MINNESOTA MANUFACTURED

THE BACKBONE OF OUR ECONOMY

An Introduction to Manufacturing in Minnesota

TEACHER GUIDE: RECOMMENDED FOR GRADES 6-12

WHO WE ARE

Minnesota Manufactured is an innovative, collaborative effort between education and industry to recruit, educate, and train workers for dynamic careers in advanced manufacturing.

MINNESOTA STATE
Advanced Manufacturing Center of Excellence

DEAR TEACHER,

"Introduction to Manufacturing in Minnesota Teacher Guide" was first published in 2015. Since then, teachers across the state have used the guide with their students, teaching them about manufacturing in Minnesota. We are excited to share this updated version of the guide with you. It has been revised to include more hands-on activities that appeal to a broader group of students, including girls.

We've worked hard to make this guide one that has value for you and your students. Each chapter includes applicable educational standards, teaching objectives, talking points, and various activities to engage a variety of student learning styles.

We are also excited to announce the launch of the Minnesota Manufactured Minnesota Digital Badge pathway, which encourages students in grades 7-12 to progress along a manufacturing career path. Several of the badges can be claimed by completing activities in this guide. These activities are noted throughout the guide. Students who complete the badge pathway can earn a scholarship, valued at $4,000.

If you are not familiar with Minnesota Manufactured, you may be wondering why we have created this guide. Minnesota Manufactured is an initiative that is dedicated to changing the perception of manufacturing and providing advanced manufacturing career information. Along with the Minnesota State Advanced Manufacturing Center of Excellence, an innovative, collaborative effort between education and industry to recruit, educate, and train workers for dynamic careers in advanced manufacturing. We are working to make students aware of the opportunities manufacturing can offer them.

Manufacturing is the backbone of Minnesota's economy. In fact, according to the Minnesota Department of Employment and Economic Development,

- **Minnesota has more than 309,300 manufacturing careers statewide.**
- **Manufacturing contributes $52.01 billion to the state economy.**
- **The average manufacturing salary is around $59,000.**
- **Many top manufacturing brands are based in Minnesota, including Land O' Lakes, General Mills, and Cargill.**

This is just a little bit of the information we've developed for you to share in your classroom. We hope you find this guide and accompanying disc to be effective tools for sharing manufacturing information in your classroom.

We also encourage you and your students to check out our website, **www.mnmfg.org**, which is full of up-to-date information about manufacturing careers. If you have any comments or questions, please contact us.

Sincerely,

Jeremy Leffelman
Executive Director
Minnesota State
Advanced Manufacturing
Center of Excellence

Jaimee Meyer
Director of Marketing and
Outreach - Minnesota State
Advanced Manufacturing
Center of Excellence

Minnesota Manufactured works with many people and organizations across the state to promote modern manufacturing. We thank our sponsors for their support!

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TO VIEW ALL CORRESPONDING VIDEOS AND PRESENTATIONS REFERENCED IN THIS GUIDE PLEASE VISIT:

https://mnmfg.org/educators/teacher-guide/

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What is manufacturing?

HOW TO DEFINE MANUFACTURING

According to O*NET, manufacturing involves: "Planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering."

In short, manufacturing is making stuff.

Manufacturing has a range of fields, including designing machinery, developing products, knowing how to fix robots, working in software, and developing green technology. Later in this guide, we'll provide career information about the many fields in manufacturing.

Manufacturing Requires Skill and Ability. Do you like…

ROBOTICS?
FIXING CARS, SNOWMOBILES OR BIKES?
ASSEMBLING MODELS?
BUILDING WITH LEGOS?
SOLVING PUZZLES?

These skills, and more, all relate to manufacturing — being able to visualize, design, program — all of those are skills you use to develop products. Just think, instead of fixing a car, you could design the parts for a car. The manufacturing industry requires other areas of expertise too, offering careers from customer service to marketing or to finance.

> **" We make, or help make, or help our customers make, pretty much anything… The range of what we can do is endless."**
>
> **REBECCA GRAMSE, MRG TOOL AND DIE — FARIBAULT, MN**

APPLICABLE EDUCATION STANDARDS

Science: (Grade 6-12)

Strand 1: Nature of Science and Engineering

- Sub strand 1: The practice of Science (grade 7-12)
- Sub strand 2: The practice of Engineering (grade 6, 9-12)
- Sub strand 3: Interaction among science, technology, engineering, mathematics, and society

Technology: (Grade 9-12)

Strand 1: Inquiry, Research, and Problem Solving: The student will learn a continuous cycle of questioning, gathering, synthesizing, evaluating, and using information individually and collaboratively to create new knowledge and apply it to real world situations.

Strand 2: Expanding Literacies: Read, view, listen, and communicate in any format for a variety of purposes.

- Sub strand 2: Collaboration

Language Arts: (Grade 6-12)

ANCHOR STANDARDS FOR SPEAKING, VIEWING, LISTENING, & MEDIA LITERACY:

Strand 1: Comprehension and Collaboration

Strand 2: Presentation of Knowledge and Ideas

Strand 3: Media Literacy

ANCHOR LANGUAGE STANDARDS:

Strand 4: Conventions of standard English

ANCHOR STANDARDS FOR WRITING:

Strand 5: Text types and purposes

Strand 6: Research to build and present knowledge

OBJECTIVES

Students will be able to:

- Place parts of a story in the appropriate order to represent the manufacturing cycle.
- Understand and identify 12 manufacturing terms with their definitions.
- Contrast the phenomenon of reality vs. perception.
- Appreciate machining and welding in Minnesota.
- Apply the manufacturing cycle to a product they create.
- Differentiate steps of the manufacturing cycle.
- Apply research from different manufacturing companies into a creative jingle or slogan.

Introduce your students to manufacturing by showing them one of the partner videos from the Minnesota Manufactured website.

www.mnmfg.org

EXERCISE

1. INSTRUCTOR

Review terms for Activity 1.

2. STUDENTS

Complete Chapter 1, Activity 1: *What is Manufacturing? Manufacturing Terms & Definitions.*

3. INSTRUCTOR

Explain The Manufacturing Cycle Diagram for Chapter 1, Activity 2. Provide students with Chapter 1, Handout 1.

4. INSTRUCTOR

Show students the MaxBat video to introduce students to another manufacturing company in Minnesota.

5. STUDENTS

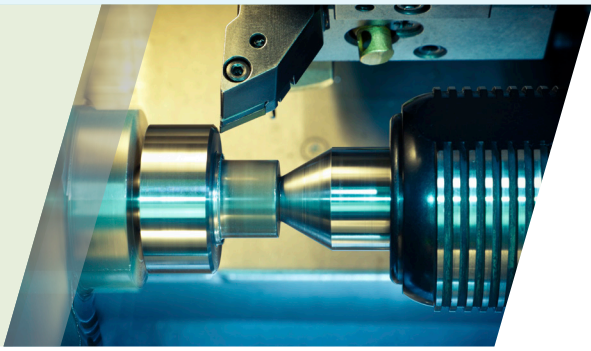
Complete Chapter 1, Activity 2: *What is Manufacturing? The Manufacturing Cycle.*

REALITY VS. PERCEPTION

Often, when we think of manufacturing, we think of how it was in the Industrial Revolution, but that's not what manufacturing is today. Now, manufacturing uses technology and robotics—it's clean, safe, and innovative.

Additionally, while there is a lot of talk about manufacturing jobs moving overseas, there are many manufacturing companies who have stayed and will continue to stay in the United States. The reasons are many, including being able to better manage intellectual property and quality control—things that affect the overall cost. Today's manufacturing jobs are all about being innovative and creative to meet consumer needs—like you hear about in the videos.

> **" Manual equipment is the equipment that sits in the corner now. We have gone to CNC and that is all you will do, and the machine tools are very, very high-tech machine tools."**
>
> **SETH ANDERSON, DOUGLAS MACHINE**



EXERCISE

1. INSTRUCTOR

The next exercise focuses on Machining and Welding in Minnesota. Students should focus on the manufacturing cycle.

2. STUDENTS

Complete Chapter 1, Activity 3: *What is Manufacturing? Applying the Manufacturing Cycle.*

3. INSTRUCTOR

Show students the Clow Stamping Profile video. Students should focus on the manufacturing cycle.

4. STUDENTS

Complete Chapter 1, Activity 4 or the Optional Activity 4: *What is Manufacturing? Applying the Manufacturing Cycle.*

Activity 1

MANUFACTURING TERMS & DEFINITIONS

STUDENT NAME _____

Directions: Match each term with their definition on the other column by letter.

1. _____ **MARKET RESEARCH**
2. _____ **PROTOTYPE**
3. _____ **RAW MATERIAL**
4. _____ **HANG TAG**
5. _____ **WAREHOUSE**
6. _____ **PRODUCTION**
7. _____ **DESIGN & DEVELOPMENT**
8. _____ **INNOVATION**
9. _____ **SUPPLIER**
10. _____ **OUTPUTS**
11. _____ **DISTRIBUTION**
12. _____ **MANUFACTURING COSTS**

A. Taking a concept through the process of making a configuration, drawing, model, or plan that serves as the basis for the actual product and making sure the product meets specific needs or wants.

B. An original model on which something is patterned and used to develop a product.

C. Being creative.

D. A company that provides another company with goods or services, also called a vendor.

E. Amount of energy, work, products, or services produced in a given period by a company, individual or machine.

F. Process of assessing a new product or service through research (like surveys, focus groups, or product testing) to test reactions to a product or service before making it available to the general public.

G. Make the actual product: usually includes technology, advanced machines, robotics and assembly lines.

H. Something attached to a product (like a piece of clothing) that shares information about the manufacturer & the product.

