South Dakota Manufacturing
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Mitchell

Participants:

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Participants introduced themselves stating name, location, and curricular area of expertise.

An introductory video, *Success in the New Economy* written and narrated by Kevin Fleming and produced by Bryan Y. Marsh, was shared. This video (available on the Internet at https://vimeo.com/67277269), describes a fallacy in the traditional "college for all" model of education and encourages individuals to select career paths based on interests and skills.

It was noted that the purpose of the work was to develop South Dakota's state standards for manufacturing to ensure that they:

- Are aligned with industry needs
- Prepare students to be successful in employment and in postsecondary training
- Establish a sequence of courses leading to completion of a program of study.

It was clarified that standards describe "what" is to be learned, not "how" it is to be learned.

Information was provided regarding the importance of the federal Carl D. Perkins Career and Technical Education Act to the work and an update on progress toward reauthorization of the Act, last authorized by Congress in 2006.

The role of the standards committee was clarified to show that the standards committee members were selected because they were subject matter experts who would:

- Take the suggestions of industry
- Utilize personal expertise about how students best learn, and
- Write a standards draft.

It was further clarified that the work of the committee will go through industry validation and multiple public hearings before consideration for adoption by the State Board of Education.

Program of study was defined as:

- A nonduplicative sequence of both academic and technical courses
- Beginning no later than grade 11 and continuing for at least two years beyond high school
- Culminating in a degree, diploma or certification recognized as valuable by business/industry partners.

A program of study was viewed as the bridge connecting preparatory and advanced work in high school with further study at the postsecondary level through a collegiate program or advanced training through work.

A summary of a recent labor market analysis for South Dakota was presented, with separate slides shown identifying the 20 largest industry clusters, the fastest growing industry clusters by percentage growth and increase in employment demand, and the occupations with a projected demand of 50 or more.

Participants were asked to identify industry trends by describing what was new in the industry, what is emerging in the industry but not yet routinely practiced, and what is no longer done in the industry. It was intended that this information would guide discussion about where new standards were needed and where existing standards could be deleted. For manufacturing the discussion suggested:

New

- 3D printers for plastic, metal and food
- Lean manufacturing
- Robotics
- Computer Numerical Control (CNC)
- Liability/International Organization for Standardization (ISO)
- Vertical integration
- Cross-training
- Vision systems
- New manufacturing processes
- Computer skills

Emerging

- Individual conceptual design
- Web learning
- Multi-axis machining to reduce set-up
- Cars that drive themselves
- Safety devices and safety certifications

No longer done

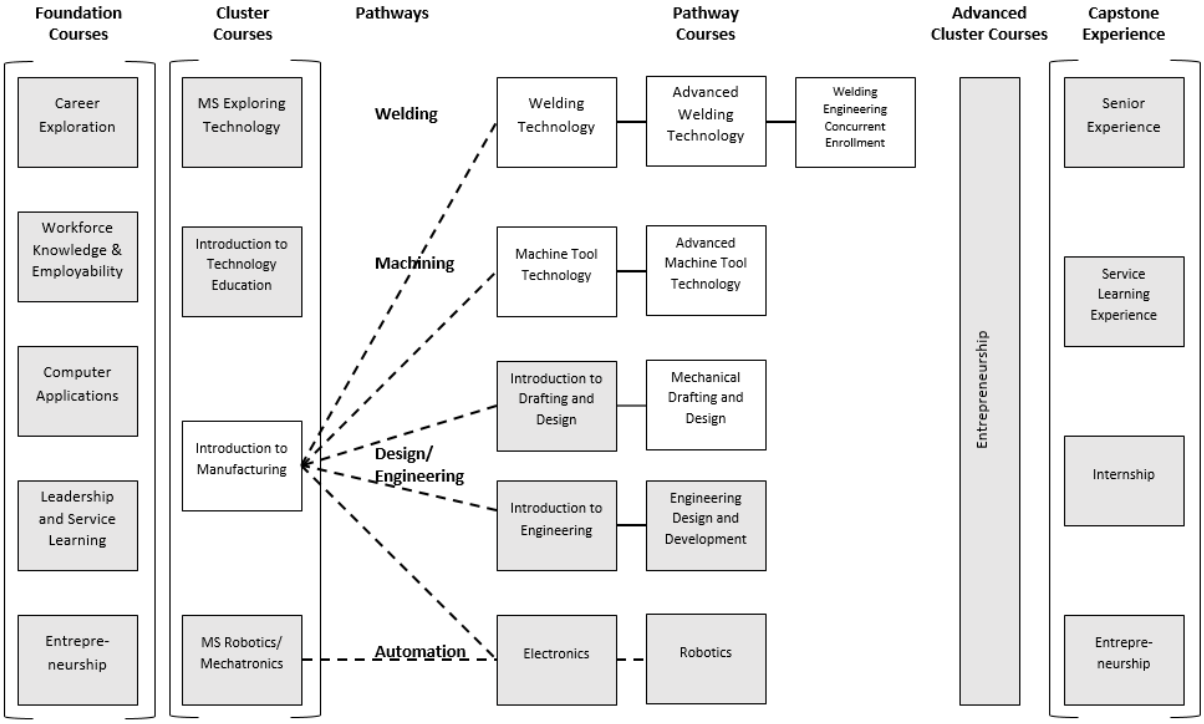
- Oxy-acetylene welding
- Hand drafting
- Backyard mechanics
- Physical hard labor
- Stick welding
- Manual machining

