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Development of a cost effective organizational model for the shipbuilding welder labor workforce

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NAVAL POSTGRADUATE SCHOOL

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THESIS

DEVELOPMENT OF A COST EFFECTIVE ORGANIZATIONAL MODEL FOR THE SHIPBUILDING WELDER LABOR WORKFORCE

by

Michael S. Stegelman

September 2009

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13. ABSTRACT (maximum 200 words)

For the past twenty-five years, the United States shipbuilding industry has experienced a slow decay in both hiring and retaining critical skilled professionals. One of the most critical skills required to fabricate a ship is welding, as welders play a major role in shipbuilding, from pre-fabrication to delivery. Many factors can be identified with the cause of this reduction in the welder workforce. These factors include technology enhancement, outsourcing, growth of optional career opportunities, and family pressure. The latter factor is identified as playing a role in reducing initial accessions within the Department of Defense. Military recruiters have been required to alter their tried and true recruitment strategies. Parents, who do not wish to see their children subjected to the violence of war or to serve within, what they perceive, as a low return on investment career, are pushing their children away from military service in favor of continued education or careers in the private sector. This phenomenon is not unlike the pressures that potential welders receive from their own families. Shipbuilding is a demanding profession, requiring a level of mental and physical toughness not necessarily found in most manufacturing industries. Under the best conditions, commercial welding is challenging; it requires manual dexterity and mental visualization skills, as well as years of experience. Given the existing conditions in most shipyards, marine welding is even more challenging. These skilled craftsmen work in hot, tight, poorly-lit spaces, often working around corners with no clear line of sight to their work. Yet, the expectations of first-time, "perfect" quality is a hard requirement. For years, shipyards around the country relied upon third- and fourth-generation welders to replace their ranks caused by attrition. But due to the factors presented, these companies must employ new strategies to combat losses in its workforce. One such strategy is to better define requirements traceable to period and cumulative scope of work, and to formulate a more responsive organizational structure to meet this need so that the right number and the right skill sets can be targeted for recruiting and retention goals. This thesis identifies attributes within military organizations that could aid in the development of a similar organizational model for use in shipbuilding.

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DEVELOPMENT OF A COST EFFECTIVE ORGANIZATION MODEL FOR THE SHIPBUILDING WELDER LABOR WORKFORCE

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ABSTRACT

For the past twenty-five years, the United States shipbuilding industry has experienced a slow decay in both hiring and retaining critical skilled professionals. One of the most critical skills required to fabricate a ship is welding, as welders play a major role in shipbuilding, from pre-fabrication to delivery. Many factors can be identified with the cause of this reduction in the welder workforce. These factors include technology enhancement, outsourcing, growth of optional career opportunities, and family pressure. The latter factor is identified as playing a role in reducing initial accessions within the Department of Defense. Military recruiters have been required to alter their tried and true recruitment strategies. Parents, who do not wish to see their children subjected to the violence of war or to serve within, what they perceive, as a low return on investment career, are pushing their children away from military service in favor of continued education or careers in the private sector. This phenomenon is not unlike the pressures that potential welders receive from their own families. Shipbuilding is a demanding profession, requiring a level of mental and physical toughness not necessarily found in most manufacturing industries. Under the best conditions, commercial welding is challenging; it requires manual dexterity and mental visualization skills as well as years of experience. Given the existing conditions in most shipyards, marine welding is even more challenging. These skilled craftsmen work in hot, tight, poorly-lit spaces, often working around corners with no clear line of sight to their work. Yet, the expectations of first-time, “perfect” quality is a hard requirement. For years, shipyards around the country relied upon third- and fourth-generation welders to replace their ranks caused by attrition. But due to the factors presented, these companies must employ new strategies to combat losses in its workforce. One such strategy is to better define requirements traceable to period and cumulative scope of work, and to formulate a more responsive organizational structure to meet this need so that the right number and the right skill sets can be targeted for recruiting and retention goals. This thesis identifies attributes within military organizations that could aid in the development of a similar organizational model for use in shipbuilding.

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LIST OF ACRONYMS AND ABBREVIATIONS

ABS	American Bureau of Shipbuilding
ACE	Aviation Combat Element
ASR	Authorized Strength Report
AWS	American Welding Society
CPh	Construction Phase
ES	End Strength
ESGM	Enlisted Staffing Goal Model
ESGR	Enlisted Staffing Goal Report
GAR	Grade Adjusted Recapitulation
GCE	Ground Combat Element
LCpl	Lance Corporal
MAGTF	Marine Air Ground Task Force
MCCDC	Marine Corps Combat Development Command
METL	Mission Essential Task List
MGCSC	Mississippi Gulf Coast Shipbuilding Corridor
MMEA	Marine Manpower Enlisted Assignments
MOS	Military Occupational Specialty
NAM	National Association of Manufacturing
NSRP	National Shipbuilding Research Program
OccFldSpo	Occupational Field Sponsor
OIF	Operation Iraqi Freedom
OPFOR	Operational Forces
SG	Staffing Goal
Sgt	Sergeant
T2P2	Trainees, Transients, Patients, Prisoners
TIG	Tungsten Inert Gas
TO&E	Table of Organization and Equipment
USMC	United States Marine Corps

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EXECUTIVE SUMMARY

Shipbuilding, as an industry, is a blend of both automated production processes and labor-intensive manual crafts. Of the latter, none is more difficult or demanding than marine welding. Technology insertion, including automatic seam welders, have replaced a portion of manual welding functions, but hand welding remains a vital and necessary element in ship construction. The demands of welding coupled with external career opportunities offering higher pay and cleaner work environments present challenges in both recruitment and retention. The strategy proposed in this thesis is to develop an organizational model for maritime welders based on requirements and structure found in the United States Marine Corps (USMC). All USMC organizational structures are based on three distinct components: the Table of Organization (T/O), Mission Essential Task Lists (METLs'), and the Table of Equipment (T/E), commonly referred to as the TO&E. USMC organizations including ground, aviation or support, have within their basic structure an assortment of Military Occupational Specialties (MOS). As an example, aviation squadrons have MOS mixes that include pilots, aircraft mechanics, logisticians, intelligence analysts and operation clerks. All of these skills sets are then matched with a rank/pay grade and become a TO&E structure. These skill sets and ranks are by no means absolute, but do provide a basic framework to support the employment and maintenance of the authorized equipment in training and combat environments. Elements within the USMC TO&E and associated manpower directives have the potential to support and enhance the development of welding organizations to more successfully meet scope of work requirements.

Marine welding organizations are functional in nature, designed to provide numerous welding applications throughout the ship construction cycle. The potential exists to incorporate practical USMC manpower organizational elements to enhance welder's ability to meet requirements set forth by the construction schedule. This thesis describes the challenging aspects of marine welding, suggests opportunities for improvement through enhanced organizational development and proposes a strategy to create a more effective recruitment and retention practice for marine welders.

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I. INTRODUCTION

A. BACKGROUND

The manufacturing industry, in general, is experiencing a shortage of workers in the skilled labor workforce. Employment advertisements for positions as welders, electricians and pipefitters can be found in newspapers, magazines and on billboards across the country. Richard Sennett, a New York University sociologist, stated that "employers are looking for people who have acquired an exacting skill, first through education—often just high school vocational training—and then by honing it on the job. That trajectory, requiring years, is no longer an easy task in America" (Uchitelle, 2009). Exactly when the United States began its transformation from a manufacturing-based economy to a technology-driven one is debatable. It is evident that a movement occurred that lured future craftsman away from seeking skilled careers as skilled laborers to those demanding less physical strength, dexterity and a cleaner and safer working environment.

Shipbuilding is unique within the realm of heavy industry. Unlike many other forms of product manufacturing, to include auto making and the aircraft industry, ships—especially combatant naval vessels—require a high percentage of manual labor. In general, shipbuilding can accommodate only a limited amount of technology within the construction process. As construction of a ship progresses, the magnitude, size and impact of technological devices decreases. In early stages of construction, large mechanical cutters and welders shape individual plates of steel into the complex structures that form the ship's hull. This equipment is housed in large open areas or covered buildings. The movement of personnel is unconstrained in these environments. As the steel plates mature in both form and shape, craftsmen begin the integrated process of unit construction and outfitting. Many production strategies incorporate the stacking of multiple units to create large modules, thereby increasing the outfitting opportunities and allowing increased integration prior to joining the units into the hull of the ship. As each unit or module is attached into larger more complex elements, workspaces become limited and cramped, thus increasing the level of hands-on work required within the construction spaces. It is the skilled labor piece, especially for experienced marine trained welders, that present the greatest challenge to the shipbuilding industry.

B. PURPOSE

According to the Mississippi Gulf Coast Shipbuilding Corridor (MGCSC) study (2005), in the early 1980s there were more than 200 major new construction or repair shipyards in the U.S., with a combined workforce of more than 112,000 workers. Two decades later, the numbers dropped to just over 80 yards, with a significantly lower total workforce (MGCSC, 2005). The preponderance of those affected in this 41 percent decrease in the labor pool were people with skills as marine pipefitters, electricians and welders. As an example of the impact resulting from these shipyard realignments, consider the effect felt on the East Coast. In 1982, the East Coast had 41 shipyards; by 2005, that figure had dropped to 27 yards, a loss of 34 percent (Figure 1). As shipyards declined in numbers, so did the skilled labor pool supporting their efforts (MGCSC, 2005).

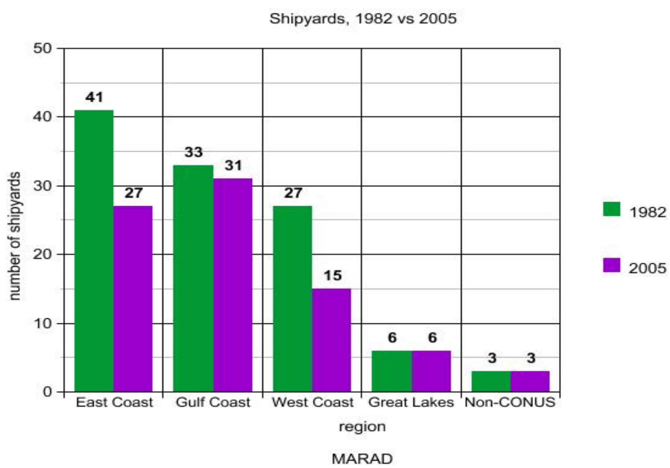

Figure 1. Realignment of U.S. Shipyards between 1982 and 2005 (MGCSC, 2005)

The impact of this realignment had a dual effect. First, the skilled marine craftsman directly affected by losing their jobs lost proficiency in their craft, either through atrophy or by entering another industry other than shipbuilding. Secondly, the number of future craftsman was reduced purely due to the lack of career potential within a contracting and seemingly unstable industry. The pool of skilled craftsmen, many of whom belonged to fourth- and fifth-generation shipbuilding families, were no longer influenced to continue in the shipbuilding tradition and were thus being motivated by family, friends, and the environment to seek employment in other more stable and less demanding career paths, as discussed below:

> According to officials at the National Association of Manufacturing (NAM), a twofold problem in attracting young people to skilled trades include outmoded stereotypes of Henry Ford-style assembly lines and the widely held belief that four-year degrees are prerequisites for success. Teachers and parents promote four-year degrees as a ticket to success, but that belief is disconnected from the career trends emerging in today's economy. (NAM, 2009)

The report goes on to make the case that manufacturing actually conjures up mental images of dirty, rust-ridden factories and atrocious working conditions, all for little to no pay (NAM, 2009). As these stereotypes and misconceptions continue, the movement away from heavy manufacturing will continue as workers seek more white collar-type careers. This adjustment in the U.S. labor base continues to affect shipbuilding. Many industries are employing foreign labor to fill gaps in recruitment and retention.

As the need for skilled labor increases and the shortages in craftsmen, especially marine welders, continue, new strategies must be incorporated to meet current and future need. This thesis will provide methods and strategies to maximize available labor through capitalizing on best practices employed by Marine Corps manpower agencies. The use of military type manpower initiatives and procedures within civilian industry will be limited, due to the nature of the Marine Corps mission. Therefore, only segments of USMC organizational development will be pertinent and applicable to shipbuilding and the welder workforce organization. Any application must be centered on development of an organization that is flexible to changing requirements, identifies its workforce based upon well defined skill sets and proficiency levels and provides a cost effective model that is repeatable and predictive.

C. RESEARCH QUESTIONS

Thisthesis addresses the following questions:

1. How does the Marine Corps organize its units and meet manpower requirements?
    - Organizational structure?
    - Definition of needed skills?
2. How does the shipbuilding industry organize its marine welder workforce and meet manpower requirements?
    - Organizational structure?
    - Definition of needed skills?
3. What elements or attributes of the Marine Corps organizational model can transfer and benefit the shipbuilding industry and its welding organization?
    - Tables of Organization?
    - Mission Essential Tasks Lists?
4. How might a functional organization framework, based upon USMC policy aid marine welder organizations in better satisfying requirements while minimizing cost impact to the shipbuilding industry?

D. BENEFITS OF STUDY

This thesis will provide a basis of knowledge that can be leveraged by other commercial industries to enhance their organizational structure and maximize workforce performance. The knowledge presented in the study will transfer to other critical craft skills and labor workforces, particular within the shipbuilding and marine fabrication industry, to meet capacity requirements meeting schedule and costs objectives.

E. SCOPE AND METHODOLOGY

This thesis will focus on the marine welding profession and how Marine Corps organizational concepts could be implemented within the shipbuilding industry to maximize the available labor workforce. It will attempt to identify several characteristics of Marine Corps organizational structures and apply them to marine welder organizations. Much of the analysis will be dependent on data obtained from literature, knowledge of the marine industry, the Bureau of Labor and Statistics, interviews of subject matter experts, and past experience of the author within USMC operational units and manpower directorates at the Marine Corps Headquarters level.

The primary text to be utilized in this effort for Systems Engineering methods, guidance, direction and approach is the Fourth Edition of Blanchard and Fabrycky's *Systems Engineering and Analysis* (2006). Specific areas of interest are the Systems Engineering approach to organizations in the areas of functional development, benchmarking, goals and objectives, and leadership. To further accomplish the goals and remain within the scope of this effort a blend of data collection and personal experience and knowledge within both the Marine Corps and shipbuilding industry will be applied. The following list defines the full methodology behind this study:

1. Conduct literature review of United States Marine Corps and shipbuilding industry organizational history.
2. Conduct a review of current marine welding performance related trends.
3. Research and analyze various marine based industry organizations and analyze requirements and methodologies used in organizational development and execution of requirements.
4. Apply experience gained from within USMC operational units and manpower directorates.
5. Develop recommendations for improving shipbuilding welder organizational structure to produce a more cost effective utilization of available labor workforces.

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II ORGANIZATION OF THE MARINE CORPS

A PURPOSE

An organization is a collection of interdependent agencies, groups, networks and individuals working toward the accomplishment of a common goal. Organizations, like systems, feed off of requirements and are structured to meet the requirements in the most effective, efficient means possible. Typical elements that lead to the development of and the cohesiveness of an organization include its mission, values, and purpose. Michael Beck (2008) clearly articulates these elements through his descriptions:

> The mission defines what the organization does to achieve its Purpose. The better defined an organization's mission is, the easier it is to choose among the many opportunities that will present themselves. A mission—the means to achieve the Purpose—can be fairly narrow or be somewhat broad. However, one that is too narrow can unduly restrict an organization from considering opportunities that would otherwise be an excellent fit, and one that is too broad offers no guidance at all and may cause an organization to spread itself too thin, do a poor job at everything, and essentially dilute its effectiveness. Values define how the Mission will be carried out in an effort to achieve the Purpose. They define the "rules of the game." Some of them will come to mind quite easily—things like honesty, courtesy, kindness, and ethics. But some other important values will only surface when brainstorming takes place - when different perspectives and voices are heard. Values like authenticity and vulnerability may be placed on the table for consideration. It doesn't matter which values are decided upon as being important to the organization. What is important is that however they are defined everyone in the organization lives by them and supports. It's important that the policies and decisions of the organization are in alignment with them. If the organization has an acknowledged list of values it purports to live by and then chooses to ignore them, the list becomes a sore point and acts as a negative reflection of what kind of organization you really lead. (Beck, 2008)

Purpose, simply put, is the overarching reason for the organization to existe. As illustrated in Figure 2, purpose is a product of the extension of the term. The upper right quadrant of Figure 2 is highlighted to illustrate a critical dependant variable of purpose, that is "Function," that has value within the expanded baseline term.

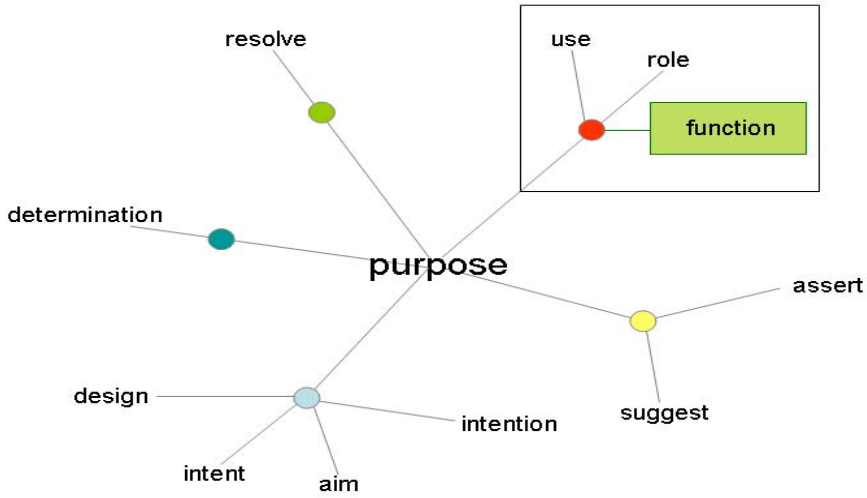

Figure 2. Associated Elements of Purpose
(From Visual Thesaurus, 2009)

Function is a critical attribute to the development and structure of any organization, no matter its purpose, size or complexity. Considering function during development can aid the structuring of an organization through a systems and systems engineering approach. As described by Kossiakoff and Sweet in their book *Systems Engineering, Principals and Practice*, they accentuate the term function within systems in that:

> A complex system that performs a number of different functions must of necessity be configured in such a way that each major function is embodied in a separate component capable of being specified, developed, built, and tested as an individual entity. Such a division takes advantage of the expertise of organizations specializing in a particular type of product or service and hence capable of engineering and producing components of the highest quality at the lowest, most competitive cost. (2003, p.9)

When a business has clearly defined its purpose, mission, and values, then all decisions, policies, and actions will have a means to keep on course and an organizational structure which can provide the best possible service or product that satisfies customer requirements is realized.

