

ODU/HRGCC “Think Tank”

White Paper

Labor Shortages in the Virginia Ship Repair Industry

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1. Introduction

The U.S. ship-building industry has experienced many challenges since the frenzied pace of vessel production precipitated by World War II with the industry being marked by declining production volumes since the conclusion of the war. As a result, the number of large commercial and naval ship builders (see Figure 1) has decreased from 30 to 9 nationally and from 14 to 4 in the Atlantic region (Colton, 2019). Additionally, over the past 15 years, the U.S. Navy has changed its contracting strategies multiple times to find efficiencies and seek cost savings within its limited budgets. These shifting strategies have affected shipyard business volumes as well as their labor needs. It has not been uncommon, over the years, for shipyards to cycle between periods of mass-hiring and -layoffs. This historic lack of employment stability has done little to make the industry attractive to prospective employees and made it more challenging to develop strategies for consistently meeting its workforce needs.

In a potential reversal of fortunes, the U.S. ship- and boat-building industry (NAICS 3366ⁱ) will

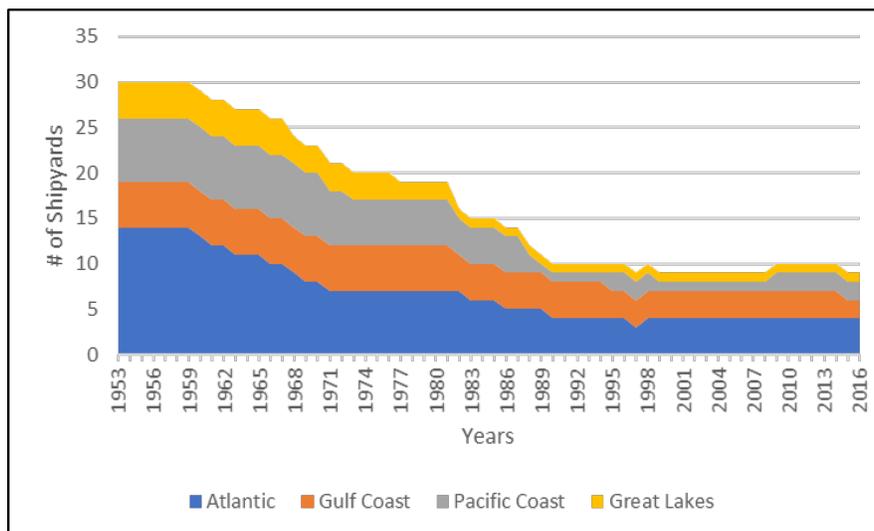


Figure. 1 Number of Large Naval and Commercial Shipyards in U.S. by region

likely face a new challenge. With government contracts currently calling for the construction of new

ⁱ North American Industry Classification System (NAICS) 3366 includes NAICS 336611 (Ship Building and Repair) and NAICS 336612 (Boat Building).

U.S. Navy ships over the next five decades, U.S. vessel production levels are expected to increase to a steady state volume. This will likely create a persistent need for skilled labor at shipyards for the foreseeable future while national industrial output is expected to continue its current path of growth. Given demographic trends, however, there will be a steady decline in the size of the U.S. labor force. This will likely pose a significant problem for all U.S. industries and individual firms as each competes for the services of a smaller pool of available employees, thus generating upward pressures on labor prices in the long run.

Norfolk Virginia, and the surrounding area known as Hampton Roads,ⁱⁱ is positioned along the mid-Atlantic coast as a major hub for shipbuilding and ship repair. Unsurprisingly, much of the work is generated by the U.S. Navy with Norfolk, Virginia being home to the world's largest Naval base. Currently, the ship- and boat- building industry accounts for approximately 4.3% of the employment in Hampton Roads (GO Virginia, 2019). The Norfolk Naval bases serve as a significant source of employment for those in the Hampton Roads area due to the large number of naval and commercial vessels that require periodic and ongoing maintenance. However, with unemployment in Hampton Roads at its lowest level since 2007 and a growing federal budget, this industry is being challenged to recruit and retain sufficient numbers of qualified employees.

Despite the large volume of work generated by the Navy, volatility in the Federal Budget creates variable labor needs over time in the Hampton Roads ship- and boat- building industry. Historically, this has led to cycles of mass layoffs and rehiring. Additionally, Congress' use of Continuing Resolutions to fund the government places another constraint on the industry whereby government funding cannot to be allocated to ship building or repairs. This affects the industry's ability to maintain a steady employee

ⁱⁱ Hampton Roads includes: cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach and Williamsburg along with Accomack, Isle of Wight, James City, Northampton, Southampton and York counties

base. During periods when Federal Budgets reduce government-related work, shipyards are often forced to increase their reliance on commercial projects and, at times, projects not directly related to the shipping business to more fully utilize their workforces. Even with “backfilling”, layoffs are sometimes unavoidable. On the other hand, during periods of budgetary expansion, shipyards can struggle to complete projects on time as they attempt to hire, and train, new employees or re-hire previously laid off employees. Additionally, the ship building and repair workforce is aging and within just a few years many of these workers will be retiring, thus depleting employers’ ranks of their most experienced and valuable employees. These troubling trends require immediate action to mitigate both the immediate labor challenges faced by the industry as well as to prevent future degradation to the ship building and repair industry that have the potential to compromise future military readiness.

The purpose of this paper is to characterize the skilled labor challenges facing the ship repair industry in Hampton Roads and to provide insights with respect to initiatives the industry’s shipyards might take to address this important issue. In the next section, an overview of the U.S. outlook for ship building and repair is explored along with the labor environment for the types of skilled employees that tend to be in shortest supply within the industry. Section three focuses more specifically on the challenges facing ship repair yards in the Hampton Roads area. Finally, in section four, a number of approaches to the meet future skilled labor requirements at shipyards in the Hampton Roads area are offered.

2. U.S. Outlook

2.1. U.S. Ship Building and Repair Production

As shown in Figure 2, between 2018 and 2028, U.S. output (Real GDP) is projected to grow at a compounded annual rate of 1.9% while manufacturing output is projected to grow at the relatively slower rate of 1.6% per annum. During the same time frame, the Ship and Boat Building Industry (NAICS 3366) is expected to grow at a more robust 2.4% per year (Bureau of Labor Statistics, 2019). The reduced rate of growth in manufacturing output in conjunction with increased ship- and boat-building output represents a potential opportunity to recruit labor into the ship building and repair industries. As workers depart manufacturing sectors experiencing contraction, one might logically expect that they will look to growth sectors for employment opportunities. The projected growth in the ship- and boat-building industry between 2018 – 2028 represents a sharp departure from the negative growth (-1.7%), attributable to reduced government contracts, experienced by the industry between 2008 – 2018. The projected upcoming growth for the period 2018 – 2028 can be linked to the U.S. Navy’s plan to increase its force from 290 to 355 ships by 2050.

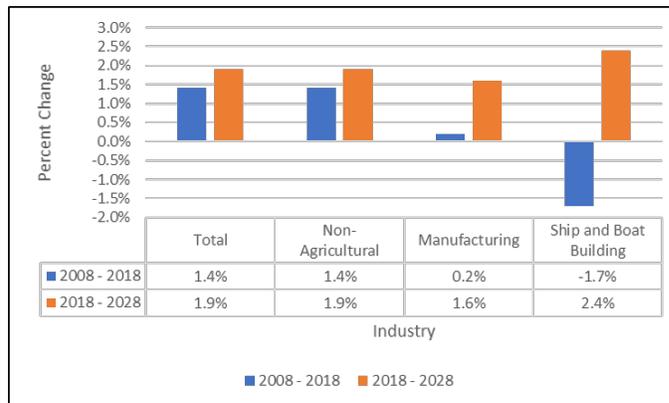


Figure 2. Compounded Annual Rate of Change - Production Output

Figure 3 identifies the total number of ships produced in the U.S. by type while Figure 4 identifies sources of revenue generation between 1987 and 2015 (Colton, 2019). While the U.S. Navy accounted for only 6 out of the 1,803 vessels built in the U.S. in 2015, it accounted for 50.5% of the

