associated with the LCS design and presents the framework for the analysis in chapter 4.

CHAPTER 3

RESEARCH METHODOLOGY

The methodology used to answer the primary research question is a risk management process known as the *Australian and New Zealand STandard 4360*. This model, which has been accepted and is being used globally to measure risk, provides the following five-step process: establish the context, identify risks, analyze risks, evaluate risks, and treat risks. This model has become a standard primarily in the business community; however, it provides a generic risk management process that can be used to help determine the associated risk with the LCS and its reduced manning design. Figure 4 provides a visual representation of this process.

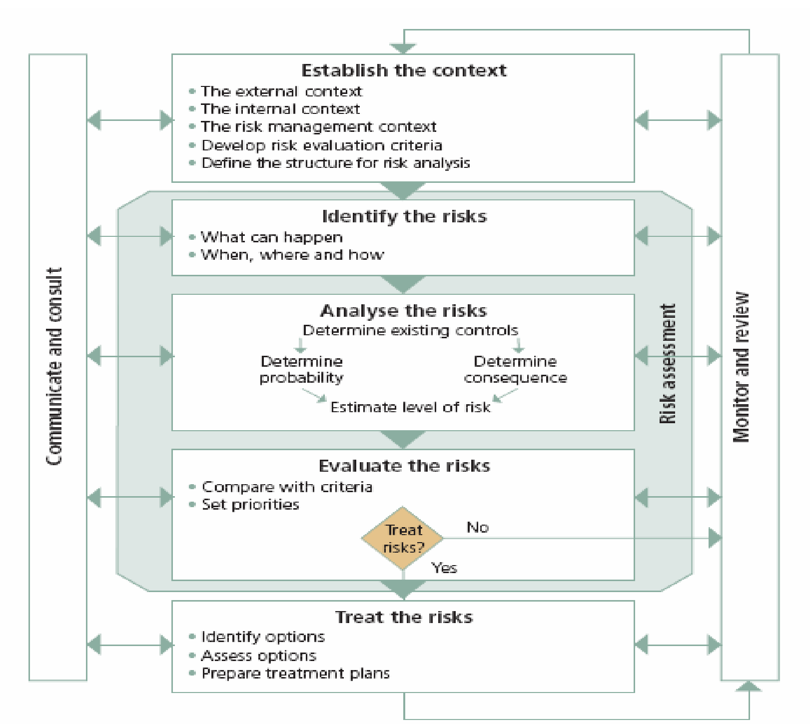

Figure 4. The Risk Management Process

Source: "Chapter 3: The Risk Management Process," *Standards Association of Australia*, 2004, 39; [database on-line]; available from http://www.standards.com.au; Internet; accessed on 15 December 2005.

This chapter introduces each of the five steps and explains how they will be applied in answering the primary and secondary research questions of this study.

In Step 1 (Establish the Context), risk evaluation criteria are developed based on the secondary research questions. First, this study will review each of these criteria using the *"STandard 4360"* model and discuss them in detail in chapter 4. Then, the study will analyze internal and external context for each of the criteria. In the case of the LCS, internal context will focus on the things over which the US Navy has control, such as required capabilities or mission requirements. US Navy cultural considerations and resistance to change also provide internal context and will be included in the study. External context will deal with the factors over which the US Navy has little or no control, that is, the operational environment and threat. Establishing the risk management context is also an important part of this step. Chapter 1 provides the limitations and delimitations as well as the significance of this research. This study will focus on the following risk evaluation criteria.

Table 1. Risk Evaluation Criteria

Risk Criterion	Objective
Survivability	Ship's crew will be able to conduct damage control / repair in mass conflagration environment and save the ship
Reduced manning w/ Hybrid Sailors	Fewer sailors with better training will replace larger / traditional crews
Mission Accomplishment	Ship will maintain mission capability and accomplish the mission in the littorals while operating independently
Acquisition timeline	Rapid delivery to the Fleet will provide the necessary littoral capability

Finally, the study will use the *Australian and New Zealand STandard 4360* model for the structure of the risk analysis.

In Step 2 (Identify the Risks), the study will look at each of the risk criteria from Step 1 in greater detail. The terms “retrospective” and “prospective risks” will be useful in this analysis of the LCS. Retrospective risks are those risks that have previously occurred such as accidents or incidents. The USS *Cole* bombing provides a good example of retrospective risks, a risk that the LCS will certainly face during its lifetime. The term prospective risk deals with risks that have not happened yet but might happen in the future.

It is also important to understand that not all risk is bad. The SWOT analysis, which looks at the strengths, weaknesses, opportunities, and threats associated with risk, helps to illustrate both the positive and negative risks associated with the LCS. The following SWOT analysis for the LCS is conducted in chapter 4:

Figure 5. Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis *Modified from Source*: “Chapter 3: The Risk Management Process,” *Standards Association of Australia*, 2004, 29; [database on-line]; available from http://www.standards.com.au; Internet; accessed on 15 December 2005.

In Step 3 (Analyze the Risks), the study will analyze the risks using the following simple equation (Risk = Consequence x Likelihood) (Standards Association of Australia 2004, 31). This equation will help determine the different levels of risk that the LCS may face. As likelihood increases from rare to frequent and the consequence increases from minor to significant, so will the risk. Understanding this relationship will help assess and evaluate the different risks found during the literature review and frame conclusions and possible recommendations. In addition, a qualitative approach provides the best analysis of the literature available on the LCS and will be used throughout this study. However, there are some disadvantages to the qualitative approach since it is subjective in nature. Therefore, I will keep my personal opinion to a minimum and limited to areas where my personal experience warrants it.

In Step 4 (Evaluate the Risks), this study will answer the primary research question: Is the US Navy assuming too much risk with reduced manning aboard the LCS? Using the analysis and comparing it to the risk criteria listed in figure 5, will help provide recommendations for mitigating potential risks.

In Step 5 (Treat the Risks), this study will identify and assess the options to reduce risk. The *Australian and New Zealand STandard 4360* provides several options when dealing with risk: accept it, avoid it, change the likelihood of occurrence, change the consequences and/or share the risk. These options will be helpful when making recommendations in regards to the LCS and reduced manning.

In summary, the *Australian and New Zealand STandard 4360* provides a model for analyzing the risk criteria associated with the LCS reduced manning design and will help answer the primary and secondary research questions of this study. Chapter 4 applies this methodology and provides the resulting analysis.

CHAPTER 4

ANALYSIS

The LCS, a proposed class of fifty-five ships, will soon become a significant portion of the US Navy's future surface combatant fleet. With its reduced crew design, this ship will operate in the congested littorals and be asked to go into harms way. Even though there are several attractive reasons to reduce crew size, this modification increases the overall risk of operating the LCS. The US Navy must ensure that the LCS has the capability to operate safely in peacetime as well as combat without assuming an unacceptable level of risk. It is important, therefore, that decision makers as well as ship designers are aware of other risks that are present in the current LCS design.

This chapter analyzes the literature presented in chapter 2 using the risk management model known as the *Australian and New Zealand STandard 4360.* This model is used to answer the secondary questions which are listed as risk criteria. As a result of answering the secondary questions, this study's primary research question: Is the US Navy assuming too much risk with reduced manning aboard the LCS, is answered. This chapter begins with a general analysis of the issues surrounding the LCS and establishes the context of the analysis. Risk criteria are then analyzed further to include two vignettes which illustrate the risks that US Naval ships have faced in recent history and the role that their crews' actions have played in the survival of both.