1. Organizational Complexity

Organizations are developed and structured to support a purpose. Whether it be a small business such as a hot dog vendor, or a multi-national conglomerate that produces countless products and provides services to millions of people, the basic nature of both remain the same; understand the need and organize around that need in the form of function. An organization must have an adhesive that binds its different functions together for stability. Structure can be described as the system of rules, levels of hierarchy, fixed roles, and separate compartments within an organization. Structure comes with a cost—it requires energy and overhead within the organization to maintain it. However, a burdensome organizational structure can lead to entropy in the form of red tape and excessive process requirements. In the organizational/social sense, members forced to work within the confines of a highly structured, rule-bound organization constrain their contributions to adapt to the formal structure. While any creative individual will find ways to work around the confining system, reward processes in these organizations tend to keep those that closely follow the structure in positions of authority, which perpetuates the process (Jones, 1997). An organization must consider all needs and scope of requirements and must then align themselves accordingly. Balance of structure is key to stability and productivity. As illustrated in Figure 3, Jones' Preliminary Model of Organizational Complexity shows the relationship and consequence of two extremes, over-simplification or excessive organizational complexity, and the balance required to obtain a peak in optimal organizational complexity.

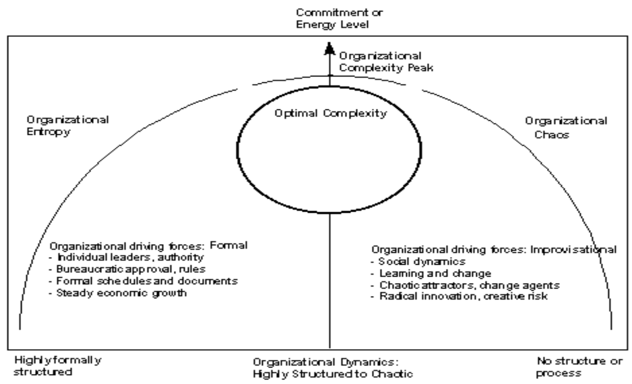

Figure 3. A Preliminary Model of Organizational Complexity: Optimizing Chaos in Organizations (From Jones, 1997)

The model can best be viewed as a pendulum that moves from right to left. The anchor end to the right signifies a business entity that is completely devoid of mission, value or purpose. As the company begins to assume these attributes, the pendulum tracks to the left and toward an area of optimality, where balance between chaos and stagnation is maintained. The far left side of the model represents a company that has lost vision and allowed the internal organizational technicalities, procedures and structural rigidity to take priority over mission, value and purpose.

a. The Hot Dog Vendor

Hot dogs have long been a favorite quick service fare among children and adults. They are quick to make and not very expensive to buy. Hot dog vendors capitalize on these features by selling hot dogs and snacks at sustainable markups that produce quick profits with little overhead (eHow, 2009). The purpose of the vendor is to sell hot dogs; this is the straightforward function of the business. The vendor satisfies customer need by providing quality hot dogs to people who are generally on the move and unable to take the time for a sit-down type of meal. The physical aspects of the hot dog vendor include a transportable cart and a covering, typically a large beach type umbrella, allowing operations in climate. A chair for the vendor is optional dependant upon the age and mobility of the vendor, but it is not a necessity to satisfy the function of the business. The cart itself can be viewed as a system that also represents 95 percent of the vendor's investment. The system is composed of four primary sub-systems to include storage function, cooking function, refrigeration function, and function to complete financial transactions. Additional decomposition of these sub-systems show the elements of use for each, to include storage of hot dogs, condiments, napkins and buns; refrigeration of drinks and other spoilage-prone items; and electronic devices needed to complete and store monetary transactions. The storage and refrigeration sub-systems illustrate a required interface needed for the system to operate as designed. With the basic function and physical characteristics of the hot dog vendor, defined different hypothetical scenarios can illustrate how this business can fit into the extremes of the areas of the preliminary model of organizational complexity shown in Figure 3. A scenario that could drive the pendulum to the far right side of the model involves site selection. When a person decides he or she wants to become a hot dog vendor, seeks and obtains financial backing, purchases a cart, stocks all of the appropriate items, but then positions the cart in a location that is wholly composed of vegetarians or anti-hot dog advocates, the vendor has most likely abandoned the basic elements (mission, values, and purpose) required for success. Consequently, operating in the far left region of the model is characterized by an organization that has become so entrenched in its own structural constraints (such as loyalty to an disordered supply purchasing system), that mission, values, and purpose have been superseded by zealous bureaucratic obedience. Somewhere between chaos and lethargy exists the optimal solution, one that promotes innovation but regulates extreme exploits through a measured, deliberate and logical devotion to process.

B. MODELING THE MARINE CORPS ORGANIZATION

From the Halls of Montezuma to the Shores of Tripoli, the United States Marine Corps has served and protected the citizens and the United States Constitution for over 243 years. From the Corps' initial assembly and its ensuing amphibious battles in the Bahamas to its current role supporting the multi-front effort supporting the Global War on Terrorism, the Corps has adapted, both internally and externally, to military and political constraints while keeping true to its basic function. No matter the era or threat-driven requirement, the Corps has always found ways to adjust. The primary mission of the Marine Corps is to keep America and its citizens free.

On November 10, 1775, the Continental Congress passed a resolution stating that "two battalions of Marines be raised" for service as landing forces with the fleet. This established the Continental Marines and marked the birth of the United States Marine Corps (USMC 1, 2002). Initially, the Corps was chartered with providing combat-trained forces to operate on land and at sea. As such, these early forces were recruited and trained to support operations in both environments. Consequently, the early Marine was required to shoot straight and wield a sword in support of offensive operations against the enemy or protect and defend vessels or encampments. Although not written in any formal order or directive, these essential tasks set the foundation of how the Marine Corps would evolve and formalize recruitment, training, promotion and attrition policies to support higher and subordinate units designated as either combat arms or combat support.

1. Organization

The Marine Corps, not unlike civilian organizations, is constructed from the bottom up. Within the infantry, the fire team supports the squad, the squad supports the platoon, the platoon supports the company and the company supports the battalion. Within aviation, specifically within the fixed wing fighter attack community, the squadron supports the MAG, the MAG supports the MAW and the MAW supports the MEF. In its totality and end state as a system, the Marine Corps supports the Commander in Chief. As chartered in MCRP 5-12D, Organization of Marine Corps Forces (1998):

> The Marine Corps is organized as a general purpose force in readiness to support national needs. Deploying for combat as combined-arms Marine air-ground task forces (MAGTFs), the Marine Corps provides the National Command Authorities (NCA) with a responsive force that can conduct operations across the spectrum of conflict. Sea based, combat ready, forward deployed naval forces have been involved in more than 28 major military operations since 1995. Whether responding to natural disasters or to the specter of regional aggression, Navy and Marine forces provide

> self-contained and self-sustained air, land, and sea strike forces, operating from a protected sea base, that can be tailored to meet any contingency. (HQ USMC, 2002)

The Marine Corps is composed of four primary components, three active and one reserve. Two of the active components and their reserve counterparts are located within the continental United States, while the final active component is located on foreign soil. Unlike the Air Force and Army, the Marines have no guard units in their organization. Additionally, as defined within MCRP 5-12D, and as related to its organizational constructs (1998):

> The Marine Corps is an integrated structure consisting of multiple levels of organizational hierarchy. The Marine Air Ground Task Force is the principle organization for the conduct of all missions across the range of military operations. MAGTFs are balanced, combined-arms forces with organic ground, aviation, and sustainment elements. They are flexible, task-organized forces that can respond rapidly to a contingency anywhere in the world and are able to conduct a variety of missions. Although organized and equipped to participate as part of naval expeditionary forces, MAGTFs also have the capability to conduct sustained operations ashore. (2001 - General)

Each component of the Marine Corps is similarly configured, based upon function, allowing a certain level of repeatability and traceability amongst the various functions. Although each will have a specific mission assigned that necessitates a level of variance in both unit and individual skills for training and equipment each contains the basic functions to support land, sea, and air based operations. To complete the full system organizational network, each unit is similarly configured with functional entities that provide both support and higher level command and control. Although dated, Figure 4 illustrates the basic organization of the Second Marine Air Wing (2DMAW), located at Marine Corps Air Station Cherry Point, North Carolina. With regard to MAGTF composition 2DMAW would provide aviation forces to provide the role of the Aviation Combat Element (ACE) within the MAGTF structure. This model is a reasonable representation of organizational commonality that comprises the Marine Air Ground Task Force (MAGTF), with regard to top level and lower level functions. Although not specifically displaying the full scope of functions inherent within the MAGTF, it does provide an overview of the broader MAGTF organizational functional requirements of providing a Command Element (CE), Aviation Combat Element (ACE), Ground Combat Element (GCE), and Combat Support Element (CSE).

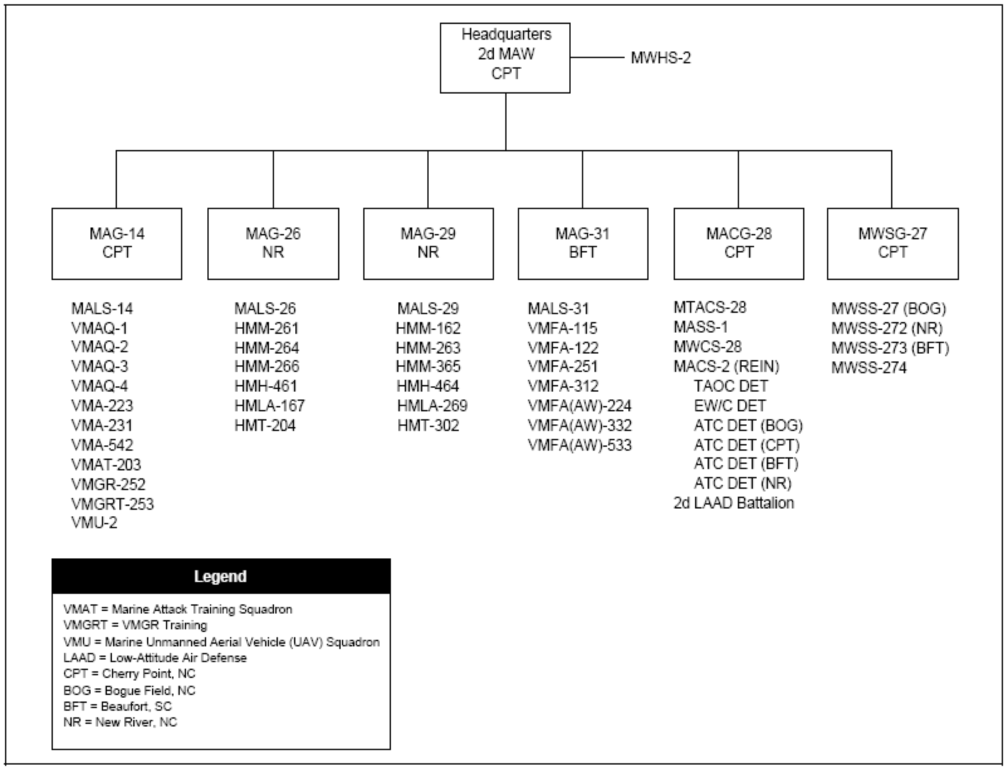

Figure 4. Organization of Second Marine Aircraft Wing (From MCRP 5-12D 1998)

It is within the construct of the MAGTF organization that we can further examine the basic elements of organizational structure and how it is maintained and adjusted based upon changing requirements, both at the unit and individual Marine echelon. Further exploration will be performed through the analysis of Marine All Weather Fighter Attack Squadron 332 (VMFA (AW)-332), a subordinate element attached to MAG-31, Marine Corps Air Station Beaufort South Carolina (MAG-31, BFT). If measured and considered as a microcosm of Marine Corps organizations, this F/A-18D Hornet squadron represents the basic assemblage of how manpower and equipment are designed, integrated and managed to meet combat and training requirements. Every unit in the Marine Corps has evolved over time, each possessing a common, integral component; mission. From its original conception to its current role combating the War on Terrorism, the Corps has been driven by mission, whether it be a generalized concept or a deliberate set of defined requirements. This direction set the initial assembly of individual units within the functional construct and continues to feed structural alterations as required based upon fluctuations in need.

C. THE MANPOWER PROCESS–SUPPORTING THE ORGANIZATION

The Marine Corps available manpower, both officer and enlisted, is ultimately based upon a set of constraints and allowances as defined by Congress. The definitive number of Marines allowed during any particular period in time is known as End Strength (ES). As illustrated in Figure 5, End Strength is further divided into two distinct and dissimilar segments, those Marines available for assignment to active units (manning) and those classified as trainees, transients, patients and prisoners, (T2P2).

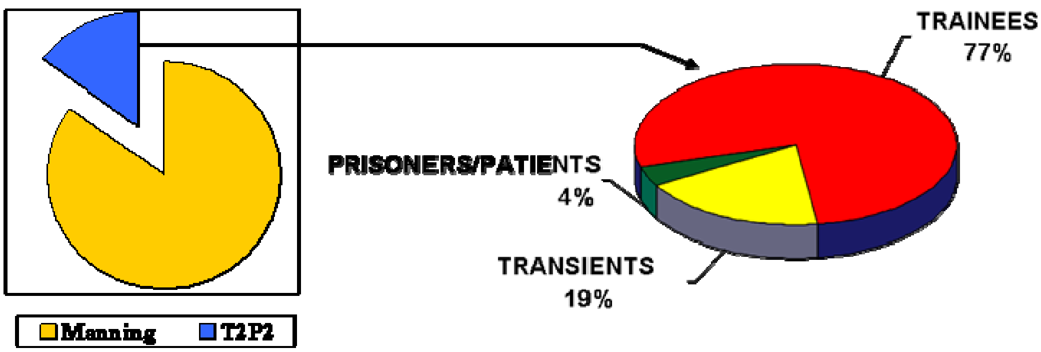

Figure 5. End Strength and Manpower Manning Constraints (From USMC Manpower 101)

T2P2 is an important term in the manpower equation due to its impact and influence on available unit manning. Since it is a Department of Defense (DoD) mandated measurement and included within the bounds of ES its impact is significant. T2P2 is further defined below:

- Trainees: entry level accession or in excess 20-weeks
- Transients: PCS/PCA (access, train, operational, rotational, and separation)
- Patients: hospitalized > 30-days
- Prisoners: incarcerated > 30-days and < 6-months

The most significant consideration regarding ES is that although Marines classified as T2P2 are part of the total number of the congressionally authorized manpower base, they are not assignable to active units and therefore do not support immediate needs of operational units (USMC, 2009).

Every Marine Corps unit is firstly defined by the Commandant of the Marine Corps during the Concept Based Requirements (CBR) process. Although most standing units have been in active service the CBR process allows iterative examination of both personnel and equipment based upon current and future need. This document contains a core mission statement (statement of purpose), the associated Mission Essential Task List (METL). The former is driven by its core mission statement, while the latter provides an architectural foundation allowing deliberate control of the unit regarding roles and functions as defined by higher headquarters, threat and necessity.

The Table of Organization is the principal document that defines the scope of each and every unit within the Marine Corps structure, both active and reserve. It prescribes the organizational structure, billet authorization, personnel strength allocation, and individual weapons assigned for each Marine and Naval personnel allocated to the unit (T/O 8840, 1990). The T/O is the fundamental source document that describe the who, what, when and where. The preamble is the mission statement, the guidance that sets the course of the unit and asserts its cause. For the F/A-18D squadron the T/O mission statement declares that the unit shall Attack and destroy surface targets, day or night, under all weather conditions. Conduct multi-sensor imagery reconnaissance. Provide supporting arms coordination and intercept and destroy enemy aircraft under all weather conditions (T/O 8840, 1990). The mission statement is a set of generalized instructions that allows the manufacturing of the way each unit develops and implements their platforms Tactics, Techniques and Procedures (TTP). The TTP's are generally common to a particular aircrafts platform Type, Model, and Series (TMS). For standardization purposes, each TMS platform, no matter the physical location, has similar TTPs, which aid in obtaining a level of repeatability, maintainability and accountability. Amplifying the mission statements position a list of specific tasks providing additional guidance to the unit. These tasks are known as the Mission Essential Task List (METL), which focuses a unit's combat mission training on those key essential tasks that are critical to mission accomplishment. These functions must interface with both higher headquarter and subordinate command requirements, as defined in the METL developmental process:

> METLs do not stand on their own necessarily. They fit in the overall picture of mission accomplishment for the force. A Commander has his METL. Subordinate commanders have their METL and their subordinate units all have METLS. These must be "linked together" to fully understand the mission. We "link" METLs on a task-by-task basis between commands. We start from a top-down mission analysis and build links to each level. A lower level METL has tasks which support higher-level Mission Essential Tasks (METs). (2003, p. 2)

Units are not expected to be proficient in every possible task, but are required to be ready to execute, at a minimum, those combat essential tasks critical to mission accomplishment. A units' approved METL is a collection of these critical tasks. A sample of specific METL's inherent and listed within T/O 8840 is provided below. These include, but are not limited to:

TACTICAL EMPLOYMENT

- CONDUCT DAY AND NIGHT CLOSE AIR SUPPORT, UNDER THE WEATHER.