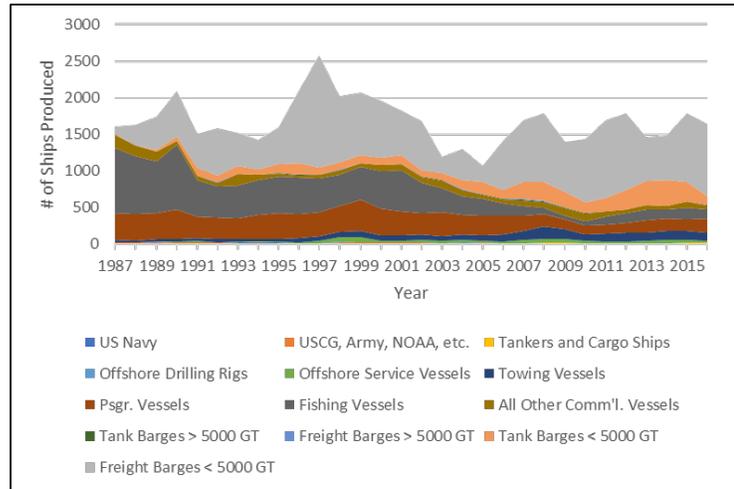


Figure 4. Ships and Vessels Produced in U.S.

revenues generated from ship building and 17.5% of all ship repair revenues in that year.ⁱⁱⁱ Although the defense industry is one of the largest revenue generators for the ship- and boat-building industry,

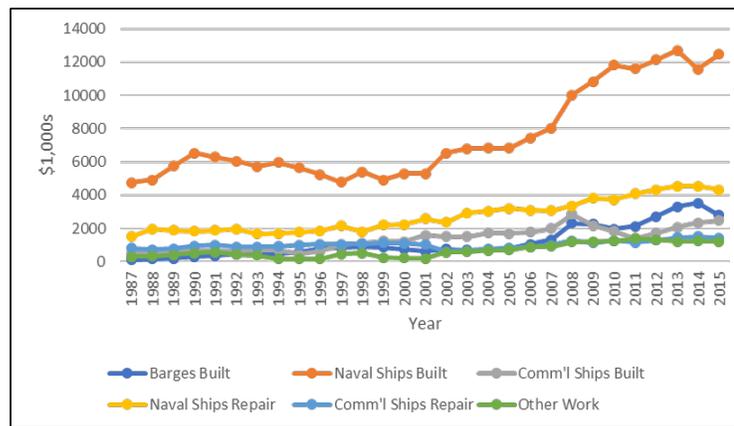


Figure 3. Revenue in U.S. Ship Building and Repair

inconsistent government funding for ship building and repairs affects the industry's ability to maintain a consistent labor force. Greater stability in revenue streams and labor requirements (extending into the year 2050) should accrue to the industry based on the Navy's 355 shipbuilding plan. The U. S. Navy's

ⁱⁱⁱ Some years from the source data were missing. To account for the missing years, the author took the average from the year prior and year after.

Long Range Ship Plan calls for the new construction of 54 ships (valued at \$106.5B) and decommissioning of 21 ships over the FY19 Future Years Defense Program^{iv} (FYDP) or about 11 ships per year through 2023 (Office of Chief of Naval Operations, 2018). In contrast, an average of 6 U.S. Navy ships per year were built between 2005-2015.

On average, the construction and repair of naval vessels accounted for 68.73% of the total revenue generated between 2005-2015 (or \$2.19 of revenue for U. S. Naval Ships per \$1 of revenue from other commercial ships and barges produced or repaired in the U.S.), while the total number of naval vessels produced accounted for only 0.68% of production during the same period (Colton, 2019). Additionally, \$0.364 was spent on average for US Naval ship repairs for each dollar spent on building a new naval vessel during that same period. Extrapolating the U.S. Navy's FY19 FYDP projections, there is a potential for over \$38.77B in U.S. Navy ship repairs between 2019-23, exclusive of U.S. Coast Guard and Army vessels.

2.2. U.S. Ship Building and Repair Employment

The U.S Census Bureau projects (see Figure 5) an historically low 0.5%^v annual labor growth rate between 2018-2028 (Bureau of Labor Statistics, 2019). Over the past decade, workers in the 55+ age group retired at a later age than has historically been the case. This increased participation in the overall labor force and contributed to work force growth. These workers will certainly begin to depart the labor force in increasing numbers over the next decade and as the remainder of the workforce (under 55) grows at a muted rate, the overall size of the labor force may not be sufficient to meet the economy's labor needs (Dubina, Morisi, Rieley, & Wagoner, 2019). In accordance with Department of

^{iv} Dollar figures are constant FY18 dollar figures. Construction for the 54 new build ships are expected to begin within the FY19 FYDP. FY19 FYDP is from 2019-2023.

^v Employment data for wage and salary workers are from the BLS Current Employment Statistics survey, which counts jobs.

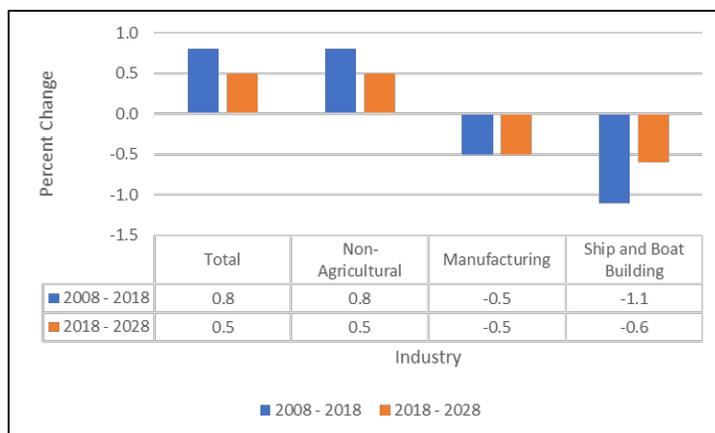


Figure 5. Compound Annual Rate of Change - Employment

Labor employment data, and as seen in Figure 5, the total number of jobs across the U.S. Industrial base is expected to grow 0.5% from 2018-2028, but manufacturing jobs are expected to decrease by 0.5% between 2018 and 2028, while the ship and boat building industry is expected to decrease at a higher rate of 0.6% (Bureau of Labor Statistics, 2019). At first glance this looks bad, but when compared to the industry’s job growth between 2008-2018 of -1.1%, job opportunities are decreasing at a slower rate. The slower rate of negative growth (from -1.1% to -0.5%) can be attributed to the Navy’s 355 ship building plan which is projected to improve employment opportunities across the industry. This highlights an interesting aspect of labor for this industry. Nationally, the number of jobs is declining, but the ship- and boat-building industry is still struggling to hire additional skilled workers. This suggests the

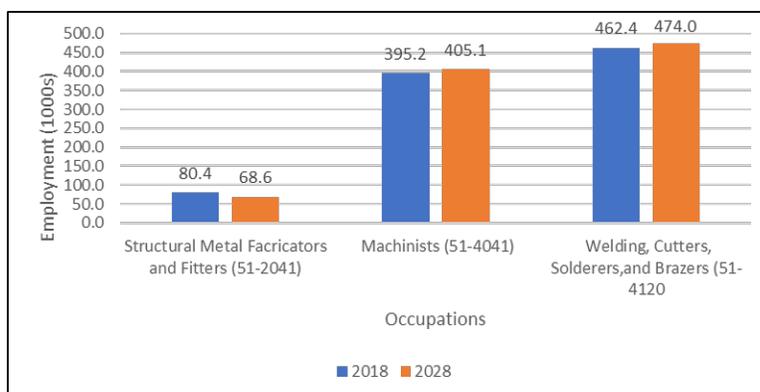


Figure 6. Occupations Across all Industries

available number of skilled workers is decreasing more quickly than the rate at which jobs in the industry is decreasing.

Norfolk-based repair shipyards have identified four occupations for which it is particularly difficult to recruit/develop and retain sufficient numbers of qualified workers: machinists, welders, pipe



Figure 7. Occupational Pay

fitters and ship fitters. As indicated in Figure 6, there will be an increased national demand (between 2018 and 2028) across all industries for machinists and welders, but a decline in number of jobs for fitters. Thirteen of the 30 occupations experiencing the fastest rate of decline in available jobs include hand-cutters/trimmers, coil winders, and machine tool setters (Bureau of Labor Statistics, 2019).

Workers in these occupations are no strangers to challenging work environments such as those found in the ship repair industry. It might not be unreasonable, therefore, to believe that displaced workers from these occupations would represent a good recruiting source. These workers possess certain technical skills, and understanding of hard work, that while not directly transferrable would likely make them good candidates for retraining into the occupations for which shipyards have the greatest need. Figure

7 shows the labor rates for Fitters, Machinists and Welders in the ship- and boat-building industry compared to those same occupations across all industries in the U.S. Labor rates tend to be comparatively higher (and significantly so in many cases) in ship building (Bureau of Labor Statistics, 2019). Starting pay (assumed to be represented at the 10th percentile of labor rates) nationwide for ship- and boat-building industry fitters is about \$3.51 more per hour compared to other manufacturing industries; machinists make almost \$3.95 more per hour; and welders make \$2.57 more per hour. The machinist occupation in the ship-building industry is the only one that does not maintain a significantly higher wage scale (at all percentiles) compared to other manufacturing industries. In this case, there is a near-convergence with other industries at the 90th percentile. There are obvious potential financial advantages to working in the ship- and boat-building industry compared to other manufacturing industries. Such advantages can be vigorously marketed to prospective employees as a recruiting tool.

