STATE OF ILLINOIS

Model Programs of Study Guide

DRAFT

Manufacturing and Engineering

COLLEGE & CAREER PATHWAYS

ICCB ILLINOIS COMMUNITY COLLEGE BOARD

EdSystems EDUCATION SYSTEMS CENTER at NORTHERN ILLINOIS UNIVERSITY

REVISED MAY 2025

Funding for this project was provided through a grant agreement from the Illinois Community College Board, utilizing Perkins Leadership funding.

About ICCB

In 1965, the Illinois General Assembly established the Illinois Community College Board to create a system of public community colleges that would be within easy reach of every resident. Today, the Illinois Community College System covers the entire state with 48 colleges and one multi-community college center in 39 community college districts. Community colleges serve nearly one million Illinois residents each year in credit and noncredit courses and many more through their public service programs.

Illinois' community colleges meet both local and statewide needs for education and workforce development through high-quality, affordable, accessible, and cost-effective programs and services. Learn more at iccb.org.

About EdSystems

Education Systems Center (EdSystems) is a mission-driven policy development and program implementation center based within Northern Illinois University. We work at the state level to create ecosystem and policy change while simultaneously working at the local level to create organizational change. This bi-directional approach allows us to align local efforts to state policy while elevating local experiences and learnings to state tables. Learn more at edsystemsniu.org.

Table of Contents

I. About the Model Programs of Study Guide 1

II. Development of the Model Programs of Study 2

Process for Development 2

III. Priority Occupations and Promising Credentials 4

Promising Credential Program Categories 4

DIAGRAM: Postsecondary Opportunities 5

TABLE: Selected Occupations, Wages, and Job Growth 6

High-Priority Occupations 7

Levels of Education Needed 7

Advisory Committee Considerations 8

Clean Energy Working Group 8

IV. Programs of Study Sequence Description 9

DIAGRAM: Career-Focused Instructional Sequence 9

High School Career-Focused Instructional Sequence and Work-Based Learning 10

DIAGRAM: General Education Instructional Sequence 12

High School General Education Courses 13

First-Year Postsecondary Courses 13

V. Strategic Dual Credit Courses: Competency Descriptions 14

Appendices 17

A: Technical and Essential Employability Competencies for Manufacturing, Engineering, Technology, and Trades 18

B: Cross-Sector Essential Employability and Entrepreneurial Competencies 19

C: Postsecondary Competency-Based Education Competencies for Industrial Maintenance and Welding Programs 21

D: 2020 Advisory Committee Membership 38

E: 2025 Clean Energy Working Group Membership 40

F: College and Career Pathway Endorsements Framework 41

G: Illinois' Work-Based Learning Continuum 42

H. DIAGRAM: Pathway Map 43

I. About the Model Programs of Study Guide

The Illinois Community College Board (ICCB) sponsored the development of the State of Illinois Model Programs of Study Guides in crucial industry areas as part of the "Illinois State Plan for Strengthening Career and Technical Education for the 21st Century Act" (also known as the Perkins V plan). This guide was developed in consultation and collaboration with the Illinois State Board of Education (ISBE) through a process led and facilitated by Education Systems Center at NIU (EdSystems). As further detailed in this guide, the process involved extensive research into labor market information and credential programs, and dialogue across secondary, postsecondary, and employer stakeholders.

The primary purposes and goals for the Model Programs of Study Guide are to:

1. **Provide guidance and exemplars** for local pathway programs to adopt or customize as they develop programs of study for approval as part of Perkins V or Illinois' College and Career Pathway Endorsements.
2. **Establish a framework** for state agencies to develop and implement program supports.
3. **Identify priority dual credit courses** that are foundational to the industry sector's program of study and well-situated for statewide scaling and articulation.
4. **Define the competencies** that should be sequenced across a program of study course sequence to prepare students for the future of work in that industry area.
5. **Identify entry points** for employers to support coursework and work-based learning experiences.

The Model Programs of Study Guides supplement and complement other State of Illinois Career and Technical Education and career pathway resources, including the "ISBE Career Guide," State of Illinois Career Pathways Dictionary, Career Development Experience Toolkit, "Recommended Technical and Essential Employability Competencies," State of Illinois Workforce Development Strategic Plan, and related state and regional data resources. School districts, community colleges, and their partners are encouraged to use this guide, state resources, and local program and course information to develop materials for student and family outreach.

The Model Programs of Study Guide in Manufacturing and Engineering can be used as a reference in local planning processes. The guide presents and describes in detail each component of the sequence, including descriptions of the underlying research, analysis, and Advisory Committee input. In addition to the complete guide, a pathway map depicting the diagrams of the secondary and postsecondary sequences, as well as a table of the selected occupations, wages, and job growth, is available at the end of this document or at edsystemsniu.org/guides.

II. Development of the Model Programs of Study

Programs of study are a coordinated, non-duplicative sequence of academic and technical content at the secondary and postsecondary levels that culminate in a recognized postsecondary credential. The State of Illinois Model Programs of Study Guides are aligned with broader state policy goals to promote college and career readiness, including the state's Perkins V and ESSA plans (in particular, the College and Career Readiness Indicator), the Postsecondary and Workforce Readiness Act, the Dual Credit Quality Act, and the Illinois Career Pathways Dictionary.

Process for Development

Each model program of study was developed using a data-driven, backward-mapping approach that extended from the areas of job growth down through to the high school course sequence. The specific steps in this analysis included:

1. **Identifying high-priority occupations** in the industry sector that are high-skill, high-wage, and in-demand based on federal Department of Labor data for Illinois.
2. **Identifying promising postsecondary credentials** (degrees or certificates) that are broadly accessible to and through the Illinois community college system, and lead to high-priority occupations.
3. **Mapping the stackable degrees and certificates** that progress to promising credentials.
4. **Identifying strategic community college courses** that appear broadly among promising credentials, provide a solid foundation of knowledge essential to that industry sector, and are feasible for dual credit delivery.
5. **Mapping a course sequence from secondary through the first year of postsecondary** that incorporates strategic early college credit (including at least six early college credits in the career-focused course sequence) and is applicable to both Illinois secondary and postsecondary Perkins V requirements.
6. **Defining related technical competencies** for the foundational program of study courses that can be utilized to guide course development and postsecondary articulation.

Using data from the Department of Labor, Illinois Department of Employment Security, and MIT's Living Wage Calculator for the State of Illinois as a reference, the project team identified "high-priority occupations" as jobs with a positive growth outlook over the next 10 years, of high relative volume within that industry sector, and with median salaries that could sustain various family sizes within Illinois.[1] As of May 2025, occupations with median salaries higher than the living wage for 1 adult + 1 child ($40.41/hour) are considered as having a "high" living wage potential. Occupations with median salaries only higher than the living wage of 1 adult, no children ($23.56/hour) are considered as having a "medium"

[1] U.S. Department of Labor, Employment and Training Administration (n.d.). "Explore Careers." CareerOneStop. Retrieved March 2025, from careeronestop.org/explorecareers. Illinois Department of Employment Security, "Long-Term Occupational Projections 2020-2030" and "Wage Information: Occupational Employment and Wage Statistics (OEWS) Statewide." Retrieved March 2025, from ides.illinois.gov. Amy K. Glasmeier, "Living Wage Calculator," Massachusetts Institute of Technology, 2025. Retrieved March 2025, from livingwage.mit.edu.

living wage potential, and occupations with median salaries below the living wage of 1 adult, no children (less than $23.56/hour) are considered as having a "low" living wage potential.

The team identified as a "promising credential" any degree or certification that immediately prepares an individual for entry into or is a stackable for the identified high-priority occupations, then analyzed community college programs leading to these credentials from a sampling of six to ten colleges from across Illinois, representing a mix of urban, suburban, and rural institutions.[2] EdSystems analyzed and categorized all the career-focused and general education courses across the full sampling of the promising credential programs to determine which of these courses:

- are broadly common across multiple college programs in the sample,
- are likely accessible for dual credit opportunities considering student prerequisites and teacher credentialing requirements, and
- are generally transferable through Illinois Articulation Initiative or various articulation agreements.

This analysis and categorization process led to a recommended set of strategic career-focused and general education courses that provide a critical foundation for the program of study sequence.

Following this internal analysis, EdSystems and ICCB convened a stakeholder Advisory Committee of secondary, postsecondary, and private sector representatives to vet the recommendations and provide expertise and guidance on the development of the model programs of study (see appendix D). Over multiple webinars and feedback sessions across four months, the Advisory Committee and smaller working groups provided information about industry trends that may not be reflected in the Department of Labor or IDES data, credentials and degrees that are emerging as most promising in the field, on-the-ground implementation considerations for secondary and postsecondary programs, and future of work implications for the sector. The Advisory Committee further informed important decision-points, including adjusting the course map and promising credential endpoints, selecting strategic early college credit courses, and identifying key competencies for target courses lacking broad statewide articulation. The culmination of EdSystems' analysis and the input of the Advisory Committee is reflected in this guide.

[2] For the analysis of this guide, EdSystems surveyed City Colleges of Chicago, College of Lake County, Elgin Community College, Illinois Central College, McHenry County College, Rock Valley College, and Southwestern Illinois College.

