North Dakota Automated Manufacturing Education

Content Standards

Adopted and Approved June 2026

North Dakota Department of Career and Technical Education
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Standards Development Process

Standards development is a multi-phase process. Existing and/or industry standards are the basis for the North Dakota Program Standards. A team of expert secondary and postsecondary teachers, business and industry representatives, and the state program supervisor draft the standards document. Once the document is finalized, the State Board for Career and Technical Education approves and adopts the standards.

Course Frameworks are also developed by the writing team. A framework includes a brief overview of the course content, topical units of study, and identifies the standards recommended for inclusion within the course. The frameworks are tailored to prepare young people for the opportunities in North Dakota. School Districts will use the frameworks as a guide for developing curriculum that reflects local needs.

This set of standards was reviewed by North Dakota Automated Manufacturing Education teachers, with special thanks to Joseph Ostgarden, Career Impact Academy/Grand Forks; Justin Johnsrud, Bakken Area Skills Center; and Andrew Henjum, Fargo South High

Adapted from National Institute for Metalworking Skills, Inc., Machining Level 1 & Metalforming Level 1 Standards, 2001.

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Vision

A Future-Ready Workforce for North Dakota

Mission

Delivering high-quality Career and Technical Education to empower all students to achieve workforce readiness for lifelong success.

Key Principles of Career and Technical Education

We believe that Career Technical Education:

1. **Draws its curricula, standards, and organizing principles from the workplace.**
   The workplace provides the context, objectives, and organizing constructs for instruction and assessment. The workplace also defines the standards of performance necessary, including those required for academic, technical, and employability skills.

2. **Is a critical and integral component of the total educational system, offering career-oriented benefits for all students.**
   CTE classes offer educational benefits to students pursuing careers requiring specific technical skills as well as providing a strong foundation for those pursuing a traditional four-year (or more) degree.

3. **Is a critical and integral component of the workforce development system, providing the essential foundation for a thriving economy.**
   Preparation of a well-prepared, qualified workforce requires solid academics, good work ethics, and specific technical skills as well as the ability to communicate, work with others, solve problems, and use information. CTE contributes directly to this preparation by providing a curriculum tied to specific workplace requirements.

4. **Maintains high levels of excellence supported through identification of academic and workplace standards, measurement of performance (accountability), and high expectations for participant success.**
   Career Technical Education is committed to continuous improvement, attention to industry certification, and the development of highly qualified teachers.

5. **Is robust and flexible enough to respond to the needs of the multiple educational environments, customers, and levels of specialization.**
   CTE involves a large and complex delivery system that (1) integrates career exploration, (2) provides effective tools for organizing all curricula, (3) facilitates the teaching and use of technology, (4) is integrated into the total learning experience, (5) enhances the learning of academic subjects, (6) teaches broad occupational skills, (7) includes all aspects of the industry, (8) teaches how to balance family and work responsibilities, (9) provides job-specific training, (10) is offered at multiple levels of the educational continuum, and (11) is delivered through a variety of educational environments.

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Standard 1	*JOB PLANNING AND MANAGEMENT*	
Topic 1.1	**Job Process Planning--Develop a process plan for a part requiring milling, drilling, turning, or grinding.**	
	Student Competencies	
	1.1.1	Formulate a set of strategies to manufacture the part, given a print detailing a part requiring milling, drilling, turning, and grinding; verbal instructions; and appropriate references.
	1.1.2	Fill out an operation sheet detailing the process plan and required speeds and feeds.
	1.1.3	Identify all major components and functions of the machine tools (all major hand tools, measuring tools, tools and fixtures, work materials, etc.) and provide the rationale for the speeds and feeds selected.
Topic 1.2	**Read Job Process Plan--Read and understand a process plan for a formed metal part.**	
	Student Competencies	
	1.2.1	Given a process plan, make the appropriate interpretations required of a machine operator.
	1.2.2	Make a verbal presentation explaining each of the process plan requirements and steps, while highlighting the items of primary importance to the machine operator.
Topic 1.3	**Identify and Respond to Warning Signals During Production Operations**	
	Student Competencies	
	1.3.1	Monitor the process, both visually and audibly as required by the process plan and respond to problems as they arise in production.
	1.3.2	Understand the awareness of monitoring responsibilities not specifically stated on the process plan but required of all production jobs.

