Colorado Helps Advanced Manufacturing Program

Addressing Industry Needs in the CTE Classroom

Renée Edwards

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RUTGERS
Education and Employment Research Center

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INTRODUCTION

The overall goal the Colorado Helps Advanced Manufacturing Program (CHAMP), a TAACCCT grant-funded project, was to enhance and build programs at nine Colorado colleges[1] to prepare students for careers in advanced manufacturing. To achieve this goal, the CHAMP grant involved the design or redesign advanced manufacturing programs, the purchase of state of the art equipment, and the expansion of hands-on learning. This brief considers the integration of hands-on learning, one of CHAMP's central goals at the consortium colleges. Over the course of three project years (2014-2016), Rutgers' Education and Employment Research Center (EERC), CHAMP's third party evaluators, collected data on hands-on learning as part of its larger TAACCCT evaluation. Data presented here is qualitative in nature, collected from in-person and phone interviews Most interviews were taped and transcribed; non-taped interviews involved extensive note taking. Transcriptions and notes, as well as the documents cited above, were coded using NVivo qualitative data management software and analyzed by EERC team members.

This brief discusses implementation methods and strategies used by CHAMP schools, explores challenges institutions encountered, and discusses the resulting impact of hands-on learning on the institutions. It also briefly discusses next steps and sustainability issues relative to hands-on learning as implemented through the grant.

IMPLEMENTATION METHODS AND STRATEGIES

Several strategies emerged from the project data relative to hands-on learning and the implementation of the CHAMP project: 1) the identification and expression of strong consortium goals early in the project, 2) the alignment of consortium goals with those of individual schools, and 3) the sharing of curriculum across the consortium to save time and resources. Further, the grant used an industry-centric framework involving employers throughout the grant – the industry representatives helping colleges make decisions about equipment purchases, and skills sets to teach. Each of these strategies is considered in detail in the sections that follow.

Strong Consortium Goals

In response to industry input, the CHAMP consortium envisioned a total re-vamping of participating schools' advanced manufacturing programs, including the redesign if not restructure participating colleges' advanced manufacturing programs, to better prepare students to meet the changing needs of industry and to be more responsive to the current job market. A central goal of the program was to increase the amount of exposure students had to

[1] The CHAMP consortium colleges included seven community colleges: Community College of Denver (CCD), Front range Community College (FRCC), Lamar Community College (LCC), Pueblo Community College (PCC), Pikes Peak Community College (PPCC), Red Rocks Community College (RRCC); one technical colleges, Emily Griffin Technical College (EGTC); and one four-year institution, the University of Colorado Denver

industry-specific machinery, enabling students to increase the quality of students' learning experience and achieve competence with each machine. Attention was especially paid to the needs of local employers and incumbent workers. For example, specialized training material was added to some courses, and some classes were offered during evenings and weekends. In addition, some courses were transformed into a "hybrid" format—course material offered online with hands-on learning occurring during scheduled lab times.

Hands-on learning was to be focused primarily on equipment found in the manufacturing shop floor: machining equipment, manual and computer numerical controlled mills and lathes, other metal-working machines, 5-axis milling machines and related software, Swiss screw machines, 3D printers and scanners, virtual welding simulators, coordinate measurement machines, mechatronic (the combination of mechanical and electrical systems) modules and advanced soldering stations.

Institutional Alignment of Consortium Goals

At the start of CHAMP, most of the nine colleges had developed plans for restructuring their programs, but lacked the resources for equipment purchases and space renovation. As such consortium goals matched those identified by the nine individual institutions. Under CHAMP, schools were given latitude to develop their own advanced manufacturing program, and to choose the equipment that best suited the needs of their regional employers. In the end, while there was variation in the choice of purchased machinery, most colleges created similar technology-enabled learning environments that mimicked a manufacturing shop floor. They also expanded hands-on learning activities on the new equipment, developing students' knowledge and skill sets, thereby increasing the marketability of their graduates.

