HIGH SCHOOL LEVEL MANUFACTURING EDUCATION: SHARED EXPERIENCES AND FUTURE DIRECTIONS FOR GEORGIA

Ben Kraft

Georgia Institute of Technology
School of City and Regional Planning
Enterprise Innovation Institute
EXECUTIVE SUMMARY

Background

The importance of manufacturing to national and local economies and the concomitant shortage of skilled manufacturing workers have received significant media and policy attention in recent years. Developing a highly skilled manufacturing workforce has been recognized as a key component to strengthening the manufacturing sector. Traditionally, these workforce strategies have targeted adults and been housed at the post-secondary level.

While community and technical colleges are certainly important links in strengthening the manufacturing talent pipeline, there is also evidence from around the country that successful manufacturing workforce development can begin as early as high school. This research project has been an effort to learn from these high school-level manufacturing training programs and to translate the findings into a set of principles and strategies that communities in Georgia can follow to build a competitive manufacturing workforce.

The cases in this study are five nationally recognized high school manufacturing training programs from around the country. They each approach manufacturing training through the lens of career and technical education (CTE), meaning that as opposed to simply teaching students how to perform a set technical tasks, this manufacturing training is part of a holistic endeavor to provide students with the academic, social, and technical skills to have fulfilling careers in manufacturing or any other field of their choosing.

The Importance of Career and Technical Education Delivery

The foundational element that sets these cases apart from other high school manufacturing programs is that they have been innovative in their approach to CTE delivery. Even though some of the cases follow the more traditional model, described below, they have each, through their delivery method, created an environment that
generates a small, dedicated community of learners and instructors with enough resources to provide students with meaningful career and college preparation. For the purposes of this report, there are three ways to classify CTE delivery:

• The traditional model – CTE classes are taken as occasional electives in a traditional, academic-oriented comprehensive high school, or students concentrate in CTE at a regional vocational or alternative high school. While not always the case, comprehensive high schools can underemphasize technical training in favor of academics, while vocational high schools may do the opposite.

• The integrated model – In this model of delivery, instructors and administrators try to give equal weight to applied technical skills and academics. In practice, this approach often takes place in area career centers, to where students from several high schools in a region may travel for portions of their school day or week, or career academies, in which groups of students with similar interests may form a small “school” within a larger one.

• Apprenticeships – An apprenticeship can be administered out of any model, but because it is highly specialized and underutilized at the high school level, this research report approaches it as a separate model.

The Cases

In addition to being recognized by various trade, professional, and media sources, the five manufacturing CTE cases were chosen for this research because they comprise a representative sample of the geographical, economic, and demographic circumstances that exist across Georgia. The study cases represent each of the three delivery models as well as a wide variety of regions of the country and a wide variety of communities, from rural Wisconsin to South Los Angeles.
Table 1: Cases of High School Manufacturing CTE Programs

<table>
<thead>
<tr>
<th>School</th>
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<th>Delivery Model</th>
<th>Programs Offered</th>
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Methods and Findings

This research involved interviewing representatives from each manufacturing program, consulting information from the schools’ websites and other media sources in which they have been featured, and consulting academic and professional literature related to best practices in CTE and manufacturing education. After conducting a systematic cross-case analysis of shared experiences of the five cases, the following five recommendations were developed for Georgia to consider in implementing manufacturing CTE.

1. **Create small learning communities.**

Delivering manufacturing CTE in a way that groups motivated and like-minded students and teachers together creates an energized community of learners. Following one of the integrated delivery models—especially the career academy model such as the Hawthorne School of Manufacturing and Engineering—can facilitate this, but small
learning communities have been created by each of the cases by making adjustments to the delivery model that it uses.

2. **Seek non-traditional funding sources.**
While most of the cases receive some federal and school district funding, these sources rarely provide enough money to run a manufacturing program. Successful programs find funding outside of school district budgets including competitive federal, state, and trade association grants, industry assistance, donations, and partnerships, and even the revenue that their program itself has generated, as is the case for Cardinal Manufacturing in Wisconsin.

3. **Partner with industry and industrial advocacy groups.**
Successful programs involve local business and industry early and often. High school programs that maintain relationships with industry—and also industrial councils like Manufacturing Renaissance in Chicago—are better able to keep up with industry needs. Industry and industrial councils themselves can also be more than just partners when funding is needed. They can in fact be the driving force behind high school manufacturing education.

4. **Recognize that high school students are not too young to receive on-the-job training in the form of internships or apprenticeships.**
Another misperception about contemporary manufacturing is that factories and shops are unsafe places to work and that child labor laws prevent students under 18 from working in them. In general, neither of these circumstances is true. While potential partners should be vetted to ensure that they do adhere to safe work practices, most companies are very safe and clean, and federal and state labor laws allow officially designated student learners and apprentices to receive on-the-job training when they are at least 16 years of age.
5. Reach out to younger students and their parents.
Because the programs in this study all provide purposeful manufacturing education, it is essential that the students and their parents recognize the benefits it can offer, and that any negative impressions they have of manufacturing might be dispelled. The obvious recruitment options are high schools and middle schools, but two of the high schools studied in this report reach out to students who are in fifth grade.