- CONDUCT DAY AND NIGHT DEEP AIR SUPPORT, UNDER THE WEATHER TO INCLUDE; ARMED RECONNAISSANCE, RADAR SEARCH AND ATTACK, INTERDICTION, AND STRIKES AGAINST ENEMY INSTALLATIONS, UTILIZING ALL TYPES OF WEAPONS COMPATIBLE WITH ASSIGNED AIRCRAFT.

- CONDUCT MULTI-SENSOR IMAGERY RECONNAISSANCE TO INCLUDE PRE-STRIKE AND POST-STRIKE TARGET DAMAGE ASSESSMENT AND VISUAL RECONNAISSANCE.

- CONDUCT DAY AND NIGHT SUPPORTING ARMS COORDINATION TO INCLUDE FORWARD AIR CONTROL, TACTICAL AIR COORDINATION AND ARTILLERY/NAVAL GUNFIRE SPOTTING.

- MAINTAIN THE CAPABILITY TO OPERATE FROM AIRCRAFT CARRIERS, ADVANCED BASES, AND EXPEDITIONARY AIRFIELDS.

- PERFORM ORGANIZATIONAL MAINTENANCE ON ASSIGNED AIRCRAFT.

CONCEPT OF ORGANIZATION.

- THIS SQUADRON WILL NORMALLY FUNCTION AS AN INTEGRAL UNIT. IT IS STRUCTURED TO OPERATE AS A SUBORDINATE UNIT OF A MARINE AIRCRAFT GROUP (MAG).

CONCEPT OF EMPLOYMENT.

- THIS SQUADRON WILL NORMALLY BE EMPLOYED AS AN INTEGRAL UNIT OF AN AVIATION COMBAT ELEMENT (ACE)

MAINTENANCE.

- CAPABLE OF ORGANIZATIONAL (1ST ECHELON) MAINTENANCE ON ALL ASSIGNED MARINE CORPS EQUIPMENT AND ORGANIZATIONAL (2D ECHELON) MAINTENANCE ON INFANTRY WEAPONS.

- CAPABLE OF PERFORMING ORGANIZATIONAL MAINTENANCE ON ASSIGNED AIRCRAFT AND SUPPORT EQUIPMENT.

These METL’s allow the commander to focus his units training efforts to more effectively manage all elements of the units assignments toward the accomplishment of key near, mid and long-term goals. These tasks do not specify the level of detail involved with accomplishing the top level METL’s, but only direct the focus to particular top level functions. It is the responsibility of each unit’s higher headquarters to specify the level of standardization and interface with external training agencies and similar organizations to fully exploit the unit’s readiness to operate in both training and combat environments.

Each of the top level functions of the METL's, Tactical Employment, Concept of Organization, Concept of Employment and Maintenance, can be further decomposed to expose multiple layers that are essential to accomplishment of the functional objective. Regarding the METL function of Maintenance, the lower level attributess that feed into this task include recruitment, initial training, TMS training, proficiency, retention, and promotion. Decomposition of the organizational structure will identify requirements and identify positive attributes of the USMC organization and the manpower process.

It is not within the scope of this thesis to dissect and examine all functions on the USMC organization, or the individual units, CE, ACE, GCE, SE. Nor is it possible to identify every element within a specific unit. The focus is on one individual structural element identified as a requirement within T/O 8840, the Military Occupational Specialty (MOS) 6094, identified on line 835 of the T/O; Hydraulic Mechanic (HYD MECH), Marine Enlisted, rank of Corporal, with a structural allocation of one (1). The following organizational and manpower attributes are terms and elements of the process used within the Marine Corps to meet current mission needs as defined by higher headquarters and the threat.

1. Structure

As previously discussed, the T/O contains a listing of personnel required by the unit to meet mission objectives as defined in the mission statement and METL's. Structure describes the basic requirement in terms of function, rank and amount. MOS 6094, HYD MECH, is one of two-hundred-seventeen (217) enlisted requirements within the T/O Maintenance function. This number does not illustrate the number of functions performed, only the number of individual Marines required to support the requirement. At a micro level, the HYD MECH function within the T/O contains three specific elements that comprise the Hydraulic Mechanic requirement within the Maintenance function. All such functions are MOS 6094, but have a graduated rank structure to include one Sergeant (Sgt), one Corporal (Cpl) and one Lance Corporal (LCpl). Each of these individual and cumulative structures supports the unit's Primary Authorized Aircraft (PAA) allocation of twelve F/A-18D Hornets. Structure defines the requirement, it does not, however define the individual Marine assigned to a unit, only the requirement as defined by higher headquarters. If a unit was staffed at 100 percent T/O, then the commander would have personnel filling each and every by-line MOS defined within the T/O. Although optimal, as based upon requirements, it does not reflect the reality of the manpower process. Due to multiple internal and external constraints, the boundaries encompassing the unit level organization prevent, with few exceptions, 100 percent T/O state. Certain units are listed as "excepted command" due to their mission and visibility. HMX-1, located in Quantico, Virginia, is one such command, due to its role of providing helicopter support to the President of the United States. The squadron receives 100 percent of its T/O to ensure its manpower base is both stable and capable of meeting all of its defined functions. It is interesting to note that the 8840 T/O, used as reference in thisthesis (circa. 1990), contained a structural requirement of one welder, MOS 6043. Due to changing requirements, consolidation of functional MOS areas and composite and adhesive technology achievements, this MOS no longer exists at the organizational level within the 8840 T/O.

2. Authorized Strength Report (ASR)

Examination of the ASR exposes one of the critical elements within the manpower process and how the Marine Corps balances meeting T/O structural requirements with the realities of budget and congressionally mandated limits in manpower end strength. As described in Marine Corps Order (MCO) 1300.31A, the ASR contains a recapitulation by grade and primary military occupational specialty (PMOS) of the manpower authorized to each monitored command code (MCC). The ASR incorporates the most recent decisions affecting the Marine Corps' structure. The ASR consists of a percentage of table of organization (T/O) billets (known as manning level) for all Fleet Marine Force (FMF) commands (1990, p.1). Additionally, MCO 1300.31A describes the ASR's normal report generation, delivery dates and ownership, by directing:

> The ASR is normally updated in April, August, and December and incorporates the most recent decisions affecting the Marine Corps' structure. The ASR consists of a percentage of tables of organization

> (T/O) billets (known as manning level) for all Fleet Marine Force (FMF) commands and 100 percent of T/O for non-FMF commands. The functional manager for the ASR is the Commandant of the Marine Corps. (p. 2)

An additional narrative describing the ASR is presented by Brian Tivnan in his thesis titled Optimizing United States Marine Corps Manpower (1998), Mr. Tivnan states that:

> The ASR classifies billets by current year, budget year, and the remaining five years of the Future Years Defense Plan (FYDP). The ASR identifies billets by grade, military occupational specialty (MOS), and Monitored Command Code (MCC). Grade represents the rank of the Marine required for the billet. MOS identifies the specific training and technical skills required for the billet. For the current year, the ASR provides the authorized billets for staffing. The list of authorized billets for out years is used in planning to develop the right "kinds" of Marines. (p. 3)

The Troop List (TL) is a Macro view of manpower requirements and a process step precondition before moving to the ASR for the determination of need. The Manpower 101 presentation describes the ASR as the Micro view, breaking out manning in more detail down to the MOS and Grade requirements by Monitored Command Code, not T/O. This slight adjustment in the view of information introduces the difficulties with aligning staffing targets to specific Tables of Organization. The lowest common denominator is the MCC (2009, p. 18).

3. Staffing Goal

The staffing goal is the realization of the constraints placed upon the Marine manpower system. It is the final allocation of actual Marines that are available to fill structure within a unit. The pool of assignable Marines is set by the feasible region primarily defined and bounded by End Strength, T2P2, unit exception code and budget. Other, less definable elements such as Temporary Additional Duty (TAD) training, non-deployable personnel, and unit movement requirements also place limits on available manpower. MCO 1300.31A defines staffing goal as:

> Produced by the Enlisted Staffing Goal Model (ESGM), staffing goals represent assignment targets, by grade and Primary MOS, 6 months into the future. These targets provide for the equitable distribution of the

> current enlisted population to the authorized billets defined in the ASR in accordance with enlisted inventory availability and current staffing policies. Staffing goals are produced once each month and the functional manager for the staffing goal process is the Commandant of the Marine Corps, Marine Manpower Enlisted Assignments (MMEA). (1992, p.3)

Tivnan also adds that authorized billets from the ASR represent ideal staffing goals. These goals must be reconciled with the current inventory and USMC distribution policies. The complete population of active duty enlisted Marines constitute the current inventory (Tivnan, p. 4).

4. Enlisted Staffing Goal Model (ESGM)

The Force Deployment Planning and Execution Operational Advisory Group (FDP&E/OAG) presentation titled *The Manpower Process*, defines ESGM as an optimization model that takes planned manning levels (Authorized Strength), against a given inventory with the Marine Corps Total Force System (MCTFS). Utilizing the policy on staffing precedence dictionary, the ESGM converts these inputs into STAFFING GOALS such that the staffing goals:

- Are as close as possible to the ASR
- Accommodate staffing policies IAW MCO 5320.12D (Staffing Precedence Level Order)
- Are consistent with existing chargeable inventory

ESGM allocates resources (individual Marines) to requirements (billets) using rules of thumb (based on manpower policies) to find solutions (FDP&E/OAG).

5. Military Occupational Specialty (MOS)

The MOS is a four-digit code consisting of the Occupational Field (OccFld) code completed by two additional digits. It describes a set of related duties and tasks that extend over one or more grades required by units of the Operating Forces and Supporting Establishment. The MOS is used to identify skill-knowledge requirements of billets in T/Os, to assign Marines with capabilities appropriate to required billets, and to manage the force (MCO 1200.17A, 2009, p. v). The T/O also defines the types of MOSs available to USMC organizations as Basic, Primary MOS (PMOS), Necessary MOS (NMOS), Free MOS (FMOS), Exception MOS (EMOS) and Additional MOS (AMOS):

> Basic Entry level MOSs required for the P2T2 T/O, or other T/Os requiring non-OccFld trained Marines. In addition, when a Reserve Component (RC) Marine transfers to a new unit and does not possess the MOS required for the billet filled, he will be assigned a Basic MOS until the completion of required formal school training.
>
> Primary MOS (PMOS) Used to identify the primary skills and knowledge of a Marine. Only enlisted Marines, warrant officers, chief warrant officers, and limited duty officers are promoted in their primary MOS. Changes to an Active Component Marine's PMOS without approval from CMC (MM) and changes to a RC Marine's PMOS without approval from CMC (RA) are not authorized.
>
> Necessary MOS (NMOS) a non-PMOS that has a prerequisite of one or more PMOS. This MOS identifies a particular skill or training that is in addition to a Marine's PMOS, but can only be filled by a Marine with a specific PMOS. When entered as a requirement into the TFSMS, a billet bearing a necessary MOS must identify a single associated PMOS even if several PMOS are acceptable prerequisites.
>
> Free MOS (FMOS) Non-PMOS that can be filled by any Marine regardless of primary MOS. A free MOS requires skill sets unrelated to primary skills.
>
> Non-PMOS that is generally FMOS, but include exceptions that require a PMOS.
>
> Additional MOS (AMOS) any existing PMOS awarded to a Marine who already holds a PMOS. Marines are not promoted in an AMOS.

The MOS classification system provides for efficient assignment as well as effective utilization of Marine Corps personnel (MCO 1200.17A, 2009).

6. Occupational Field Sponsor

The Occupational Field Sponsor (OccFldSpo) duty is generally assigned to a Marine who is currently serving at one of the higher headquarters manpower directorates.

When a Marine assumes the role of OccFld Sponsor, they become the Marine Corps point of contact for operational units regarding a particular or functional MOS (i.e., 6094, HYD MECH, or F/A-18D Maintenance MOS). This Marine may or may not be a subject matter expert of the MOS they represent, but they are responsible for cross departmental coordination with other manpower agencies ensuring that deficiencies in the MOS population are addressed. They are also the coordinating agent for the deletion or creation of MOS within their prevue. The OccFldSpo must understand the organizational network associated with their MOS and must maintain open communication with the operating forces.

D. CHAPTER SUMMARY

The Marine Corps organizational structure is dependent upon the proper identification of unit requirements (T/O structure) and efficient use of available manpower. Figure 6, depicts the basic life cycle manpower model. Understanding the flow of Marines into and out of the model is critical to allow for the maximization of personnel (Manpower 101, 2009).

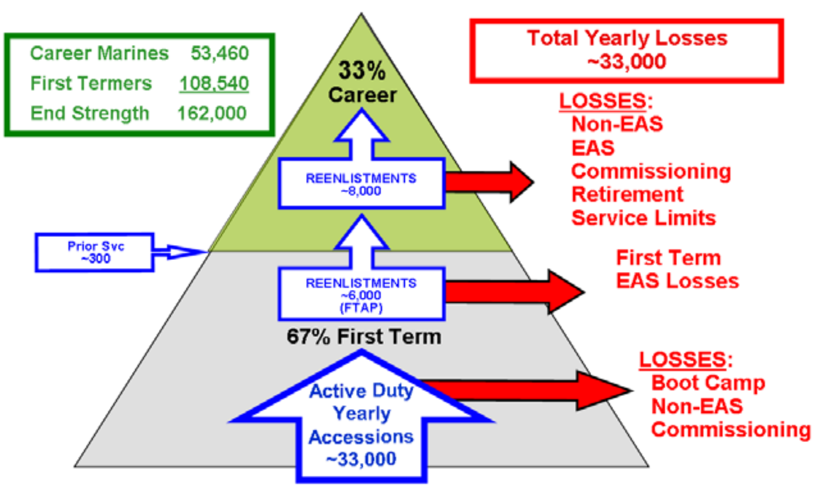

Figure 6. Enlisted Manpower Flow Model (DoN/USMC Manpower 101 presentation, 2009)

The critical nature of identifying required skill sets within the T/O, maintaining those skills through training, amending those MOS skills not longer required or more effectively performed by other organizational functions, must all couple with the manpower process. It is especially important to understand the gaps that can occur when external demands are placed upon the system. One such gap that surfaced has been the impact felt by the scale of the Individual Augment (IA) program. A product of the prolonged Global War on Terrorism (GWOT) IA's were a response to changing manpower and skill needs identified and requested from commanders on the battlefield. Since this emerging requirement was not identified or funded within the traditional USMC organizational or manpower models, the Marines sent to fill these positions diminished the population of available manpower to the established T/O units. The Marine Corps response to the additional requirements placed upon it by GWOT prompted General James T. Conway, Commandant of the Marine Corps to state before the House Appropriations Committee, Military Construction Subcommittee, on 11 March 2008 that:

> To fulfill our obligations to the Nation, the Marine Corps will grow its personnel end strength to 202,000 Active Component Marines by the end of Fiscal year 2011. This increase will enable your Corps to train to the full spectrum of military operations and improve the ability of the Marines to address future challenges of an uncertain environment. (HAC, 2008)

The request by the Commandant was a response to an over utilized and strained total force that was beginning to operate outside of the boundaries of the normal organizational and supporting manpower construct, as depicted in Figure 7.

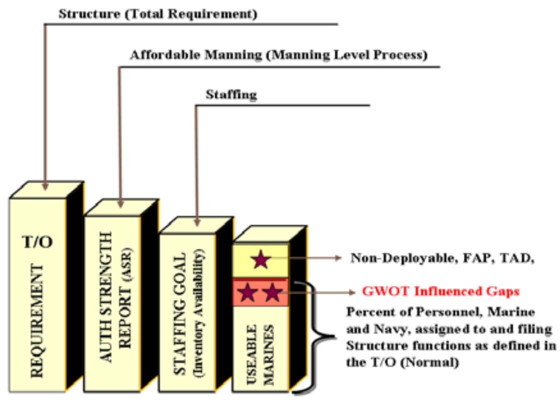

Figure 7. Requirements and Manpower Process (Manpower 101)

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III THE SHIPBUILDING INDUSTRY

A. THE CHALLENGE

Despite periodic bursts of activity, American shipbuilding has been a chronically irregular and an unsettled industry since the Civil War (Boyer, 2001). Irregularity within the heavy manufacturing industry, specifically shipbuilding, presents challenges not inherent to other industries. Other forms of manufacturing rely heavily upon technology to perform major functions in the construction process cycle. Smaller, more agile products, such as automobiles and aircraft, employ assembly line-like methodologies contained within large, covered and climate-controlled assembly and manufacturing buildings. These industries allow a high level of predictability, repeatability, maintainability, reliability and producibility. These "ilities" are not necessarily associated with shipbuilding. Although much of the initial steel work is done in covered buildings, as the construction process matures, individual plates of steel are connected to form units, which become larger modules. Eventually, the larger modules come together to form the ship. Due to the enormous nature and complexity of ship construction, the use of technology in the manufacturing process is limited by the need for skilled craftsman to perform large portions of the construction process. Moreover, the skilled workforce must apply their craft in an unforgiving and harsh environment. An additional obstacle caused by unpredictable funding and DoD ship buying policies is the inability of the shipbuilder to predict and plan for the consistent need and scheduled use for specific crafts on a long-term basis. It is this skilled craftsman, vital to the shipbuilding process, who suffers during these uncertainties. Unlike Marine Corps personnel, industry craftsman are not bound to remain in service for any particular period of time. Elective career opportunities in similar labor fields, flexibility with personal movement and prospects of higher paying, less strenuous professions, constantly pull skilled craftsman away from the shipyard. The Marine Corps can weather periods of uncertainty the shipbuilding industry cannot. Long-term employment of proficient and capable craftsmen is critical to obtaining cost, schedule and quality business objectives.