III. Priority Occupations and Promising Credentials

Manufacturing and engineering occupations are a cornerstone of the Illinois economy. According to the Illinois Manufacturers' Association, the total economic impact of manufacturing in Illinois is estimated to be between $580 billion and $611 billion every year—the largest share of the state's Gross Domestic Product by any industry. Further, the industry directly provides 9.5 percent of total employment in Illinois, and indirectly supports 29.6 of overall Illinois employment.[3] These occupations are spread across a breadth of manufacturing employer types, including metalworking, automotive production, plastic, food processing, and chemical processing. Strengthening the region's workforce is essential to ensuring the manufacturing supply chain is protected from disruption by international events. The continued availability of a qualified workforce in manufacturing and engineering is essential as this sector continues to serve as an anchor for Illinois' economic growth and recovery.

Promising Credential Program Categories

The project team's analysis of occupations and related postsecondary credentials in the manufacturing and engineering sectors led to an identification of two credential program categories or pathways and additional subcategories:

1. **Advanced manufacturing**
    a. **Welding** credentials for careers in welding, fabrication, and structural steel industries.
    b. **Machining and production** credentials for careers utilizing manufacturing processes to transform raw material into a finished product. Subcategories include:
        - Machine tool technology, involving the set-up, operation, and testing of machines before production.
        - Precision machining and production, involving the set-up, testing, and operation of manufacturing machines and equipment involving a variety of types of production processes.
    c. **Industrial maintenance** credentials, preparing students to install, repair, adjust, and maintain industrial production and processing systems.
2. **Engineering and automation** credentials, preparing students for a range of careers to analyze, design, evaluate, and continuously improve complex manufacturing and industrial systems. Subcategories include:
    a. Computer integrated manufacturing and mechatronics, involving the design, utilization, and maintenance of complex design and production processes involving mechanical, computerized, and electronic components.
    b. Guided transfer programs leading to a Bachelor of Science in Engineering, focusing on mechanical or industrial engineering.

[3] Illinois Manufacturers' Association (2022, August). "Manufacturing Matters: Our Impact in Illinois." Retrieved April 2024, from ima-net.org/wp-content/uploads/2022/08/ManufacturingMatters2022.pdf.

Diagram: **Postsecondary Opportunities**

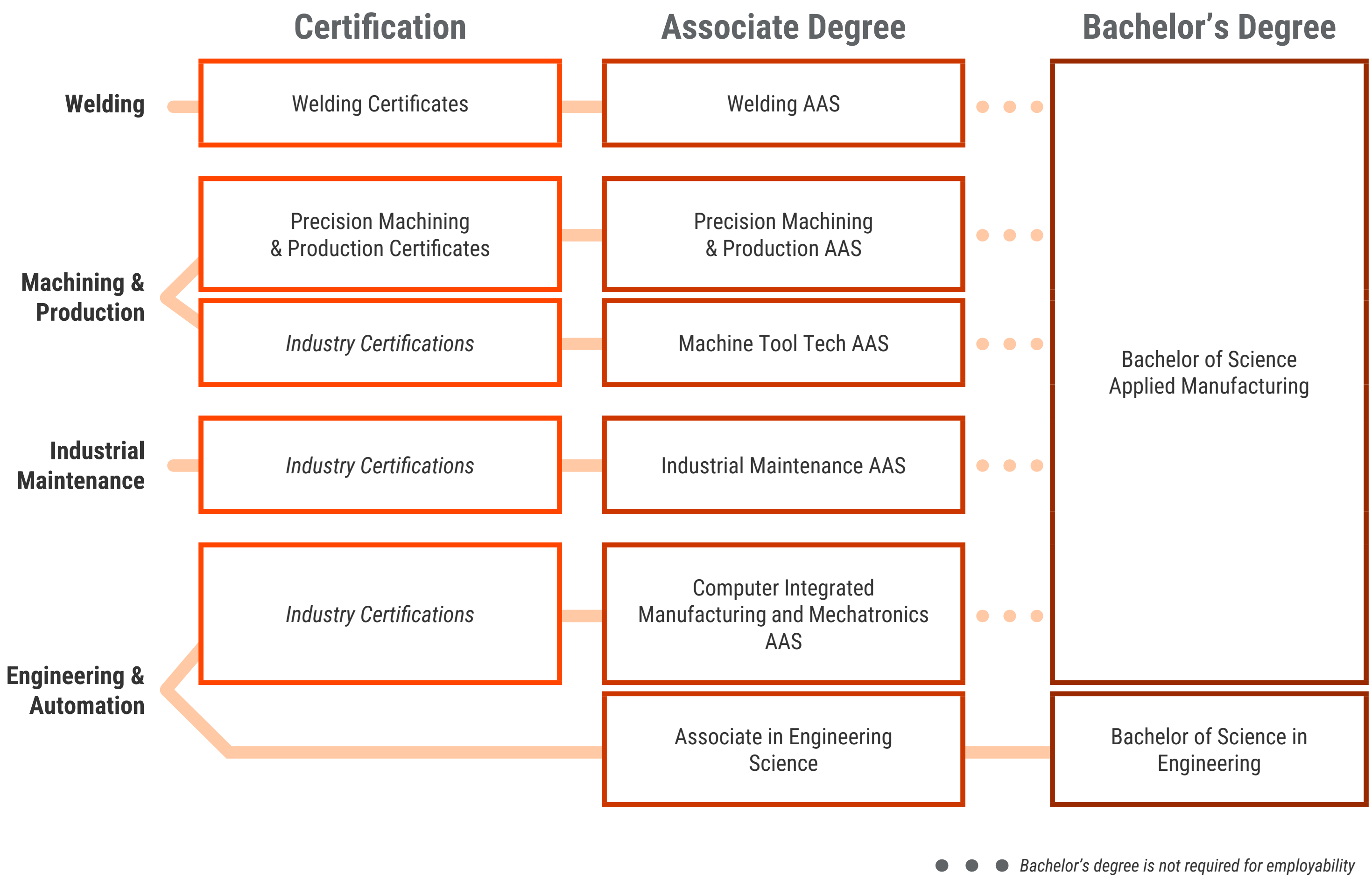

Table: **Selected Occupations, Wages, and Job Growth**

Program	Typical Job(s)	Living Wage Potential*	Median Annual Wage**	IL Growth: Change over 10 years ***	IL Annual Job Openings***	Typical Educational Requirements
Engineering and Automation	Electrical and Electronic Engineering Technicians	Medium	$34.17	0%	270	Associate Degree
	Industrial Engineering Technicians	Medium	$33.55	4%	290	
	Mechanical Engineering Technicians	Medium	$33.12	1%	140	
	Mechanical Engineers	High	$48.66	11%	800	
	Industrial Engineers	High	$48.77	13%	1,120	Bachelor's Degree
Industrial Assembly	Electromechanical Equipment Assemblers	Low	$18.43	-1%	1,410	High School Diploma
	Sheet Metal Workers	High	$43.04	-1%	430	
Industrial Maintenance	Electrical and Electronics Repairers, Commercial and Industrial Equipment	Medium	$31.26	3%	50	Postsecondary Certificate
	Industrial Machinery Mechanics	Medium	$30.71	18%	890	High School Diploma, Some College
Machining & Production	Tool and Die Makers	Medium	$29.78	2.4%	456	Postsecondary Certificate
	Computer Numerically Controlled Tool Programmers	Low	$23.40	18%	180	High School Diploma, Some College
	Machinists	Low	$23.56	4%	2,120	
	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Low	$22.30	3%	645	
Welding	Welders, Cutters, Solderers, and Brazers	Low	$23.03	5%	1,680	High School Diploma

* Living wage potential is based on MIT's Living Calculator (livingwage.mit.edu) for Illinois in 2025. Occupations with median salaries higher than the living wage for 1 adult + 1 child ($40.41/hour) are considered as having a "high" living wage potential. Occupations with median salaries only higher than the living wage of 1 adult, no children ($23.56/hour) are considered as having a "medium" living wage potential, and occupations with median salaries below the living wage of 1 adult, no children (less than $23.56/hour) are considered as having a "low" living wage potential.

** Illinois Department of Employment Security (2022). Wage Information: Occupational Employment and Wage Statistics (Statewide). Retrieved March 2025, from ides.illinois.gov/resources/labor-market-information/oews.html

*** Illinois Department of Employment Security. Employment Projections (Long-Term Occupational Projections 2020-2030). Retrieved March 2025,, from ides.illinois.gov/resources/labor-market-information/employment-projections.html

High-Priority Occupations

The high-priority occupations associated with each of the promising credential program areas are identified in the table entitled Select Occupations, Wages, and Job Growth. The occupations associated with CNC programming, industrial maintenance, computer-integrated manufacturing technologists, mechatronics, and engineering all meet the job growth and living wage thresholds described in this guide.

In Illinois, occupations such as industrial machinery mechanics, a range of skilled technologist and technician roles, and various types of engineers have relatively high projected growth in the number of annual openings.