Establishing the Context

In accordance with the *Australian and New Zealand STandard* model, risk identification is at the source of risk management. In order to identify what is "at risk" this study will define the context of the risk assessment by establishing the internal and external context associated with the LCS. Internal context of the LCS program deals mainly with those factors over which the US Navy has control. By the development and approval of the concept of operations for the LCS, the Navy has the ability to control the environment in which the LCS is tasked to operate. The LCS concept of operations clearly states that the LCS will most likely operate with other strike group assets such as ESGs or CSGs but may also operate independently (US DoN 2004a, vii). This is an important factor to consider when looking at how much risk the LCS will assume. The US Navy has the ability to assign or not assign the LCS to conduct a particular mission. A better understanding of the potential threats to the LCS and the risks it will assume will help determine the proper tasking for the LCS.

Additional internal context includes the perceived need for the US Navy to fill a littoral mission gap. This presents risk either way. If the US Navy decides to delay or even cancel production of the LCS, there would be a mission capabilities gap related to the Navy's reduced capability in the littorals. A study conducted by the United States Government Accountability Office in March of 2005 indicated concerns that the current acquisition timeline would not allow the Flight 1 designs time to benefit from the initial prototype testing (GAO 2005, 31). The US Navy responded to the study by stating that it is attempting to balance acquisition risk with the risk of delaying the closure of the littoral mission gap. The Navy also stated that it is willing to accept additional risks in the initial Flight 0 design in order to field the needed mission capability, "The Navy intends for LCS Flight 0 to deliver an immediate capability to the fleet to address critical littoral anti-access capability gaps and to provide risk reduction for follow-on flights." (GAO 2005, 42)

External context deals with the factors over which the US Navy has limited control. The bombing of the USS *Cole* is a reminder that the US Navy operates in a very volatile and unpredictable threat environment. Even though the Navy has the opportunity to learn lessons from past experiences, it will not be able to predict future threats with any level of certainty. Without the ability to control the future threat environment, these factors and their associated risks will have to be assumed. In addition, budget constraints and the need to accomplish more with less, provide additional external pressures which have led to the interest and investment in reduced manning designs. Even though the US Navy could pursue other options to solve the problem of budget constraints, there is significant interest, both internally and externally, to have the Navy reduce its crew numbers.

Identify the Risk

Part of determining the acceptable level of risk involves reviewing all forms of risk. Risk itself is not always bad. A strengths, weaknesses, opportunities and threats (SWOT) analysis (figure 6) is a useful tool that can represent both the negative and positive risks associated with the LCS. This study used the SWOT analysis to divide risks into positive (strengths and opportunities) and negative risks (weaknesses and threats). Potential positive risks associated with the LCS were found to be the multi-mission capability and the flexibility that it provides the US Navy. Additionally, the modular capability promises the ability to quickly change the ship's primary mission in theater as mission requirements dictate. For example, if the current operational environment demands more mine warfare assets, any LCS in theater will have the capability (assuming the modules are also in theater and a secure port is available to support the conversion) to be reconfigured and assigned the task to support the new mission area (US DoN 2004a, v). The exact amount of time to reconfigure a ship has yet to be determined since the individual mission modules have not been delivered to the Navy and will not be tested until the first LCS is in operation in 2007. However, preliminary design documents for the Flight 0 LCS indicate that mission package change-out (including operational testing or OPTEST) should not exceed four days (DoN 2003b, 4).

Figure 6. Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis *Modified from Source*: "Chapter 3: The Risk Management Process," *Standards Association of Australia,* 2004, 29; [database on-line]; available from http://www.standards.com.au; Internet; accessed on 15 December 2005.

Additional positive risk of the LCS is its low cost relative to other surface combatants. The current price tag on an Arleigh Burke-class destroyer is approximately $1.7 billion, making the cost of the LCS, projected at less than $300 million without mission modules, very attractive (Cavas 2005, 2). In a highly competitive military budget environment, each service is doing its best to accomplish more with less. The LCS presents the US Navy an opportunity, through reduced unit cost, to increase fleet numbers at a discount.

Finally, the LCS provides the US Navy with a platform that will implement reduced manning from the ground up. The LCS, leading a family of reduced manning ship designs, will be the first naval combatant designed to operate with a crew that is drastically smaller than that of the traditional warship. As illustrated in chapter 1, the current Arleigh Burke-class destroyer enjoyed limited success in crew reductions. Ship crews involved in the manning reduction experiments recognized that further reductions would require more drastic design changes. Crew reductions based on changes in policies and procedures helped spark interest in reduced crew designs but could not provide the reductions that are projected for the LCS and other future ship designs. Since manning accounts for up to 50 percent of the total life cycle cost of a ship, a reduction in crew size has significant potential to save the US Navy vital funds (Riche 1997, 74). This study found that reduced manning was both an opportunity and a potential weakness. The LCS's reduced crew, even though it presents significant savings, may be the ship's limiting factor. Assessing the risk that the LCS will assume with reduced manning, as well as other risks, is the focus of this study.

Negative risks associated with the LCS include its dependency on others whether it is other surface combatants offsetting its limited combat system suite capabilities when facing a larger enemy combatant (O'Rourke 2005, 44) or shore facilities providing support such as maintenance and administration to offset its reduced crew and organic capability. This dependency will require the LCS to operate in company with better armed surface combatants and remain closely coordinated with shore support. An LCS operating independently in the littoral or deep water environment will be highly dependant on others for support and assume additional risk as a result.

One of the major concerns which became apparent during this study was a question of the ability of the LCS to save itself during a major conflagration. Recent naval incidents involving fire and flooding have proven to be crew-intensive events. With the optimal crew design of the LCS, where every sailor is assigned a specific role or multiple roles that support mission accomplishment, can this ship design sustain combat damage and still be able to save itself? The objective of this study is not to determine the necessary crew numbers required to maintain such a capability, but to look at the risks that are associated with such a design.

Two vignettes presented later in this chapter provide examples of actual ship casualties caused by external attacks and illustrate the important role that individual ship crews played in saving their ship. These incidents of fire, flooding and a major conflagration are retrospective risks and helpful in this study's final analysis.

Finally, the littorals present a complicated environment for any surface combatant to operate in. Increased ship density, reduced maneuverability and stand-off distance, are just a few of the many challenges that ships face in this congested operating area. This coupled with the fact that terrorists are heavily reliant on asymmetrical attack, often their only means against a much stronger conventional force, further complicates the problem in the littorals. Not knowing how and when the next attack on a US Naval combatant will occur presents prospective risks.

Based on the SWOT analysis, this study has developed four risk evaluation criteria associated with the LCS: ship survivability, reduced manning with “Hybrid Sailors”, the ability to accomplish the mission, and the rapid acquisition timeline. Table 2 below lists these risk criteria with their associated objectives. In accordance with the *Australian and New Zealand STandard* model, the inability to accomplish the objectives of any of the listed criteria presents unacceptable risks.