Results of a recent survey of employers were shared. The survey was designed to ascertain if employers were having hiring difficulties, if applicants were deficient in either soft or technical skills, and options for a state response. Forty six survey responses were included in the results with largest participation from hospitality and tourism (8), architecture and construction (6), business management (6), agriculture, food and natural resources (5), manufacturing (5), and marketing (4). In general:

- Four out of five employers noted having hiring difficulties in the previous 12 months.
- Primary reasons for this hiring difficulty were:
    - Low number of applicants (29)
    - Lack of work experience (21)
    - Lack of technical or occupational skills (21)
    - Lack of soft skills (14)
    - Unwillingness to accept offered wages or work conditions (9)
- Occupational areas noting the greatest hiring difficulties were hospitality (8), and marketing (6) though these results are skewed by the response rate from the individual sector
- The most highly noted soft skills lacking were:
    - Initiative (33)
    - Attendance/dependability (30)
    - Communications (25)
    - Customer service (24)
    - Problem solving (23)
- Similarly, employers noted the highest needs for additional training in:
    - Attendance/timeliness/work ethic (73%)
    - Customer service (68%)
    - Problem-solving (50%)
    - Teamwork (41%)
- Slightly over half of employers noted that applicants lacked technical skills.
- Employers asked that the state response focus on:
    - Work ethic (8)
    - Communications (8)

The current state program of study in manufacturing was reviewed and participants were asked to chart out a new program of study incorporating course titles for which standards would be developed. The process involved placing course titles on post-it notes on the wall with an open process to place courses where deemed appropriate, remove courses not considered appropriate, and add courses deemed necessary. The resulting structure is shown in the chart below and includes foundation courses, four cluster courses (three for which standards had been adopted in 2016), three levels of pathway courses in four separate pathways (welding, machining, design/engineering, and automation), an advanced cluster course option (entrepreneurship whose standards would be developed by the Finance working group) and four capstone experience options. The structure gives students latitude to move from cluster courses to any of the four pathways, though early pathway courses are generally considered prerequisite for the advanced pathway courses.

Manufacturing Programs of Study



The group suggested that the third pathway course opportunity in the welding pathway would be available as a concurrent enrollment opportunity with Mitchell Technical Institute or, perhaps, Lake Area Technical Institute.

