Manufacturing Career Pathways & Skill Standards (Credentials)
Descriptive Model

Prepared by the Center for Individual & Organizational Effectiveness (C4IOE.com)
for the Tri-County Workforce Investment Board – Butler, Pennsylvania
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This Descriptive Model accompanies a Manufacturing Report and a Graphic Model of Manufacturing Career Pathways & Skill Standards, which are all available on the Tri-County Workforce Investment Board website. This model is not intended to identify ALL manufacturing occupations (and their related credentialing requirements), but does identify representative occupations within each of the occupational clusters.

CAREER PATH: Machinist, Metals & Plastics – Entry to Senior Level

JOB ROLE	POTENTIAL WORK SETTINGS	EDUCATION & TRAINING REQUIREMENTS	CERTIFICATION / LICENSE REQUIREMENTS
Machine shop Manager, Industrial Production Manager	Office, fabricated metal production plant; chemical/ machinery/ food manufacturing plant; transportation equipment manufacturing plant	BA in Business Administration or related + considerable amount of work-related skill, knowledge, or experience.	Not required but could include: ACIPS: Certified in Production and Inventory Management ATMAE: Certified Senior Technology Manager
CNC Setup Programmer	Office, fabricated metal production plant; chemical/ machinery/ food manufacturing plant; transportation equipment manufacturing plant	AS, training in vocational schools, apprenticeship, related on-the-job experience, or an associate's degree	Recommended but not required: NIMS: Slide Forming Level II or III/ Slide Forming Operations II/III
CNC Machinist/ Tool & Die Makers/ CNC Turning Specialist/ CNC Milling Specialist/ Multiple Machine Tool Setters, Operators & Tenders*	Machine shop floor, fabricated metal production plant; chemical/ machinery/ food manufacturing plant; transportation equipment manufacturing plant	High School diploma or equivalent plus: students enroll in for-credit or certificate-based program and earns industry credentials and/ or OJT	Recommended but not required: NIMS: Machining Level I - CNC Milling: Programming Setup & Operations; or Machining Level I - CNC Turning: Programming Setup & Operations
CNC Operator/ CNC Machine Tool Operator	Machine shop floor, fabricated metal production plant; chemical/ machinery/ food manufacturing plant; transportation equipment manufacturing plant	High school diploma or equivalent, some OJT or trade school	Recommended but not required: NIMS: Machining Level I
Apprentice or Novice Machinist	Machine shop floor, fabricated metal production plant; chemical/ machinery/ food manufacturing plant; transportation equipment manufacturing plant	High school diploma or equivalent; some skills can be learned while in HS or technical / trade school	

JOB ROLE	JOB DESCRIPTION
Machine shop Manager, Industrial Production Manager	Oversee the daily operations of manufacturing and related plants. They coordinate, plan, and direct the activities used to create a wide range of goods, such as cars, computer equipment, or paper products. Oversee manufacturing products in accordance with cost, quality, and quantity specifications.
CNC Setup Programmer/	Develop programs to control machining or processing of metal or plastic parts by automatic machine tools, equipment, or systems.
CNC Machinist/ Tool & Die Makers/ CNC Turning Specialist/ CNC Milling Specialist/ Multiple Machine Tool Setters, Operators & Tenders*	Set up and operate a variety of machine tools to produce precision parts and instruments. Includes precision instrument makers who fabricate, modify, or repair mechanical instruments. May also fabricate and modify parts to make or repair machine tools or maintain industrial machines, applying knowledge of mechanics, mathematics, metal properties, layout, and machining procedures.
CNC Operator/ CNC Machine Tool Operator	Operate computer-controlled machines or robots that cut, shape, and form metal and plastic materials or pieces. Measure dimensions of finished work pieces to ensure conformance to specifications, using precision measuring instruments, templates, and fixtures. The complexity of the equipment usually determines the time required to become an operator.
Apprentice or Novice Machinist	Helps more experienced machinist or CNC operator, mix of OJT and classroom learning

*This includes such occupations as: Grinding, Lapping, Polishing & Buffing Machine Tool Setters, Operators & Tenders; Molding, coremaking, and casting machine setters, operators, and tenders; Metal and plastic cutting, punching, and press machine setters, operators, and tenders.

