The Community-Engaged College: Grand Valley State University's Industry and Community Partnership Model

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The Grand Valley State University (GVSU) Seymour & Esther Padnos College of Engineering & Computing (PCEC) deeply values industry and community partnerships. Our academic programs were developed at the request of, and in collaboration with, industry stakeholders in order to bolster the professional workforce in West Michigan. We are rooted in the local community, working together on innovative methods for student engagement, talent development, and problem-solving. To ensure success, five key avenues through which PCEC engages with community partners were identified: 1) K-12 Pipeline Development, 2) Experiential Education, 3) Applied Research & Development, 4) Talent Recruitment, and 5) Continuous Learning.

BACKGROUND

This paper explores the Grand Valley State University (GVSU) Seymour & Esther Padnos College of Engineering & Computing's (PCEC) commitment to developing and sustaining industry and K-12 partnerships. Our engineering, computing, and occupational safety & health programs were developed at the request of, and in collaboration with, industry stakeholders in order to bolster the professional workforce in West Michigan. Since conception, our programs have grown strategically in response to the changing needs of local employers. Recently, the addition of a new Innovation & Design Center with dedicated space for K-12 outreach, industry project work, and applied research and development has inspired us to think creatively about the ways in which we are engaging with industry and the community.

As industry needs and student populations continue to shift over time, GVSU is committed to meeting changes in demand. To ensure success, five key avenues through which PCEC engages with community partners were identified and a comprehensive communication strategy highlighting opportunities for engagement and support was developed. The five key avenues are: 1) K-12 Pipeline Development, 2) Experiential Education, 3) Applied Research & Development, 4) Talent Recruitment, and 5) Continuous Learning.

K-12 PIPELINE DEVELOPMENT

Creation of a strong talent pipeline that will prepare today's young people for the science, technology, engineering, and mathematics (STEM) careers of the future is a challenge in West Michigan, as it is throughout the country (Sitole, et al, 2017; Xue & Larson, 2015; Rising Above the Gathering Storm, 2007). PCEC is rising to that challenge by fostering K-12 students' interest in engineering, computing, occupational safety & health, and technology careers. Our faculty, staff, students, alumni, and volunteers connect with approximately 13,000 K-12 students annually. We are deeply rooted in the local community, working together with K-12 schools and community partners on innovative methods for student engagement, talent development, and problem solving.

Dedicated PCEC outreach staff manage our K-12 efforts by building strong connections with teachers and industry partners. We have found that we build the most effective relationships by providing STEM content-heavy programming rather than focusing on sharing information about GVSU, engaging with the same partners continually over sustained periods of time, sharing information and resources, and by being able to meet our partners where they are at. We provide hands-on workshops both on-campus and in the local schools to expand students' confidence and interest in STEM activities. Our college advisors frequently attend career-fair events hosted by local school districts and speak one-on-one with K-12 students about the opportunities, challenges, and benefits of pursuing a career in engineering, computing, or occupational safety & health.

The college students in our academic programs accomplish some truly magnificent projects during the course of their studies. PCEC invites K-12 schools to visit campus and interact with the college students about their projects through showcase events each semester. During these events, the K-12 students have opportunities to try out inventions, learn about career opportunities, ask the college students what it is like to study engineering, computing, and occupational safety and health, and vote for their favorite projects.

The Padnos College of Engineering & Computing also engages with students through our summer camp programming. The Science, Technology, and Engineering Preview Summer (STEPS) Camp has inspired 1,483 middle-school students to pursue careers in STEM since its inception in 2002. Week-long activities focused on aviation and culminating in the flight of camper-created remote-control airplanes give students real-world opportunities to explore STEM careers in an environment where it is safe to experiment and fail. University and industry volunteers commit hundreds of hours each summer to encouraging the campers and assisting in airplane construction. Recently, a partnership with Battle Creek Public Schools funded by the W.K. Kellogg Foundation has allowed us to reach even more K-12 students from populations underrepresented in STEM. PCEC is constantly considering opportunities to expand our summer camp offerings and provide new experiences for K-12 students to explore STEM careers and interact with the latest technologies. In 2019, PCEC debuted a faculty-led cybersecurity bootcamp for high-school students in which they learned about cybersecurity fundamentals, DNS pharming attacks, and buffer overflow attacks to get a feel for different attacks and countermeasures.

Since the late 1990s, PCEC has been heavily involved in FIRST Robotics, supporting local teams by providing a practice field and build sites, hosting workshops, kick-off events, and the District FIRST Robotics Competition, connecting with students at the nearest FIRST World Competition, and providing scholarship opportunities to students engaged in FIRST. This partnership has exposed many K-12 students to university faculty and campus, allowing them to see first-hand the unique resources and opportunities available to college students who study at GVSU.

Many natural synergies exist between the K-12 outreach efforts of PCEC and those of other units embedded within the university. Whenever possible, PCEC looks to combine forces with faculty and staff from other units to provide high-quality interdisciplinary STEM opportunities to the community. For example, the GVSU-based Regional Math and Science Center leads a state-wide initiative to engage businesses, K-12 schools, universities, and community organizations in identifying ways to develop equitable, meaningful, and sustainable partnerships that provide opportunities for all K-12 students to solve authentic, real-world problems. PCEC personnel have contributed to the collective brainstorming process and are actively seeking ways to incorporate findings into our own K-12 outreach work.