Table 2. Risk Evaluation Criteria

Risk Criterion	Objective
Survivability	Ship’s crew will be able to conduct damage control / repair in mass conflagration environment and save the ship
Reduced manning w/ Hybrid Sailors	Fewer sailors with better training will replace larger / traditional crews
Mission Accomplishment	Ship will maintain mission capability and accomplish the mission in the littorals while operating independently
Acquisition timeline	Rapid delivery to the Fleet will provide the necessary littoral capability

The first risk that this study reviews is the LCS’s ability or inability to survive during a mass conflagration. Next, the use of highly trained “Hybrid Sailors” presents additional risks for the LCS. Managing the crew of a future LCS where every single sailor plays a critical role in mission success presents several challenges. The third risk criterion that this study addresses is the LCS’s ability or inability to accomplish its mission. This criterion is directly related to the first because if the LCS does not have the proper survivability then it is at risk and may not be able to accomplish the mission.

Finally, the rapid acquisition timeline of the LCS promises to provide the US Navy with the needed littoral warfare capabilities, although not without assuming additional risks.

Analyze the Risk

This study approaches the risk analysis by first reviewing two individual ship casualties. The following vignettes provide two real world examples of US Navy surface combatants that were attacked and significantly damaged, and the challenges that the crews faced during the damage control efforts.

Vignettes: Practical Examples from the Past

History provides many examples of how ships have faired during casualties at sea. Whether the casualty has been caused by enemy attack or occurred during normal ship operations, the damage and challenges to the crew have been similar. The following vignettes provide examples of two ships: the USS *Stark* and the USS *Cole*. Both ships were involved in major damage control efforts: USS *Stark* was struck by two Exocet missiles and the USS *Cole* was attacked by suicide bombers. Both examples illustrate the important role that the individual crews played in saving their ships and provide insight into the challenges that tomorrow's ships may face in future operations. In addition, these examples further depict the inherent risks that US naval ships assume in an ever-changing environment and provide potential lessons for the LCS. Even though they depict different ship types and crew manning than those of the LCS, these vignettes still furnish a potential glimpse of how the LCS would fair in a similar situation given its current assumed risks.

<u>Vignette Number One: USS *Stark*, 17 May 1987</u>

Background

USS *Stark* (FFG-31), an Oliver Hazard Perry class frigate, deployed as part of the Middle East Force (MEF) and was assigned to protect Kuwaiti and Saudi oil tankers as well as vital shipping lanes in the straits of Hormuz. Leading up to the incident, hostilities between Iran and Iraq were increasing as both countries began attacking unarmed tankers, the development which later became known as the "Tanker War."

On 17 May 1987, the USS *Stark* was operating off the coast of Bahrain in international waters when it was struck by two Exocet missiles launched from an Iraqi F-1 Mirage fighter. Even though the fighter was detected and queried as part of standard procedure, there was no detection of the missile launch. Both missiles hit without warning. The first missile impacted the port side hull creating a nine-foot-by-twelve-foot hole in the bulkhead. The missile failed to detonate on impact; however, its propellant burst into flames aiding in the spread of fire throughout the ship. Twenty-five seconds later the second missile hit nearby and immediately exploded (Grosick, 1988, 14). The double missile hit resulted in the death of thirty-seven crew members and the injury of twenty-one.

Following the attack, the remaining crew members struggled to save the ship. Firefighting and damage control efforts presented several challenges as the crew rapidly realized that they were dealing with a major conflagration. As a result of the missile impacts, the primary fire main piping (which provides pressurized firefighting water throughout the ship) was ruptured and required the crew to use hoses to re-route the water around several damaged areas. The fire became so hot in some places that the ship's aluminum superstructure began to melt. The intense heat further led to the spread of the fire due to radiant heat causing adjacent spaces to catch fire. Crew estimates following the incident are that temperatures reached 1,800 degrees in some spaces (US Congress 1987, 26). Adding to the challenges facing the crew, the ship began to develop a seventeen-degree list as a result of flooding caused by accumulating firefighting water (US Congress 1987, 26).

The brave and resourceful crew of the USS *Stark* managed to gain control of the fire and damage control efforts twenty hours following the attack and eventually returned the ship unassisted to Bahrain. The USS *Stark* was repaired and later returned to service.

USS *Stark* Analysis

Many of the lessons learned from the USS *Stark* incident can be applied to the new LCS. First, the USS *Stark* incident provides a real world example of what challenges a ship may face during a major conflagration. Immediately following the attack, fire main pressure was not adequate and had to be re-routed, all communications were disabled with the exception of emergency hand-held radios, the ship began developing a severe list and extreme temperatures caused the ship superstructure to melt in some spaces. In addition to the chaos, the officers and crew, with an initial strength of 201 personnel, were dealing with the loss of almost 20 percent of their ship’s company (Levinson and Edwards 1997, 8). Based on the investigation report following the incident, there is little doubt that the actions of USS *Stark’s* crew saved the ship. Several reports support this conclusion and describe the actions of the crew as the primary reason for her survival following the attack:

> Based on the interviews with *Stark* crew members and MEF officers, it became apparent that the crew's success in containing the fire, controlling the damage, and reducing the list considerably reduced the scale of damage that might otherwise have devastated *Stark*. The crew's actions may well have saved the ship. (US Congress 1987, 26)

Levinson and Edwards in their book titled "*Missile Inbound – The attack of the Stark in the Persian Gulf,*" noted that damage control efforts were directly affected by this missile attack:

> Repair Two, isolated in the forecastle area, was critically hampered by the loss of men, including the death of EMCS (Senior Chief Electrician's Mate) Stephen Kiser, one of its two repair party leaders, and the locker quickly fell victim to smoke and fire damage. Communication with Repair Two was lost shortly after the fire started. The death of several experienced damage-control CPOs - the "loss of khaki"- made the job of saving the *Stark* that much more difficult. (Levinson and Edwards 1997, 23)

In addition, following the major firefighting, the USS *Stark* did not have enough crew members to support the vital "reflash watches" used to monitor spaces throughout the ship to ensure the fires remained out. Not until two other destroyers in the area provided assistance was the USS *Stark* able to support this task (Levinson and Edwards 1997, 31). By reducing crew numbers on the new LCS to as low as forty personnel the loss of 20 percent of the crew during an initial attack could be devastating to the ship's ability to deal with the resulting damage. For example, if the LCS received a similar hit in the vicinity of its Mission Control Center, a space designed to have up to nine personnel on watch during normal operations, according to draft watch station manning documents of USS *Freedom*, the potential loss of more than 20 percent of the core crew could rapidly be achieved.

Another reason for the USS *Stark's* damage control success was a result of the Commanding Officer's insistence that the ship's crew conduct cross-training. Repair lockers trained their sailors to conduct multiple tasks that were normally conducted by other positions, in case of personnel losses within their respective lockers. This training requirement implemented on the USS *Stark* is similar to the US Navy's "hybrid sailor" training concept which implies that a sailor that can do the job of two or three sailors is better. However, the LCS emphasis on cross-training is more focused on better economy rather than increased redundancy as in the case of the USS *Stark.* The much smaller crew of the LCS will, without a doubt, be populated by more versatile sailors, but due to its small size, will not have the redundancy of the USS *Stark's* crew. LCS sailors appear to already be over-leveraged, having to perform multiple tasks on a daily basis in order to accommodate the crew reduction. The loss of only a few "hybrid sailors" could have a large effect on the LCS's performance and survival, especially during a major conflagration.

Finally, this incident further illustrates that even a high technology ship, with an advanced combat system suite, is vulnerable to attack. The Exocet missile, which typically maneuvers to within a few meters above the ocean surface in its terminal phase and travels just under the speed of sound, provides little time to react (Grosick, 1988, 14). The Exocet missile is still a threat to the US Navy surface fleet along with a long list of other more capable missiles. In addition, the LCS will be most likely employed in the littoral waters which present further challenges as a ship faces increased ship density, reduced maneuverability, and reduced stand-off distance, making it even harder to identify the threat and react in time to prevent attack.