The close alignment of grant and college goals is reflected in an Aims' staff member comment, "We were in the process of developing the program when the grant came along. It would've happened either way, but it was certainly fortuitous." Another staff member at CCD stated "to be able to meet the needs of the community, we needed these pieces of equipment."

Shared Curriculum

CCCS led consortium colleges in a process to develop open-access courses which focused on similar pieces of equipment purchased under the grant. CCCS and college staff and faculty open-access courses to have a number of benefits: increased access to subject matter experts and instructional designers located at different consortium colleges; greater cross–campus faculty collaborations; and the sharing of materials. All which could lead to faster implementation of new CHAMP related courses.

Many instructors in advanced manufacturing had never developed or taught material online. CCCS therefore provided a team of instructional designers to help them develop courses, put them online, and make sure they were open access. Faculty at schools without their own

instructional designer appreciated the assistance of these CCCS-based staff. A number of colleges, however, decided to hire their own in-house instructional designers, e.g., Aims and FRCC. These schools felt that, although time consuming, the process of developing the courses was highly beneficial since the end product was so good. Despite the availability of online curriculum, faculty made less use of it than expected. Further, some college staff felt the exercise of creating open source material was unnecessary and time-consuming.

Industry-Led Equipment Purchasing

Staff at some consortium schools involved industry partners in deciding what equipment to purchase for their institution. Most employers gave input during regularly scheduled advisory board meetings. Some schools had one or two local employers who acted as 'spokespeople' for other employers in the community. Staff at PPCC had such a spokesperson, who told them: "You need to purchase equipment that will work for all the employers here in town." Staff members said,

> He was wise enough to recognize that we needed to train a core or critical mass for all of Colorado Springs so buy generic equipment, buy generic CNC equipment, and buy things that are readily used by all companies.

FRCC also had an employer who served as a voice for other employers. He discussed with EERC what he told college staff:

> We told them what we were using in our shops…what the industry's using for machines that [are] affordable. We [want students to] come out of the program with some experience on machines that folks are going to have in their business[es].

At PCC, staff asked advisory board members to provide input, but also made calls to local employers to solicit their direct input. They also toured the facilities of local employers to "look at their shops, see what kind of equipment they're on [employees are using] and see what kind of tools they're using, that kind of stuff." A staff member commented that this process was "a little less formal, but gave us a good insight as to what kind of equipment we should buy." One employer described the process to EERC as something they enjoyed:

> That was great fun. 'We'd like one of these and one of these and oh, six of those.' Yeah, we had a couple of meetings. Several of us were not so much, I guess, going around shopping in places, but we would go to one facility or the other. …We'd get together and talk about what machines, what brands were ones that they could get for – that were good enough, but not so expensive they couldn't afford them. That kind of thing.

Staff and instructors at several colleges mentioned their reliance on industry representatives at program advisory board meetings. One staff member said:

> They do help out. For instance, [I ask:] 'Do I need to teach this?' and they say 'No, you don't' or 'Yes'. So, they are helpful. They have driven a lot of the purchasing too. 'Do we need to have this?', 'Yes, you have to have this'.

At another school, other staff echoed this by describing a similar process through their advisory meetings:

> We pitched ideas of what we thought would be interesting to teach at advisory meetings. And then as we went through it, industry actually selected all of our equipment. So, we went through, said 'Hey, what do you want to see here?' And then when we got bids in and everything else. [We said] "What do you want? What do you think is the most valuable for us to teach?' And so, there's machines that maybe I thought would be more interesting that ultimately don't have as much as a representation in the market. So, it was important to me to make sure that they had the buy-in and we were picking equipment that was for them. Because ultimately, this is to support them.

A staff member at FRCC also discussed a situation in which staff chose not to heed to advice of employers. These employers advised the college not to purchase 3D printing equipment as they were not yet using them. Staff chose to purchase the equipment anyway, to "stay ahead of the curve'' and to train students on equipment that faculty envisioned would eventually be part of the workplace.

