WIP: Advancing Scholarly Pursuits Within Standard Curriculum Through the Ocean County College Honors by Contract Program

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***Abstract*—This Work in Progress (WIP) paper is about the innovative practice for providing community college students access to advanced and specialized topics in a community college setting. The Ocean County College Honors by Contract program allows eligible students to work individually with faculty members on higher-level educational activities related to course objectives while enrolled in a regular course. This paper written jointly from the perspective of the Engineering & Industrial/Technical Studies program chair and a student will provide an example of access to biomedical engineering well ahead of what would have happened after the completion of the associate's degree in engineering, then transfer to a four-year program that specializes in biomedical engineering. Through this program, the student can pursue focused projects relating to their interests in fields where there can be a connection but not a full course available. In this paper we will highlight the initial project "IMPLANTABLE MYOELECTRIC PROSTHESIS (IMES)" that allowed the student to research the topic then utilize CAD skills to start a multi-semester extracurricular project that will look at materials, mechanical and electrical design for this bio-mechanical device. This initial project will benefit additional students as the later phases will be implemented through the Engineering club. All Engineering Club projects are executed with industry quality methodology: Customer contract, formal requirements, high level design, detailed design, build and manufacturing, and formal verification testing. Later Honors by Contract projects for this student, are allowing her to study the general theory and application of mathematics to Electrocardiogram (ECG) and Electroencephalography (EEG). Overall, students are expected to do at least four Honor by Contract courses, after which they may graduate with honors. In addition to this acknowledgement of their academic strength, the direct access to personalized academics and in-depth work with their sponsoring instructor energizes their pursuit of our degree and those that will follow. (*Abstract*)**

***Keywords—Biomedical Engineering; Community College; Innovative Practice; Experiential Learning** (key words)*

I. BACKGROUND

As was shown in prior work, some of the key enablers to student success, especially in higher education in this current era of educational practices include contextualization [1] and immediate application of skills [2]. These two practices work best upon a foundation of the student's academic area of study that aligns with their career goals. In most four-year institution, the student is able to have an immersive experience that provides them with a focused area of study that provides the foundation knowledge in a contextualized manner as well as the experiential learning both inside and outside of the classroom. This Work in Progress paper outlines a method for providing those aspects within an academic pathway that starts in a community college.

For many students, their pathway to a bachelor's degree in engineering will start at a community [3]. Although the statistics in [3] are from 2017, they align with the statistics within the Ocean County College Engineering & Industrial/Technical Studies program between 2017 and the present. A key aspect to see in [3] is the difference between the percent of students that will attend a community college prior to completion of their bachelors in engineering and those that will also complete their associates degree in engineering prior to completing their bachelors degree. According to [3] across all engineering, 41% had some education at a community college as part of their pathway to a bachelors degree in engineering, while only 14% of the overall bachelor in engineering degree recipients also received their associates in engineering from a community college. There are a number of reasons that contribute to this situation such as the lack of an ABET accreditation for Associates in Engineering. Only Associates in Engineering Technology [4] are eligible for ABET accreditation in a two-year program . This, along with the perpetual challenge of trying to achieve 100% transfer of all credits for use within the Bachelor's degree cause students to "cherry pick" courses in the Associates program and not fully engage in the community college level program and its many electives. A final challenge at the community college engineering associates program level is legislation [5] that was passed in August of 2018 requiring that an associates degree in NJ be no more than 60 credits. As stated in [6], an AS degree must have no fewer

than 50% of the credits be general education courses, while a baccalaureate degree must have approximately half of the required 120 credits be general education. The first legislation, [5]. also limited Bachelors degrees to 120 credits, forcing those degrees to specialize much earlier in the their four-year programs as well as keep program-aligned general education courses instead of traditional general education courses, thus putting more pressure on their ability to accept credits from the community college programs.