<u>Vignette Number Two: USS *Cole*, 12 October 2000</u>

Background

On 12 October 2000, the USS *Cole* (DDG-67) was conducting a routine fuel stop in the harbor of Aden, Yemen, at a water-borne refueling platform known as a dolphin. During the refueling operation a small craft was allowed to approach along the USS *Cole's* port side. The small craft, loaded with explosives, detonated and tore a forty-by-forty-foot hole in the port side of the ship. The resulting hole caused major flooding in the *Cole's* engineering spaces and provided an immediate challenge for the startled crew.

Aggressive actions by the crew to isolate damaged electrical systems and contain fuel ruptures were critical to the prevention of deadly fires which could have resulted in a major conflagration and loss of the ship. The crew continued their damage control efforts in extreme heat and stress for more than ninety-six hours (Global Security Database 2006). On the third day, the ship's portable pumps could no longer stay ahead of the flooding that was rapidly filling the engine rooms. The static head pressure was too great for the small pumps to push the water out of the spaces almost three stories below. The ship was sinking. The ship's crew quickly reacted and began using buckets to remove the water that was flooding the ship: "Technology on the billion-dollar, state-of-the-art warship had failed. The enlisted men began forming a bucket brigade" (Thomas 2001, 2). In an effort to overcome the pump problem, the *Cole's* Executive Officer suggested cutting a hole in the side of the ship just above the waterline in an effort to reduce the work load on the pumps (Thomas 2001, 2). The plan worked. The USS *Cole* successfully dewatered the engineering spaces, an outcome that was critical to the ship's stability.

This would later prove to be one of many examples of how the crew's fast reaction and ingenuity kept the USS *Cole* afloat.

The attack resulted in the death of seventeen sailors and injury of almost twice that number. Due to the extensive damage, the USS *Cole* returned to the United States with the aid of a semi-submersible heavy-lift ship. The ship was repaired, and like the USS *Stark*, eventually returned to service.

USS *Cole* Analysis

The USS *Cole* is a recent reminder that US Navy surface combatants are vulnerable and will remain vulnerable as the United States faces a new and unpredictable enemy. Terrorists will continue to seek out single vulnerabilities and have the advantage of determining when and how they will strike (US Army TRADOC 2005, 4-1). This has certainly made the US Navy's job of mitigating these risks even more complicated.

Several lessons learned that relate to this study are found in the investigation of the USS *Cole* bombing. The investigation found that ships transiting into theater, often traveling thousands of miles between refueling, lacked the time and resources to properly determine the safety of potential locations for port stops. As a result, ships relied heavily on outside support to help detect, disrupt and mitigate terrorist attacks (US DoD 2001, 2). In the case of the LCS, with a reduced crew, this outside support will also be important. With a crew that is already heavily tasked there will be little room for additional crew workload.

Not directly reflected as a lesson learned following the investigation but derived from the crew's actions, is the need to avoid the over-reliance on technology. Following the bombing, with unreliable power, the ship found itself sinking. If not for the ingenuity of the crew and the decision to deviate from standard procedures, the ship may have been lost. Similar to the USS *Stark* example, this study questions the impact this event would have had on a reduced manning ship. Following the loss of over 15 percent of the total crew along with almost no automated damage control capability, could the LCS have survived this attack?

LCS Risk Analysis

Applying the lessons from the USS *Stark* and USS *Cole* this study analyzes the risk of the LCS using the following equation (Risk = Consequence x Likelihood). Each of the risk criteria were placed in a risk evaluation matrix based on both the consequence and the likelihood of each risk criterion occurring. The risk analysis equation indicates that as the likelihood increases from rare to frequent and the consequence of the risk increases from minor to significant, so will the level of risk.

The circle on the matrix in figure 7 identifies where the majority of medium and high risks occur and therefore will be the focus of this study. In addition, assumptions were made to determine what would be the likelihood that each of the risk criteria would not be met. These assumptions are discussed in detail as each risk is analyzed.

The first risk analyzed was reduced manning and the use of “hybrid sailors.” This study found that this manning concept assumes a high level of risk. The likelihood of this risk is high since it will be continuously employed throughout the life cycle of the ship and the impact or consequence will be significant if ship manning does not support mission accomplishment and ship survival. Even though the addition of an aviation detachment, which could add up to twenty personnel to the crew, and the additional personnel associated with individual mission packages called “mission specialist,” could add up to fifteen more, these numbers are deceiving. Since these personnel are not part of the “core crew,” and their presence will fluctuate as the aviation detachments or mission packages embark and disembark, these numbers cannot be relied upon without assuming additional risks. To assume that a crew of seventy-five (core crew plus aviation detachment and mission specialists) will always be present, train together and be able to respond as a well-trained team is unrealistic based on the fluidity associated with the current manning plan.

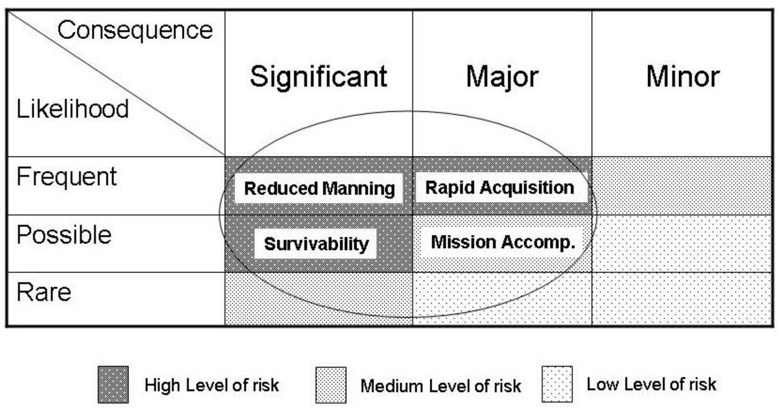

Figure 7. Analysis Matrix for Determining Level of Risk
Modified from Source: “Chapter 3: The Risk Management Process,” *Standards Association of Australia*, 2004, 31; [database on-line]; available from http://www.standards.com.au; Internet; accessed on 15 December 2005.

Therefore, in order to determine the risk that the LCS would have to assume during normal operations due to manning, this study focused on the “core crew” number of forty personnel. It is worth noting that this core crew will consist of blue and gold teams. This two-crew policy will allow for a “shore-based” and “at-sea” rotation where the shore-based crew will be available to rapidly support any manning deficiencies identified by the at-sea crew. The logic behind that design is that a “back-up crew” will help prevent any vital crew manning shortfalls. The two-crew policy will surely help prevent potential personnel gaps due to disciplinary action, emergency leave, or other short-fused loss of personnel; however, when the ship is at sea conducting operations, the forty sailors assigned will be required to complete all assigned tasks on their own without rapid support and crew replacement.

In order to facilitate crew reductions on the LCS, shore facilities will have to assume several functions normally accomplished by a traditionally manned naval combatant. LCS crew will still have to accomplish basic preventative maintenance; however, shore facilities, including the ship’s Immediate Superior in the Chain of Command (ISIC), will have to support the ship much more than in the past (Lundquist 2005, 8). Risks are associated with this model as seen in recent history with the Oliver Hazard Perry-class frigate. When the new frigate, with its reduced manning design, was promised increased shore infrastructure support to help relieve the stress on the crew in the late 1970s, shore facilities were not ready or organized by the time the frigates became operational. As a result, the crews had to assume the additional work load that was originally assigned ashore. The promise that the LCS will have all the necessary shore support to properly offset its reduced crew size has not yet been tested and adds additional risk to the program.