The training of students in the most advanced equipment gave regional employers the option of purchasing newer equipment knowing that they could employ graduating students who would be able to operate them. An instructor at CCD who used to be in the industry discussed what this means for employers:

> It means that our employers now can purchase these machines because they have a place to get people trained to run them. Before I was with the college I was in industry. Someone would come in and say, 'Hey, I have this great machine. It's a $300,000 machine. I've got an extra one on the floor. I'll give it to you for $200,000.' My answer would be 'If you could sell me somebody who can run it, fine. If you can't, it's just a $200,000 boat anchor. I don't need it.'

Most CHAMP schools were forward-thinking, both recognizing the skills needed in the current work place but also anticipating the skills that students would need in the future as new technologies were introduced into advanced manufacturing. For example, most of the CHAMP schools were teaching some level of automation, regardless if local employers were already using automation. Staying ahead of changes to the industry was believed to help expand the employability of students, and insuring that their skill sets were relevant to a changing industry.

CHALLENGES

The nine CHAMP colleges encountered some challenges during the development and implementation of the newly designed courses. Most challenges centered on insuring the effective incorporation of new, technologically advanced equipment into curriculum. Finding instructors able to run—and teach—the new equipment was also challenging for some schools. In addition, several schools had to renovate space or find new space for the new equipment. This next section details challenges schools faced and how they overcame them.

Curriculum Development

There were a number of challenges in respect to the shared curriculum that was developed under CHAMP. First, what content would be integrated with existent courses and how to effectively do that. Second, was the learning curve of faculty. For example, staff at RRCC discussed how difficult it was for instructors to implement the new curriculum. One faculty member said:

> I feel like I'm running a lot more than I have in years past. It's been a lot more interesting for me because it's – all of it's new. So, it's like being a new teacher all of a sudden again. All the curriculum is new. All the equipment is new. But it's made the job a lot more fun again.

A third challenge was about equipment. Some schools chose to purchase equipment beyond that included in the shared curriculum. This meant individual campuses had to develop course content outside of what was done at the consortium level. This was sometimes time consuming and meant instructors had to take on additional duties outside their normal teaching load. At the same time, some schools decided not to purchase all the equipment for which the shared curricula had been developed. This meant shared course material taught students about equipment they did not have access to. Faculty members had to remove such material and replace it with relevant information. Welding instructors at LCC noted that each semester with the new curriculum, they discovered additional references to equipment they did not have. Each time this occurred, they had to make course adjustments, which were time consuming. Nevertheless, LCC faculty members were optimistic, knowing that eventually they would no longer need to make changes. Thus, overall, they stated they were happy with the shared curriculum as it saved them time.

CCD chose to write their own curriculum, which meant instructors had to take on designing over 50 courses on top of their regular work load. Although the school hired a team of instructional designers to work with the instructors, it was a slow process.

Finding Instructors

Purchasing technologically advanced equipment comes with its own challenge. Some of the schools lacked staff to operate the equipment or to teach it. Schools wanted to hire instructors who were experts in their fields, and preferably still working in or recently retired. But some of the technology was so advanced that only a few individuals in the schools' geographic region were familiar with it. Employing these individuals and others with the right qualifications, however, was often cost-prohibitive as industry pays so much more than teaching.
Hiring instructors that were no longer actively working raised other issues—there was the loss of skill over time, or individuals might be an expert on one piece of equipment but not others. Nonetheless, staff felt "it was very important that our instructors all have recent machining experience, and hopefully, ongoing machining experience." Most CHAMP staff members across the consortium noted the perfect balance seemed to be instructors who worked part-time in the field and taught either full- or part-time.

Another challenge related to employing instructors with expertise in specific equipment was staff size. Often, instructors were expert only on a few types of equipment, but not expert on all the new technology. Given that most of the schools had purchased multiple pieces of specialized equipment, they found they needed to hire several different instructors. One staff member noted:

> For our 5-axis mill class, it wasn't enough just to have somebody who knew three and 4-axis, and who could figure out 5-axis mill. We needed to find somebody who was an expert at 5-axis. And same with the Swiss turning center, same with Mastercam, and so, eventually what you find out is, you have 10 instructors. And so, it's hard to keep all of them going.