Promising credentials include machine tool technology, due to its capacity to lead to jobs that pay a living wage and its adaptability to other careers in machining and manufacturing. Welding is also a high-value credential because of its critical role across many Illinois regions and integration with other manufacturing programs and its increasing relevance in the clean energy sector. As highlighted in the "Illinois Clean Energy Jobs and Training Program Inventory" curriculum framework recommendations, foundational manufacturing skills such as welding, machining, and mechanical maintenance are essential to clean energy careers, including those in energy-efficient systems, electric vehicle production, and renewable energy infrastructure. These credentials serve as a bridge between traditional manufacturing and the emerging green economy, helping ensure that Illinois' workforce is equipped for both current and future industry demands.[4]

Levels of Education Needed

The levels of education needed for advanced manufacturing and engineering and automation pathways vary greatly. Two-thirds of welders, cutters, solderers, and brazers have no postsecondary education, making this career highly accessible for students receiving industry credentials and training in high school. A majority of CNC programmers and industrial machinery mechanics have some postsecondary education, and entry-level positions are accessible upon completion of a short-term postsecondary credential. For welding and machining pathways, employers often rely on industry certifications as validation of competencies; hundreds of industry certificates are available in the sector.

The course sequence in this guide aligns to the certifications of two predominant providers of manufacturing industry certifications: the Manufacturing Skill Standards Council (MSSC) and the National Institute of Metalworking Skills (NIMS). Students pursuing machining or production technician careers should earn the MSSC Certified Production Technician or NIMS Operator certificates and a stackable community college credential as entry-level career preparation. Students pursuing welding careers should be supported to attain stackable credentials provided by the American Welding Society (AWS), the primary industry association establishing standards in the United States for welding. Through community college programs, students should be prepared to earn additional stackable industry credentials.

Careers in computer integrated manufacturing and mechatronics typically require at least a long-term certification (e.g., 40 or more credits) or an Associate of Applied Sciences (AAS) degree. As completion of the AAS better positions manufacturing workers to enroll in a baccalaureate degree program at a later stage in their careers, an AAS is recommended in these pathways.

Several Illinois universities offer a Bachelor of Science in Applied Manufacturing Technology or Applied Engineering that articulate AAS degrees in advanced manufacturing or engineering.[5] Whenever possible,

[4] Illinois Department of Commerce and Economic Opportunity. "Illinois Clean Energy Jobs and Training Program Inventory," 2023. Retrieved December 2024, from dceo.illinois.gov/cleanenergy/programinventory.html

[5] Examples include Northern Illinois University's Bachelor of Science in Engineering Technology with an emphasis in Applied Manufacturing Technology, Southern Illinois University's Bachelor of Science in Industrial Management and Applied Engineering, or Governors State University's Bachelor of Arts in Manufacturing Management.

community colleges should ensure that AAS degrees in advanced manufacturing or engineering articulate to baccalaureate degree programs that offer articulation. Students may need targeted instructional supports to complete the math sequence requirements typical of bachelor's degrees.

Engineer positions typically require a Bachelor of Science degree, a requirement for licensure. Therefore, engineering is depicted as a guided transfer program pathway, from an Associate of Science to a Bachelor of Science in Engineering.

Advisory Committee Considerations

Across the occupational areas, the Advisory Committee emphasized the need for the future workforce to be prepared for highly automated manufacturing environments involving integrated robotics and human-operated systems, and to understand additive manufacturing processes creating three-dimensional objects through layering. The committee emphasized the importance of ensuring programs prepare students for manufacturing environments involving both durable products (e.g., metalworking) and non-durable goods (e.g., food, chemicals). The committee also emphasized the need for a broader approach to welding that includes not only metal fabrication but also experience with adhesives and other emerging joining technologies. These considerations are reflected in the included course sequences and competencies.

Clean Energy Working Group

In 2024–2025, a Clean Energy Working Group for the State of Illinois Model Programs of Study Guides convened to review labor market information and career pathways for a broad range of clean energy jobs, drawing from the "Illinois Clean Energy Jobs and Training Program Inventory." For this guide, the group identified additional high-growth, clean energy-focused occupations, as shown in the Selected Occupations, Wages, and Job Growth table, to better align with emerging industry demand.

IV. Programs of Study Sequence Description

The recommended programs of study sequences, which begin in high school, introduce students to a broad range of careers in the industry. The career-focused instruction includes Career and Technical Education (CTE) and early college coursework, coupled with work-based learning opportunities, to prepare students to demonstrate fundamental knowledge in their interest areas. The identified general education courses complement the career-focused instruction and align to typical postsecondary degree programs. Together, these comprehensive learning pathways prepare students to pursue promising postsecondary degrees and credentials leading to high quality, living wage careers.

As school districts and their community college partners develop a program of study sequence, they should ensure that the high school coursework enables all students in the pathways to attain technical and employability competencies (see appendices A and B). Districts should engage students in career awareness and exploration in middle school if possible, to prepare students to select and start a career-focused pathway in 9th or 10th grade. An early start gives students more openings in their schedule to complete skill development and capstone options, obtain significant early college credits, earn valuable industry credentials, participate in a career development experience, and potentially acquire a College and Career Pathway Endorsement by high school graduation.

Diagram: **Career-Focused Instructional Sequence**

	GRADES 9–10 **Orientation**	GRADES 10–12 **Skill Development**	GRADE 12 **Capstone**	1ST YEAR* **Postsecondary**
Advanced Manufacturing	**Introduction to Technology and Engineering**	**Foundations of Production and Manufacturing Processes**	**Advanced Production and Manufacturing Processes** **Basic Welding**	**Manufacturing Materials and Processes** **CNC Programming**
Engineering		**Principles of Engineering** *Additional Engineering Courses*	**Computer Integrated Manufacturing** *Additional Engineering Courses*	**Advanced CAD/CAM Technology** **Industrial Electricity**
Work-Based Learning	**Career Exploration (2)**	*Choose 1:* **Career Development Experience** *or* **Youth Apprenticeship**		
	Team-Based Challenge (2); *may be offered through Career and Technical Student Organizations including a FFA Career Development Event*			

KEY:
- *AP or dual credit course*
- *Course prepares for industry credential*
- *Dual credit course*
- *College & Career Pathway Endorsement*

High School Career-Focused Instructional Sequence and Work-Based Learning

The model programs of study for manufacturing and engineering include a sequence of career-focused instruction that includes strategic early college and coursework from the Illinois State Board of Education's CTE program matrix for Manufacturing Systems. The career-focused instructional sequence provides high school students with an orientation in both advanced manufacturing and engineering, followed by the opportunity to focus on either area as students move into skill development and capstone courses. However, students should not be limited to either focus area; instead, the high school program should support integration and expanded opportunities for taking courses across both advanced manufacturing and engineering to the extent possible.

The advanced manufacturing course sequence provides options for schools to align with one of two commonly utilized industry credential sequences in the manufacturing sector: Manufacturing Skill Standards Council (MSSC), or National Institute of Metalworking Skills (NIMS). The high school's selection of either MSSC or NIMS should be made in collaboration with a community college partner and with input from regional employers or an employer collaborative, and other industry credentials may be incorporated depending on regional employer needs.

The engineering-focused courses generally align to the Project Lead the Way sequence, but can also be fulfilled through curriculum options that incorporate secondary, postsecondary, and employer input.

Orientation Coursework

The orientation level commences with the broadly applicable Introduction to Technology and Engineering course, through which students will (i) demonstrate awareness of career pathways and manufacturing processes, (ii) develop a safety mindset that will be critical to further coursework and work experience, and (iii) gain understanding of basic, introductory concepts in the field. Schools may use the Project Lead the Way Introduction to Engineering Design for this course, with enhancements to address the course expectations. The course may also provide an introduction to other related career clusters, such as architecture, construction, and energy.

To begin preparing for the College and Career Pathway Endorsements, students should also participate in multiple virtual and in-person visits to employer sites to better understand authentic industry environments and engage with professionals in the field. Students should hear from a variety of guest speakers in an array of manufacturing and engineering careers to better understand opportunities in the field. Through the orientation course, students should be prepared to document their own personalized career pathway that leads to a promising credential.

Skill Development Coursework

The skill development level includes Foundations of Production and Manufacturing Processes, an advanced manufacturing-focused course recommendation. Generally aligned to the Project Lead the Way sequence, engineering-focused courses should include Principles of Engineering and another engineering course that emphasizes the development of software skills, such as SOLIDWORKS, that are valuable for employer internships. As students' schedules permit, students are highly encouraged to take skill development courses across both focus areas.

The Foundations of Production and Manufacturing Processes course (or two-semester course sequence) provides all students in an advanced manufacturing pathway with a strong foundation in production, safety, and other foundational concepts for promising credentials in the field. The course emphasizes application of safety, production processes, and other basic concepts under close teacher direction, and should utilize authentic projects addressing realistic customer needs. Understanding production, either machining or non-durable production processes, is critical for students planning for a career requiring postsecondary credentials. The course competencies scaffold on to those attained in the orientation-level Introduction to Technology and Engineering course, and, for machining-focused programs, address the expectations of the Beginning Machining and Machine Shop Technology I courses in the CTE program matrix. For programs emphasizing production processes other than machining, the high school will need to consult with its Education for Employment director and ISBE on the appropriate CTE course at the this level as well as more advanced courses in the sequence.

In addition, students should be prepared to attain the foundational certifications in MSSC (Safety; Quality Practices and Measurement) or NIMS Machining Level I (Measurement, Materials, and Safety; Job Planning, Benchwork and Layout). Students can prepare to earn these certifications using tools and equipment found in a typical high school shop without investment in CNC milling and lathe machines. Students should also attain the Occupational Safety and Health Administration (OSHA) ten-hour course completion card, which can be earned online through the CareerSafe program.

