

Introducing Students to Manufacturing: Best Practices Guide and Program Resources 2018



Connecticut State Department of Education

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Careers in Manufacturing Introductory Program Chairwoman

- Dr. Christine Mahoney, Superintendent of Schools, East Granby Public Schools

Best Practices Chairwoman

- Susan Palisano, Director, Education & Workforce Development, Connecticut Center for Advanced Technology

Manufacturing Committee Overview

Section 10-21j of the Connecticut General Statutes establishes the Manufacturing Committee to coordinate the education of middle and high school students about careers in manufacturing.

The law requires:

- the committee to compile a [catalog of programs](#) offered at public and independent institutions of higher education in the state that offer training in the field of manufacturing;
- the committee to provide [an analysis](#) of whether current programs available to Connecticut students are meeting workforce needs;
- the Commissioner of Education, in consultation with the committee, to develop and administer a program to introduce middle school and high school students, their families, and guidance counselors to careers in manufacturing; and
- the Department of Education, in consultation with representatives from the manufacturing industry and the Connecticut Center for Advanced Technology, to develop a best practices guide to help local and regional boards of education to incorporate relationships with manufacturing in their middle school and high school curricula.

All Manufacturing Committee materials are found on the dedicated [Manufacturing Web site](#).

Background

Connecticut students graduating in the next ten years will have access to thousands of competitive, high-wage Connecticut career manufacturing opportunities. According to the Connecticut Department of Labor and the Connecticut Department of Economic and Community Development (2018), one of the top growing Connecticut industries is manufacturing. The largest manufacturing industry within Connecticut is transportation equipment manufacturing (e.g., aerospace and shipbuilding). Other Connecticut manufacturing industries include:

- fabricated metal manufacturing;
- machinery manufacturing; and
- computer and electronic product manufacturing.

The *Introducing Students to Manufacturing: Best Practices Guide and Program Resources* offer materials to assist curricula developers, principals, guidance counselors, and middle and high school teachers:

- develop curricula that incorporate an introduction to modern manufacturing;
- incorporate manufacturing relationships; and
- promote modern manufacturing to middle and high school students and their families.

Developing Curricula that Incorporate an Introduction to Modern Manufacturing

When developing curricula that include an introduction to modern manufacturing, there are some action steps that schools should consider:

1. Examine Science, Technology, and Engineering and Mathematics (STEM) pathways currently available for students and build on existing infrastructure.
2. Use Board approved standards and frameworks when writing curricula to expand courses and pathways.
3. Use the Student Success Plan process to guide student career exploration and advisement.
4. Examine current authentic career exploration learning experiences (e.g., job shadowing, internships, pre-apprenticeships, unpaid experiential learning).
5. Reach-out to local manufacturers, businesses, Regional Workforce Development Boards, and Chambers of Commerce. Creative collaborations begin with a simple introductory conversation.
6. Utilize local and regional business needs and students' interests to draft a plan to expand authentic learning opportunities.
7. Develop opportunities with local manufacturers and businesses that introduce, engage, and immerse middle and high students in manufacturing.

Flexible Career Pathways and Student Success Plans

The Connecticut State Department of Education (CSDE) knows that a skilled, prepared workforce is dependent upon Connecticut students having a solid foundation in reading and mathematics as well as having flexible, career-connected pathway opportunities situated in real-world experiences.

In Connecticut, local and regional boards of education must offer a minimum of nine (9) credits in the humanities and nine (9) credits in STEM. The decision of which learning opportunities or courses are eligible to be part of the humanities or STEM pathway is local. The specific pathway for a student should be the one that supports the individual student's learning needs, personal interests, and career aspirations. Local Board of Education graduation policy should be constructed to align with the legislation and with local goals for their graduates.

A [Student Success Plan \(SSP\)](#) is an integral part of career exploration and career advisement. The SSP is an individualized, student-driven career plan that is developed to address each student's needs and interests to help every student stay connected in school and achieve postsecondary educational and career goals. The SSP begins in sixth grade and continues through high school to provide the student support and assistance in setting goals for social, emotional, physical, and academic growth as well as exploring postsecondary education and career interests.

The CSDE has posted resources to support districts and schools in configuring a career pathways program including [model programs of study \(POS\)](#). Schools and districts should engage with manufacturers to assist in the development of flexible, individualized authentic manufacturing learning pathway opportunities for students.

Authentic Experiential Learning Opportunities that Engage Students in Manufacturing

Career exploration cannot occur only in the schools. Students must be engaged in relevant Work-based learning experiences that support their individual career pathways. Experiential learning (e.g., internships, pre-apprenticeships, summer programs) provide students authentic opportunities to develop career and employability skills while establishing meaningful partnerships with manufacturers.

Internships

In the 2018 legislative session, the State of Connecticut amended Section 31-23 of the Connecticut General Statutes to support school district, higher education, and manufacturing technology partnerships. This statute allows 16 and 17 year old high school students, who are enrolled in manufacturing and mechanical course work, to obtain a waiver to obtain paid internships in certain hazardous occupations in manufacturing and mechanical establishments. The waiver certifies that during the internship students are working on learning tasks related to

the course work being studied in school. This legislation advances the effort to engage more students in programs of study toward fulfilling the need for trained and qualified employees in the manufacturing sector.

