Industrial Expectations for Marine Engineering Major Students

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Abstract

Massachusetts Maritime Academy (MMA) has a special mission to deliver highly qualified graduates in marine engineering to the maritime industry. The engineering department of MMA has an engineering advisory council (EAC) comprised of industrial representatives who meet with the department twice a year to provide feedback on the emerging job market and the strengths and weaknesses of the MMA marine engineering program. While the majority of the EAC members are from Massachusetts-based companies, it would be beneficial to seek the industrial expectations on a national scope.

This paper targets the industrial expectations for the marine engineering major students on a national scope. Job hunting websites, including *indeed*, *linkedin*, *glassdoor*, *monster* and *careerbuilder*, have been used to collect national information on the 115 marine engineering jobs available from May 2017 to Oct 2017. Statistical analysis has revealed the industrial expectations for the top job placements (locations), the top job categories, and software skills most in demand. The paper also discusses possible modifications to the existing MMA curriculum and course contents to better meet these industrial expectations, including assigning practical projects in courses such as Strength of Material, Electronics, etc.

Introduction

Massachusetts Maritime Academy (MMA) is one of the only seven maritime academies in US delivering highly qualified graduates in marine engineering to the maritime industry [1]. Based on the survey result from the office of career and professional services at MMA, the MMA's marine engineer major students have 94% job placement within 6 months after graduation [2]. The curriculum of the marine engineer major has course credit requirements and four co-op requirements of sea terms aboard USTS Kennedy and commercial ships. In order to graduate from MMA, the students are also required to obtain United States Coast Guard (USCG) License for a Third Assistant Engineer of Steam, Motor and Gas Turbine vessels any horsepower [3]. The engineering department of MMA has an engineering advisory council (EAC) comprised of industrial representatives who meet with the department twice a year to provide feedback on the emerging job market and the strengths and weaknesses of the MMA marine program in order to improve the existing curriculum and adjust course contents to meet the dynamic industrial expectations.

It is known that there is a difference between student's expectations and dynamic industrial expectations for major requirements. Research on different expectations of graduates and employers of construction management major on professional knowledge and skill have been reported in [4]. The result suggested the development of three main categories, including a need for general intellectual and analytical skills, specialist technical skills, and more practical hands-on training. The research in [5] reported the importance of integration of academic assessment with the workplace appraisal practices to close the gap of employer's expectations for students and student' expectation for the major. It specifically targeted on meeting industrial expectation on transferrable skills, including using of relevant data, structure and systems thinking, critical thinking and writing skills, etc, through improving the course contents. The changing expectations of future employers for computer technology major students have been examined in [6], which led a complete reinvention of the curriculum and the revision of student learning outcomes.

The university and industrial partnerships, such as EAC, industry advisory board(IAB), etc, have a unique role to quickly understand the dynamic industrial expectations and serve as external advocates to the curriculum development [7]. The research in [7] reported that the IAB can improve the engineering technology curriculum and ensure the engineering technology major students have industrial preferable skills to enhance their competence and employment prospects. The IAB can also provide internship for faculty and applied research opportunities to establish new programs to satisfy the market demand. An IAB has been created for an engineering undergraduate program to continuously revise and adapt the courses to remain relevant to the industry or market [8]. The research in [9] discussed how to set up and maintain an IAB for computing major in order to keep it fresh with the goal to understand the market and adapt the major program educational objectives.

The benefits which have been brought by the EAC to the MMA engineering department include the revelation of increasing job demand on marine construction observed in their business, the co-op opportunities working with new equipment, etc. The current EAC is largely composed of representatives from Massachusetts-based companies. The advantages of local representatives include easy in-person meeting, flexible schedule, reduced cost for travel and accommodations, etc. While the marine engineer students from MMA probably consider their future employments outside of Massachusetts, it is beneficial to them to understand the national market and then meet the national industrial expectations. The national industrial expectations can be a supplement to the advice brought by the EAC to further improve the existing curriculum and course contents.

Targeting the industrial expectations for the marine engineering major students on a national scope, this paper intends to reveal the national industrial expectations on the top job placements (locations), the top job categories, and software skills most in demand. The top job placement can help the students to understand the job distribution in the whole nation, which might be a critical factor for them to decide where they choose their first jobs to best benefit their lifelong career. The top job categories can help the students to better understand what the national market is eagerly looking for, which can direct their study effort in courses and probably help them to determine which co-op experience they should be looking for. The software skills most in

demand can motivate the students to decide what software they should learn in school and then apply it in their course projects, senior design project or co-op projects.