I. A material or substance used to make something.

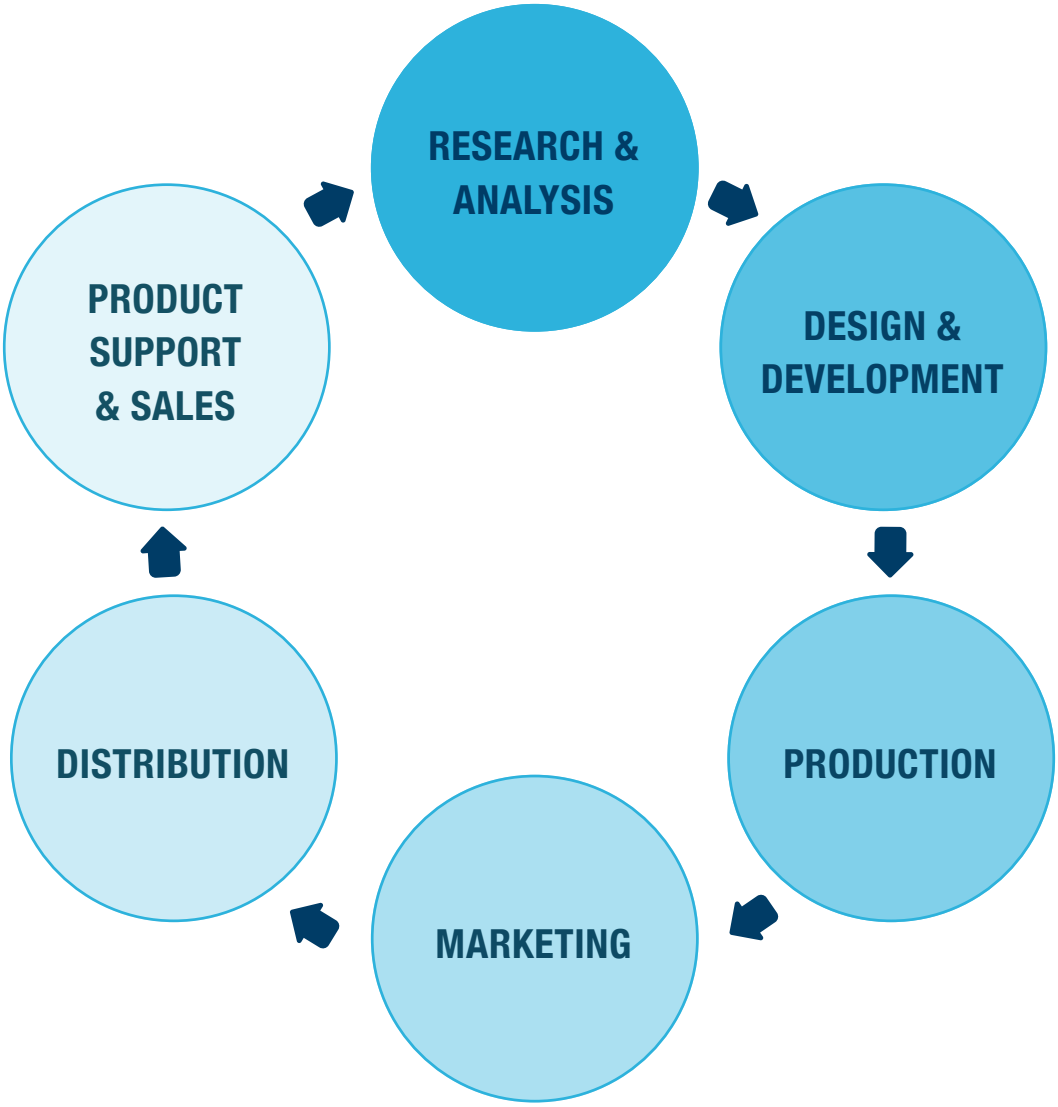
J. Taking an item after it has been manufactured and getting into the hands of a consumer.

K. The expense of materials, labor, and other components of the manufacturing process to create an end product.

L. Where products can be stored before distribution.

Handout 1

THE MANUFACTURING CYCLE



RESEARCH & ANALYSIS:
Research and analyze your product as well as other products that are out there

DESIGN & DEVELOPMENT:
Prototype

PRODUCTION:
Includes testing, production costs

MARKETING:
Includes marketing analysis and product marketing

DISTRIBUTION:
Includes delivery methods

PRODUCT SUPPORT & SALES:
Return policies, equipment failure

Complete Activity 1 and 2 and claim the Novice badge, part of the Minnesota Manufacturing Digital Badge Pathway. Complete the pathway and earn a scholarship! Get started on the badge pathway by going to **www.mnmfg.org**

Activity 2

THE MANUFACTURING CYCLE

STUDENT NAME _____

Directions: Apply what you have learned about the manufacturing terms and the manufacturing cycle to organize information about how MaxBat got started manufacturing baseball bats. Information about how Jim Anderson began MaxBat was found on their website and on line.

Some parts of the manufacturing cycle have multiple answers. Match the following terms with the MaxBat descriptions.

A. RESEARCH & MARKETING ANALYSIS (2)

B. DESIGN & DEVELOPMENT (2)

C. PRODUCTION (TESTING & PRODUCTION COSTS) (2)

D. MARKETING (3)

E. DISTRIBUTION (DELIVERY) (2)

F. PRODUCT SUPPORT & SALES (1)

1. _____ Mr. Anderson's son, Max, helps pack the bats for shipping.
2. _____ Following the many steps to create a custom MaxBat, 5 – 10% of the bats do not pass inspection because of their "attention to detail and commitment to the customer."
3. _____ Owner, Jim Anderson, found his first client, Joe Mauer, the Minnesota Twins' #31 overall pick in the 2001 draft.
4. _____ MaxBat began and was able to take advantage of the fact that aluminum bats were banned in Minnesota's adult leagues.
5. _____ The owner's wife used her graphic design skills to create the company brochures, flyers, and website.
6. _____ After making the first bat, which was "okay," people asked Jim if he could make them a bat.
7. _____ Jim contacted Major League Baseball to learn the rules and regulations for making bats and made a prototype.
8. _____ Jim sent his prototype to MLB, and to his surprise, it wasn't approved. He learned that everything was correct except the logo was ¼ inch too high. He had two days to fix the problem and finish 6 bats to send in for approval.
9. _____ MaxBat is a division of Glacial Wood Products (custom wood turning).
10. _____ Bats are usually shipped by ground transportation.
11. _____ When six bats are ordered, bats can be customized.
12. _____ MaxBat offers various packages such at the "MVP Package," which includes a bat, shirt, and gloves.

Activity 3

APPLYING THE MANUFACTURING CYCLE

STUDENT NAME _____

Directions: Create and present a PowerPoint, brochure, poster, or write a paper (presentation) on one of the machines listed below.

1. CHOOSE ONE OF THE FOLLOWING TOOLS OR MACHINES:

- CNC Lathe
- Water Jet
- CNC Milling Machine
- Robotics
- Wire Feed EDM Machine
- Compression Mold
- Sinker EDM Machine
- Horizontal Mill
- Laser Cutters (Sheet Metal Fabrication)
- Tube Laser
- TIG Welder
- Die Manufacturing
- MIG Welder
- SMAW Welder (Stick Welding)
- 3D Printing
- Grinder
- Laser Texturing
- Steel Stamping Press
- Multiple Pallet CNC
- Hydraulic Shear
- Plastic Injection Mold
- Press Brake (Brake Press)
- Belt Sander
- Manual Lathe
- Band Saw
- Vertical Mill
- Hydraulic Power Press
- Faro Arm
- Ironworker Machine
- Swiss Turning Machine
- Roll Bending & Forming Machine
- Pyramid Rolling Machine
- Screw Machine
- Other: Teacher approval

2. INCLUDE THE FOLLOWING IN YOUR PRESENTATION:

1. Image (photo) of the machine.
2. Explain an industry where the machine is used.
3. Describe a product made by this machine in Minnesota.
4. Where is the product made in Minnesota?
5. Explain which portion of the manufacturing cycle this machine is used for (could be more than one focus).

Complete Activity 3 and claim the Career Wise badge, part of the Minnesota Manufactured Digital Badge Pathway. Complete the pathway and earn a scholarship! Get started on the badge pathway by going to **www.mnmfg.org**

Complete Activity 4 and claim the Creator badge, part of the Minnesota Manufactured Digital Badge Pathway. Complete the pathway and earn a scholarship! Get started on the badge pathway by going to **www.mnmfg.org**

Activity 4

APPLYING THE MANUFACTURING CYCLE

STUDENT NAME _____

Supplies Needed:

- 1 square piece (5 ½ inches) of corrugated (tubes inside) cardboard
- 2 CDs
- 1 wooden skewer (kabob skewer)
- 1 or 2 rubber band(s)
- Duct tape – 2 feet
- Scissors
- Ruler

Directions: Divide students into groups of 2-4 people.

DESIGN & DEVELOPMENT/PRODUCTION:

1. **Design & Develop** a vehicle (use the materials to build a vehicle that can travel 3 ft).
2. Draw a sketch of the vehicle before you develop the **prototype.**
3. **Test** the vehicle (students can videotape this portion).
4. Modify the **prototype.**

ANSWER THE FOLLOWING QUESTIONS:

1. RESEARCH & MARKET ANALYSIS: Who would you market this vehicle to? (age group, gender, etc.)

2. MARKETING: Would you sell this product as a kit or fully assembled? Why? How will you promote the product?

3.DISTRIBUTION & PACKAGING: How would you distribute your product? How would you package your product?

4. DISTRIBUTION: What stores or venue would you sell this product?

Activity 4

OPTIONAL ACTIVITY

STUDENT NAME _____

Supplies Needed:

- 1 balloon (9 inch or smaller)
- 1 flexible straw
- 1 wooden tongue depressor or craft stick
- 1 straight straw
- 2 candy mints (with a hole in the middle)
- 2 feet of duct tape
- 1 rubber band

Directions: Divide students into groups of 2-4 people.

DESIGN & DEVELOPMENT/PRODUCTION:

1. **Design & Develop** a vehicle (use the materials to build a vehicle that can travel 3 ft).
2. Draw a sketch of the vehicle before you develop the **prototype.**
3. **Test** the vehicle (students can videotape this portion).
4. Modify the **prototype.**

ANSWER THE FOLLOWING QUESTIONS:

1. RESEARCH & MARKET ANALYSIS: Who would you market this vehicle to? (age group, gender, etc.)

2. MARKETING: Would you sell this product as a kit or fully assembled? Why? How will you promote the product?

3.DISTRIBUTION & PACKAGING: How would you distribute your product? How would you package your product?

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Manufacturing In Minnesota

APPLICABLE EDUCATION STANDARDS

Science: (Grade 6-12)

Strand 1: Nature of Science and Engineering

- Sub strand 2: The practice of Engineering (grade 6, 9-12)
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Strand 2: Expanding Literacies: Read, view, listen, and communicate in any format for a variety of purposes.

- Sub strand 2: Collaboration

Strand 4: Ethical Participation in a Global Society: The student will participate productively in the global learning community and demonstrate safe, ethical, legal, and responsible behavior in the use of information and technology.

