

North Dakota Automated Manufacturing Education

Content Standards

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North Dakota Department of Career and Technical Education

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

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This set of standards was approved and edited
by current North Dakota teachers of Automated Manufacturing
over a period of three months, through a cooperative process.

Career and Technical Education Standards Introduction

Mission

The mission of the State Board for Career and Technical Education (CTE) is to work with others to provide all North Dakota citizens with the technical skills, knowledge, and attitudes necessary for successful performance in a globally competitive workplace.

Vision

The State Board for Career and Technical Education (CTE) is committed to providing career awareness, work readiness skills, occupational preparation, and retraining of workers throughout the state. Career and technical education will span all educational levels, providing youth with exploration opportunities and the foundation skills needed to enter the world of work while providing adults with skills needed to enter, re-enter, or advance in the workforce.

Goal

North Dakota Career and Technical Education's goal is to create a competitive and knowledgeable work force. This is accomplished through a variety of educational program areas that are organized to prepare students for careers in their chosen fields, to take leadership roles, and balance their multiple roles in life. CTE programs prepare students with the knowledge and skills to make informed career choices, to integrate and apply academic concepts, to prepare for successful participation in a global society, and to engage in lifelong learning.

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.

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, hand held 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, scribe, 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. Act as a Responsible and Contributing Citizen and Employee

Career-ready individuals understand the obligations and responsibilities of being a member of a community and demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them, think about the near-term and long-term consequences of their actions, and seek to act in ways that contribute to the betterment of their teams, families, community, and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

2. Apply Appropriate Academic and Technical Skills

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications and make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.

3. Attend to Personal Health and Financial Well-Being

Career-ready individuals understand the relationship between personal health, workplace performance and personal well-being; they act on that understanding to regularly practice health diet, exercise and mental health activities. Career-ready individuals also take regular action to contribute to their personal financial well-being, understanding that personal financial security provides the peace of mind required to contribute more fully to their own career success.

4. Communicate Clearly, Effectively, and with Reason

Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice and organization and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

5. Consider the environmental, social, and economic impacts of decisions

Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organizations and the environment. They are aware of and utilize new technologies, understandings, procedures, materials and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and profitability of the organization.

6. Demonstrate creativity and innovation

Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

7. Employ valid and reliable research strategies

Career-ready individuals are discerning in accepting and using new information to make decisions, change practices, or inform strategies. They use a reliable research process to search for new information and evaluate the validity of sources when considering the use and adoption of external information or practices. They use an informed process to test new ideas, information, and practices in their workplace situation.

8. Utilize critical thinking to make sense of problems and persevere in solving them

Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur, quickly take action to address the problem, thoughtfully investigate the root cause of the problem prior to introducing solutions, and carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

9. Model integrity, ethical leadership, and effective management

Career-ready individuals consistently act in ways that align to personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the direction and actions of a team or organization, and they apply insights into human behavior to change others' actions, attitudes, and/or beliefs. They recognize the near-term and long-term effects that management's actions and attitudes can have on productivity, morale, and organizational culture.

10. Plan education and career path aligned to personal goals

Career-ready individuals take personal ownership of their own educational and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience, and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the educational and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.

11. Use technology to enhance productivity

Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring and using new technology, being proficient with ubiquitous technology applications. They understand the inherent risks, personal and organizational, of technology applications, and they take actions to prevent or mitigate these risks.

12. Work productively in teams while using cultural/global competence

Career-ready individuals positively contribute to every team whether formal or informal. They apply an awareness of cultural differences to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.