Additionally, some experts were great at running the machinery, but not teaching courses. Across the consortium staff discussed challenges with instructors who did not have pedagogical backgrounds—they were not trained instructors. This especially became an issue when courses were transitioned to hybrid formats—instructors had to rely on pedagogical knowledge to effectively transition course material including lectures, assignments, quizzes and simulations to an online format so students could spend more class time working with the machinery. In several cases, curriculum development and/or online formats were so foreign to instructors that they had to rely heavily on their schools' or the systems' instructional designers as well as other faculty and staff who regularly used their schools' online learning platform.

Across the consortium, not only identifying faculty but also keeping these qualified instructors was challenging. As one staff member observed,

> We find that some come in and after a semester they just can't cut it. They're just not built for instruction. Their expectations, perhaps, are not realistic. And so after a

semester or two they say, that's enough. So that's been an ongoing challenge, and will continue to be.

However, having qualified experts teaching industry-specific courses and equipment was a benefit that most staff felt far outweighed the challenges.

Space Renovations

All nine schools did some space renovation to accommodate new equipment. Four schools proceeded with major space renovations: Aims, CCD, RRCC, and LCC. As is often the case, major renovations involve significant delays. But under CHAMP, common construction delays were often exacerbated by federal purchasing requirements for equipment, and federal approval processes for the remodeling of facilities. In some cases, equipment purchases were approved before renovations were completed, creating situations where equipment was ready to be delivered with no place to put it. Likewise, renovation approval sometimes came during the regular school year, when students were using the facilities. Given that renovations represented a safety hazard, schools could not proceed until there was a school break and the buildings were vacant. Timing, thus, represented a major challenge for some schools. There were also instances where renovations were completed, but when the equipment arrived it became clear the renovations were incompatible with the equipment. Further renovation modifications were then needed in order to locate and operate the equipment work.

IMPACT

The impact of hands-on learning reverberated across the consortium. Several common themes emerged relative to positive changes. First, most schools experienced major changes in classroom pedagogy and the structure of the classroom. How students learned also changed. Hands-on learning increased shop time and decreased classroom—textbook—time with students learning theory outside of the classroom on their own time. Second, hands-on learning improved the students' skill sets and their level of confidence, potentially increasing their employability and earnings.

Consortium wide hands-on learning also had an impact on industry. It encouraged industry representatives to keep pace with the colleges in terms of highly technical equipment purchases and the development of shop floor skill sets. In fact, colleges leveraged the availability of new equipment and hands-on learning, developing specialized training opportunities for incumbent workers (see the benefits of hands-on below).

Classroom Structure/Pedagogical Changes

At most of the consortium schools, the purchase of new equipment changed the basic structure of classrooms. In many cases, adding several large pieces of equipment required the expansion of classroom or shop space, or relocation. CCD actually moved its shops to a new facility. Other

colleges re-appropriated space on campus or expanded existing space by moving out other programs that had been sharing the space. At the colleges which significantly renovated their space or moved into new facilities, faculty and staff unanimously endorsed the changes and felt that the changes inspired and improved student learning. A staff member at CCD stated:

> In more ways than just the equipment, but [also] the building itself—the atmosphere—helps with education, and it also helps with the mentality and learning environment that encourages people to say: 'Hey, look! I can do better at a shop here. I can learn this.'

While some schools had used online formats and employed hands-on learning prior to CHAMP, curriculum and pedagogy changed with the addition of new equipment. At most colleges there was a shift towards more hybridized coursework done at home in respect to theory, and an increase hands-on in-class. The availability of more equipment also meant less of a need to share equipment. As a result, most schools transitioned their classes from "watching" classes to "doing" classes. One staff member recounted what the change had meant for his students:

> We used to have just the lecture and give the students an idea of what this does. But now since we got these equipment, now we have a lab component associated with these where students could do the hands-on experience since our program is more on applied engineering rather than theory-based. So, this equipment gave us very good opportunity to do more practical applications – how this really applies in real world.