CAREER PATH: Welding – Entry to Senior Level

JOB ROLE	POTENTIAL WORK SETTINGS	EDUCATION & TRAINING REQUIREMENTS	CERTIFICATION / LICENSE REQUIREMENTS
Welding Supervisor	Found in many industries, but are most common in manufacturing, shipbuilding, automotive, construction, engineering, and fabrication industries.	Varies by employer: but an AWS certification, a post-secondary degree, or a combination of vocational instruction and OJT is typically required. Common BA degrees include: Welding Technology, Welding / Fabrication Engineering. Industrial Engineering, Materials Science	AWS Certified Welding Supervisor Certification – not always required but beneficial to have. AWS Specification for the Qualification of Welding Supervisors serves as a guide to the type of experience needed.
Welding Inspector	An integral part of every industry that uses welding as a core process, such as manufacture, construction, or fabrication of products.	Varies by employer, but an AWS certification, a post-secondary degree, or a combination of vocational instruction and OJT is typically required. Serves as a solid foundation for a position as a Welding Supervisor or Administrator.	AWS Certified Welding Inspector – not always required but beneficial to have. AWS Specification for the Qualification of Welding Inspectors serves as a guide to the type of experience needed.
Welding Engineer (may specialize in a number of fields, such as: R&D, Design Engineering, Product Engineering, Manufacturing Engineering**,** Fabrication & Construction)	Found in many industries, such as automotive, aerospace, construction, energy, shipbuilding, electronics, robotics and appliances.	AS or BS degree or higher in welding, materials science, metallurgy, mechanical, structural, and/or industrial engineering (or other related fields) from a college program that teaches competencies in welding engineering.	AWS Certified Welding Engineer (CWEng) – not always required but beneficial to have
Welding Technician	Many industries require welders, such as: agriculture, transportation, construction, mining, shipbuilding, nuclear energy, aviation, and aerospace.	AS degree in welding, materials science, metallurgy, mechanical, and/or industrial engineering technology from a college program that teaches competencies in welding and welding engineering technology. OR	AWS *Specification for the Qualification of Welding Technicians is currently undergoing drafting and approval* – it will serve as a guide to the type of experience needed.

		welding technicians can also develop the required skills through experience and OJT from equipment manufacturers and technical organizations like AWS.	
Welder, Cutter, Solderer / Boilermaker / Pipefitter	Many industries require welders, pipefitters and boilermakers, such as: construction, manufacturing, nuclear energy, oil and gas, power generation, transportation, and shipbuilding, working both in factories and outside on work sites and pipelines.	High school diploma or equivalent required; an apprenticeship or other additional training, such as OJT, CTE or union sponsored classes, would be a benefit and may be required for some jobs.	American Welding Society (AWS) Welder Certification Also recognized are certifications specific to an industry, such as: American Society of Mechanical Engineers (ASME) welder certification; American Petroleum Institute (API) certification for the pipeline industry.
Novice or Apprentice Welder, Tender, Helper	Many industries require welders, such as: manufacturing, oil and gas, nuclear energy, power generation, construction, shipbuilding, working both in factories and outside on work sites.	High school diploma or equivalent; may start learning skills in HS. After high school, most prospective welders seek out apprenticeships or additional training through CTE. Apprenticeships are sponsored by unions or employers.	