To be on track to earn the College and Career Pathway Endorsements, regional high school and community college partners should ensure students have earn three to six early college credit hours through the skill development courses. Additionally, students should continue progressing through the work-based learning continuum. Classroom instruction should be coupled with continued employer site visits, an opportunity for students to participate in a job shadow experience at an employer site, and clubs or challenges related to their program area, such as a robotics or SkillsUSA Illinois or Technology Student Association of Illinois competitions. Team-based challenges should be completed either as activities embedded within course curriculum or through a student/extracurricular organization. Students should be encouraged to engage in student or professional manufacturing and engineering organizations, including Career and Technical Student Organizations, to continue to build familiarity with the profession and pathways towards various career options.

Capstone Coursework

At the capstone level, students engage in advanced topics in advanced manufacturing, engineering, or both. The recommendations for students with an advanced manufacturing focus are to either complete the Advanced Production and Manufacturing Processes course (or two-semester sequence), or, for students interested in pursuing a welding career, the Basic Welding Course. Basic Welding should emphasize foundational skills in the welding field, as well as introduce non-metallurgic fabrication approaches involving adhesives and plastics. The course should also prepare students to attain one or more foundational AWS certificates.

Students with an engineering focus should complete the Computer Integrated Manufacturing course (based on the Project Lead the Way sequence), and additional career-focused coursework schedules permit. Computer Integrated Manufacturing should require students to (i) engage with computer aided manufacturing (CAM) software and (ii) design, build, program, and present a manufacturing system model capable of creating a product.

The Advanced Production and Manufacturing Processes course (or two-semester course sequence) develops students' advanced production skills, either for entry-level employment, to continue into a postsecondary machining or other production program, or as a foundation for other related programs such as Machine Tool Technology or Industrial Maintenance. As a capstone project, students should plan, calculate, and safely machine a part (for courses aligned to NIMS) or produce a good (for courses aligned to MSSC) meeting customer requirements. This course should also provide students with a basic understanding of supply chain logistics, maintenance, and robotic automation. However, students seeking entry-level careers in industrial maintenance and automation fields will require at least a postsecondary certificate, and typically an associate degree.

Students should be prepared to attain industry certifications in MSSC or NIMS expected for entry-level employment: the MSSC Certified Production Technician Certificate, or the NIMS Level I CNC Turning

(Lathe) Operations and CNC Mill Operations certificates. This coursework will require the high school to either invest in CNC machines, or arrange for their use at the community college, a regional vocational school, or an employer site.

To be eligible for the College and Career Pathway Endorsements, all students should complete a career development experience of at least 60 hours in length and earn at least six or more early college credit hours, through a mix of both career-focused and general education coursework. As their schedules permit, students can participate in a for-credit cooperative class to obtain work experience in addition to the career-focused courses shown in the pathway model. Additionally, students should continue participation in clubs, professional organizations, or challenges related to their pathway, such as robotics.

Diagram: **General Education Instructional Sequence**

	GRADES 9–10 **Orientation**	GRADES 10–12 **Skill Development**	GRADE 12 **Capstone**	1ST YEAR* **Postsecondary**
Math	*Math sequence: highest-level course possible*	*Math sequence: highest-level course possible*	*Choose 1:* • **College Algebra** (Dual credit course with IAI) • **Calculus** (AP or dual credit course) • **Pre-Calculus** • **Transitional Math: STEM** • **Transitional Math: Technical Math**	*Choose 1:* • **Technical Math** • **College Algebra*** • **Trigonometry** • **Calculus*** (Postsecondary course with IAI)
English	*English sequence*	*English sequence*	*Choose 1:* • **Transitional English** • **English Composition** (AP or dual credit course)	*Choose 1:* • **English Composition*** (Postsecondary course with IAI) • **Oral Communication** (Postsecondary course with IAI)
Science	*Science sequence*	*Science sequence*	**Physics** (AP or dual credit course)	**General Physics** (Postsecondary course with IAI) **General Chemistry** (Postsecondary course with IAI)
Social Science	*Social science sequence*	*Social science sequence*	*Social science sequence* (AP or dual credit course)	*Social science sequence* (Postsecondary course with IAI)

KEY:
AP or dual credit course
Dual credit course with IAI
Dual credit course
Postsecondary course with IAI
College & Career Pathway Endorsement

** If credit was already earned through an early college course, take the next requirement in the sequence or, if none, additional AAS or major courses*

High School General Education Courses

There are several critical considerations for general education coursework before graduating high school. The courses mentioned here are frequent requirements for many postsecondary promising credentials in manufacturing and engineering and enhance students' opportunities for postsecondary success in addition to the career-focused courses already delineated.

- In **science**, students should complete physics, where possible, as either Advanced Placement (AP) or dual credit.
- In **math**, students should complete the highest course possible in a calculus-based sequence to be prepared for the full range of career options in manufacturing and engineering. Districts should consider math courses that contextualize application in career fields, such as Geometry In Construction, and that expose students to data analytics occurring in the context of manufacturing businesses. Students that do not demonstrate readiness for an early college math course during their senior year of high school should enroll in Transition to STEM, a transitional math course that guarantees placement into College Algebra at the postsecondary level. Students pursuing a postsecondary credential in welding or machining and production may instead take Technical Math, also a transitional math course, if it guarantees placement into the required math for that credential at the partner community college.
- In **English**, students prepared for college-level coursework in their senior year should enroll in a dual credit English Composition course (if available) or AP English Language and Composition. If not prepared for college-level coursework, students should enroll in a transitional English course that guarantees placement into the partner community college's English Composition course.

First-Year Postsecondary Courses

The recommended first-year postsecondary courses build upon the knowledge and skills recommended at the capstone level. As with high school programs, community colleges should pursue opportunities to integrate and align advanced manufacturing and engineering coursework and work-based learning opportunities.

In advanced manufacturing pathways, students in machining-related programs will take more advanced CNC programming courses and a course such as Manufacturing Materials and Processes that focuses on the properties of materials and their transformation into fabricated components and finished goods.

In engineering pathways and some advanced manufacturing pathways, students will take coursework in areas such as Industrial Electricity addressing electrical theory, electrical circuits and components, and basic electrical maintenance. In addition, engineering pathway students will take advanced coursework in computer-aided drafting (CAD) and computer-aided manufacturing (CAM) technology.

In the general education course areas, students will take the required 100-level courses. In science, this will be typically be Physics 101, although process operations credentials will also require a foundation in chemistry. If the 100-level courses have been accomplished through early college credit, students will take the next required course in the subject or, if none, additional AAS or courses in their major.

Competency-Based Education Considerations

In 2021–2022, ICCB engaged a group of community colleges to design a competency-based education program in the high-demand sectors of industrial maintenance and welding. Through that process, colleges developed a set of competencies essential for students to succeed in postsecondary programs and persist in the welding and industrial maintenance fields. These competencies should be used as a resource for aligning courses and programs of study with postsecondary and workforce expectations (see appendix C).

V. Strategic Dual Credit Courses: Competency Descriptions

To support implementation of the model programs of study, a working group of the Advisory Committee identified key competencies for the identified early college courses that lack statewide articulation. In manufacturing and engineering, those courses are Introduction to Technology and Engineering, Foundations of Production and Manufacturing Processes, and Advanced Production and Manufacturing Processes.

Introduction to Technology and Engineering *Key Competencies*	
Goal	Students build pathway awareness, excitement, and foundational knowledge.
Competencies	• Students can demonstrate awareness of the career pathways in advanced manufacturing and engineering in order to plan a personalized pathway leading to a promising credential. • Students can demonstrate awareness of and have exposure to the range of manufacturing processes including fabrication, machining, non-durable good production, additive manufacturing, and robotic automation in order to contextualize their instruction in the field. • Students can use their understanding of safety practices and PPE in order to demonstrate a safety mindset when navigating a manufacturing environment. • Students can use their understanding of simple hand and power tools in order to identify, correctly set-up, and safely operate them. • Students can use their understanding of simple machines to describe how levers, gears, pulleys, and other simple machine components work. • Students can use their understanding of basic concepts in layout, print reading, measurement, and quality practices in order to describe the steps in the design and development process.
Work-Based Learning	• Students can assess and implement procedures used to recruit, train, and retain employees in order to create a sustainable pipeline of human resources for AFNR operations. • Students can identify and apply business management skills in order to conduct AFNR business operations in an efficient, legal, and ethical manner. • Students can use their understanding of verbal and written communication to effectively maintain relationships with employers, employees, and customers.
Postsecondary and Career Expectations	Students have documented a personalized career pathway leading to a promising credential in Advanced Manufacturing or Engineering.