1. Manufacturing a System

Until about 1840, nearly all vessels were built of wood. Up to that time, great expertise had been obtained in the use and application of the material required for the construction of sea going vessels. Due to its limitations of size and strength, pre-1840s-built ships rarely exceeded 200 feet in length (Holms, p.1). Holms goes on to say that although the exact time ship construction shifted from wood to steel is unknown, emerging seagoing vessel requirements of speed, size, strength and capabilities necessitated the transition. Although wooden vessels conformed and adhered to changing requirements during their life cycle and dominance of the seas, the level of complexity and rate of technological achievement has accelerated since the initial steel ships came into existence. With the evolution of technology, ships have become more advanced and capable, which in turn has lead to an increase in complexity that must be considered and planned for prior to and during the construction process. As new hull forms are created and more sub-systems integrated modern ships are comparable to systems that require new methods and techniques to meet performance specifications. To meet these developing requirements shipbuilders must recruit, train and retain those skilled craftsmen best suited to meet the challenges of current ships construction.

2. The Shipbuilding Environment

Whether a ship is constructed from wood or steel, the labor requirements have and probably always will be harsh. As described by Tom Bell, workers in the era of wooden ships typically began their careers with the dirtiest, most physically demanding jobs in the yard. They lugged hot tar to caulking crews, hauled lumber, mixed paint, set up scaffolding, pounded fastenings, drilled holes and drove teams of draft horses (2007). The trade of building ships required both skill and stamina. Mr. Bell goes on to further describe the average worker during the 1900s who built wooden ships in Maine as 42-years-old, worked 10 hours a day, and earned $541 a year. This amounts to $11,700 in today’s dollars, according to Maine Bureau of Industrial Labor Statistics data compiled by the Maine Maritime Museum (2007). The shipyard environment of today, although highly mechanized and more protective of employees due to the implementation of occupational health and safety rules and regulations, continues to presents challenges in the modern environment. Due to the proximity of shipyards to coastal waters, seasonal changes can add to the discomfort when working within the restrictive spaces of the ship's hull. Southern shipyards experience a combination of intense heat and humidity in the summer. Northern yards must deal with bitter cold and icing conditions during the winter. These realities of ship construction do not aide in the recruitment of young craftsmen and may lead older workers to seek employment in more hospitable surroundings.

3. Status of U.S. Shipyards

Irene Smith comments her article "Preparing the Shipyard Work Force of Tomorrow" that current projections indicate that over the next ten years, U.S. shipyards will need to hire and train an additional 1,400 workers each year to compensate for attrition and maintain critical skills (2002). This statement is the result of projections and estimates, based upon attrition, that would become realized as the baby boomer generation began to filter out of the workforce and into retirement. Based upon the July 2009 update to the Directory of U.S. Shipyards, there are eight different types of shipyards of record:

- B L: A large shipbuilder, fully facilitized, capable of building large oceangoing naval and commercial ships.
- B M: A mid-size shipbuilder, fully facilitized, capable of building oceangoing commercial ships, rigs, barges, etc.
- B S: A small shipbuilder, with limited capability in oceangoing vessels and mostly building boats and barges for coastal or inland service.
- B A: A builder of aluminum boats intended for commercial or governmental use.
- B Y: A builder of mega yachts, i.e., custom-designed and built yachts that are at least 100 feet in length.

- R L: A large ship repairer, capable of dry-docking an oceangoing vessel of at least Panamax beam (i.e., 106 feet).

- R S: A small ship repairer, capable of dry-docking smaller vessels.

- R T: A topside repairer, i.e., one with no dry-docking capability.

The July Directory update shows that of those shipyards identified, there are twenty-three listed under the B.L. category, and an additional twenty-five categorized as B.A. (2009, July). The first due to its size and number of government contracts, requires the preponderance of the skilled labor workforce. All other listed shipyard categories that require similar labor skill sets must compete for those same skilled employees to meet contractual requirements. As pointed out in a 2001 National Security Estimate, the six largest shipbuilders, referred to as the Big Six, account for two-thirds of the industry's total revenue (over $6.7 billion in 1998) and perform nearly 90 percent of all military work. Ninety-five percent of the revenues of these yards are defense-related. The Big Six accounted for about 11 percent of the industry's commercial revenues during the 1996-2000 periods (p. 3). Another element affecting future shortfalls in available skilled labor is that there appears to be no hesitation of yards to invest capital to enhance and to modernize their facilities. The intent of active yards to strengthen their positions in the market is illustrated by Peter Meredith in an article he penned in the "professional mariner," on-line edition, titled The State of Shipbuilding:

> He acknowledged that even though yards are having difficulty finding labor they are pouring money into new facilities. With state and federal assistance, Austal USA broke ground July 31 on 840,000 square feet of modular manufacturing, warehouse and office space aimed primarily at Navy projects such as the Littoral Combat Ship (LCS). In Pascagoula, VT Halter Marine is buying two 310-ton cranes. And in Houma, La., Edison Chouest Offshore broke ground on a new shipyard that it says will ultimately employ 1,000, an investment that drew a $10 million promise of state support. (2009)

Each of these diverse, marine-oriented manufacturing and repair facilities will need the support of skilled craftsman to meet their needs. Competition is not limited to the shipbuilding industry, but includes other marine-based companies such as sea-based oil platform repair and manufacturing facilities, pipeline construction and repair and offshore and inland port station construction. This intense and expanding competition is stretching available shipyard and marine industry workforce resources to a critical point. Those resources available must be utilized to the maximum extent possible. One such way to maximize value added work is to decompose the production schedule to identify specific required tasks and the level of skill required to accomplish those tasks. Production planning tasks must be considered critical to accomplishing long-term industry goals and ensuring future bid and proposals efforts.

4. The Workforce

Within shipbuilding there exist the primary functions of any business network inherent in most companies. Elemental functions such as administration, human resources, supply chain management, planning, scheduling and material all co-exist, interact and ultimately play their own particular role in achieving senior leadership's vision. Within the Marine Corps, these functions would be supporting elements to the primary USMC MOS, 0311 (rifleman), the basic component of the infantry unit. Comparatively, the skilled production workforce supporting the construction of ships can be viewed as the 0311's of the shipbuilding industry. All other elemental organizational functions ultimately support the efforts of those who provide skills in the areas associated with Hull, Mechanical and Electrical (HM&E).

As discussed earlier in this paper, ships are a product of steel plates that are cut, formed, attached together and then outfitted with ducting, pipe, and electrical components. As the process continues the smaller components (units) are joined together to make larger modules that require additional welding, piping, electrical and duct work. The larger modules are attached together to further shape the hull and eventually the full vessel emerges. Simplistic and grossly truncated, these process steps shed light to the skill sets required to construct these sea-going giants. Although the skilled labor workforce is comprised of many diverse and important trades, there are three that are known as the critical crafts: welders, pipefitters, and electricians. Those within the critical crafts with three or more year’s experience are the most highly regarded and recruited. They are also the hardest to retain due to the flexibility their experience provides. Due to the nature of shipbuilding and the materials used in construction, welders are generally the skill set most sought and prized within the industry. Due to the shear amount of steel used, welders are utilized from initial construction to the delivery of the ship. Another element that must be taken into consideration is the increasing welder skill level required as the ship progresses in the construction cycle. As more of the ship is completed, spaces become more restricted and have more outfitting to consider during hot work events. This lends itself to more complex welding as there is a higher level of risk involved due to the possibility of shipboard fires and having to “rip-out” previous work completed due to improper welding technique or work package misinterpretation. Rework on a nearly complete vessel is a major contributor to late delivery and increased costs.

5. Shipyard Employment Concerns

According to a 2001 National Security Assessment titled U.S. Shipbuilding and Repair, performed by The U.S. Department of Commerce, Bureau of Export Administration (BXA), shipyards claim that labor shortages have reduced profits, impacted construction costs, and delayed project completions. In addition, many shipyards are subcontracting work normally done at the yard and are turning away new business opportunities. A few shipyards have begun to use contract labor even though contract labor within represented shipyards is a touchy subject and can result in contentious contract negotiations. Labor shortages affect military and commercial yards equally (BXA, p.4). These shortages are due in part to job insecurity caused by uneven workload (irregularity in the DoD procurement plan), harsh work environments, and a competitive labor market. Turnover in a competition-rich environment can be prompted by as little as an increase in pay of less than $1 an hour. Many in the skilled labor pool see short-term fiscal opportunity as more beneficial than long-term employment stability, seniority and health benefits. The study also goes on to state that:

> Both government and industry sources state that military procurement contracting practices can lead to overspecialization within the workforce. Narrowly defined job classifications can cause idle time and reduce a shipyard's ability to utilize its workforce effectively. Also contributing to overspecialization are union activity and tradesmen certification requirements. In contrast, Kvaerner Philadelphia has applied the Lean production business model used in Europe in its newly established commercial shipyard facility at the former Philadelphia Naval Shipyard. The company reported that it currently uses four job categories in order to maximize the flexibility of its workforce. Kvaerner is creating subcontractors to do major subassembly work. The skill base of the U.S. shipbuilding industry is eroding, especially for welders, pipe fitters, and ship fitters. Shipyards also cited shortages of machinists and electricians. Shipyards compete with other industries and with each other for skilled labor (BXA, p.4).

Internet searches for shipbuilding employment opportunities produce large numbers of advertisements for these highly sought after "critical craft." A common response to acute labor shortages by some U.S. shipyards, is to hire and train unskilled workers to fill gaps in production functions. Often these workers are used as helper-cleaners either in the production areas, in the yard or on ship. Training unskilled workers, referred to as green labor, imposes additional costs with no guarantee the workers will stay long enough for the yard to recoup its investment (BXA, p.5). Some commercial yards reported that worker morale and work-related accidents due to inexperience posed additional challenges for all layers of organizational leadership (BXA, p.5). These challenges faced by shipyards around the U.S. will be amplified in years to come due to looming retirements of master craftsman, continued exodus of its three to five year skill base and continued DoD procurement practices.

6. The Trade Union Constraint

Trade union representation of skilled labor is a reality within many, if not, most heavy manufacturing industries. It is beyond the scope of thisthesis to detail the complex relationships that exists between industry and the trades. The reader should appreciate that union contracts are negotiated and bound when accepted by the two parties. These agreements, varying in levels of duty and restraint, present non-relaxable constraints to certain production strategies.

B. THE SHIPBUILDING WELDER

Ships are made from plates of steel of various thickness, size and grade. The average amphibious LPD-17 class ship is made up of over three million individual plates of steel (Forster, 2009). Much of the work associated with producing one of these ships from these steel plates is on the shoulders of welders. Welders, Cutters, Brazers and Fitters use hand-welding or flame-cutting equipment to weld or join metal components and to fill holes, indentations, or seams of fabricated metal products. Structural welders, those whose primary function deals with the hull of the ship, deal with metals and alloys of various sizes and shapes. Welders operate various types of AC and DC electric arc welding equipment. They use portable, automatic, and semiautomatic equipment with metallic electrodes that include inert gas shielded, flux-shielded (submerged arc), and hydrogen-shielded methods. Welders connect tanks, hose regulator torches and welding rods to work pieces or use coated rods as required by the nature of the weld. Welders select the type of electrode to use when welding with stick electrodes. They form an electric arc by inserting electrodes in holders, touch electrodes to the work to complete the electric circuit and must then instantly withdrawal the electrode to a short distance away from the work. Welders must ensure the quality of welds that are subject to x-ray analysis, magnetic particle inspection, dye check and water-or-gas tight pressure of other tests.

1. Wages and Recruitment

"The labor crises in U.S. shipyards is caused by several factors that include competition from other trades that offer lucrative work such as construction in areas hit by Hurricane Katrina in 2005," said Matthew Paxton, president of the Shipbuilders Council of America (SCA), a Washington-based trade group that represents more than 35 companies that operate 100 shipyards nationwide (Lovering, 2008). The effect of hurricane Katrina on Gulf Coast shipyards was dramatic. The storm destroyed facilities and equipment. Katrina damaged ships already launched and anchored in berths. Also it dispersed thousands of employees across the country many of whom did not return to the area because of the total loss of their homes and lack of insurance to rebuild. Four years later, Gulf Coast shipyards are still feeling the effects of this displaced workforce. Although billions of dollars in public funding has been targeted to rebuild the local infra-structure many workers have moved on to new locations and new professions. It has not been easy to replace those with shipbuilding skills, especially those with marine welding experience. As many of the Gulf Coast shipyards continue to rebuild and begin to return to constructing ships instead of sub contracting the work, they are looking to replace those workers lost in recent years. In Louisiana, home of both military and commercial shipbuilding, as well as other marine oriented industries, the long term growth for Welders, Cutters, Solderers, and Brazers is predicted to be growing (see Table 1). The number of those employed in these welding professions in Louisiana in 2006 was 16,558. It is projected that in 2016 there will be 20,004. This represents an annual average growth rate of 1.9 percent, faster than the 1.6 percent growth rate for all occupations in Louisiana (Dept of Labor, 2006).

	2006 Employment	2016 Projected Employment	Total 2006-2016 Employment Change	Annual Avg Percent Change
Welders, Cutters, Solderers, and Brazers IN DEMAND	16,558	20,004	3,446	1.9%
All Occupations	1,957,203	2,296,747	339,544	1.6%

Table 1. Long Term Occupational Employment Projections (From Department of Labor, 2006)

Table 2 illustrates national averages for salary and employment numbers for Welders, Cutters, Solderers, and Brazers:

Welders, Cutters, Solderers, and Brazers (National average)	
Median wages (2008)	$16.13 hourly, $33,560 annual
Employment (2006)	409,000 employees
Projected need (2006-2016)	107,000 additional employees

Table 2. Wage and Employment Trends, National averages (From O*NET, 2009)

2. The Welder Organization

Welders are basically organized around a shop and ship concept. Shops are those welding facilities within the shipyard that pre-fabricate, construct and repair components of various sizes and shapes. Ship welders are those whose primary function is on the hull of the ship or on larger construction areas where modules are assembled into the hull. Basic knowledge of welding techniques are shared by both shop and ship welders, yet proficiency and competency of certain welding techniques are not necessarily shared between the two areas. Another element adding to the divergence of skill sets is the environmental challenges of being on the ship. Certain skills that include overhead and 3g (vertical groove) welding are more common on ship than in the shops. Another area of divergence is the seniority and experience level of those welders on ship versus those in the shops. This is primarily due to the rigors of shipboard construction. Work spaces are tighter, lighting is inconsistent and sometimes non-existent. Air quality can be poor and climate control features do not match those permanent systems installed within the enclosed facility areas. All these considerations have the cumulative affect of dictating that shipboard construction requires more agility, strength and stamina of younger, less experienced welders. This is by no means an absolute requirement. Given the environment of the shipyard, more senior welders if given the opportunity may opt to work in the more hospitable areas offered by covered facilities.

Welding organizational structures vary from shipyard to shipyard; each capitalizing on an individual company business strategy that drives a human capital management technique that creates recruitment, training, retention and promotion strategies. They also are greatly affected by the scope of work driven by the type and size of ship(s) in construction. Some shipyards, such as General Dynamics Marine Systems, Bath Iron Works in Maine, build one class of ship, the DDG-51 Arleigh Burke class destroyer (GDBIWS, 2009). Benefits of constructing one class of ship are immense principally due to the level of repeatability built into the construction cycle. Schedules, material, processes, craft utilization, vendor relationships all benefit from executing the same procedure time and time again. Opportunities to reduce costs, enhance quality and deliver ahead of schedule are a product of this single product construction strategy. The downside of a single product construction strategy is a loss in flexibility to change the established construction series. Referencing the Preliminary Model of Organizational Complexity: Optimizing Chaos in Organizations provided in Chapter II (Figure 3), the single customer/product supplier tends to operate on the left side of the pendulum. Other shipyards settled into process and structure, maximizing the level of repeatability, but restricting elements of innovation and advancement. There are other major shipyards that operate on the opposite side of the pendulum, due to the diversity of their product. One such shipyard is Northrop Grumman Shipbuilding – Gulf Coast (NGSB-GC).

For more than seventy years, NGSB-GC facilities and the more than 18,000 employees of the Gulf Coast operations have pioneered the development and production of technologically advanced, highly capable warships for the surface Navy fleet, U.S. Coast Guard, foreign and commercial customers (NGSB-GC, 2009). For the last ten years, the Gulf Coast shipyards of Northrop Grumman, formerly Ingalls shipyard, have been producing no less than five different classes of ship including the DDG-51 Destroyer, Large Deck Amphibious ships (LHA and LHD), LPD 17 class Amphibious Transport Dock ship and the Coast Guard (CG) National Security Cutter Legend Class. Not only does each of these ship classes differ in function (combatant, transport, cutter) they also belong to different customers with different funding sources. These basic supplier-customer fundamentals lend themselves to a hectic manufacturing environment. Unlike the production stability enjoyed by shipyards like BIW, NGSB-GC must deal with the full spectrum of issues that comprise a ships' construction schedule. In a vacuum, a ships' construction scheduled start (SS) and scheduled complete (SC) dates would equal the actual start (AS) and actual complete (AC) dates. There would be no negative cost or schedule variance. The ship would be delivered to the customer on time with zero defects and meet or exceed their expectations. The perfect manufacturing vacuum only exists in concept. The realities of the process are the constant and unpredictable random negative variables that disrupt and alter the course of the original plan. In essence, no plan ever survives first contact with the enemy, and the enemy, in this case is multi-faceted. One such facet being the organizations and manpower process established to support the construction process. For shipyards with diverse products and multiple customers the challenges are accentuated. When the workforce is in a state of flux, a skilled, experienced labor force is harder to recruit, train and retain past the three to five year employment anniversary.