- Sub strand 4: Reflection/Evaluation

Language Arts: (Grade 6-12)

ANCHOR STANDARDS FOR SPEAKING, VIEWING, LISTENING, & MEDIA LITERACY:

Strand 1: Comprehension and Collaboration

Strand 2: Presentation of Knowledge and Ideas

Strand 3: Media Literacy

ANCHOR LANGUAGE STANDARDS:

Strand 4: Conventions of standard English

ANCHOR STANDARDS FOR WRITING:

Strand 5: Text types and purposes

Strand 6: Research to build and present knowledge

"You see on TV all these manufacturing plants that are really dirty, and then you come here and everything is clean! It's nothing like what people hear, or see, or think manufacturing is."

- ALICIA THOMSEN, ELECTRICAL ASSEMBLER

OBJECTIVES

Students will be able to:

- Recall information from chapter one and relate it to the companies they learn about in chapter two.
- Appreciate what Minnesota manufacturing jobs have to offer.
- Recognize manufacturing opportunities throughout Minnesota.
- Explain their manufacturing tool of choice in a class presentation, brochure, or poster.
- Realize what Minnesota manufactures.
- Visualize manufacturing in Minnesota.
- Recognize the manufacturing professional organizations.

EXERCISE

Introduce students to Minnesota's manufacturing industries, and to reinforce the first chapter's content.

1. STUDENTS

Complete Chapter 2, Activity 5: *Manufacturing in Minnesota, True/False worksheet.*

2. INSTRUCTOR

Watch the Douglas Scientific and BTD profile videos.

3. STUDENTS

Complete Chapter 2, Activity 6: *Manufacturing in Minnesota, Discover MN Manufacturing.*

4. STUDENTS

Complete Chapter 2, Activity 7: *Manufacturing in Minnesota, Digging Deeper into Minnesota Manufacturing.*

Ask the students:

- How does this fit with what you learned about manufacturing in the previous chapter?
- How does this affect what you think of manufacturing?
- Did you know Minnesota had manufacturing like this?

Activity 5

TRUE / FALSE

STUDENT NAME _____

1. _____ Minnesota's manufacturing sector is the backbone of the state's economy.
2. _____ Manufacturing is Minnesota's tenth largest industry.
3. _____ Manufacturing in Minnesota has the second-largest payroll of any business sector in the state.
4. _____ The land rover sent to Mars was made at Andrew Tool in Plymouth, MN.
5. _____ Major league baseball bats are made at MaxBat in Brooten, MN.
6. _____ Manufacturing jobs are repetitive and low skilled.
7. _____ The U.S. manufacturing sector is so huge that if it were its own country, it would rank as the tenth largest world economy.
8. _____ Manufacturing creates more economic value and supports more additional jobs than any other sector.
9. _____ Minnesota has 500 manufacturing companies.
10. _____ Manufacturing supports 2 million jobs in the United States.
11. _____ Minnesota's largest manufacturing sectors are computers and electronics, food, fabricated metal products, and machinery.
12. _____ Minnesota is not known as a national leader in manufactured medical devices.
13. _____ The average manufacturing salary in Minnesota is $30,000.
14. _____ Manufacturing jobs require creative and technical skills.

Complete Activity 5 and watch 2 videos to earn the Map Maker badge, part of the Minnesota Manufacturing Digital Badge Pathway. Complete the pathway and earn a scholarship! Get started on the badge pathway by going to **www.mnmfg.org**

Activity 6

DISCOVER MN MANUFACTURING

(Page 1 of 3)

STUDENT NAME _____

Directions:

1. Go to the company website or go to **www.mnmfg.org**.
2. Find the location for each company.
3. List at least one product the company makes/produces or list what the company does.
4. Find and mark the city of the company on a map of MN in your classroom.

1. AAGARD GROUP
www.aagard.com
Location:
Product:

2. AITKIN IRON WORKS, INC.
www.aiw.com
Location:
Product:

3. ALTEC HILINE, LLC
www.altec.com
Location:
Product:

4. ANDREW TOOL & MACHINING
www.andrewtool.com
Location:
Product:

5. ARROWHEAD PRODUCT DEVELOPMENT, INC.
www.arprodev.com
Location:
Product:

6. ATEK ACCESS TECHNOLOGIES
www.atekcompanies.com
Location:
Product:

7. BADGER FOUNDRY COMPANY
www.badgerfoundry.com
Location:
Product:

8. BUHLER, INC.
www.buhlergroup.com
Location:
Product:

9. CAST CORPORATION
www.castcorporation.com
Location:
Product:

10. CEDAR LAKE ENGINEERING
www.cedarlakeeng.com
Location:
Product:

11. CHAPPELL CENTRAL, INC.
www.chappellcentral.com
Location:
Product:

12. CRYSTAL CABINETWORKS
www.crystalcabinets.com
Location:
Product:

13. CUSTOM PRODUCTS OF LITCHFIELD, INC.
www.cpcabs.com
Location:
Product:

14. DEE, INC.
www.deeinc.com
Location:
Product:

15. DOODLE TOWN TOYS
www.doodletowntoys.com
Location:
Product:

Activity 6

DISCOVER MN MANUFACTURING

(Page 2 of 3)

STUDENT NAME _____

Directions:

1. Go to the company website or go to **www.mnmfg.org**.
2. Find the location for each company.
3. List at least one product the company makes/produces or list what the company does.
4. Find and mark the city of the company on a map of MN in your classroom.

16. DS MANUFACTURING, INC.
www.dsmfgmn.com
Location:
Product:

17. DYCAST SPECIALTIES CORPORATION
www.dycastspec.com
Location:
Product:

18. ERICKSON METALS OF MN, INC.
www.ericksonmetals.com
Location:
Product:

19. EXTREME PANEL TECHNOLOGIES, INC.
www.extremepanel.com
Location:
Product:

20. FALCON INDUSTRIES, INC.
www.falconindustries.com
Location:
Product:

21. HOMARK COMPANY, INC.
www.homark.com
Location:
Product:

22. INDUSTRIAL FINISHING SERVICES
www.industrial-finishing.com
Location:
Product:

23. INDUSTRIAL MOLDED RUBBER PRODUCTS
www.imr-inc.com
Location:
Product:

24. INNOVA INDUSTRIES, INC.
www.innovaind.com
Location:
Product:

25. MASSMAN AUTOMATION DESIGN, LLC
www.massmanllc.com
Location:
Product:

26. METRO MOLD AND DESIGN
www.metromold.com
Location:
Product:

27. NEW FLYER OF AMERICA
www.newflyer.com
Location:
Product:

28. NORTHLAND MACHINE, INC.
www.northlandmachine.com
Location:
Product:

29. PLASTICS INTERNATIONAL
www.plasticsintl.com
Location:
Product:

30. PPG INDUSTRIES
www.ppg.com
Location:
Product:

Activity 6

DISCOVER MN MANUFACTURING

(Page 3 of 3)

STUDENT NAME _____

Directions:

1. Go to the company website or go to **www.mnmfg.org**.
2. Find the location for each company.
3. List at least one product the company makes/produces or list what the company does.
4. Find and mark the city of the company on a map of MN in your classroom.

31. RIE COATINGS

www.riecoatings.com

Location:

Product:

32. RITALKA, INC.

www.ritalka.com

Location:

Product:

33. WINDINGS, INC.

www.windings.com

Location:

Product:

34. WOODCRAFT INDUSTRIES, INC.

www.woodcraftind.com

Location:

Product:

Activity 7

DIGGING DEEPER - DEVELOP A JINGLE OR SLOGAN

STUDENT NAME _____

Directions: Divide students into groups of 2-4 people.

1. Choose a manufacturing company in Minnesota.

   Here are some websites you can use to find a company:

   ARROWHEAD MANUFACTURERS & FABRICATORS ASSOCIATION: *www.midwestmanufacturers.com/amfa/*

   CENTRAL MINNESOTA MANUFACTURERS ASSOCIATION: *www.midwestmanufacturers.com/cmma/*

   MINNESOTA PRECISION MANUFACTURING ASSOCIATION: *www.mpma.com*

   TRI-STATE MANUFACTURERS ASSOCIATION: *www.midwestmanufacturers.com/tsma/*

2. Research the company and take notes on the following questions.
   - What is the name of the company?
   - What does the company make?
   - Is there something unique about them?
   - Who do you think is their target audience?
   - What stands out to you about the company?
   - How does the company show they are innovative, creative, and/or use modern manufacturing?

3. Use your notes to develop a slogan or jingle that highlights the company.
4. Present your jingle or slogan to the class.
5. Explain why your group chose to highlight certain aspects of the company.

Careers in manufacturing

APPLICABLE EDUCATION STANDARDS

Science: (Grade 6-12)

Strand 1: Nature of Science and Engineering

- Sub strand 1: Interaction among science, technology, engineering, mathematics, and society

Technology: (Grade 9-12)

Strand 1: Inquiry, Research, and Problem Solving: The student will learn a continuous cycle of questioning, gathering, synthesizing, evaluating, and using information individually and collaboratively to create new knowledge and apply it to real world situations.

Strand 2: Technology Use and Concepts: Students will explore multiple technologies, evaluate their suitability for the desired educational or personal task, and apply the tools needed.

- Sub strand 2: Use of Technology

Strand 3: Ethical Participation in a Global Society: The student will participate productively in the global learning community and demonstrate safe, ethical, legal, and responsible behavior in the use of information and technology.

- Sub strand 3: Reflection/Evaluation

Language Arts: (Grade 6-12)

ANCHOR STANDARDS FOR SPEAKING, VIEWING, LISTENING, & MEDIA LITERACY:

Strand 1: Presentation of Knowledge and Ideas

Strand 2: Media Literacy Anchor Language Standards

Strand 3: Conventions of standard English

ANCHOR LANGUAGE STANDARDS:

Strand 4: Conventions of standard English

ANCHOR STANDARDS FOR WRITING:

Strand 5: Text types and purposes

Strand 6: Writing process: Production & distribution of writing

Strand 7: Research to build and present knowledge

Find up-to-date information about the different areas of manufacturing discussed in the third chapter and salary information from the Minnesota Manufactured website.

www.mnmfg.org

"This is a lifelong career for me because it's something that'll always be needed; it's never going to go away."