Additionally, PCEC seeks out opportunities in the community to support youth engagement with STEM. Engineering faculty frequently provide expertise through workshops and panel participation at events for K-12 students hosted by local school districts. Through partnership with the Grand Rapids Public Museum we are able to assist with large-scale community events that are open to the public.

When planning for the recent addition of the new Innovation & Design Center, PCEC intentionally dedicated space to K-12 programming, considering logistical needs for meeting spaces, classroom-like environments, presentation capabilities, and large project areas. In addition to our programming, this space is offered free-of-charge to external organizations with similar missions of growing the STEM workforce.

It has taken approximately thirty years to build the K-12 and Community Outreach model we have today. During the late 1980s and early 1990s GVSU's K-12 STEM outreach was led by the Regional Math and Science Center. So, PCEC partnered with them on events such as Science Olympiad and Super Science Saturdays which engaged K-12 students in hands-on STEM activities. A grant from the Society of Manufacturing Engineers propelled us into the summer programing realm in the mid-1990s with a camp that introduced students of color in Grand Rapids Public Schools to manufacturing engineering. This work eventually led to the creation of our current STEPS Camp.

Even as our outreach programs have expanded and grown, PCEC has faced a variety of obstacles to supporting that growth. Until very recently, all of the financial support for outreach activities came from external sponsors through grants and gifts. Now, some of our part-time Outreach Coordinator's time is supported through University base funding. Obtaining external funding remains an ongoing effort for the vast majority of our outreach work. Since many sponsored-funded programs last for limited periods of time, a significant amount of effort is required to continually search and secure funding.

Another challenge faced in providing K-12 programming was limited physical space. Until the recent addition of the Innovation & Design Center, we did not have dedicated space for outreach activities. With academic courses for our college-level engineering and computing students running during the entire calendar year, scheduling locations for K-12 outreach events that did not conflict with University course offerings was a struggle.

The third internal challenge to expanding K-12 outreach for PCEC has been gaining sufficient faculty buy-in and engagement in the work. The primary factor behind faculty reluctance to get involved is high workload and limited additional time capacity. Our faculty teach in 12-month programs, which leaves little time for them to engage in activities outside of their university teaching loads. In addition, there is some hesitancy on the part of some faculty to engage with K-12 students as this is not the population they are accustomed to, and most comfortable working with.

Once the internal factors aligned to support K-12 outreach activities, we discovered that there were a variety of external factors that also impacted the success of our programming. Challenges included getting the right level of participation from the target audience, management of industry and community partnerships, and shifting government policies impacting programming requirements.

First of all, there are several logistical components to getting people to participate. Getting the word out to local schools and K-12 students' parents and guardians is challenging in that it requires developing and sustaining connections with teachers and professionals at a number of schools across a variety of school districts. For many potential participants, physical transportation to camps was an issue. This was particularly problematic for low-income and minority students. We learned that in order to reach our target populations, it was necessary to provide busing, otherwise they may be prohibited from participating. In order to ensure that summer camp programming was accessible to students from a variety of economic backgrounds, we initially offered the camps at no cost to participants. Over time we learned that rates of participation were highest when participants had some financial commitment to the program. Therefore, we implemented a modest registration fee for participants and began to offer scholarships based on financial need.

The success of our K-12 outreach programs is highly dependent upon community partners and volunteers (Sheikh & Arvaniti, 2014). Community organizations and individuals that dedicate their time and resources to support K-12 outreach help us to reach far more students than we would be able to connect with on our own, and substantially increase the number of young people exposed to experts in STEM

careers. Further, community partners and volunteers become some of the biggest advocates for the programs that they have experienced. When volunteers' own children reach the K-12 grade levels required to participate, we've observed that the level of support for our outreach programs skyrockets.

While a strong base of volunteers is essential in promoting and operating outreach programs, community partnerships can also be difficult to maintain and manage. The most prominent challenge in managing a large volunteer base is establishing common expectations and knowledge to ensure that all members of the team are on the same page regarding program operations. Additionally, community organization values sometimes don't align perfectly with the mission, vision, and purpose of a particular outreach program. In these cases, significant effort is required to maintain positive relationships while ensuring that program integrity is not compromised.

When working with individuals external to GVSU, a host of other legal factors and campus-specific regulations also come into play. For example, background checks may be needed for all individuals external to the organization prior to allowing them to work with K-12 students. To complicate matters, university policies and broader legal requirements are often moving targets. It is essential that outreach personnel are intentional about staying current with any changes.

In our early efforts to build the K-12 talent pipeline, PCEC intentionally developed programming designed to reach groups underrepresented in STEM fields such as minority and female students. Interestingly, despite the push by industry and at the federal level for more STEM professionals in the workforce and research demonstrating the effectiveness of targeted programming in supporting underrepresented students, federal and state regulations have been one of the largest barriers we have faced in providing programming aimed at diversifying the profession. Due to Michigan's Proposal 2 we are unable to provide programming that focuses on students of a particular gender or ethnicity, and federal Title IX requirements have limited our ability provide programming that focuses on reaching students of a single gender (Michigan Constitution art. I, § 26; Education Amendments Act of 1972, 20 U.S.C. §§1681 – 1688). Both of these changes in the political and legal environment have forced us to modify our programs and think creatively about ways to reach underrepresented students without actually limiting program enrollment to specific populations.

As we look toward the future of our K-12 outreach initiatives there are both opportunities for growth and new challenges. PCEC hopes to continue expanding outreach activities and would like to offer more programming and summer camp opportunities than we do today. Implementation of the new Next Generation Science Standards in K-12 schools across the state provides a great opportunity for us to engage with schools as engineering content is now required at all grade levels (Next Generation Science Standards).

