

## **Adaptive Learning Environment for High Value Manufacturing (HVM) Geared towards the Energy Industry**

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Maria Henri is a doctoral student in Educational Psychology, at Texas A&M University, focusing on measurement and statistics. She graduated from the University of Texas at San Antonio with a MS in psychology in 2015, where she taught undergraduate psychology courses. She worked as a data analyst on a variety of quantitative and qualitative projects that strived to improve education in San Antonio. Her interests include hierarchical linear modeling and structural equation modeling. Currently, she is Graduate Research Assistant at Texas A&M University, working on a project aimed to create a sustainable certificate program in high value manufacturing that provides multiple pathways for community college students and meets future workforce needs.

### **Dr. Norma Perez, Houston Community College**

Dr. Perez is currently the Interim Associate Vice Chancellor of Curriculum and Learning Initiatives at Houston Community College (HCC). She has served in various positions during her thirty years of service to HCC, such as Executive Dean, Dean of Health Sciences, and Director of Institutional Assessments. Dr. Perez was instrumental in working with faculty to create the first student success course for the Health Sciences students to impact the success rate of these students. Dr. Perez also worked with faculty and industry experts to create several new programs, such as Histologic Technician, Computed Tomography, Cardiovascular Technology, Massage Therapy, and Dental Hygiene. Most recently, she worked with faculty and industry experts to create the Insurance Associate/Specialist program to train students for the insurance business. Dr. Perez has had many successes during her tenure and is dedicated to making an impact for the success of all students at HCC.

### **Dr. Madeline Burillo, Houston Community College**

Dr. Burillo is the President of Houston Community College Southwest and oversees the Center of Excellence for Advanced Manufacturing. She has led the engagement of a highly engaged industry Advisory Committee. This center provides certificate associate degrees and customized training in Machining, CNC, PLC, Robotics, Electronics, Additive Manufacturing, Digital and 3D Manufacturing. Dr. Burillo holds a bachelor's degree in Economics and a Doctorate degree in Educational Leadership; She is highly recognized nationally as a leader and trailblazer in workforce development.



**Mr. Roberto Sanchez, Houston Community College**

I was born in Lima-Peru and moved to United States shortly after earning my Bachelor's of Science in Industrial Engineering at the University of Lima. I worked for manufacturing companies serving the oil and gas industry since 1990 to 2010, year in which I joined the Manufacturing Engineering program at the Houston Community College. I have been teaching since and it has been one of the most gratifying jobs I had in my life.

Roberto

# **Adaptive learning environment for high value manufacturing (HVM) geared towards energy industry**

## **Abstract**

This paper presents a project framework for the development of an adaptive learning environment to provide a wide range of students with the skills necessary to work in high value manufacturing (HVM) aimed at the energy industry. More specifically, it discusses a HVM certificate program being developed at Houston Community College (HCC) in collaboration with Texas A&M University (TAMU). The aim of the project is to create a sustainable certificate program in HVM that provides multiple pathways for community college students while meeting the critical workforce needs of a vital industry in Texas. The novelty of the certificate program includes innovative pedagogical methods, such as competency-based learning and skills need assessment and provision through online learning modules is presented; this allows students an adaptive and personalized education in this needed area. Upon completion of the certificate program, the community college students will have multiple pathways including: a) an A.S. at the Community College; b) transfer to four year institution; and c) return to industry to join the workforce. By incorporating a new co-educational paradigm between the community college and the university, as opposed to traditional articulation agreements, this project provides a novel pathway for community college students to transition to a four-year degree program. It also incorporates a new method for trying to ensure that community college students who matriculate to partner 4-year institutions receive reverse transfer credit for their associate degrees at their home community college. Furthermore, HVM modules are developed for high school students that are aligned with the Next Generation Science Standards.