2.3. Conclusion for U.S. Outlook

The expected 2.4% growth rate in production (Figure 2) in the ship- and boat-building industry between 2018 and 2028 should serve as a positive sign for employees seeking careers in the skilled trades. Given the current outlook for the industry, these fields should offer stable employment opportunities. The industry's higher projected growth rate in output relative to the national average can be largely attributed to the U.S. Navy's Long-Range Ship Building Plan to "grow the Navy" to a 355-ship fleet. As the size of the Naval fleet grows with the completion of new vessel builds, increases in future ship repair requirements will be generated, and provide revenue generation opportunities in the industry. Despite this positive news, current U.S. labor projections suggest that the industry will likely experience labor shortages that may compromise its ability to meet production and future ship repair requirements. Labor (especially skilled labor) shortages present a major concern for the ship- and boat-building Industry as well as the U.S. Navy. As the population of 55+ year old workers retires, the remaining working-age population is not growing at a commensurate pace to provide the workers

needed for continued national growth (Dubina, Morisi, Rieley, & Wagoner, 2019). Such demographic realities will increase competition among all industries to find qualified workers who are willing to do the type of work a ship repair company requires. Fortunately for the ship- and boat-building industry, it already offers a higher pay scale for the toughest-to-fill occupations. This should provide the industry with a built-in recruiting advantage for attracting new employees just entering the work force or to draw workers from other lower paying industries.

3. Ship Repair in Hampton Roads, Virginia

3.1. Region 5



Figure 8. Map of the 9 Regions of Virginia

The Commonwealth of Virginia is segmented into nine regions (see Figure 8) each of which is comprised of cities that are geographically and economically similar (Map of Virginia, 2019). The Hampton Roads area, located in Region 5, is comprised of the cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach and Williamsburg along with Accomack, Isle of Wight, James City, Northampton, Southampton and York counties. The unemployment

rate in the region stands at 3.3% with a median household income of \$45,720 (GO Virginia, 2019). As revealed in Figure 9, unemployment in the Hampton Roads area is at its lowest rate in 16 years (McNab, 2019).

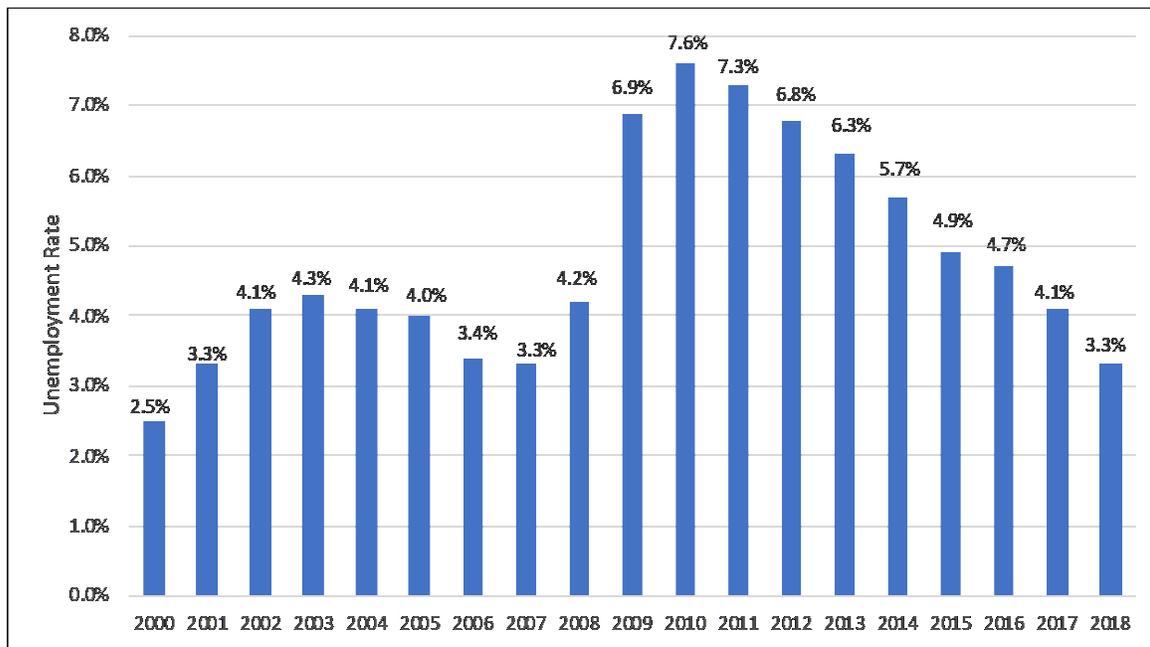


Figure 9. Average Unemployment Rate: Hampton Roads, 2000-2018. Adapted from *The State of the Region Hampton Roads 2019*.

The shipyard and ship repair industries have a major presence in Region 5 due to a strong naval presence and excellent port access. In 2017, the industry employed approximately 34,000 people (GO Virginia, 2019). As shown in Figure 10, the current average wage rate for production workers in the Hampton Roads area is \$19.97 per hour (United States Department of Labor, 2019). Amongst the listed production occupations machinists earn the most followed by welders (and affiliated occupations) and fitters (and affiliated occupations). Relative to all occupations in Hampton Roads, machinists and welders earn higher average wage rates at \$24.94 and \$23.97, respectively.

Although the industry is one that can be very lucrative, it is also one that can be viewed as volatile. The shipyard/ship repair industry is largely at the mercy of the federal budget. Cycles of mass hires and layoffs are not uncommon responses to the uncertainties created by variable budgets. In 2013,

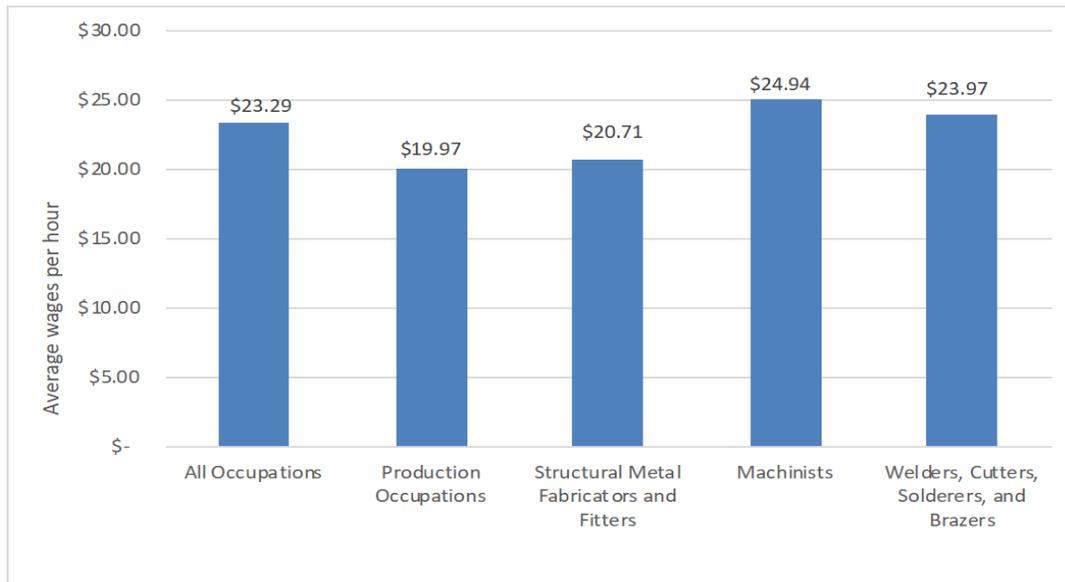


Figure 10. Hampton Roads Median Pay Production Occupations

the Department of Defense decreased spending by one billion dollars, causing shipyards to seek commercial projects to supplement their revenues (McNab, 2019). According the October 2019 State of the Region Report, the Bipartisan Budget Act enacted by President Trump in August, 2019 will increase national defense spending throughout the 2020 and 2021 fiscal years by \$90.3 billion in 2020 and \$81.3 billion dollars in 2021 (McNab, 2019). Figure 11 shows a steady increase in Department of Defense spending over the past three years (McNab, 2019). Based on the passage of the 2019 Bipartisan Budget Act, spending will likely continue its upward trajectory over the next two years; however, there is no viable information to indicate whether this trend will continue beyond 2021 (McNab, 2019). The potential for future budget uncertainties presents a number of challenges for the ship repair industry in Hampton Roads, particularly with respect to local yards' ability to accurately manage their labor capacity. If significant defense budget cuts occur, and insufficient commercial work is available to

replace government contract work, it is certainly possible that such a scenario could lead to a reduction in needed labor capacity.