Standard 2	***JOB EXECUTION***	
Topic 2.1	**Manual Operations: Benchwork--Exemplify the ability and knowledge of activities and devices used at a common workbench.**	
	Student Competencies	
	2.1.1	Explain how to use mildsteel, handheld drill, and hand tap holes.
	2.1.2	Identify use of hand drills, hand taps, tap wrench, files, scrapers, and coated abrasives to deburr parts.
	2.1.3	Describe the use of arbor presses to perform press fits.
	2.1.4	Demonstrate the use of bench vises and hand tools appropriately.
Topic 2.2	**Manual Operations: Layout--Exemplify the ability, knowledge, and activities surrounding a common layout.**	
	Student Competencies	
	2.2.1	Identify the correct application of layout ink to a surface.
	2.2.2	Demonstrate the ability to have lines struck once.
	2.2.3	Demonstrate the importance of intersections that are clean and clear.
	2.2.4	Identify the center of intersections in order to correctly place punch marks.
	2.2.5	Demonstrate and lay out the location of hole centers, radii, and surfaces matching the specifications and within an accuracy of +/- .015, given a surface plate, surface gage, layout height gage, combination set, scriber, layout ink, prick punch, ball peen hammer, process plan, and part print.
Topic 2.3	**Turning Operations: Between Centers Turning--Exemplify the ability, knowledge, and activities concerning turning between centers.**	
	Student Competencies	
	2.3.1	Demonstrate the setup and carry-out between centers turning operations for straight turning.
	2.3.2	Demonstrate correct turning between centers finishing skills to at least 125 Ra microinches.
	2.3.3	Understand and exemplify product with no sharp edges.
	2.3.4	Produce a part matching the process plan and the part print specifications (to at least three diameters within +/-.002, one UNC external thread, one UNF external thread, and require an end-for-end swap) using appropriate trade techniques and speeds and feeds, given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories.
Topic 2.4	**Turning Operations: Chucking--Exemplify the ability, knowledge, and activities concerning turning and chucking.**	
	Student Competencies	
	2.4.1	Demonstrate the setup and carry-out of chucking operations for turning.
	2.4.2	Demonstrate correct chucking finishing skills to at least 250 Ra microinches.
	2.4.3	Understand and exemplify product with no sharp edges.

	2.4.4	Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the print specifications (to at least three diameters within +/-.005", two bores within +/-.005", one UNC external thread, and at least two chuckings or other workholding setup) using appropriate trade techniques and speeds and feeds.
Topic 2.5	**Milling: Square Up a Block--Set up and perform squaring up the six surfaces of a block.**	
	Student Competencies	
	2.5.1	Understand and replicate a part that requires squaring up from its raw state matching the process plan and the part print specifications to within +/-.002 and .002 over 4.5" squareness.
Topic 2.6	**Vertical Milling--Exemplify the ability, knowledge, and activities concerning a vertical milling machine.**	
	Student Competencies	
	2.6.1	Define the setup and operation of vertical milling machines.
	2.6.2	Perform routine milling activities, including the location of hole centers within +/- .005.
	2.6.3	Demonstrate correct finishing skills to at least 125 Ra microinches.
	2.6.4	Understand and exemplify product with no sharp edges.
Topic 2.7	**Surface Grinding--Exemplify the ability, knowledge, and activities concerning a surface grinder.**	
	Student Competencies	
	2.7.1	Demonstrate the application of ring test grinding wheels, perform visual safety inspection, and mount and dress a grinding wheel in preparation for surface grinding.
	2.7.2	Given a selection of wheels in various conditions, determine which are suitable for use, mount one on the spindle, and dress it in preparations for surface grinding.
	2.7.3	Demonstrate the setup and operation of manual surface grinders with an 8" and smaller diameter wheel.
	2.7.4	Perform routine surface grinding, location of surfaces, and squaring of surfaces.
	2.7.5	Define and perform wheel dressing.
	2.7.6	Demonstrate correct surface grinding skills to at least 32 Ra microinches or better.
	2.7.7	Understand and exemplify product with no sharp edges.
Topic 2.8	**Drill Press--Exemplify the ability, knowledge, and activities concerning a drill press.**	
	Student Competencies	
	2.8.1	Demonstrate the correct setup and operation of a drill press.
	2.8.2	Perform routine drill press operations.
	2.8.3	Demonstrate correct finishing skills using a drill press to at least 250 Ra microinches.
	2.8.4	Understand and exemplify product with no sharp edges.
	2.8.5	Identify and demonstrate the importance of countersinking the mouths of holes.
Topic 2.9	**CNC Milling--Exemplify the ability, knowledge, and activities concerning a CNC mill or machining center.**	
	Student Competencies	
	2.9.1	Understand the setup, programming, and operation of a CNC mill or machining center and the manufacturing of a part within tolerance.
	2.9.2	Demonstrate the ability to work from a process sheet and part print.