For both challenges and opportunities, what has been the response within the Ocean County College Engineering & Industrial/Technical Studies program. For the academic foundation there is a spectrumn of courses that range from what is termed "applied academics" to the traditional academics of an engineering program. Due to the open enrollment of a community college the Engineering & Industrial/Technical Studies programs and the wide spectrum of academic capabilities of the students in the programs there is a wide breadth of academic and practical skills, that prepare students for jobs as Engineers, Technologists and Technicians. Offering a wide set of choices for courses is one method to address the need to support the academic success in the engineering & technology space for a larger percentile of the population than a traditional four-year program. To further address the diverse population within the program, this paper outlines the use of the Honors by Contract program to provide academically advanced students the opportunity to further contextualize the topic and apply it to their career goals, thus enriching their learning experience [1], [2].

II. Honors by Contract Program

The Honors by Contract Program [7] at Ocean County College provides students with the opportunity to work directly with their instructor to expand upon the curriculum in a regular course. Participants will work throughout the semester on research and/or a project that will count for a portion of their final grade. Some students may also have their research and/or project submitted to the annual competition that results in monetary awards for the students. Finally, there is an annual showcase where students display their work in a poster presentation style event that is open to the full student body.

The following are statistics about the general program that demonstrate the academic strength and success of the participants. (HBC = Honors By Contract Participant, GENL = Total Population)

- Three Year Graduation Rate: HBC = 89.3%, GENL = 39.1%
- Retention Rate (Full Time): HBC = 96.9%, GENL = 65.9%
- Retention Rate (Part Time): HBC = 100%, GENL = 48.7%
- GPA: HBC mean = 3.61, std = 0.41, GENL mean = 2.41, std = 1.31

For students taking STEM courses as an HBC participant, their projects were evaluated in two dimension to demonstrate the exposure to advanced topics and practice of skills that students are able to achieve through this program: 1) Additional topics were explored in the field of study of the course. 2) Applied Skills from the course were applied within the project (application of skills excluded a project that only resulted in a research paper/presentation). The following were the results of this analysis for participants between Fall 2021 and Spring 2024:

- Additional Topics: Yes & Applied Skills: Yes = 65.85%
- Additional Topics: Yes & Applied Skills: No = 29.27%
- Additional Topics: No & Applied Skills: Yes = 4.88%
- Additional Topics: No & Applied Skills: No = 0%

III. Alternate Academic Pathway

As stated earlier in this paper, students pursuing a bachelor's degree in engineering may follow multiple pathways. The following shows a comparison of the course schedule in a 4-year biomedical engineering program vs. a two-year community college path vs. a two-year community college path with the addition of Honors by Contract. The four-year biomedical engineering curriculum was taken from Steven Institute of Technology's website [8] and the two-year community college from Ocean County College, Engineering, Associate in Science, [9]:

TABLE I. Standards Paths vs. Accelerated Honors by Contract Path

Year	*Standard 4-year Program Path*	*Standard Community College Path (Mechanical Engineering Option)*	*Accelerated Path with Honors by Contract*
1	• Intro to Engineering Design • Calculus I-III • Intro to Programming • Chemistry I-II • Mechanics	• Graphics Engineers • Calculus I-II • Intro to Programming • Chemistry I • Physics I	Graphics Engineers* Calculus I-II** Into to Programming Chemistry I Physics I
	• Systems • Humanities	• First-year engineering fundamentals • English & Humanities	First year engineering fundamentals English & Humanities
2	• Differential Equations • Statics and Intro to Mechanics • Electricity and Magnitism • Thermodynamics • Design of Dynamical Systems • Circuits and Systems • Thermodynamics • Probability and Statistics with Data Science Applications • Intro to Biomedical Engineering • Biology and Biotechnology	• Calculus III/ Diff. Equations • Engineering Statics • Strength and Materials • Physics II • Engineering Dynamics	Calculus III/Diff. Equations Engineering Statics Strength and Materials Physics II Engineering Dynamics
3	• Cell & Molecular biology • Biomaterials in medical device design* • Biomechanics** • Engineering Design *		***Accelerated exposure to topics due to Honors by Contract**
	• Infenite Series • Biotransport • Biomedical digital signal processing lab • Engineering economics & Project Management		
4	• Engineering Design VIII • Physiology for Engineers • Senior Innovation • Technical Elective • Humanitites		