Although these programs represent a wide variety of educational models and a diverse set of communities, the experiences that emerged are universal and applicable to similar efforts in Georgia. Through their shared experiences, Georgia can begin to build a highly skilled manufacturing workforce starting as early as high school.
INTRODUCTION

The importance of manufacturing to national and local economies and the concomitant shortage of skilled manufacturing workers have received significant media and policy attention in recent years.\textsuperscript{1} Developing a highly skilled manufacturing workforce has been recognized as a key component to strengthening the manufacturing sector (Helper, Krueger, & Wial, 2012), and the post-secondary education system tends to be the default location for interventions to augment manufacturing training capacity and skills.\textsuperscript{2}

While community and technical colleges are certainly important links in strengthening the manufacturing talent pipeline, a robust body of evidence shows that the most effective and efficient educational strategies start much earlier (Heckman & Krueger, 2003). Accordingly, several educational initiatives around the country are demonstrating that manufacturing workforce development can begin as early as high school and that outreach about manufacturing careers can target students at even earlier stages of educational attainment. This research project has been an effort to learn from these high school-level manufacturing training programs and to translate the findings into a set of principles and strategies that communities in Georgia can follow to build a competitive manufacturing workforce.

The findings from a systematic cross-case comparison of five high school manufacturing education programs suggests that cultivating a skilled manufacturing workforce can begin in Georgia’s high schools, if not earlier, and I offer five recommendations for how Georgia begin to proceed along this path.

\textsuperscript{1} For example, see the Brookings Institution’s Manufacturing series (http://www.brookings.edu/research/topics/manufacturing), the United States Economic Development Administration’s Investing in Manufacturing Communities Partnership (http://www.brookings.edu/research/topics/manufacturing), and the White House’s manufacturing portal (http://www.manufacturing.gov/welcome.html).

\textsuperscript{2} For example, the workforce components of recent industrial strategies from major cities such as Philadelphia (Manufacturing Task Force, 2013), Minneapolis (Maxfield Research Inc., SEH Inc., & Quam Sumnicht and Associates Inc., 2006), and San Francisco (San Francisco, 2007), fail to mention high schools as places where manufacturing education can take place and focus instead on post-secondary training and “re-skilling.”
The main avenue for building a skilled manufacturing workforce is through the “career and technical education” (CTE) approach. While many of us may not be familiar with the term, we are familiar with the concept. In general, it refers to what, until recently, we in the United States have called “Vocational Education.” This shift in terminology reflects an actual shift in paradigm, which I will discuss shortly.

First, however, a brief background of the history and evolution of CTE in the United States is in order. The U.S. government established vocational education as a national policy and educational objective with the Smith Hughes National Vocational Education Act of 1917. Smith-Hughes gave educators a federal, state, and local organizational structure for vocational education, as well as a source of funding.

Leading up to the Act, the increasingly mechanical and scientific nature of agriculture required a more educated rural population, a fact that was recognized 55 years earlier with the passage of the Morrill Land-Grant College Act that established the well-known system of American “State” and “Agricultural and Mechanical” universities. However, as the nation industrialized through the second half of the century, so too did vocational education. It came to take the form with which we are now familiar, being implemented in “shop class” and vocational high schools. Increasingly seen as a tool to help poor students and members of disadvantaged populations become meaningful members of the workforce, vocational education legislation policy in the post-WWII years tended to emphasize training for minorities, the rural and urban poor, women, and disabled students. Women could take “home economics” or typing classes, and non-college bound men had the option to begin learning a trade in high school (Lerman, 2010; Scott & Sarkees-Wircenski, 2008)

However, towards the end of the 20th century, general deficiencies in the K-12 system, such as its lack of ability to prepare enough students with not only basic skills, but also skills relevant to the changing global and tech-heavy economy, were becoming more apparent. While educators and policy makers were questioning the status quo
that expected all students to strive for college, they were also beginning to debate the role of vocational education in relation to academic education (Lerman, 2010).

To reflect these changing attitudes, the 1990’s saw the introduction of the Tech Prep model (integrating secondary education with one or two years of post-secondary education along a career pathway) and the School-to-Work program, with the aim of preparing students for meaningful work right out of high school (Lerman, 2010).

Finally, in 2006, the Carl D. Perkins Career and Technical Education Act began using the term “career and technical education” instead of vocational education.

CTE now tends to be thought of as a holistic approach to education defined more by its goals and emphases than how or where it is implemented. In general, CTE prioritizes

• The development of specific technical and career skills, like professionalism and communication, in addition to traditional academic competencies.
• Career exploration
• The equal viability of various post-high school options (e.g. entering the workforce directly, obtaining a certificate or two-year degree, or continuing on to a four-year college), and
• Contextual, project-based, and work-based learning (Scott & Sarkees-Wircenski, 2008).