Methodology

In order to seek the industrial expectations for the marine engineering students on a national scope, job hunting websites, including *indeed*, *linkedin*, *glassdoor*, *monster* and *careerbuilder*, are used as the resources to find the top job placements (locations), the top job categories, and software skills most in demand.

The job title of *Marine Engineer* has been put into the job hunting website to search for the available jobs in the whole nation. The searching results are further refined to strictly include the key words *marine* and *engineer* in the job title. Some searching results, such as embedded engineer for designing marine products, software engineer for developing marine product, etc, are not further processed. Since the job of embedded engineer for designing marine product is more targeted to the electrical or electronic engineering major students. The required background on embedded system design, real-time programming, etc, is outside MMA's marine engineering major curriculum.

For each available job, the job location and the top five job requirements on the technical aspects (listed) are collected. The technical requirements, such as *experience on ship propulsion systems, piping, machinery design development and testing, experience with SolidWorks or similar 3D CAD system*, etc, are collected. Other general requirements, such as *excellent communication skills in verbal, written, telephone, email, and presentations, creative and artistic abilities*, etc, are not collected. Job advertisements having more than five technical requirements are processed to only collect the first five. Conversely, job advertisements having less than five technical requirements are processed to collect all of the available ones.

Based on all of the job locations, statistical analysis is conducted to rank the available states and districts nationwide according to the job distribution by calculating the ratio of the marine engineering jobs in each state to the total marine engineering jobs across the entire nation. The top rankings of the job ratios can reveal where the marine engineering jobs are concentrated across the nation. While the majority of the EAC members are from Massachusetts-based companies, the top rankings would be beneficial to understand the industrial expectations in terms of the job placements (locations) on a national scope. It can be as a factor for the marine engineer students in MMA to decide where they choose their first jobs to best benefit their lifelong career. It can also be used as an indicator for the students to look for the co-op opportunities outside of Massachusetts.

Based on all of the job requirements, statistical analysis is conducted to report the top job categories and software skills most in demand. Examples of job categories are *Design of Ship Component/Structure*, *Operation and Maintenance of Component/Structure*, etc. Furthermore, the specifics of each job category are also assessed. For example, in the job category *Design of Ship Component/Structure*, the specific components and structures are *Propulsion Machines*,

Power Supply Systems, etc. The top job categories and software skills most in demand can guide the marine engineer students in MMA for their choice and concentration on senior project design and/or co-op education. This information can also guide the faculty in the engineering department of MMA to make modifications to the existing MMA curriculum and course contents to better meet these industrial expectations, including assigning practical projects in courses, such as Strength of Material, Electronics, etc.

Result

Between May 2017 and Oct 2017, there were 115 marine engineer jobs in the whole nation reported on the job hunting websites investigated, including *indeed*, *linkedin*, *glassdoor*, *monster* and *careerbuilder*. They were processed based on the proposed methodology and the results are presented as follows.

Figure 1 shows the marine engineering job placements (locations) ranking in the whole nation. It can be seen that the top five states or districts having greatest numbers of the marine engineering jobs are DC, Florida, Virginia, Louisiana and California, taking 12.17%, 12.17%, 12.17%, 10.43% and 9.57% of the total jobs. The five states or district in total takes over half the jobs available in US (56.5%). It is also interesting to observe that there is a job concentrated region, covering DC, Virginia and Maryland. This region contributes one quarter of the jobs to the total jobs in US and and is in close proximity to the federal government; especially the Defense Department and Transportation Department. While most of the MMA students primarily look for or consider co-ops or permanent jobs in Massachusetts, Figure 1 suggests that a good alternative is to consider jobs within the more concentrated regions, which probably provide more diverse job opportunities and benefits to their lifelong career.