## **Introduction**

The new boom in the energy sector is having very positive effect on manufacturing activities in Texas. U.S. census data from 2013 shows that Texas ranks first in the nation in terms of manufacturing exports (\$250.4 billion) and manufacturing capital investment (\$17.6 billion), and ranks second in the nation with respect to manufacturing employment (874,460)<sup>1</sup>. A significant portion of this manufacturing activity is aimed at the oil and gas sector; manufacturing serves this sector in multiple ways. The direct applications of manufacturing in oil and gas sector are in refineries and petrochemical industries. Likewise, manufacturing of machines and the fabricated metal industries supply upstream exploration and production (E&P) operations. While there is a steady growth in the manufacturing sector within the energy industry, it is faced with the challenge of skilled workforce availability. Given the type of equipment used for oil and gas E&P is often high value, the manufacturing of this type of equipment and tooling requires a workforce with multifaceted skills. In this type of high value manufacturing, where a single component can be valued at tens of thousands of dollars, personnel must have expertise in various areas to meet customer demand under exacting time and quality constraints. To prepare such a workforce requires skills that span: design, materials, manufacturing processes, project management, quality, and logistics and supply chain management. These skills, aimed at the energy sector defined in this project as “high value manufacturing (HVM)” are very critical for technician level (both upstream and midstream) jobs due to globalized marketplace and recent developments in oil and gas drilling and production methodologies<sup>2</sup>.

Research shows that nearly 50% of the skilled workforce in petroleum industry could retire within next five years<sup>3</sup>. One study<sup>4</sup> shows that the Houston metropolitan area had 117,000 manufacturing jobs in 2012 and that number is expected to grow very rapidly in the coming years. Although currently there is a down turn in oil and gas industry, it is expected that the demands for skilled workers in E&P and other supporting operations including manufacturing and logistics will increase over the long term<sup>5</sup>. It is important to recognize that the energy E&P operations are a special kind of operations that largely follow manufacturing principles and best practices. Further, out of 1.3 million expected new oil and gas jobs by 2020, Kimrey<sup>6</sup> suggests that there will be high demand for such skillset as project controls, drafting and design,

procurement, project administrators, and data management due to the recent boom in oil and gas E&P technology. Given this rapidly rising skills gap, there is a strong need for a structured and adaptive learning environment in high value manufacturing focused on the energy industry. Texas is the capital of the US oil and gas industry. While Texas community colleges have a number of Associate of Applied Science and Certificate programs in process technology, petroleum technology, pipe fitting technology, petroleum data technology, and other safety related programs, there is very little focus on broader perspectives of manufacturing like manufacturing and joining processes, materials science, design, quality, and project management (see Table 1).

Table 1: Texas Comm. College educational programs related to petroleum & manufacturing technology

<b>Community College, City</b>	<b>Educational Program (Degree)</b>
Laredo Community College, Laredo, TX	Oil and Gas Industry Specialization (Certificate Programs)
Lee College, Baytown, TX	Pipefitting Technology (AAS) Process Technology (AAS) Pipefitting Technology (Certificate of Completion) Pipefitter Helper (Certificate of Completion) Process Technology (Certificate of Completion)
Lone Star College System- Houston, TX	Petroleum Data Technology (AAS & Certificate) Machining Technology (AAS & Certificate) Welding Technology (AAS & Certificate) Petroleum Field Service Technician (AAS & Certificate) Automated Manufacturing (AAS & Certificate) Oil & Gas Drilling - Motor Hand Workforce (Certificate)
North Central Texas College, Gainesville, TX	Petroleum Technology (AAS & Certificate)
Western Texas College, Snyder, TX	Petroleum Technology (AAS)
Coastal Bend College, Beeville, TX	Oil and Gas Technology (AAS & Certificate)
Houston Community College Systems, Houston, TX	Petroleum Engineering Technology (AAS and Certificate) Process technology (AAS and Certificate) Advanced Welding (Certificate) Basic Welding Helper (Certificate) Manufacturing Technology(AAS and Certificate)
Del Mar College , Corpus Christi, TX	Process Technology(AAS & Certificate)
Palo Alto College, San Antonio, TX	Oil & Gas Process Technology Specialization (AAS)
College of the Mainland, Texas City, TX	Petrochemical Process Technology ( AAS) Entry Level Welding (Certificate) Advanced Level Welding (Certificate)
Victoria College , Victoria , TX	Process Technology (AAS Degree) Pipefitting Level 1 & 2 (Certificate of Completion)
South Texas College, McAllen , TX	Precision Manufacturing Technology (AAS & Certificate)
Texas State Technical College, Harlingen, TX	Precision Manufacturing Technology (AAS & Certificate)
Odessa College, Odessa, TX	Machine Technology (AAS & Certificate)
Amarillo College, Amarillo, TX	Machine Technology (Certificate)
El Paso Community College, El Paso, TX	Advanced Technology Industrial Manufacturing (AAS)
Alvin Community College, Alvin, TX	Process Technology ( AAS)
Dallas County Community College District, Eastfield, TX	Advanced Manufacturing/Mechatronics Technology (AAS )
Navarro College, Corsicana, TX	Petroleum Technology (AAS & Certificate) Oil & Gas Technology (Certificate)
San Jacinto College, Pasadena, TX	Process Technology (AAS)
Texas State Technical College, Marshall, TX	Process Operations Technician (AAS)
<i>AAS- Associate of Applied Science Degree</i>	