The next risk analyzed was ship survivability. Damage control is a crew-intensive activity and therefore a capability that is closely tied to crew numbers. Recent advances in damage control technology such as remotely operated firefighting systems and “smart” sensors, which can detect and take initial steps in the damage control efforts, will no doubt provide the ability to use sailors in a more efficient manner. However, damage control systems must be extremely reliable and able to survive the rigors of a combat environment in order to be effective. As the previous vignettes illustrate, the high-technology solution to damage control is not always available when a ship suffers extensive damage. Both the USS *Stark* and USS *Cole* survived as a result of their crews' actions. Furthermore, the USS *Cole*, a modern and highly advanced ship, provides an example of a ship's crew who used low technology and innovative methods as the available means to conduct damage control which saved the ship. The inherent risk in reducing the manning on a ship, down to the bare essentials, results in less redundancy and fewer sailors to fight the damage and lend a hand in the ship saving effort. The consequence of a LCS not being capable of recovering from damage resulting from an attack is significant.

The likelihood of future attacks on US naval combatants is without argument high, especially in the congested littoral environment where the ships are exposed to multiple hazards to include mines, small boat attack, shoal water and decreased stand-off distance. Again, the attack on the USS *Cole* reminds the US Navy that the current threat is complex and the enemy will use any means available to strike on a timeline of his choosing; the LCS must be ready.

Next, mission accomplishment was analyzed. In essence, if the ship cannot "stay in the fight" for any reason and fails to complete its assigned mission, it not only fails to complete the mission but also becomes a liability to the other surface combatants operating in company. An inability to accomplish the mission would have major consequences. If the LCS is tasked to operate independently and cannot accomplish the mission, it not only fails the mission, but may present the inability to provide the appropriate level of organic ship survivability.

The mission package that the LCS has installed could make the difference in the ship's ability to properly defend itself against a credible threat. The LCS concept of operations provides insight into this design limitation:

> While the seaframe will include inherent self-defense capabilities, other combat systems will not be permanently installed. Rather, the major elements of the ship's combat system will be embedded in the LCS mission packages and modules. (US DoN 2004a, iii)

For example if an LCS is assigned to conduct antisubmarine warfare in the littorals and has the associated mission module installed, it may be vulnerable to other threats and will have to assume additional risks. Since US Navy commanders have control of where they send the LCS, this will help prevent assigning the ship to a task or environment where it may not be successful. However, due to the dynamic littoral environment the US Navy cannot expect to anticipate all potential threats and required missions. Therefore, how the LCS is configured based on the assessed threat environment will be very important to the ship's success.

Finally, the rapid acquisition timeline of the LCS was analyzed. The LCS design incorporates drastic changes to the way the US Navy has done business in the past such as new technology, reduced manning and new training methods. There will undoubtedly be several changes to the design as the Flight 0 ships become operational. Sufficient time may not be available to incorporate these modifications in follow-on flights (Flight 1 and up) based on the projected six-month acquisition timeline. Future flights are at risk if they cannot benefit from the lessons learned from the initial prototypes. The USS *Freedom* (Flight 0 prototype) is scheduled for delivery from Marinette Marine in 2007; however, follow-on Flight 1 models will be in production only six-months later. Furthermore, the fact that several of the mission modules will not arrive until after ship delivery to the Navy and will therefore be unavailable for testing, presents compelling reasons to slow the acquisition process down (GAO 2005, 21).

The early procurement of the Arleigh Burke-class destroyer, the only US Navy surface combatant in production since FY1989 (O'Rourke 2005, 10), provides a good example of ship design changes that occur during acquisition. The Flight I and II designs of the Arleigh Burke-class destroyer did not have the capability to embark helicopters. After the ships were placed in operation, the US Navy found that the need for this shipboard capability was greatly underestimated and follow-on Flight IIA designs added the facilities to support two SH-60 helicopters. As a result, the first twenty-eight ships in the Arleigh Burke-class do not have this highly valued capability (Polmar 2001, 143). With the radical design changes of LCS there are sure to be modifications that will need to be made. Allowing sufficient time for these modifications to be identified and incorporated will be essential to the improvement of the ship's design.

Using the *Australian and New Zealand STandard 4360* methodology this chapter has established the context and identified and analyzed the risks associated with the LCS. Chapter 5 evaluates the risks, summarizes the study's findings, and provides recommendations for reducing the risks that are present in the LCS design. The next chapter also offers recommendations for further study on this topic.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

The arrival of the first LCS, the USS *Freedom*, will present a new chapter in US naval history. When USS *Freedom* becomes operational in 2007, it will represent the first ship designed from the ground up for reduced manning and the first of a new family of surface combatants built to face the future maritime threat. With the proposed ship class of up to fifty-five total ships, the US Navy needs to make sure that the LCS is successful. The purpose of this research was to explore the current risks associated with the LCS and to continue the discussion and debate on the utility of this ship. As mentioned in chapter 4, there are several compelling reasons for the radical changes incorporated in the LCS design; however, a better understanding of the risks that the ship and crew will assume is vital to the proper use of this new platform and will help ensure the safety of both. This study does not advocate the complete mitigation of the risks associated with the LCS, but strives to increase the overall awareness of these risks. The risk of combining so many new and untested elements on a single ship must be understood by all of those who are involved in its implementation. Finally, as the first reduced manning ship in a family of future ship construction (DD(X) and CG(X)), the spotlight is on the LCS. Lessons learned from the LCS will directly affect follow-on ship designs and the decision to continue the use of reduced manning.

In chapter 4, the *Australian and New Zealand STandard* model was used to identify the risks associated with the LCS. After several risks were reviewed using a strengths, weaknesses, opportunities and threats (SWOT) analysis, four risk evaluation criteria were identified with their associated objectives: survivability, reduced manning with "hybrid sailors", mission accomplishment, and acquisition timeline. Next, these individual risk criteria were analyzed and ranked. In addition, two vignettes were used to provide historical examples of the risks that were similar to those that the LCS will face. These examples are a reminder that warships should be designed for war and should have the ability to survive a hit, continue fighting, and return home safely. This chapter evaluates the identified risks, provides suggestions for risk treatment or mitigation, and concludes with recommendations for further research.

Evaluate the Risk

As mentioned in chapter 4, not all risks are considered negative. As the SWOT analysis illustrates, positive risks resulting in strengths and opportunities have some very attractive features. This being said, the US Navy is assuming a high level of risk with the LCS reduced manning design. The following paragraphs summarize the study's findings following the comparison of the original risk criteria with the risks found during the analysis. This evaluation also answers the secondary questions of this study. Table 3 represents a summary of the LCS risk evaluation.

In the case of reduced manning and the use of "hybrid sailors" this study found that there are several variables that will affect the overall risk. Many of these variables are still in their early stages of development. The training of the new hybrid sailor has just begun and the sailors that will report to the USS *Freedom* are only now beginning to pool their skills for a ship that is still being built.