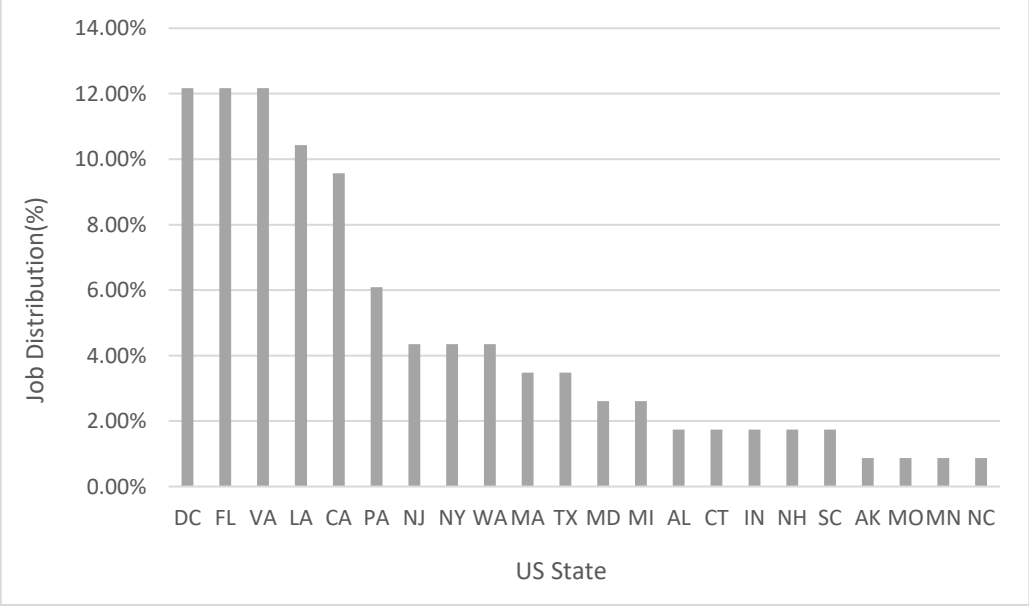

Figure 1, Marine engineer job placements(locations) ranking in US between 5/2017 and 10/2017

Table 1 shows the job category ranking for marine engineer jobs. It can be seen that the top three job categories are *Design of Ship Component/Structure*, *Operation and Maintenance of Component/Structure*, and *Manufacturing and Production of Ship Component/Structure*, taking 35.78%, 23.85% and 10.09% of the total jobs.

Table 1, Marine engineer job category ranking in US between 5/2017 and 10/2017

Job Category	Ratio
Design of Ship Component/Structure	35.78%
Operation and Maintenance of Component/Structure	23.85%
Manufacturing and Production of Ship Component/Structure	10.09%
Installation and Deployment	7.34%
Design of Geotechnical Structure	7.34%
Construction of Geotechnical Structure	7.34%
Others	8.26%

Table 2 shows the top 5 components or structures in the job category of *Design of Ship Component/Structure*. Table 1 and Table 2 indicate a student having the design experience with propulsion system or the operation and maintenance experience with power supply system can better satisfy the industrial expectations and have a higher chance to land a job.

Table 2, Top 5 components or structures in the job category of Design of Ship Component/Structure.

Component/Structure	Total Number of Appearance
Propulsion machine	12
Piping system	10
Hydraulics	7
Power supply system	5
HVAC	5

Table 3 shows the top 3 components or structures in the job category of Operation and Maintenance of Component/Structure, which are propulsion system, HVAC and power supply system. It can guide the marine engineer students in MMA to concentrate their study in the propulsion system and power supply system and also to look for co-op in these areas to obtain the related experience to benefit future permanent jobs hunting.

Table 3, Top 3 components or structures in the job category of Operation and Maintenance of Component/Structure.

Component/Structure	Total Number of Appearance
Propulsion machine	10
HVAC	3

Power supply system	2

Table 4 shows the ranking of the marine engineer software skills most in demand. It can be seen that the top 3 software skills are AutoCAD, Solidworks and STAAD. It indicates that a student with designing software experience can be more favored by the maritime industry. The way to obtain designing software experience can be using the AutoCAD and Solidworks in course projects or senior design project. Table 4 also indicates the programming software Matlab and Labview are also preferred in marine engineer jobs. Since the major courses of the marine engineering curriculum in MMA usually don't intensively train the programming skill, selective courses using Matlab and Labview, such as Control Engineering, Data Analysis, etc, can be designed to meet the industrial expectations.

Table 4, Marine engineer software skills most in demand in US between 5/2017 and 10/2017

Software Skills	Total Number of Appearance
AutoCAD	21
Solidworks	10
STAAD	4
Matlab	2
SAP	2
Microstation	2
Ansys	2
Others(Labview, PLC, etc)	15

Discussion

Table 1, Table 2, Table 3 and Table 4 lay the ground work for potential modifications to the existing MMA marine engineering curriculum and course contents to better meet the industrial expectations. Two major courses, Strength of Material and Electronics, have been taken as examples to be advised with adjustments.