CTE AS AN EFFECTIVE EDUCATIONAL STRATEGY

Of course, not all communities, schools, or instructors have adapted with the changing paradigm; many outdated and token shop classes still exist. But the CTE approach in general has been shown to be effective. Bishop and Mane (2004) find that out of a sample of students who graduated in 1992, those who took more CTE classes earn more money in the short and long term, are more likely to be employed, and demonstrate similar academic performance to those students who took fewer CTE classes. Using a smaller sample, Orozco (2010) shows CTE concentrators actually do
demonstrate higher academic achievement than non-concentrators and furthermore, CTE concentrators perceive themselves to be more workforce-ready than other students. There is also evidence that CTE benefits teachers by helping them to feel that they are more effective in their roles (Orr, 2005).

Regarding dropout rates, the data is mixed. For example, Plank et al. (Plank, DeLuca, & Estacion, 2008) find in a longitudinal study that for students who enter 9th grade at age 15 or younger, their risk of dropping out is at its lowest as they approach a ratio of taking one CTE course for every two academic courses. However, greatly exceeding this ratio of CTE courses to academic courses increases dropout risk, and CTE course taking in general increases dropout risk for those who enter 9th grade when they are older than 15. A problem with studying CTE in this way, as the authors note, is that it is difficult to control for the quality of CTE.

The state-of-the-art in research regarding CTE’s effectiveness remains Kemple’s comprehensive 2008 study of career academy students. For the first time, Kemple was able to control for the primary problem in comparing CTE to non-CTE students—that of self-selection bias—by studying a sample of students who applied to CTE programs and were accepted in a lottery system. Kemple’s analysis shows that eight years after graduation, CTE students earned on average over $2,000 per year more than non-CTE students. They also were more likely to live independently and be custodial parents (Kemple, 2008). While this study provides the most compelling evidence of the effectiveness of CTE to date, it comes with two caveats: these results only apply to males—females in CTE show no significant differences compared to their non-CTE counterparts—and the universe for this study was specifically “career academy” students. A career academy is a specific model of CTE delivery that will be discussed later in this report.

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3 Because students choose to enroll in CTE classes, researchers cannot determine whether their better (or worse) performance was due to chance or may instead be attributable to the motivation and aptitude of students who decide to enroll in CTE.
MANUFACTURING AND THE MANUFACTURING WORKFORCE IN THE 21ST CENTURY

Like the vocational education system, the US manufacturing sector is also undergoing a shift in structure, strategy, and philosophy. As the decades-long drop in manufacturing jobs seems to have stopped, and possibly even reversed with the recovery from the Great Recession, scholars, policy-makers, and manufacturers are beginning to realize both the importance of a strong manufacturing sector as well as what some possible steps may be to help foster its growth.

While progress is being made in modernizing and improving both pursuits, challenges still persist. Many plants are still trying to compete by cutting expenses rather than upgrading processes, skills, and technology. Older manufacturing workers face difficulties learning new skills late in their careers. And many high schools and districts either have no career and technical education at all, or a few token shop classes where students who have trouble in academic subjects can find refuge.

Perhaps the most daunting challenge is the stigma that faces both manufacturing and career and technological education. The Manufacturing Institute found that while over three quarters of respondents to a recent survey believe that manufacturing is important to the U.S. economy and the standard of living, only 35% would encourage their children to pursue a career in manufacturing, and only 17% reported that they had been encouraged by their parents to do so (Deloitte Development LLC, 2012). Likewise, each of the 12 manufacturing educators and advocacy professionals to whom I spoke during the course of this research noted that the unfavorable perception of manufacturing as a career is a significant problem. They also, however, noted that with some effort and effective messaging, students, parents, other educators, and guidance counselors can begin to view manufacturing as a viable and even desirable career option.

It is important to emphasize that the manufacturing jobs that are growing are not dirty, dangerous, or mind-numbingly routine. For the foreseeable future, there will still be a need for experienced welders and talented manual machine operators, especially in small and boutique job shops. These manual skills can lead to fulfilling
careers, especially for people who are drawn to manual and craft work. But most of the manufacturing jobs of the future will involve designing, programming, maintaining, and repairing all kinds of complex machines and systems from chemical mixers to computer numeric controlled (CNC) lathes to robots. The people who perform these jobs will all be able to think creatively, solve problems, and will have levels of education ranging from post-secondary technical certificates to PhDs.

Part of this message must explain that despite the conventional narrative, manufacturing has plenty of career and educational opportunities. There is in fact a well documented “skills gap” currently. A report 2011 report reveals that 74% of the more than 1,100 manufacturing executives surveyed believe that a shortage of skilled production workers is negatively impacting the growth of their firms (Deloitte Development LLC, 2011). Also, much of the current manufacturing workforce is set to retire in the coming years. Even if the overall number of jobs in manufacturing were to decline between now and 2018, projections show that there would still be an increase in overall manufacturing job openings due to the 2 million vacancies left by retiring baby boomers (Carnevale et al., 2011). At least at the time of this writing, the manufacturing sector is still growing. Since its precipitous drop in employment during the Great Recession, it has added almost 650,000 jobs between early 2010 and the spring of 2014 (Bureau of Labor Statistics, 2013).

Georgia’s manufacturing economy is on a similar trajectory. The Georgia Department of Labor predicts overall production openings to grow by almost 1% per year through 2022 while specialized production jobs like aircraft assembly and computer-numeric machine tool operators grow at a rate of around 3.5% annually (Georgia Department of Labor, 2014).