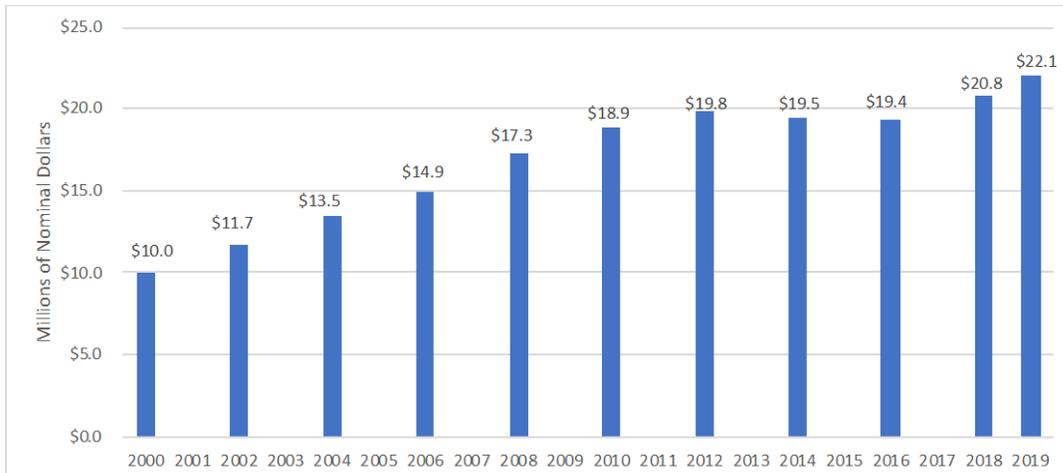


Figure 11. Estimated Direct Department of Defense Spending: Hampton Roads, 2000-2019. Adapted from *The State of the Region Hampton Roads 2019*.

3.2. Hampton Roads-Based Ship Repair Yards Challenges

To gain greater insight into the labor challenges facing the ship repair industry in Hampton Roads, several representative repair yards were interviewed. It was noted that the amount of government work available is driven by uncertain defense budgets; however, these uncertainties were cited as being less pressing than a number of other concerns. The current sentiment, shared by all of the yards interviewed, was that the overall demand for yard services, between government contracts and commercial work, leads to plenty of work. The challenge is ensuring that there are enough hands available to do it.

During interviews it was clear that although each organization faces its own yard-specific issues, all share a number of common problems. As suggested above, ensuring sufficient labor availability is a common challenge faced by yards in Hampton Roads. Consequently, the competition for skilled labor amongst Hampton Roads' yards is very high. In some instances, especially amongst employees who only recently completed their apprenticeship programs, there is a high degree of wage sensitivity. For example, one shipyard executive noted that it is not uncommon for an employee to depart for another

yard for a \$.25 per hour raise, and that employee turnover can be as high as 20-30% annually. The area's largest yards appear to be at an advantage in that they seem to have a greater ability to offer more lucrative wage-benefit packages compared to smaller yards. While losing employees to competitor yards for relatively small marginal differences in compensation is problematic in and of itself, the problem is compounded when the losing yard invested heavily in developing the employee through an in-house apprenticeship program. Yards certainly lose if an employee is not retained long enough for it to break even on the investment it has made in that person. Employee churn is problematic for these yards for a number of reasons. Development of the basic skills needed in certain trades can require up to 2-3 years of hands-on experience and certification procedures can be costly, around \$3,000 each. Furthermore, the costs associated with recruiting, onboarding and training new talent can be considerable.

Positive working relationships between labor and management may help to mitigate the problem of churn. During a site visit at a particular yard, it was noted that a number of employees had been with the company for many years with one employee having recently celebrated more than 40 years with the company. At some yards, personal connections can be very tight. A portion of these yards are family owned and operated or have generations of families who have worked at the yard. A common theme noted during site visits was that there is a high level of respect that managements have for their teams. The employees in turn, seemed to be proud of their work and their respective jobs. Many were eager to share information about the projects they were currently working on or had previously completed. However, retention still remains at the forefront of the problems these yards are facing due to competition for the same pool of labor and a shift in how the "new" generation of employees view work and their work-life balance.

A second common problem being experienced by yards is the aging workforce. Many of the jobs at repair yards demand a high level of technical skill and the ability of workers to employ judgment and problem-solving skills. Many of the technical skills demanded at the yards require many years of

training. On the other hand, the judgment and problem-solving skills needed to be a successful employee are typically only gained through experience and characteristics endemic to someone who takes pride in his or her workmanship. An overriding concern is that these types of employees (typically in the 55+ year old age group) will be retiring and departing the workforce in large numbers in the near future. Unfortunately, these most valuable employees are not easily replaced, and some of the characteristics that defined this generation are less prevalent amongst the next generation.

The trades that are currently (and for the foreseeable future) in shortest supply include welders, shipfitters, pipefitters and machinists. Although these trades pay very well, as noted in Figure 10 above, it can be a difficult task to recruit these employees. Further, years of training are needed for an individual to attain the certifications and skills needed to move up the ranks within these trades and meet the ongoing labor needs of the shipyards.

For many years, society has emphasized the value of pursuing a four-year bachelor's degree from an institution of higher education. The unfortunate consequence is that pursuing skilled trades as a viable career path has been devalued. This problem has been intensified, arguably, with the diminished proportion of GDP associated with manufacturing in the United States. This has made the challenge of recruiting high school students into the trades much more difficult.

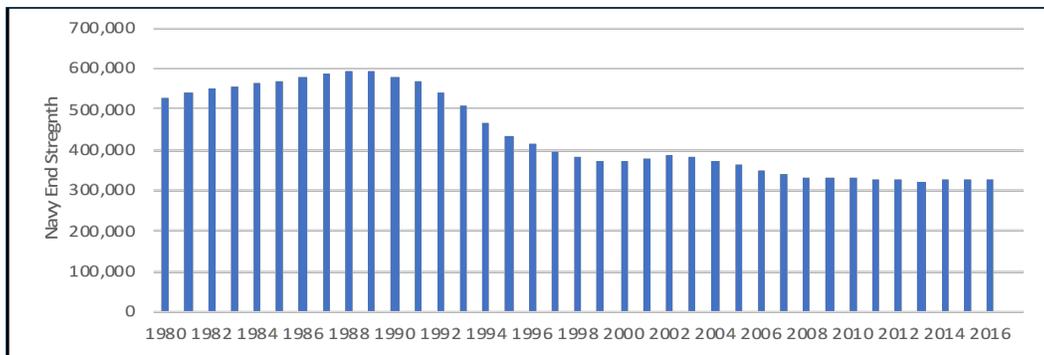


Figure 12. U.S. Navy Employment: 1980-2017

Historically, the U.S. Navy, has been a good source of trained (or trainable) shipyard employees. As indicated in Figure 12, however, the number of U.S. Navy personnel has decreased significantly since the early 1990's (United States Navy Recruiting Command, 2019). Along with the force reduction, in 2002, the Navy reduced its internal training program related to internal ship repair. Additionally, shipyard executives indicate that the skills the Navy's revised training programs impart result in technicians who essentially replace parts as opposed to fix parts. As a simple example, the technician will replace a failed pump with a new pump as opposed to repairing the underlying cause of failure. This was highlighted by the yards as a growing concern. There was some shared optimism, however, that the Navy's approach to training its personnel (in scale if not scope) is something that will be rectified in the future. However, there was full recognition that the results of any training program revisions would likely take many years to realize. An existing proposal is the development of a Maritime Maintenance University (MMU) (Maritime Maintenance University, 2019). MMU is envisioned to be a collaborative effort between industry and government to develop standards for maritime maintenance occupation training, competencies and credentials. Standards, established jointly between industry and government, would assist with transition for sailors leaving the Navy and entering the civilian workforce as training curricula would be synchronized.