Where new equipment was delivered just prior to the beginning of a term, a number of schools decided to have students assemble the equipment as part of their class. Instructors at PCC and RRCC, two schools which adopted the assembly teaching method, found students learned better and faster when they understood how a piece of machinery was constructed. For example, when something wasn't assembled properly and didn't work, students could back track and learn from their mistakes. The instructional benefits of assembling were so significant that a number of instructors made assembly a permanent part of their curriculum. Their students therefore learned not only how to use the equipment, but also how to assemble and dis-assemble equipment as they readied it for the next class of students.

Instructors regularly told EERC that the new equipment enabled them to shift from just theory based lessons to teaching more practical applications. Instructors at LCC noted that adding new equipment and changing their courses to a hybrid format forced them to restructure their welding program as a whole. As a result, they believed LCC's welding program now offers a "strong set of courses" which "strengthens the program a tremendous amount," and takes LLC into the future.

Another pedagogical change across the consortium was the development of cross-educational classes. PCC, for example, developed classrooms where students from a variety of programs such as machining, HVAC, electronics and CAD shared classroom space for foundation-level

courses such as blueprint reading. This enabled students from different backgrounds and with different interests and insight to learn together. Such a classroom closely mimics how some shops operate in the "real world," further preparing students for employment.

The use of a hybrid format for courses, a goal of the CHAMP project, was another pedagogical change. Hybrid courses also increased course access for the students who were balancing family and work responsibilities. These students, including incumbent workers, could do the online course work at any time, while they engaged in hands-on learning in labs that were often scheduled for nights and/or weekends. Thus, while not all campus faculty and staff were positive about transitioning to hybrid courses, many students embraced the change as it allowed them to spend more time "on the shop floor," learning hands-on.

Improved Student Skills/Confidence

Hands-on learning and enhanced curriculum has given students the ability to learn a wider set of skills than pre-CHAMP curriculum. Students now assemble and learn to operate state of the art machinery, understand manual and technologically advanced processes, and improve their soft skills. One instructor also observed that the renovated facilities has also given students the confidence they need to secure jobs in advanced machine shops.

Employers told EERC and project staff that students trained through the expanded and enhanced programs have improved skills sets and are more employable than prior graduates. One employer stated:

> A kid coming out of that school or an adult taking the classes, they have a good skill set when they come in. They know what a mill is. They know what a lathe is. They know how to use a micrometer. They know how to read a print. So I can teach them very specific things, the way I want them to learn my machine, but they have a base knowledge and I think that's what's critical for me.

Improved Earnings Potential

In general, improved skills lead to improved earnings potential. Therefore, improving students' skills through CHAMP programs was anticipated to result in students not only getting jobs but ones with good pay. In fact, over the course of the CHAMP grants EERC did find that incumbent workers who earned a CHAMP related credential improved their salaries post credential.

Faculty shared with the EERC team that one of their primary goals was to help students find jobs with a career ladder—jobs with increased earnings potential and upward mobility over time. To that end, a major focus was on the latticing of credentials and developing students' ability to work with multiple types of machinery. For example, some machining students were also trained in engineering graphics, enabling them to design and produce a project. Having the

capacity to create products start to finish gave some students an employment edge, increased earnings potential, as well as greater on the job flexibility. That is, the range of job for which they could apply, and the potential to fill multiple positons for one employer.

Regional employers echoed the advantaged of this cross-training – several actually sent their employees through CHAMP programs so they could be trained on multiple types of machinery. Theoretically, such cross –training enables employers to have a smaller number of employees, off-setting the cost of paying more salary for the cross-trained employee.