PUTTING IT TOGETHER: CAREER AND TECHNICAL EDUCATION AS A TOOL FOR BUILDING A SKILLED MANUFACTURING WORKFORCE IN GEORGIA
While the manufacturing sector will never again be the monolithic employment source that it was in the early part of the 20th century, it is poised to offer fulfilling careers to many future workers in Georgia and across the country. However, these workers will need both an interest in manufacturing and the educational pathways that will lead to these careers. This is where CTE comes in. Out of the 16 recognized CTE career clusters (National Association of State Directors of Career Technical Education Consortium, 2014), only 4.2% of the nation’s CTE concentrators (those who have taken at least 2 or 3 CTE credits, depending on the cluster) concentrate in manufacturing. In Georgia, only 1.3% of CTE concentrators specialize in manufacturing (Perkins Collaborative Resource Network for Program and Data Quality, 2014). There is clearly room for manufacturing CTE (M-CTE) expansion in Georgia, especially since the state’s manufacturing employment concentration is 10.8%, which is slightly higher than the national concentration (Bureau of Labor Statistics, 2014).

M-CTE has the potential to improve Georgia’s educational outcomes and workforce skills in several ways. Students who are at risk of dropping out of high school or are unlikely to attend college because of interest, test scores, or family finances will have an extra, worthwhile option with M-CTE. Some students may simply find that they thrive more in the “hands-on” learning environment of a manufacturing related class than they do in a traditional classroom setting. This situation is a common anecdote among the M-CTE educators interviewed for this report. Students like this, for some of whom college may not be an option, can be much more optimistic about a future that includes much higher wages than most jobs requiring only a high school degree, certification, or two-year college degree. In keeping with the earlier example, both aircraft assemblers and CNC operators in Georgia enjoy average wages above $20 per hour (Bureau of Labor Statistics, 2014), and these positions typically come with benefits also.

Even academically strong students may find new challenges in M-CTE classes. The excitement of designing and creating is not unique to students transcends socio-economic status and learning style. There are dozens of degrees offered at colleges and
universities related to manufacturing, and the skills that manufacturing involves are highly transferable to other disciplines, such as engineering, computer science, and robotics.

CAREER AND TECHNICAL EDUCATION DELIVERY

The way that CTE reaches the students, or the CTE delivery method, can be categorized in various ways. For the purposes of this report, they are divided into the three basic models shown in Table 1. The first is the more traditional model. In this model, students at comprehensive, academically oriented high schools take CTE credits as electives—auto shop or “home economics” for example. Alternatively, they attend a vocational or alternative high school nearby for a more career-focused education.

What I am calling the “integrated model” gained popularity more recently. The logic of this model is that it integrates CTE into academic learning so that the two no longer occupy separate physical or philosophical realms. It can come in the form of an area career center, which centralizes career and technical training for students from a district or a region, or a career academy,\footnote{4 Despite having "career academy" in their names, some of Georgia's College and Career Academies are technically area career centers based on their physical organization.} which is in a way the opposite of the area career center in that it more closely clusters students along a similar pathway within a high school, creating what’s often referred to as a “school within a school” (United States Department of Education, 2014)

Finally, apprenticeships can be administered as part of any model of school organization, but because of the potential that it holds at the high school level, I am treating it separately and profiling a nearby case from South Carolina.

Each model comes with benefits and drawbacks. Comprehensive high schools are often thought of as “academics first” institutions while vocational high schools can suffer from a negative stigma or under-emphasize academics. These perceptions are not necessarily the case though, as the examples in this report show. Within the integrated model, the central location of area career centers minimizes the cost of facilities,
equipment, and materials, but it can necessitate complex scheduling and busing arrangements to accommodate students of different ages from different home schools. Alternatively, career academies may keep together for most of the day a group of students pursuing the same CTE pathway, but can be resource intensive, especially if other schools nearby are offering similar curricula.

Apprentices may receive their academic and basic technical training through either of the other two models, but a dedicated industry partner must be involved for the more specialized work-based training. The necessity for a willing and engaged partner nearby may limit the possibilities for apprenticeships.

This report and its findings hinge on the delivery method as a distinguishing factor in the success of the cases. All five programs highlighted in this report took risks by delivering manufacturing CTE in a novel way, especially in their respective communities. Even the schools that follow more traditional models—Eleva-Strum High School and Austin Polytechnical Academy—have added elements to them that challenge the status quo and create better places for high school students to learn about—and take seriously—manufacturing.

