Advanced Manufacturing

The Future of Engineering and Producing

The modernized National Career Clusters Framework comprises 14 industry-oriented, sector-specific Career Clusters and 72 Sub-Clusters. Industry sector profiles serve as a resource for each Career Cluster. Each profile provides a Cluster overview, details the Sub-Clusters, and contains labor market data, occupational data, and relative skills.

Each industry sector profile was developed through an analysis of quantitative and economic data organized by the North American Industry Classification System (NAICS), Standard Occupation Classification (SOC) codes, as well as national labor market data from the U.S. Bureau of Labor Statistics (BLS) and other federal sources. The Career Cluster title and caption, full definition, and Sub-Clusters with definitions are part of the official Framework and informed by input from sector-focused Industry Advisory Groups convened.

The Industry Sector Profiles can be used in a variety of ways, including to:

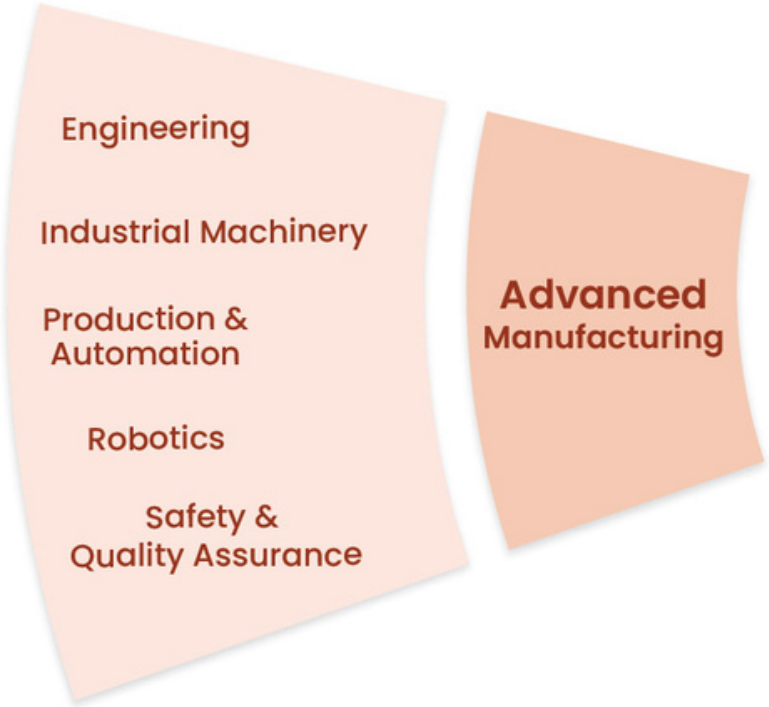
- understand the breadth and depth of each Cluster;
- identify skills, competencies, and careers that can be incorporated into curriculum and program design;
- create connections and opportunities for work-based learning;
- assist learners in career exploration and advising;

...and many other possible uses!

Overview: Advanced Manufacturing Career Cluster

The Advanced Manufacturing Career Cluster focuses on various career opportunities that center around developing products and processes, particularly utilizing new and emerging technologies, including automation and robotics, to develop solutions to current and future industry challenges. Skills developed from programs in this Cluster lead learners to work in specialized laboratories, smart factories, and other places where the design thinking process is regularly utilized. This Cluster falls within the "Building and Moving" Cluster grouping, recognizing learners' passion for how products, materials, and structures are designed, transported, and built. Based on national labor market data, this Career Cluster is most closely connected to the **Agriculture**; **Arts, Entertainment, & Design**; **Construction**; **Energy & Natural Resources**; **Healthcare & Human Services**; and **Supply Chain & Transportation** Career Clusters. Read the Interdisciplinary Elements explainer resource for more information.

The Advanced Manufacturing Career Cluster blends innovative technologies and practices to enhance design and production. It covers areas such as engineering, research and development, automation and artificial intelligence, equipment maintenance, safety protocols, and quality control. This Cluster aims to increase efficiency, reduce waste, ensure safety, and produce high-quality goods, driving the industry's growth and adapting to modern demands. For more information on changes within this Cluster, see Appendix A.



Sub-Clusters, Definitions, & Example Programs of Study

Engineering

Careers that use engineering principles to develop and improve manufacturing processes and systems and to design products. Professionals in this field tackle production challenges, boost efficiency, leverage advanced technologies, and contribute to the sector's advancement. The manufacturing sector encompasses numerous types of engineering, including mechanical, electrical, chemical, biopharmaceutical, materials, and industrial. This Sub-Cluster also involves research and development and prototyping for emerging products and systems.