Members were also asked to look at their Program of Study to make certain that students would be ready to make the transition from middle school to high school and from high school to the postsecondary level. To do so, postsecondary partners were asked what they would want students to know and be able to do upon entry into their programs, not as hard prerequisites, but general expectations for students to be ready to participate fully and effectively. Similarly, high school partners were asked what they would want students to know and be able to do upon entry into their programs, and to reflect upon whether those expectations were included in the courses available at the middle level or in the foundational courses. For manufacturing, the following skills were identified:

Middle School to High School

- Read tape measure to 1/16 inch
- Write results of measurement
- Read and write
- Add and subtract fractions
- Convert fractions to decimals and decimals to fractions
- Use a textbook – technical reading
- Work in a group
- Loosen and tighten a bolt
- Problem solving

- Deductive reasoning
- Apply math
- Course expectations [why are they there]
- Exposure to mechanical drawing

High School to Postsecondary Program

- Basic Safety
- Safety Certificate
- Tool Use and Identification
- Basic Measurement
- Print Reading
- Terminology
- OSHA Standards
- Problem Solving

Participants were encouraged to identify a "big picture" concept statement describing what was to be accomplished within each course before developing standards. This "big picture" statement would eventually be revised to be an executive summary statement at the time that the standards had been drafted.

Information was provided about what makes good standards. These criteria included:

- Essential – does it define knowledge and skills that an individual must have to participate fully and effectively in programs that prepare them to enter careers with livable salaries, and to engage in career advancement in growing, sustainable industries?
- Rigorous – does it ask a student to demonstrate deep conceptual understanding through the application of knowledge and skills to new situations?
- Clear and specific – does it convey a level of performance without being overly prescriptive? Is it written in a way that the general public would understand?
- Teachable and Learnable – does it provide guidance to the development of curricula and instructional materials? Is it reasonable in scope?
- Measurable – Can it be determined by observation or other means that the student has gained the knowledge and skills to be demonstrated to show attainment of the standard?
- Coherent – Does it fit within the progression of learning that is expected for the program of study?
- Sequential – Does it reinforce prior learning without being unnecessarily repetitive? Does it provide knowledge and skills that will be useful as the student continues through the program of study?
- Benchmarked – Can the standard be benchmarked against industry or international standards? Does it prepare the student to be successful in the regional, state and global economies?

State agency staff met in May of 2015 to review the processes to be used for standards review. During that session the staff identified other criteria to be considered when writing standards:

- Connections to postsecondary programs
- Relevant across the content area
- Compatible with virtual learning
- Reflects business/industry input
- Adaptable to change over time

- Allows for instructional creativity
- Appropriate for the target audience
- Aligned with relevant academic content
- Applicable to student organizations
- Recognizes unique features of CTE

These additional criteria were shared with participants for their consideration during standards development, and an exercise was conducted in which participants individually, and then as a group, reviewed four sample standards.

Brief mention was made of resources available in the Dropbox in which members shared information. Because an introductory video regarding the Dropbox had been prepared and reviewed by participants prior to participation in the standards review team, the Dropbox review conducted here only showed categories of information provided in the general section and note that a Working Drafts folder would be created in which participants would store their work.

A Standards Template was shared with the participants and reviewed:

- The course title was inserted at the top.
- A grid of administrative information was completed to the extent the information was known. This grid included:
    - The Career Cluster [Manufacturing]
    - The Course Code [to be added by state staff if not known]
    - Any prerequisites or recommended prior coursework
    - Credits [generally established by the individual school district]
    - Graduation requirement [generally established by the individual school district]
    - Program of study and sequence [a listing of the components of the program of study]
    - Student organization options
    - Coordinating work-based learning appropriate for the course
    - Industry certifications [if appropriate for the course]
    - Dual-credit or dual enrollment options if available
    - Teacher certification requirements [to be completed by state staff]
    - Resources
- Course description. Eventually this will be an executive summary describing the course, but in the process participants were encouraged to develop a “big picture” statement about the course to serve as a reminder when developing standards.
- Program of study application: a more detailed description of the elements within the program of study and where the particular course fits within a sequence.
- Course Standards and prods
    - “Prods” is a list of topics to keep in mind when developing standards to see that related topics are included. The prods identified by state staff include:
        - Safety
        - Soft skills
        - Reinforcing academic concepts in math, language arts, science and social studies
        - Addressing all aspects of the industry
        - Trends [so that students are thinking of the direction that an industry is moving]
    - Indicators – the main topics written in terms of a demonstration of knowledge and skills
    - Sub-indicators – statements identifying in more detail how the indicator will be demonstrated

- Integrated content – A space that allows for examples, explanation, reference to credentials, alignment with other academic standards or other useful information to bring clarity to the understanding about the intent of the sub-indicator
- Notes – a place for additional information to clarify the intent and expectations of the indicator.