Table 1, Table 2 and Table 4 indicate a strong industrial expectation of design background. Considering the propulsion machine in Table 2 and Solidworks, AutoCAD in Table 4, a project on designing the camshaft of the diesel engine can be designed and assigned in the course of Strength of Materials. While the input/output torque requirements of the camshaft can be given, the students have the freedom to choose the dimensions and diameters of camshaft and the materials to satisfy the design requirements of shearing stress and angle of twist. Their final project report can be required to include 3D drawings in Solidworks of the final camshaft design and different views(i.e, top, front, left, etc) in 2D drawings in AutoCAD. Similar design concepts can be applied for other components of propulsion machine or ship components, such as gear, engine cover, etc.

Table 1, Table 3 and Table 4 also indicate a strong industrial expectation of the operation and maintenance of ship component and structure. Considering the propulsion machine in Table 3

and Labview in Table 4, a project on understanding the low-pass filter of the diesel engine camshaft can be designed and assigned in the course of Electronics. A student can be asked to measure the angular velocity of a diesel engine camshaft using an encoder and Labview. As the raw angular velocity has high frequency noise, the student is further required to read existing literature, technical reports and vendors' handouts to find a proper low-pass filter. Finally, the student is asked to model the low-pass filter in Labview and tune the filter parameters to only allow the low frequency of the camshaft velocity to pass.

These two advised adjustments to course contents of Strength of Materials and Electronics can expose students to the opportunities in the design, operation and maintenance of ship component and structure. Additionally, since these two advised adjustments are both related to the propulsion system, the marine engineering student can learn the same ship component from different courses which might contribute to better learning outcomes.

Conclusion

This paper discussed the industrial expectations for the marine engineering major students on the top job placements (locations), the top job categories, and software skills most in demand. Based on the job hunting websites, *indeed*, *linkedin*, *glassdoor*, *monster* and *careerbuilder*, the job information of 115 marine engineering jobs available between May 2017 to Oct 2017 were collected. Statistics analysis have been conducted to reveal that (1) the top job placements are DC, Florida, Virginia, Louisiana and California, taking 12.17%, 12.17%, 12.17%, 10.43% and 9.57% of the total jobs; (2) the top job categories are the design of ship component/structure, operation and maintenance of ship component and structure, and manufacturing and production of ship component/structure, taking 35.78%, 23.85% and 10.09% of the total jobs; (3) the top software skills most in demand are AutoCAD, Solidworks and STAAD. The results may lay the ground to improve the existing MMA marine engineering curriculum and course contents to better prepare the marine engineering students to meet the industrial expectations. Two courses, Strength of Material and Electronics, have been taken examples to be advised with possible adjustments.

Reference

[1] Farzam S. Maleki, Gail M. Stephens, "A case study on gender gap in Massachusetts Maritime Academy", American Society of Engineering Education Annual Conference and Exposition, 2017

[2] https://www.maritime.edu/career-statistics

[3] https://www.maritime.edu/meng-learning-outcomes

[4] GourangaBanik, "Employer's Expectations of the Performance of CM Graduates", American Society of Engineering Education Annual Conference and Exposition, 2008

[5] Ngat-Chin Lim, “Towards an integrated academic assessment: closing employers’expectations”, Education + Training, Vol. 57 Issue: 2, pp.148-169, 2015

[6] Troy Harding, Thomas E. Mertz , William E. Genereux, Sue A. Guzek and Timothy Bower, “Reinventing a Computer Technology Curriculum to Meet the Needs of Students and Future Employers”, American Society of Engineering Education Annual Conference and Exposition, 2017

[7] Walter O. Craig III, “Industry Advisory Boards’ Role In The Accreditation of Engineering Technology Schools”, American Society of Engineering Education Annual Conference and Exposition, 2007

[8] Duncan J Bremner, Kathleen Meehan, Yangyang Liu and XingangLiu, “Creating a University-Industry Advisory Board for a Joint Engineering School”, American Society of Engineering Education Annual Conference and Exposition, 2016

[9] Raymond Greenlaw, “Setting Up and Maintaining A Strong Industrial Advisory”, Journal of Scientific and Practical Computing, Vol.3, No.2, pp 23–34, 2009