Specifically, the “twists” that the case programs take on traditional manufacturing education tend to facilitate “small learning communities” (SLCs). While there is no specific class or school size that qualifies as “small,” the idea behind SLCs is that breaking schools into smaller cohorts that allow more frequent interaction with peers and teachers, and a more personalized educational experience, will benefit students. While SLCs are also difficult to study because of the wide variety of cultures and practices within individual schools, they, like CTE, seem to be part of a promising emerging approach to education (Bernstein, Millsap, Schimmenti, & Page, 2008; DeAngelis, 2004; Stern, Dayton, & Raby, 2010). Career academies tend to be associated with SLCs, and indeed received much of the funding from the U.S. Department of Education’s recent Small Learning Community grant program (Stern et al., 2010), but it is important to remember that SLCs can be created in any educational environment, and this is certainly what the five case schools have done.
Table 1: CTE Delivery Models

<table>
<thead>
<tr>
<th>Format</th>
<th>Description</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional model*</td>
<td>Comprehensive High School or Technical/Vocational High School</td>
<td>Can emphasize or de-emphasize academics. Vocational schools may have stigma.</td>
</tr>
<tr>
<td>Integrated model*</td>
<td>Career Academy or Area Career Center</td>
<td>Similar to a college “major”; Creates small learning communities, can be resource intensive or efficient, depending on model</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>Paid, “on-the-job” training combined with academics at home high school</td>
<td>Less flexible, requires significant industry involvement</td>
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</table>

**METHODOLOGY AND CASE DESCRIPTIONS**

In this report, I examine five cases of manufacturing high school programs for comparison. They represent each of the delivery models and a wide variety of community types—urban, suburban, and rural—from a diverse sampling of geographic regions. Each of these programs has also been recognized by various media and industry sources. The Austin Polytechnical Academy and the Aiken Career and Technology Center’s apprenticeship program have been featured in the New York Times (Knight, 2011; Schwartz, 2013), and Cardinal Manufacturing has appeared in *Modern Machine Shop*, a manufacturing trade publication (Zelinski, 2012). Several of the programs have also been recognized for their exceptional performance by the Association for Career and Technical Education (ACTE), the Partnership Response in Manufacturing Education (PRIME) (http://www.smeef.org/prime/page/prime-schools), which is a nationwide
program run by SME (the Society of Manufacturing Engineers) to recognized and encourage exemplary manufacturing education, and the M-List
(www.themanufacturinginstitute.org/Skills-Certification/M-List/M-List.aspx), which the Manufacturing Institutes created to endorse high schools and colleges teaching manufacturing skills.

Table 2: M-CTE Programs in Current Study

<table>
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Source: Interviews with representatives from schools, schools websites, association websites, and articles.

The focus on programs outside of Georgia is not meant to imply that there are no innovative high school manufacturing programs within the state. The aim is simply to bring outside knowledge and experiences to Georgia’s existing manufacturing and CTE infrastructure. Three exemplary Georgia high school manufacturing programs are listed in the “Acknowledgements” section of this report.

The following section provides narratives of each case, and a formal cross-case comparison including all five programs is presented in Appendix 1 of this report. The
information for the narratives was provided by interviews and email communication with representatives from each of the schools and school websites.

FRANCIS TUTTLE TECHNOLOGY CENTER
Integrated Model – Area Career Center
Oklahoma City, OK
“The CTE Pioneer”

Francis Tuttle is the “grand-daddy” of the M-CTE programs in this report. The manufacturing program is housed at one of its three campuses, which offer all of their programs for free to any high school in the seven school district region that feeds it. It has been around since 1982, although it has adapted to the times. For example a plastic injection molding program that was closed because it was having trouble placing students in jobs.

As it stands now, high school students in manufacturing and machining are in classes that are mostly comprised of post-secondary and adult students. This isn’t the same everywhere, but according to the director, it can be a benefit to these high school students because, in the first place, lessons are highly individualized, and secondly, it creates a more mature and focused learning environment than what exists at their home high schools.

An important reason to discuss Francis Tuttle is because it highlights Oklahoma’s pioneering state Technology Center system. Tuttle is one of 29 Centers throughout the state, which are part of neither school districts nor community college districts and are funded by ad valorem local property taxes assessed only to communities that vote in favor of them.

Francis Tuttle has been recognized by the SME (Society of Manufacturing Engineers) Education Foundation as an outstanding high school manufacturing and engineering program. It is also on the Manufacturing Institute’s M-List
(http://www.themanufacturinginstitute.org/Skills-Certification/M-List/M-List.aspx), which recognizes secondary and post-secondary institutions that “deliver high quality manufacturing training programs” (Manufacturing Institute, 2014).

**HAWTHORNE HIGH SCHOOL**

School of Manufacturing and Engineering

Integrated Model – Career Academy

“Inner-City Aerospace Pipeline”

The Hawthorne School of Manufacturing and Engineering’s location is both a challenge and an asset. This career academy is located in a neighborhood south of Los Angeles with a nearly 20% poverty rate and low educational attainment among its adults. However, the same small area is also home to one of the nation’s pre-eminent aerospace manufacturing and engineering clusters, with Northrop Grumman and Space Exploration Technologies (commonly known as SpaceX) facilities only a few blocks away.

As a career academy, the School of Manufacturing and Engineering is a school within the larger Hawthorne High School. Each year, 300 to 400 students from 9th through 12th grades spend most of their school days together in their own “wing” of the school, and instructors emphasize tying the traditional academic curriculum into the manufacturing and engineering subject matter.