JOB ROLE	JOB DESCRIPTION
Welding Supervisor	Combines management skills with an extensive knowledge of welding processes and welding economics to plan, staff, monitor and safely deliver welding projects according to schedule and budget.
Welding Inspector	Employs their extensive knowledge of welding processes, test methods, discontinuities, materials, qualifications, and standards to ensure that welding related activities comply with all applicable quality and safety criteria. Welding inspectors are critical to the safety and structural soundness of buildings, vehicles, machinery and consumer products that require strong, secure welds.
Welding Engineer	Employ their extensive knowledge of physics, engineering, metallurgy, materials, welding, and standards to carry out tasks, such as the design, examination, and evaluation of welds and the planning, supervision, and documentation of welding operations in accordance with codes, contracts or drawings. The Welding Engineer is critical to the integrity of the vast number of buildings, vehicles, machinery, infrastructure and products.

Welding Technician	Use their extensive knowledge of joining processes, materials, welding equipment, welding techniques, and standards to assist welding engineering personnel with the development, application, evaluation, and documentation of welding techniques, equipment, and processes used to manufacture welded products according to relevant codes. Welding technicians may also play a role in product engineering and research and development.
Welder, Cutter, Solderer / Boilermaker / Pipefitter	***Welder, Cutter, Solderer***: a skilled professional who specializes in fusing materials. Welders usually work with metals such as steel or aluminum, but some work with thermoplastics or ceramics. In order to weld, cut, shape, braze, solder, or otherwise manipulate a work piece, welders use a variety of tools and equipment, including torches, gases, electrodes, hand tools, wire feeders, filler metals, and industrial chemicals. ***Boilermaker***: a skilled craftsperson who fabricates, installs, maintains, and repairs boilers, tanks, vats, pressure vessels, and other structures. ***Pipefitters*** (also called steamfitters or gasfitters): a skilled professional who fabricates, installs, maintains, assembles, and repairs piping systems. These systems include cooling, hydraulic, pneumatic, and high-pressure assemblies that transport water, steam, chemicals, or fuel, for commercial, industrial, or marine use.
Novice or Apprentice Welder, Tender, Helper	Apprentice or helper often working in support of a more skilled welder. Provides the opportunity to receive training and classroom instruction in a real hands-on work environment.

CAREER PATH: Production Worker – Entry to Senior Level

JOB ROLE	POTENTIAL WORK SETTINGS	EDUCATION & TRAINING REQUIREMENTS	CERTIFICATION / LICENSE REQUIREMENTS
Industrial Production Manager Industrial Production Engineer Mechanical Engineer	Office, manufacturing plant production area or work sites	BA in industrial engineering, mechanical engineering, electrical engineering + 5 years of experience	Useful but not always required: Production and Inventory Management (CPIM); ASQ quality control; OSHA Safety Standards
First-line production supervisor	Manufacturing plant or work sites	HS diploma + 1 or more years experience, AS or BA	Useful but not required: credentials in the trade area, like NIMS for metalworkers or AWS for welders.
Production Technician or Specialist	Manufacturing plant or work sites	HS diploma or equivalent, plus 3-12 months experience/ OJT	Useful but not required: credentials in the trade area, like NIMS for metal workers.
Helper - Production Worker	Manufacturing plant or work sites	HS diploma or equivalent, plus 0 -12 months experience	

JOB ROLE	JOB DESCRIPTION
Industrial Production Manager Industrial Production Engineer Mechanical Engineer	IPM: Plan, direct, or coordinate the work activities and resources necessary for manufacturing products in accordance with cost, quality, and quantity specifications. IPE: Oversees the daily operations of manufacturing and related plants. They coordinate, plan, and direct the activities used to create a wide range of goods. ME: Design, develop, build, and test mechanical and thermal sensors and devices, including tools, engines, and machines.
First-line production supervisor	Directly supervise and coordinate the activities of production and operating workers, such as inspectors, precision workers, machine setters and operators, assemblers, fabricators, and plant and system operators.
Production Technician or Specialist (may include: precision workers,	Set up and operate a variety of machine tools to produce precision parts and instruments. Includes precision instrument makers who fabricate, modify, or repair mechanical instruments. May also fabricate and modify parts to make or repair

machine setters and operators, assemblers, fabricators, automation technician, among others)	machine tools or maintain industrial machines, applying knowledge of mechanics, mathematics, metal properties, layout, and machining procedures.
Helper - Production Worker	Help production workers by performing duties requiring less skill. Duties include supplying or holding materials or tools, and cleaning work area and equipment.