At the same time, the K-12 population in the United States is shrinking. It is imperative that we continue to connect with students and grow the number of STEM professionals, just as the pool of students to draw from is getting steadily smaller. The growing wealth gap in the United States adds a layer of complexity in reaching low-income and underrepresented populations. Often the schools with the most funding and resources are the first to reach out to us to establish partnerships and the easiest to work with. PCEC is intentional about ensuring the resources and support are available for students in less wealthy school districts to participate in our programming so that we do not unintentionally contribute to the widening disparities between those who have access to high-quality educational opportunities and those who do not.

Universities are also challenged by increasingly negative public perceptions (Kim, Carvalho, & Cooksey). Federal and state funding for higher education has declined significantly and, with student loan debt rising to record levels, the public is questioning the value of a college education (Pew Trust, 2019; Freidman, 2020). Compounding this issue is a growing negative public perception of social support programs such as those that would provide funding to improve access to educational opportunities to students from underrepresented populations (Advancing Diversity and Inclusion in Higher Education, 2016; Weddle-West & Fleming; McAfee & Ferguson, 2006).

PCEC has learned from experience that real K-12 impact comes from a continuum of experiences from elementary school through high school and that it takes continued positive exposure to STEM in order for outreach efforts to have an impact on students' college trajectory. Given recent and anticipated demographic

and political shifts, we know that we are going to have to work ever harder to build the STEM talent pool for tomorrow (Green, 2018; Grawe, 2018).

EXPERIENTIAL EDUCATION

The Padnos College of Engineering & Computing heavily engrains experiential education into each of our academic programs. The curriculum is designed to engage students in high-impact hands-on learning in which they apply theory to solve problems and then prototype and test their solutions through actual product development. State-of-the-art facilities provide both undergraduate and graduate students with access to a wide variety of tools such as machine tools, 3D printers, and advanced instrumentation. For example, sophomore electrical engineering students use a cleanroom for fabricating solar cells from scratch. Students have key-card access to buildings twenty-four hours per day to facilitate project work on their own schedules. This flexibility in access to facilities is appreciated and important to both traditional and nontraditional students.

More than two-thirds of PCEC courses have lab components. Throughout their coursework, engineering, computing, and occupational safety & health students are involved in industry-sponsored projects that provide tangible experience solving real problems. There are ample opportunities for students to engage with faculty on applied research and development (R&D) and many students work alongside faculty in labs or R&D facilities in addition to their regular coursework. In every program, this leads to a culminating capstone project.

Each year, engineering students complete approximately 30 senior capstone projects for a variety of businesses. In any given semester, over 150 engineering students are out in the work-place on one of their three co-op rotations. Internships in other disciplines drives the number of students to over 300. Without our industry partners, we would be unable to provide authentic projects for students or ensure that they graduate with real-world employment experience.

The computing programs utilize two models for externally-driven capstone projects for a similar number of students. Students in computer science, cybersecurity, and information technology programs each complete industry-driven and -funded projects similar to those described above for engineering. In the information systems (IS) program, projects are intentionally solicited from and completed for non-for-profit organizations. These organizations have tremendous mission and content insight, but tend to be lacking in technical support and infrastructure. The projects completed by IS students are regularly cited as major upgrades for these organizations.

Most importantly, PCEC students complete mandatory co-op (engineering) or internship (computing and occupational safety & health) placements as a requirement for graduation. This unique experiential learning model distinguishes the program at GVSU from most other programs, as there are fewer than a dozen mandatory co-op and internship programs in the nation, and only a small number more internationally. In 2012, GVSU was selected as one of 29 "Exemplars of Real-World Engineering Education" by the National Academy of Engineering and, in 2014 and 2015, the School of Computing & Information Systems was named #1 in U.S. undergraduate computing programs by College Factual.

The mandatory co-op and internship model works well at GVSU because of the large and diverse cadre of employers in West Michigan. Numerous, strong industry partnerships are essential in order to provide this high-quality experiential learning to our students. One of the major challenges in getting a mandatory co-op program up and running was building our employer network and helping them to understand the benefits of the co-op model. Since PCEC's co-op model is rare among universities, many companies had no experience working with students outside of a more traditional internship experience. PCEC employees worked hard to help industry partners understand how the program would align with their work and be beneficial for their organizations. Significant time is also spent with each employer building a shared understanding of the features of a strong experiential learning program. Both employers and students need a preparation program in order to set expectations and clarify program requirements. Interestingly, it seems that the companies and students who need the preparation the most are often the most difficult to help appreciate this training.

The benefit of experiential education to our industry partners is that they have several relatively inexpensive and lower-risk opportunities to use student expertise and labor to solve company problems. Industry partners also love that our graduates enter the workforce not only knowledgeable, but also skilled, with hundreds of hours of real-world industry work experience. When companies provide students with a co-op, internship, or project experience, it also exposes students to the company and aids in their employee recruitment efforts.

This intense commitment to experiential education impacted how PCEC developed academic programs and curriculum over time. A typical engineering curriculum follows a pattern with students completing general education and foundational requirements in their first two years before really digging into engineering-specific coursework in the final years before graduation. This model would not work well for our mandatory co-op program as students need some engineering knowledge and skills before entering the workforce. As a result, the engineering curriculum was designed so that engineering-specific courses were pushed earlier into the students' academic careers and general education courses were spread out more evenly over the course of the program. Recognizing that engineering professionals need to be able to write project proposals, proposal development and technical writing was integrated into the second cooperative education semester and well in advance of the senior design project (How Good Writing Skills Can Benefit Your Engineering Career, 2019; Boyd & Hassett, 2013).