The authors interactions with industry collaborators revealed that current curricula in these programs need more practical or laboratory experiences for students, namely more experiential learning. In some cases, companies have to provide up to 14 weeks of training before these community college graduates can actually start the job. This represents a significant cost to employers in terms of training costs and loss of employees’ productive time. More importantly, the impact of such in-house training programs will be limited to their company employees, and so will not be accessible to a broader student population. To narrow this HVM workforce gap, this project proposes a learning environment with following goals and objectives as shown in Table 2.

Table 2: Project goals and objectives

<b>Goals and Objectives:</b>
<b>Goal 1: Prepare students with the multifaceted skills required for high value manufacturing technicians geared towards the energy industry</b>
<b>Objective 1a:</b> Increase the number of students with the necessary skills for immediate contribution in a HVM industry environment
<b>Objective 1b:</b> Improve student engagement and enhance participant education of HVM topics
<b>Objective 1c:</b> Provide students a more personalized and adaptive educational experience
<b>Goal 2: Attract a diverse group of participants into manufacturing and engineering and provide pathways to both industry and higher education</b>
<b>Objective 2a:</b> Promote student success in completing a certificate program in HVM topics
<b>Objective 2b:</b> Expand high school teacher and student knowledge in the skills required for HVM and jobs related to HVM
<b>Objective 2c:</b> Enhance the knowledge of practicing professionals in HVM topic areas
<b>Objective 2d:</b> Increase the number of students receiving course credit from certificate programs towards four year bachelor’s degrees

As shown in Table 2, the key goal of this project is to provide a diverse population of students with the necessary skills in manufacturing, materials, computer-aided design (CAD), logistics, and project management, geared towards the energy industry in Texas. Providing experiential learning opportunities in these critical areas in high value manufacturing at a community colleges not only reduces the financial burdens on students but also will serve a larger number of students in energy industry and beyond. Many companies including upstream oil E&P, midstream pipelines and processing, and engineering companies have their headquarters located in Texas. By offering the proposed certificate program at a community college, it can fill this critical workforce need of a relevant industry in their geographic proximity.

**Project Plan**

***Curriculum development and integration***

The main goal of this project includes preparing a wide range of students with the skills necessary to work in high value manufacturing (HVM) aimed at the energy industry. This project aims to offer the proposed certificate to different populations of students with varying goals. This is summarized in Figure 1.