While the Hawthorne community itself is struggling economically, the school has actually been able to put together a state-of-the-art manufacturing training facility which allows high school students to work with technology more advanced than most college students—and even professionals for that matter—are exposed to throughout the country. This advantage is possible because of the close business and industry ties that the staff and program director, Lucas Pacheco, have cultivated and maintained. As an example of how local industry recognizes the mutual benefit of outfitting Hawthorne with cutting edge equipment, the Oxnard, California-based machine tool manufacturer,
Haas, donated “threw in” two additional advanced Computer Numeric Control (CNC) machines with the School’s purchase of one.

While it is often difficult enough to recruit high school students to choose a manufacturing pathway in the first place, the Hawthorne School of Manufacturing and Engineering faces extra obstacles because of other high schools that offer pathways like business that may be more appealing to students and parents, as well as the recent creation of several charter schools nearby that offer a similar curriculum to Hawthorne’s. With this competitive environment in mind, the academy implemented a multi-pronged outreach strategy that has allowed it to increase its enrollment over the years. Academy staff regularly attends middle school career nights and hold workshops for local middle-schoolers. Pacheco has also found that how they talk to potential students and parents is important. Rather than simply making the “pitch” himself, he often invites alumni of the program and representatives from local partner companies to speak directly to students and parents about the possibilities in manufacturing. The academy even goes as far as inviting parents to tag along on field trips to manufacturing facilities. Finally, it’s well-known and perennially competitive First Robotics team certainly also helps the academy’s reputation.

There is clearly something special going on in this small 300-400 student manufacturing and engineering academy within the 1,900-student Hawthorne High School. Aside from the impressive college placement record of the School of Manufacturing and Engineering, its 2012 graduation rate of 98.9% dwarfs that of the High School as a whole, which was 61.5% for the same year (Centinela Valley Union High School District, 2014)

**AUSTIN POLYTECHNICAL ACADEMY**

**Traditional Model – Vocational School**

**Chicago, IL**

“Community Development Through Manufacturing Education”
The Austin Polytechnical Academy is a community development, economic development, workforce development, and educational initiative wrapped up into one small school in a disadvantaged neighborhood in Chicago’s west side. The seeds for “Austin Polytech” were planted in 2001 when a comprehensive study of Cook County’s manufacturing industry and workforce (Chicago Federation of Labor & Center for Labor and Community Research, 2001) revealed a gap in training pathways for future manufacturing workers, especially in the metal and machinery sectors. The study recommended creating a formal manufacturing “career path,” and Austin Polytechnical Academy became one of the ways that this path was implemented.

It is an ongoing partnership between the Chicago Public Schools and the Chicago Manufacturing Renaissance Council, a manufacturing advocacy and workforce development organization. The school, opened in 2009, shares a rehabbed high school building with two other career and college prep academies. The Manufacturing Renaissance Council helped design the manufacturing training facility and a full-time industry coordinator maintains ties with local industry. Its six staff members in the school find internship and employment opportunities for students and works with the Chicago Public Schools teachers to ensure that the skills that are being taught keep up with local industry demands.

Austin Polytech faces the challenges that come along with being an inner-city school. For example, Austin educators must spend as much time providing students with basic academic and “soft” skills as they do teaching the technical skills that industry needs. While some the students are drawn to the school because of the manufacturing career pathway that Austin offers, many come for other reasons—for example, because it is a relatively new public school in the neighborhood or because they know others who attend. For this reason, the Manufacturing Renaissance staff must work hard to educate neighbors and even its own teachers and administrators that the school’s mission goes beyond providing a traditional general education and is also in the
business of helping the community and creating a highly skilled manufacturing workforce.

The participation and leadership of Manufacturing Renaissance is of particular importance in this case. Aside from providing a built-in manufacturing community presence, it shows that communities that are interested in initiating an M-CTE program do not need to wait for a school district or a large employer to spearhead it. Manufacturing advocacy groups, trade associations, industrial councils, or expansion and retention organization can provide the necessary leadership.

CARDINAL MANUFACTURING AT ELEVA-STRUM HIGH SCHOOL

Traditional Model – Comprehensive High School

Strum, WI

“Student Run Manufacturing Business”

Eleva-Strum in many ways is a typical rural high school. But its manufacturing education is anything but a typical shop class. In addition to its machining, metalworking, and welding electives, the school runs an actual commercial manufacturing job shop called Cardinal Manufacturing. The shop offers contract machining and fabrication services for many types of clients. The following are examples of typical work:

- The stainless steel components to custom wood-turned wine bottle stoppers for a local hobbyist
- CNC milling custom aluminum parts for a vintage snowmobile
- Welding custom brackets for beam placement in cabin construction
- CNC milling a custom intake manifold spacer for a pulling tractor to increase its horsepower (Cegielski, 2014a)

These small, custom jobs may not be worthwhile for nearby professional shops, but provide some revenue for the school as well as valuable learning experiences for the
students.

Students who have taken the required introductory classes apply—just as they would for a regular job—in their junior or senior year to be part of Cardinal Manufacturing. Because the business generates revenue, it is essentially self-funding. The profits are used for equipment and building upgrades. It is currently renovating the shop to include a professional meeting space. Also, a small portion of profits are distributed to the student employees once per year.