	2.9.3	Understand the x, y, z Cartesian coordinate system.
	2.9.4	Create a correctly formatted tool setup sheet.
	2.9.5	Understand fundamental machine processing, feeds and speed, and select simple parts.
	2.9.6	Demonstrate the ability to match the requirements of the part print to at least 63 Ra microinches using a machining center.
Topic 2.10	**CNC Turning--Exemplify the ability, knowledge, and activities concerning a CNC lathe or turning machine.**	
	Student Competencies	
	2.10.1	Understand the setup, programming, and operation of a CNC lathe or turning center and the manufacturing of a part within tolerance.
	2.10.2	Demonstrate the ability to work from a process sheet.
	2.10.3	Understand the x, y, z Cartesian coordinate system.
	2.10.4	Create a correctly formatted tool setup sheet.
	2.10.5	Understand fundamental machine processing, feeds and speed, and select simple parts.
	2.10.6	Demonstrate the ability to match the requirements of the part print using a turning center.

Standard 3	*QUALITY CONTROL AND INSPECTION*	
Topic 3.1	**Part Inspection--Develop an inspection plan and inspect simple parts using precision tools and techniques, while preparing reports on the compliance of the parts.**	
	Student Competencies	
	3.1.1	Identify and select the required measuring instruments and conduct the required inspection procedure(s).
	3.1.2	Complete required written inspection report and make a decision to accept or reject component parts.
	3.1.3	Provide brief verbal explanation of inspection procedures, results, and decisions.
Topic 3.2	**Process Control—Understand the steps and meaning of a plan, data, charts, graphs, and warning conditions given when producing a product.**	
	Student Competencies	
	3.2.1	Demonstrate how to follow a sampling plan.
	3.2.2	Given the necessary job process sheets for a part, verbal instructions, and the necessary charts and inspection tools, inspect parts according to the sampling plan, collecting the data required for the process control chart.
	3.2.3	Working with the supplied control and warning limits, place the data, produce new data as needed, graph the data, and take the “Stop or Go” actions as indicated by the results of producing the process control chart.
	3.2.4	Provide brief verbal explanation regarding the decisions taken in controlling the process.