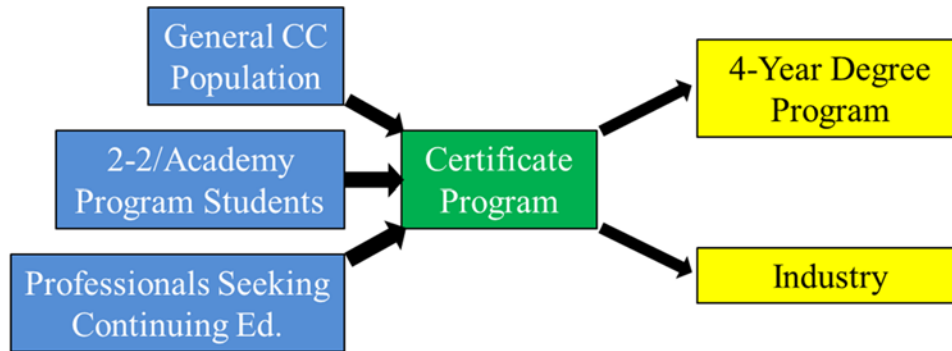


Figure 1: Certificate Program Pathways

The proposed certificate will be offered at a Texas community college as a *Level 2* certificate. This is defined by the Texas Higher Education Coordinating board as requiring between 43 and 59 semester credit hours and being subject to the Texas Success Initiative (TSI). The TSI provides an initial assessment of student readiness for college-level work. Those students that do not score adequately on the TSI Assessment, are required to take development courses in the areas where they did not meet the necessary proficiency. The TSI is aimed at *Objective 2a*: the promotion of student success in the certificate program. This will allow for a wide array of students to be eligible for the proposed certificate program as well as ensuring that they are at a level to complete the necessary courses successfully.

In addition to serving as a continuing education opportunity for those already in industry or looking to join a particular industry, the certificate program is “stackable” and can therefore be used towards an A.A.S. degree. The proposed certificate program will build off of the HCC’s experience in developing and offering industry-based certificate programs in petroleum engineering and process technologies. The Houston community college also has manufacturing engineering technology program at their central campus. These programs are highly popular in industry. The certificate program will be developed in collaboration with Texas A&M University’s Manufacturing Engineering Technology and Industrial Distribution programs.

***Curriculum Outline and Proposed Certificate Program Structure***

Houston community college currently offers students certificate and degree program with three main choices: a Level 1 certificate (27 credits), a Level 2 certificate (45 credits), and an associate’s degree in applied science (60 credits). These programs are stackable; they provide students with three separate entry and exit points; and each develops employment pathways for students.

The overall curriculum for proposed HVM certificate program is displayed in Table 3. It combines existing student success courses (LEAD 1370; MATH 1314) along with manufacturing courses to provide the necessary technical background. These courses include a basic print reading course (MCHN 1302) as well as manufacturing process courses (MCHN 1338; MCHN 1308; MCHN 1313; INMT 1345), and instrumentation basics (INCR 1302). For students to appreciate the needs and unique demands of the energy industry, students must understand the uses and importance of the products they will be responsible for in energy E&P. Four existing Petroleum Engineering Technology courses are included to provide participants with the necessary context for HVM aimed at the energy industry. These courses provide a broad introduction to the petroleum industry and the necessary equipment (PTRT 1301); an introduction to the principles of geology, geophysics, and petrophysics (PTRT 1470); an overview of the drilling, completion, and development of production systems (PTRT 1471); and the fundamentals of oil production operations (PTRT 2370).

As shown in Table 3, In addition to the existing courses, five new courses are proposed to provide a unique focus on HVM for the energy industry. The interplay among design, materials, and manufacturing is extremely important in any product, but becomes even more crucial in high value manufacturing.

Table 3: Proposed HVM Curriculum

Course Number	Course Number	Credit Hours
Semester 1		
LEAD 1370	Workforce Development	3
MATH 1314	College Algebra	3
MCHN 1302	Print Reading for Machining	3
MCHN 1338	Basic Machine Shop I	3
PTRT 1301	Introduction to Petroleum Industry	3
PTRT 1470	Petroleum Data Management I – Exploration	4
Semester 2		
MCHN 1308	Basic Lathe	3
MCHN 1313	Basic Milling Operations	3
INMT 1345	Computer Numerical Controls	3
TBD XXXX	Materials and Applications	3
PTRT 1471	Exploration and Production I	3
INCR 1302	Physics of Instrumentation	3
Semester 3		
PTRT 2370	Petroleum Operations	3
TBD XXXX	CAD and GD&T	3
TBD XXXX	Quality and Assessment	3
TBD XXXX	Project Management	3
TBD XXXX	Machine Shop Logistics	3

Often the materials being processed or E&P applications are high value alloys that may exhibit unique behaviors; the design requirements may necessitate post-processing (e.g., heat treatment or cladding) that needs to be taken into account during initial manufacturing processes. Quality is also critical in these often precision components. The value of the components along with the investments associated with oil and gas E&P necessitate that project management and logistics are taken into account in the manufacturing process. The addition of courses in these areas to the existing courses highlighted above will help meet the needs of industry and ensure that participants can contribute immediately to this area of growing employment. These courses will be developed by TAMU and HCC faculty with input from an industry advisory panel formed as part of the project.