It is evident through Table 1 that the standard community college program, Associate in Science-Engineering, has little to no opportunities for early exposure and direct experience with biomedical engineering and focuses solely on general education and basic mechanical engineering / engineering courses. Through the Honors by Contract program general engineering students are given the opportunity to have accelerated access to their field of choice as early as their first semester at the community college. As seen in TABLE I, the traditional two-year program path would not have students introduced to these topics until they transfer to their four-year program. The Honors by Contract program is a way to accelerate academically strong students looking to take advantage of individual studies to accelerate their engineering studies in their field of choice. This early exposure will provide for the benefits outlined in [1], [2]. Also as seen

in the program statistics it improves both graduation rates and retention rates, because students have an academic experience that is more aligned with their overall career goals.

IV. Initial Student Project

The Honors by Contract program created an opportunity to perform outside research related to the selected course, ENGR 181 Graphics for Engineers. This course, taken in the early years of the engineering program, focuses on basic mechanical drawings and is designed to teach the basics of drawings and general engineering graphics. After the general engineering associates degree the student plans on pursing a 4-year program with a focus on biomedical engineering, a topic with little to no coverage during the 2-year engineering degree. The goal of the Honors by Contract project was to focus on biomedical engineering concepts and design, to create two-dimensional drawings using AutoCAD and the basic mechanical engineering skills learned in the regular course. An interest in prosthetics led to research on the varying types and features. The final project focuses on prosthetics with an implantable myoelectric sensor (IMES); prosthetics that use an implant inside the arm and external coils. The student decided to design the small implants that would be planted inside the muscles of the forearm. Figure I shows the initial drawing of the overall prosthetic done with research and leveraging the design from [9].

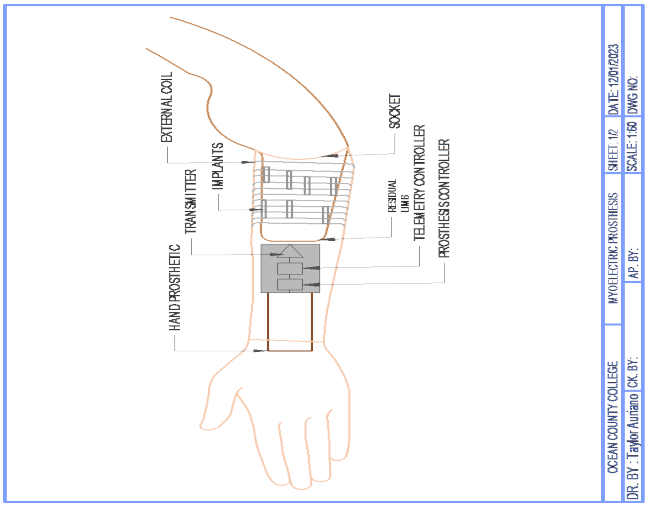

FIGURE I
DESIGN - ENTIRE IMPLANTABLE MYELECTRIC PROSTHESTIC

The outcomes of ENGR 181, a mechanical drawing class, led the student to use the drawing skills gained from taking the course to design multiview layouts of the implant. Skills include the creation of orthographic views and assembly drawings as well as the use of formal engineering title blocks. Figure II, Figure III, and Figure IV show two-dimensional drawings of the design of the capsule and electrodes used to make-up the implant.

The final aspect of the research and design of the implantable prosthetic included picking materials. Research was conducted on the best materials for these implants to read signals from the muscle and perform well while also being the safest option for inside the human body. Figure V shows the final implant.