BRANDON DECENT, LAKELAND MOLD

OBJECTIVES

Students will be able to:

- Gather information from the web, handouts, videos, and possible personal experiences to help support their understanding of career areas in manufacturing.
- Investigate manufacturing careers and career areas.
- Recognize careers in manufacturing that are available in Minnesota.
- Distinguish the education required for manufacturing careers.
- Identify potential earnings in manufacturing in Minnesota.
- List 6 main areas in engineering (manufacturing specific).
- Recognize the college manufacturing programs available in Minnesota.
- Recognize the salaries for careers in manufacturing.

EXERCISE

1. INSTRUCTOR

Present the Douglas Machine profile and Dynamic Group videos. Ask students to listen for what type of jobs they talk about, duties and tools, and how that information lines up with the different areas of manufacturing.

2. STUDENTS

Complete Chapter 3, Activity 8 and/or 9: *Areas in Manufacturing, career investigation worksheet.*

3. INSTRUCTOR

Watch the Douglas Machine Testimonial, Lakeland Mold Testimonial, and the video from Bemidji State University about manufacturing careers with your students.

4. STUDENTS

Complete Chapter 3, Activity 10: *Career Information, careers and education.*

5. INSTRUCTOR

After the videos, talk about what students have learned, and how what they heard compared with what they expected.

6. INSTRUCTOR

Watch the Marvin Windows video with your students.

7. STUDENTS

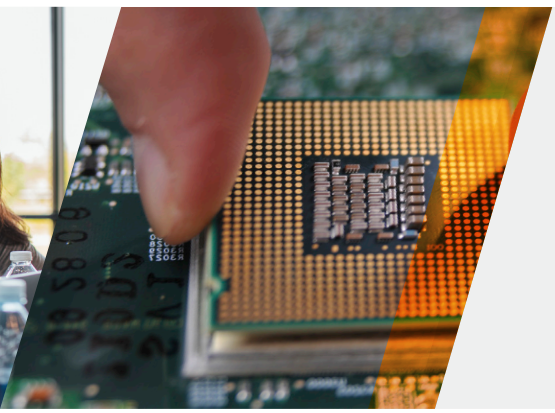
Complete Chapter 3, Activity 11: *Career Information, careers and education.*

8. INSTRUCTOR

Watch the Central Boiler and Altoz Precision Mowers video with your students.

9. STUDENTS

Complete Chapter 3, Activity 12: *Career Information.* Students can play a welding game at **www.tradesgamer.com**



Is manufacturing the right fit?

Often, students who would enjoy a career in manufacturing enjoy:

- **Working with their hands**
- **Science, engineering, mathematics, or technology**
- **Teamwork**
- **Solving problems**
- **Puzzles**
- **Critical thinking**
- **Computers and electronics**
- **Design**

Handout 1

MANUFACTURING CAREERS

(Page 1 of 8)

CAREER OUTLOOK

Did you know that in Minnesota, advanced manufacturing:

- Is the third largest industry?
- Needs an estimated 5,000 workers?
- Is looking for educated workers who understand science, technology, engineering and math?
- Invents things? In fact, between 2006-2010, Minnesota had the largest number of patents.
- Includes some of the top brands, like 3M Company, Boston Scientific Corporation, Hormel, and Ecolab.

BUILD YOUR CAREER

With the right education, you can build your pathway to success-receiving a good paycheck for your work and advancing your career.

You can start by taking technical courses at a two-year college, earning a certificate or diploma. You'll have the skills to start your career, or you can keep going in your education.

You can take more courses to earn an Associate in Applied Science (A.A.S.). This will make you more qualified to move up the career ladder.

Your coursework will likely transfer to a four-year college or university, where you can earn a Bachelor's degree. You may even find some online opportunities that are convenient for your schedule.

CAREER OUTLOOK

Average Salary

MANUFACTURING JOBS	$74,370
MOST MN JOBS	$50,112

Minnesota manufacturing has over **3,766** job openings every year, and has paid over...

$22,100,000,000

in wages to employees during 2019

"One to two years in a technical program and you can come into a job making a very, very good wage."

ANDREW FREYHOLTZ, MECHANICAL DESIGNER

Handout 1

MANUFACTURING CAREERS

PRODUCTION TECHNOLOGY

What is it:

Working in modern manufacturing, using your knowledge of technical math, print interpretation, quality and safety, and manufacturing processes and production.

What that means:

In the "heart of manufacturing," you'll be making the products that will be sold. Reading and interpreting drawings and prints, operating machines, and refining parts are all things you might do. You have to understand how a product is manufactured, how to read general prints used in manufacturing, and how to create and measure quality products.

Possible career titles:

Inspector, Fabricator, Team Assembler, and Operator

Education:

You'll start with at least a certificate and can move up with a diploma, gaining the skills you need to start in advanced manufacturing. You can move up the career pathway if you continue your education and specialize with a two- or four-year degree.

What you'll learn in college:

You'll learn a broad range of topics along with the basics of manufacturing so you have a solid foundation to pursue your career.

Openings for production occupations 2016-2026:

293,471

Potential earnings:

$11 - $18/HR

"I didn't even know that manufacturing like this existed. Something that was clean, something that I would want to do. But now I love my job! I get here at six in the morning smiling!"

ALICIA THOMSEN, ELECTRICAL ASSEMBLER

Handout 1

MANUFACTURING CAREERS

(Page 3 of 8)

ELECTRONICS / ROBOTICS / MAINTENANCE / AUTOMATION / MECHATRONICS

What is it:

People run, inspect, install and maintain autonomous and semi-autonomous machines.

What that means:

Ever drive or build a robot? Fixed a lawn mower? That's the type of stuff you get to do, but on a larger scale.

You use your skills in math and engineering to design, build, or improve how things are made—from small parts to large pieces of machinery. You might work with robots to put parts together or make sure that things are always running. You could be inspecting machines or implementing changes to make sure everything and everyone is manufacturing quality parts. You'll apply your knowledge of mechanics, design, production, computers, and electronics as you work with power tools, precision measuring instruments, motors, sensors, programming, and electrical and electronic testing devices.

Possible career titles:

Maintenance Machinist, Maintenance Technician, Applications Programmer, Electrical Controls Engineer, Production System Technician, Automation Technician, Development Mechanic, Experimental and Electrical Mechanic

Education:

You can get started with a certificate or a diploma, but a two-year degree and experience will help you succeed.

What you'll learn in college:

In college, you'll get to have hands-on experience in mechanics, pneumatics, and hydraulics and work with machine tools and electrical circuits. This knowledge will help you test and troubleshoot equipment and prevent problems from happening. You also can study robotic programming, CAD (computer-aided design), CAM (computer-aided manufacturing), other computer software programs, and robotic welding. These types of courses prepare you to understand how they work with robots, circuit boards, and other machines used in manufacturing and understand how they work within the manufacturing process.

"I'm proud to work here. I'm proud of the work I produce. It is always changing; it is always new. I have a good opportunity to keep learning, and I'm excited about that."

WILLIAM JOHNSON, ROBOTIC WELDER

Potential earnings:
$23 - $35/HR

Handout 1

MANUFACTURING CAREERS

MACHINE TOOL TECHNOLOGY

What is it:

Programming and operating computer numerically controlled (CNC) machines to make parts to sell or assemble.

What that means:

You make sure parts turn out how they should, often cutting away material that isn't needed, starting from a block or sheet or an existing part. You have to understand procedures, print reading, reports, and how to analyze data. You could be making parts that are used for a diverse group of products from computers to medical devices.

> **"You take an aluminum block and make it into something that can fly. That's pretty cool."**
>
> **TODD BAUMHARDT, SENIOR MACHINIST AND SETUP**

You'll work with today's machines using computer software and technology, like writing the program on the computer to tell the machine how to custom cut and assemble parts. Many of the machines are automated, but you still have to understand science, technology, engineering, and math (STEM) to manage the machines and have them do what you want. You may operate the machines or develop programs, but you also have to be able to understand the product design as you apply your knowledge of mechanics and programming to help create a final product. You work with tools like lathes, gauges, and calipers as well as computer software.

Possible career titles:

Machine Operator, CNC Programmer, CNC Tool Maker, CNC Operations Technician, Tool & Die Maker, Moldmaker

Education:

You can earn a certificate or diploma to enter this area as well as earn a two-year degree.

What you'll learn in college:

You'll be trained how to work with hand tools, power tools, and computer software like computer numerically controlled (CNC) programs that are used in manufacturing. Hands-on experience will give you knowledge that you'll use throughout your career.

Potential earnings:
$23 - $28/HR

> **"I like the R&D (research & development) aspect. Somebody brings you something that's never been done before, and [asks] 'Hey, can you build this part?'"**
>
> **SETH ANDERSON, CNC PROGRAMMER**

Handout 1

MANUFACTURING CAREERS

(Page 5 of 8)

WELDING & FABRICATION

What is it:

Making parts come together using heat.

What that means:

You melt pieces of material together to form new parts or products. This can be done in a manufacturing plant, outside, under water, or even outer space! You will study the science of materials and metals to know how they work together (metallurgy). Materials you'll work with can include titanium, aluminum, and plastics. There are lots of different areas and processes for welding, like gas metal arc welding (GMAW or MIG), gas tungsten arc welding (GTAW or TIG), or shielded metal arc welding (SMAW). You'll work with blow torches, brazing equipment, and welding guns along with raw materials to get the job done.

Possible career titles:

Manufacturing Welding Technician, Welding Technician, Advanced Welding Technician, Fitter

Education:

Certificates and diplomas are available, but you can also earn a two-year degree.

What you'll learn in college:

You'll learn about different types of welding processes, what type of welding to use in different situations, power sources, how to work with torches, how metals work together, how to read fabrication drawings, and how to design fabrication assemblies. With all of this, plus hands-on experience, you'll learn how to work with the different technology in welding. Along with applying the science of materials to welding, you'll know how to apply math to be effective at your job.

Potential earnings:

$18 - $23/HR

"I love my job in manufacturing because it's not a dead end job, and it's not just a job that you are at. It's a career that you can keep for a lifetime."

ERICA MORRISON, FABRICATOR/QUALITY SUPPORT

Handout 1

MANUFACTURING CAREERS

MECHANICAL DESIGN & DRAFTING

What is it:

Using computer-aided design (CAD) to create models, design parts, write manufacturing instructions for the creation and assembly of parts.