Pre-apprenticeship Programs

As technology and demand for highly-skilled, entry-level workers increases, [pre-apprenticeship and Registered Apprenticeship strategies](#) have proven to be successful examples to meet potential employee, employer, and industry needs.

Quality pre-apprenticeship programs offer a starting point toward a successful career path and business model. Pre-apprenticeships help individuals and employers cultivate talent and accelerate entry requirements for apprenticeship programs and ensure pre-apprentices are prepared to be successful in their apprenticeship.

- Students learn theory, and receive related instruction credit hours transferable to meet the requirements of a Registered Apprenticeship program.
- Students have hands-on learning experiences and are awarded certificates of advanced study. As a pre-apprentice, the student is a part-time paid “intern.” Upon course completion, an individual can become a full-time Registered Apprentice, with completed education requirements and credited on the job hours attained as a pre-apprentice applied toward an Apprenticeship Completion credential.

Manufacturing Pre-apprenticeship Models

- [Electric Boat Internship/Pre-apprenticeship Summer Program](#): This Connecticut Department of Labor (CTDOL) registered pre-apprenticeship program offers students from partnering high schools a six-week summer pre-apprenticeship program at Electric Boat. Students are paid \$15.92-\$16.72 an hour and work closely with mentors to learn manufacturing skills. In the summer of 2018, students from these 11 area high schools participated:
 - East Lyme High School, East Lyme Public Schools
 - Ella T. Grasso Southeastern Technical High School, Groton, Connecticut Technical Education and Career System
 - Fitch Senior High School, Groton Public Schools
 - Ledyard High School, Ledyard Public Schools
 - Montville High School, Montville Public Schools
 - Norwich Free Academy, Norwich
 - Norwich Technical High School, Norwich, Connecticut Technical Education and Career System
 - Science and Technology Magnet High School of Southeastern Connecticut, New London

- Stonington High School, Stonington Public Schools
- Waterford High School, Waterford Public Schools
- Windham High School, Windham Public Schools
- [Cromwell High School, Cromwell Public Schools](#): Students at Cromwell High School may earn pre-apprenticeship completion credentials based on courses they have successfully completed at Cromwell High School (e.g., Mathematics).
- [Synergy High School, East Hartford Public Schools](#): This program was designed by the members of the [Advanced Manufacturing Employers Partnership \(AMEP\)](#) and is taught by Connecticut Center for Advanced Technology (CCAT) staff at the Synergy High School. Many students became pre-apprentices, working in manufacturing shops in the afternoon while enrolled in the CCAT educational program in the morning.
- [Valley Regional High School, Region 4, Deep River](#): The Employer Council at Valley Regional High School has evaluated two of the Career and Technical Education programs for pre-apprenticeship and developed two certificates currently endorsed by the CTDOL:
 - [Certificate of Advanced Study in Manufacturing](#): This certificate is awarded to those high school seniors who have successfully completed Introduction to Manufacturing and Advanced Manufacturing. This certificate, as an industry recognized portable credential, is awarded to students who have completed one full credit at Valley Regional High School. Local manufacturers have recognized that this 200 hour certificate can be applied towards their apprenticeship requirements in the area of manufacturing.
 - [Certificate of Advanced Study in Engineering & Design](#): This certificate is endorsed by CTDOL for those high school seniors who have successfully completed Technical Drafting, Engineering and Design and Advanced Engineering and Design. This certificate, as an industry recognized portable credential, is awarded to students who have completed two full credits at Valley Regional High School. Local manufacturers and related industries have recognized that this 400 hour certificate can be applied towards their apprenticeship requirements in those areas.
- [Waterbury Career Academy, Waterbury Public Schools](#): The Waterbury Career Academy has an articulation agreement with the Naugatuck Valley Community College (NVCC) in which the graduates of Waterbury High School get academic credit at NVCC for the manufacturing program and a pre-apprenticeship credential. Many of the students are working part-time as pre-apprentices in local companies. During the 2018-19 school year, 58 graduates earned these academic credits and pre-apprenticeship credentials.

For more information on [pre-apprenticeships](#), contact [Todd Berch](#), Program Manager at the Connecticut Department of Labor Office of Apprenticeship Training. For more information on internships, contact [Harold Mackin](#), Education Consultant at the Connecticut State Department of Education.

Summer Programs for Middle School Students

- The [Connecticut Technical Education and Career System \(CTECS\)](#) offers students entering grades 6-8 opportunities to learn about careers. The Exploration Academy is a multi-week, half-day program that occurs four days a week at the technical schools. Students spend a week in each career area, including manufacturing, and complete a “mini” project in each area.
- CCAT offers a yearly [Young Manufacturers Summer Academy \(YMSA\)](#) designed for students entering grades 7-9. YMSA is an eight-day program in which students use the CTECS machine and CAD shops to explore manufacturing careers. Students create projects, visit manufacturing sites, and engage with local manufacturers. On the last day of the YMSA students showcase their work with their families and the manufacturers.

Incorporating Manufacturing Relationships into Middle and High Schools

In order for students to develop a relationship with manufacturing, the Manufacturing Committee analyzed activities that introduce, engage, and immerse middle and high students in manufacturing. The Manufacturing Committee organized these experiences into the chart below according to three stages: exposure/awareness, engagement, and college/career readiness.

Please note that the experiences are not organized by value as **all of these experiences have value** when added to the curricula and assist in establishing relationships with manufacturers.