3. The Ship Construction Process

The shipbuilding process (including concept development, bid and proposal, construction and delivery) is unlike any other manufacturing process. Unlike the auto or aviation industry, large presses cannot stamp out and automatically assemble a military amphibious or combatant vessel. Adding to the complexity of ship construction is the integration of weapons, C4ISR, aviation flight operations and maintenance, crew living and other USN/CG specifications. Many of these functions are not the responsibility of the prime contractor, but are in fact contracted to external vendors. The addition of vendors adds one more element of complexity to the process that requires additional performance and management oversight. These factors and many more stress the system. At the heart of this system is the workforce that includes welders, who will ultimately work through the chaos surrounding the ships construction cycle and deliver a vessel that meets or exceeds customer expectations.

The top level construction schedule is represented by multiple means, but for simplicity Figure 8 shows a generic schedule for Ship X. It is comprised of segmented Construction Phases (CPh), defined by scheduled start (SS) and scheduled complete (SC) dates that are scheduled to occur in a specific quarter in given fiscal year, i.e., Q206:

Ship X		CPh A	CPh B	CPh C	CPh C_1	CPh D	CPh E	CPh F	CPh G	CPh H	CPh 101	CPh 102	CPh 103	CPh 104
	Weeks	10	10	10	10	12	12	12	14	14	14	14	20	20
	SS	Q105	Q205	Q305	Q405	Q106	Q206	Q306	Q406	Q107	Q207	Q307	Q407	Q208
	SC	Q205	Q305	Q405	Q106	Q206	Q306	Q406	Q107	Q207	Q307	Q407	Q208	Q408

Figure 8. Construction Schedule, Ship X

The construction schedule is the culmination of hundreds of inputs stretching back to the original contract and extending to real time considerations, such as, material availability. Each CPh is further defined by elements including budget, scope of work, material and workforce requirements. Figure 9 illustrates the functional workforce requirements for Ship X, and the allotted hours required for construction of the entire vessel from CPh A to CPh 104:

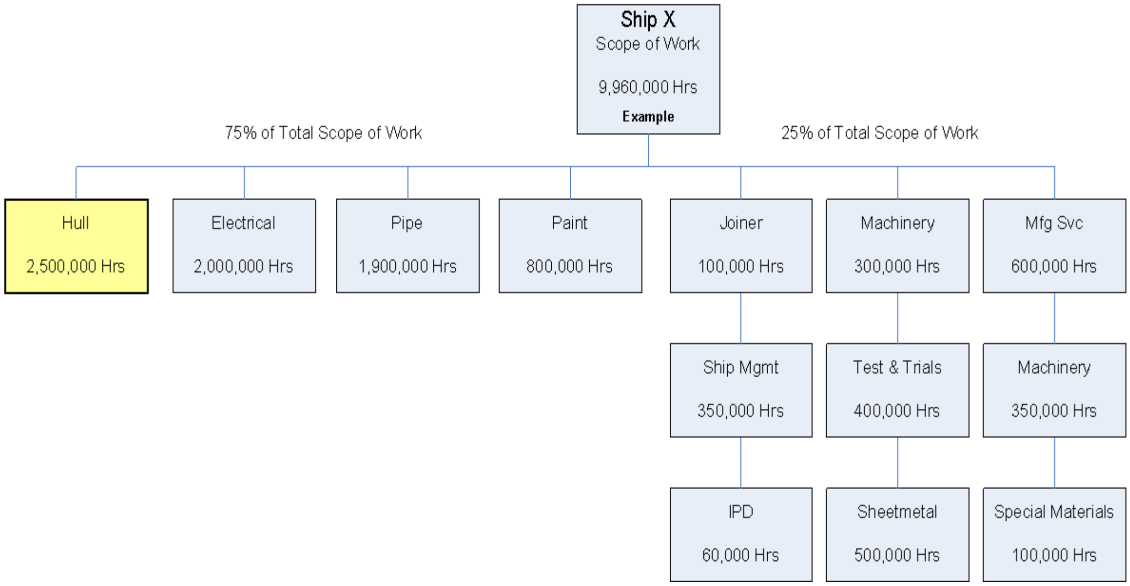


Figure 9. Functional Craft Workforce Requirements for Ship X

The functions listed are primarily those associated with the crafts. Supporting elements including HR, supply chain management and administration, are not represented; however, they play a critical part in the shipbuilding process. Approximately seventy-five percent of the overall effort in ship construction is the responsibility of Hull, Electrical, Pipe and Paint. It is important to understand that even though the decomposition above is an example for Ship X, in an environment where multiple classes of ships are constructed in parallel, the workforce comprising the functional areas may or may not be assigned to one particular hull or ships' class for the duration of construction. In an effort to accelerate construction and meet impending contractual target dates, there are times when backlog, schedule slip and milestone deadlines require that certain hulls receive more workforce support. Figure 10 continues the decomposition of the Hull function and defines those sub-layers of functionality that comprise the department:

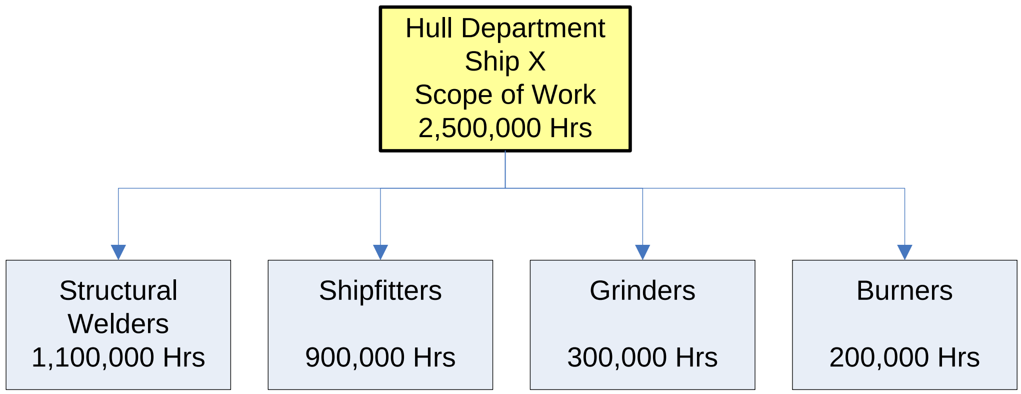


Figure 10. Hull Department Functional Areas and Scope of Work for Ship X

The efforts associated with each of these Hull department functions are not equally apportioned and in fact are a product of varying levels of effort required within each stage of the construction cycle. In the early phases of construction the structural welders and ship fitters play critical roles in unit, modular and ships assembly. As construction progresses and as the ship reaches a more mature completed state of fabrication these functions peak. As the ship nears completion, functional areas such as the paint and electrical departments increase their scope of work. One final layer comprising the welder function is variation in levels of skill and competency. As depicted in Figure 11, welders are primarily categorized based upon experience:

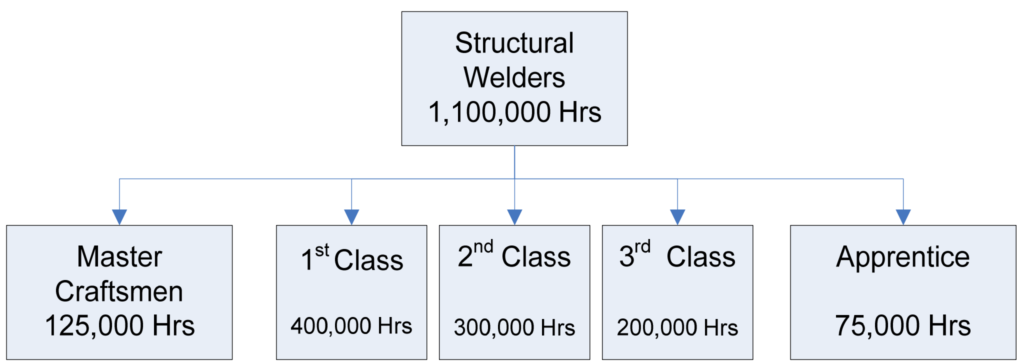


Figure 11. Welder Experience Categories

The structural welding function is further layered to represent those most common experience levels within the department. These numbers are generally accepted rules of thumb as to the ratio of 1st to 2nd to 3rd Class, Master Craftsmen and Apprentice welders required through the shipbuilding process.

It is evident through extensive shipyard employment queries on internet search engines to include Google, Ask, Alta Vista, Lycos and newspaper classifieds from both Mississippi and Alabama that these skill levels are highly sought. In a recent pamphlet produced by The Gulf States Shipbuilders Consortium (GSSC) an announcement stated that hourly wages in the shipbuilding and repair industry are competitive with those in other industries. Skill level determines how much a welder can earn (GSSC, 2009). Below, illustrated in Table 3, is a snapshot of the starting hourly wages for four job functions that shipyards along the Gulf Coast are aggressively seeking and in the highest demand:

Jobs	Skill Level	Average Hourly Rate
Shipfitter	1st Class 2nd Class 3rd Class	$18.20 $14.92 $12.08
Welder	1st Class 2nd Class 3rd Class	$18.20 $14.92 $12.08
Pipefitter	1st Class 2nd Class 3rd Class	$18.20 $14.92 $12.08
Pipewelder	1st Class 2nd Class 3rd Class	$18.20 $14.92 $12.08

Table 3. Critical Craft Shipbuilding Salary, Class Adjusted (From GSSC, 2009)

These varied functions responsible for the bulk of effort in the shipbuilding process each have their own very specific and important list of missions. They also represent an element of rank, based upon either time in grade or skill level, comparable to USMC and other military organizational structures.

4. The Shipyard Manpower Process

Unlike the Marine Corps and other DoD organizations, the shipyard industry cannot maintain their end strength in the same manner as the congressionally funded Department of Defense services. Shipyards operate on profit, and since most ship contracts are competed and awarded on an individual basis, long-term employment of the workforce is challenging. Inevitably, there are surges in production where shipyards go on hiring frenzies. There are also valleys that drive the release of a certain number of workers. Most capacity planning organizations consider both firm (contracted vessels) and potential (bid and proposal phase) hull scope of work in their charts. These charts can provide near, mid and long term queues identifying need for craft workforce and allow management and human resources to seek early remedies and plans of action to minimize the effects of critical craft losses. The key to successfully navigating through periods of reduced capacity within the shops and on ship is to understand the need for the type and level of craftsman required to meet construction milestones. The dilemma for the shipbuilding industry is to determine who provides maximum value at each phase of the construction cycle.

The USMC Enlisted Flow Model, depicted in Chapter II, Figure 6, illustrated a manpower process driven by rank and experience. It is a classic pyramid whose base is comprised of First Term Accession Marines, the most junior ranking members of the service. As a Marine progresses in time and rank, the pyramid maintains its cost and end strength balance by application of constraints that forces a manpower attrition rate that seeks stability with end strength, ASR and staffing goals. It also allows the Marine Corps to remain within funding patterns set by the Program Objective Memorandum (POM) cycle.

The shipyard seeks experience among its ranks of craftsman. Those with three to five years of shipbuilding experience represent 1st class craftsmen, the core group desired by management and labor to provide value added work and contribute to the success of the construction sequence. As shown in Figure 12, the optimal skill set welder manpower structure, or the model most desired within shipbuilding, is not developed to maximize cost savings. Each rung of the pyramid represents total aggregate numbers of employees within the rung, while the numeric value on the right hand side represents the cost burden assumed by the company, one (1) being the highest and five (5) representing the lowest. The top of the pyramid is structured similarly to those of USMC models in that the most senior group has the fewest in aggregate numbers. This senior leadership node in the pyramid has a cost impact value of one (1), the highest cost burden to the organization. This allows for sufficient numbers of senior enlisted Marines to fill critical leadership billets while minimizing the cost impact to the budget. The pyramid deviates from a balanced cost-to-skill solution due to the desire for 1st class craftsmen. Having the maximum number of 1st class craftsmen in the shipyard performing the majority of welding tasks would be most desired. Based upon this desire the 1st Class Craftsman would represent the highest aggregate number of employee type in the pyramid and have the second highest cost burden. Although the skill set desired is met, the budget is negatively impacted due to the high numbers of employees within the second highest cost burden category. As compared against the USMC model, it is upside down with respect to flow:

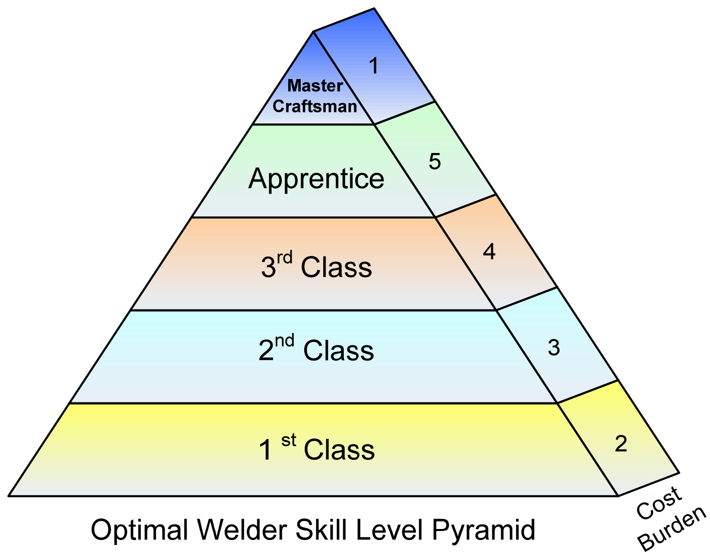


Figure 12. Optimal Welder Skill Level Pyramid and Cost Burden Rate Impact to Operating Budget

If budget was of no concern or consequence, and recruitment policy and practices supported sufficient 1st class welder accessions (recruitment) directly into the workforce, shipyards would take a giant leap forward in the progress of ships construction. Unfortunately, costs associated with the labor workforce are a primary driving factor constraining profit. The Marine Corps manpower burden has historically hovered between 60 and 65 percent of the total annual budget; commercial industry carries nearly the same manpower burden. The difference between the two organizations is the necessity and requirement to maintain an acceptable profit margin. Instead of reliance upon historical information to drive hiring, training and placement shipbuilding could potentially benefit from a detailed analysis of its workforce need to better meet construction objectives. Strategies based upon certain aspects of USMC organizational structure coupled to Tables of Organization could set the stage for increased efficiency. Subsequent development of MOS's aligned with T/O mission statements and METL's could create MOS's for welders not defined on loose generalizations of experience and skill, but would be tied to quantitative scope of work requirements.

C. CHAPTER SUMMARY

The shipbuilding industry, especially those that support the Department of Defense, is a cyclic business that is at the mercy of congressional funding. It is a complex, multi-faceted, long term construction process that cannot rely upon any one particular customer funding stream to support its workforce. Unlike the Marine Corps, funded to support operations geared toward national defense, shipyards must make manpower decisions based upon a profit margin and capacity plan. Unfortunately, there are those negative valleys in the construction process that force the release of skilled workers. In years past these workers released from employment commitments could be easily rehired when capacity increased. With the expansion of opportunities in the commercial sector the shipbuilding workforce, not unlike military recruitment, has experienced its share of shortages in the workforce. It is imperative that shipyards fully understand the performance standards, experience and competency connected with each employee rating to better match skill set to production effort, throughout the ships' construction process. Potential opportunities exist to develop an industry recruitment and retention model to more effectively meet scope of work, no matter the diversity of class of ship in construction. The Marine Corps model may present some beneficial attributes transferable to the shipbuilding industry and its welder workforce.

IV. IDENTIFICATION AND APPLICABILITY OF ATTRIBUTES FROM USMC ORGANIZATION AND MANPOWER PROCESSES THAT ARE TRANSFERABLE TO SHIPBUILDING WELDER ORGANIZATIONAL STRUCTURE

A. INTRODUCTION

Organizations, like systems, have purpose. They both consist of structures that are comprised of several layers. Systems are the product of sub-systems, elements and components, while organizations are generally the product of a workforce, middle management, and senior leadership. Elementary layers of both structures have a core function that ultimately supports the efforts of the structure to provide a product or service to the respective customer. Organizations and systems have goals that satisfy and meet the larger objective or mission. Objectives of organizations can be compared to the Table of Organization's mission statement in that they both must amplify purpose in a reasoned, logical and systematic style. Dr. Phil Bartle states that objectives have clear and unambiguous characteristics. One method to construct and manage an objective is through the use of a simple acronym S.M.A.R.T. (2007):

- Specific: Clear about what, where, when, and how the situation can or will be changed
- Measurable: Must be able to quantify the targets and benefits
- Achievable: Must be able to successfully attain the objective
- Realistic: Must be able to obtain the level of change reflected in the objective without introducing conjecture and arbitrary variables
- Time bound: Stating the time period in which they will each be accomplished.

The characteristics of stable and achievable objectives identified in the SMART acronym align with the intent of the USMC T/O mission statement given that both seek to direct functional effort toward the achievement of base requirements. For USMC units the base requirement is to provide support to the infantryman while shipyards provide support for their craftsmen. Each shares common mission characteristics in that both provide products and/or services on time and on schedule. The product or service satisfy all specifications that meets predetermined levels of quality for physical, functional and operational performance requirements as specified in either the mission statement (USMC), or contract vehicle (shipyard).