Table 3. Risk Evaluation Summary

Risk Evaluation Summary

Risk Criterion (in order of priority)		Research Questions	Findings (Accept or Treat?)
Reduced Manning and Hybrid Sailors	↑ INCREASED RISK	What level of risk is the Navy assuming with the Littoral Combat Ship reduced manning design?	• High level of risk assumed
		Will the multi-tasked "hybrid sailor" have sufficient skills and support to compensate for the reduced manning onboard the LCS without assuming too much risk?	• TBD – Monitor crew morale closely to ensure we are not overburdening our ship crews and that they are sufficiently supported from shore
Survivability		In the hostile environment of the littorals, is the LCS assuming too much risk with its ability to conduct damage control and recover from a mass conflagration?	• Yes – (Treat) Train crews extensively on damage control while avoiding excessive reliance on high-technology solutions
Mission Accomplishment		Will the LCS have the necessary capability to allow it to accomplish its mission in the littorals while operating independently without assuming excessive risk?	• No – (Treat) Avoid mission creep by educating Navy planners/leaders on the proper use of the LCS to limit excessive exposure to risks
Acquisition Timeline		Will the rapid acquisition timeline of the LCS assume too much risk by not allowing follow-on designs to benefit from the initial Flight 0 prototype?	• Yes - (Treat) Slow down acquisition process in order to fully benefit from Flight 0 production

Furthermore, the shore infrastructure that promises to support and relieve a significant burden from the LCS sailors is still waiting for the first ship to come off the production line. However, this does not remove the risks that will be present as these two pieces of the puzzle come together. This study recommends that this process be closely monitored as the first Flight 0 ships become operational. It is extremely important that these newly designed crews are fully supported. If they are not, the loss of crew morale will surely degrade the ships' mission capability.

With regards to ship survivability, the study found that the LCS is assuming a high level of risk. Attempting to provide sufficient ship survivability with a reduced crew size while operating in the high-threat environment of the littorals, involves risk. The two vignettes used in this study further illustrate the complexity of this problem. The USS

Cole and the USS *Stark* were saved due to an aggressive crew who fought for the ship's life when computers and automation failed. Focused damage control training with an emphasis on innovative solutions, while reducing the over-reliance on modern technology to solve the problem, is the way to treat this risk. In addition, closely monitoring the lessons learned from initial Flight 0 prototypes will help to facilitate the improvement and survivability of follow-on designs. Increasing the number of "core crew" if necessary to make the ship safer may be the long range solution as the US Navy begins to truly understand the rigors this ship and reduced crew will face. In today's volatile world, the US Navy will never be able to mitigate all the risks with any ship design; however, this ship will eventually find itself in a major conflagration situation and it must be ready. With a future LCS fleet consisting of up to fifty-five ships, there is a lot at stake.

Closely related to ship survivability is the ship's ability to accomplish its mission. For a ship that is highly dependant on outside support, proper mission assignment is critical to reduce risk. Furthermore, if the LCS is tasked to operate independently, where outside support is even more limited, the ship will assume the greatest risk. Here again, the US Navy is in the position to mitigate some of this risk. Operational commanders as well as planners should be ultimately familiar with the capabilities and limitations of the LCS in order to prevent the ship from being over-tasked. Ship limitations based on crew size and mission package configurations are not in the current Navy culture. This culture change will have to occur in order to protect the LCS from operating outside of its capabilities and limitations and assuming too much mission risk.

Finally, the rapid acquisition timeline of the LCS will limit the proper integration of lessons learned from initial Flights 0 prototypes and therefore assumes too much risk. This process should be slowed down in order to sufficiently allow design changes to be incorporated in follow-on Flight 1 designs. The LCS platform represents a large combination of new changes in ship design. There are likely to be several improvements required as the US Navy tests the initial prototype. The chapter 4 example of the Arleigh Burke-class destroyer is a reminder that sometimes these initial prototypes result in major design changes. Delaying the initial LCS designs for additional testing, and not immediately filling the littoral mission gap capability, may be a better choice that results in a better Flight 1 ship design. Furthermore, if the initial prototypes determine that the manning is not sufficient on the LCS and needs to be increased, berthing design changes may be necessary. These changes will most likely require large modifications in the ship design, changes that would present significant challenges under the current timeline.

Conclusions

The four risk evaluation criteria present a considerable amount of risk for the LCS. However, a majority of these risks can be treated by education, close monitoring and prudent use of the LCS. To treat the LCS as simply another new weapon system without due regard for the significant changes that it presents would, without a doubt, present unacceptable risks for the LCS. These changes are not only in the area of technology and procedure, but also include the cultural changes and the mental shift in how the US Navy has been doing business for the past several decades. Previous surface combatants have been multi-mission capable whereas the LCS uses modular "plug and fight" technology that will require greater planning timelines as ships are required to reconfigure for different missions. Also, the potential loss of the “traditional control” associated with a ship’s commanding officer (CO) will present a new challenge. As a result of the LCS’s heavy dependence on the shore facilities to not only relieve the work load on its reduced crew but also to provide an increased number of required services necessary in order to keep the ship operational, the CO will be even further removed from the driver’s seat. CO’s have traditionally held full responsibility for their ships and their job will become more difficult as they find themselves in less control.

This study found definite value in the reduced manning design and its ability to better utilize personnel along with the use of “hybrid sailors.” However, the results indicated a high level of risk that should be recognized by all of those who are involved in the application of the LCS. Based on the results of this study, the US Navy should proceed with the LCS cautiously. As the US Navy moves aggressively towards the future, it would be unwise to rush ship acquisition considering many of the elements that comprise the ship are new and untested both physically and culturally.

It is impossible to mitigate all risks present with any ship design, especially a naval combatant in a navy with a finite budget; however, understanding the risks and developing an awareness of their combined effects will help to mitigate the risks that this study identified. Those involved with the LCS in the future would be well served to understand these risks, especially during the early years of development when combining so many new and different elements. It is this study’s recommendation that the LCS be given considerable time for testing and training. There is little doubt that the LCS, even with the longest timeline, will require some changes; however, the goal should be to avoid large-scale design changes. A rush to full-mission status without the benefits of a full utilization of the prototypes could present exceptional risks, risks that are not worth taking. The success of the LCS may very well rely on training and ship design; this ship needs sufficient time to develop and refine both.

Risk assessment and management is an on-going process and requires continual review. Following the USS *Cole* bombing, Secretary of the Navy Richard Danzig recognized the need to understand risk and make sure that it was in balance. "Secretary Danzig asked the CNO to work with the joint staff and within the Navy to strengthen procedures assuring that risk is repeatedly recognized, reassessed and balanced." (Cole 2001, 11) The need to recognize, and constantly reassess the risks that are present with the LCS cannot be over-emphasized. As the operation environment and threats change, the risk that the LCS will assume will also change. Only by careful monitoring and reassessing can the US Navy provide the protection that the LCS deserves.

Recommendations for Further Research

Based on the limitations of this study, mentioned in chapter 1, there were several other risk-producing areas on the LCS that were not covered. For example, there are risks associated with the materials used in ship design. The Lockheed Martin LCS design will center on a steel monohull whereas the General Dynamics design will focus on an all-aluminum trimaran hull. Additional study of the pros and cons based on these two designs and their selected materials would be helpful in determining additional LCS risk exposure. Moreover, based on the challenges that the USS *Stark* faced following her attack as several areas of the aluminum superstructure reached melting point, the use of different materials will be important when determining risk.