As enrollment in engineering and computing programs grew, managing the volume of co-op and internship placements and industry projects became more challenging. Fortunately, thanks to the generosity of one of our founding community partners, we were able to create an endowed chair in cooperative education. In addition, faculty were hired to manage and oversee the logistical components of the industry placements and to mentor students working on industry projects. This has been incredibly beneficial, despite the increased cost of building experiential education into faculty workload, as it has helped us to strengthen our industry partnerships and ensure that students are gaining valuable work experience. This also fosters insightful curricular growth and innovations.

PCEC developed a strong partnership with the GVSU Career Center in order to provide job search and interview skills coaching and support for the large number of students seeking co-op and internship placements. The first discipline-specific academic course entirely devoted to professionalism and preparing students for the co-op or internship experiences was added to the engineering curriculum nearly three decades ago and was subsequently added to all other PCEC programs more recently.

An ongoing challenge in providing experiential education is determining how best to sustain a large number of industry partnerships over time. It's important for PCEC to maintain connections with a broad base of employers in a variety of industries so that there will be an adequate number of placements for students required to complete co-op and internships even as industries experience cyclical changes in the economy. Individuals we work with on senior projects and co-op placements frequently accept new positions with other companies, sometimes creating a gap in the organizational relationship. Constant effort is required to keep track of the movement of our industry partners and establish new key connections within organizations as positions change. In the future, we hope to implement a more refined Customer Relationship Management system to help manage this relationship data.

Recently, some new challenges in managing experiential education have begun to emerge as a result of a rapidly changing political and social landscape. Student expectations for the program and career aspirations have changed over time (Delaney et al, 1999; Yanik et al, 2016). We have given considerable thought to how best to help students with disabilities disclose that information to employers and the timing of those conversations. Another emerging challenge involves communication that arises between the university and employers when working with students who have informally, but not legally, changed their names and gender identities. Similarly, recent legalization of marijuana and societal norms for recreational use are in conflict with employer policies on drug use and can impact the employment opportunities of our students (Nagele, 2018; Gies & Grant, 2015). Being able to adapt rapidly to issues such as these will be essential in ensuring that our experiential education model succeeds into the future.

APPLIED RESEARCH & DEVELOPMENT

The Padnos College of Engineering & Computing supports industry-oriented applied research and development (R&D) through partnerships with faculty experts and students in our state-of-the-art facilities. We have five R&D centers providing a variety of services to industry ranging from application development, to incubator space, to rapid prototyping, and more. The centers provide faculty with professional engagement and growth opportunities not typical at a teaching-oriented institution while providing invaluable real-world problem-solving experience to the undergraduate and graduate students they employ.

The first R&D Center established, the Design, Optimization, Evaluation, and Redesign (DOER) Center, was founded in 2006 to foster engagement in the community and benefit local industry by matching industry partners with a team of engineering faculty and students who apply their knowledge to solve industrial problems. This model has proven mutually beneficial for the parties involved. Industry clients receive high-quality service at minimal cost and retain all of the intellectual property affiliated with the projects. Student researchers gain experience in applied research and product development. Faculty have the opportunity to work on high-impact projects and to engage with industry. The DOER Center currently supports approximately two to three projects per year in the areas of design consultation, process control, experimental design, failure mode effect analysis, short-courses for industry partners, and proposal preparation and review. These projects are conducted on a fee-for-service basis utilizing and employing faculty and students.

The DOER Center's charter addresses smaller-scope projects within a single engineering or science discipline. The clients often are looking for a solution to a technical question and/or a prototype quickly. Lessons-learned and challenges with the DOER Center's projects tend to be matching industry pace with academic pace and building a skill specific faculty-student team rapidly. Finally, these smaller-scope projects tend to have a small- to modest-budget. However, that requires that vetting projects also needs to be expeditious, else a great deal of time is spent in determining that the industry client is not a good fit for DOER.

PCEC's other R&D centers began to grow organically based on faculty areas of interest around the same time. The Applied Computing Institute (ACI) provides industry partners with support in computer sciences and related disciplines. Similar to DOER, the ACI connects expert faculty and current students with industry partners to solve problems. Depending on the scope and duration of the project, industry partners can choose to sponsor a semester-long senior project or to work with ACI on more long-term projects. Whereas senior projects must involve implementation of a functional software system, projects that are handled by ACI can involve applied research, advanced development, and rapid prototyping. Faculty involved in ACI projects are assigned based on their areas of expertise and experience. Graduate assistants and undergraduate students are assigned to projects based on their skills, interests, and aspirations. Senior projects are billed at a flat fee, whereas ACI project costs are determined based on the complexity and scope of the project. ACI currently supports approximately 20-25 senior projects and 2-3 lab projects per year in areas such as application development, cybersecurity, data science, health informatics, and high-performance computing.

Increasing enrollment in high-demand computing programs is a priority for GVSU. As such, ACI was selected as the first entity to receive support from the GVSU Innovation Fund, expanding the institute's experiential learning opportunities. This will allow ACI to recruit and hire up to 10 graduate assistants and five undergraduate students to work on industry collaborations, creating a talent epicenter which will attract entrepreneurs and employers to GVSU and provide a myriad of opportunities for selected students.