B. ORGANIZATIONAL ATTRIBUTES

Marine Corps organizations, from the smallest individual unit to the largest are defined and driven by the Table of Organization. The T/O defines a Marines skill and experience level (rank) required to best meet the need defined within the mission statement. Annotated on the T/O is the primary aircraft authorization (PAA), which defines the total number of Type, Model and Series of aircraft, allotted to the squadron. Coupled to the T/O is the Table of Equipment (T/E), a document that defines all necessary equipment for the unit to operate and achieve the mission statement goal. Combined together the T/O and the T/E are the Table of Organization and Equipment (T/O&E). A Table of Organization and Equipment (T/O&E) was a chart-like document published by the War Department which prescribed the organic structure and equipment of military units from divisional size and down that includes the headquarters of corps and armies (AR 310-60, 1943). The scope and function of a T/O&E was described by noted military historian Dr. Robert R. Palmer in his report titled Reorganization of Ground Troops for Combat:

> Dr. Palmer stated that For each unit the T/O&E prescribed the number of its officers and men, the grade and job of each, the proportion of various occupational specialists, the arrangement of command and staff and administrative personnel, the means of transport and communications, the provisions for supply, maintenance, construction, and medical care, and the kind and quantity of individual and unit armament, together with the relationship between supporting weapons and consequently the tactics of the unit. (p. 265)

Prior to 1943, organization and equipment were expressed in Tables of Organization (T/Os) and Tables of Basic Allowances (T/BAs). Unfortunately the T/BAs were not closely coordinated with the T/Os. In October 1942 the Table of Equipment (T/E) was substituted for the T/BA. The difference is that a T/E was set up for each standard unit, whereas there had been a single T/BA for each combat arm, covering all standard units of that arm. To provide complete coordination between organization and equipment, a consolidated T/O&E, was issued for each standard unit in August 1943 (AR 310-60, 1943). By aligning the T/E to the T/O of specific types of units a higher level of standardization was created. This standardization allowed for a more consistent organization, training, manpower processing and operational consistency regardless of the unit's geographical location.

The T/O sets the baseline for like units. Each individual allotted structure position, such as the F/A-18D Hydraulic Mechanic, rank LCpl, quantity one, must be the same regardless of unit location. This is the standardization nucleus that allows for movement of the individual Marine from one unit to the next in time of need due to reapportionment of resources driven by combat or other critical requirement. During the Gulf War and throughout the Global War on Terrorism, USMC manpower agencies have dealt with such movement of personnel from one unit to the next. Due to deployment cycles, increased requirements and unit deactivation, the Hydraulic Mechanic may be needed in another unit to satisfy the other unit's staffing goal. Due to clear delineation of baseline requirements within the T/O structure frame, and the level of standardization that ensues, this movement (although not necessarily a positive influence on retention) does meet high priority unit staffing goals. It is the T/O that sets the foundation for all Marine units and has allowed for the design and refinement of the manpower process.

1. Table of Organization and Equipment: Requirement Baseline

Tables of Organization and Equipment are based on generalized templates for each specific type and size of unit, e.g., a weapons company of an infantry battalion, or all weather fighter attack squadron of a Marine Air Group. These templates are then modified as needed by the individual unit. The Marine Corps also relies on other documents to report what personnel and equipment a unit actually possesses. The T/O section denotes every authorized billet within a unit by rank and Military Occupational

Specialty required fulfilling the necessary duties. The T/E section denotes authorized equipment by number and quantity (Wiki, 2009). Table 4 is an extract from a working 8840 T/O for an F/A-18D squadron. As noted, the T/O is supplemented with the T/E, N8840, which defines the full listing of equipment needed for the squadron to train, support, maintain and deploy. The promulgation statement along with the top level mission statement for the unit is also listed. The individual METL's would follow the mission statement and would, in much greater detail define lower level functional and operational requirements of the squadron and its assigned personnel:

AS OF: 03/02 T/O CHECKLIST PREPARED: 03/03/07
Sample Extract

T/O: 8840 F/A-18D Squadron
T/E: N8840
PROMULGATION STATEMENT: THIS TABLE OF ORGANIZATION PRESCRIBES THE ORGANIZATIONAL STRUCTURE, BILLET AUTHORIZATION, PERSONNEL STRENGTH, AND INDIVIDUAL WEAPONS FOR THE MARINE FIGHTER/ATTACK (ALL-WEATHER) SQUADRON
MISSION: ATTACK AND DESTROY SURFACE TARGETS, DAY OR NIGHT, UNDER THE WEATHER; CONDUCT MULTI-SENSOR IMAGERY RECONNAISSANCE; PROVIDE SUPPORTING ARMS COORDINATION; AND INTERCEPT AND DESTROY ENEMY AIRCRAFT UNDER ALL-WEATHER CONDITIONS.

LINE NO.	ENGLISH DESCRIPTION	BLT GRD	ALPHA GRADE	MOS	B R N	T Y P	S T A	MARINES OFF	MARINES ENL	MARINES CIV	OTHER SERVICES OFF	OTHER SERVICES ENL	NON-CHARGEABLE OFF	NON-CHARGEABLE ENL	NON-CHARGEABLE CIV	S C G	U P N	EDU	S E P	S G	LNG	SKW SCH	FTN
300	A/C MAINTENANCE DEPARTMENT																						
*301	AIRCRAFT MAINT OFF		MAJ	7525	M	O							1				P						
332	MAINT CTL CHIEF		MSTSGT	6019	M	E			1								P						
372	QUALITY ASSURANCE OFF		CAPT	7523	M	O							1				P						
834	HYD MECH		SGT	6094	M	E			1								M						
835	HYD MECH		CPL	6094	M	E			1								M						
836	HYD MECH		LCPL	6094	M	E			1								M						
**838	WELDER		CPL	6043	M	E			1								M						
		6092M																					
	SECTION TOTALS MARINE								5				2										
	MAINT ORGANIZATION TOTALS MARINE							6	176														

Recapitulation by MOS
GRADE AVERAGE
MARINE OFFICER 2.79
MARINE ENLISTED 4.22

* This is an additional billet non-chargeable, filled by a chargeable structure from a Pilot or Naval Flight Officer
** Welder MOS can only be assigned to a qualified Aircraft Structures Mechanic, MOS 6092

Table 4. Extract From Table of Organization 8840, F/A-18D Squadron (From Manpower 101, 2009)

Other significant elements of the T/O are the descriptions of each function within the squadron and the number of personnel associated with that function. Note line number 301, Aircraft Maintenance Officer. This position should be filled by a major with a primary MOS of 7525, Naval Flight Officer (NFO). In any case the position is budgeted to be filled by a Marine Officer (MO). This line on T/O 8840 shows that this position, although identified as a requirement, is not a chargeable structure and, thus, was not budgeted. It is in fact a position that will be filled by a chargeable structure from the ranks of aircrew. Within the squadron there are approximately fourteen pilot (MOS 7523) and fourteen NFO (MOS 7525) chargeable structures. Within the ranks of chargeable Majors, the AMO position is an additional or secondary duty. This is also the case with T/O line number 372, Quality Assurance Officer, except this secondary duty will be filled by one of the squadron's Captains (MOS 7523). Lines 332, 834, 835, 836 and 838 all designated as Marine Enlisted (ME) are chargeable, as these positions represent primary MOS's that are processed within the Enlisted Staffing Goal Model (ESGM) and apportioned to units by the appropriate MMEA agency, based upon unit precedence level and available resources.

The T/O consists of separate sections, each defining requirements and total chargeable and non chargeable structure. Table 4 illustrates the section extracted from the Aircraft Maintenance Department, which consists of six chargeable MO's and one-hundred-seventy-six chargeable ME's, as shown under the Maintenance Organization Totals line. If the maintenance department was staffed with six MO's and 176 ME's (one Marine fills one structure), they would be at one-hundred percent T/O. If every chargeable structure in every Marine unit was filled with an actual Marine, then the Marine Corps, as a whole, would be operating at one-hundred percent T/O. As discussed in Chapter II, total staffing of structure is not possible due to budget and end strength constraints (T2P2). Staffing goals allow a maximum percentage of deployable Marines to populate a unit T/O, thus maintaining the equilibrium between requirement and availability. Application of staffing goal for the maintenance department can be illustrated by showing a relationship between chargeable structure and assigned Marine. If four Marines were physically inside the unit filling lines 332, 834, 835, 836 and 838, the extracted portion of the unit would be at eighty percent T/O. If this staffing goal was applied to the entire complement of chargeable structure within the maintenance department, the total number of assigned Marines would number one-hundred-forty-one, or eighty percent of T/O. Regardless of the ultimate staffing goal applied to a unit the T/O sets forth definitive functional requirements for any Marine Corps unit to operate, support, maintain and deploy. It allows the manpower process to determine appropriate staffing based upon the attributes listed in Chapter II. The T/O is also a dynamic document that has process steps to allow change based upon emerging requirements. The Marine Corps is unique among the other services in that it leverages the input from the operating forces to lead change based upon true need, not a casual understanding of need from those serving in USMC manpower directorates. The Occupational Field Sponsor is a critical link to the operational forces and represents specific MOS's and leads the process of altering, reorganizing and eliminating T/O structure when needed.

a. Occupational Field Sponsor: Requirements Manager

The Occupational Field Sponsor (OccFldSpo) is the linkage that connects headquarters with the functional MOS's comprising units in the operating forces (OPFOR). Each MOS group has an OccFldSpo, a Marine, usually ranging in rank from Capt through LtCol, determined by the size of the MOS field. This person is generally in the same MOS field as the community he or she represents allowing a level of understanding of the on-going or emergent conditions pressuring the OPFOR. The OccFldSpo is responsible to the OPFOR to ensure that their request for T/O structure changes or realignments are acted upon. Each year, OccFldSpo in the Marine Corps gather together to convey the state of their individual MOS field to the broader group. Through open dialogue a better understanding of the whole emerges adding greater levels of granularity to the entire breadth of current USMC T/O conditions. The OccFldSpo can change structure deemed not necessary by the OPFOR and realign it to meet a new and more pressing function, thus adding to the T/O's relevance. The OccFldSpo also has an understanding of the organizational networks that exists between the various USMC manpower directorates. This makes navigation through the various channels a much easier task, allowing more responsive and timely results.

C. ORGANIZATION SIMILARITIES

The Marine Corps and the Shipbuilding industry are both constructed from an organizational perspective that begins with a mission statement, similar to the T/O development process. Historically, Marine Corps preparedness has been characterized by the phrase, “The First to Fight.” Marines are trained, organized and equipped for offensive amphibious employment and as a “force in readiness.” Officially, the mission of the Marine Corps is set forth in the National Security Act of 1947 as amended (1952). The key parts of the act, as presented in an article of the Marine Corps Gazette (2009, July) are listed below:

> 1. To seize or defend advanced naval bases and to conduct such land operations as may be essential to the prosecution of a naval campaign.
>
> 2. To provide detachments and organizations for service in armed vessels of the Navy or for protection of naval property on naval stations and bases.
>
> 3. To develop, with the other Armed Forces, the tactics, techniques, and equipment employed by landing forces in amphibious operations.
>
> 4. To train and equip, as required, Marine forces for airborne operations.
>
> 5. To develop, with the other Armed Forces, doctrine, procedures, and equipment of interest to the Marine Corps for airborne operations which are not provided for by the Army.
>
> 6. To be able to expand from peacetime components to meet the needs of war in accordance with mobilization plans.
>
> 7. Perform such duties as the President may direct.

Based upon these mission elements, coupled with historical precedents, the Marine Corps has developed an organization that meets those direct and implied task requirements set forth by the NSA. Figure 13 provides an abbreviated USMC organizational structure that culminates with the identification of physical skill requirements (Hydraulic Mechanics) within the Maintenance Department function.

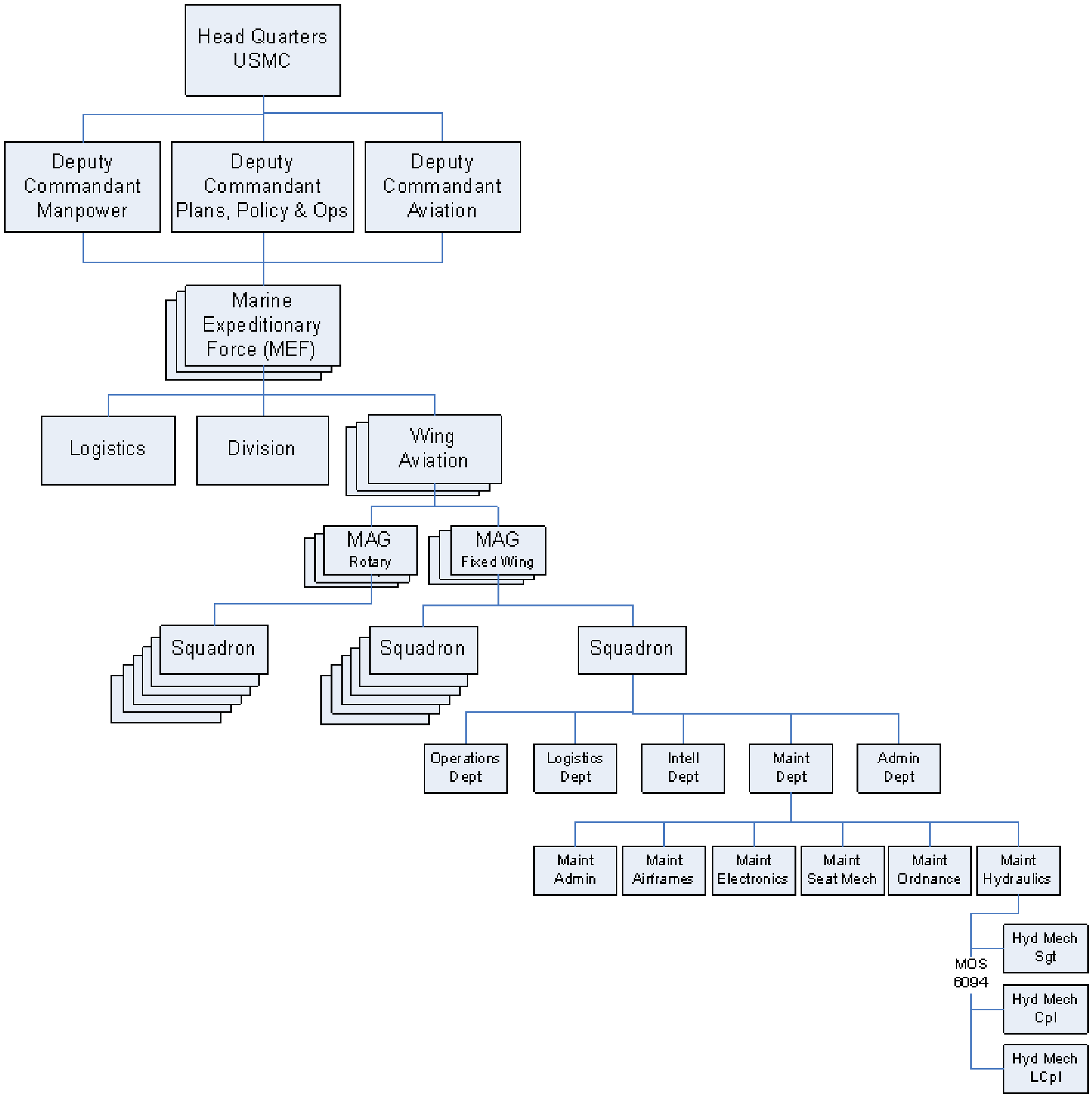


Figure 13. USMC Organizational Decomposition (Abbreviated Sample)

The development of any business organization, to include the shipbuilding industry, also follows a similar methodology that is ultimately dependant upon a mission statement. This statement may be as simple as provide quality products and services that meet or exceed customer expectations. As with Marine Corps organizations, each layer will have a specific mission or tasks list developed to meet the broader requirements. Figure 14 culminates with the identification of physical skill requirements (Welder rating classes) within the structural welder function.