An example was shared to ensure understanding.

Working teams of two to five individuals were then established to write the standards. Teams were grouped generally by pathway: drafting, welding, machining, and a team to address the introductory cluster course. Since standards in the automation pathway had been previously developed, no team addressed those courses. Each team selected a course to begin the work. Early drafts were reviewed by the consultants and participants were led with guiding questions so that they could refine their own work. Eventually, when standards had been developed for all courses, the participants did a final group review of all standards to give their approval. Final documents were then reviewed by the consultants for format and structure, and saved to the shared Dropbox. Participants were given two weeks to make any final comments or suggestions, at which time the Dropbox was put into a "read-only" status.

For Manufacturing, the following course standards were developed:

Cluster Course

Introduction to Manufacturing

Career exploration and development

- Recognize the various career pathways/occupations that are available in manufacturing process/industry/business
- Design a career path for individual career interest in the manufacturing cluster

Plan, manage and perform the processing of materials into intermediate or final products and understand related professional and technical support activities such as production planning and control, maintenance and manufacturing/process engineering

- Develop a business plan for manufacturing operations
- Explain trends and issues in the manufacturing industry
- Summarize how planning a budget is used in manufacturing and/or business
- Summarize how material controls are related to the production of products
- Compare how social and economic changes have had an effect on business and various manufacturing processes
- Describe the cause and effect of risk management as it relates to a business or manufacturing process
- Identify the roles and functions of government in regulating and supporting manufacturing business
- Demonstrate a management plan for the manufacturing process for the production of a product and/or business
- Identify and apply accounting procedures

Implement manufacturing technology safety practices

- Maintain general safety in accordance with government regulations, health standards, and company and/or school policy
- Evaluate ergonomic factors associated with the manufacturing industry
- Identify state, federal and local worker safety, health and environmental regulations including correct use and storage of hazardous materials according to current safety standards

Apply ethical practices in the workplace as they relate to today's society

Identify and display professional practices in the workplace
Utilize the appropriate tools and equipment used in the manufacturing industry
Use basic tools and equipment common to the manufacturing processes
Differentiate among a variety of manufacturing industries
Differentiate products/components in relationship to size, proportion and tolerances
Interpret working drawings and schematics
Design a working drawing and/or a schematic circuit
Describe electron theory and the related laws that apply
Describe basic hydraulic and pneumatic systems and the related laws that apply
Describe concepts and usage of robotics/automation in manufacturing
Describe welding procedures for various materials
Describe various material joining processes
Identify machining procedures for various materials/processes
Describe the application of basic mechanical physics
Describe how various materials (recyclable, ferrous/nonferrous, and synthetic) are produced and used in manufacturing
Explain the impact of emerging technologies in manufacturing
Describe basic metallurgy and metal processing
Design and create a product using the engineering design loop
Develop a prototype of a product
Test and evaluate a product
Redesign product for final production.

Welding Pathway

Welding Technology

Identify and understand welding safety
Identify and demonstrate proper industry safety standards
Read, comprehend, and communicate written and spoken technical terminology and instructions related to welding and welded assemblies
Demonstrate mathematical skills related to work assignments
Read and demonstrate understanding of welding terms and definitions from American National Standards Institute (ANSI)/American Welding Society (AWS) A3.0, *Standard Welding Terms and Definitions*
Interpret drawings and welding symbol information
Read and sketch drawings
Identify basic weld symbols
Identify lines and joints
Understand and Perform metal cutting operations
Identify and explain the use of oxyfuel and plasma cutting equipment
Prepare layouts for cutting individual parts
Perform cuts using oxyfuel and plasma cutting processes
Exhibit knowledge and perform base metal preparation
Prepare base metal for various welding processes
Understand and Perform Shielded Metal Arc Welding (SMAW) process
Identify and understand SMAW equipment and setup
Define and understand the application for different Shielded Metal Arc (SMAW) electrodes
Demonstrate knowledge of Shielded Metal Arc Welding (SMAW) process
Identify and demonstrate knowledge of quality control of the welding process