What that means:

You use your knowledge of math, science, technology, and computer software to create 2D and 3D drawings and models so people know what they are making, such as its size, shape, and dimensions. You can develop how to put parts together and provide instructions for making and assembling everything from simple one-piece parts to complex machines. As you gain experience, you can work your way up to designing custom parts customers buy directly. Nearly everything that is made needs someone who identifies the details needed to make it right.

Possible career titles:

CAD Drafter, CAD Designer, Engineering Technician, Mechanical Technician

Education:

To get started in this field, you'll want to look at a two-year degree.

What you'll learn in college:

You'll learn software like SolidWorks, Autodesk Inventor, or Creo (PRO/Engineer) so you know how to make models. You'll also learn how things work in manufacturing and the science of how materials work, like how much pressure it can take.

Potential earnings:

$28 - $41/HR

"It's really satisfying at the end of the day to say, 'Hey, I made this part of that fixture over there,' or 'I made this part of that car emblem mold.'"

REBECCA THOMAS, INDUSTRIAL ENGINEER

Handout 1

MANUFACTURING CAREERS

(Page 7 of 8)

Potential earnings:
$25 - $38/HR

ENGINEERING & ENGINEERING TECHNOLOGY

What is it:

A commonly known field, you might not know that engineers in manufacturing can design new products or manage process and people who make the products.

What that means:

You may work in product design, generate computer-based models, improve current processes, and manage projects. Hands-on experience working with products and today's machines and technology helps you know how to design and work through the manufacturing process.

Possible career titles:

Product Development Technician, Industrial Designer, Quality Engineer, Industrial Engineer, Manufacturing Engineer, Product Engineer

Education:

There are some two-year programs available to get you started, but a four-year degree will really help you succeed in engineering.

What you'll learn in college:

You'll use what you learn about science, engineering, and math and apply it to research, product development, and manufacturing processes. You'll take lots of classes in science and math, like calculus, physics, and engineering courses.

DIFFERENT ENGINEERING AREAS OF STUDY

Industrial Engineering:

You'll learn how to manage the "big picture"–different projects, equipment, manufacturing operations, product design, quality, people–to know the best way to manufacture products.

Mechanical Engineering:

You will work with the mechanics of manufacturing, from designing machines to testing tools. You will study things like thermal and mechanical systems, machine design, materials, and fabrication.

Chemical Engineering:

Focused on chemical processes and production, you will study how to make products from cosmetics to food to medicine. You learn about chemical reaction and how materials work together so you can plan, test, and manage the chemical design.

Electrical Engineering:

Working with electrical and electronic systems, you learn about computers, controls, automation, and circuits. You will need to know how electrical power works and how to harness it to create electrical equipment, like iPods and GPS systems.

Applied Engineering & Engineering Technology:

Applied engineering combines technical skills with management. You will learn things like CAD, CNC, machining, 3D modeling, and how to manage manufacturing operations, like supply chain management, technical sales, and packaging.

Manufacturing Engineering:

You'll focus on manufacturing production—how to set-up and implement manufacturing processes. You will use modern equipment and techniques to create cost-effective designs and processes.

Handout 1

MANUFACTURING CAREERS

OTHER CAREER OPPORTUNITIES:

These are areas specific to manufacturing, but there is more you can do. Think about the manufacturing cycle—the industry also needs people in logistics, marketing, finance, human resources, and more.

AREAS OF STUDY:

Program names, certificates, diplomas and degrees for manufacturing can vary according to the college, but here's a sampling of what to look for: Engineering Technology, Applied Engineering, Manufacturing Engineering, Manufacturing Maintenance, Welding & Fabrication, Mechanical Design, Energy & Mechatronics, Machine Tool Technology, Manufacturing Technology, Electronics Technology, 3D Model Making, CNC Programming, and Robotics/Automotive Technology.

Learn more at:
www.mnmfg.org

Activity 8

CAREER INVESTIGATION

STUDENT NAME _____

Directions: Watch the Douglas Machine profile (Alexandria, Minnesota) video and answer the following questions. https://youtu.be/0bpz-JtDa0o

1. **What does the company do/make?**

2. **The following are careers of some of the employees at Douglas Machine in Alexandria, MN. In one or two sentences, describe the following careers.**

   CNC PROGRAMMER

   PRESIDENT & COO (WHAT DOES COO STAND FOR?)

   SALES SUPPORT

   FIELD SUPPORT

   MECHANICAL ENGINEER

   ADMINISTRATIVE ASSISTANT

   CEO

   ENGINEERING TECHNICIAN

Activity 9

CAREER INVESTIGATION

STUDENT NAME _____

Directions: Watch the Dynamic Group (Coon Rapids, Minnesota) video and answer the following questions. https://youtu.be/w8OKkYpudDE

1. **What does the company do/make?**

2. **The following are careers of some of the Dynamic Group employees in the Coon Rapids, MN area. In one or two sentences, describe the following careers.**

   TOOLING MANAGER

   CO-OWNER

   MOLDING MANAGER

   IT MANAGER

Activity 10

CAREERS & EDUCATION

(Page 1 of 2)

STUDENT NAME _____

Directions: Review Handout 1

Match the college awards to the # of years in college

1. _____ **CERTIFICATE**
2. _____ **DIPLOMA**
3. _____ **A.S. DEGREE**
4. _____ **A.A.S. DEGREE**
5. _____ **B.S. DEGREE**

A. 2 years of college education (Associate of Science)

B. Typically 18 weeks or less of college education

C. 4 years of college (Bachelor of Science)

D. 2 years of college education (Associate of Applied Science)

E. Typically 1 year of college education

Match the careers to the education required

6. _____ **PRODUCTION TECHNOLOGY: INSPECTOR**
7. _____ **AUTOMATION TECHNICIAN (2)**
8. _____ **ELECTRICAL MECHANIC (2)**
9. _____ **ELECTRICAL ENGINEER**
10. _____ **ENGINEERING TECHNICIAN**
11. _____ **WELDING TECHNICIAN (2)**
12. _____ **ADVANCED WELDING TECHNICIAN**
13. _____ **CAD DRAFTER**
14. _____ **CAD DESIGNER**
15. _____ **CNC PROGRAMMER**

A. 2 year degree

B. Certificate

C. 4 year degree

D. Diploma

Activity 10

CAREERS & EDUCATION

STUDENT NAME _____

Match the potential earnings to the manufacturing area.

16. _____ **PRODUCTION TECHNOLOGY**

17. _____ **ELECTRONICS / MAINTENANCE / ROBOTICS / AUTOMATION / MECHATRONICS**

18. _____ **MACHINE TOOL TECHNOLOGY**

19. _____ **WELDING & FABRICATION**

20. _____ **MECHANICAL DESIGN & DRAFTING**

A. $16 - $29/hour

B. $15 - $29/hour

C. $15 - $33/hour

D. $16 - $25/hour

E. $11 - $18/hour

List six areas of engineering listed in Handout 1.

21.

22.

23.

24.

25.

26.

Where do I go to college?

1. Go to www.minnstate.edu.
2. Click on Find a program or major.
3. Click on Browse for programs.
4. Click on Category/Topic.
5. Click on Manufacturing, Maintenance and Repair.
6. Click on Engineering and Engineering Technology.

Choose one college manufacturing program available and list it below.

What degree is needed for that program?

Where is that college located?
(Include the link you found your information)

Activity 11

CAREER & EDUCATION

STUDENT NAME _____

Directions: View the Marvin Windows video. Then go to www.marvin.com, click on "careers" (bottom of page), then click on "Career Areas."

1. How many career areas does Marvin Windows list?

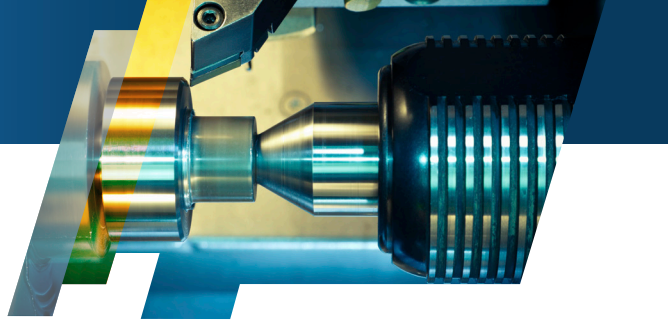
2. Choose two (2) career areas you are interested in and list them.

3. Find one career in each of the career areas you listed above. List the careers. Print the position description.

4. Write a paragraph on what intrigues you about this position.

5. What kind of education or certifications would you need after high school graduation for these positions? (list your source)

6. "Is your future made in manufacturing?" Why or why not?



Activity 12

PROFESSIONS

STUDENT NAME _____

Directions: Watch the Central Boiler & Altoz Precision Mowers videos.
https://youtu.be/RCoFlqbNyVg

1. Andy Hedlund is a Safety & Environmental Director. What do you think he does in that position?

2. Marita Becker works in Materials Management. What is materials management?

3. Jason Lee is the Welding Manager. Match the following terms.

1. _____ **GMAW (MOST WIDELY USED)**
2. _____ **SMAW**
3. _____ **TIG**
4. _____ **OXY ACETYLENE**

A. Tungsten Inert Gas. Expert operators are used.

B. Also called MIG welding. Gas Metal Arc Welding.

C. Used for maintenance work and gas metal cutting.

D. Called stick or arc welding. Shielded Metal Arc Welding.

4. Can you grow professionally and financially in manufacturing? Why or Why not?

Activity 13

WHAT'S SO COOL ABOUT MANUFACTURING?

STUDENT NAME _____

1. **Now that you know so much about manufacturing in Minnesota, if you were stopped in the street by a reporter and asked, "What do you think is cool about manufacturing in Minnesota?" What would you say?**

NEW!

Mini Challenges

APPLYING LEARNING AS STUDENTS FINISH THEIR INTRODUCTION TO MANUFACTURING

Teacher Notes

Historically, the manufacturing industry has been male-dominated. Few females have entered manufacturing careers or considered it a viable option. Increasingly, this is changing. Today's manufacturing industry is abundant with opportunities for women.

The mini challenges found on pages 40-65 of this guide were designed to pique the interest of larger numbers of youth, including girls and others who may not be "handy" or the typical Tech-Ed student. These exercises are more in-depth than the hands-on activities found earlier in the guide. In addition to reinforcing the manufacturing concepts students have learned so far, the mini challenges encourage teamwork and creativity, as well as strengthening problem-solving skills.