Foundations of Production and Manufacturing Processes *Key Competencies*	
Goal	Students engage in teacher-directed machining applications.
Competencies	• Students can use their understanding of safety principles in equipment usage, practices, and procedures in order to maintain a secure work environment and safely engage in manufacturing processes. • Students can use their understanding of personal safety and environmental regulations to comply with local, federal, and company health and safety demands. • Students can use their understanding of basic machining or other automated production methods to conduct authentic projects under close adult direction and supervision. • Students can apply basic concepts in layout, print reading, measurement, and quality assurance practices in authentic situations. • Students can apply their understanding of supply chain logistics in an authentic situation involving the movement and storage of materials and products.
Work-Based Learning	• Additional virtual and in-person site visits to manufacturing and engineering employers; • A job shadow with a professional in the field; and • At least one team-based challenge, such as a robotics team or SkillsUSA competition.
Credential Preparation	Students are prepared to attain either: • OSHA 10-hour course completion card and MSSC Safety + Quality Practices and Measurement • NIMS ML I: Measurement, Materials, and Safety + Job Planning, Benchwork and Layout

Advanced Production and Manufacturing Processes *Key Competencies*	
Goal	Students are self-directed in production applications.
Competencies	• Students can use their understanding of production applications and production process to, with minimal supervision, plan, calculate, and safely (i) machine a part meeting customer requirements (for courses aligned to NIMS) or (ii) make a product within a production system (for courses aligned to MSSC) meeting customer requirements. This competency addresses the following sub-competencies: equipment safety; manufacturing environment; personal health and safety; spatial reasoning; process, design, and development; installation; and customer focus. • Students can apply their understanding of supply chain logistics in authentic scenarios involving materials for the part or product and its distribution to the customer. • Students can apply their understanding of digital manufacturing tools and robotic automation in an authentic situation involving their application within production applications. • Students can apply their understanding of quality control practices and continuous improvement in an authentic situation involving quality system requirements as defined by customer specifications. • Students can use their understanding of maintenance principles and requirements to recognize potential maintenance issues and perform preventative maintenance and routine repairs.
Work-Based Learning	• At least one additional team-based challenge, and • A career development experience of a minimum of 60 hours with a manufacturer or engineering employer sponsor.
Credential Preparation	Students are prepared to attain either: • MSSC Certified Production Technician • NIMS Level I CNC Turning (Lathe) Operations + Mill Operations

Appendices

A: Technical and Essential Employability Competencies for Manufacturing, Engineering, Technology, and Trades

The following are from "Recommended Technical and Essential Employability Competencies for College and Career Pathway Endorsements," a document developed through an iterative process involving public-private steering committees established pursuant to the Postsecondary and Workforce Readiness Act in order to implement College and Career Pathway Endorsements.

Technical and Essential Employability Competencies for **Manufacturing, Engineering, Technology, and Trades**	
Equipment Safety	Students can use their understanding of equipment usage, practices, and procedures to maintain a healthy, safe, and secure work environment.
Manufacturing Environment	Students can use their understanding of workstations, tools, and equipment operations to safely navigate a manufacturing environment.
Personal Health & Safety	Students can use their understanding of personal safety and environmental regulations to comply with local, federal, and company health/safety demands.
Spatial Reasoning	Students can use their understanding of objects in relation to one another to understand three-dimensional imaging.
Process, Design, & Development	Students can use their understanding of technical drawings and schematics to complete the design and development process.
Installation	Students can use their understanding of tools to assemble and disassemble simple tools.
Customer Focus	Students can use their understanding of communication and project management to understand client needs and complete project accordingly.
Quality Assurance & Continuous Improvement	Students can use their understanding of product and process to meet quality systems requirements as defined by customer specifications.
Digital Manufacturing	Students can use their understanding of digital manufacturing tools and computer-based programs to complete the design and develop implementation process.
Supply Chain Logistics	Students can use their understanding of materials, suppliers, and internal systems to plan and monitor movement and storage of materials and products.

B: Cross-Sector Essential Employability and Entrepreneurial Competencies

The following are from "Recommended Technical and Essential Employability Competencies for College and Career Pathway Endorsements," a document developed through an iterative process involving public-private steering committees established pursuant to the Postsecondary and Workforce Readiness Act in order to implement College and Career Pathway Endorsements.

Essential Employability Competencies	
Teamwork & Conflict Resolution	Students can use their understanding of working cooperatively with others to complete work assignments and achieve mutual goals.
Communication	**Verbal**: Students can use their understanding of English grammar and public speaking, listening, and responding, convey an idea, express information, and be understood by others. **Written**: Students can use their understanding of standard business English to ensure that written work is clear, direct, courteous, and grammatically correct. **Digital**: Students can use their understanding of email, keyboarding, word processing, and digital media to convey work that is clear, direct, courteous, and grammatically correct.
Problem Solving	Students can use their critical thinking skills to generate and evaluate solutions as they relate to the needs of the team, customer, and company.
Decision Making	Students can use their understanding of problem solving to implement and communicate solutions.
Critical Thinking	Students can use their understanding of logic and reasoning to analyze and address problems.
Adaptability & Flexibility	Students can use their understanding of workplace change and variety to be open to new ideas and handle ambiguity.
Initiative & Self-Drive	Students can use their understanding of goal setting and personal impact to achieve professional goals and understand personal impact.
Reliability & Accountability	Students can use their understanding of commitment, time management, and follow through to ensure that a professional team functions properly and meets collective goals.
Cultural Competence	Students can use their understanding of diversity and inclusion to communicate and work effectively across a multitude of abilities, cultures, and backgrounds.
Planning & Organizing	Students can use their understanding of time management to plan effectively and accomplish assigned tasks.

Entrepreneurial Competencies	
Principles of Entrepreneurship	Students can apply their understanding of the process and characteristics of business development and promotion in order to apply strategies of innovation to personal and professional business pursuits.
Innovation & Invention	Students can use their understanding of idea generation, design thinking, product and business development in order to introduce and process new and effective ideas.
Growth Mindset	Students can use their understanding of learning from challenges, set-backs, and failure in order to adapt strategies and continue efforts to achieve personal goals.

C: Postsecondary Competency-Based Education Competencies for Industrial Maintenance and Welding Programs

In alignment with Illinois' Career and Technical Education Plan (i.e., Perkins V) and the Higher Education Strategic Plan, the following competencies were released by Education Systems Center at Northern Illinois University in partnership with the Illinois Community College Board in 2023. The competencies support postsecondary, competency-based education programs in welding and industrial maintenance. Competency-based education focuses on determining a student's achievement by evaluating proficiency within a set of learning outcomes and objectives moving away from traditional time-based constraints.

Industrial Maintenance	
OSHA Standards	
Definition	I can perform my duties observing and utilizing OSHA standards.
Level of Mastery: **Developing**	• Audit a machine following guides to indicate what's safe; identify violations following the OSHA checklist; recognize and document safety violations. • Identify workplace hazards.
Level of Mastery: **Developed**	• Identify safety violations before they occur. Correct a safety violation by reporting and following proper procedure to remedy a situation. Respond appropriately to a safety hazard. • Identify ways to mitigate the workplace hazard.
Level of Mastery: **Highly Developed**	• Instruct another individual on how to do a safety audit. You can train someone else to make the area safe. • Develop a safety program that recognizes and mitigates workplace hazards.
Example Assessment: **Formative**	• Multiple choice • Online modules with quizzes, including interactive components and discussion boards • Case study with a scenario and pictures • Simulation/role play to note all of the violations • Creating a checklist • Complete an OSHA checklist
Example Assessment: **Summative**	• Get OSHA 10 card certification • Quizzes/exams • Case studies • Final safety project

Industrial Maintenance	
Repair Equipment	
Definition	I can perform equipment repairs utilizing various processes and systems.
Level of Mastery: **Developing**	Identify what tools, practices and procedures that must be followed to perform a required repair.
Level of Mastery: **Developed**	Utilize the tools and procedures to perform the repair.
Level of Mastery: **Highly Developed**	Can instruct others on the proper tool usage and procedures to perform a required repair task.
Example Assessment: **Formative**	• Template/checklist (work order) • Tag tools with tool name and application cards
Example Assessment: **Summative**	• Observation/demonstration • Video submission of demonstration
Industrial Wiring	
Definition	I can demonstrate wiring techniques to meet industry standards in order to actuate motors and other devices.
Level of Mastery: **Developing**	Wire a motor control circuit using an existing diagram with minimal supervision.
Level of Mastery: **Developed**	Wire a functional motor control circuit, from a reference diagram, meeting industry standards with no assistance.
Level of Mastery: **Highly Developed**	Develop a wiring schematic based upon a set of parameters and wire a functional motor control circuit that meets industry standard with no assistance.
Example Assessment: **Formative**	• Sketches • Digital designs • Online modules with interactive components • Exam/quiz
Example Assessment: **Summative**	• Observation/demonstration • Video submission of demonstration

Industrial Maintenance	
Use of Tools	
Definition	• I can properly use the correct basic tools commonly used in the industry. • I can properly use the correct specialized/domain-specific tools commonly used in the industry.
Level of Mastery: **Developing**	• Identify tools for their application and intended use; state common industry nomenclature for tools. • Recognize tools for their application and intended use; identify the tool and it's purpose; demonstrate understanding of common industry nomenclature.
Level of Mastery: **Developed**	• Identify and select an appropriate tool from a toolbox then use it correctly to correct a given scenario, maintaining a proper work environment. Store the tool properly when work is complete. • Identify and select an appropriate tool from a toolbox then use it correctly to correct a given scenario, maintaining a proper work environment; store the tool properly when work is complete.
Level of Mastery: **Highly Developed**	• Instruct a colleague on the proper application of a tool or identify applications for a tool beyond common use. Identify when a tool is used improperly and coach a colleague on its correct application. • Demonstrate tool usage to a classmate or colleague; use a tool to solve a problem outside its designation; identify when a classmate/colleague is not using a tool properly and coach them on the proper usage.
Example Assessment: **Formative**	Basic tools: • Online modules with interactive components • Scenario with pictures • Exams/quizzes Specialized/domain-specific tools: • Multiple choice • Online modules with interactive components • Scenario with pictures • Exams/quizzes
Example Assessment: **Summative**	• Observation/demonstration • Video submission of demonstration