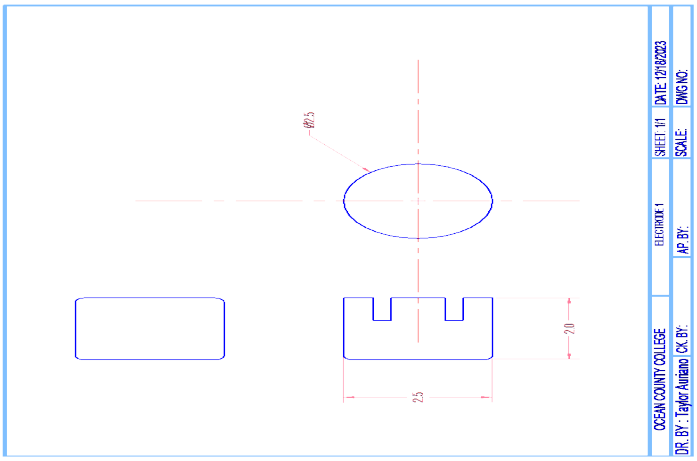

FIGURE II
ELECTRODE 1 DESIGN

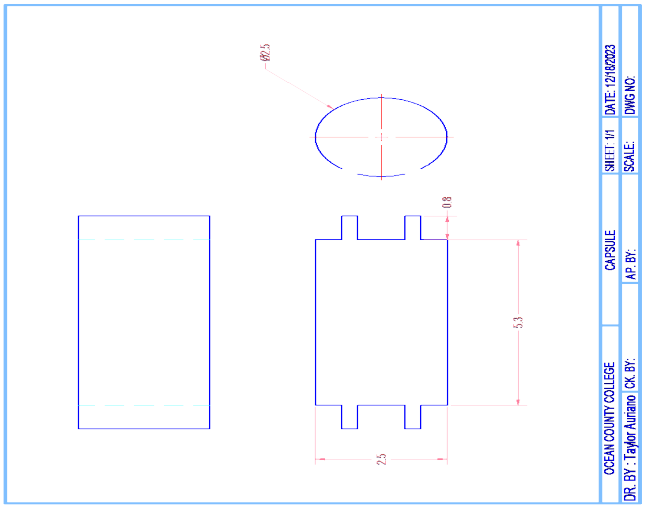

FIGURE III
CAPSULE DESIGN

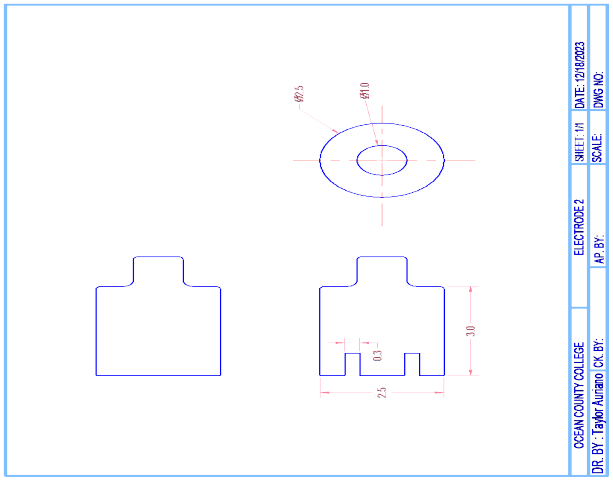

FIGURE IV
ELECTRODE 2 DESIGN

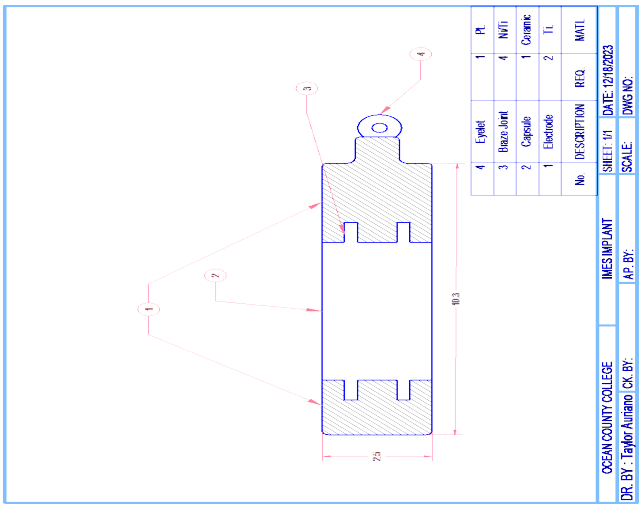

FIGURE V
FINAL IMES IMPLANT ASSEMBLY DRAWING

This project led to the research of not only the mechanical design of these implants and prosthetics but the electrical design as well. With this research, later phases of the design process were looked into and will be implemented over multiple semesters. This Honors by Contract project was an opportunity to do research in the biomedical engineering field early on in the pursuit of an associate degree in engineering, where these areas of focus are not yet available.

V. Student Perspective about Honors by Contract

Ocean County College's Honors by Contract program is an excellent program that gives community college students a way to work independently alongside professors to conduct higher-level education activities and are given the opportunity to then graduate with honors. [6], [12],[13],[14], [15] There are notable benefits to being a student in this program that are summarized in TABLE II and further details are outlined below:

TABLE II. Student's Perspective: Pros and Cons

Pros	***Cons***
• Acceleration • Engagement • Opportunites • Research • Acknowledgement	• Limitations • Workload • Relatively unknown

- *Acceleration of studies in fields of interest.* In this case, the pursual of an associate degree in engineering at Ocean County College keeps the students in general studies of engineering topics. Before transferring to the four-year program that will specialize in biomedical engineering, there are little to no ways to introduce the aspects of biomedical engineering throughout the time enrolled at Ocean County College. The Honors by Contract program, alongside program chair, Professor Bogdan introduced a way to apply general studies and engineering concepts into individual research to gain access to the specialized field of interest. The research on implants while implementing the general studies of two-dimensional AutoCAD design led to the pursual of Honors by Contract in later classes. This inspired research on biomedical engineering topics related to the general theories and applications of mathematics and physics. Later projects introduced the idea of the derivate applied to the electrocardiogram (ECG). This opportunity early on in the studies of engineering and later biomedical engineering offers an opportunity to accel forward and gain knowledge prior to transferring to the program of specialized studies.