Two of the mini challenges are considered gender neutral, appealing to both boys and girls. Two of the mini challenges were designed to enhance the learning experience for girls exploring manufacturing. Girls generally approach manufacturing with a different mind and skill set. They typically come to a STEM course(s) with less hands-on and problem solving experience than their male counterparts. They usually work better in teams and are more willing to help each other to succeed. These challenges were created with girls in mind and without need for specialized equipment in the classroom.

We encourage you to let your students self-select the mini challenge that appeals to them.

For more information on women in manufacturing, read the Manufacturing Institute's article: Untapped Resource – How manufacturers can attract, retain, and advance talented women: www2.deloitte.com/content/dam/Deloitte/us/Documents/manufacturing/us-indprod-pip-women-in-manufacturing-report-02052013.pdf

MINI CHALLENGES

Two mini challenges are female focused & two are gender neutral.

1. INDUSTRIAL PRODUCTS
Focus: Gender Neutral
3-4 Class Periods
PAGES: 40-44

2. LEAN MANUFACTURING
Focus: Gender Neutral
2 Class Periods
PAGES: 45-52

3. AUTOMOTIVE
Focus: Women in Manufacturing
3 Class Periods
PAGES: 53-55

4. ENERGY
Focus: Women in Manufacturing
4-5 Class Periods
PAGES: 56-65

Industrial Products

MINI CHALLENGE 1

Gender Neutral

TEACHER INSTRUCTIONS

(Minimally 3 - 4 class periods/60 minutes each class period)

Introduction:

This challenge is a design & problem solving project in the Industrial Products area of manufacturing. The project was created without the need for specialized equipment in the classroom.

Challenge:

Design a sorting process to sort seeds by size and shape. Build a prototype.

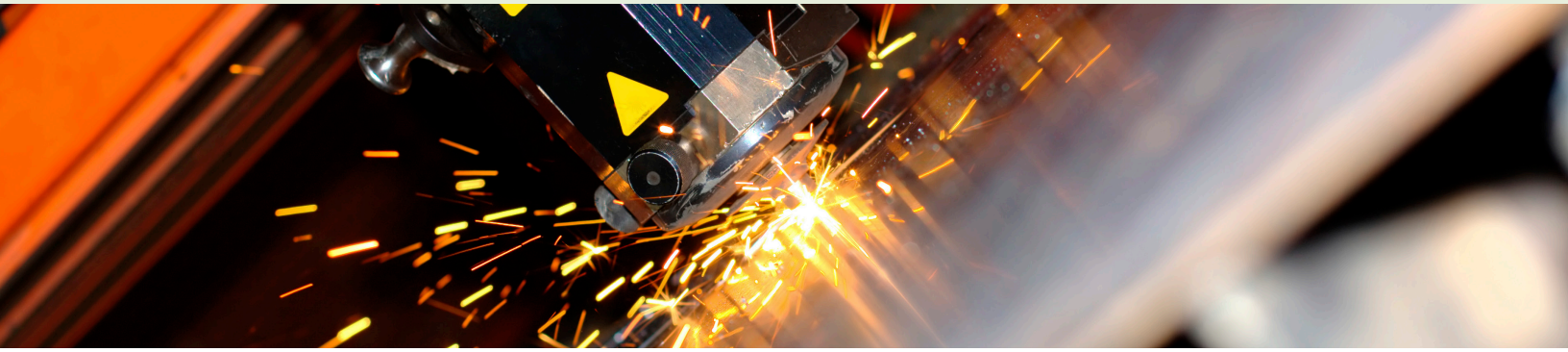
Scenario:

A seed company has hired your manufacturing company to solve a problem. Your group is the design team for this project. The seed company needs a way to separate seeds by size and shape in order to increase the speed of their production.

Think of a cob of corn. All the kernels are different sizes. When you purchase corn in a bag or can at the store, the kernels are approximately the same size and shape. The kernels have been sorted in some way. This process can be duplicated with thousands of different applications for many different companies.

Materials for each group:

- Seed Simulation
  - Marbles
  - Small BB's
  - Pea Gravel
  - Seeds: various sizes
- Shoe Box
- X-ACTO® knife
- Scissors
- Cardboard or Tagboard
- Tape
- Hole punch
- Tray
- Funnel
- Paper
- Paper towel or toilet paper rolls



Industrial Products

MINI CHALLENGE 1

Gender Neutral

CHALLENGE INSTRUCTIONS

1. **Ideation Session**

   An ideation session is when you put together a diverse group of people working on a problem that has been identified and coming up with a number of creative solutions to be able to solve that problem. Read the article at **www.interaction-design.org/literature/article/what-is-ideation-and-how-to-prepare-for-ideation-sessions** to understand how to do an ideation session. Teachers can also invite college faculty, parents or an industry representative to help guide this process.

2. **Minnesota Manufactured Career Tool**

   Students will take the Career Assessment Quiz found at www.**mnmfg.org/students/career-tool/**. Upon completion of the Career Assessment Quiz, students should analyze their results by researching the top three suggested careers. Students can print their results and provide you with a copy.

3. **Place students into Manufacturing Research & Design Teams based on their Career Assessment Quiz.**

4. **Teams will have an ideation session to determine how they will solve the problem to effectively sort the seeds.**

5. **Team members will work together to choose which idea the group will use to make a working model using the materials provided to them.**

6. **Build a Working Model – Finished Product**

   Teams will build a working model of their idea using the materials listed above, as well as other materials they may have at home.

7. **Group Presentation**

   WHAT PARTS OF YOUR PROJECT TURNED OUT THE BEST?
   WHAT WOULD YOU DO DIFFERENTLY INDIVIDUALLY AND AS A GROUP?
   HOW COULD YOU HAVE WORKED BETTER TOGETHER TO COMPLETE THE PROJECT?
   WHAT PARTS OF MANUFACTURING DO YOU BELIEVE WOULD BE NEEDED TO ACTUALLY MAKE THIS PROJECT?

8. **Discuss as a class if the groups combined their ideas. How could they make the product better?**

Industrial Products

MINI CHALLENGE 1

Gender Neutral

TEACHER NOTES

If your school subscribes to **"Nepris - Connecting Industry Professionals to Every Classroom"** teachers can follow up with a Nepris Virtual Industry Tour. For more information go to **www.nepris.com**.

INSTRUCTOR KEY:

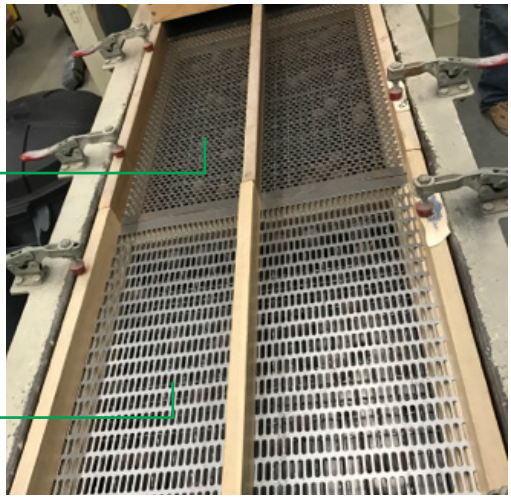
Seed Sorter in Business

SEEDS ARE POURED IN THE TOP OF THE MACHINE

BLUE TRAY MOVES BACK AND FORTH (VIBRATES)

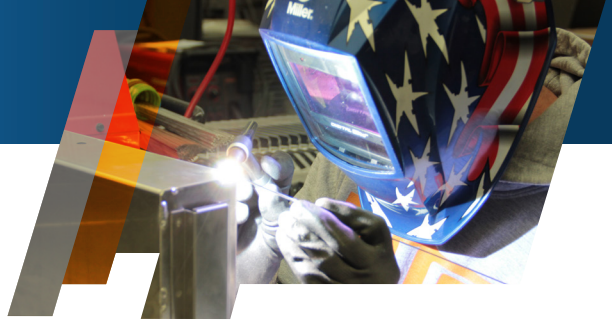
WOODEN BOXES ARE A SERIES OF SCREENS

SEEDS COME OUT INTO 4 DIFFERENT BUCKETS NOW SORTED



GRATE OPENING SIZE DEMONSTRATES SEED SIZE #1

GRATE OPENING SIZE DEMONSTRATES SEED SIZE #2



Industrial Products

MINI CHALLENGE 1

Gender Neutral

INSTRUCTOR KEY: SAMPLE PROTOTYPE #1:

1. Cut the bottom out of a shoe box.
2. Cut 4 pieces of tagboard to fit the bottom of the shoe box.
3. Measure the seeds to determine holes to be punched or cut into the tagboard.
4. Make the holes in the tagboard to meet the size specifications for the seeds.
5. Label the tagboard cut outs #1 – 4 with the #1 being the smallest size holes for sorting.
6. Students will use the tagboard with the smallest holes first to “shake out” the smallest seeds onto the tray.
7. Remove the #1 tagboard cut out and replace with the #2 tagboard and so on.
8. Students will demonstrate how they have sorted the seeds in their group presentation.
9. Students in the audience will provide feedback after all the groups have presented. How would the project been improved if they all exchanged their ideas?

INSTRUCTOR KEY: SAMPLE PROTOTYPE #2:

1. Student will cut thick paper, cardboard, or tag board to fit on one end of the paper towel roll.
2. Measure the seeds to determine holes to be punched or cut into the tagboard.
3. Make the holes in the tagboard to meet the size specifications for the seeds.
4. Label the tagboard cut outs #1 – 4 with the #1 being the smallest size holes for sorting.
5. Students will pour the seeds through a funnel into the cardboard tube and sort the seeds.
6. Students will demonstrate how they have sorted the seeds in their group.
7. Students in the audience will provide feedback after all the groups have presented. How would the project been improved if they all exchanged their ideas?

Industrial Products

MINI CHALLENGE 1

Gender Neutral

STUDENT INSTRUCTIONS

Challenge:

Design a sorting process to sort seeds by size and shape. Build a prototype.

Scenario:

A seed company has hired your manufacturing company to solve a problem. Your group is the design team for this project. The seed company needs a way to separate seeds by size and shape in order to increase the speed of their production. Think of a cob of corn. All the kernels are different sizes. When you purchase corn in a bag or can at the store, the kernels are approximately the same size and shape. The kernels have been sorted in some way. This process can be duplicated with thousands of different applications for many different companies.

1. Minnesota Manufactured Career Tool

Take the Career Assessment Quiz found at www.**mnmfg.org/students/career-tool/**. Upon completion of the Career Assessment Quiz, students should analyze their results by researching the top three suggested careers. Students can print their results and provide you with a copy.