Impact on the Industry

In interviews with college staff and employers, EERC began to see the development of a mutually beneficial synergy between the CHAMP colleges and local industry. Each was helping to support and grow the other sector, thereby re-organizing the state's manufacturing industry. A staff member at FRCC observed that,

> the manufacturing industry in the state right now is…trying to decide…how [to] become more cohesive.

The colleges in the CHAMP consortium were helping to "lead that charge." As the colleges purchased state of the art equipment and trained students in labs that mimicked a real-world work environment— industry partners saw the colleges' "commitment to trying to solve a need for them." In response, knowing that quality potential employees were being trained, companies became more confident to invest in new equipment.

The synergy further mobilized industry support and community awareness of CHAMP programs. For example, FRCC faculty noted the effect of the college's program restructuring and its construction under CHAMP of a training center-style manufacturing center that mimics real-world work environments, on local employers.

> When they [industry partners] came and saw our open house and saw what was there, more and more have jumped on the bandwagon to help support it…and the community as well, [is] so impressed.

Staff at Aims reported that the college's CHAMP funded high-tech equipment is not yet being used by regional employers. As such, the college was "raising the bar pretty heavily within [the] industry." One of FRCC's employer-partner echoed this when he said,

> the folks that are coming out of trade schools these days, they're learning on these new machines so it's trying to stay up with technology because that's what they're teaching at the schools.

In brief, CHAMP funded quality hands-on learning on state-of-the art equipment is having an impact on industry and driving innovation in the field.

Specialized Training Opportunities

Another impact hands-on learning has had for the CHAMP colleges relates to the development of specialized training opportunities for incumbent workers. Schools with new training curriculum focused on specific machines have begun to see local machine shop employers sending employees to be trained on specific equipment, such as the 5-axis mill and the Swiss Turn machine. The enrollment of more incumbent workers has helped to expand enrollments and diversify student populations. With increased numbers of employers paying for training costs, advanced manufacturing programs may also be sustained longer term.

Student Learning

One of the most significant effects of the college's acquisition of CHAMP funded equipment has been its impact on student learning. Prior to CHAMP, schools with advanced manufacturing programs often focused more on theory, relying heavily on lectures and textbooks to teach technique. Some colleges had manual machines donated by industry or purchased by the college. Often, however, these machines were outdated – the faculty using them to teach students foundational principles. Some colleges had a few more current pieces of machinery, but frequently, not enough for each student to use. As a result, students either took turns operating the machinery while the rest of the class watched, or instructors operated the machinery while students watched. For example, some colleges ran 3-D printing classes, but without individual machines on which students could learn. Often the 3-D printer was an older one with slower technology forcing faculty to print only demonstration pieces rather than students' individual projects. The purchase of grant-funded state of the art equipment therefore significantly changed the student experience. They now had multiple opportunities to the operate the equipment – gaining hands on experience – and experience their designs being transformed into actual 3D products.

Throughout the CHAMP grant period, EERC interviewed students at colleges across the consortium. Overwhelmingly, students were very positive about their hands-on learning, sharing that their labs were truly preparing them for the workplace. For a detailed reporting of students experiences during 2016 and the impact of the grant, see the EERC Brief "Student Voices."[2] What follows here is a brief discussion of their perspectives on equipment purchases and its impact on their hand-on learning.

All students interviewed appreciated hands-on learning more than the alternative—theory-based knowledge. Most students stated they learned better hands-on than from books or lectures. This is not surprising since most students self-selecting for machining, welding,

[2] See https://smlr.rutgers.edu/content/publications-0

drafting, or other technical programs are less likely to enjoy theory-centric classes than those who might pursue, say, a liberal arts education. One student said he enjoyed working with the equipment because he was "getting to do something instead of taking notes all day. I'm learning a skill instead of writing and reading all the time." Another described how easy it was for him to learn while doing, and how impressed he was that he was learning from the very first day of classes:

> When I first got here I had no idea of what I was getting into. But I was impressed the first day because it was all hands-on. I was in Motors Control. It was my first class. We actually went out and…put the parts in there and made sure that they were – the wiring was screwed in, and then, boom, the motor came on.