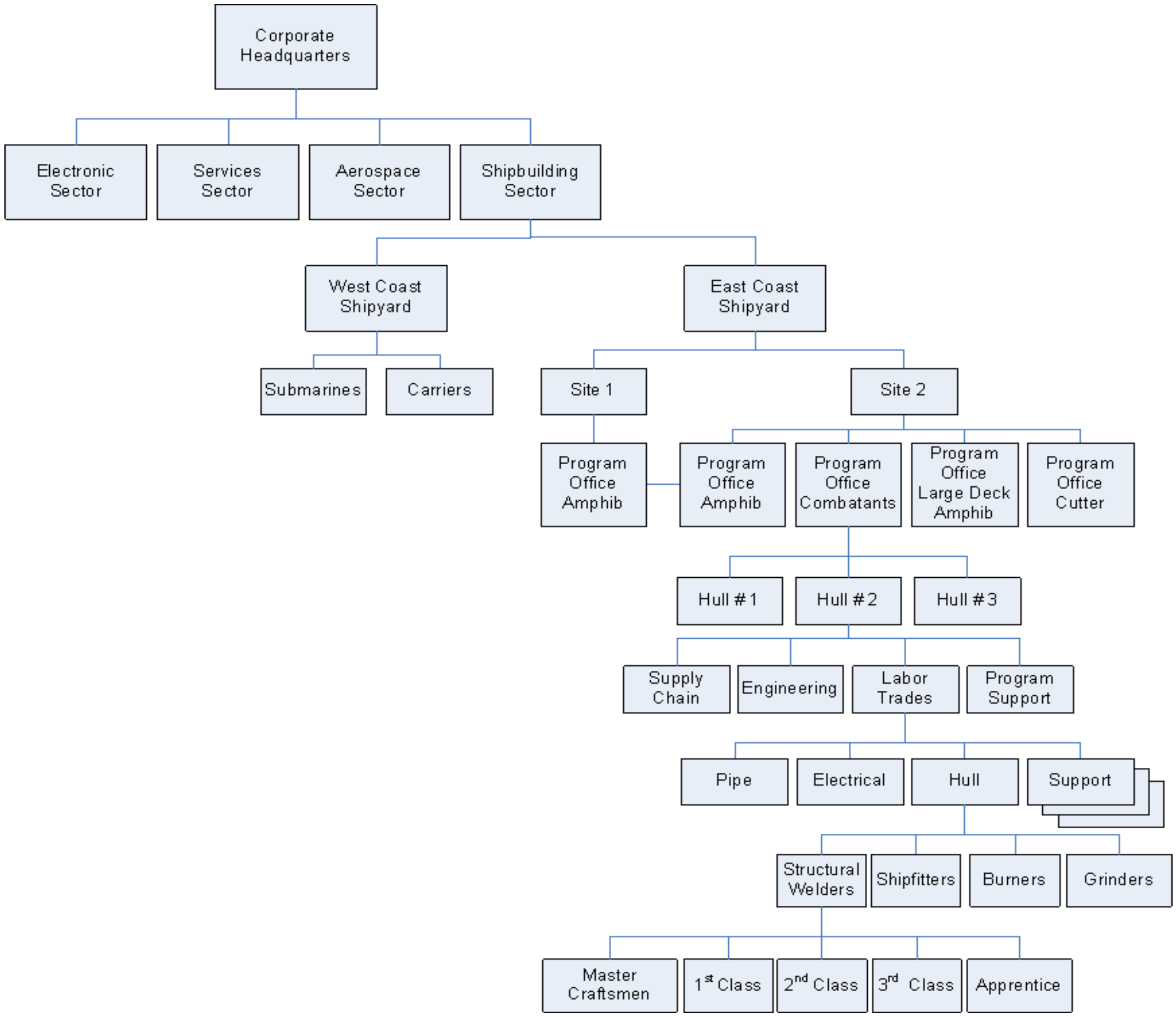


Figure 14. Shipbuilding Organizational Decomposition (Abbreviated Sample)

A side-by-side comparison of the two organizations does not readily expose easily interpretable similarities in functional description. Top level functions, such as a headquarters element, are common to most organizations, military or industrial, but lower layer functions are not quickly linkable. An understanding of the functions of each layer is required to better match and assess commonalities. Table 5 attempts to link USMC and shipbuilding organization functional elements together to allow a qualitative assessment of similarity.

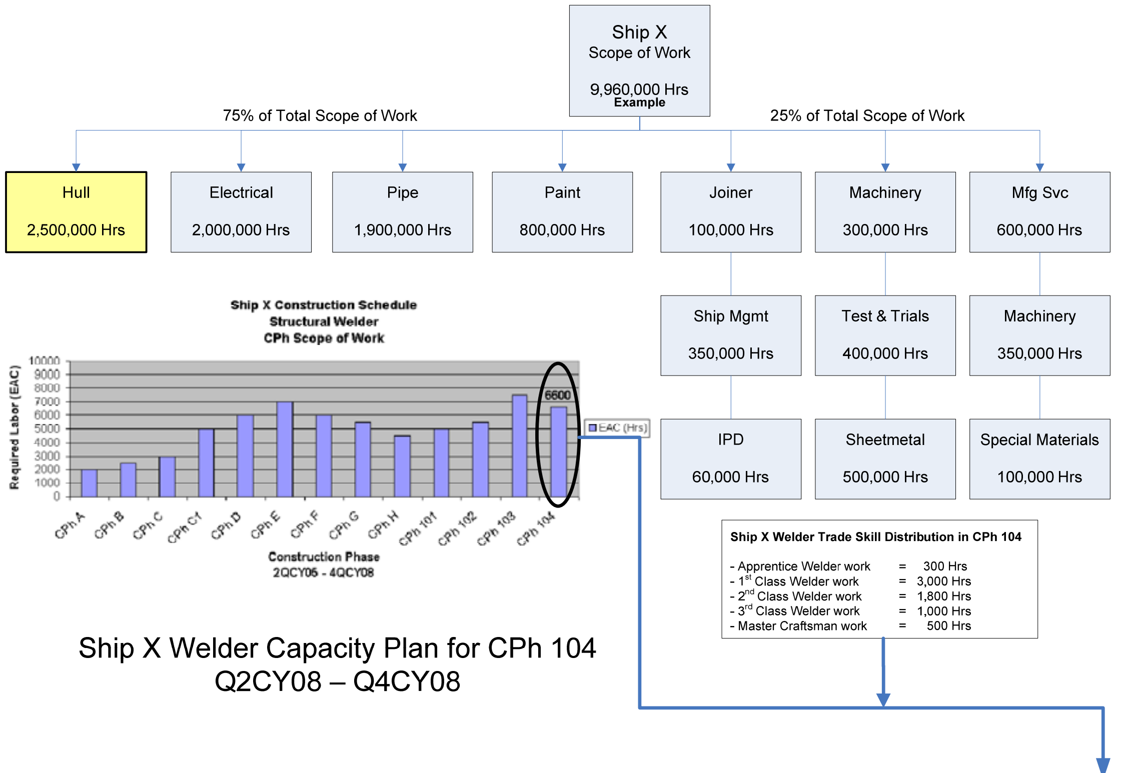
Organizational Similarities		
USMC	Similarity Value	Shipbuilding Industry
Headquarters	2	Corporate Headquarters
Deputy Commandant	2	Sector
MEF	2	Shipbuilding
Wing	3	Shipyard
MAG	3	Geographical Site
		Program Office
Squadron	3	Ship Hull
Departments	3	Departments
		Labor Trades (Craft)
Maintenance Department	4	Hull Department
Hydraulics Division	4	Hull Skill Sets
Hydraulic Mechanic	5	Structural Welders
Rank	5	Rating
Lo 1……2……3……4……5 Hi		

Table 5. Organizational Similarities: Qualitative Assessment of USMC and Shipbuilding Functions

Some of the functional elements of USMC organizations, such as the Marine Air Group (MAG) and Squadron Departments, cross multiple boundaries when compared to the shipbuilding organization. As the layers become more defined at the lower end of the spectrum, the functions become better aligned, beginning with the USMC Maintenance and Shipbuilding Hull Department comparisons. These lower layers show commonality in that their relationships align by providing hands on service, maintenance and repair capabilities to the host organization. The maintenance department is aligned with the T/O to provide maintenance, repair and support services to the squadron's primary equipment, twelve F/A-18D Hornets. Each entity within the department has a distinct purpose and structure that supports this effort. The Hull department within shipbuilding is also structured and arranged to meet the obligations of ships construction. Each of the skill sets within the Hull department provides a basic function, and welders provide the preponderance of this effort. As the assessment continues to descend in order and reach the individual Marine (rank) or Craftsman (rating) level, the commonality of function and similarity value increases. Each of these functions are defined by criteria as established by the host organization. The Marine Hydraulic Mechanic is an allowable structure defined on the unit T/O. This specialty is staffed to the unit based upon available assets within the broader USMC manpower system as constrained by the POM and resultant end strength. The Hull department welder, as a craftsman, can be defined by common welding practices within the industry or more narrowly, if need dictates, a specific set of skills required for ship fabrication such as specialty metal welding techniques.

The Marine hydraulic mechanic and the shipbuilding welder have, at their core, skill sets needed to provide the utility necessary to accomplish the mission. The elements that dictate their use and consistency deviate greatly due to a myriad of different factors. The Marine is funded and allocated to a unit based upon congressional funding. This allocation of budget has been fairly consistent through the years. There are also elevations in the budget cycle that account for increased activity for Marines, such as, supplemental to offset the cost associated with protracted engagements. A key difference between military funding and manpower use and industries application of human capital management strategies is the ability of the military to utilize resources in alternative ways. Within the Marine Corps a Marine will remain employed regardless of the current global situation. During peacetime or contingency operations, USMC forces remain active while conducting training. Within industry, when capacity is low it is cost prohibitive to retain excess manpower. Without a method to utilize a craftsman in an area that may be in demand during the reduced period of need, the company has no alternative other than releasing a portion of the over-manned shipyard. The opposite is true when capacity increases and more resources are required. In this case, the company may not have an external pathway to bring in skilled just-in-time labor to fill the void. Consistency in funding, scope of work, and the inability of the shipyard to cross train its workforce to better meet need is a constraint that impedes production and ultimately affects cost.

Figure 15 shows the combination of the decomposition of Ship X required Craft departments and associated hours based on the capacity plan for CPh 104 and the top level Integrated Master Schedule (IMS) for Ship X construction. Assessing each of these elements together allows a detailed examination of scope of work, but more importantly it sets the stage for detailed analysis and identification of skill level requirements for the welders for a specified period of time (CPh 104).



Ship X		CPh A	CPh B	CPh C	CPh C_1	CPh D	CPh E	CPh F	CPh G	CPh H	CPh 101	CPh 102	CPh 103	CPh 104
	Weeks	10	10	10	10	12	12	12	14	14	14	14	20	20
	SS	Q105	Q205	Q305	Q405	Q106	Q206	Q306	Q406	Q107	Q207	Q307	Q407	Q208
	SC	Q205	Q305	Q405	Q106	Q206	Q306	Q406	Q107	Q207	Q307	Q407	Q208	Q408

Figure 15. Welder Work Load Estimate Model

The first prerequisite in a physical assessment of welder scope of work is to conduct a detailed analysis of the IMS. CPh 104 is the final phase of Ship X's construction cycle, a phase that is 20 weeks long, beginning 2nd Quarter 2008 and ending 4th Quarter 2008. Since this is the final phase of construction the ship is between 94 to 96 percent complete. Most actions during this phase are associated with final outfitting, corrections to problems found from previous construction phases (rework) and testing of ship sub-systems. There are hours budgeted within the phase for all crafts, support and construction management, each separated into different planning packages and distributed to the individual agencies from program management. Within CPh 104 both the welding hours and type and location of welding work required can be determined. Figure 16 details the process flow for the unwinding of CPh 104 and exposure of essential tasks within the welding craft. The ultimate goal of the process flow model is to present an effort level, skill requirement and planning baseline for CPh 104. This baseline will be transferred into a T/O like document (see Table 6) that will allow better organizational structure for the welder craft and support improved use of the skill set. If scope of work and skill requirement is known for each CPh then a separate T/O can be created for the entire construction cycle for all classes of ship under contract.

Ship X		CPh A	CPh B	CPh C	CPh C_1	CPh D	CPh E	CPh F	CPh G	CPh H	CPh 101	CPh 102	CPh 103	CPh 104
	Weeks	10	10	10	10	12	12	12	14	14	14	14	20	20
	SS	Q105	Q205	Q305	Q405	Q106	Q206	Q306	Q406	Q107	Q207	Q307	Q407	Q208
	SC	Q205	Q305	Q405	Q106	Q206	Q306	Q406	Q107	Q207	Q307	Q407	Q208	Q408

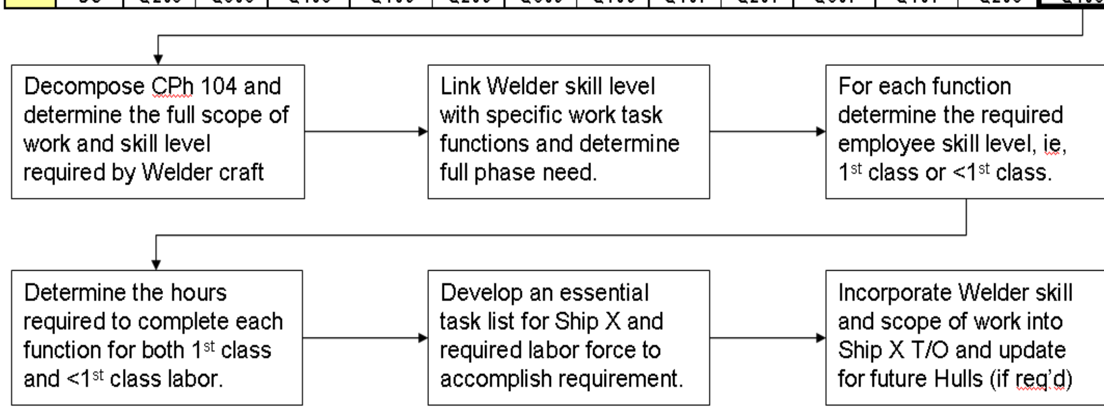


Figure 16. Phase CPh 104 Welder Skill Level and Scope of Work Process Flow Model

Ship construction is not a process that occurs within a vacuum. Changes occur in the construction process as additional ships in class are constructed. However, the core scope of work, materials and critical path milestones remain close to the original baseline. If change is required the welder T/O can be updated or revised to accommodate these changes to future ship planning packages with a relatively high level of confidence.

Table 6 represents an example to what a Ship X Table of Organization Checklist might resemble. Like its Marine Corps counterpart this document would provide the baseline craft skill structure requirement for each major craft department responsible for

the construction of a particular class of ship. Application of the process steps defined in

Figure 15 and 16 will allow the shipbuilding industry a means to predict near, mid and long-term functional and physical requirements.

AS OF: 08/07

SHIP X T/O CHECKLIST

EXAMPLE

PREPARED: 08/25/07
LOCATION: SITE 1
FROM: 1/08 TO: 1/10

T/O: 0519 HULL DEPARTMENT - SHIP CLASS X
T/E: N0519

PROMULGATION STATEMENT: THIS TABLE OF ORGANIZATION PRESCRIBES THE ORGANIZATIONAL STRUCTURE, RATING, TYPE, PERSONNEL STRENGTH, AND INDIVIDUAL EQUIPMENT WITHIN THE HULL DEPARTMENT FOR THE CONSTRUCTION AND FABRICATION OF SHIP CLASS X.

MISSION: HAND-WELD OR UTILIZE FLAME-CUTTING EQUIPMENT TO WELD OR JOIN METAL COMPONENTS AND TO FILL HOLES, INDENTATIONS, OR SEAMS OF FABRICATED METAL PRODUCTS. OPERATE AC AND DC ELECTRIC ARC WELDING EQUIPMENT. USE PORTABLE, AUTOMATIC, AND SEMI-AUTOMATIC EQUIPMENT WITH METALLIC ELECTRODES THAT INCLUDE INERT GAS SHIELDED, FLUX-SHIELDED (SUBMERGED ARC), AND HYDROGEN-SHIELDED METHODS. CONNECT TANKS, HOSE REGULATOR TORCHES, AND WELDING RODS AS REQUIRED BY THE NATURE OF THE WELD. ENSURE THE QUALITY OF WELDS THAT ARE SUBJECT TO X-RAY ANALYSIS, MAGNETIC PARTICLE INSPECTION, DYE CHECK, AND WATER-OR-GAS TIGHT PRESSURE OF OTHER TESTS.

LINE NO.	ENGLISH DESCRIPTION		HULL 1	HULL 2	HULL 3	HULL 4	CONTRACT LABOR
300	STRUCTURAL WELDERS						
301	MASTER CRAFTSMAN	SHOP	30	20	50	10	5
302	MASTER CRAFTSMAN	SHIP	50	75	60	45	10
303	1ST CLASS	SHOP	100	40	40	20	5
304	1ST CLASS	SHIP	200	150	80	40	10
305	2ND CLASS	SHOP	30	20	20	10	5
306	2ND CLASS	SHIP	100	75	40	20	10
307	3RD CLASS	SHOP	15	10	10	5	-
308	3RD CLASS	SHIP	50	50	25	15	-
999	APPRENTICE	DUAL	30	30	15	15	-
	SECTION TOTALS STRUCTURAL WELDERS						
		SHOP	185	120	135	60	15
		SHIP	420	350	205	120	30
	HULL ORGANIZATION TOTALS						
	SITE 1		250	200	140	90	20
	SECTOR		355	270	200	90	25

EXPERIENCE AVERAGE	
MASTER CRAFTSMAN	25.23
1ST CLASS	8.44
2ND CLASS	5.38
3RD CLASS	3.19
APPRENTICE	1.14

Table 6. Example of a Potential Table of Organization for the Hull Department, Structural Welder Section

This manpower requirements document defines the structure needed to support both the shop fabrication and repair requirement for the shipboard construction process. It would also allow the creation of a database that could track the efficiency of labor skills and would be able to develop metrics to allow for the creation of a baseline experience table. The mix of structure, skill level and experience may drive shipbuilding to better understand the scope of work to better match need and identify the specific level of experience required to most effectively and efficiently complete ships construction on time and on budget.

1. Unplanned Requirements: The Individual Augment (IA)

One gap in the USMC T/O concept is the identification and rapid filling of combat related and identified need. During Operation Iraqi Freedom (OIF) commanders in the field began to identify organizational requirements not specified on established T/O's. The unique nature of the conflict placed the Marine Corps outside of traditional mission roles. As the conflict continued, Marines began to identify additional functions in both Iraq and Afghanistan. To allow staffing of these new requirements USMC manpower agencies were forced to reassign personnel from traditional unit staffing goals. The end results were Marines filling non-structured positions and leaving structure in T/O units understaffed. Formal IA review boards were eventually established to help alleviate the strain on the manpower system by validating each IA request. Once vetted through the board, the position was staffed by seeking a best fit solution from the available manpower resources.

D. MANPOWER PROCESSES

The Marine Corps manpower process uses the T/O as its primary requirement. Through the application of various models, processes and procedures the output arrives at the optimal number of actual Marines available to fill the T/O structures of each USMC unit organization. Figure 17 illustrates the basic information required within the ASR and the process models that optimize both near and long-term manpower needs. The models seek to maximize the number of available Marines for T/O structure match.