The proposed certificate program will use a combination of in-person and online delivery to allow for flexibility and self-paced learning. The first new course is *Materials and Applications*; in this course students will be introduced to materials science with an emphasis on applications. While there will be a general overview of material types, the focus will be on ferrous and non-ferrous materials commonly used in the oil and gas industry; students will also highlight the relationship between material characteristics and application needs. Another new course focused on quality, *Quality and Assessment*, will be developed and provide students with an introduction to basic quality statistics and a survey of various metrology and assessment techniques. These two courses will be delivered in-person and incorporate *experiential laboratory exercises* to enhance student learning. In the case of *Materials and Applications*, this will include materials assessment and characterization as well as examining processing characteristics on materials properties. In the case of *Quality and Assessment*, the laboratory component will give students “hands-on” experience with modern metrology tools and techniques. These laboratory exercises will be

developed based on best practices in experiential learning and using the expertise in developing such courses.

Three other courses will be developed as on-line courses that use competency-based assessment. The first of these is *CAD and GD&T*; this will be a computer-aided design (CAD) course that will also introduce ASME Y14.5 dimensioning and tolerancing standards. A course in *Project Management* will be developed to provide the principles of project management with a focus on oil and gas E&P projects. A *Machine Shop Logistics* course will examine materials, tools, inventory, and work in process in a job shop environment and their economic impact. These courses will be delivered online, but provide students with the opportunity to interact with HCC faculty for necessary scaffolding; this process along with the online modules are detailed below.

***Online Modules and Competency Based Assessment***

Of the five new courses created for the proposed HVM certificate, three will be developed as competency based learning courses: *CAD and GD&T*, *Project Management*, and *Machine Shop Logistics*. The principles of competency based learning align with the theory of constructivism <sup>7</sup>. These courses will be offered online. This type of learning model allows students to learn at their own pace, and has been widely adopted in STEM disciplines <sup>8-10</sup>. The courses will be divided into several modules and specific competency outcomes will be developed to assess student learning. In order to provide the “traditional classroom experience” to students, online discussion forums will be created and moderated by the specific course or module instructors. They will be provided an orientation with clearly explained requirements and learning assessment methods for each module. In addition, students will have access to HCC faculty instructors who will have access to data regarding student performance that will allow these instructors to provide instructional scaffolding. Instructional scaffolding is a dynamic process where the instructor continuously evaluates the learner’s cognition and identifies the cognitive gaps the learner experiences <sup>11</sup>. This will ensure that the students are fully engaged in the learning process.

Table 4: Learning modules for competency-based courses

<b>Course name</b>	<b>Learning Modules</b>
CAD and GD&T	<ul style="list-style-type: none"> <li>• Solid Modeling Basics</li> <li>• Solid Modeling</li> <li>• Assemblies</li> <li>• Engineering Drawing Preparation</li> <li>• Tolerance Stack Up Analysis</li> <li>• Fits and Tolerancing</li> <li>• Geometric Tolerancing</li> </ul>
Project Management	<ul style="list-style-type: none"> <li>• Project organization</li> <li>• Project selection</li> <li>• PERT, CPM, Project planning and control, resources allocation</li> <li>• Project team development &amp; management</li> <li>• Conflict and change management</li> <li>• Six-sigma &amp; quality improvement projects</li> <li>• Oil &amp; Gas exploration case studies</li> </ul>
Manufacturing logistics	<ul style="list-style-type: none"> <li>• Productivity measures</li> <li>• Forecasting techniques for manufacturing</li> <li>• Capacity planning and break even analysis</li> <li>• Layout methodologies and strategies</li> <li>• Inventory management</li> <li>• Materials requirements planning</li> <li>• Machine scheduling</li> <li>• Warehousing, shipping, and transportation planning</li> <li>• Energy related manufacturing case studies</li> </ul>