While Craig Cegielski, the director, does reach out to 7th graders to introduce them to manufacturing, in such a small school that is comprised of grades 7 through 12, Cardinal Manufacturing has achieved a status somewhat akin to a varsity football team. Its application process is in fact quite competitive because students are motivated to join this elite group.

AIKEN CAREER AND TECHNOLOGY CENTER
MTU Apprenticeship Program
Aiken, SC
“German-style Youth Apprenticeship”

The Aiken County Career and Technology Center is a successful area career center in its own right (serving all Aiken County High School students), but what makes it truly unique in manufacturing education delivery is the German-style apprenticeship program it offers jointly with MTU, a German diesel engine manufacturer that operates a manufacturing plant in Graniteville, South Carolina.

Concerned about its ability to find local workers with the skills to work in its production facility, MTU (formerly Tognum) worked with the Aiken County Career and Technology Center to develop an apprenticeship program similar to its German program. The first class of six high school juniors in 2012 began on a course of study that requires 600 hours of traditional high school academics at their home high schools and
technical training at the Career and Technology Center, as well as an additional 1,000 hours of paid work and training at the MTU facility. Upon completion of the program, the apprentices will earn high school diplomas and an “industrial mechanic basic” certificate, which is a German certification recognized in the US.

Apprenticeship programs like Aiken’s, while effective, require a special set of considerations. Federal laws allow 16 and 17 year-old apprentices to work in most manufacturing settings, although some states may have more stringent laws. In this case, MTU was an eager partner with experience running apprenticeships. While a German-based partner is not a requirement for running a successful program, it will require a substantial commitment on the part of the school, the industry partner, and the student. Students must be able to travel back and forth between the home high schools, career centers (if applicable), and workplaces. Additionally, apprentices must log a significant number of hours. This requirement can be difficult to harmonize with high school schedules. Finally, in this case, the apprenticeship is quite rigorous. During the summer, apprentices work 40 hours per week, beginning at 6 a.m., Mondays through Fridays. Sticking with the program takes a drive and focus that not all high school students will possess. Finally, the apprentices must pass a rigorous four-day written and practical examination to graduate.

Three of the original six 2012 apprentices—the three that continued with the program—recently graduated from high school and passed the exam. They will earn their certifications upon completion of their required 1000 hours at the end of the summer.

One important insight that Aiken’s case supplies is that in Georgia, like South Carolina and much of the United States, labor regulations do not prevent high school-aged students from receiving paid, on-the-job training in manufacturing in the form of apprenticeships or internships. The perception that manufacturing is too dangerous 16 to 18 year-olds—and that labor laws prevent them from receiving manufacturing training—must be dispelled. While potential partners must be vetted to ensure that their facilities are safe and that they will take the training and supervision of minors
seriously, federal labor law allows 16 to 18 year-olds to learn most manufacturing functions on the job provided that they are enrolled in recognized trade- or school-based programs (Electronic Code of Federal Regulations, 2014). Further, Georgia’s laws do not contradict these federal regulations in that they only address children under 16 (Georgia Department of Labor, 2011).

In an additional effort to allay safety concerns, Wisconsin’s Youth Apprenticeship program often incorporates safety certificates into the curriculum of manufacturing apprentices. Not only are safety-related credentials for manufacturing valuable in their own right, but they often take less time to acquire than other types of technical credentials and so are appropriate for the limited time that high school student learners have in their apprenticeship programs (Phillips, 2014).

**FINDINGS, SHARED EXPERIENCES, FUTURE DIRECTIONS FOR GEORGIA**

The following five recommendations come from synthesizing common themes and experiences of the five manufacturing programs that have been reviewed. They can inform Georgia’s manufacturing CTE efforts in the future.

1) **Create small learning communities**

Delivering manufacturing CTE in a way that groups motivated and like-minded students and teachers together creates an energized community of learners. Following one of the integrated delivery models—especially the career academy model—can facilitate this, but small learning communities can be created with tweaks to any of the models. Rather than thinking of a manufacturing class as an occasional break from traditional academic work, the instructors try to ensure that students share a common, systematic, and evolving learning experience that prepares them for the real world.

2) **Seek non-traditional funding sources**
While most of the cases receive some Perkins funding and normal school district funding, it is usually not enough to run a manufacturing program. Successful programs find funding outside of school district budgets including competitive federal, state, and trade association grants, industry assistance, and even the revenue that their program itself has generated.

3) **Partner with industry and industrial advocacy groups**
Successful programs involve local business and industry early and often. High school programs that maintain relationships with industry—and also industrial councils like Manufacturing Renaissance in Chicago—are better able to keep up with industry needs. Industry and industrial councils themselves can also be more than just partners when funding is needed. They can in fact be the driving force behind high school manufacturing education.

4) **Recognize that high school students are not too young to receive on-the-job training in the form of internships or apprenticeships.**
Another misperception about contemporary manufacturing is that factories and shops are unsafe places to work and that child labor laws prevent students under 18 from working in them. In general, neither of these circumstances is true. While potential partners should be vetted to ensure that they do adhere to safe work practices, most companies are very safe and clean, and federal and state labor laws allow officially designated student learners and apprentices to receive on-the-job training when they are at least 16 years of age.