4. Approaches for Resolving Current and Future Labor Gaps

In this section, a number of approaches are offered to help resolve the skilled labor gaps in the Hampton Roads ship building and repair industry. The industry is already experiencing difficulties in its ability to meet its needs for skilled labor and the challenge will only become greater as projected work backlogs increase and the industry's workforce continues to age. Consequently, it is incumbent upon the industry's shipyards to act now to seek creative and productive means for meeting their current and future labor needs. The approaches offered here can be broadly classified as churn reduction, efficiency enhancement, and workforce recruiting/development.

4.1. Person-Environment Fit – Churn Reduction

Turnover is extremely costly to companies and often has a direct influence on overall employee morale. The best way to combat employee turnover is to decrease the likelihood of it happening from the very beginning by improving the employee selection process. One theory that can be applied to this process is the theory of Person-Environment Fit which connects a persons' personality to his or her work environment (Stack, 2019). This Person-Environment Fit theory can be further broken into Person-job fit, Person-group fit, Person-supervisor fit and Person-organization fit. Person-job fit specifically connects an individual's skills and abilities to the duties required of the job. Person-supervisor fit describes how some people are innately drawn to one another and share similar morals and values. Person-group fit describes the extent to which an employee feels included within his or her workplace. And finally, Person-organization fit explains how an employee connects with specific organizational values within the workplace (Stack, 2019).

If shipyard recruiters are able to identify specific traits for employees who genuinely enjoy the scope, environment and atmosphere of shipyards, there will be a greater likelihood that newly hired employees will be retained. This theory has been used for decades to reduce overall employee turnover through identification of psychological needs (goals, abilities, values) for the job-specific duties that are required (Career Research, 2019).

Once employees are selected, it is important to maintain engagement in order to keep the employee happy and to prevent him or her from becoming a flight risk. Decreased productivity, calling off or leaving early and an overall negative attitude are signs that an employee may no longer feel the job meets the criteria for Person-Environment Fit (Gardner & Hom, 2019). Research shows that managers and supervisors can combat the risk of employees looking elsewhere by establishing a strong culture. This can be done by maintaining an open-door culture through regular one-on-one chats with employees, and giving regular and meaningful personal recognition and feedback. Employees should

also be given opportunities to work with their employers to develop plans to meet their career aspirations. Employees who want to grow within the industry should have a clear path forward that includes personal action items (such as skill development and education) and the support of his or her supervisor along the way. Other rewards such as pay increases can be helpful as well in order to maintain consistent engagement (Gardner & Hom, 2019).

4.2. Investment in Technology – Efficiency Enhancement

The shipyard and ship repair industry should continue to be vigilant in order to identify and evaluate the potential application of new, or evolving, technologies to support its workforce and increase productivity. In the face of restricted skilled labor pools, enhanced productivity can help to alleviate the strain of a shrinking labor force and/or increasing demand for such labor.

Many shipyard occupations rely on a worker's experience, judgment, and skills that are not replicable with currently available technology. And, much of the work is done in tight spaces that are not conducive to the application of robotic welders or similar equipment that requires a significant footprint. Furthermore, no two ships are alike in most instances. So, attempting to apply programmable automation tends to be impractical given the "one-off" nature of the majority of the work at a yard. Obviously, one should not expect to replace human labor with technology in the foreseeable future. However, it is already possible to enhance worker productivity using existing technology. Productivity enhancing tools have found wide application in the industry already and were observed during tours of Hampton Roads Shipyards: Computer Aided Design (CAD), Computer Numerical Control (CNC)-enabled equipment, etc. One example of a new advancement finding its place in the industry is a robotic structural fabrication system which can process beams, angles, squares, and rectangular tubes using detailed drawings provided by the user. Additionally, Puget Sound Naval Shipyard is piloting an Exo Skeleton, a form of wearable robotics that amplifies a person's strength and endurance (Farley, 2019). Kranendonk Smart Robotics advertise, "We offer high-end automation solutions for the shipbuilding

industry. With smart robotics, we automate welding and cutting processes throughout the shipyard. This speeds up processes, and enhances quality of the entire work flow.” (Kranendonk, 2019) Finally, in San Francisco, BAE is piloting the use of M3500 Robotic Systems to aid in speeding up the coating removal process for ships. By utilizing this robotic system, it will not only be able to service vessels faster, but it will also protect employee health as well (The Maritime Executive, 2019). These are just a small sample of technologies that can be utilized to mitigate labor shortfalls and enhance productivity.

3D printing, or additive manufacturing, is becoming more prevalent across all industries, including the military. Old Dominion University established a program to train U.S. Navy sailors to use 3D printing on ships and within ports to improve efficiency by reducing sizes of supply warehouses and time waiting for parts, develop a training program for sailors, and be able to repair ships at sea (Audette, Jovanovic, Bilgen, Arcaute, & Dean, 2017). The Hampton Roads ship repair industry can leverage the ODU program to build a similar program for their industry to support future 3D development. Additionally, there are existing sites, such as Shape Ways (ShapeWays for Business, 2019), that will conduct 3D printing on demand. They will partner with your business to provide 3D products to support your specified requirements. This could be especially useful for parts that are difficult to find or built in limited quantities.

4.3. Criminal Record – Recruiting/Development

According to an article written by the National Conference of State Legislators, approximately 77 million Americans in society are plagued with criminal records. This status eliminates approximately 1.7 million people from the workforce at large (Umez & Pirius, 2019). Individuals with criminal records are often challenged to meet governmental restrictions on occupational licensing. An occupational license is needed in some industries as a requirement for employment and usually requires a certain level of education. Unfortunately, only approximately 37% of the prison population possesses a high school diploma (Slivinski, 2016).

Those who are unable to be integrated back into the workforce quickly often see higher rates of recidivism—the likelihood of committing another crime and being sent back to prison. Recidivism is most likely to occur during the first three years of release following incarceration, and by reducing recidivism altogether it is estimated that states could save on average \$15.5 million dollars (Slivinski, 2016). Moving forward, prisons should continue to focus on strategies that will increase GED completion rates for inmates who are incarcerated. By doing so, inmates will be more likely to obtain post-release employment and reduce recidivism rates.

In 2018 President Donald Trump passed the First Step Act (FSA) which aims to improve criminal justice outcomes and reduce recidivism (Federal Bureau of Prisons, 2019). Part of this Act focuses on having inmates complete a recidivism reduction program along with a series of productive activities which can earn the inmate a shorter sentence. This Act piggy backs onto the Second Chance Act which was passed in 2008. This Bi-Partisan Act supports state and local government as well as non-profit organizations with federal grant funding for important programs that have the purpose of aiding the reentry process (The Council of State Governments Justice Center, 2019). In 2017, 13,000 inmates in the U.S. completed vocational training programs and as these programs become more widely available, we would expect that number to increase dramatically (Department of Justice, 2019). The issue of

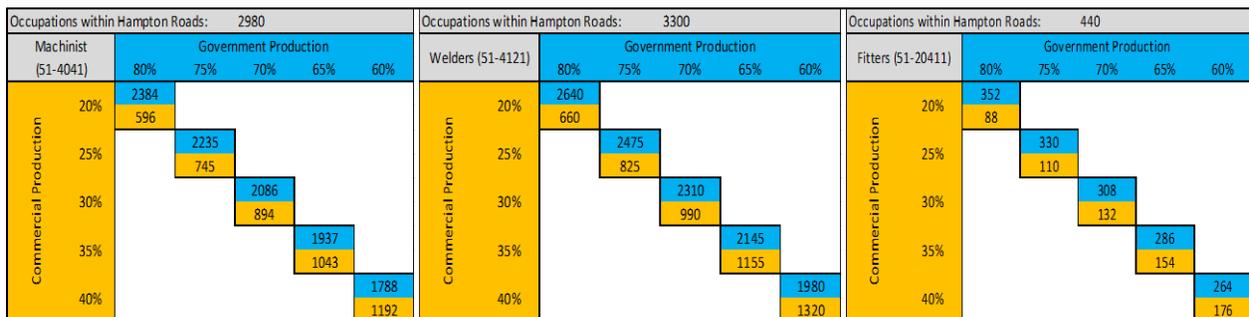


Figure 13. Government vs. Commercial Production (2018 Hampton Roads Employment Data)

integrating those with criminal records back into the workforce has become a hot-button issue over the last year and is likely to continue to gain attention.

Although constraints exist within government employment for those with criminal backgrounds, there may be increased room in the workforce for them in the shipbuilding and repair industry. Non-government contracted projects exist and account for a significant portion (30-40%) of the workload at these yards at any given time. Figure 13 depicts employment estimates using 2018 Bureau of Labor statistics data for Hampton Roads for the machinist, welder and fitter trades. This figure breaks down the labor needs by occupation for various levels of government-to-commercial projects (Bureau of Labor Statistics, 2019). These projects would all still require trade skills and training, but allow this segment of the workforce to work on commercial projects and those without criminal records to focus on the government shipbuilding and repair work that accounts for the balance of the workload.