Examples of Experiences that Assist in Building Relationships with Manufacturers		
EXPOSURE/AWARENESS	ENGAGEMENT	COLLEGE/CAREER READINESS
Industry Site Visits (Appendix B)	Summer/Afterschool Programs	Dual Credit Programs including Connecticut College of Technology (Appendix E)
Manufacturing-themed Events (e.g., career fairs, expositions, and open houses)	In-school Programs	Concentration/Pathway
Presentations/Speakers Representing Manufacturing	Workshops/Courses	Work-based Learning, Internships and Pre-apprenticeships
Goodwin College Advanced Manufacturing Mobile Lab	Site-based Opportunities	Manufacturing Institute Resources

Free Program Materials to Promote Modern Manufacturing

Middle and high schools should use the materials compiled here when developing a program to introduce middle school and high school students, their families and high school counselors to manufacturing. Although these resources are not inclusive, they provide a starting point to assist schools in introducing modern manufacturing careers.

In October 2011, Governor Dannel P. Malloy officially proclaimed October as Manufacturing Month in Connecticut to introduce students to manufacturing career opportunities. Schools and districts may choose to use October as a launch month to begin to introduce students to the many careers in manufacturing.

Manufacturing Program Materials from the Connecticut Center for Advanced Technology, Inc. (CCAT)

[Connecticut. Dream It. Do It.](#) is licensed and led by the non-profit CCAT as part of the National Association of Manufacturers and The Manufacturing Institute's nationwide campaign to create a positive image of today's manufacturing and re-position manufacturing as a viable, cutting edge career. Connecticut. Dream It. Do It. is generously funded by the Connecticut Department of Economic and Community Development.

Connecticut. Dream It. Do It. offers a variety of resources, events, and activities to assist students, parents, and educators with introducing manufacturing to students and assist schools in developing partnerships with Connecticut manufacturers. CCAT staff run student workshops, arrange manufacturing site visits or job shadowing, arrange meetings with their manufacturing partners, attend school career expos, and provide staff with professional learning to assist in recognizing the value of incorporating relationships with manufacturing in middle and high school curricula.

Contact CCAT for free promotional materials including the following booklets:

- *Bring Your Passion to Life with Manufacturing: Manufacture Your Future!*
- *Communicating Positive Career Choices*
- *Guiding Their Pathways*

Additional Manufacturing Program Materials and Ideas

- Sharing narrated videos of manufacturing businesses/environments
 - <http://madeinct.cptv.org/>
 - www.advancingmanufacturingct.com
 - www.ct.edu/makeithere
 - www.nextgenmfg.org/videos
 - apprenticeship opportunities videos [here](#) and [here](#)

- Utilizing the [Advanced Technology Manufacturing Center](#) Career Awareness Guide
- Creating a display of [public and independent institutions of higher education](#) manufacturing program information in print and/or electronically (e.g., booklets, brochures, Programs of Study, course/college catalogs)
- Providing information pertaining to [local manufacturing businesses](#) events and/or opportunities
- Sharing [Connecticut statistics on career paths](#) and [national career outlook and manufacturing salaries](#) to assist students in decision-making
- Providing information on [Advanced Technology Manufacturing Center](#) programs
- Advertising [apprenticeship programs](#) for persons interested in manufacturing
- Encouraging students to enroll in high school manufacturing classes and dual college enrollment programs
- Utilizing the tools published by Advance CTE (e.g., [New Resources to Help You Sell CTE to Parents and Students](#))
- Post student-created video productions highlighting manufacturing careers

The Catalog of Programs at Public and Independent Institutions of Higher Education

[The Catalog of Programs at Public and Independent Institutions of Higher Education](#) is an online catalog of programs at public and independent institutions of higher education in the state that offer training in the field of manufacturing. This catalog includes for each program: (1) the degree, certification, license or credential awarded upon completion; (2) the period of time and requirements for completion; (3) the enrollment process; and (4) the cost of attendance.

Middle schools and high schools may use the catalog to bolster:

- SSP development and career interest inventory activities;
- secondary Program of Studies documents and/or post-secondary documents;
- school/district Web pages (e.g., Guidance, Career and Technical Education, College Connections, and Adult Education);
- career awareness information and student pre-apprenticeship/internship planning;
- adult education communication (e.g., program fliers); and
- family communication (e.g., include in the “Family Connections” page of Naviance).

Goodwin College Advanced Manufacturing Mobile Training Lab

The [Goodwin College Advanced Manufacturing Mobile Training Lab](#) brings manufacturing training to:

- high school students who can earn college credit in manufacturing;

- middle school students to become inspired to be part of the next generation’s workforce; and
- the community to share information on opportunities for careers in manufacturing.

The mobile lab reaches audiences who may not otherwise have access to training and introduces them to a world of career possibilities. This state of the art mobile classroom is self-powered and climate-controlled. With easy entrance and accessibility, the mobile lab is perfect for school fairs and expos, career exploration events, and public relations opportunities. The mobile lab is equipped with:

- 13 workstations to accommodate 12 – 15 students;
- an 84 amp generator, a Borescope, soldering equipment, 3-D printing equipment; and
- devices to measure fatigue in materials.