Standard 4	*PROCESS ADJUSTMENT AND IMPROVEMENT*	
Topic 4.1	**Process Adjustment: Single Part Production--Analyze the performance of a single-part production process.**	
	Student Competencies	
	4.1.1	Demonstrate formulation of process adjustments or improvements where appropriate.
	4.1.2	Understand how to notify supervision of the proposed adjustment and/or improvement where appropriate.
	4.1.3	Demonstrate implementation of the strategies for process adjustment and/or improvement where authorized.
	4.1.4	Explain the corrective actions and the reasoning used to perform the diagnosis.
Topic 4.2	**Participation in Process Improvement--Analyze the performance of a production process, within a process team.**	
	Student Competencies	
	4.2.1	Demonstrate formulation of process adjustments or improvements where appropriate.
	4.2.2	Understand how to notify supervision of the proposed adjustment and/or improvement where appropriate.
	4.2.3	Demonstrate implementation of the strategies for process adjustment and/or improvement where authorized.
	4.2.4	Carry out the cause and effort analysis by participating in the development of a fishbone diagram with the team.
	4.2.5	Explain the fishbone diagram, the corrective actions, and the reasoning connecting the fishbone root cause analysis to the remedial actions taken.

Standard 5	*GENERAL MAINTENANCE*	
Topic 5.1	**General Housekeeping and Maintenance--Keep the duty station clean and safe for work.**	
	Student Competencies	
	5.1.1	Maintain the cleanliness of the general work area.
	5.1.2	Keep the tools, workbenches, and manual equipment clean, maintained, and safe for work.
	5.1.3	Clean, maintain, and respond appropriately to safety hazards on all benchwork tools and conventional and CNC machine tools.
Topic 5.2	**Preventive Maintenance, Machine Tools--Inspect and assess the general condition of an assigned machine tool.**	
	Student Competencies	
	5.2.1	Understand the importance on making routine adjustments as necessary to assigned machine tool.
	5.2.2	Understand and report problems to supervision which are beyond the scope of authority.
	5.2.3	Demonstrate awareness to carry out daily, weekly, and/ or monthly routine upkeep chores cited on checklists for a given machine tool.

Topic 5.3	**Tooling Maintenance—Understand methods used to inspect and assess the condition of tooling, refurbish tooling where appropriate, and refer tooling for repair or regrind where appropriate.**	
	Student Competencies	
	5.3.1	Understand and diagnose the tooling, given samples of turning, milling, and drilling tooling (both insert as well as conventional) in various conditions.
	5.3.2	Demonstrate the correct steps to put the tooling back in service.
	5.3.3	Demonstrate the offhand regrinding of a turning tool and the correct rotation and replacement of inserts in an insert style milling cutter body between the diameter of .125" and 1.000".
	5.3.4	Demonstrate the ability to recognize when a cutter should be referred to a tool and cutter grinder.
Topic 5.4	**Adjust Lubrication System, Coolants, Fill and Refill the Lube System--Fill and refill lubrication and coolant reservoirs as necessary with appropriate lubricants and fluids.**	
	Student Competencies	
	5.4.1	Fill the lubrication reservoirs as required by the machine and tooling specifications.
	5.4.2	Adjust flow rates for the delivery of lubes and coolants.
	5.4.3	Understand the importance of mixing lubricants to specific ratios.
	5.4.4	Perform associated housekeeping and spill-containment responsibilities.

Standard 6	***INDUSTRIAL SAFETY AND ENVIRONMENTAL PROTECTION***	
Topic 6.1	**Machine Operations and Material Handling—Understand the importance of OSHA and safety requirements.**	
	Student Competencies	
	6.1.1	Carry out assigned responsibilities while adhering to safe practices in accordance with OSHA requirements and guidelines.
	6.1.2	Demonstrate safe workplace practices in material handling, machine operations, handling of tooling, handling and application of coolants, cutting fluids and lubricants.
	6.1.3	Explain the actions taken, both orally and in written form, which directly or indirectly bear upon safe practice in the execution of duties.

Topic 6.2	**Hazardous Materials Handling and Storage--Handle and store hazardous materials as assigned while adhering to safe practices in accordance with OSHA and EPA requirements and guidelines.**	
	Student Competencies	
	6.2.1	Demonstrate safe workplace practices in the identification, handling, and storage of hazardous materials in compliance with OSHA and EPA requirements and guidelines.
	6.2.2	Understand how to document safety activities as required by OSHA and EPA.
Topic 6.3	**Identify and Demonstrate Usage of Machine Safety Equipment and Procedures.**	
	Student Competencies	
	6.3.1	Identify and explain the usage of machine guarding and safety equipment such as light curtains, etc.
	6.3.2	Know and demonstrate lock-out and tag-out procedures.