Additional research could also focus on specific ship features and new technologies as part of the General Dynamics and Lockheed Martin designs. During the writing of this study many of the design specifics were either unavailable or not releasable to the public due to the design competition between the two shipbuilders. As more information becomes available and decisions are made as to which design is awarded contract for follow-on flights, more detailed research into the risks associated with specific design features and technologies could be conducted. In addition, as LCS sister ships get closer to production, research similar to this study needs to be conducted on the future destroyer and cruiser (DD(X) and CG(X)) designs.

Another recommendation for additional research involves revisiting this study's questions again after the initial Flight 0 prototypes become operational. The availability of actual test results would be beneficial in answering this study's question about the long-term effect of reduced manning and the use of the "hybrid sailor." This study's recommendation in reference to this question was to monitor their progress closely; future research could accomplish this and continue a productive dialogue on this topic.

The US Navy needs to continue to take heed of Secretary Danzig's words following the USS *Cole* bombing. The US Navy needs to continue the effort of recognizing and reassessing the risks associated with its ships and especially the new LCS design. Only by continually revisiting this topic will the US Navy be certain to recognize and rebalance these risks as necessary.

APPENDIX A

EXAMPLES OF LITTORAL COMBAT SHIP MISSIONS

Focused missions **Examples of tasks**

Littoral mine warfare • Detect, avoid, and/or neutralize mines
• Clear transit lanes
• Establish and maintain mine cleared areas

Littoral antisubmarine warfare • Detect all threat submarines in a given littoral area
• Protect forces in transit
• Establish antisubmarine barriers

Littoral surface warfare • Detect, track, and engage small boat threats in a given littoral area
• Escort ships through choke points
• Protect joint operating areas

Inherent Missions

Battle space awareness • Intelligence, surveillance, and reconnaissance

Joint littoral mobility • Provide transport for personnel, supplies and equipment within the littoral operating area

Special operations forces support • Provide rapid movement of small groups of special operations forces personnel
• Support hostage rescue operations
• Support noncombatant evacuation operations
• Support and conduct combat search and rescue

Maritime interdiction/interception • Provide staging area for boarding teams
• Employ and support MH-60 helicopters for maritime interdiction operations
• Conduct maritime law enforcement operations, including counternarcotic operations, with law enforcement detachment

Homeland defense • Perform maritime interdiction/interception operations in support of homeland defense
• Provide emergency, humanitarian and disaster assistance
• Conduct marine environmental protection
• Perform naval diplomatic presence

Antiterrorism/force protection • Perform maritime interdiction/interception operations in support of force protection operations
• Provide port protection for U.S. and friendly forces and protection against attack in areas of restricted maneuverability

Source: GAO Report 05.255.2005. *See* U.S. Government Accountability Office (GAO). 2005.

WORKS CITED

Cavas, Christopher. 2005. U.S. Ship Plan to Cost 20% More: Price Control will be Key to Finding 313-Vessel Fleet. Article on-line. Available from http://defensenews.com. Internet. Accessed on 14 March 2006.

Clark, Vern. 2002. Sea Power 21: Projecting Decisive Joint Capabilities. *United States Naval Institute Proceedings* 128, no. 10:31-41.

Cole, Dick, and Joseph Gunder. 2001. USS Cole: Where Do We Go From Here? *Surface Warfare* 26, no. 1:11.

Global Security Database. DDG 67 Cole: Determined Warrior. Article on-line. Available from http://www.globalsecurity.org/military/agency/navy/ddg-67.htm. Internet. Accessed on 9 February 2006.

GAO Report 05.255.2005. *See* U.S. Government Accountability Office (GAO). 2005.

Grosick, Frederick, Patrick Massey, and Mark Peterson. 1988. *Harpoon Employment in Naval Antisurface Warfare (ASUW)*. Alabama: Air University, United States Air Force. Accession Number: AD-A202-045.

Harris, Paul. 2005. Training’s New Wave: The U.S. Navy aims to ensure that a fully trained sailor is always in the right place at the right time. *Training and Development Magazine,* August, 45-48.

Henson, Susan. 2005. LCS Crew to be Hybrid Sailors. *All Hands Magazine*, 12 July, 1.

Hinkle, James, and Terry Glover. 2004. *Reduced Manning in DDG 51 Class Warship: Challenges, Opportunities and the Way Ahead for Reduced Manning on all United States Navy Ships*. Arlington: Anteon Corporation. OMB No 074-0188.

Klain, David. 1999. How Can we Save Ships with Small Crews? *United States Naval Institute Proceedings* 125, no. 9:66-69.

Levinson, Jeffery, and Randy Edwards. 1997. *Missile Inbound: The Attack on the Stark in the Persian Gulf.* Maryland: Naval Institute Press.

Lindquist, Edward. 2005. First Littoral Combatant Taking Shape in Midwest. *Surface Warfare* 30, no. 4:6-11.

Moran, Kevin. 2005. Sea Warrior: A True Revolution in Training, interview with Vice Admiral J. Kevin Moran, Commander, Naval Education and Training Command. *CHIPS Magazine,* October-December, 10.

NTTP 3-20.31. 2004. *See* U.S. Department of the Navy, Officer of the Chief of Naval Operations. 2004.

O'Rourke, Ronald. 2005. *Navy DD(X), CG(X), and LCS ship Acquisition Programs: Oversight Issues and Options for Congress.* The Library of Congress, Congressional Research Service. Order Code-RL32109.

________. 2006. *Navy Littoral Combat Ship (LCS): Background and Issues for Congress*. The Library of Congress, Congressional Research Service. Order Code-RS21305.

Peoships Littoral Combat Ship. 2006. Lockheed Martin and General Dynamics LCS Designs, Database on-line. Available from http://peoships.crane.navy.mil. Internet. Accessed on 14 March 2006.

Polmar, Norman. 2001. *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet.* Maryland: Naval Institute Press.

Schank, John, Roland Yardley, Jessie Riposo, Harry Thie, Edward Keating, Mark Arena, Hans Pung, John Birkler, and James Chiesa. 2005. Options for Reducing Costs in theUnited Kingdom's Future Aircraft Carrier (CVF). Article on-line. Available from http://www.rand.org. Internet. Accessed on 14 March 2006.

SkillsNET Corporation. 2006. Database on-line. Available from http://www.skillsnet.com. Internet. Accessed on 14 March 2006.

Standards Association of Australia. 2004. Chapter 3: The Risk Management Process (AS/NZS 4360). Available from http://www.standards.com.au. Internet. Accessed on 15 December 2005.

Thomas, Evan, and Sharon Squassoni. 2001. Desperate Hours: The Blast Claimed 17 Lives and Crippled a Destroyer. The Inside Story of the Heroic Bid to Save the USS Cole. *Shipmate*, June, 9-13.

U.S. Army Training and Doctrine Command. 2005. *Terror Operations: Case Studies in Terrorism,* DCSINT Handbook No 1.01, 4-1 to 4-13.

U.S. Congress. House. Committee on Armed Services House of Representatives. 1987. *Report on the Staff Investigation into the Iraqi Attack on the USS Stark.* 100th Cong., 1st sess., Committee Print 8.

U.S. Department of Defense. 2001. *USS Cole Commission Report Executive Summary.* January.

U.S. Department of the Navy. 2003a. Navy Warfare Development Command. Littoral Combat Ship Concept of Operations, V3.1. Article on-line. Available from http://www.nwdc.navy.mil. Internet. Accessed on 14 March 2006.

________. 2003b. *Preliminary Design Interim Requirements Document for Littoral Combat Ship (LCS) Flight 0*. February, Serial no. N763F-S03-026.