CAREER PATH: 3D Printing / Additive Manufacturing* – Entry to Senior Level

JOB ROLE	POTENTIAL WORK SETTINGS	EDUCATION & TRAINING REQUIREMENTS	CERTIFICATION / LICENSE REQUIREMENTS
Industrial Engineer / Manufacturing Engineer / Mechanical Engineer	Manufacturing plant, especially in areas like rethinking assembly line processes with 3D printers, quality control and automation. Other industries: defense, automotive, materials science, agriculture, medical, aerospace, architecture, and software development.	BA required, typically in industrial engineering, mechanical engineering, manufacturing engineering, industrial engineering technology, electrical engineering, computer science or general engineering.	Licensure is not required for entry-level positions. A Professional Engineering (PE) license, which allows for higher levels of leadership and independence, can be acquired later in one's career.
3D Printing Modeler / Designer	Manufacturing plant, esp. needed for developing new tools to maximize or prepare digital files for 3D printing, or to create utilities that streamline the design process for a 3D-printed object.	Associates Degree or BA in multimedia design or equivalent and some prior experience in 3D/ CAD design and modeling	Requires 3D printing-specific modeling skills, such as feature size, geometrical constraints and knowledge of materials. Knowledge of CAD skills and 3D printing software
3D Printing Technician	Manufacturing plant, computer-focused position at a desk; esp. needed for ensuring proper CAD data and drawings, and maintaining 3D printers.	Associates Degree in a technical field, trade school, or a high school diploma with 0- 2 years experience in manufacturing, engineering, design, or similar fields.	Knowledge of CAD skills and 3D printing software
3D Printing Apprentice / CAD Trainee	Manufacturing plant, computer-focused position at a desk	HS diploma or equivalent	

JOB ROLE	JOB DESCRIPTION
Industrial Engineer / Manufacturing Engineer / Mechanical Engineer/	Assesses ways to eliminate wastefulness in production processes. They devise efficient systems that integrate workers, machines, materials, information, and energy to make a product or provide a service. They assess and balance many factors, such as time, number of workers needed, available technology, actions workers need to take, achieving the end product with no errors, workers' safety, environmental concerns, and cost.
3D Printing Modeler / Designer	Converts product designs into digital blueprints for 3D printing. Conceptualize printable object and create its digital representation. Can construct models for mass 3D printing or custom products. Industry experts expect bespoke manufacturing and custom prototyping to gain in demand as customization costs continue to decline.
3D Printing Technician	Performs a variety of design/drafting activities including, helping with designing and programming products, preparing/ updating/ installation drawings for projects, preparing assembly/ manufacturing drawings, ensuring guidelines and procedures for CAD data.
3D Printing Apprentice/ CAD Trainee	Works alongside more experienced workers to learn 3D printing operations and / or the basics of CAD.

*Given that this career pathway is still evolving due to rapid changes in the technology, emphasis here is on needed skills and how they will most likely be used in the near-term, more than job roles.