- *Increased engagement in regular courses.* With research of the student's topic of interest, the Honors by Contract program gives the student a way to engage in their basic courses by relating back to topics that they enjoy. This in turn helps the success in the students' early, general studies while at Ocean County College and sets them ahead for later more focused studies at their 4-year program or in the work field.
- *Capability to pursue research in various fields.* With the availability to do 2 honors classes every semester, students are given opportunities to research and explore different fields and topics in their two years at Ocean County College. This can help the student explore topics of interest long before their four-year program where they will focus on a specific engineering field.
- *Academic acknowledgement.* The Honors By Contract program is a way for students to be acknowledge for their hard work and research. The program gives the student an opportunity to show off their work and graduate with honors.

Nevertheless, from the student's perspective, the following potential negative impacts were considered:

- *Limitations.* The Honor's by Contract program is limited to a certain number of classes, due to professors who participate, and resources for students to do their projects and research. To be able to do the research and projects of their choice students must find a professor to support their request and will create time outside of their regular courses to get experience in the field that interests them.
- *Workload.* The Honors projects, depending on the project of choice, could be a disruption to the regular high-volume workload of a college student, especially a community college student. Community college student's workload includes not only that of a regular college student but also an at home workload and a 30–40-hour job. The Honors by Contract program introduces topics of interest to standard community college curriculum, but it is extra work on top of the regularly assigned workload. Limitations due to time and required assignments might put pressure on some students and push them away from the program.
- *It is relatively unknown.* Most professors do not inform students about the honors program. Without knowledge of the program students do not know of the access that they have to get ahead at their community college and completing their own research on their individual engineering fields that will later be pursued. More students would take advantage of the opportunity if they knew about the ways to advance their general curriculum to focus on their future and goals in their individual studies.

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