Another student said: "I like the hands-on part. I am not good at focusing but when I have to do something with my hands, I can do that." Another echoed this sentiment, saying that he learns more easily if concepts are applied in a hands-on manner:

> It's so much more valuable, at least to me, than book learning. I feel like I can grasp a concept much easier if I'm actually doing it and I can see it and be like 'Oh, yeah, well we blew that circuit.' It makes a lot more sense if I'm actually doing it and I'm watching the sparks fly. And I go 'Oh, yeah, that's because it shorted right here.' Reading things in a book it seems like – it seems more like regurgitation. It's like, okay, I memorize it, take the test, and a week later I'm not gonna remember it. Whereas hands-on learning I feel like I still remember the lessons that I learned a year ago with that type of learning. So, it's more valuable.

A student in a drafting course discussed the difference having 3-D printers has made in his class:

> I like the 3D printers because it helps with your designing even and the – because you can see – you're able to print out what you make and see it, hold it, and see how it works, and make changes, and you can adapt your designing to how they're gonna actually work in the real world as opposed to having it here and then having it shipped off somewhere else where it's got to be printed and then shipping it back. And it cuts out a lot of time on it and it's a huge help to actually be able to see it, see it work. And like you said, with the hands-on stuff, it's really, really good.

Similarly, an instructor for this course discussed the benefits the equipment brought to his class:

> The 3D printer has really helped us out. It shows the students not only what they're building, but they make mistakes and they get into what we do in real life. You build something and it doesn't work out. We used to have to do it in metal and when it didn't work out, we used to say, "Come pick up your boat anchor." But now with the 3D printing, the students make the mistakes, turn around and reprint.

Some schools purchased both manual and high-tech versions of equipment, giving students the ability to learn the foundations of a skill before moving to more automated machinery. Many students interviewed by EERC appreciated learning in this manner and felt it was the only way to truly learn skills applicable to employment. One student said:

> I kind of compare it to math, like with math you can't do calculus without knowing how to add. You can't work on a CNC lathe without knowing what it takes to do it manually at first because that can only enrich your experience and enrich your knowledge as to what you want. So, I really enjoy it.

Marketing/Recruitment/Enrollment

Marketing the programs through open houses and demonstration days has proven an important student recruitment tool for CHAMP colleges. Open houses and demonstrations have enabled employers to see the quality of instruction students receive and to show case their new equipment. In fact, the colleges' new equipment has often been a "selling point" as both employers and students visually see the credit and non-credit training opportunities available at the college. This has helped to increase program enrollment.

A staff member from FRCC told EERC about the college's open houses,

> You just walk out and go 'Wow!' And we have held several events here. The very first one an information session that had 150 people attend when machining was considered icky and nobody knew what it was and we had 150 people attend.

A staff member at CCD told EERC that the equipment…

> …brings us more students because of all this exposure. It has brought us more incumbent workers to get training. It's had an impact in that way. Students didn't know we were here [before]. I'm still surprised by the number of students and employers who don't know we're here because we don't have a marketing budget for the programs. It has impacted the school because it has brought them tremendous exposure.

Similarly, a staff member at EGTC spoke of the "wow factor."

> When you come in and you see the guys on the floor and sparks are flying and they just look really cool and they've got all this awesome gear on, I think it peaks a lot of interest. And it's like, 'Wow, what is that?!' And 'I think I can do that.' And "I want to try that." So, I think, yeah, there's a demand and there's a need for it, but people like seeing it. It looks cool.

At LCC, EERC again heard about the "wow factor" in respect to new equipment as faculty described open houses at which they set up a welding simulator. One LCC instructor commented,

> …probably been our biggest recruiting marketing piece…. There's a line throughout the whole thing to try out the welding simulator, and then students sign up for the program right there.