Correctional facilities around the United States have begun to implement educational and vocational programs for inmates. These vocational training programs teach inmates job and industry specific skills to help them integrate back into the workforce and make them more marketable overall. Training offered can vary based on funding, inmate interest and teachers available (Crime Solutions.Gov, 2019). In Virginia, there are a number of correctional facilities that teach the pipefitting trade as a seven and a half month program and the welding trade as an eleven month program (Virginia.Gov, 2019). Although these trades would require additional and specialized training due to the specific nature of the ship repair industry, inmates would come prepared with a basic knowledge of job duties and requirements. In order for the shipyard industry to benefit from these vocational programs already in place, they will need to create relationships with the facilities that offer trade programs of interest.

4.4. Recruiting at High Schools – Recruiting/Development

According to the United States Census Bureau, the recession that began in December 2007 caused many people to seek education to improve their future employment prospects. Enrollment levels climbed until reaching their peak in 2010. During the 2010/2011 school year, two-year college program enrollments were approximately 33% higher compared to the 2006 school year. Four-year institutions

also saw an increase in enrollment. In 2006, there were approximately 9.5 million students enrolled in 4-year institutions. By 2011, that number had climbed to 10.9 million (Schmidt E. P., 2018). Projections made from 2014-2025 indicate college enrollment will continue to increase by approximately 15% for associate’s, bachelor and doctoral degrees (Schmidt E. , 2018).

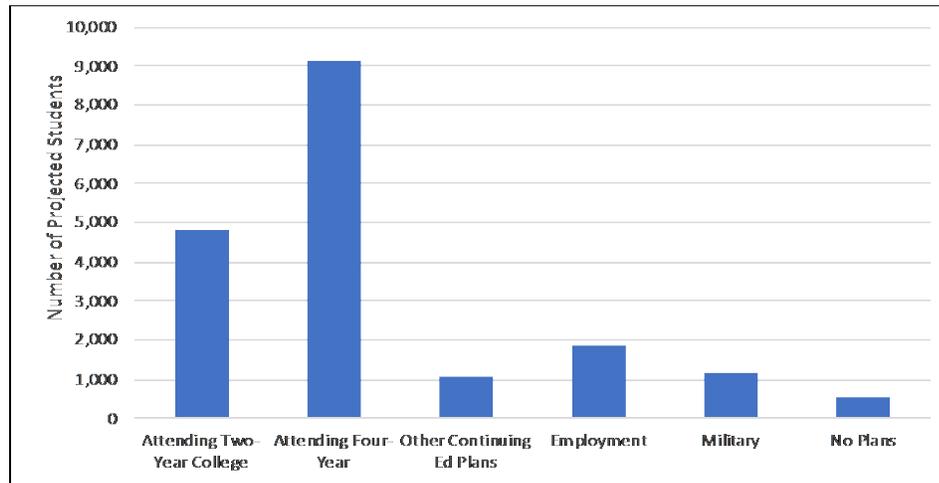


Figure 14. Hampton Roads Continuing Education Plans: 2017-2018 Year

The Virginia Department of Education’s Report of Recent Graduates from 2017 - 2018 data (Figure 14) show that most Region 5 graduates planned to attend a two-year or four-year college. In fact, only 10% of students planned to enter into the workforce directly after high school graduation, compared to 75% of students whose path involved higher education. In Hampton Roads, approximately 26% of students planned to attend a 2-year institution while 49% planned to attend a 4-year institution (Virginia Department of Education, 2019). These statistics are slightly higher for Hampton Roads than the national averages for high school students as students planning to attend a 2-year or 4-year institution were 22.6% and 44.2%, respectively (National Center for Education Statistics, 2019). With only a small number of graduates entering the civilian workforce directly from high school, it is paramount for the ship repair industry to work closely with area high schools to educate students and parents about the benefits of pursuing skilled trade careers immediately after high school. It would also be prudent to target students planning to attend a 2-year institution by discussing the wage and benefits provided by shipyards.

Annual room, board and tuition rates for public institutions in the United States for the 2016-2017 school year averaged \$17,237 and \$44,551 for private institutions (National Center for Education Statistics, 2017). These costs are staggering considering that many ship repair yards include tuition assistance once a student has completed his or her apprenticeship and is fully employed by the yard. Additionally, according to the most recent report of 2018 graduate salaries by the National Association of Colleges and Employers, the average salary for recent graduates was \$51,000 in the United States (National Association of Colleges and Employers (NACE), 2019). That average is much lower than the average wage of someone working within the ship building and ship repair industry in Hampton Roads which boasts an average salary of \$72,377 (GO Virginia, 2019). Students graduating from a two-year or four-year institution quickly face the issue of debt repayment with the average student graduating with between \$16,200 and \$43,000 in student loan debt (National Center for Education Statistics, 2019). Such debt can be significantly reduced, if not altogether eliminated, for students who choose to enter the workforce through the trades directly from high school.

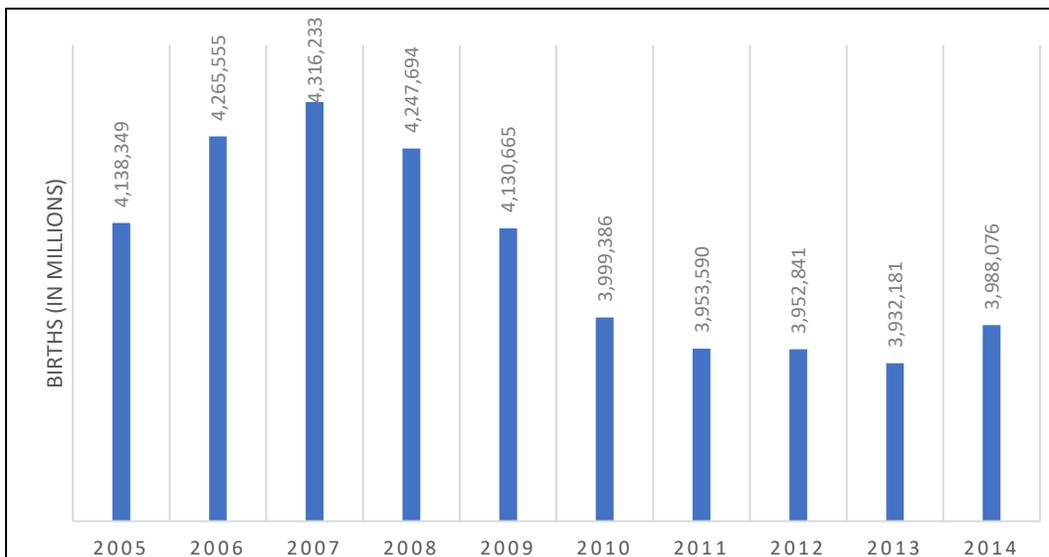


Figure 15. U.S. Birth Rate 2005-2014 (United States Department of Labor, 2019)

However, students need to be educated on the benefits of entering the workforce first and the value of possessing meaningful work experience prior to pursuing a college degree. Educating future

potential employees will become more important over the next 5-10 years given birthrates following the start of the Great Recession began to steadily decline as indicated in Figure 15 (CDC, 2019). Fewer 18-year-olds will be entering the workforce each year causing a further limitation on the supply of potential new employees for yards to recruit. Many of the ship-repair yards interviewed mentioned their partnerships with schools in the immediate geographic area. In addition to intensifying shipyards' current recruiting efforts in schools, it would be advantageous for them to create a program similar to what is already being offered at Tidewater Community College (TCC). The TCC program allows students to get hands-on experience while completing college courses relevant to the maritime industry. Students choose a trade which determines the number of credits required and time spent in school. Students are also encouraged to complete apprenticeship programs that allow them to work in their field of interest. After completion of the program, graduates of the program are able to apply for positions in the yard (Tidewater Community College, 2019). At this time, these apprenticeship programs are hosted by the larger shipyards. It is recommended that the smaller yards in the industry jointly host a similar program that meets their common needs. Graduates of this program could then be strategically allocated to, and placed in positions, at the participating yards.