Demonstrate knowledge of weld quality
Participate in career exploration activities
Research career opportunities in manufacturing/welding fields
Practice ethical work behaviors
Students will follow the following required ethical practices of Manufacturing Industry

Advanced Welding Technology
Identify and understand welding safety
Identify and demonstrate proper industry safety standards
Identify and conform to basic welding safety standards
Identify and practice the proper industry safety standards.
Interpret, layout, and fabricate in conformance to fabrication drawings
Correctly interpret dimensions and locations of components in fabrication drawings
Correctly scale dimensions in fabrication drawings
Correctly interpret orthographic and pictorial plan views shown in fabrication drawings
Recognize and correctly interpret lines and symbols commonly used in fabrication drawings
Exhibit knowledge and perform base metal preparation.
Prepare base metal for various welding processes.
Understand and perform Gas Metal Arc Welding (GMAW) process
Identify and understand GMAW equipment and setup
Demonstrate Gas Metal Arc Welding (GMAW) on steel
Understand and perform Gas Tungsten Arc Welding (GTAW) process
Understand GTAW equipment and filler metals
Demonstrate Gas Tungsten Arc Welding (GTAW) process on Steel
Understand and perform Shielded Metal Arc Welding (SMAW) process
Understand SMAW equipment and filler metals
Demonstrate knowledge of the Shielded Metal Arc Welding (SMAW) process
Understand and perform Carbon Arc cutting and gouging process
Understand carbon arc equipment
Demonstrate Carbon Arc cutting process
Identify and demonstrate knowledge of quality control of the welding process including visual and destructive testing.
Demonstrate knowledge of weld quality
Participate in career exploration activities
Research career opportunities in the welding pathways.
Demonstrate ethical work behaviors.
Follow the following required ethical practices of Manufacturing Industry

Welding Engineering
Demonstrate proper safety protocols in the welding lab.
Describe roles and welding radiation.
Demonstrate being alert to electric shock, fires and burns.
Illustrate how to diagnose fumes, gases and noise.
Recognize welding hazards
Demonstrate specific welding safety steps
Demonstrate how to properly operate an Oxy-fuel cutting torch.
Illustrate how to properly operate an Oxy-fuel cutting torch.
Demonstrate how to manipulate hand held plasma equipment skillfully. (WMT-149 Basic Welding Lab)

Demonstrate how to manipulate hand held plasma equipment skillfully.

Demonstrate how to properly operate GMAW equipment.

Demonstrate proper technique on 10ga steel to accomplish stringer beads with the GMAW-S process

Investigate proper technique on 10ga steel to accomplish 1/4 Fillet weld T-Joint 2F with the GMAW-S process

Apply proper technique to 10ga steel to accomplish a lap-joint 2F with GMAW-S process

Simulate proper technique on 10ga steel to accomplish 1/4 Fillet weld T-Joint 3F down hill with the GMAW-S

Demonstrate proper technique on 10ga steel to accomplish 1/4 Fillet weld T-Joint 4F with the GMAW-S

Demonstrate proper use of measurement tools.

Exercise the ability of micrometer use

Read fraction/metric tape Measure

Apply the use of a Fillet Weld Gauge

Operate Dial Indicators

Use dial caliper in measurements of various piece parts

Analyze welding symbols on weld drawings.

Identify Weld Symbols

Demonstrate actual welding scenarios with welding symbols

Demonstrate proper use of welding drawings.

Interpretation of Blueprints

Understand the functions of electronic file creation through drafting and design.