CAREER PATH: Quality – Entry to Senior Level

JOB ROLE	POTENTIAL WORK SETTINGS	EDUCATION & TRAINING REQUIREMENTS	CERTIFICATION / LICENSE REQUIREMENTS
Quality Auditor	Manufacturing setting – can range from heavy-equipment to high-tech lab setting.	Varies by job but certification requires 8 yrs of job experience, with 3 in a decision-making position. Varying years of work experience can be waived with the completion of a 2 or 4-year degree or greater.	ASQ offers a Certified Quality Auditor (CQA) certification – not required but very helpful. A CQA needs to recertify every 3 years.
Quality Engineer	Manufacturing setting – can range from heavy-equipment to high-tech lab setting.	Varies by job but certification requires 8 yrs of job experience, with 3 in a decision-making position. Varying years of work experience can be waived with the completion of a 2 or 4-year degree or greater.	ASQ offers a Certified Quality Engineer (CQE) certification – not required but very helpful. A CQE needs to recertify every 3 years.
Quality Inspector	Most inspectors work at one location, but some may travel to more than one. Inspectors in some industries may be on their feet all day and may have to lift heavy items. In other industries, workers may sit during their shift and read electronic printouts of data.	High School diploma or equivalent plus 1-12 months OJT. Some employers may require certification or a college degree; certification requires 8 yrs of job experience or combination of degree and work experience.	ASQ offers a Certified Quality Inspector (CQI) certification, and various levels of Six Sigma certifications – not required but very helpful.
Quality Technician	Manufacturing setting – can range from heavy-equipment to high-tech lab setting. Jobs may require hours of sitting or standing, as well as heavy lifting or reading data and writing reports.	High School diploma or equivalent plus OJT. Some employers may require certification or a college degree in quality technology or other engineering technology degrees. 4 yrs of work experience or a BA is needed for certification.	ASQ offers a Certified Quality Technician (CQT) certification – often not required but beneficial.
Quality Improvement Associate	Manufacturing setting – can range	High School diploma or equivalent;	The American Society for Quality

	from heavy-equipment to high-tech lab setting.	certification requires 2 years of work experience, or an associate degree or two years of equivalent higher education.	(ASQ) offers a Certified Quality Improvement Associate (CQIA) certification – often not required but beneficial.

JOB ROLE	JOB DESCRIPTION
Quality Auditor	Quality Auditors understand the standards and principles of auditing and the auditing techniques of examining, questioning, evaluating and reporting to determine a system's adequacy and deficiencies. The Auditor analyzes all elements of a quality system and judges its degree of adherence to the criteria of industrial management and quality evaluation and control systems.
Quality Inspector	Quality Inspectors examine products and materials for defects or deviations from specifications. They mark, tag, or note problems and certify goods when they meet quality standards. There are a number of types of inspectors, including: • **S***amplers* test or inspect a sample for malfunctions or defects during a batch or production run. • *Sorters* separate goods according to length, size, fabric type, or color. • *Testers* repeatedly test existing products or prototypes under real-world conditions. Through these tests, manufacturers determine how long a product will last, what parts will break down first, and how to improve durability. • *Weighers* weigh quantities of materials for use in production.
Quality Engineer	Quality Engineers understand the principles of product and service quality evaluation and control. This body of knowledge and applied technologies include development and operation of quality control systems, application and analysis of testing and inspection procedures, the ability to use metrology and statistical methods to diagnose and correct improper quality control practices, an understanding of human factors and motivation, facility with quality cost concepts and techniques, and the knowledge and ability to develop and administer management information systems and to audit quality systems for problems and correction.
Quality Technician	Quality Technicians work with quality engineers to improve efficiency or performance of machinery, personnel, and process controls. Duties can vary by area of manufacturing and employer; however, it is common for workers in this occupation to take measurements using physical or electronic tools and instruments or monitor electronic systems that carry out these tasks automatically.
Quality Improvement Associate	Quality Improvement Associates have a basic knowledge of quality tools and their uses and are involved in quality improvement projects, but do not necessarily come from a traditional quality area.