Lessons-learned and challenges with ACI's projects tend to be attracting a sufficient number of projects with an appropriate scope for a semester or an academic year, respectively. With the growing number of entering students, every year for the past seven years, attracting and vetting the projects requires dedicated staff and faculty. A complement to this challenge is building right-sized, multi-disciplinary teams that are matched with appropriate faculty mentors. Finally, as the number of student teams grows, so does the need for project space for ACI. A dedicated space for the ACI is currently under construction in the new DeVos

Center for Interprofessional Health, scheduled to open in May 2021. This facility will also be able to benefit from an adjacent expansion of the GVSU high performance computing facilities that are a collaboration between PCEC and the GVSU Center for Scholarship and Creative Excellence.

West Michigan is well-known for its excellence in health care and a prevalence of health-related industries. The third R&D Center, the applied Medical Device Institute (aMDI) fills an important need in the medical device community by providing access to researchers, expert faculty, and medical professionals as well as technical services, intellectual property support, business review, and mentoring. Services include physical and analytical model development, rapid prototyping and fabricating systems, technical feasibility testing, and incubator space. aMDI contracts with both small and large companies to provide responsive models for early concept development and proof-of-concept delivery when commercially and technically viable. It is unique among our R&D centers in that it operates exclusively on a self-sustaining fee-for-service model. The size of these programs ranges from $80,000 4-month projects to $1.3M multi-year, public-private-partnerships. An example of the latter is the addition of a state-of-the-art medical materials-based 3D Additive Manufacturing (AM) capability for applied research and development, small-batch production services, and supporting the regional entrepreneurial eco-system.

aMDI's strategy is to build upon their recognition and leadership in the emerging 3D AM industry, which attracts, develops, and retains talent. Currently, aMDI enjoys a unique position of having the highest performance 3D AM – Polymer system, the only university in the U.S., at the time of this writing, with a focus on medical device development and production. Because of aMDI's capabilities, the learnings from the Carbon3D system, and on-going research, an aMDI engineer and project manager has been named to the international standards committee (American Society of Test Methods) ASTM – 3D Additive Manufacturing.

Lessons-learned through the aMDI's projects are similar in many ways to those above, yet at a larger scale. First, it essential to add industry engineers and leadership to the Padnos College of Engineering and Computing's staff. These non-faculty professionals have 15 to 25 years of industrial experience required to meet the longer-term needs and the multi-disciplinary nature of the projects. Similarly, it is essential to keep continuity in the graduate and undergraduates that are selected for these programs. Thus, building the right faculty/staff/student team is time consuming. Finally, the nature of engineering/science development as a service results in projects that can be out-of-sync with an academic calendar. Therefore, tight coordination with the academic administrative offices is essential for aMDI.

The fourth R&D center, the DTE Electromagnetic Compatibility (EMC) Center is the only university-based facility in the world to provide electromagnetic compatibility product development and pre-compliance testing for industry. Housed in the Innovation & Design Center, the EMC Center is a 6,000 square-foot facility providing seven test chambers for electrostatic discharge as well as radiated and conducted emissions and immunity testing. Electromagnetic compatibility certificate courses for industry as well as undergraduate and graduate courses are provided. The EMC Center employs graduate and undergraduate students through a unique industry collaboration with an onsite electromagnetic compatibility pre-compliance testing company. Tests performed have supported a variety of projects in the medical, automotive, consumer, industrial, and office furniture industries.

Lessons-learned with the EMC Center's projects also are similar in many ways to those above, yet are unique with the testing equipment and pre-compliance testing that is provided. First, the pre-compliance testing requires employment of industry engineers and leadership with 15 to 25 years of industrial experience in addition to the PCEC's faculty and staff. This expertise is well beyond the technician level, requiring mastery from years of experience in theory and regulatory standards. The comprehensive type of electromagnetic testing that is offered requires a commitment in space, calibration, and client-required virtual and physical firewalls to maintain confidentiality. The EMC Center, as all of the others, provides a unique learning experience for our students and opportunities for scholarly works for our faculty.

The fifth R&D center, the Power Mobility Lab (PML), has grown through a collaborative focus by faculty from both PCEC and the GVSU College of Health Professions. These faculty share a passion to provide solutions to the under-served physically challenged children demographic; specifically, those that are wheel-chair bound. With a faculty member from engineering and a second from occupational therapy,

the PML has garnered national attention and recognition in developing and clinically testing mobility solutions for children. This multi-year effort was achieved by pursuing internal funding and grants, as well as external funding. The challenge as a teaching institution is that internal funding for development projects is limited. The challenge with the external funding, beyond the highly-competitive nature of federal grants, is that the number of mobility limited children are few in comparison to the overall population and thus the number of available grants and funding amounts are also few and small, respectively. Finally, the Power Mobility Lab has learned to develop test environments, recruit candidates, and adapt to the availability of the children and their care-givers. While this center is the most challenged in developing funding, the personal level impact of the projects is often profound and those involved with the children are the most appreciative.

One lesson that PCEC has learned in establishing applied research and development centers is that having a passionate, energetic faculty member with experience in industry relations leading the charge is critical to the center's success. Center leaders need to be skilled at soliciting industry projects, managing multiple projects simultaneously, and recruiting additional faculty to join in the work. Engaging faculty in R&D projects is challenging at GVSU due to the primary focus on teaching and heavy course loads of most instructors. Faculty may also be hesitant to join a project if they do not feel that it aligns well with their area of expertise. While having charismatic leaders with both depth and breadth of knowledge is essential in getting a R&D center up and running, it does make succession planning difficult as it is hard to find the same level of enthusiasm and expertise in a new candidate.