Standard 7	***ENGINEERING DRAWINGS AND MEASUREMENT***	
Topic 7.1	**Interpret blueprints and symbols detailed therein.**	
	Student Competencies	
	7.1.1	Interpret orthographic blueprints.
	7.1.2	Interpret GDT orthographic prints.
	7.1.3	Identify the common symbols, the use of datum references and tolerances used in GD&T.
Topic 7.2	**Interprets measuring instruments accurately.**	
	Student Competencies	
	7.2.1	Recognize and applies basic measuring instruments such as rules, protractors, and basic transfer tools such as simple inside and outside calipers.
	7.2.2	Recognize and applies precision measuring instruments such as micrometers, vernier, dial, and electronic calipers, dial indicators, precision transfer tools such as telescoping gages and adjustable parallels.
	7.2.3	Recognize and applies appropriately precision tools and instruments for surface plate work such as precision angle plates and tool blocks, precision transfer gages, and precision height gages.
	7.2.4	Demonstrate ability to convert all measurements to metrics.

Standard 8	*METALWORKING THEORY*	
Topic 8.1	**Understand and demonstrate ability in theories, tooling, fluids, and properties of metalwork.**	
	Student Competencies	
	8.1.1	Understand and can explain the ideas of heat, shock, friction, zone of distortion, cutting interface, machinability, cutter presentation, cutter geometry, and chip-holding capacity as they relate to machining applications.
	8.1.2	Recognize a wide variety of cutting tools, tool holding devices, and work holding devices, understanding the appropriate application of these cutters and devices.
	8.1.3	Recognize common materials and their principal properties relevant to machining tasks.
	8.1.4	Recognize differences between ferrous and non-ferrous, magnetic, and ductile materials, understanding the changes which heat-treat impart to materials.
	8.1.5	Recognize the common classes of machine tools, understands the function of the major subsystems of the machine tools, selects and applies a given machine tool appropriately.
	8.1.6	Recognize, select, and apply appropriate coolants and coolant delivery systems.

Career Ready Practices

1. Lead as a Contributing & Professional Employee

Career-ready individuals understand the role and responsibilities of their position and demonstrate this understanding by regularly contributing to the success of their organization. They are reliable and lead by example through work ethic and professionalism, as defined by the standards set by their workplace. This Career Ready Practice includes understanding and exhibiting the core values of their organization and modeling strong morals, motivation, excellence, and consistency.

2. Communicate Clearly, Effectively, & with Reason

Career-ready individuals are able to communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. This Career Ready Practice includes actively listening to peers and colleagues regardless of level and ensuring that diverse perspectives are heard, considered, and fostered. Regardless of communication method, individuals understand the needs of a specific audience and are able to tailor their message or style to meet these needs. Proficiency in communication helps build strong relationships, facilitates collaboration, and ensures that information is accurately exchanged.

3. Think Critically to Make Sense of Problems & Persevere in Solving Them

Career-ready individuals are able to communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. This Career Ready Practice includes actively listening to peers and colleagues regardless of level and ensuring that diverse perspectives are heard, considered, and fostered. Regardless of communication method, individuals understand the needs of a specific audience and are able to tailor their message or style to meet these needs. Proficiency in communication helps build strong relationships, facilitates collaboration, and ensures that information is accurately exchanged.

4. Collaborate Productively while Using Cultural & Global Competencies

Career-ready individuals are able to work effectively in diverse teams to successfully accomplish a goal in both in-person and virtual environments. This Career Ready Practice includes understanding team dynamics, respecting diverse perspectives, demonstrating empathy, and contributing positively to team outcomes. Effective collaboration leverages the strengths of team members, enhances problem-solving, and leads to innovative solutions by recognizing that each team member has something unique to contribute. Preparing to work in diverse teams ensures readiness for the collaborative nature of modern workplaces and requires recognizing biases and advocating for inclusive practices. Cultivating an inclusive environment not only enhances team dynamics but also drives innovation and reflects positively on organizational culture.