________. 2004a. *Littoral Combat Ship Concept of Operations*, December.

________. 2004b. Officer of the Chief of Naval Operations. NTTP 3-20.31, *Navy Tactics, Techniques, and Procedures (NTTP), Surface Ship Survivability* Newport, RI: DCNO, October.

U.S. Government Accountability Office. 2005. *Defense Acquisitions: Plans Need to Allow Enough Time to Demonstrate Capability of First Littoral Combat Ships*. March. GAO-05-255.

Wise, Alexis. 2003. Militarizing Commercial Automation for Integrated Power System Warship Command and Control, 5 December 2003. Article on-line. Available from, http://nerc.aticorp.org/papers/warships.pdf.

SOURCES CONSULTED

Bennis, P.M. 1994. Aftermath of a Tragedy. *Fathom*, July-August, 24.

Bost, Robert, and George Galdorisi. n.d. Transforming Coalition Naval Operations by Using Human Systems Integration to Reduce Warship Manning: Lessons Learned from the United States Navy DDG 51 Warship Reduced Manning Study. California: The Ninth International Command and Control Research and Technology Symposium. Available from http://whitepapers.silicon.com. Internet. Accessed on 14 March 2006.

Bost, Robert, James Mellis, and Philip Dent. n.d. Is the Navy Serious about Reducing Manning on Its Ships? Available from http://www.manningaffordability.com. Internet. Accessed on 14 March 2006.

Cloud, David. 2005. Navy to Expand Fleet with New Enemies in Mind. *New York Times*, 5 December.

Cordle, John. 2001. Manning DD-21. *United States Naval Institute Proceedings* 127, no. 2:59-61.

Enockson, Elizabeth. 2005. PCU Freedom, Hybrid Sailors Experience New Way of Training. Navy Newsstand. Available from http://www.news.navy.mil. Internet. Accessed on 14 March 2006.

Garza, Michael A. 2001. DD21 Land Attack Destroyer: Effect of Reduced Crew on Damage Control. Master of Military Art and Science thesis, U.S. Army Command and General Staff College, Ft. Leavenworth, KS.

Kaufman, A. I., J. T. Buontempo, J. F. Nance, S. M. Ouellette, and E. Zdankiewicz. 2004. *How Many Sailors to Man a Surface Combatant?* Alexandria, VA: Institute for Defense Analyses. IDA Paper P-3782.

Lavell, Kit. 2003. New Technology Transforming Naval Power. Available from http://www.signonsandiego.com. Internet. Accessed on 14 March 2006.

Lehmann, John. 2004. Will the Littoral Combat Ship Pass Muster? *United States Naval Institute Proceedings* 130, no. 6:71.

Stubbs, Bruce. 2005. Smarter Security for Small Budgets. *United States Naval Institute Proceedings* 131, no. 8:37-41.

Sweetman, Bill. 2005. Small, Speedy, Shallow LCS Signals Major Shift. *International Defense Review*, November.

U.S. Congressional Budget Office. 2003. *Transforming the Navy's Surface Combatant Force*. The Congress of the United States, March.

Vining, Pierre. 1999. Can a Minimum-Manned Ship Survive Combat? *United States Naval Institute Proceedings* 125, no. 4:80-83.

INITIAL DISTRIBUTION LIST

Combined Arms Research Library
U.S. Army Command and General Staff College
250 Gibbon Ave.
Fort Leavenworth, KS 66027-2314

Defense Technical Information Center/OCA
825 John J. Kingman Rd., Suite 944
Fort Belvoir, VA 22060-6218

Mr. Robert M. Brown
DJMO
USACGSC
1 Reynolds Ave.
Fort Leavenworth, KS 66027-1352

Mr. Phillip G. Pattee
DJMO
USACGSC
1 Reynolds Ave.
Fort Leavenworth, KS 66027-1352

Dr. Ronald E. Cuny
DGDP
USACGSC
1 Reynolds Ave.
Fort Leavenworth, KS 66027-1352

CERTIFICATION FOR MMAS DISTRIBUTION STATEMENT

1. Certification Date: 16 June 2006

2. Thesis Author: LCDR Jonathan C. Russell, USN

3. Thesis Title: The Littoral Combat Ship: Is the US Navy Assuming Too Much Risk?

4. Thesis Committee Members: Robert M. Brown, M.M.A.S. ______________________

Signatures: Phillip G. Pattee, M.M.A.S. ______________________

Ronald E. Cuny, Ph.D. ______________________

5. Distribution Statement: See distribution statements A-X on reverse, then circle appropriate distribution statement letter code below:

(A) B C D E F X SEE EXPLANATION OF CODES ON REVERSE

If your thesis does not fit into any of the above categories or is classified, you must coordinate with the classified section at CARL.

6. Justification: Justification is required for any distribution other than described in Distribution Statement A. All or part of a thesis may justify distribution limitation. See limitation justification statements 1-10 on reverse, then list, below, the statement(s) that applies (apply) to your thesis and corresponding chapters/sections and pages. Follow sample format shown below:

EXAMPLE

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
Direct Military Support (10)	/	Chapter 3	/	12
Critical Technology (3)	/	Section 4	/	31
Administrative Operational Use (7)	/	Chapter 2	/	13-32

Fill in limitation justification for your thesis below:

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
	/		/	
	/		/	
	/		/	
	/		/	
	/		/	

7. MMAS Thesis Author's Signature: ____

STATEMENT A: Approved for public release; distribution is unlimited. (Documents with this statement may be made available or sold to the general public and foreign nationals).

STATEMENT B: Distribution authorized to U.S. Government agencies only (insert reason and date ON REVERSE OF THIS FORM). Currently used reasons for imposing this statement include the following:

1. Foreign Government Information. Protection of foreign information.

2. Proprietary Information. Protection of proprietary information not owned by the U.S. Government.

3. Critical Technology. Protection and control of critical technology including technical data with potential military application.

4. Test and Evaluation. Protection of test and evaluation of commercial production or military hardware.

5. Contractor Performance Evaluation. Protection of information involving contractor performance evaluation.

6. Premature Dissemination. Protection of information involving systems or hardware from premature dissemination.

7. Administrative/Operational Use. Protection of information restricted to official use or for administrative or operational purposes.

8. Software Documentation. Protection of software documentation - release only in accordance with the provisions of DoD Instruction 7930.2.

9. Specific Authority. Protection of information required by a specific authority.

10. Direct Military Support. To protect export-controlled technical data of such military significance that release for purposes other than direct support of DoD-approved activities may jeopardize a U.S. military advantage.

STATEMENT C: Distribution authorized to U.S. Government agencies and their contractors: (REASON AND DATE). Currently most used reasons are 1, 3, 7, 8, and 9 above.

STATEMENT D: Distribution authorized to DoD and U.S. DoD contractors only; (REASON AND DATE). Currently most reasons are 1, 3, 7, 8, and 9 above.

STATEMENT E: Distribution authorized to DoD only; (REASON AND DATE). Currently most used reasons are 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10.

STATEMENT F: Further dissemination only as directed by (controlling DoD office and date), or higher DoD authority. Used when the DoD originator determines that information is subject to special dissemination limitation specified by paragraph 4-505, DoD 5200.1-R.

STATEMENT X: Distribution authorized to U.S. Government agencies and private individuals of enterprises eligible to obtain export-controlled technical data in accordance with DoD Directive 5230.25; (date). Controlling DoD office is (insert).