Introducing Careers in Manufacturing into Existing School Programs and Events

Schools may consider the following additional activities to incorporate manufacturing into existing programs and events:

- Meet informally with your local manufacturers and businesses often over a cup of coffee a conversation begins that leads to many exciting collaborative opportunities
- Conduct/sponsor manufacturing [career fairs](#) and expositions to share promotional materials and create partnerships
- Include higher education institutions and/or manufacturing demonstrations at middle and high school events (e.g., parent conferences, open houses)
- Sponsor/organize end of school year manufacturing education student exposition
- Schedule quarterly presentations in schools from education practitioners, manufacturers, higher education manufacturing programs
- Encourage students to share their apprenticeship, cooperative work experiences, and/or career shadow experiences at Board of Education meetings
- Promote regular inter-district manufacturing conventions
- Encourage development and sharing of a manufacturing events calendar of activities with the community
- Promote Young Manufacturers Associations and programs
- Offer the broadest possible range of science courses and research opportunities that allow students to continue to develop their abilities to design laboratory investigations; understand measurement error; troubleshoot problems with equipment; and collect, interpret and present data

- Connect and collaborate with other [Connecticut High Schools offering manufacturing courses](#)

Connecticut Models of College/Career Readiness Manufacturing Partnerships

The Committee compiled a list of best practice models of Connecticut early college partnership programs offering Connecticut students manufacturing opportunities.

- [College Career Pathways Program \(CCP\)](#): CCP gives high school students the opportunity to experience college-credit bearing courses taught by college-approved high school teachers. CCP is a concurrent enrollment program which receives funding through the Carl D. Perkins Career and Technical Education Improvement Act of 2006. Community Colleges throughout Connecticut (e.g., Capital, Housatonic, Manchester, Middlesex, Tunxis) partner with area high schools and industries to award students with postsecondary credits and assist them in work towards earning an industry-recognized credential or certificate.
- [College Connections Program](#): College Connections provides high school students with the ability to transition to long-term careers in advanced manufacturing technology. ACC has established a series of technology programs designed to provide high school juniors and seniors with opportunities to consider career paths in manufacturing. See Appendix D for more information on ACC's College Connections Program.
- [Early College Academy](#): Northwestern Connecticut Community College offers early college academy dual enrollment (concurrent enrollment) courses with area high schools including: Housatonic Valley Regional High School, Northwestern Regional High School, The Gilbert School, and Torrington High School.
- [East Granby Public Schools and Asnuntuck Community College \(ACC\) Fifth Year Program](#): Dr. Christine Mahoney, Superintendent of Schools of the East Granby Public Schools, and Frank Gulluni, Director Emeritus of Advanced Manufacturing Technology at ACC, developed a model hands-on program to introduce students in grades 6-10 to Advanced Manufacturing. Students in grades 11-12 earn 30 college credits in their last two years of high school plus an additional year (the Fifth year) at ACC. See Appendix C for more information on the Fifth Year Program.
- [Hamden Early College Academy](#): This Academy is a branch of the Hamden High School STEM Academy and, beginning in the fall of 2019, will provide students the opportunity to concurrently earn their high school diploma and collegiate level training in Manufacturing Technology or Manufacturing Engineering. This initiative partners the New Haven Manufacturers Association, the Hamden Public Schools, the Town of Hamden, and Gateway Community College. During their high school experience students will be mentored by manufacturers both in the school setting and through experiential

learning ranging from shadows to internships. Upon program completion students will be 'hire ready' and will have the opportunity interview for open positions.

- [Materials Manufacturing Summer Teachers' Institute](#): The Materials and Manufacturing Summer Teachers Institute is a school-to-career initiative that targets Science, Technology, Engineering & Mathematics (STEM) skills instruction in the New Haven and Bridgeport Public Schools grades 7-12. The project is sponsored by the New Haven Manufacturers Association (NHMA) and the Center for Research on Interface Structures Phenomena (CRISP), an NSF funded MRSEC at Southern Connecticut State University (SCSU) and Yale University. Through this professional learning, teachers learn to incorporate hands-on STEM experiences that integrate manufacturing so that their students are creating products and problem-solving.
- [Valley Regional High School](#): Valley Regional High School offers a robust program of manufacturing studies in which students earn a certificate of advanced study in Manufacturing or Engineering from Connecticut's Department of Labor. In addition to earning a manufacturing certificate, high school students receive 200 – 400 apprenticeship hours and are eligible to take courses through the school's partnership with Middlesex Community College.
- [Waterbury Career Academy partnership with Naugatuck Valley Community College](#): The Northwest Connecticut Workforce Investment Board has been working on career pathways since 2006. Their first program involved high school students in grades 11 and 12 in a sequence of courses at Naugatuck Valley Community College (NVCC) that resulted in certificates in advanced manufacturing. The initial program was small, but highly successful. They have since worked with the Waterbury Public Schools to create the Waterbury Career Academy (WCA). The Academy opened its doors in the fall of 2013 with a class of ninth graders. This program was developed to encourage high school students in 9-12 to take a combination of core high school courses and college courses to receive their diploma as well as a certificate in Manufacturing and Information Technology. Students from the WCA could then build on this "stackable" credential at NVCC, using their credits to be accepted for the Associate degree in Technology Studies: Machine Tech Option program. This associate degree in turn transfers directly to Central Connecticut State University program for a Bachelor's degree in Industrial Technology.
- [Externships for Teachers and Guidance Counselors](#): ACC utilized a portion of their Perkins funds to provide an Advanced Manufacturing learning opportunity to local high school counselors, technology education teachers and business teachers. During this one week professional development, educators were provided insight into manufacturing education and careers as they designed and made shepherd hooks and solar lights.