Example Programs of Study

Engineering & Technology Pre-Engineering
Semiconductor Manufacturing Engineering Technology

Industrial Machinery

Careers focused on working with manual equipment, such as computer-numerical-controlled (CNC) machines, 3D printers, quality control equipment, material handling tools, maintenance and repair devices, specialized machining and surface treatment machines, fabrication equipment, and energy management systems. Professionals in this field set up, operate, maintain, and repair advanced machinery, ensuring efficient and safe performance.

Example Programs of Study

Industrial Machine Mechanics
Precision Machining

Production & Automation

Careers centered on the hands-on management and execution of manufacturing processes. This field involves automation, overseeing production lines, quality control, assembly and product finishing, and ensuring efficient workflow. This Sub-Cluster includes specialized sectors such as processed food and beverage production and textile manufacturing, emphasizing efficiency and adherence to industry standards across diverse production types.

Example Programs of Study

Apparel & Textile Production
Manufacturing Production Process Development

Robotics

Careers involved in developing, implementing, and maintaining technologies that deploy robotics. This field encompasses roles focused on programming robots; overseeing production lines enhanced by robotics, mechatronics, and smart manufacturing concepts; and ensuring that these technologies operate efficiently and safely.

Example Programs of Study

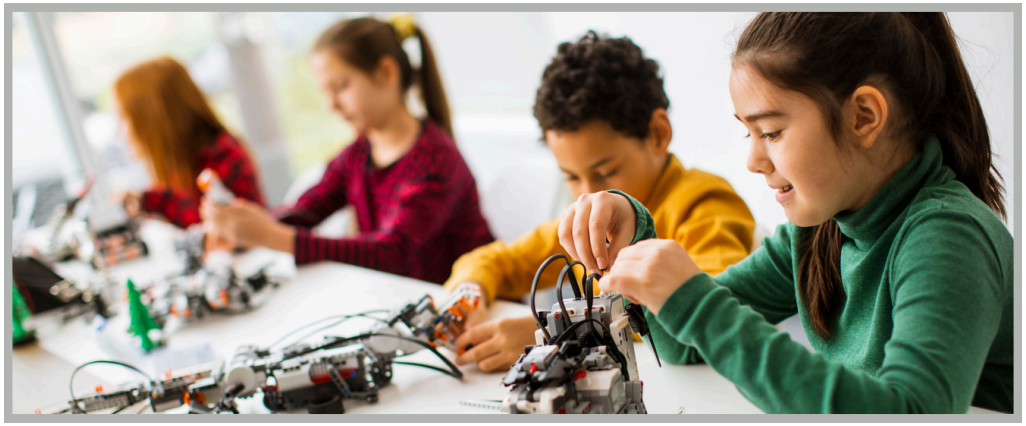
Industry 4.0
Robotics Technology

Safety & Quality Assurance

Careers are dedicated to ensuring workplace safety, worker health, environmental compliance, and product quality. Professionals in this field develop and implement standards and practices to maintain safe and sustainable operations while conducting rigorous testing and inspections to uphold product integrity.

Example Programs of Study

Safety & Environmental Assurance



Occupations, Employment Contexts, Credentials, & Skills

Designing intentional and labor market-aligned pathways requires understanding the occupations and skills that are in demand and commanding family-sustaining wages in your context. Building a deeper understanding of employment trends, including wage potential, a clear picture of the types of employment contexts or businesses this sector offers, and the knowledge and skills needed for success are all important aspects of a learner's journey through their pathway and into the world of work. Leaders can use the data below to inform pathway design at the state or local levels or by advisors and learners as they plot paths to the future. The skills and occupations below were validated using real-time labor market information from 2023 and 2024 from online job postings, which provided the frequency with which skills were mentioned in digital job postings.

Top Occupations

The following table (Figure 1) displays the top occupations within this Cluster. Occupations are listed in order of typical entry-level education required for the position, beginning with a bachelor's degree and then moving through an associate degree, a Postsecondary nondegree award, and a High School Diploma to demonstrate the potential occupational pathways available in this Cluster. Data points for each occupation include five-year job projections, 2023 hires, average annual job openings, 10th percentile hourly earnings (as a proxy for entry-level wages), median hourly earnings, and required entry-level education. The table is reflective of national data and was pulled in 2024. Users should be mindful that the data in this table will not be updated, so the percentages and numbers are subject to change in real-time. For updated state-level occupation projection data, please visit O*NET's Projection Central.

FIGURE 1

Source: U.S. Bureau of Labor Statistics, QCEW; Lightcast Database; U.S. Census Bureau.
*To contextualize this data, educators are encouraged to identify and share their hourly living wage by family size for their state, county, or region at the MIT Living Wage Calculator or other source of living wage data.