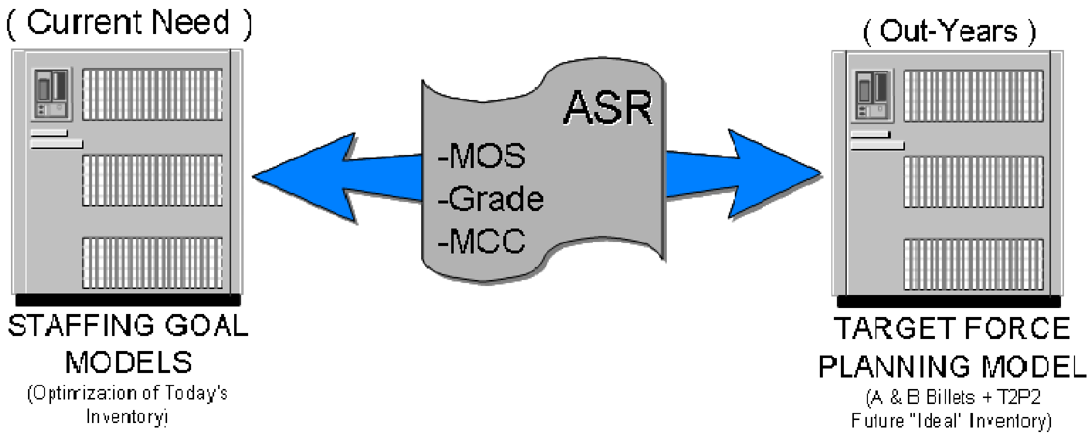


Figure 17. Immediate Need and Future Forecast USMC Manpower Model (From HQ USMC, 2006)

The process model shown above allows for both reactive and proactive manpower policy planning. The ASR feeds the staffing goal model to allow optimal staffing of USMC units in the short term. The Target Force Planning Model (TFPM) accounts for A and B billets and T2P2 to produce an optimal future inventory. It is the latter, driven by the unit T/O and end strength that must occur first in the process, as this defines the requirement and will ultimately drive recruitment, training and manpower placement.

1. Recruitment

The primary mission of the Marine Corps Recruiting Command (MCRC) is to supply recruiters with the resources they need to spread the Corps' message and enlist the best talent they can find for Marine Corps Units, while maintaining the Corps motto "The Few, The Proud, The Marines." Recruitment of Marine recruits is the product of a complex network of Marine Corps recruiting districts, satellite offices, on-site high school and college liaison teams and national advertisement campaigns. This network is vital to supplying a constant number of future Marines to satisfy unit requirements and meet attrition rates planned for within the EGSM. Another key component of USMC recruitment is the former and retired Marines who pass down stories of their past exploits and adventures in the Marine Corps. History, service to country, and the unique nature of becoming a Marine are key elements that help promote long-term sustainable recruitment. The shipbuilding industry has many challenges to recruitment due to the nature of the industry that does not either have the resources or recruiting network breadth afforded to government funded entities, such as the military.

Shipbuilding, due to its nature, is a coastal, regionally bound industry. Most shipyards throughout the U.S. are well established having been anchored in their communities for decades. Recruitment of shipbuilders has primarily been a cyclic process, driven by individual ship contracts as dictated by the shipbuilding strategy of the U.S. Navy, presidential administrations and congress. This process is neither steady nor predictable. With additional regional competition for skilled craftsman, shipbuilding has had to alter its strategy and seek more progressive recruitment strategies to persuade both the apprentice class and the experienced shipbuilder to join their production workforce. Unlike the Marine Corps, shipbuilding cannot retain its entire force when production slowdowns. Carrying the cost burden of an employee who is not actively working is not an option in profit industry. Therefore, shipyards have built mechanisms that balance workforce requirements with technology insertion and a percentage of outsourcing. Shipyards are also constrained by distance from soliciting potential workforce members in other regions throughout the U.S.

2. Cross Functionality

As discussed in Chapter II, the Marine Corps has various models to predict and forecast long-term manpower needs based upon the foundational structure functions listed in USMC unit T/O’s. Because the baseline structure requirements are consistent, the Marines can develop recruitment strategies that will satisfy their needs. They also have the capability to adjust the models in the event of end strength fluctuations and other unforeseen attrition factors. The primary key to maximum utilization of Marine manpower resources is the ability of the Marine Corps to move personnel around to fill various functions outside of their PMOS when needed. This skill crossover capability allows Marines to satisfy functions outside their primary specialty. Lateral transfers are another mechanism the Marine Corps uses to reduce over-populated MOS’s and bolster the ranks of MOS’s whose target manpower goals are not being met. During OIF, it became apparent that the intelligence community did not have sufficient numbers to sustain the ever increasing need for intelligence gathering personnel able to provide analysis capability. Eventually the unit T/O's was revised to account for this shortfall with the addition of structure, but in the interim the lateral transfer policies allowed near term population of the community. Due to labor union representation of the craft workforce, cross training of individual craftsmen to meet other craftsmen duties and functions is not a workable option. Welders, ship fitters, pipefitters, pipe welders and general laborers all function within a narrow scope of work and skill set. They belong to trade unions that represent their specific function. Although some elements of cross training exist, it does not translate over to primary craft skills.

E. CHAPTER SUMMARY

The Marine Corps and the Shipbuilding industry are both constructed from an organizational perspective that begins with a mission statement, similar to the T/O development process. The Marine Corps and the Shipbuilding industry also rely upon and utilize manpower to execute their respective functions. Without the constant flow of new and experienced personnel into each respective entity, neither could accomplish their mission. Each organization experiences periods of reduced pace and increased operations. For the Marine Corps, combat operations represent the most critical stressors on the manpower process due to its surge and chaotic nature. Primarily, these stressors are most significant in the areas of functionality due to the identification of emerging needs. Shipyards experience ebbs and flows in production due to construction capacity requirements between the phases and the variances in the construction process. The Marine Corps builds its manpower foundation on the basis of function, mission and essential tasks within each unit within its T/O structure. The shipyard must work within a mission framework that is balanced between the skill sets required ship construction and the associated costs to maintain a steady state production model. The two substantive differences between the two agencies are funding and the ability to utilize manpower in other than conventional roles.

Unlike the Marine Corps, shipyards are prevented from applying a multi-role functionality to its workforce due to the constraints placed upon it by the trade unions.

USMC manpower agencies and even local units have the latitude to use its force as needed in a variety of roles outside of primary function, as deemed necessary by local commanders. The shipyard is prohibited from such actions and must apply its workforce skills to a very narrow range as defined by trade union representation. Shipyards do have the capability or opportunity to redefine their organizations based upon the USMC manpower system. Yet, there are elements within the USMC model that can potentially shift to shipbuilding manpower processes without disrupting the trade union balance. The T/O provides a methodology defining structure needed to support both the shop fabrication and repair requirement and the shipboard construction process. A T/O for welders would allow the creation of a firm set of requirements, transferrable to each successive ships in class and allow the creation of a database capable of tracking and analyzing the efficiency of labor skills. The mix of structure, skill level and experience may allow shipbuilding to better understand the skill match needed to perform the scope of work, thus, allowing for a more effective utilization of its critical shills workforce.

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V. CONCLUSIONS AND SUGGESTIONS FOR ADDITIONAL FUTURE RESEARCH

A. CONCLUSIONS

Chapters II through IV of this thesis provided insight to organizational structures and manpower processes of both the Marine Corps and the Shipbuilding industry. Chapter V will discuss the research questions initially posed in Chapter I and will present possible areas of further research.

B. KEY POINTS AND RECOMMENDATIONS

1. Research Question Number 1

How does the Marine Corps organize its units and meet manpower requirements?

- Organizational structure?
- Definition of needed skills?

The foundation that supports the accomplishment of the USMC unit mission is prescribed in the Table of Organization. Coupled with the Table of Equipment the Table of Organization and Equipment (TO&E) sets the baseline for required functions, primary equipment and personnel skills needed to train, maintain and support the unit for combat and combat related operations. Chapter IV, Extract from Table of Organization 8840, F/A-18D Squadron, shows those specific skills required within the maintenance department to support the functions of hydraulic repair and maintenance on primary equipment. The TO&E is a dynamic, event driven document that allows emerging long-term needs to be incorporated into its structure. Many primary MOS's become marginalized through technology advances or the reapportionment of skill sets into more condensed, collective sub-organizations or functional sub-section groups. It is this realignment feature that allows unit TO&Es to remain relevant and proactive to changes in strategy, employment, budget and end strength. TO&E's provide the basis for all organizational capability within the Marine Corps allowing the manpower process to satisfy both near and long term staffing requirements. Clearly defined functional layers, skill sets, numbers of Marines required and rank allow an unambiguous definition of requirements (personnel) needed to support the mission.

2. Research Question Number 2

How does the shipbuilding industry organize its marine welder workforce to better meet manpower requirements?

- Organizational structure?
- Definition of needed skills?

Simply stated, revenue - costs = profit. Private industry operates within the boundaries of this equation and must maximize profit to prosper in a competitive business environment. Whether a company creates a product, provides a service, or develops systems the bottom line drives continued growth and future expansion. Shipbuilding, unique in the realm of manufacturing industries, provides a product that is neither easily constructed nor simple in its systems architecture. A ship, especially a DoD USN combatant or large deck amphibious class, is one of the most complex structures built. Its construction timeline from actual start to actual complete exceeds most other similar products. It is an industry that cannot heavily rely upon excessive technology for construction due primarily to the nature of fabrication. It is the labor workforce serving the functions related to welding and pipe fitting that drive the preponderance of the shipbuilding process. For those shipyards that construct one class of ship the challenge to provide an experienced workforce is less than a shipyard that constructs multiple classes of ships. It is the latter that must utilize its workforce on multiple vessels as dictated by delivery milestones. The physical movement from class to class does not allow full application of the learning curve by skilled craftsmen making the process less efficient and predictable than it would in the single class shipyard.

Shipyard organization is a product of two functional area constructs, those of shop and ship. Within the welding shop environment large portions of steel are cut and molded to form single units as the fabrication process matures those units become a ship. As this more mature vessel progresses in construction, it requires different or additional skill sets and functions to complete the process. Specifically, within each of these areas are layers of descending leadership that support the organizational function of welding. Within the ranks of welder's there are skill sets based upon time and competency that define a welders capabilities. Figure 14, Shipbuilding Organizational Decomposition (Sample Extract) shown in Chapter III, illustrates the organizational and functional layers of a generalized shipyard. Each level of the organization provides varying levels of management and welder experience. At the lowest layer, the Hull welder is defined in experience levels that range from apprentice to master craftsman. Within this experience range exist the required unit function as depicted within the USMC TO&E section that specifies both MOS and required rank. The F/A-18D 8840 TO&E require three hydraulic mechanics of various ranks. The LCpl can be approximated to the level of apprentice welder, while the Cpl and Sgt can be compared to the 2^{nd} and 1^{st} class welders, respectively. The structure between the welder and the hydraulic mechanic are similar in nature. Although both serve vastly different functions and are under the control of two very different parent organizations; the profit driven shipbuilding industry and the DoD.

3. Research Question Number 3

What elements or attributes of the Marine Corps organizational model and manpower processes could transfer and benefit the shipbuilding industry
and its welder organizations?

- Tables of Organization and Equipment?
- Enlisted Staffing Goal Model?
- Additional Duties: Skill Set Cross Training?

There are large fundamental differences between the Marine Corps and the Shipbuilding industry. No difference being greater than shipbuilding's requirement to maximize profit. The other primary difference is illustrated by the Marine Corps maxim that every Marine is at first and foremost a rifleman (PMOS 0311). Due to the representation of the craft workforce by trade unions this concept cannot be replicated within the shipyard. However, there are elements of the USMC organizational model and subsequent manpower process that could potentially benefit the shipyard if applied and managed.

The concept of the Table of Organization and Equipment is a primary element of a USMC organization that could transfer to shipbuilding. As discussed in Chapter III, and illustrated in the sample TO&E for the Hull department, a manning document could better quantitatively define the need for welding personnel in both the shop and ship environments. A welder TO&E could set the foundation for a construction baseline that would meet both near and long term ship construction objectives. Creation of a broad mission statement and detailed mission essential task list would channel the functional and physical requirements to the welder force. As illustrated in the Welder Work Load Estimate Model depicted in Figure 15, Chapter III, skill and experience levels would allow better clarity to meet construction needs. This model represents the first process step in the quantification of welder skills required, as based upon schedule and known scope of work. As the class of ship matures and more vessels are constructed, the welder TO&E would operate similar to the USMC. The TO&E would allow modifications based upon emergent needs as defined by the welder workforce and their cognizant functional skill representative, comparable to the USMC MOS Occupational Field Sponsor.

The Enlisted Staffing Goal Model (ESGM) is transportation based Linear Program designed specifically for the Marine Corps. As described by L.A. Wright, a staff member at MMEA, the ESGM (Enlisted Staffing Goal Model) "distributes the current inventory by PMOS and Pay Grade (PGRD) based upon CMC priorities. Working as a supporting element of the ESGM is the EGSR (Enlisted Grade Structure Review). This model is the infamous pyramid you hear about that creates the even flow for accessions, promotions, First Term Alignment Plan (FTAP), Second Term Alignment Plan (STAP), steady state schools, and recruiting" (Wright, 2009). The essence of the

ESGM and EGSR is to seek a level of optimization that maximizes the number of available Marines allocated to unit requirements, as defined by TO&E structure. This same methodology could be transferred to the shipbuilding welder community and aid in the distribution of available welders to vessel work packages. The model could also allow a more comprehensive assessment of future need, as defined by firm and potential work capacity plan that could translate into more effective recruitment, training and retention policies within the shipyard.

One attribute of the USMC organizational and manpower model that could, if negotiated and accepted by the trade unions, benefit the shipbuilding industry is that of the Secondary MOS. If during low periods of welder usage a welder could fill a craft skill in peak need, such as pipe welding, a process could be established that would prevent layoffs of under-utilized craftsmen. Each CPh of the ships construction process requires an uneven level of effort among the craft functions. If a welder could be cross trained in the craft function of pipe welding, then that individual could provide a valuable secondary skill set to meet need. A 1st class welder may not be able to perform at the proficiency level of a 1st class pipe welder, but even if that welder had a pipe welder 2nd or 3rd class level he or she could continue to contribute to the overall construction cycle and thus broaden the ability of the shipyard to meet construction deadlines. The essential element of this concept is to obtain buy-in from the trade unions. Craft handling is set by contract and rarely negotiated after contract signature.

4. Research Question Number 4

How might a functional organization framework, based upon USMC policy, aid marine welder organizations in better satisfying requirements while minimizing cost impact to the shipbuilding industry?

The author illustrated the effectiveness and utility of USMC organizational structure and supporting manpower processes. There are many constraints that would hamper the application of these attributes and elements into the shipbuilding industry. Primary among these is the relationship between the skilled craft and the trade unions.

Certain performance criteria are set in negotiated contracts that would prohibit or discourage cross colonization of USMC organizational and manpower fundamentals.

Funding sources also set the two entities apart. The Marine Corps is an element of the DoD POM and is further reliant upon the USN budget to fund programs, equipment and personnel. Additionally, the Marine Corps does not have to compete for funding in the same way private industry must. The shipbuilding industry is at the mercy of many factors not present in USMC stability. The shipyard must compete for and expend energy and funds to create bids and proposals to compete for and win ship contracts. There is no guarantee that their efforts will result in contract award, but the process must continue or else there will be little probability of securing new ships construction work. A functional organization framework, based upon USMC policy could aid marine welder organizations to better satisfy requirements by quantification of skills and definition of personnel required. Instead of basing CPh manning on historical trends and rules of thumb shipbuilding, management could determine levels of craft effort required for each CPh in a vessels construction IMS and more effectively match skill sets and numbers of personnel to scope of work. Ultimately, organizational realignment and application of identified USMC manpower attributes could minimize the cost impact of the labor workforce and increase productivity within the shipbuilding industry.

C. AREAS TO CONDUCT FUTURE RESEARCH

The following areas of future potential research are products of analysis that extend the original scope of thisthesis. These potential research areas could be of benefit to both organizational structures and the manpower processes that support the Shipbuilding industry in maintaining profitability.

1. Identification of Marine Welder Personality Characteristic Markers

Part of the original thesis scope of work was a section titled, future research into what defines a potential marine or shipbuilding welder. The intent of this chapter was to identify key personality traits and characteristics that would help human resource agencies better define and develop recruitment strategies. Not unlike the military in its efforts to reach out to a more diverse demographic audience, shipbuilding could leverage the identification of personality markers as data points in a near, mid and long term recruitment policy.

2. Optimization of the Skilled Craft Workforce within the Shipbuilding Industry

The author firmly believes that increases in effectiveness, efficiency and productivity will result from a full scale optimization study of the skilled craft workforce. As the Marine Corps sought and obtained tailored optimization models from private companies the shipyard could also benefit from such a tailored model to support more efficient use of manpower in the ships construction process.

3. Modeling of Shipyard Functions

Similar to the intent of future research question number 2, a full scale optimization study of the shipyard and its primary, secondary and tertiary functions would better help leadership understand the true nature of its organizational functions. This study would allow planners to see the inputs and desired outputs of agencies, areas, facilities and workforce. Understanding these products could help in the identification of gaps in processes and allow realignment based upon optimization techniques.

Shipyards, not unlike the Marine Corps, are machines in motion. It is neither feasible, desirable, nor even possible to stop the machine to correct core deficiencies. If viewed as a gyroscope, deficiencies affect the orientation of the gyro from optimal rotation to a state of imbalance. The size and complexity of the organization will not allow the gyro to be stopped, reset and reengaged to correct the state of imbalance. It is possible though to correct the imbalance by subtle changes to the gyro’s orientation to better approximate the state of optimality. Corrections to both the organizational structure and manpower processes related to the welder workforce are methods to correct for a listing gyro.

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