Another recommendation related to educating students for the ship repair industry is to expand upon the current high school curriculum in schools within Hampton Roads and surrounding areas. Many maritime programs exist in high schools around the United States, in areas such as Texas and Washington, as well as one high school in Hampton Roads. These academies allow students to choose a maritime career path in high school and receive trade-specific training. Hampton High School, the first school within the Hampton Roads area to offer a maritime academy, currently has 37 students enrolled in its program (Hammond, 2019). The purpose of the academy is for it to closely align with a regular high school curriculum, but also provide a trade-focus geared to the maritime industry. So, while a high school student in a regular curriculum is taking a math course, so is the maritime academy student;

however, the academy student is also learning how that math directly relates to the maritime industry (Hammond, 2019). By expanding this curriculum to more schools in Hampton Roads, and surrounding areas, students will be afforded the opportunity to begin their maritime career path earlier. And, shipyards can begin to identify their future employees much earlier.

Finally, recruiting students has changed over the years. In today's market, it is important to capture students' attention, not only through one-on-one communication but also by creating an interactive atmosphere. Many institutions have turned to a more creative marketing approach to capture students' attention. Blogging, podcasts, and social media have become increasingly popular tools (Marinopoulos, 2017). Although these avenues would require an investment, they can be leveraged to help students and their parents to see that shipyards, and the ship repair industry, are engaging places to work and offer many opportunities. These are especially important factors for the industry to showcase given the work environment's longstanding reputation as being difficult and physically demanding. Having employees share personal success stories and what they most enjoy about their jobs would offer prospective employees a peak into the proud culture and fast-paced work environment of Hampton Roads shipyards. (College Stats.Org, 2019)

4.5. Women in the Work Force – Recruiting/Development

In 2018, 57.1% of women (16 years and older^{vi}) participated in the U.S. workforce, but only 54.9% were employed. The unemployment rate amongst women was 3.8% (2.9 million women). In 2017, women accounted for 51.67% of the U.S. population. The female participation rate in the work force grew through the 1970s and 1980s before slowing in the 1990s and decreasing at a greater rate following the Great Recession to a recent low of 56.7% in 2015. (Bureau of Labor Statistics, 2019) In 2018, women accounted for 46.9% of the workforce in the U.S., but only about 29.2% of the

^{vi} Included are people 16 years of age and older residing in any of the 50 states or the District of Columbia who are not confined to institutions, such as nursing homes and prisons, and who are not on active duty in the Armed Forces.

manufacturing workforce and 13.6% of the ship- and boat-building industry's workforce (Bureau of Labor Statistics, 2019).

Nationally and across all occupations, women earned a median wage of \$770 in weekly earnings, compared to men who earned \$941, while female machinists earned \$831 and female welders earned \$812 weekly. No earnings data were available for fitters (Bureau of Labor Statistics, 2018). Although women are less likely to work as machinists, fitters, or welders, women entering the workforce today show a greater willingness to choose hands-on occupations and environments such as shipyards. Evidence of this can also be seen with women's increased participation in combat roles in the military and in civilian occupations that have been traditionally viewed as manual labor. According to a study conducted by the Deloitte Center for Industry Insights, *Women in Manufacturing*, women from Generation Y (born between 1982 – 2004) are seeking employment that can provide attractive income/pay (52%), work life balance (49%), and career progression (43%). They are most likely to leave a job due to unattractive pay (41%), lack of promotion opportunities (41%), and poor working relationships (39%) (Giffi, Huelsman, Drew-Rodriguez, & McClelland, 2017).

The four occupations (ship fitters, pipe fitters, machinists, and welders) for which labor has been noted as being in short supply, all provide more competitive pay in the ship- and boat-building industry compared to other U.S. industries. Additionally, the median pay is higher for these four occupations within the Hampton Roads area compared to other production occupations. The ship- and boat-building industry already provides higher wages which is the greatest incentive for Generation Y and their primary reason for leaving a job. These occupations' pay scales are derived from skill-based certification completion and experience within the industry. By providing women the opportunity to progress within their occupation and build their experience levels equivalent to men, they will be more willing to remain with the company. If women are provided the opportunity to grow within their profession, they are more likely to remain. The most difficult area to affect in order to retain women will be work-life

balance in a traditional setting. In an industry such as the ship repair industry, work-life balance is a challenging aspect for all employees due to the extensive use of overtime to achieve project completion requirements. This is a challenge for both men and women employees, but as shown in a survey by *“Women in Manufacturing,”* it is known to be of high importance to women. To successfully recruit women, especially those with families, flexible schedules are necessary in order to support their needs. This could potentially be achieved through the staggering of shift schedules or increasing the use of part-time employment.

A Hampton Roads Workforce Council initiative called, Women in Skilled Careers (WISC) provides women who are currently receiving services for domestic violence, human trafficking, homelessness, and poverty an opportunity to build a career in the ship repair industry (Hampton Roads Workforce Council, 2019). The program provides training, hands on learning, guaranteed interviews, and after care. Additionally, participants are provided transportation, childcare, and stipends to support their requirements during this 12-week course to achieve certification in a number of occupational fields. The final objective for Women in Skilled Careers is for 40 women to earn 120 nationally-recognized credentials.

A resource that may be available to assist in recruiting women into the ship repair industry is an organization called Women in Manufacturing (WiM). WiM is, “a national trade association dedicated to providing year-round support to women who have chosen a career in the manufacturing industry.” (Women in Manufacturing Organization, 2019) WiM started in 2010 as Women in Metalforming and has grown into a national organization with conferences and summits to support, promote and inspire women into the work force. Although there is currently no chapter in Virginia, North Carolina has an active chapter that could be leveraged to assist with developing a program to recruit women into ship repair occupations within Virginia or to establish a Virginia Chapter sponsored by the ship- and boat-building Industry.

4.6. Out-of-State Recruiting/ Neighboring States' Unemployment – Recruiting/Development

A principle challenge with hiring in the state of Virginia is the state's low unemployment rate, 2.7%, that is one of the lowest in the country (Bureau of Labor Statistics, 2019). An option might be to recruit from neighboring states whose unemployment rates are higher (see Figure 16). West Virginia has one of the highest unemployment rates in the nation at 4.7% with the most persistent unemployment being in the western part of the state near Charleston. Unemployment in this area has risen steadily since 2009 (Bureau of Labor Statistics, 2019). The unemployment rate in the mining,

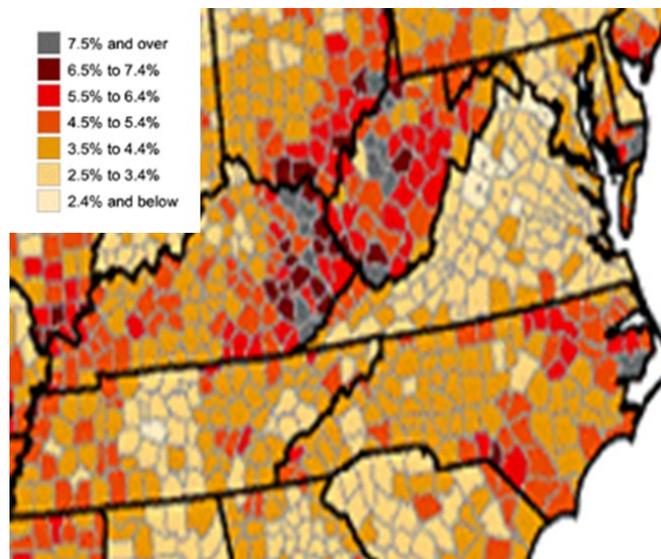


Figure 16. Unemployment by County (The Bureau of Labor Statistics, 2019)

logging and construction industries within this region has increased by 2.7% since 2018 and provides a potential pool of employees from which to recruit. Workers from these industries are familiar with the hard work and tough environmental conditions that shipyard employees face. Similarly, the Huntington area of Kentucky is the highest area of unemployment in the state and has an increased unemployment rate of 2.3% within the mining, logging and construction industries and 0.9% in manufacturing industries (Bureau of Labor Statistics, 2019). Although North Carolina's unemployment rate sits at 4.1%, it is spread throughout the state amongst different industries. This would make it a more challenging state

from which to recruit since unemployment does not appear to be geographically, or industrial sector, focused.

Due to the low unemployment rate in Virginia, recruiting from neighboring states with higher unemployment rates may be a productive source of qualified labor. Additionally, both West Virginia and Kentucky have the target occupations the shipyards are seeking. A primary risk for out of state recruiting is how long would a geographically displaced worker remain in Virginia before returning home. Most of the areas in Kentucky and West Virginia with the highest unemployment rates are rural areas where family is very important. Many young men and women would be hesitant to leave the family structure they so highly value. Perhaps, by highlighting higher pay, steady employment, and the less-than-a-day driving distance from their hometowns, the Virginia ship building and repair industry could successfully recruit from these states.