Occupation Title	2024 Jobs	2029 Jobs	% Change	2023 Hires	Avg. Annual Openings	10th Percentile Hourly	Median Hourly	Typical Entry Level Education
Industrial Engineers	346,609	379,506	9%	102,248	26,551	$31.26	$47.73	Bachelor's degree
Mechanical Engineers	298,399	323,972	9%	84,881	21,942	$30.88	$47.85	Bachelor's degree
Industrial Production Managers	233,166	245,129	5%	72,476	18,651	$33.98	$55.87	Bachelor's degree
Architectural and Engineering Managers	216,533	229,627	6%	62,369	16,558	$51.34	$79.42	Bachelor's degree
Electrical Engineers	195,890	208,505	6%	48,588	13,382	$33.07	$51.37	Bachelor's degree
Engineers, All Other	177,570	186,971	5%	50,128	12,415	$29.02	$53.66	Bachelor's degree
Occupational Health and Safety Specialists	128,386	141,938	11%	88,945	16,867	$23.76	$39.00	Bachelor's degree
Natural Sciences Managers	104,901	112,453	7%	34,509	9,112	$37.27	$75.84	Bachelor's degree
Chemists	88,692	94,719	7%	28,062	7,551	$25.42	$40.71	Bachelor's degree
Environmental Scientists and Specialists, Including Health	86,909	92,869	7%	35,857	8,259	$23.33	$37.97	Bachelor's degree
Aerospace Engineers	74,516	79,775	7%	18,327	5,111	$39.06	$62.83	Bachelor's degree
Electrical and Electronic Engineering Technologists and Technicians	107,988	112,942	5%	45,809	11,740	$22.07	$34.91	Associate's degree
Industrial Engineering Technologists and Technicians	76,241	80,655	6%	31,516	8,043	$21.53	$30.07	Associate's degree
Engineering Technologists and Technicians, Except Drafters, All Other	75,226	79,262	5%	34,154	7,840	$20.47	$35.27	Associate's degree
Computer, Automated Teller, and Office Machine Repairers	93,173	91,321	-2%	41,278	9,500	$15.55	$21.63	Some college, no degree
Miscellaneous Assemblers and Fabricators	1,529,468	1,535,918	0%	1,136,208	172,376	$14.36	$18.69	High school diploma or equivalent
First-Line Supervisors of Production and Operating Workers	699,899	731,417	5%	314,169	72,881	$20.78	$31.60	High school diploma or equivalent
First-Line Supervisors of Mechanics, Installers, and Repairers	636,135	668,395	5%	307,123	60,136	$22.08	$36.42	High school diploma or equivalent
Inspectors, Testers, Sorters, Samplers, and Weighers	615,827	631,067	2%	404,326	75,598	$15.25	$22.03	High school diploma or equivalent
Welders, Cutters, Solderers, and Brazers	471,332	495,733	5%	271,087	52,461	$17.35	$23.41	High school diploma or equivalent

Top Industry-Recognized Credentials

- Six Sigma Certification
- Commercial Driver's License (CDL)
- Certified Safety Professional
- Project Management Professional Certification
- EPA HVAC Certification
- HVAC Certification
- Forklift Certification
- American Society For Quality (ASQ) Certification
- Airframe and Powerplant (AandP) Certificate
- Certified Quality Auditor

These credentials are commonly requested by employers for the occupations listed on page 6, and were identified using national real-time labor market information from 2024. In addition to the credentials shown here, employers also requested credentials that require a degree, including a Professional Engineer or Engineer in Training License.

HIGH-DEMAND SKILLS

- Construction
- Electrical Engineering
- HVAC
- Machinery
- Mechanical Engineering
- Plumbing

- Hand Tools
- Housekeeping
- Power Tool Operation
- Preventive Maintenance

- Auditing
- Automation
- Process Improvement
- Project Management

- Customer Relationship Management
- Marketing
- Sales Prospecting
- Selling Methods

HIGH-DEMAND SOFTWARE SKILLS

AutoCAD
Autodesk Revit
MicroStation (CAD Design Software)
SolidWorks (CAD)
SAP Applications

Amazon Web Services
Automation
LESS
Operating Systems
Salesforce
Spreadsheets

C++, MATLAB, Python, SQL

Sample Occupations & Emerging Occupations

These tables list sample occupations, emerging occupations, and sample places of work based on quantitative industry data validated by Industry Advisory Groups.