2. Your instructor will assign you to a manufacturing team.

3. Ideation Session

An ideation session is when you put together a diverse group of people "working on a problem that has been identified and coming up with a number of creative solutions to be able to solve that problem."

- Solve the problem to effectively sort the seeds.
- Work together to choose which idea the group will use to make a working model using the materials provided by your teacher.

Finished Product – Working Model

- Build a working model of the group idea using the materials provided by your teacher.

4. Group Presentation

WHAT PARTS OF YOUR PROJECT TURNED OUT THE BEST?

WHAT WOULD YOU DO DIFFERENTLY INDIVIDUALLY AND AS A GROUP?

HOW COULD YOU HAVE WORKED BETTER TOGETHER TO COMPLETE THE PROJECT?

WHAT PARTS OF MANUFACTURING DO YOU BELIEVE WOULD BE NEEDED TO ACTUALLY MAKE THIS PROJECT?

Lean Manufacturing

MINI CHALLENGE 2

Gender Neutral - Lean Manufacturing Impacts Green Manufacturing Technology

TEACHER INSTRUCTIONS

(Minimally 2 class periods/60 minutes each class period)

Introduction:

"Polaris was founded in the small Minnesota town of Roseau. Located just south of the Canadian border. Roseau is home to one of the Polaris facilities that handle Snowmobile and ATV production, plastics manufacturing, aspects of engineering and product testing." **www.polaris.com/en-us/company/polaris-experience-center**.

Challenge:

Manufacture a simulated snowmobile track in order to demonstrate the 7 Wastes of Lean Manufacturing. The project was created without the need for specialized equipment in the classroom. Thousands of different applications for many different companies.

Materials:

- Snowmobile Track - 3 Rubber bands 7" X 5/8" (black rubber bands would better represent a snowmobile track)
- Lugs - 3 Rubber bands 7" X 1/8"
- End Caps and Rails - Thin cardboard or tag board (8 ½ X 11)
- Sprockets or Bogie Wheels - Paper towel roll
- Axles - Skewers (11.75")
- Scissors or a tool to cut (wire cutter) the wood skewers
- Pen
- Pencil
- Marker
- Glue gun and glue sticks
- Ruler
- Compass
- Small box or bowl to put scraps in

Lean Manufacturing

MINI CHALLENGE 2

Gender Neutral - Lean Manufacturing Impacts Green Manufacturing Technology

TEACHER INSTRUCTIONS

1. **Work with students to understand the following definitions.**

   - **Definition of Waste -** Something that adds no value.
   - **Definition of Lean Manufacturing -** Elimination of waste from the manufacturing process.
   - **Definition of Green Manufacturing -**Method of manufacturing that minimizes waste and pollution.

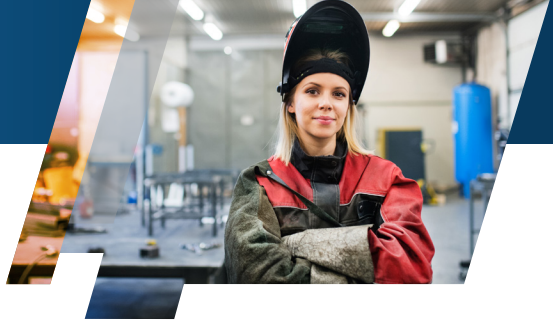
2. **Discussion Question - What are some reasons to remove waste from manufacturing? (sample answers - in no particular order)**

   1. **Decrease pollution**
      - Less gas used for transport.
      - Decreased inventory leads to smaller buildings to heat and cool.
   2. **Decrease on-the-job injuries caused by unnecessary motion.**
      - Employee leaning over to pick up a part when it could be at waist level.
   3. **Fewer defects in the production of a product equals less waste. Therefore, increased production and profits.**

3. **List and discuss the 7 Wastes of Lean Manufacturing. A simple mnemonics to remember the seven wastes is TIMWOOD.** (www.leanmanufacturingtools.org/77/the-seven-wastes-7-mudas)

   - **T**ransport – Unnecessary movement of parts or people in product production.
   - **I**nventory – Parts and materials that are not being used but stored.
   - **M**otion – Unnecessary movement of parts or people in the manufacturing process.
   - **W**aiting – This be anything from waiting for materials to arrive to make the product to waiting for a machine to finish a cycle.
   - **O**ver Processing – Inappropriate techniques, oversized equipment, working to tolerances that are too tight, performing processes that are not required by the customer are all examples of over processing.
   - **O**ver Production – Producing more goods than there is customer demand.
   - **D**efects – Products that are rejected because of flaws.

4. **Students can create the prototype individually or in pairs.**



Lean Manufacturing

MINI CHALLENGE 2

Gender Neutral - Lean Manufacturing Impacts Green Manufacturing Technology

CHALLENGE INSTRUCTIONS

Each time students produce a piece of scrap material during the challenge, they must put the scrap in their waste container. (Instructional photos are included in the student instructions)

1. Measure two strips of cardboard 5½" long and ½" wide.
2. Measure diameter of one end of the paper towel roll. (Diameter/2 = radius)
3. Set your compass to the radius.
4. Draw four circles.
5. Cut 4 circles out of the cardboard.
6. Cut two 3 inch rolls from the paper towel roll.
7. Place three wide rubber bands on the rolls to represent the snowmobile track.
8. Use the point of the compass to make a hole in the middle of each round circle.
9. Place one round circle on the skewer.
10. Place the skewer through one roll and secure the circle to the end of the roll with the glue gun. Attach the remaining circles to the end of each roll.
11. Mark a dot ½ inch in from the end of each thin piece of cardboard.
12. Use the point of the compass to make a hole in the middle of each round circle.
13. Place the strip on the end of each skewer.
    (Students can secure the end with the glue gun but it is not necessary)
14. Use the cutting tool to cut each skewer so approximately ¼ inch remains.
15. Cut the smaller rubber bands into 3 inch strips to make the lugs.
16. Place the lugs on the track using the glue gun, placing the lugs approximately ¼ inch apart.

Lean Manufacturing

MINI CHALLENGE 2

Gender Neutral - Lean Manufacturing Impacts Green Manufacturing Technology

CHALLENGE FOLLOW UP

Student Discussion Questions

Ask students to think about the 7 Wastes of Lean Manufacturing.

1. How could you or your team have improved on transportation?
2. How could you or your team have improved on Inventory/waste?

   Could you have combined your teams to use less inventory?
3. What motions could you have eliminated or streamlined?

   Would it be practical to create a production line?

   Could a machine do parts of the manufacturing?
4. Were there supplies that didn't work or that you didn't need?
5. If you are not going to bring your project with you, how can you recycle the materials or use them again?

ADDITIONAL STUDENT CHALLENGES:

1. **Review the www.polaris.com website. Have students share one thing about Polaris they didn't know.**
2. **Minnesota Manufactured Career Tool**

   Students can take the Career Assessment Quiz found at **mnmfg.org/students/career-tool/.** Upon completion of the Career Assessment Quiz, students should analyze their results by researching the top three suggested careers.
3. **Research Poka-Yoke.**
4. **Find additional examples of Lean Manufacturing.**
5. **Create teams to manufacture different sections of a snowmobile to replicate a manufacturing facility.**

Lean Manufacturing

MINI CHALLENGE 2

Gender Neutral - Lean Manufacturing Impacts Green Manufacturing Technology

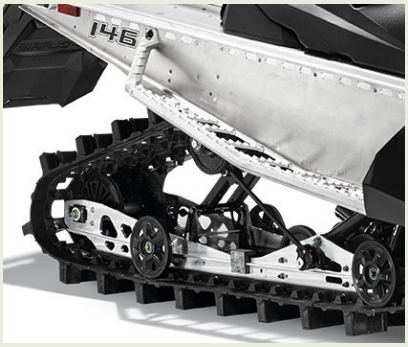
STUDENT NAME _____

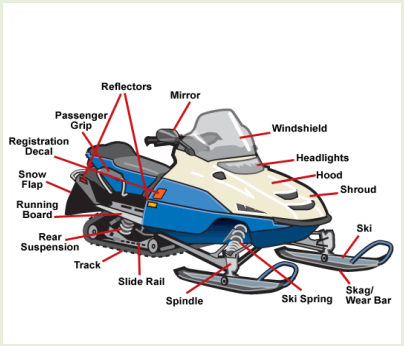
STUDENT INSTRUCTIONS

"Polaris was founded in the small Minnesota town of Roseau. Located just south of the Canadian border. Roseau is home to one of the Polaris facilities that handle Snowmobile and ATV production, plastics manufacturing, aspects of engineering and product testing." **www.polaris.com/en-us/company/polaris-experience-center**

Challenge:

Manufacture a simulated snowmobile track or prototype in order to demonstrate the 7 Wastes of Lean Manufacturing.





1. **Define Waste**

2. **Define Lean Manufacturing**

3. **Define Green Manufacturing**

4. **What are some reasons to remove waste from manufacturing?**

Lean Manufacturing

MINI CHALLENGE 2

Gender Neutral - Lean Manufacturing Impacts Green Manufacturing Technology

STUDENT NAME _____

STUDENT INSTRUCTIONS CONTINUED

Define the 7 wastes of Lean Manufacturing. A simple mnemonics to remember the seven wastes is TIMWOOD. www.leanmanufacturingtools.org/77/the-seven-wastes-7-mudas

Transport

Inventory

Motion

Waiting

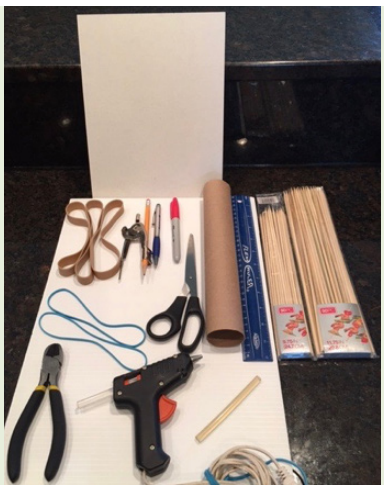
Over Processing

Over Production

Defects

Materials:

- Snowmobile Track - 3 Rubber bands 7" X 5/8" (black rubber bands would better represent a snowmobile track)
- Lugs - 3 Rubber bands 7" X 1/8"
- End Caps and Rails - Thin cardboard or tag board (8 ½ X 11)
- Sprockets or Bogie Wheels - Paper towel roll
- Axles - Skewers (11.75")
- Scissors or a tool to cut (wire cutter) the wood skewers
- Pen
- Pencil
- Marker
- Glue gun and glue sticks
- Ruler
- Compass
- Small box or bowl to put scraps in



Lean Manufacturing

MINI CHALLENGE 2

Gender Neutral - Lean Manufacturing Impacts Green Manufacturing Technology

STUDENT INSTRUCTIONS

Challenge:

Each time a piece of scrap material is produced during the challenge, place the scrap in the waste container.