Multiple assessment methods will be used to assess the students' competency in the courses, which is defined by "their skills, ability, and knowledge to perform specific tasks" in the related field <sup>12</sup>. The assessment instruments will include both a *competency performance examination* (CPE) and *competency performance assessment* (CPA). These instruments have been regarded in the literature as successful assessment methods in assessing competency based learning <sup>8</sup>. The CPA instruments will include module level assignments, quizzes, and discussion forum contributions. The CPE instruments will also assess students overall learning of the course through comprehensive exams, a real-world project, and case studies related to energy industry. Table 4 shows the proposed modules for the three competency-based learning courses. Like other courses, the development of these courses will be based on the inputs from industry partners, subject area body of knowledge, manuals for CAD, GD&T, professional certification in project management, and logistics. Similarly, the course development activities include the initial development of the course materials, delivery of the course, revision of the course materials based on the students and employers' feedback. The finalized courses will be disseminated through the HCC website. Authors from both TAMU and HCC have experience in developing and delivering online courses.

### ***Certificate Approval Process***

The development of the proposed certificate program will follow the existing process at HCC. In this process, faculty may design certificates and/or revise certificates or degree plans, as needed; a formal, multi-step curriculum approvable process is in place to facilitate this. Figure 2 depicts the steps in the process as the proposed changes are reviewed and passed to the next level of authority. The last step is submission of the proposed new or revised courses to the Texas Higher Education Coordinating Board (THECB on the chart) for approval. This review process ensures that the quality of the certificates is met and state requirements are followed.

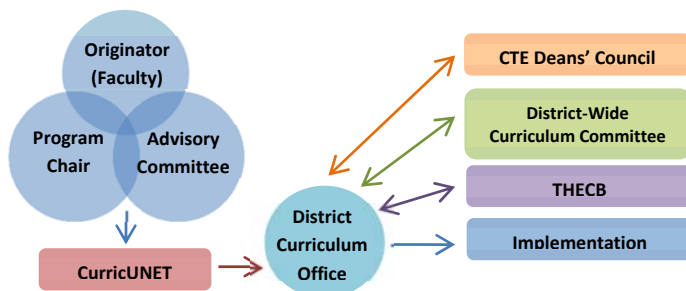


Figure 2: Certificate Approval Process

### ***Student Readiness Testing***

Like other Texas colleges, first-time students at HCC are required to take the Texas Success Initiative (TSI) assessment test to determine their levels in reading, writing and math. The TSI will contribute to *Objective 2a* and help ensure student success. Students who fail to meet the minimum passing standards are deemed not college ready or in progress and are required to enroll in a course designed to strengthen skills in reading, writing, or mathematics. These students will meet with an HCC academic advisor prior or during registration to initiate an individualized HCC Student Success Plan. The plan will record student test scores, educational objectives, declaration of a major, and direct students to student support resources. It will also provide benchmarks for tracking success, including the developmental education course sequence (as per student's major), and begin a plan for achieving a degree or Level 2 certificate. In addition, they will enroll during their first semester in a Student Success course. HCC currently has several Student Success courses such as EDUC 1300: Learning Frameworks and LEAD 1200: Critical Thinking in Workforce. Student Success instructors will provide students with additional advising as to completion of their individualized success plans. All developmental education students will be assigned an advisor during their first semester

of enrollment. Students will meet with their assigned advisor periodically to track completion of their individual success plan.

### ***Teacher Outreach and High School Module Development***

*Objectives 2a and 2b* are to broaden the impact of the proposed project and ensure that a wide audience of potential participants is cognizant of the employment opportunities related to HVM, a program to incorporate high school teachers and develop modules for high school students is proposed. This project will use the existing Engineering's Enrichment Experiences in Engineering (E<sup>3</sup>) RET program at Texas A&M University. The E<sup>3</sup> program brings high school science and mathematics teachers to the Texas A&M University for a summer residential experience where the teachers are mentored by engineering faculty. In this case, a special focus on the recruitment of technical and vocational high school teachers will be made. For the HVM project, teachers will work with faculty in manufacturing and logistics to learn about career opportunities in HVM. They will then help in the development of on-line modules targeted at high school students related to HVM topics and aligned with Next Generation Science Standards. These teachers can then also integrate these modules into their own curricula. The E<sup>3</sup> is an integral part of the TAMU's Look College of Engineering's outreach plan. The E<sup>3</sup> RET Site program has been funded by the NSF and had 150 teachers participate since 2002.