Leveraging your Career and Technical Education (CTE) Perkins Funds to Enhance Manufacturing Experiences and Partnerships in CTE Courses

The chart below shows ways in which schools may use their Perkins funds to enhance manufacturing experiences and partnerships in CTE courses. Only CTE courses taught by CTE-certified teachers may utilize Perkins funds.

Bolster Teaching and Guidance	Deepen Learning	Improve Program Quality
Partner with Community Colleges for summer learning opportunities for CTE teachers and guidance counselors to be provided with hands-on Advanced Manufacturing experiences	Fund buses for CTE students to visit manufacturing sites and career fairs	Provide virtual access to workplace experts by purchasing new computers and technologies
	Expand dual credit CTE manufacturing programs with Community Colleges	Purchase textbooks for new courses
Fund CTE teachers' attendance at manufacturing conferences or professional development and fund substitutes for attendees	Provide CTE students with presentations/speakers (not selling a product) representing Manufacturing	Fund new Career Center Counselor position (up to 3 years)
Support curricula writing outside of contracted hours to enhance manufacturing experiences for students	Offer Work-based learning experiences	Purchase equipment such as 3-D printer, multi-material printer, CNC 5-axis milling machine
	Support school-based enterprises	

References

Pisano, G. P. and Shih, W. C. (October 2012). Producing Prosperity: Why America Needs a Manufacturing Renaissance, Harvard Business Review Press, Boston, MA.

The Connecticut Economic Digest, September 2018, Vol. 23, No.9, Connecticut Department of Labor and Connecticut Department of Economic and Community Development found at <https://www1.ctdol.state.ct.us/lmi/digest/pdfs/cedsep18.pdf>

Appendix A: Connecticut Manufacturing Associations Contact List

Connecticut Associations		
Association	Contact Name	Contact Email
Aerospace Components Manufacturers	Paul Murphy	pmurphy@acm-ct.org
American Mold Builders Association	Troy Nix	tnix@amba.org
Connecticut Center for Advanced Technology	Susan Palisano	spalisano@ccat.us
Connecticut Tooling and Machining Association	Christopher DiPentima	cdipentima@pegasusmfg.com
Eastern Advance Manufacturing Alliance	Kelli Valleries	kvallieres@soundmfg.com
Manufacturing Alliance of Connecticut	Kathy Saint	ksaint@schwerdtle.com
New Haven Manufacturing Association	Ed Fenton	edfenton@newhavenmanufacturers.com
Northwestern Manufacturing Coalition	Joanne Ryan	joann@nwctchamberofcommerce.org
Small Manufacturers Association	Cyndi Zoldi	Cyndi@sma-ct.com
National Associations		
Association	Email Address	Contact Phone Number
Plastics Industry Association (PLASTICS)	www.plasticsindustry.org	202-974-5200
National Association of Manufacturers (NAM)	http://www.nam.org/	202-637-3000

Appendix B: New Haven Outreach and Partnership Development

The New Haven Manufacturers Association (NHMA) Workforce Enhancement Committee in partnership with the New Haven Public Schools (NHPS), New Haven Science Fair Program, CONNSTEP, and NHPS Hill Regional Career High School developed an outreach program focused on affording the opportunity for students to visit several STEM-related and manufacturing facilities to observe the company’s operations, learn about the types of skills employees need and understand the requirements for new and present employees. Students routinely express the valuable perspective that they have gained as a result of this program.

Goals

- Increase student awareness of promising career and educational pathways among local businesses and institutions and inspire them to raise their level of performance
- Increase awareness among businesses in terms of student skills and attributes
- Establish, maintain, and advance partnerships with community stakeholders with the goal of supporting our school community and improving student achievement

Bringing STEM and Manufacturing Careers into the Classroom: A Tiered Approach to Incorporating STEM Career Awareness in the NHPS

1. The first steps, required no changes to classroom instruction or associated activities
 - a. survey students in order to define their interests and degree of familiarity
 - b. share with students (and their families) a list of fast-growing occupations
 - c. share with students (and their families) a list of STEM-related firms, including their websites and a summary about their work
 - d. meet with the PTO and listen to their feedback, as well as their hopes and dreams (for their sons and/or daughters)
2. The next steps, which required the addition of or changes to existing classroom activities
 - a. teacher discloses how laboratory exercises are consistent with what someone might do as a biological technician, statistician, or chemist, for example
 - b. students present a STEM-related firm (of their choosing) to their peers:
 - i. disclose the company’s name
 - ii. describe what this company does
 - iii. describe one of their products or services in terms of how they make it or what it does
 - iv. describe how this product or service relates to course content
 - v. furnish a related “show-and-tell” picture, device, video, etc.
 - vi. finish within 1-2 minutes

3. Additional steps, which required changes to classroom instruction or the addition of a dedicated class (to existing course offerings).
 - a. Project-based approach (aligned with NGSS skills and practices as well as DCIs) through which students have specific roles in solving a problem or producing a finished product.
 - b. Develop and implement a class that is designed to address student awareness of career pathways and support students seeking industry relevant certifications.