Sample Occupations

- Assembler & fabricator
- CAD/Drafter
- CNC machinist
- Coil winder, taper & finisher
- Electrical assembler
- Engineering technologist
- First line supervisor
- Food production-related role
- Industrial machinery mechanic
- Lean manufacturing specialist
- Machine Operator
- Maintenance & repair worker
- Millwright
- Process technician
- Quality control inspector
- Robotics technician
- Safety coordinator
- Sewers & setters
- Textile Dyeing & finishing
- Tool & die maker
- Welders, cutters, solderers, brazers

Emerging Occupations

- 3D Printing Technician
- Automation Engineer
- CMM Operators & Programmer
- Composite Materials Engineer
- Cybersecurity Analyst for Manufacturing Systems
- Digital Twin Engineer
- Environmental Safety
- Industrial Internet of Things Specialist
- Process Optimization Specialist
- Quality Assurance Technologist
- Supply Chain Role
- Sustainable Manufacturing Specialist

Sample Places of Work

- Aerospace & Defense Manufacturers
- Automotive Manufacturers
- Distribution Centers
- Electronics Manufacturers
- Engineering & Design Offices
- Factories & Production Facilities
- Food & Beverage Producers
- Manufacturing Consulting Firms
- Manufacturing Equipment Suppliers
- Medical Device Manufacturers
- Metalworking & Fabrication Shops
- OSHA Consulting Firms
- Pharmaceutical Manufacturers
- Plastics & Rubber Producers
- Quality Control & Testing Centers
- Research & Development Laboratories
- Robotics Manufacturers
- Self-Employed, Entrepreneur
- Small Businesses
- Steel/Aluminum Mills
- Supply Chain & Logistics Companies
- Textile & Apparel Manufacturers

Acknowledgements

This Advance CTE resource was authored by Janeva Wilson, policy associate, with contributions from Advance CTE staff members Dan Hinderliter, associate director of state policy, and Emily Passias, deputy executive director. Research for this resource was conducted by Alexandria M. Wright Ph.D., senior research associate for economic, labor market & educational data, WestEd Center on Economic Mobility; Sheri Smith, chief executive officer, Indigo Education Company; Jessi Maddox, senior policy associate, Advance CTE; and Marie Falcone, policy associate. Additional support was provided by Kimberly Marques, project manager, Indigo Education Company; and Susann Skjoldhorne M.S., research associate, WestEd. Communications support was provided by Stacy Whitehouse, associate director of communications, Layla Alagic, digital associate, and Jodi Langelotti, senior associate. This resource was created with the generous support of the Bill and Melinda Gates Foundation.

About Advance CTE

Advance CTE is the longest-standing national non-profit that represents State Directors and state leaders responsible for secondary, postsecondary, and adult Career Technical Education (CTE) across all 50 states and U.S. territories. Established in 1920, Advance CTE supports state CTE leadership to advance high-quality CTE policies, programs, and pathways that ensure career and college success for each learner. Advance CTE is the steward of the National Career Clusters Framework.

ADVANCE CTE
State Leaders Connecting Learning to Work

Visit the Career Clusters resources to access the full Framework and to explore the complete methodology that informed its modernization.

Appendix A: Cluster Changes

This appendix provides additional context about the change from the 2002 National Career Clusters Framework to the modernized National Career Clusters Framework released in 2024.

The National Career Clusters Framework, originally developed in 2002, provided the first consistent national organizing structure for CTE programs and was mostly aligned with education taxonomy and structure. The modernized Framework, centers industry taxonomy and structure to reflect the full world of work. More information about the modernization process can be found on the Advancing the Framework initiative page. The original Framework contained a Manufacturing Career Cluster.

Terminology Adjustment

The Cluster name was changed from Manufacturing to Advanced Manufacturing because the term "advanced manufacturing" aptly captures the essence of a sector driven by innovation and modern technology. This change was validated during the input process by Industry Advisory Groups (IAGs) consisting of professionals from the manufacturing industry. . It signifies a field that goes beyond traditional methods, integrating automation, data analytics, and smart technologies. Here, "advanced" is not just an adjective but a modern industry term used across the United States, indicating a commitment to progress and efficiency. As the sector evolves, industry experts verified this term will remain relevant, embodying the industry's forward-looking nature and its ongoing technological advancements.

Cluster Content Alignment

The decision to include Engineering careers more broadly within the Advanced Manufacturing Cluster, while delineating specific disciplines like Civil and Structural Engineering within Construction and Environmental Engineering in Energy, was made with careful consideration of the engineering field's diversity and its intersection with various sectors as specified by industry experts in multiple IAGs. Engineering was formerly housed in the STEM Career Cluster in the original Framework.