Industrial Maintenance	
Career Planning	
Definition	I can explain the various industries in my local area; locate potential career opportunities; build a cover letter, resume, follow up letter; demonstrate basic interviewing skills.
Level of Mastery: **Developing**	Struggles to identify potential career opportunities; resume, cover letter, and follow up letter has grammatical errors; unable to demonstrate good interviewing techniques.
Level of Mastery: **Developed**	Able to identify potential career opportunities; able to build a resume, cover letter and follow up letter; able to demonstrate basic interviewing techniques.
Level of Mastery: **Highly Developed**	Able to identify multiple career field career opportunities; resume, cover letter, and follow up letter are well written; outstanding interviewing skills and answers questions fully and articulately.
Example Assessment: **Formative**	• Observation • Exam/quiz
Example Assessment: **Summative**	• Cumulative observation • Performance project • Quiz/exam • Case study
Operation of Systems	
Definition	I can operate automated systems by programming devices controls through problem solving and analyzing the processes and task.
Level of Mastery: **Developing**	Program and troubleshoot using controllers to find potential failures.
Level of Mastery: **Developed**	Design, program and troubleshoot using controllers to find the most likely cause with no assistance.
Level of Mastery: **Highly Developed**	Demonstrate to others how to design, program and troubleshoot using controllers to find potential failures and choose the most likely cause with no assistance.
Example Assessment: **Formative**	• Lab activity with rubric • Build a simulator • Case study questions • Exams/quizzes
Example Assessment: **Summative**	• Observation/class demonstration • Lab activity using a rubric • Build and troubleshoot a project • Case study questions

Industrial Maintenance	
Mechanical Systems	
Definition	I can operate, install, mechanical systems by analyzing for proper operation.
Level of Mastery: **Developing**	Recognize when a system is not functioning as it was intended.
Level of Mastery: **Developed**	Solve a given problem based on the description of the problem; give possible solutions to fix the issue.
Level of Mastery: **Highly Developed**	Teach someone what to look for in the problem statement and help them identify the problem item/items.
Example Assessment: **Formative**	• Various exams in review of content must pass with 80% before moving on to the next module • Lab activity with rubric
Example Assessment: **Summative**	• Passing their C-210 SACA certification • Exams/quizzes
Fluid Power Systems	
Definition	I can operate fluid powers systems by troubleshooting and analyzing for proper operation.
Level of Mastery: **Developing**	Define and recognize symbols for the Hydraulic and Pneumatics.
Level of Mastery: **Developed**	Identify the flow of the schematic drawings.
Level of Mastery: **Highly Developed**	Demonstrate how to identify and follow flow through system.
Assessment: **Formative**	• Various exams in review of content must pass with 80% before moving on to next module • Lab activity with rubric
Assessment: **Summative**	• Passing their C-209 SACA Pneumatic and/or C-255 SACA Hydraulic Certifications • Exams/quizzes

Industrial Maintenance	
Electronics Systems	
Definition	I can repair electronic systems through troubleshooting and testing of components.
Level of Mastery: **Developing**	Identify what tools and systems are used; troubleshoot and/or repair electronic systems following practices and procedures.
Level of Mastery: **Developed**	Use tools, systems, practices and procedures to troubleshoot and/or repair electronic systems.
Level of Mastery: **Highly Developed**	Teach others how to repair electronics systems with the proper tools, practices and procedures.
Example Assessment: **Formative**	• Multiple choice • Online modules with interactive components • Scenario with pictures • Exams/quizzes
Example Assessment: **Summative**	• Observation/demonstration • Video submission of demonstration
System Faults	
Definition	I can troubleshoot and diagnose common system faults for industrial machinery.
Level of Mastery: **Developing**	Identify potential failures and choose the most likely cause.
Level of Mastery: **Developed**	Identify the single cause of failure using testing procedures and replace the component as needed.
Level of Mastery: **Highly Developed**	Identify the single cause of failure using testing procedures and meters and replace the component as needed within the allotted time expected by industry.
Example Assessment: **Formative**	• Lab activity with a rubric • Troubleshoot with simulator • Case study questions
Example Assessment: **Summative**	• Observation/class demonstration • Lab activity using a rubric • Troubleshoot a project • Case study questions

Industrial Maintenance	
Circuits and Components	
Definition	I can successfully construct electrical circuits and components.
Level of Mastery: **Developing**	Wire an electronic circuit using an existing electronic diagram with minimal supervision.
Level of Mastery: **Developed**	Wire a functional electronic circuit from a diagram that meets industry standard with no assistance.
Level of Mastery: **Highly Developed**	Develop an electronic diagram based upon a set of parameters and wire a functional circuit that meets industry standard with no assistance.
Example Assessment: **Formative**	• Lab activity with a rubric • Build with simulator
Example Assessment: **Summative**	• Observation/class demonstration • Lab activity using a rubric • Build a project
Self-Regulation	
Definition	I can demonstrate commitment, time management, and follow through.
Level of Mastery: **Developing**	Absent less than the maximum allowed days/hours; complete tasks when allotted more time than required.
Level of Mastery: **Developed**	Show up on time; prepare for task-at-hand prior to starting; solicit and receive feedback.
Level of Mastery: **Highly Developed**	Help others; well-prepared for tasks; arrive early and stay late; able to receive feedback and seeks feedback from others.
Example Assessment: **Formative**	• Online modules with interactive components • Scenario with pictures
Example Assessment: **Summative**	• Cumulative observation with tracking (attendance) • Checklist

Industrial Maintenance	
Communication	
Definition	I can communicate and manage a project to address customer needs.
Level of Mastery: **Developing**	Orally convey needs to others; transmits clear written communication using professional terms; all communications are respectful (free from derogatory or generalizing language).
Level of Mastery: **Developed**	Orally communicate with minimal distracting words; able to communicate in written word with minimal grammatical and spelling errors; able to utilize computer-based communication software.
Level of Mastery: **Highly Developed**	Orally communicate in an articulate manner with no distracting words; written communication has no spelling or grammatical errors; utilizes computer software with no issues.
Example Assessment: **Formative**	• Scenario with pictures • Written correspondence
Example Assessment: **Summative**	• Written “exam” (resume/cover letter) • Scenario application
Reasoning/Critical Thinking	
Definition	I can problem solve to create and evaluate solutions.
Level of Mastery: **Developing**	Unable to recognize a problem; bring the problem to a supervisor’s attention.
Level of Mastery: **Developed**	Recognize a problem exists; identify the root cause; independently gather information to refine understanding of the problem; proactively seek solutions; execute solution.
Level of Mastery: **Highly Developed**	Implement solutions; recognize problems as break-through for future advancement.
Example Assessment: **Formative**	• Online modules with interactive components • Scenario with pictures
Example Assessment: **Summative**	• Observation/demonstration • Scenario application

Welding	
Shop Safety	
Definition	I can demonstrate proper shop safety by identifying potential hazards and following shop procedures utilizing industry standards.
Level of Mastery: **Developing**	Identify and correct safety violations after an incident happens.
Level of Mastery: **Developed**	Identify and correct safety violations before an incident happens.
Level of Mastery: **Highly Developed**	Identify co-workers that are demonstrating risky behavior and can provide targeted intervention to help bring their skills up to speed.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study
Welding Fundamentals	
Definition	I can identify and explain the similarities and differences between welding processes, cutting processes, welding polarities, welding positions, welding joint designs, and welding joint preparation.
Level of Mastery: **Developing**	Explanations of the differences between welding polarities, processes, joint types and designs have major inconsistencies or include inaccurate information.
Level of Mastery: **Developed**	Able to explain differences between welding polarities, processes, joint types and designs with minor inconsistencies.
Level of Mastery: **Highly Developed**	Able to explain differences and similarities between welding polarities, welding processes, welding joint types, and welding preparations with detail.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study

Welding	
Metallurgy	
Definition	I can identify differences between ferrous and non-ferrous metals, recognize the difference between hot rolled (HR) and cold rolled (CR) materials, describe production of iron, steel, and cast irons and their classifications, and explain the differences between heat-treatment processes commonly used in welding.
Level of Mastery: **Developing**	Inconsistent with identifying materials; unable to explain differences between HR and CR steels; unable to explain heat treatment.
Level of Mastery: **Developed**	Able to recognize ferrous and non ferrous materials, able to explain production of materials, and explain heat treatment processes.
Level of Mastery: **Highly Developed**	Able to explain differences between ferrous and non ferrous materials, visually identify HR and CR materials, able to demonstrate a variety of heat treatment processes, and able to accurately explain material production.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study
Print Reading	
Definition	I can demonstrate a working knowledge of print reading; recognize the alphabet "of lines"; welding symbols and abbreviations; and demonstrate proper use of various measuring devices using imperial and metric formats.
Level of Mastery: **Developing**	Inconsistent in welding symbol identification; difficultly using basic measuring tools; struggles to recognize basic line types on a print.
Level of Mastery: **Developed**	Able to accurately read welding symbols; identify line types on working drawings; accurately measure using various tools; able to convert fractions to decimals.
Level of Mastery: **Highly Developed**	Able to make a set of mechanical drawings; write welding symbols; convert imperial dimensions to metric.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study