CAREER PATH: Logistics – Entry to Senior Level

JOB ROLE	POTENTIAL WORK SETTINGS	EDUCATION & TRAINING REQUIREMENTS	CERTIFICATION / LICENSE REQUIREMENTS
Logistics Engineer Reliability Engineer Systems Engineer	Industry office setting, fabricated metal production plant; chemical/ machinery/ food manufacturing plant; transportation equipment manufacturing plant	BA (usually in engineering, logistics or transportation) + considerable amount of work-related skill, knowledge, or experience. Optional MA and/or certification. Common skills: uses science and mathematics to ensure consumer goods and services are being distributed in a way that is most efficient and profitable.	Recommended but not require: Certification through APICS or the International Society of Logistics, such as Certified Master Logistician (CML) and Certified Professional Logistician (CPL).
Logistics Analysts Supply Chain Analyst	Industry office setting, fabricated metal production plant; chemical/ machinery/ food manufacturing plant; transportation equipment manufacturing plant	BA + considerable amount of work-related skill, knowledge, or experience. Common skills: Analytical, business intelligence and data analysis software; problem solving	Recommended but not required: Certified Supply Chain Professional, Certified Logistic Professional, SAP Certified Application Associate - Logistics Execution and Warehouse Management
Supply Chain Manager Logistics Manager	Industry office setting, fabricated metal production plant; chemical/ machinery/ food manufacturing plant; transportation equipment manufacturing plant	BA is typically required for most positions (business, systems engineering, or supply chain management is common), although an associate's degree may be sufficient for some positions.	Recommended but not require: Certification through APICS or the International Society of Logistics, such as Demonstrated Senior Logistician (DSL) and Certified Master Logistician (CML).
Logistics Technician/ Specialist	Industry office setting, such as fabricated metal production plant; chemical/ machinery/ food manufacturing plant; transportation equipment manufacturing plant	BA is typically required for most positions, although an associate's degree may be sufficient for some positions. Common skills: database management, scheduling software, operations and system dynamics	Recommended but not require: Certification through APICS or the International Society of Logistics, such as Demonstrated Logistician (DL) or Demonstrated Master Logistician (DML).

Logistics Planner/ Scheduler Forklift Driver	Plant/ factory office, warehouse or loading docks, work sites; may work overnight shifts.	HS diploma or equivalent preferred, but not always required. Forklift drivers usually receive 1 month of OJT.	.

JOB ROLE	JOB DESCRIPTION
Logistics Engineer Reliability Engineer Systems Engineer	Design or analyze operational solutions for projects such as transportation optimization, network modeling, process and methods analysis, cost containment, capacity enhancement, routing and shipment optimization, or information management. Evaluate effectiveness of current or future logistical processes and direct the work of logistics analysts.
Logistics Analysts Supply Chain Analyst	Analyze product delivery or supply chain processes to identify or recommend changes. May manage route activity including invoicing, electronic bills, and shipment tracing.
Supply Chain Manager Logistics Managers	Plan, direct, and/or coordinate purchasing, warehousing, distribution, forecasting, customer service, or planning services. Manage logistics personnel and logistics systems and direct daily operations. Resolve problems concerning transportation, logistics systems, imports or exports, or customer issues. Direct inbound or outbound logistics operations, such as transportation or warehouse activities, safety performance, or logistics quality management. Supervises the work of logistics specialists, planners, or schedulers.
Logistics Technician/ Specialist	Analyzes and coordinates an organization's supply chain—the system that moves a product from supplier to consumer. Supports inbound or outbound logistics operations, such as transportation or warehouse activities, safety performance, or logistics quality management; may support customer service, shipping, record keeping, and related activities.
Logistics Planner/ Scheduler Forklift Driver	Schedules or supports the scheduling of drivers, package transport, and other elements of the supply chain. Forklift drivers use machinery to move goods around a warehouse or onto other forms of transportation.

List of Resources for this Model
(NOTE: There are other resources that were used for the entire project, including the report, listed in the accompanying report).

- U.S. Bureau of Labor Statistics https://www.bls.gov/
- Burning Glass Technologies. "Inflection Point: Supply, Demand and the Future of Work in the Pittsburgh Region", 2016: http://www.alleghenyconference.org/wp-content/uploads/2016/08/InflectionPoint.pdf
- U.S. Bureau of Labor Statistics, Occupational Handbook: https://www.bls.gov/ooh/
- O*Net Online: https://www.onetonline.org/