Solidworks drafting understanding

Machining Pathway

Machine Tool Technology

Demonstrate knowledge of safety and essential academic concepts in Machine Tool

Explain and show knowledge of machine shop operations and tool safety procedures consistent with Occupational Safety and Health Administration (OSHA) standards

Introduce concepts of basic mathematics, blueprint reading, science, and communications used in machine tool processes

Understand basic CNC programming and processes

Show proper machine use and functions, utilizing problem solving skills to resolve machining issues

Demonstrate knowledge of terminology, tools, methods of measurement, and material layout

Demonstrate problem solving skills in basic lathe and milling setups and operations

Apply proper ethical standards to machining skills and processes

Identify and demonstrate professional practices used in the machine shop

Explore Careers in the Manufacturing cluster

Identify machine tool related career pathways

Advanced Machine Tool Technology

Demonstrate knowledge of safety and essential academic concepts in machine tool.

Prove knowledge of shop operations and tool safety procedures consistent with Occupational Safety and Health Administration (OSHA) standards

Apply advanced concepts, including machine tool mathematics, blueprint reading, science, and communications to machine tool processes

Demonstrate and apply computer numerical control (CNC) programming concepts

Demonstrate ability through research, development, and implementation to create a project
- Design, analyze and create various types of projects utilizing previous knowledge and skills to manufacture a single or assembled project
- Evaluate and solve issues related to lathe and milling setups and operations

Demonstrate ethical practices and research career pathways
- Identify and demonstrate professional practices used in the machine shop
- Evaluate and describe career exploration activities to follow for a minimum of two different career pathways

Design/Engineering Pathway

Mechanical Drafting and Design

Demonstrate the use of geometric construction
- Apply geometric design and descriptive geometry to the design process
- Demonstrate basic geometric dimensioning and tolerancing (GD&T)

Prepare mechanical drawings.
- Create a multi-view drawing
- Create sectional views of a mechanical drawing
- Develop auxiliary views of mechanical drawings
- Generate pictorial drawings
- Examine drawing identification and management techniques used in mechanical drafting

Understand the design for manufacturing and assembly.
- Analyze different manufacturing processes
- Identify basic welding symbols used in manufacturing design process

Explore careers in drafting fields.
- Define/compare career pathways in drafting

A cover letter has been drafted to guide business/industry feedback to the standards developed through this process. The seven standards documents will be reformatted with three columns for business/industry feedback at the sub-indicator level utilizing a 1 (low) to 5 (high) scale:

- Is the sub-indicator essential?
- Is the sub-indicator clear and specific?
- Is the sub-indicator measurable?

Business/industry partners are also asked if the standards reflect the preparation necessary for a student to enter her/his particular occupational field. A sample of the reformatted document follows.

Course Standards

IM 1: Career exploration and development.

			Essential 1 (low) – 5 (high)	Clear and Specific 1 (low) – 5 (high)	Measurable 1 (low) – 5 (high)
Webb Level	*Sub-indicator*	*Integrated Content*			
One Recall	IM 1.1 Recognize the various career pathways/occupations that are available in manufacturing process/industry/business.	SD MyLife @ http://sdmylife.com/ Or other career exploring programs			
Four Extended Thinking	IM 1.2 Design a career path for individual career interest in the manufacturing cluster.	Career Pathways • Welding • Machining			
		• Design/Engineering • Automation			

Notes

IM 2: Plan, manage and perform the processing of materials into intermediate or final products and understand related professional and technical support activities such as production planning and control, maintenance and manufacturing/process engineering.

			Essential 1 (low) – 5 (high)	Clear and Specific 1 (low) – 5 (high)	Measurable 1 (low) – 5 (high)
Webb Level	*Sub-indicator*	*Integrated Content*			
Three Strategic Thinking	IM 2.1 Develop a business plan for manufacturing operations.	South Dakota Manufacturing and Technology Solutions http://sdmanufacturing.com/			
One Recall	IM 2.2 Explain trends and issues in the manufacturing industry.	Strengths, Weaknesses, Opportunities, Threats (SWOT) Analysis			

Following business/industry review, state staff will revise the standards documents as necessary to incorporate business/industry suggestions. The revised documents will be shared with participants in the standards development process and, eventually, with teachers of manufacturing courses throughout the state for their feedback. Final documents will be taken through public hearings and delivered to the State Board of Education for adoption.