Aligned with *Objective 2d*, HCC has long-term and highly effective relationships with the seven school districts in its service area. In one instance, it partnered with the Houston Independent School District to institute the Futures Academy, one of the most far reaching programs in HCC's history. This programmatic initiative reaches out to high schools serving students from the lowest socioeconomic communities. Several Workforce certificate programs have been taught at these high schools. Also, students have been brought to HCC Central College and other HCC campuses to participate in certificate course offerings. Students can obtain certificates and/or the AAS degree while completing their own high school degrees. The program is two years old and just graduated its first class of 18 students. In addition, HCC has a very well developed dual credit programs with various school districts throughout the HCC service area as well as a number of students outside of the district.

### ***Development of HVM Continuing Education Short Courses***

Traditional manufacturing programs offered by community colleges do not offer courses in logistics, materials planning, and project and risk management. These skills are very important for energy industry technicians and engineers as they have to perform the complex production and operational activities that involve multiple steps performed by numerous actors. In addition to the certificate program, a three- day short course will be developed for returning energy industry technicians who wish to gain an understanding of various aspects of high value manufacturing systems for their professional development. The short course will be structured like a continuing education program and will consist of the modules as listed in Table 5. The context and examples for each module will be drawn from the energy (specifically oil & gas) industry. This short course will be offered at TAMU beginning in the summer of 2016. Based on student feedback, the course materials will be revised and updated. Upon modification, the short course will be made available for both synchronous and asynchronous distance learning. Moodle® learning management systems available at TAMU will be used for broadcasting the course materials. For asynchronous distance learning, video lectures will be created and posted online. This will allow energy industry professional across the United States to receive on-site education in the above-mentioned fields via Internet.

Table 5. Curriculum for three- day program

Modules	Contents	Activity Type and Duration
Economics of materials management for manufacturers	<ul style="list-style-type: none"> <li>• Forecasting</li> <li>• Inventory classification</li> <li>• Inventory costs and economic order quantity</li> <li>• Re-order point and safety stock</li> </ul>	8 hours (lecture plus hands-on activities)
Manufacturing scheduling	<ul style="list-style-type: none"> <li>• Master production schedule</li> <li>• Bill of materials</li> <li>• Materials requirements planning</li> </ul>	4 hours (lecture plus hands-on activities)
Project risk analysis and management	<ul style="list-style-type: none"> <li>• Project selection</li> <li>• Risk analysis</li> <li>• Change management</li> </ul>	6 hours (lecture plus hands-on activities)
Project control	<ul style="list-style-type: none"> <li>• Project scheduling, Critical path method</li> <li>• Resource allocation</li> <li>• Project crashing</li> </ul>	4 hours (lecture plus hands-on activities)

### ***Pathways and Employment***

Figure 3 shows the number of HCC students who have enrolled in and successfully graduated from its Manufacturing Engineering Technology and Petroleum Engineering Technology programs with AAS degrees or certificates over the past five years. It is notable that the student success rate is 100 percent; 189 students enrolled, and 189 completed their coursework and earned a degree or certificate.

To further contribute to *Goal 2*, HCC has advisors and recruiters who go to high schools to discuss opportunities available to students who enroll at HCC. In addition, HCC has a full-time specialized workforce recruiter who implements a comprehensive recruitment plan that includes maintaining a strong presence in targeted schools and communities, collaborating with targeted middle and high schools, community-based organizations, and college program areas. Recruiting emphasis is placed on non-traditional students for various workforce programs.

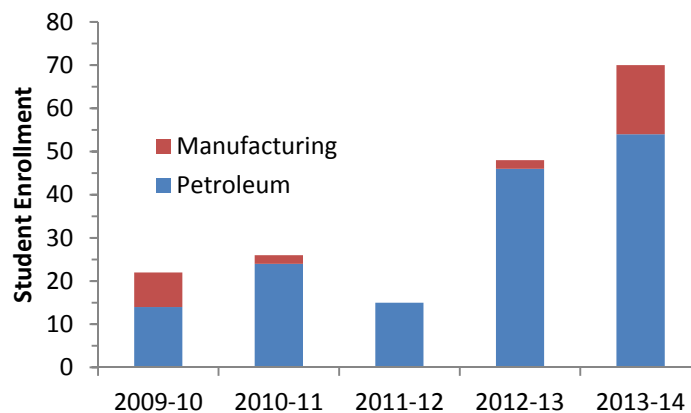


Figure 3: Degree and Certificate Completion Data 2009-2014 (As of September 29, 2014)