The other challenge to establishing and growing R&D centers is finding adequate space in which to house them. Planning for space is complicated by the need to anticipate future growth of the centers. PCEC has tried to use existing facilities when getting the centers up and running, but R&D operations that require significant equipment or specialized technology quickly outgrow the space available. In the case of the EMC Center, we have funded the additional space by collaborating with a private company for shared use. The revenue from the collaboration is then used to fund a visiting faculty member.

TALENT RECRUITMENT

As mentioned previously, the Padnos College of Engineering & Computing was founded in partnership with industry in order to prepare a vibrant, professional STEM workforce that would meet the needs of employers in West Michigan. Local companies frequently approach PCEC regarding the shortage of highly qualified professionals to take on roles in STEM in their industry. The unique emphasis on experiential education within our programs provides an opportunity for employers to recruit talented up-and-coming professionals. Companies that provide projects, co-op, or internship experiences get to work with students prior to graduation. This employment period can serve as a sort of "trial run" of a candidate, allowing the company to determine whether the student is a good organizational fit prior to making an employment offer upon graduation.

The experiential education model also helps companies to build brand awareness among soon-to-be-graduates. The more student employees and projects a company chooses to support, the more awareness the student population at-large will have of that company. Students share their industry experiences with one another and this word-of-mouth approach can do wonders in forming students' perceptions of various employers. In addition, industry partners are offered opportunities to engage with students prior to their co-op or internship experiences by participating in industry information sessions or mock interviews on campus. These venues are great ways for companies to reach multiple students at once and share detailed information on the work they perform as well as company culture and hiring needs.

Beyond direct employer recruitment of students, PCEC also contributes heavily to building the pool of STEM professionals in West Michigan. Whether or not students ultimately choose to attend GVSU, our K-12 outreach initiatives help to attract more students to STEM fields and builds a strong talent pipeline for the community. Faculty who come to GVSU to teach in the Padnos College bring their highly specialized talents and expertise. Through our R&D centers and experiential learning model, this expertise becomes available to area industry, helping to solve the community's most difficult engineering and computing

problems. Further, since students become well-connected with area employers through the mandatory co-op and internship program, approximately 70% of them stay in the region due to employment offers upon graduation. This is a significant influx of talented STEM professionals, as only 30 to 40% of our students come from West Michigan originally.

One major challenge in talent recruitment is that it is a relationship business. Significant time and effort are devoted to establishing and maintaining relationships with area employers, schools, and community organizations. Ongoing communication is needed in order to ensure shared expectations, and PCEC is constantly working to adapt programs to meet changes in industry demand.

Traditional classroom lecture-style teaching is straightforward compared to the experiential education and external project-based learning models. Adding partners to projects adds layers of regulation, oversight, and complexity to every project. In order to ensure that high-quality projects are provided to students and returned to industry partners, faculty must be adept at managing corporate agreements as well as at teaching. Faculty need to have a supportive work environment and adequate resources in order to be successful in this specialized work. This aspect includes recognition of this type of work in our promotion and tenure criteria and processes.

There are many opportunities for PCEC to expand talent recruitment efforts in the future. In fact, there are so many needs and great ideas about how to address those needs within the community, that we can't participate in all of them. Recognizing that we have limited resources and strategically determining which opportunities to engage with will remain one of our largest challenges. We rely heavily on alignment with our mission and vision to ensure that any new efforts undertaken are sustainable.

CONTINUOUS LEARNING

Grand Valley State University is intentionally modifying and expanding course offerings in order to be more accommodating of adult learners, professional skillset development, and the need for upskilling that occurs throughout employees' careers. PCEC is working to reinvent the college education with the adult learner in mind by including more online and hybrid course offerings as well as more in-person classes in the evenings and on weekends in order to accommodate the full-time work schedule of nontraditional undergraduate students. Recognizing that some learners do not need an entire degree, we have created badges consisting of individual targeted courses up to multiple 3-credit courses which students can complete in order to improve their credentials. PCEC is working to modularize learning by breaking larger courses into smaller, more manageable chunks of content. For example, a 3-credit course that covers three topics can be broken down into three separate 1-credit courses, each covering one of the three topics. This is beneficial for students who are already skilled in one of the topics but not the others, as well as for students who may need to repeat some, but not all, of the content from a course. PCEC is also examining adjusting the experiential learning requirement to be more manageable for non-traditional students or students who are already working full-time.

One of the biggest challenges in redesigning STEM curriculum to meet the needs of nontraditional learners is that knowledge is built cumulatively throughout a program. There is less opportunity for concurrent learning as students need a strong understanding of Calculus 1 before they move on to Calculus 2, for example. Naturally, this results in a more rigid course and pre-requisite structure for engineering and computing students.

There are many professionals in the workforce who are seeking opportunities to reskill and enter new careers (MacKinnon et al, 2017; Gomes et al, 2014). The STEM fields are particularly popular given their project growth and high employment rates. PCEC is actively identifying "on-ramps" for learners who are interested in a master's degree in computing but do not have an undergraduate degree in computing or the necessary background to jump right into a master's program. This will allow the students to take a few conveniently-timed courses to obtain the prerequisite knowledge needed for success in the program.