LCC's new state of the art equipment has therefore helped the welding program grow to the point it now has a waiting list.

Similarly, staff at CCD have actively marketed their revised programs, their new spaces and equipment. As an instructor explains below,

> We're seeing that evidence now with the increase growth in machining and the welding programs and the ever-increasing awareness and demand we have out in the community. So that exists and it just an issue of us keeping that moving forward as we go on to the future. That's all predicated on ensuring that the community and manufacturers in particular know that were here. So, anything we can do to let manufacturers know that we're here, we do that. National Manufacturing Week, National Apprenticeship Week which is coming up, [etc.].

In short, marketing their enhanced if not new programs, and the equipment they have - 'putting their programs in the public's eyes, and "on the map- has become an important strategy for program sustainability.

FUTURE PLANS

When asked about the future relative to hands-on learning, staff at most of the consortium schools mentioned plans to add additional pieces of equipment. Some also have plans for further expansion of their workshop facilities. FRCC, for example, convened 30 regional manufacturers to discuss the establishment of a center for integrated manufacturing. The group discussed what the center would include and design options for the facility. Subsequent to this meeting, a steering committee of local manufacturers was developed to further outline plans. Colleges are also seriously considering the future of manufacturing relative to automation. As a staff member at FRCC noted,

> Now we're looking at: 'What is automation going to mean to manufacturing? How is that going to impact those occupations?' And 'What are additional needs that are not being met out there?' ...Both non-credit customized, and then also with – certainly the machining program is really doing well, very successful – both our credit, non-credit side. But what else do we need to do? Because we know we just don't want to put all our eggs in one basket.

Employers interviewed by EERC staff were somewhat mixed in their views on automation. Some felt automation was already an important part of their operations, while others felt it was unnecessary or at the very least something they did not need to worry in the near future. Regardless, college staff across the consortium were considering the steps they needed to take to prepare students for increased automation in advanced manufacturing.

SUSTAINABILITY

Sustainability is a significant issue for the consortium's advanced manufacturing programs after the CHAMP grant ends September 2017. A variety of aspects of the CHAMP programs are addressed in the CHAMP briefs available on the EERC website.[3] Here we provide a brief discussion relative to the sustainability of hands-on learning and equipment purchases.
One issue of sustainability has been the colleges' capacities to maintain the equipment purchased under the grant. Maintenance costs can be significant. As a result, some colleges are having their instructors take special courses so they can perform maintenance functions. Others are training assistants to help with maintenance; and some were building maintenance into courses and teaching students how to maintain the equipment. The latter strategy has the added benefit of built-in maintenance of the machinery every semester.

Many schools have instituted policies and procedures to ensure daily and weekly upkeep, as well as end-of the-semester maintenance. But this may prove to be challenge. A staff member at one school spoke of new policies in place for the schools' machining programs:

> Making sure that instructors and students follow those policies is my biggest challenge—for example – cleaning the machines, daily oiling. These sound small, but they are very important. When they [students] are in real jobs they will be expected to take really good care of the equipment… because they need to keep [the] machines working.

For all colleges, sustainability of hands-on learning that involve highly technological or cutting-edge equipment, means also staying current. Given the costs of new equipment, some schools' staff expressed concern about their college's ability to continue to upgrade equipment to keep pace with changes in their respective fields. Without the infusion of new grant funds, it may be unlikely for their colleges to purchase additional equipment.

Thinking about shop equipment purchased in the 1970s which was still being used and relevant for some courses, many instructors told EERC that the equipment purchased under CHAMP had a "long life." However, some instructors and staff did worry that at some point, without new funding streams, their programs may again fall behind the technology curve of their industries. These and many other comments collected over the course of CHAMP, indicate the

[3] See https://smlr.rutgers.edu/content/publications-0

powerful impact of CHAMP grant dollars. The infusion of public funds helped transform and improve the position their programs. The need, however, remains, for new and continued resources to enable colleges to keep up with changing technology and effectively train the next generation of workers.