5) **Reach out to younger students and their parents**
Because these programs all provide purposeful manufacturing education, it is essential that the students and their parents recognize the benefits it can offer, and any negative impressions they have of manufacturing might be dispelled. The
obvious recruitment options are high schools and middle schools, but two of these cases even reach out to students in elementary schools.

CONCLUSION

Cultivating a highly skilled manufacturing workforce is essential for the sustained economic competitiveness of the United States and the State of Georgia. In addition to strengthening and tailoring efforts at the post-secondary level to provide the necessary training, there is ample evidence that these efforts can and should start even earlier. Georgia does not have to undertake this effort blindly. As this report has shown, Georgia can draw on the collective experiences of pioneering high school manufacturing programs from around the country. Particularly to provide meaningful manufacturing education at the high school level, Georgia educators can create small-learning communities, find funding sources outside of traditional school funding, partner with industrial and advocacy groups, consider apprenticeships for high school students, and especially, reach out to younger students and parents. This last point deserves extra emphasis because at the heart of this issue is a need to change the culture and perceptions surrounding CTE and manufacturing. While high schools can begin providing manufacturing skills, educators and economic developers must reach out to students even earlier to generate the requisite interest and awareness.
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ACKNOWLEDGEMENTS

This research was possible because many people graciously donated their time and knowledge. The following is a list of the people who shared their experiences and insights for this report.

Scott Brown
Pre-Engineering, Robotics, Drafting Instructor
Central Educational Center
Newnan, Georgia

Rachel Baldwin
Career Instructional Specialist, Youth Apprenticeship
Camden County High School
Kingsland, Georgia

Craig Cegielski
Technical Education Teacher
Eleva-Strum High School
Strum, Wisconsin

Jose Estremera
Director of WIRE-Net Youth Programs
Cleveland, Ohio

Catherine Imperatore
Research Manager
Association for Career and Technical Education
Alexandria, VA 22314

Danny King
Campus Director – Portland Campus
Francis Tuttle Institute of Technology
Oklahoma City, Oklahoma

Lucas Pacheco
Coordinator and Teacher
School of Manufacturing and Engineering
Hawthorne High School
Hawthorne, California

Amy Phillips
Youth Apprenticeship Program Coordinator
Wisconsin Department of Workforce Development
Madison, Wisconsin

**Brooks Smith**
CTE Director, Principal
Aiken County Career and Technology Center
Warrenville, South Carolina

**Erica Swinney**
Program Director
Manufacturing Renaissance
Chicago, Illinois

**Scott Warren**
Director of High Schools That Work/Making Middle Grades Work State Initiatives
Southern Regional Education Board
Atlanta, Georgia

**Mark Whitlock**
CEO
Central Educational Center
Newnan, Georgia

**John Zegers**
Director, Center of Innovation for Manufacturing
Georgia Department of Economic Development
Atlanta, Georgia

**Exemplary High School Manufacturing and Manufacturing Related Programs in Georgia**
- The Central Educational Center in Newnan (http://www.gacec.com)
- Southwire’s “12 For Life” Program (http://www.12forlife.com)
# Appendix 1: Cross-Case Comparison of CTE Manufacturing Programs

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<thead>
<tr>
<th>School</th>
<th>Delivery Model</th>
<th>Physical Presence</th>
<th>Estimated Costs</th>
<th>Funding</th>
<th>Outreach</th>
<th>Student Outcomes</th>
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</thead>
</table>
| Francis Tuttle Technology Center    | Integrated – Area Career Center | Regional Campus            | $90,000/year to run Mfg and Machining programs | Ad Valorem Property Tax, Perkins  | Visit local high schools and middle schools                              | • 91% direct, related employment  
• Avg starting wage - $20.27/hr |
| Hawthorne High School – School of Manufacturing and Engineering | Integrated – Career Academy | “Wing” of High School       | $2.5 million for new facility and equipment  | Perkins, State, School District, Industry | • Attend middle school recruitment nights  
• Hold manufacturing workshops  
• Bring industry partners and alums to talk to parents  
• Bring parents on field trips  
• Highlight success of robotics team | • 98.9% graduation rate in 2012  
• 97.4 attendance rate in 2012  
• Grads have gone on to engineering programs at UC San Diego, Cal Poly San Luis Obispo, and others |
| Austin Polytechnical Academy        | Traditional – Vocational High School | Shared High School Building | $250,000 for new facility and equipment       | Nonprofit group, School District, Industry | Visit middle and elementary schools                                      | • 237 metalworking credentials earned  
• 28 full-time job placements since 2011  
• 174 paid internships |
| Eleva-Strum High School – Cardinal Manufacturing | Traditional – Comprehensive High School | Inside High School       | $500,000 for the facility and equipment       | Perkins, School District, Internal profits | • Informal introductions for 7-9 graders  
• High regard for Cardinal Manufacturing students | No Data |
| Aiken Career and Technology Center – MTU Apprenticeship | Apprenticeship | Area Career Center and Company Facility | No Data | Industry, Perkins, School District, State | Visit local high schools, middle schools, and elementary schools | 3 of original 6 apprentices completing the program in 2014 |

Sources: Interviews with program representatives and school websites