Four-years of Results for NHPS Students

1. Job shadowing and networking with local businesses.
 - a. 300+ students participated in visits to 8 STEM firms: Lighting Quotient, PEP Lacey (NN Engineering), Radiall, Chabaso Bakery, Sikorsky, Ulbrich Metals, Unicorr, and Alexion + 2 Career Fairs
 - b. Prior to visiting the STEM firms, all students completed pre-learning activities designed to support their understanding of prospective career and educational pathways
 - c. Participating students routinely expressed the valuable perspective that they have gained as a result of those educational experiences and ask about future opportunities
 - d. Program has expanded to include Cooperative High School (New Haven), Dr. Cortlandt V.R. Creed Health and Sports Sciences High School, and Quinnipiac Real World Math STEM School
2. Representatives from the aforementioned companies have visited Career High School and other schools to engage and build awareness among students.
3. Related professional learning has supported 50+ teachers from the New Haven area.
4. Attracted equipment donations/loans and funding from SCSU, NHMA, + local firms.
5. A new class has been developed, STEM Careers, to bring these efforts into the classroom.
6. Genomics equipment has been made available by Jackson Labs to support STEM Careers
7. Two students earned paid internships at Unicorr.
8. Southern Connecticut State University (SCSU) can now enroll NHPS students in 100- or 200-level Comp. Science + Biology.
9. SCSU, Career HS, and Celentano K-8 are poised to form a K-18 Biopath Coalition.

Thank you to Peter Dimoulas (Science Teacher) and Jack Crane (CONNSTEP, Director, Growth & Innovation Services) for providing this information.

Appendix C: Fifth Year Model for Advanced Manufacturing Technology Education at Asnuntuck Community College

A growing concern across advanced manufacturing industries is the lack of significant, well-developed pipelines of women and men educated to replace those retiring in large numbers, often referred to as the “silver tsunami.” As an example, just three corporations—Pratt & Whitney, Sikorsky, and Electric Boat—anticipate the need to fill more than 30,000 manufacturing positions in the next decade. Additionally, their sub-contracting community of employers expect their workforce to grow approximately 10-20% in the next five to ten years. The workforce problem is exacerbated by the general public’s perception that today’s manufacturing technology is not much different from the workplace environment of the past. It is important that students, families and high school guidance counselors are aware of the benefits of a career in the manufacturing sector as well as the myriad coursework requirements mandated by the workplace.

Asnuntuck Community College (ACC) in partnership with East Granby Public Schools launched an innovative program in 2014 to develop the next generation workforce. As part of the program, interdisciplinary instruction that includes manufacturing curriculum begins in middle school grades. All students experience hands-on, engaging, project-based units of instruction. Classes are co-taught with community college faculty who are ‘on loan’ to the schools.

The program has three components:

- Starting in middle school, students participate in advanced manufacturing coursework in their regular classrooms and computer labs. Instructional modules include robotics, SolidWorks, 3D printing, electronics, and machining. Once in high school, students can take a variety of elective courses in advanced manufacturing technologies.
- In 11th and 12th grades, students enroll in academic and advanced manufacturing technology courses, earning as many as 30 college credits while completing some of their high school requirements in ACC’s Advanced Manufacturing Technology Center. Taking courses at ACC allows the students to use the same state-of-the-art equipment found in advanced manufacturing industries.
- Following high school graduation, students enroll in an Advanced Manufacturing Technology program at ACC, and can earn both a *Manufacturing Technology Certificate* and an *Associate of Science* degree in three to four semesters—twelve to eighteen months after receiving their high school diploma. (The Fifth Year) Students can pursue certificate and degree programs across a myriad of skills sets critical to aerospace and other manufacturing-related industries: CNC machining, welding and fabrication, electronics and electro-mechanical maintenance & repair, layout and inspection with metrology and CMM, CAD/CAM, and additive manufacturing.

The expansion of this program will provide ACC and its sister colleges with the means to enhance and expand this promising program, ensuring a growing pipeline to the next-generation manufacturing workforce.

The Fifth Year program has attracted attention across the state of Connecticut. ACC has launched an innovative approach to creating a pipeline of students who will choose advanced manufacturing career paths. It is a unique approach, with strong engagement from local manufacturing industries, a commitment to ongoing professional development on the part of qualified, experienced education professionals across grades and school districts, and exposure by students to the world of next generation manufacturing. Potentially, our pipeline proposal will provide participating students in grades five through twelve with more than 800 hours of manufacturing technology education, thirty college credits, the option of completing an A.S. degree in one calendar year, paid internships, and a well-paying, incentive-laden career with unlimited opportunities for advancement.

Given ACC's twenty year commitment to advanced manufacturing technology and education; our long-term, very significant involvement and leadership with all levels of the employer community: incumbent worker development, scholarships, internships, curriculum development, advisory status; and long-term influence and support of technology education in both public schools and community colleges, it is certain we will continue to share our programs, systems, and experiences with state and federal agencies, school systems, community colleges, vocational-technical institutions, and manufacturers, both in CT and nationally. Industry, especially defense-focused manufacturers, will remain and expand here with the assurance Connecticut's community colleges can and will meet their ongoing needs for women and men fully prepared for advanced manufacturing careers.

Thank you to Dr. Christine Mahoney (Superintendent of East Granby Public Schools) and Frank Gulluni (Director Emeritus of Advanced Manufacturing Technology at Asnuntuck Community College) for providing this information.