5. Use digital Skills & Technologies to Enhance Productivity & Make Data-informed Decisions

Career-ready individuals are digitally literate—proficient with the digital skills and technology that are regularly used in their evolving workplace. This Career Ready Practice involves using digital tools to enhance productivity, understanding the impact of technology on one's work, and staying updated with technological advancements that may have future impacts for a given industry area. Individuals can use technology and digital tools to analyze and report data, helping to make decisions that are data informed and data driven. Digitally literate individuals are also able to understand digital security and privacy and are able to use social media professionally and responsibly.

6. Remain Resilient in a Changing Workplace & World of Work

Career-ready individuals have the ability to adjust to change and remain resilient in the face of challenges, both within a workplace and throughout their careers. This Career Ready Practice involves maintaining a positive attitude despite challenges and being open to new ideas and feedback. Individuals seek to act in ways that contribute to the betterment of themselves and their teams, families, community, and workplace. Developing adaptability, flexibility, and resilience helps individuals navigate career transitions, embrace new opportunities, and maintain productivity and well-being under pressure. This Career Ready Practice also includes attending to one's own mental well-being and developing an appropriate work-life balance to sustain productivity, reduce stress, and enhance overall quality of life, which directly affects professional performance and satisfaction.

7. Manage Time & Space Effectively

Career-ready individuals are able to effectively manage their time and use organizational skills to prioritize tasks and meet deadlines. This Career Ready Practice includes planning, delegating tasks effectively, and maintaining a well-organized workspace in both physical and virtual environments. Developing these skills leads to increased efficiency, better project outcomes, and a balanced workload.

8. Demonstrate a Creative & Innovative Mindset

Career-ready individuals are able to use innovation and creativity to think outside the box and develop new ideas and solutions. This Career Ready Practice encourages a mindset of continuous improvement and adaptability and fosters a spirit of curiosity, experimentation, and calculated risk-taking. It prepares individuals to improve systems, drive change, create value, and stay competitive in a rapidly evolving workplace.

9. Act as a Good Steward of Organizational & Personal Finances & Resources

Career-ready individuals are financially literate and can demonstrate their ability to make cost effective decisions on behalf of themselves and their workplace. This Career Ready Practice includes managing personal finances, understanding financial documents, and making informed financial decisions. Financial literacy empowers individuals to make sound investments, budget effectively, and contribute to the financial health of their organization.

10. Navigate an Education & Career Path Aligned to Strengths, Work Style, Interests, & Goals

Career-ready individuals are self-aware about their strengths and working style and can understand how to leverage these traits effectively to maximize their careers. They are also aware of their areas for improvement, seeking opportunities for growth and acting on feedback to continuously improve. This Career Ready Practice is essential for setting realistic career goals, pursuing professional development opportunities, reskilling and upskilling to keep skills and knowledge relevant, and achieving personal and professional fulfillment.

11. Consider the Environmental & Social Impacts of Decisions

Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively affect and/or mitigate negative impact on other people, their communities, and the environment. They make decisions with integrity by considering the moral and ethical consequences of their decisions and actively planning for the long-term success of projects, systems,and processes. Developing sustainability and environmental literacy skills prepares individuals to also contribute to a greener future and address global challenges.

12. Apply appropriate academic & technical skills

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be effective and productive employees. They have the technical proficiency to use the language, tools, technologies, and methodologies that are relevant to their specific industry sector. They make connections between abstract concepts and real-world applications, and they make correct determinations about when applying an academic skill is appropriate in a workplace situation. This Career Ready Practice includes staying updated about industry advancements and continuously improving technical skills aligned with the changing needs of their sector.