Technology is changing rapidly, resulting in many employers discovering a need to help their current workforce build competencies in new software, tools, and devices (Chakrabort, 2019; Illanes et al, 2018). Traditionally, GVSU has served the needs for highly-specialized talent in the community through offering

master's degrees. While PCEC remains committed to providing well-prepared masters-level professionals in computing, engineering, and the professional sciences, we have also heard from our industry partners that there is a need for more short-term, skill-specific training in the STEM workforce.

Rising to meet this need for continuous learning in the professional community is a new challenge and unique opportunity for PCEC. Our new Innovation & Design Center (IDC) was designed with industry-university collaboration in mind, recognizing the need for professional development and an expanded definition of adult education. One of our first forays into the professional development realm is a partnership with a software and additive manufacturing support and training provider. Fisher-Unitech co-locates in the IDC, which provides a convenient location for collaboration with faculty and students. Fisher-Unitech uses classroom space to provide fee-based courses to individuals seeking training in SolidWorks. When seats are available, they also offer participation in these courses to GVSU students free-of-charge. In addition, equipment purchased by Fisher-Unitech is available for use by students.

PCEC also supports a number of professional societies by providing meeting space, content, and expertise as needed. The applied Medical Device Institute provides a brownbag lunch series open to area professionals from a variety of industries to come and learn at no cost.

Fitting professional development activities and courses with unique schedules around traditional course offerings can be challenging due to space constraints. Thankfully, the new Innovation & Design Center has alleviated many of these concerns with additional classroom and project space. Moving courses into a hybrid or online format requires strong digital learning infrastructure and training for faculty in how to teach effectively online. Engaging and retaining students is more difficult to do successfully remotely and requires targeted effort in order to be done well (Dewstow, McSporran, & Young, 2000; Lederman, 2020; McMurtrie, 2020). While GVSU currently provides online learning platforms, technology is constantly changing, and students' expectations are high. GVSU is working to strengthen its digital learning infrastructure so that it is more intuitive and user-friendly for students.

Going forward, PCEC expects to continue to adapt programming as student demographics and industry needs change. The rate of changing technology and demographics makes it difficult to predict now what skills and expertise will be needed in the future (Zao-Sanders & Palmer, 2019). Universities must be ready to respond quickly to changes in market demand. PCEC has always intentionally provided broad-based programming so that graduates are employable in multiple sectors. Many current adult students are seeking a specific skill such as training in a particular technology, without necessarily realizing that said technology will be obsolete in the near future. We continue to build programs that provide long-term knowledge base and skillsets that will help professionals adapt as changes to technology occur. However, it can be difficult to convince an adult learner that the broader knowledge set is truly more useful than the career-specific training.

CONCLUSION

While the GVSU Padnos College of Engineering & Computing remains committed to K-12 outreach, talent recruitment, and experiential learning through industry co-op and internships, we are also aware that employers are seeking opportunities to enhance the skills of their current employees in response to rapid technological advances, and that they value the opportunity to leverage university faculty and student expertise in solving industry problems. Subsequently, PCEC has expanded our industry engagement through the creation of new applied research and development institutes that support companies in product development, pre-certification testing, rapid prototyping, and application development. We are also working to expand our course offerings to be more supportive of adult learners, professional skillset development, and the need for upskilling that occurs throughout employees' careers.

Input and feedback from community and industry partners has been central to the development and expansion of our community engagement efforts. We are optimistic about the future growth and infusion of community engagement initiatives into our courses and pedagogy. Together we can build a stronger program, a more relevant curriculum, a robust talent pipeline, and a workforce better prepared to meet the demands and solve the problems of tomorrow.

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REFERENCES

Advancing Diversity and Inclusion in Higher Education. (2016, November). Office of Planning, Evaluation and Policy Development, Office of the Under Secretary, U. S. Department of Education.

Boyd, G., & Hassett, M.F. (2013, January). Developing Critical Writing Skills in Engineering and Technology Students. *Journal of Engineering Education, 89*(4), 409. Retrieved April 19, 2020, from https://doi.org/10.1002/j.2168-9830.2000.tb00544.x

Chakrabort, R. (2019, June). Successful Execs Foresee Change, Reskill to Be on Top [India business]. *The Times of India.* Retrieved April 19, 2020, from https://timesofindia.indiatimes.com/business/india-business/successful-execs-foresee-change-reskill-to-be-on-top/articleshow/69946861.cms

Delaney, C., Scalise, A., Shuman, L.J., & Wolfe, H. (1999). Engineering Attrition: Student characteristics and Educational Initiatives. *Atlanta: American Society for Engineering Education-ASEE.*

Dewstow, R., McSporran, M., & Young, S. (2000, July). Remote Remedies: Challenges When Teaching On-Line. *15th Annual Proceedings of the NACCQ 2000.* Hamilton.

Education Amendments Act of 1972, 20 U.S.C. §§1681 – 1688. (2018). Retrieved April 19, 2020, from https://www2.ed.gov/about/offices/list/ocr/docs/tix_dis.html

Friedman, Z. (2020, February). *Student Loan Debt Statistics In 2020: A Record $1.6 Trillion.* Retrieved April 19, 2020, from https://www.forbes.com/sites/zackfriedman/2020/02/03/student-loan-debt-statistics/#504bf593281f

Gies, T.P., & Grant, G.D. (2015). Legalization of Marijuana: What it Means for Employer Drug Testing. *Employee Relations Law Journal, 41*(1), 35-46.