Appendix D: College Connections Program at Asnuntuck Community College

The Pipeline from High School to High Tech

Advanced manufacturing technology companies in Connecticut will need to fill thousands of career positions in the next decade and beyond. College Connections provides high school students with the ability to transition to long-term careers in advanced manufacturing technology.

Asnuntuck Community College (ACC) conducts programs that provide high school juniors and seniors with opportunities to consider career paths in advanced manufacturing. Through College Connections, students from area high schools study and participate in a series of welding and fabrication, CNC machining, and electronics and electro-mechanical technology programs and related subject matter areas for both high school and college credit. The program provides orientation, assessment, total quality components, blueprint reading, benchwork, mathematics, and basic and advanced technology education directed specifically to the needs of the school population and the requirements of the employer community in Connecticut. All coursework is conducted at ACC in Enfield. Students are given the option after graduation to participate in post-secondary technology programs that can result in one or more of the following outcomes: certificate and associate degree, four year degree (especially through the COT's (College of Technology) Pathways program), and career employment in the advanced manufacturing sector.

The ACC Model

In the past decade, more than 400 high school juniors and seniors have participated in for-credit advanced manufacturing technology programming at ACC. Both Housatonic Community College and Naugatuck Valley Community College have adopted the program and anticipate continued expansion to a number of high schools in their service areas.

Advanced manufacturing technology training and education provides the opportunity for an innovative and challenging career that is computerized, hands-on, and high tech. The Advanced Manufacturing Technology Center at ACC is leading the way with in-demand programs developed in a close working relationship with the private sector over a period of many years.

The leading edge College Connections program is one of the key pipelines to careers in advanced manufacturing. High school juniors and seniors from the East Granby Schools and the Hartford/Enfield region can earn credits for advanced manufacturing coursework in subject areas ranging from blueprint reading and welding to CNC machining and robotics.

Manufacturing Your Teen’s Future

High school students are in ACC’s classrooms, computer labs, and manufacturing labs seven to ten hours each week throughout the school year. Upon graduation, College Connections participants can transition to the college’s certificate and associate degree programs in advanced manufacturing technology that include paid internships. College Connections students also become major candidates for scholarships funded by the manufacturing community.

Jump Start Your Career in Advanced Manufacturing

High school juniors and seniors in the College Connections program can earn between six and eight college credits annually toward a certificate or an associate degree with coursework in:

- CNC Machining;
- Welding and Fabrication;
- Electronics Systems and Electro-Mechanical Maintenance & Repair; and
- Additive Manufacturing (3D Printing).

The College Connections Program has proven to be an invaluable asset to aerospace industries across Connecticut and Western Massachusetts, and, specifically, to the Aerospace Components Manufacturers group (ACM), whose 118 companies employ more than 9,000 women and men. The advanced manufacturing sector in Connecticut and Western Massachusetts needs talented young people who are seeking long-term, challenging careers that run the gamut from CNC machining, welding and fabrication, and electro-mechanical maintenance and repair to quality assurance and inspection, software applications, and engineering.

Planned Outcomes

1. Students earn between 12 and 15 transferrable college credits in advanced manufacturing technology coursework.
2. Students make career choices based on real experiences.
3. Students participate in manufacturing technology courses and programs related directly to the needs of the private sector.
4. Students are provided support services needed to be successful.
5. Students establish a solid foundation for their college experience.
6. Students develop greater appreciation for the challenges and the opportunities inherent in the manufacturing sector.
7. Students understand more nearly comprehensively the importance of math and science studies and how critical these course materials are to careers in manufacturing.
8. Students are in priority positions for company-sponsored scholarships in manufacturing technology.

9. College Connections graduates who pursue a certificate or degree program at ACC typically perform better than their peers.

More Global Outcomes

1. The United States Department of Labor reports a need for more than one million advanced manufacturing graduates in the next 7 to 10 years. The ongoing concern is our collective ability to access the population and educate these women and men for long-term, successful careers in the manufacturing community across Connecticut;
2. Enhanced relationships potentially between education and economic development;
3. Expansion and retention of advanced manufacturing technology industries;
4. Significant upgrading of participants' technical abilities to insure a more successful employment experience;
5. Greater participation by industry in the development of internship, mentorship, and summer jobs programs for in-school population;
6. Replication of the ACC model to other community colleges. To date, the following colleges have adopted some components of the Asnuntuck program: Housatonic, Naugatuck, Three Rivers, Quinebaug, Middlesex, and Manchester;
7. Marketing advantage for state and local economic development initiatives; industry needs external sources to provide education and training;
8. Access to other funding streams for the expansion of workplace development as a vehicle to help build the manufacturing base.

For the school year September 2018 through June 2019, ACC's College Connections program is expected to serve between 80 and 130 high school juniors and seniors from across the Hartford/Enfield region.

Appendix E: Connecticut College of Technology

The Connecticut College of Technology (COT) was established in 1995 under Connecticut Public Law 95-04 and includes all 12 Connecticut community colleges as well as public and private partner universities. This unique infrastructure and governance provides seamless articulation between the community colleges and their four-year partner universities providing multiple points of entry for degree completion. The two core programs of the COT are Engineering Science and Technology Studies, which share a Common Course Numbering (CCN) system among all 12 Connecticut community colleges. The Engineering Science program provides a theoretical, calculus-based curriculum while the Technology Studies program provides hands-on, problem-based curriculum that includes credit certificates and eighteen industry-driven options that respond to workforce needs. All 12 community colleges offer the Engineering Science and Technology Degrees; the Technology Studies Options are offered based on local industry needs.