Welding	
Material Preparation	
Definition	I can explain and perform material preparation for welding using various manual and mechanized cutting tools.
Level of Mastery: **Developing**	Inconsistent in set up of equipment; material preparation is not straight or has discontinuities in the prepared edge.
Level of Mastery: **Developed**	Able to prepare welding materials using Oxyfuel, plasma, and hand tools.
Level of Mastery: **Highly Developed**	Able to prepare welding materials with accuracy according to a set of plans using Oxyfuel, plasma, and hand tools.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study
Oxyfuel Gas Welding	
Definition	I can weld using Oxyfuel gas welding to perform fillet and groove welds on basic welding joint types in the four welding positions according to American Welding Society (AWS) standards.
Level of Mastery: **Developing**	Complete welds according to AWS standards but have weld defects.
Level of Mastery: **Developed**	Complete welds according to AWS standards with discontinuities but no defects.
Level of Mastery: **Highly Developed**	Complete welds according to AWS standards with no discontinuities or defects.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study

Welding	
Shielded Metal Arc Welding	
Definition	I can weld using shielded metal arc welding to perform fillet and groove welds on basic welding joint types in the four welding positions according to American Welding Society (AWS) standards and can complete a guided bend test.
Level of Mastery: **Developing**	Complete welds according to AWS standards but have weld defects.
Level of Mastery: **Developed**	Complete welds according to AWS standards with discontinuities but no defects.
Level of Mastery: **Highly Developed**	Complete welds according to AWS standards with no discontinuities or defects.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study
Gas Metal Arc Welding	
Definition	I can weld using gas metal arc welding to perform fillet and groove welds on basic welding joint types in the four welding positions according to American Welding Society (AWS) standards and can complete a guided bend test.
Level of Mastery: **Developing**	Complete welds according to AWS standards but have weld defects.
Level of Mastery: **Developed**	Complete welds according to AWS standards with discontinuities but no defects.
Level of Mastery: **Highly Developed**	Complete welds according to AWS standards with no discontinuities or defects.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study

Welding	
Gas Tungsten Arc Welding	
Definition	I can weld using gas tungsten arc welding to perform fillet and groove welds on basic welding joint types in the four welding positions according to American Welding Society (AWS) standards and can complete a guided bend test.
Level of Mastery: **Developing**	Complete welds according to AWS standards but have weld defects.
Level of Mastery: **Developed**	Complete welds according to AWS standards with discontinuities but no defects.
Level of Mastery: **Highly Developed**	Complete welds according to AWS standards with no discontinuities or defects.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study
Flux Core Arc Welding	
Definition	I can weld using flux cored arc welding to perform fillet and groove welds on basic welding joint types in the four welding positions according to American Welding Society (AWS) standards and can complete a guided bend test.
Level of Mastery: **Developing**	Complete welds according to AWS standards but have weld defects.
Level of Mastery: **Developed**	Complete welds according to AWS standards with discontinuities but no defects.
Level of Mastery: **Highly Developed**	Complete welds according to AWS standards with no discontinuities or defects.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study

Welding	
Pipe Welding	
Definition	I can demonstrate welding using various welding processes on pipe in the 1G/1F, 2G/2F, 5G/5F, and 6G/6F positions according to American Welding Society (AWS) standards and can complete a guided bend test.
Level of Mastery: **Developing**	Complete welds according to AWS standards but have weld defects.
Level of Mastery: **Developed**	Complete welds according to AWS standards with discontinuities but no defects.
Level of Mastery: **Highly Developed**	Complete welds according to AWS standards with no discontinuities or defects.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study
Non-Ferrous Welding	
Definition	I can demonstrate welding using various welding processes to perform fillet and groove welds on basic welding joint types in the four welding positions according to American Welding Society (AWS) standards.
Level of Mastery: **Developing**	Complete welds according to AWS standards but have weld defects.
Level of Mastery: **Developed**	Complete welds according to AWS standards with discontinuities but no defects.
Level of Mastery: **Highly Developed**	Complete welds according to AWS standards with no discontinuities or defects.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study

Welding	
Fabrication	
Definition	I can discuss a project with a "client", develop a plan to solve the problem, design a set of drawings, develop a budget, order materials, and fabricate the project.
Level of Mastery: **Developing**	Struggles to communicate with "client"; drawings are incomplete; budget is inaccurate; materials are ordered improperly; fabrication skills are minimal.
Level of Mastery: **Developed**	Able to work with "client" to determine problem, develop a work plan, develop a budget, order materials and fabricate project.
Level of Mastery: **Highly Developed**	Works with "client" with no issues, able to provide multiple solutions to the problem, and develops detailed work plan.
Example Assessment: **Formative**	Direct observation
Example Assessment: **Summative**	• Performance project • Case study
Weld Inspection	
Definition	I can use various weld examinations, destructive and non-destructive testing methods to locate and identify welding discontinuities and defects as identified by American Welding Society (AWS) welding codes.
Level of Mastery: **Developing**	Unable to identify weld discontinuities and defects; unable to explain destructive and non destructive testing methods.
Level of Mastery: **Developed**	Able to explain the differences between weld discontinuities and weld defects; able to explain the differences between destructive and non destructive testing methods.
Level of Mastery: **Highly Developed**	Able to identify and explain how to correct for weld discontinuities and defects; able to perform various types of destructive and non destructive testing methods.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study

Welding	
Career Planning	
Definition	I can explain the various industries in my local area; locate potential career opportunities; build a cover letter, resume, follow up letter; demonstrate basic interviewing skills.
Level of Mastery: **Developing**	Struggles to identify potential career opportunities; resume, cover letter, and follow up letter has grammatical errors; unable to demonstrate good interviewing techniques.
Level of Mastery: **Developed**	Able to identify potential career opportunities; able to build a resume, cover letter and follow up letter; able to demonstrate basic interviewing techniques.
Level of Mastery: **Highly Developed**	Able to identify multiple career field career opportunities; resume, cover letter, and follow up letter are well written; outstanding interviewing skills and answers questions fully and articulately.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	• Performance project • Case study
Accountability	
Definition	I can demonstrate dependability, time management, and preparedness.
Level of Mastery: **Developing**	Demonstrates tardiness and absenteeism; lack of preparation.
Level of Mastery: **Developed**	Shows up on time; prepared for task at hand; receives feedback; solicits feedback.
Level of Mastery: **Highly Developed**	Helps others; well-prepared; arrives early and stays late; able to receive feedback and seeks feedback from others.
Example Assessment: **Formative**	• Direct observation • Group projects • Self-assessment
Example Assessment: **Summative**	Direct observation

Welding	
Communication	
Definition	I can effectively demonstrate oral, written, and digital competencies.
Level of Mastery: **Developing**	Struggles to communicate orally; uses distracting words; does not make eye contact; excessively fidgets while communicating; written communication contains excessive spelling and grammatical errors; unable to navigate computer software.
Level of Mastery: **Developed**	Able to orally communicate with minimal distracting words; able to communicate in written word with minimal grammatical and spelling errors; able to actively listen; able to effectively communicate using digital devices.
Level of Mastery: **Highly Developed**	Able to orally communicate in an articulate manner with no distracting words; written communication has no spelling or grammatical errors; actively listens; able to effectively communicate using digital devices.
Example Assessment: **Formative**	• Written test • Direct observation
Example Assessment: **Summative**	Performance project
Critical Thinking	
Definition	I can evaluate and analyze problems.
Level of Mastery: **Developing**	Unable to recognize a problem; bring the problem to a supervisor's attention.
Level of Mastery: **Developed**	Recognize a problem exists; identify the root cause; gather information to refine understanding of the problem (seek solutions); execute solution.
Level of Mastery: **Highly Developed**	Implement solutions; recognize problems as break-through for future advancement.
Example Assessment: **Formative**	• Oral questioning • Direct observation • Group project • Role play • Self-assessment
Example Assessment: **Summative**	• Performance project • Case study

D: 2020 Advisory Committee Membership

Natasha Allen
Director for Career & Technical Education
Illinois Community College Board

Jon Althaus
Vice President for Academic Services
Lake Land College

Nancy Awdziejczyk
Executive Director
Northwest Educational Council for Student Success

Joseph Bachman
Central Illinois Vocational Education Coop System Director
Metamora Township High School

Brent Baker
Director of Workforce Solutions
Greater Peoria Economic Development Council

Kathy Burley
Executive Director
Golden Corridor Advanced Manufacturing Partnership

Paul Carlson
Associate Dean of Business & Technology
Kankakee Community College

Angela Gerberding
Associate Director for Integrated Career Programs
Illinois Community College Board

Kathy Gilmore
President
Valley Industrial Association

Robert Gosch
Principal
River Bend School District

Susan Grzanich
Innovation and Grants Officer
Peoria Public Schools District 150

Christopher Kendall
System Director
Peoria Educational Region for Employment & Career Training

Mario Kratsch
Vice President
German American Chamber of Commerce of the Midwest

Kim Kuchenbrod
Workforce Development Consultant
Vermilion Advantage

Michael Kuhn
Principal
Woodruff Career & Technical Center

Kathy Lively
Chief Executive Officer
Man-Tra-Con Corp

Amanda Martin
Assistant General Manager, Corporate Human Resources
North American Lighting, Inc.