Gomes, R., Lopes, J., Vaz, H., Cerdeira, L., Cabrito, B., Peixoto, P., . . .Silva, S. (2014). Mobility of High Skilled Professionals: The Brain Waste and Brain Gain. *International Conference on Education and Social Sciences.* Retrieved April 19, 2020, from https://hdl.handle.net/10216/77966

Grawe, N. (2018, July). *Demographic Changes Pose Challenges for Higher Education.* EconoFact, Education Policy. Retrieved April 19, 2020, from https://econofact.org/demographic-changes-pose-challenges-for-higher-education

Green, E. (2018, April). *With Changing Students and Times, Colleges are Going Back to School.* New York Times Online, New York Times Company. Retrieved April 19, 2020, from https://www.nytimes.com/2018/04/05/education/learning/colleges-adapt-changing-students.html

How Good Writing Skills Can Benefit Your Engineering Career. (2019, January). Engineering Management Institute. Retrieved April 19, 2020, from https://engineeringmanagementinstitute.org/good-writing-skills-engineering-career

Illanes, P., Lund, S., Mourshed, M., Rutherford, S., & Tyreman, M. (2018, January). *Retraining and Reskilling Workers in the Age of Automation.* McKinsey & Company. Retrieved April 19, 2020, from https://www.mckinsey.com/featured-insights/future-of-work/retraining-and-reskilling-workers-in-the-age-of-automation

Kim, S., Carvalho, J.P., & Cooksey, C.E. (2007). Exploring the Effects of Negative Publicity: News Coverage and Public Perceptions of a University. *Public Relations Review, 33*(2), 233–235. doi.org/10.1016/j.pubrev.2007.02.018

Lederman, D. (2020, March). *The Shift to Remote Learning: The Human Element.* Inside Higher Ed. Retrieved April 19, 2020, from https://www.insidehighered.com/digital-learning/article/2020/03/25/how-shift-remote-learning-might-affect-students-instructors-and

MacKinnon, L., Bacon, L., Graven, O.H., & Velvin, J. (2017). Integrating Online Learning into Workplace Information Systems: Supporting the Goal of Lifelong Learning. *Proceedings of the 15th LACCEI International Multi-Conference for Engineering, Education, and Technology: "Global Partnership for Development and Engineering Education.* LACCEI - Latin American and Caribbean Consortium of Engineering Institutions. ISBN 978-0999344309 ISSN 2414-6390

McAfee, L.C., & Ferguson, D.L. (2006). Work in Progress: Status and Experiences of Minority Doctoral Students in Science, Mathematics, Technology, Engineering, and Mathematics Disciplines. *36th ASEE/IEEE Frontiers in Education Conference.* San Diego, CA.

McMurtrie, B. (2020, March). *Preparing for Emergency Online Teaching.* The Chronicle of Higher Education. Retrieved April 19, 2020, from https://www.chronicle.com/article/Preparing-for-Emergency-Online/248230

Michigan Constitution. art. I, § 26. (n.d.). Retrieved April 19, 2020, from http://www.legislature.mi.gov/(S(4lauqgjyjggkt0zrndihrkij))/mileg.aspx?page=GetObject&object name=mcl-Article-I-26

Nagele, L. (2018). *How Do Recreational Marijuana Laws Affect the Workplace?: Eight States Have Legalized Recreational Marijuana Use, and More May Follow in 2018.* HRNews.

Next Generation Science Standards. (n.d.). Retrieved April 29, 2020, from https://www.nextgenscience.org/standards/standards

Pew Trust. (2019, October). *Two Decades of Change in Federal and State Higher Education Funding – Recent Trends across levels of government.* Retrieved April 19, 2020, from https://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2019/10/two-decades-of-change-in-federal-and-state-higher-education-funding

Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. (2007). National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. Washington, DC: The National Academies Press.

Sheikh, S.Q., & Arvaniti, E. (2014, October). STEM Education Outreach through IEEE's Pre-University Programs – Engaging Volunteers to benefit K-12 education and local communities. *2014 IEEE Frontiers in Education Conference (FIE) Proceedings.* Madrid, Spain. IEEE 978-1-4799-3922-0/14.

Sitole, A., Chiyaka, E., McCarthy, P., Mupinga, D., Bucklein, B., & Kibirige, J. (2017). Student Attraction, Persistence and Retention in STEM Programs: Successes and Continuing Challenges. *Higher Education Studies, 7*(1), 46–59.

Weddle-West, K., & Fleming, K. (n.d.). *Chapter 10: Recommendations to Enhance Diversity and Inclusiveness.* Council of Graduate Schools, Extending the Pipeline: Model Programs for Enhancing Diversity and Inclusiveness in Graduate School at the University of Memphis. Retrieved April 19, 2020, from https://cgsnet.org/cgs-occasional-paper-series/memphis-university/part-1

Xue, Y., & Larson, R.C. (2015, May). *STEM Crisis or STEM Surplus? Yes and Yes.* Monthly Labor Review of the U.S. Bureau of Labor Statistics. Retrieved April 19, 2020, from https://www.bls.gov/opub/mlr/2015/article/stem-crisis-or-stem-surplus-yes-and-yes.htm

Yanik, P.M., Yan, Y., Kaul, S., & Ferguson, C.W. (2016). Sources of Anxiety Among Engineering Students: Assessment and Mitigation. *Atlanta: American Society for Engineering Education-ASEE.*

Zao-Sanders, M., & Palmer, K. (2019, September). Why Even New Grads Need to Reskill for the Future. *Harvard Business Review.* Retrieved April 10, 2020, from https://hbr.org/2019/09/why-even-new-grads-need-to-reskill-for-the-future