In addition to recruiting in neighboring states, the ship repair industry should also explore states with existing ship building and repair industries such as New York, New Jersey, Louisiana, Florida and

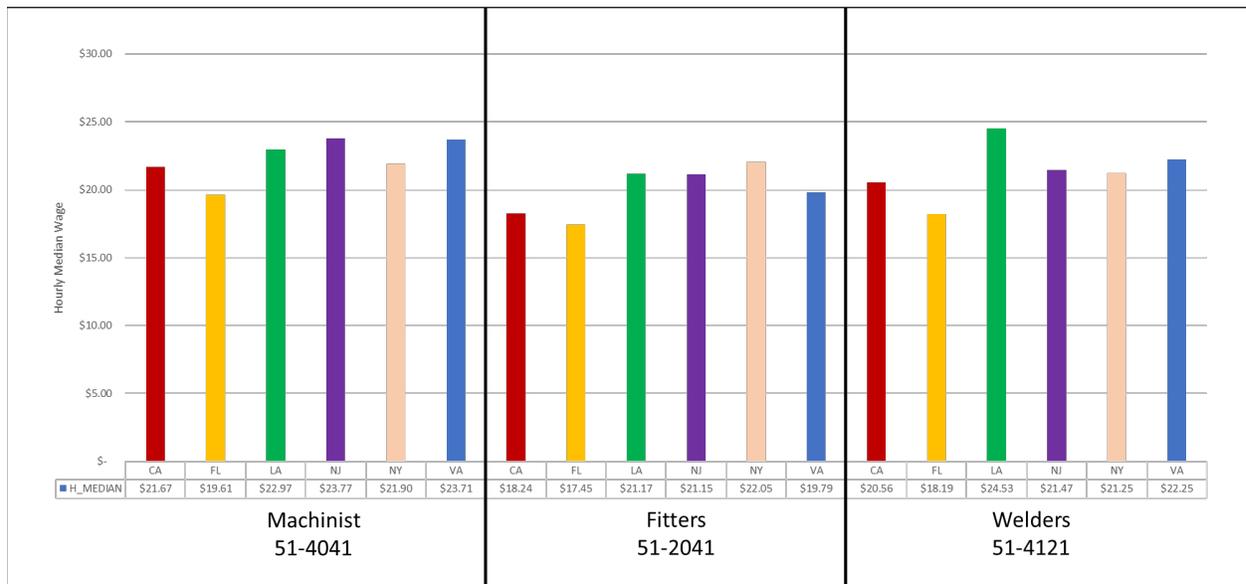


Figure 17. Hourly Mean Wage for States with Established Shipyards

California. As seen in Figure 17 (Bureau of Labor Statistics, 2019), the state of Virginia offers competitive

mean hourly wages for machinist and welders, but less so for fitters. Additionally, comparing the data from Figure 17 to Figure 10 (Hourly Wage for Hampton Roads Area), the Hampton Roads area has a higher mean wage rate for all three occupations. With Hampton Roads' cost of living being generally lower than the localities listed in Figure 17, Virginia shipyards should be able to leverage cost of living as a recruiting tool. Compared to Hampton Roads, the cost of living in San Diego is +47.1%; Jacksonville +0.51%; Baton Rouge -6.19% lower; and Brooklyn/Jersey City +75.84% (Bankrate, 2019).

5. Conclusions

As demonstrated throughout this paper, the Hampton Roads ship repair yards will continue to face challenges in the coming years; however, those challenges can be overcome. The U.S. production output is growing at a slower rate of 1.9%, but the U.S. ship- and boat-building industry is growing at a higher rate of 2.4%. Additionally, the U.S. Navy plans to build its force to 355 ships by 2050. As long as governmental appropriations supports the U.S. Navy build-up, the ship repair industry will have ample work to maintain revenues for the foreseeable future. The primary challenge as highlighted by interviews conducted with Hampton Roads ship repair yards is ability to recruiting and retain employees.

Figure 18 shows the relationship between the number of U.S. Naval ships built and the number of production employees hired at U.S. shipyards from 1987-2015. Although there appears to be a correlation between ships built and production employees hired between 1987-1995, the correlation does not hold from 1995-2015 as Defense spending decreased along with the number of ships built. Nonetheless, the number of employees remained between 60,000-70,000 over that same period. This could be attributed to increased maintenance requirements for an aging Naval fleet and the ship repair industry increasing its reliance on commercial repairs. Additionally, Figure 1 shows there were only 9-10 large, U.S. shipyards during this period. The U.S. Navy intends to build its force to 355 ships with

approximately 11 ships scheduled for construction between 2019-2023. A total production labor force of about 70,000 workers will be required over the next 4-5 years to support the Navy’s planned growth and to support its ongoing maintenance needs. With about 25% of the U.S. ship building and ship repair

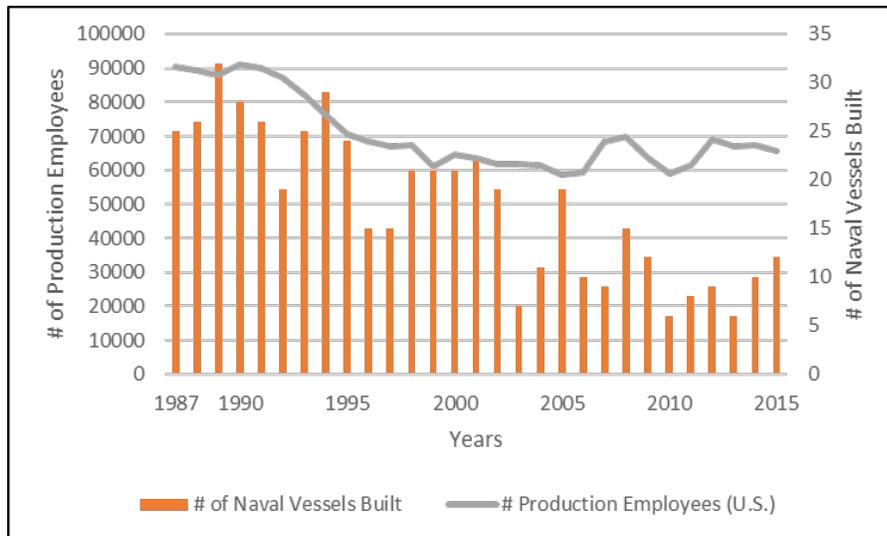


Figure 18. Number of Production Employees Compared to Number of Naval Vessels Built

capability in located in Hampton Roads (Lessig, 2018), the local industry will require approximately 17,000 production employees.

The U.S. is projected to maintain an annual labor force growth rate of only 0.5% from 2018-2028. Over the past decade, the population group of 55+ retired at older ages than has historically been the case while the remaining work force is growing at a slower rate. This has/is causing a decline in the overall available work force. Additionally, the number of jobs in the manufacturing sector and ship- and boat-building industry is expected to decline by 0.5% and 0.6% respectively. The production and labor data highlight a supply and demand mismatch for the nation that is unlikely to improve soon.

The ship repair industry has some distinct advantages it can bring to bear to combat this problem. While the ship- and boat-building industry is expected to grow, other manufacturing industries are expected to decline in growth. Hampton Roads area ship repair yards identified ship fitters, pipe fitters, machinist and welders as some of the more difficult occupations to hire and

maintain. However, 13 of 30 other manufacturing occupations are amongst the most rapidly declining occupations in the nation. Although workers in these occupations are not “plug-and-play” for shipyards, they represent a pool of individuals who are used to hard work in challenging work environments. Additionally, the ship- and boat-building industry enjoys a higher starting median hourly pay for the four previously identified hard-to-hire occupations (ship fitters, pipe fitters, machinist, and welders), paying between \$2.57 to \$3.95 more per hour. Within Hampton Roads, unemployment (3.3%) is at its lowest point since 2000. This statistic further highlights the labor supply and demand issue within the area. One advantage that can be noted is the median pay for the four occupations previously identified is significantly higher, between \$.74 and \$4.97, than the median for all production occupations. Additionally, the median wage in the state of Virginia for these same occupations is higher than most other states with major established shipyards.

Higher wages in conjunction with a strong industrial sector outlook offer the Hampton Roads Ship Repair yards the tools needed to assist in recruiting its workforce. The industry is already actively recruiting within the region, but should expand its efforts to include women entering the work force, neighboring states with high unemployment, other states with established shipyards but lower median wages, and individuals with criminal records who are looking for a second chance to succeed. All of these recommendations are challenging within themselves, but with established policy and proper leadership to support and facilitate growth of new employees, Hampton Roads shipyards can overcome the labor challenges with which they are faced.

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