Community college students who complete their A.S. degree in the COT Engineering Science program have the ability to continue their program of studies as juniors in engineering programs at the Central Connecticut State University (CCSU), University of Connecticut (UConn), Fairfield University, the University of Hartford, the University of Bridgeport or the University of New Haven (UNH). Students who complete their A.S. degree in one of the 18 COT Technology Studies Options can continue seamlessly as juniors in Industrial Technology at Central Connecticut State University or Engineering Technology the University of Hartford. Additional articulation agreements are in place with Southern Connecticut State University and Eastern Connecticut State University.

Through the COT's stackable credential model, students who complete any of the advanced manufacturing certificates offered at the Connecticut community colleges are able to apply those credits to an A.S. degree and follow the Technology Studies pathway to a B.S. degree at CCSU or the University of Hartford.

College of Technology Site Coordinators Council

The COT's leadership is a Site Coordinator's Council which meets monthly and averages between 25-30 representatives from all 12 Connecticut community colleges, 4-year public and private university partners, the Connecticut Technical Education and Career System (CTECS), and business and industry partners. Discussions and presentations focus on curriculum and program review and approval, professional development, student transfer, and outreach initiatives.

New College of Technology A.S. degrees, certificates, and option proposals and program modification proposals are presented to the Site Coordinators Council to start the academic approval process by one or more lead institutions, starting with review and approval by the Site Coordinators Council. This review focuses on curriculum, learning outcomes, and local need and

the final approval is decided through a formal vote. Once the degree, certificate, option, or modification is approved, other colleges may offer it after an abbreviated approval process for an immediate response to industry needs.

Regional Center for Next Generation Manufacturing

The Regional Center for Next Generation Manufacturing (RCNGM) is a National Science Foundation-funded Advanced Technological Education Center of Excellence that was created by the COT in 2004 to response to workforce needs for all twelve community colleges in Connecticut. The goals of the RCNGM are: the creation of articulation pathways, student recruitment and retention, curriculum development, and professional development for faculty and teachers. Through open meetings of the Site Coordinators Council, input is received from high school teachers and administrators, community college and university faculty, government representatives, business and industry partners, and educational program partners and is used to guide the initiatives that the RCNGM administers.

The RCNGM is continuously designing and implementing student recruitment and retention programs. These programs strengthen and help expand articulation agreements and instructional collaboration among four-year colleges, community colleges, and secondary schools. Student recruitment activities include regional career expos that allow students to talk to local manufacturers their workforce needs, tour a community college campus, and attend presentations on advanced manufacturing technologies. Marketing activities include the RCNGM website, social media, and DVDs with accompanying Teacher Guides. The “Manufacture You Future 2.0” and “You Belong: Women in Manufacturing” DVDs include “day-in-the life” scenarios of employees who represent different roles in a variety of manufacturing jobs. The Teacher Guides include activities that can be done in the classroom to teach students about manufacturing career possibilities. Over 8,000 copies of the “Manufacture You Future” DVD have been distributed nationally.

Professional development activities for faculty are as important as the student activities. The RCNGM continuously provides opportunities for community college and high school faculty to upgrade their knowledge base of emerging technologies needed for next generation manufacturing. Faculty externships with local industries, workshops, seminars, and conferences all provide faculty with the tools and ideas needed to create curriculum that will meet current workforce needs. High school counselor workshops are also a key activity that exposes counselors and faculty to career possibilities that they can bring back to students and parents.

High School Pathway Programs

College Connections Program: High school students attend classes at Asnuntuck Community College (ACC) 7-10 hours per week during school year, earning 6-8 college credits annually.

Students transition to ACC's certificate and A.S. degree programs under the COT upon graduation from high school to complete the remaining courses in their respective programs.

Fifth Year Program: 11th and 12th grader students take ACC courses at their high schools and at ACC. Participants can earn up to 30 college credits over the two years. After graduating high school, students can earn an advanced manufacturing certificate and A.S. degree in through the COT pathway in three semesters (12 months).

Middle School and High School Initiatives

The COT has partnered with several middle school and high school programs to develop an interest in manufacturing careers for middle school and high school students.

Engineering Technology Challenge (ETC): ETC is a National Science Foundation funded program that provides inner-city and underrepresented high school students with a Saturday hands-on educational opportunity focusing on professional and technical skills. The programs are held on community college campuses to introduce students to a college campus. Students learn about teamwork while completing assignments and projects using advanced manufacturing technology including additive manufacturing that are currently used in STEM disciplines. The COT faculty provide instruction for the program, while COT community college students serve as mentors for the high school students, with the goal of encouraging students to pursue further education and careers in manufacturing.

Connecticut Pre-Engineering Program (CPEP): CPEP is a not-for-profit organization founded in 1986 that has been nationally recognized for STEM education excellence with urban students. CPEP addresses the growing need to identify, inspire and ignite the desire of under-represented youths to pursue careers in STEM and manufacturing. CPEP represents middle school and high school students in 13 school districts and 35 schools while directly touching the lives of over 1,000 students each year. The COT has sponsored and partnered with CPEP for their student expos and summer programs, including providing mentors from the COT for the middle and high school students.