Tom McGee
Dean of Career and Technical Education
McHenry County College

Mollie Dowling
Executive Director
OAI, Inc.

Jim Nelson
Vice President, Education & Workforce Policy
Illinois Manufacturers' Association

David Osborne
Principal Consultant
Illinois State Board of Education

Patrick Osborne
Vice President of Training & Education
Technology & Manufacturing Association

Steve Parrott
Technology and Engineering Education Principal Consultant
Illinois State Board of Education

Analiesa Rackauskas
Division Talent Development Manager ITDD & ACM
Caterpillar Inc.

Andrew Rice
Teacher of Engineering, Manufacturing, and Welding
Manual Academy

Virginia Rounds
Director, Apprenticeship Networks Chicago
German American Chamber of Commerce of the Midwest

Blanche Schoup
President/CEO
Western Illinois Works

Brad Sparks
Dean of Technical Education
Southwestern Illinois College

Whitney Thompson
Senior Director for Career & Technical Education
Illinois Community College Board

Tom Wendorf
Co-Founder/ Manager
DuPage Impact LLC

E: 2025 Clean Energy Working Group Membership

Natasha Allen
Director for Career & Technical Education
Illinois Community College Board

Vincent Hobart
Instructor, Electric Vehicle and Energy Storage
Heartland Community College

David Husemoller
Executive Director
Illinois Green Economy Network (IGEN)

Meagan Mitchell, PhD
Director of Pathways
Education Systems Center at Northern Illinois University

Curt Rendall
Executive Director, Program Development and Innovation
Heartland Community College

James Stafford
Assistant Professor & Automotive Program Coordinator
Kankakee Community College

Dana Wynn
Director for Clean Energy
Illinois Community College Board

F: College and Career Pathway Endorsements Framework

The College and Career Pathway Endorsements framework is a voluntary system for school districts to award endorsements on high school diplomas to graduates who have demonstrated readiness for college and careers.

College and Career Pathway Endorsements Framework

INDIVIDUAL PLAN

Each student completing an endorsement must have an individualized plan, which includes college planning linked to early understanding of career goals, financial aid, resume, and personal statement.

PROFESSIONAL LEARNING

Awareness, exploration, and preparation activities that provide opportunities for students to interact with adults in their workplace and gain essential employability and technical competencies.

9th	10th	11th	12th
At least 2 career exploration activities or 1 intensive experience		60 cumulative hours of paid or for credit, supervised caree development experience(s) with a professional skills assessment r	
At least 2 team-based challenges with adult mentoring			

CAREER-FOCUSED INSTRUCTIONAL SEQUENCE

2 years of secondary coursework or equivalent that include essential employability and technical competencies, at least 6 hours of early college credit, and articulation to a postsecondary credential with labor market value.

9th	10th	11th	12th
Orientation / Introduction Courses			
	Skill Development Courses		
			Capstone / Advanced Courses

ACADEMIC READINESS

Ready for non-remedial coursework in reading and math by high school graduation through criteria defined by the school district and local community college.

G: Illinois' Work-Based Learning Continuum

Illinois has a defined continuum of work-based learning opportunities, which spans from secondary to postsecondary. Components, defined in statute and the Illinois Career Pathways Dictionary, include career awareness, career exploration, team-based challenges, career development experiences, youth or pre-apprenticeships, and apprenticeships.

Work-Based Learning & Host Engagement Continuums

Illinois' continuum represents the many forms of work-based learning that grow in intensity depending on the model. However, this continuum is not intended to convey a fixed or ideal progression. As individuals learn through their work-based learning experiences, they may return to less intensive models to develop different skills or explore additional interests. Individuals should be supported to engage in these activities iteratively as they explore the multiple entry and exit points of career pathways.

Providing high-quality work-based learning requires strong partnerships between educators and regional employers. As the intensity of students' experiences progress, so too does the role of employer partners serving as host sites.

STATE OF ILLINOIS

Model Programs of Study in Manufacturing and Engineering

Recommended Courses

	GRADES 9–10 **Orientation**	GRADES 10–12 **Skill Development**	GRADE 12 **Capstone**	1ST YEAR* **Postsecondary**
Advanced Manufacturing	Introduction to Technology and Engineering	Foundations of Production and Manufacturing Processes	Advanced Production and Manufacturing Processes Basic Welding	Manufacturing Materials and Processes CNC Programming
Engineering		Principles of Engineering *Additional Engineering Courses*	Computer Integrated Manufacturing *Additional Engineering Courses*	Advanced CAD/CAM Technology Industrial Electricity
Work-Based Learning	Career Exploration (2)	*Choose 1:* Career Development Experience *or* Youth Apprenticeship		
	Team-Based Challenge (2); *may be offered through Career and Technical Student Organizations including a FFA Career Development Event*			
Math	*Math sequence: highest-level course possible*	*Math sequence: highest-level course possible*	*Choose 1:* • College Algebra • Calculus • Pre-Calculus • Transitional Math: STEM • Transitional Math: Technical Math	*Choose 1:* • Technical Math • College Algebra* • Trigonometry • Calculus*
English	*English sequence*	*English sequence*	*Choose 1:* • Transitional English • English Composition	*Choose 1:* • English Composition* • Oral Communication
Science	*Science sequence*	*Science sequence*	Physics	General Physics General Chemistry
Social Science	*Social science sequence*	*Social science sequence*	*Social science sequence*	*Social science sequence*

KEY:
AP or dual credit course · *Dual credit course* · *College & Career Pathway Endorsement*
Dual credit course with IAI · *Postsecondary course with IAI* · *Course prepares for industry credential*

** If credit was already earned through an early college course, take the next requirement in the sequence or, if none, additional AAS or major courses*

Postsecondary Opportunities

	Certification	Associate Degree		Bachelor's Degree
Welding	Welding Certificates	Welding AAS	● ● ●	Bachelor of Science Applied Manufacturing
Machining & Production	Precision Machining & Production Certificates	Precision Machining & Production AAS	● ● ●	
	Industry Certifications	Machine Tool Tech AAS	● ● ●	
Industrial Maintenance	*Industry Certifications*	Industrial Maintenance AAS	● ● ●	
Engineering & Automation	*Industry Certifications*	Computer Integrated Manufacturing and Mechatronics AAS	● ● ●	
		Associate in Engineering Science		Bachelor of Science in Engineering

● ● ● *Bachelor's degree is not required for employability*

Selected Occupations, Wages, and Job Growth

Program	Typical Job(s)	Living Wage Potential*	Median Annual Wage**	IL Growth: Change over 10 years ***	IL Annual Job Openings***	Typical Educational Requirements
Engineering and Automation	Electrical and Electronic Engineering Technicians	Medium	$34.17	0%	270	Associate Degree
	Industrial Engineering Technicians	Medium	$33.55	4%	290	
	Mechanical Engineering Technicians	Medium	$33.12	1%	140	
	Mechanical Engineers	High	$48.66	11%	800	
	Industrial Engineers	High	$48.77	13%	1,120	Bachelor's Degree
Industrial Assembly	Electromechanical Equipment Assemblers	Low	$18.43	-1%	1,410	High School Diploma
	Sheet Metal Workers	High	$43.04	-1%	430	
Industrial Maintenance	Electrical and Electronics Repairers, Commercial and Industrial Equipment	Medium	$31.26	3%	50	Postsecondary Certificate
	Industrial Machinery Mechanics	Medium	$30.71	18%	890	High School Diploma, Some College
Machining & Production	Tool and Die Makers	Medium	$29.78	2.4%	456	Postsecondary Certificate
	Computer Numerically Controlled Tool Programmers	Low	$23.40	18%	180	High School Diploma, Some College
	Machinists	Low	$23.56	4%	2,120	
	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	Low	$22.30	3%	645	
Welding	Welders, Cutters, Solderers, and Brazers	Low	$23.03	5%	1,680	High School Diploma

* Living wage potential is based on MIT's Living Calculator (livingwage.mit.edu) for Illinois in 2025. Occupations with median salaries higher than the living wage for 1 adult + 1 child ($40.41/hour) are considered as having a "high" living wage potential. Occupations with median salaries only higher than the living wage of 1 adult, no children ($23.56/hour) are considered as having a "medium" living wage potential, and occupations with median salaries below the living wage of 1 adult, no children (less than $23.56/hour) are considered as having a "low" living wage potential.

** Illinois Department of Employment Security (2022). Wage Information: Occupational Employment and Wage Statistics (Statewide). Retrieved March 2025, from ides.illinois.gov/resources/labor-market-information/oews.html

*** Illinois Department of Employment Security. Employment Projections (Long-Term Occupational Projections 2020-2030). Retrieved March 2025,, from ides.illinois.gov/resources/labor-market-information/employment-projections.html