Regarding placement of program graduates, in addition to traditional approaches such as career fairs, HCC workforce programs have close relationships with employers--who serve on advisory boards and make presentations to students on job opportunities, salary and benefit expectations, and other job-related

information--who send information on open positions and who ask for entry-level workers. All of the workforce programs also require that students complete a co-op or an internship prior to graduation. In many cases, the students are hired by the employer hosting the co-op or internship student. According to the latest THECB data, the current placement rates for the Petroleum Engineering program is 92.31% and 85.71% for the Manufacturing program.

### ***Two Year Participants Advising and Placement***

To help students identify and reach their goals and advance Objective 2a, HCC provides a comprehensive student advising portal on its website called *Three Steps to Plan Your Future*. The three steps include: 1) Career Exploration: this allows students to evaluate career outlook information as well as reviewing the educational requirements for specific fields; 2) Select a Program: this shows the various programs on offer at HCC and includes a college and career planner; 3) Develop an Academic Plan: after a program is selected, an Academic Planner tool allows students to organize their courses by semester. The tool also includes the "Transfer Room" where students can review transfer guides and joint admissions programs. This is where information regarding the TAMU Engineering Academy (see below) would be found. As useful and instructive as these portals are, students still need to meet with college advisors. On the same page, additional links are available to inform students about working with a college advisor. Examples include: how to meet with an academic advisor, ways in which academic advisors can help students, how struggling students are benefitted, and degree planning worksheets.

### ***Four Year Matriculation and Advising***

A review of community colleges' role in the evolving STEM education landscape was discussed in a recent report by the National Research Council and National Academy of Engineering<sup>13</sup>. This summary of a summit, provided a guideline on how to develop a supportive STEM transfer ecosystem as well as how to expand minority participation in undergraduate STEM education. As identified by the report, current articulation and alignment agreements are ineffective in broadening the STEM transfer pathway; however, the TAMU Engineering Academy was developed as a co-enrollment program in partnership with two-year institutions and provides a guaranteed admission to TAMU upon successful completion of the two-year program. It will incorporate a curriculum alignment from the certificate program which can lead to participation in the TAMU Engineering Academy to be developed at Houston Community College. This unique opportunity will provide students a direct pathway to achieve an engineering degree (4-year) in either Manufacturing and Mechanical Engineering Technology (MMET) or Industrial Distribution (ID) and contribute to *Objective 2d*. The TAMU Engineering Academy was based on ten years of programmatic experience obtained from a transfer enrollment program and will be accepting its' third cohort of students in Fall 2015. In addition, TAMU Engineering Academy program requires all participants to apply for reverse transfer upon eligibility, thereby ensuring HCC confers an increased number of Associate degrees from students participating in this program.

### **Conclusions**

This paper presented a project framework for the development of an adaptive learning environment to provide a wide range of students with the skills necessary to work in high value manufacturing (HVM) aimed at the energy industry. The novelty of the certificate program included innovative pedagogical methods, such as competency-based learning and skills need assessment and provision through online learning modules is presented which would students an adaptive and personalized education in this needed area. Upon completion of the certificate program, the community college students would have multiple pathways including: a) an A.S. at the Community College; b) transfer to four year institute; and c) return to industry to join the workforce. The paper also presented a new method for trying to ensure that community college students who matriculate to partner 4-year institutions receive reverse

transfer credit for their associate degrees at their home community college. Lastly, we presented a plan for HVM modules for high school students that are aligned with the Next Generation Science Standards.

The broader impacts of this effort are significant. Texas ranks first in the nation with respect to manufacturing exports and manufacturing capital investment, many of these HVM activities are in oil and gas. Many community colleges in Texas are open-access institutions with large percentage of under-represented minorities and significant number of students receiving Pell grants. Particularly in the proposed Houston Community College, the under-represented minorities account for nearly two-thirds of the student population in the science, technology, engineering, and math (STEM) programs. Offering the HVM certificate program at this community college allows a diverse group of students a pathway to these high demand STEM careers.

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