1. Measure two strips of cardboard 5½" long and ½" wide.
2. Measure diameter of one end of the paper towel roll. (Diameter/2 = radius)
3. Set your compass to the radius.
4. Draw four circles.
5. Cut 4 circles out of the cardboard.
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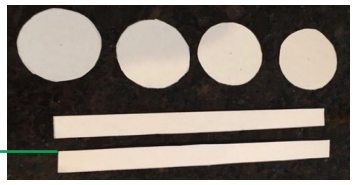
8. Use the point of the compass to make a hole in the middle of each round circle.
9. Place one round circle on the skewer.
10. Place the skewer through one roll and secure the circle to the end of the roll with the glue gun. Attach the remaining circles to the end of each roll.
11. Mark a dot ½ inch in from the end of each thin piece of cardboard.
12. Use the point of the compass to make a hole in the middle of each round circle.
13. Place the strip on the end of each skewer. (Students can secure the end with the glue gun but it is not necessary)
14. Use the cutting tool to cut each skewer so approximately ¼ inch remains.
15. Cut the smaller rubber bands into 3 inch strips to make the lugs.
16. Place the lugs on the track using the glue gun, placing the lugs approximately ¼ inch apart.

EXAMPLE: STEPS 1-5



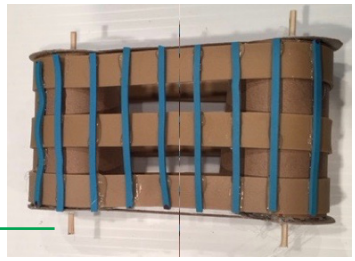
EXAMPLE: STEP 6

EXAMPLE: STEP 9

EXAMPLE: STEP 10

EXAMPLE: STEP 11

EXAMPLE: STEP 16



Lean Manufacturing

MINI CHALLENGE 2

Gender Neutral - Lean Manufacturing Impacts Green Manufacturing Technology

STUDENT NAME _____

STUDENT CHALLENGE: FOLLOW UP QUESTIONS

Think about the 7 wastes of Lean Manufacturing

1. **How could you or your team have improved on transportation?**

2. **How could you or your team have improved on Inventory/waste? Could you have combined your teams to use less inventory?**

3. **What motions could you have eliminated or streamlined? Would it be practical to create a production line? Could a machine do parts of the manufacturing?**

4. **Were there supplies that didn't work or that you didn't need?**

5. **If you are not taking your prototype with you, how can you make this project more green when disposing of the prototype?**

Automotive

MINI CHALLENGE 3

TEACHER INSTRUCTIONS

(Minimally 3 class periods/60 minutes each class period)

Introduction:

What do you think of when you hear Automotive Manufacturing? The automotive industry is more than a car or pickup engine, it's all in the details. Watch the How It's Made video Plastic injection molds to get an understanding of how injection molding is made. **https://youtu.be/seZqq1qxW30**

Challenge:

Create an accessory, decorative interior or decorative exterior trim for a vehicle. Think about how the mold will be made.

1. **Minnesota Manufactured Career Tool**
   Students will take the Career Assessment Quiz found at **mnmfg.org/students/career-tool/**. Upon completion of the Career Assessment Quiz, students should analyze their results by researching the top three suggested careers. Students can print their results and provide you with a copy.
2. **Place students into Manufacturing Research & Design Teams based on their Career Assessment Quiz.**
3. **Each student will survey four drivers: a man and woman driver under the age of 25 and a man and woman driver over the age of 26.**
4. **Survey question: "What do you wish your vehicle had that isn't a regular option when you purchased it?" For instance, "I wish my car had a garbage can with removable bags for easy cleaning. The problem is where would I put one in my car."**
   Students will take a photo(s) of the vehicle model (or find photo(s) online) and where in the vehicle in order to demonstrate where the change will be made.

Materials:

- Post-it® Notes
- Highlighters – various colors
- Pens or pencils – various colors
- Large flip chart
- Pipe cleaners
- Play dough or clay
- K'NEX®
- LEGO® bricks
- Cotton balls
- Tongue depressors
- Straws
- String
- Plastic or paper cups
- Paper plates
- Rubber bands
- Tape
- Funnel
- Small boxes
- Scissors
- Coffee filters
- Tag board
- VELCRO®
- Other

Automotive

MINI CHALLENGE 3

Women in Manufacturing

TEACHER INSTRUCTIONS CONTINUED

(Minimally 3 class periods/60 minutes each class period)

5. Ideation Session

An ideation session is when you put together a diverse group of people working on a problem that has been identified and coming up with a number of creative solutions to be able to solve that problem.

Teachers, read the article at www.interaction-design.org/literature/article/what-is-ideation-and-how-to-prepare-for-ideation-sessions to understand how to do an ideation session.

Upon completion of the student driven survey, students will come back together as a team and discuss the results through an ideation session.

Students will use Post-it® Notes to write down their ideas. Students will then work together to choose which idea the group will use to make a working model. Students may use the materials listed to demonstrate their "rough draft" idea.

Teachers can also invite college faculty, parents or an industry representative to help guide this process.

6. Build a Working Model – Finished Product

Students will build a working model of their idea using the materials listed above, as well as other materials they may have at home. Students will need to list the materials they would use in manufacturing of this product such as: steel, plastic, wood, etc.

ADDITIONAL STUDENT CHALLENGES:

1. **Research a manufacturer in Minnesota that has the tools/materials to make your product.**
2. **Group Presentation:**
   - Communicate how your team came to a consensus in choosing the product
   - Discuss how your team worked together
   - Demonstrate the working model
   - List the materials that would be used in actually producing this product
   - Class audience can provide constructive comments to the group.
   - Invite college faculty, parents or local industry to provide input on completed projects.
3. **Build the model using equipment available at your school (welding, machine or automotive shops, 3-D printers, computers & design software, and more.**
4. **If your school subscribes to Nepris - Connecting Industry Professionals to Every Classroom, teachers can follow up with a Nepris virtual industry tour.**
   For more information go to **www.nepris.com**.

Automotive

MINI CHALLENGE 3

STUDENT INSTRUCTIONS

What do you think of when you hear Automotive Manufacturing? The automotive industry is more than a car or pickup engine, it's all in the details. Watch the How It's Made video Plastic injection molds to get an understanding of how injection molding is made. **https://youtu.be/seZqq1qxW30**

Challenge:

The automotive challenge is a manufacturing design team simulation to create an accessory for a vehicle.

1. Minnesota Manufactured Career Tool

Students will take the Career Assessment Quiz found at **mnmfg.org/students/career-tool/**. Upon completion of the Career Assessment Quiz, students should analyze their results by researching the top three suggested careers. Students can print their results and provide you with a copy.

1. Problem Solving & Design Team

- You will work in a team as assigned by your teacher.
- Each member of the team will survey four people.
- Survey one female and one male who drives under the age of 25.
- Survey one female and one male who drives over the age of 26.

2. Survey Question

What item do you wish your vehicle had that is NOT part of your cars design?
(For example: I wish my vehicle had a permanent garbage can that had removable bags for easy cleaning.)

3. Discussion

Come back together as a team and discuss the answers you gathered. As a team, choose which item your team will design. Take a photo(s) of the vehicle model (or find a photo online) and the area of the vehicle you are making a change.

4. Ideation Session

Your team will have an ideation session. An ideation session is when you put together a diverse group of people to work on a problem that your group has identified and coming up with a number of creative solutions to be able to solve that problem. Your teacher will provide you with materials to use during your ideation session.

- Combine the ideas to create the best idea!

5. Prototype

- Use the materials from your instructor to create a prototype of your product.
- List the materials you would use if this product was really going to market.
  (For example: Steel, Plastic, Wood, VELCRO®, etc.)

Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

TEACHER INSTRUCTIONS

(Minimally 4 - 5 class periods/60 minutes each class period)

Introduction:

Minnesota's own Wyoming Machine **www.wyomingmachine.com** (general website) is located in Stacy, Minnesota! The Wyoming Machine is a Precision Sheet Metal Fabrication Company owned and operated by two sisters, Lori and Traci Tapani (Co-Presidents).

Present the video (5 minutes) of the Wyoming Machine co-presidents as they showcase their business and what is made at Wyoming Machine to your students.

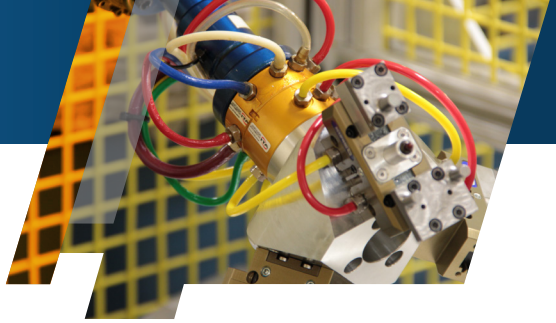
The video can be found on YouTube at **www.youtube.com/watch?v=G54ii8Lgpz0**

Challenge:

The energy and resources challenge is a manufacturing research and design team simulation to solve a problem the students identify through strategy mapping. The goal is to have students solve a societal problem through manufacturing. The video *Engineering is Saving the World with Cookstoves* is an example of how a social issue was solved through manufacturing and engineering.

Materials:

- Magazines (National Geographic, pop culture, etc.)
- Local and national newspapers (within the last year)
- Post-it® Notes
- Highlighters – various colors
- Pens or pencils – various colors
- Large flip chart
- K'NEX®
- LEGO® bricks
- Pipe cleaners
- Play dough or clay
- Cotton balls
- Tongue depressors
- Straws
- String
- Plastic or paper cups
- Paper plates
- Rubber bands
- Tape
- Funnel
- Small boxes
- Scissors
- Coffee filters
- Other miscellaneous items such as knick-knacks from around your home.



Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

TEACHER INSTRUCTIONS CONTINUED

1. **Present the PBS (Public Broadcasting Service) video *Engineering is Saving the World with Cookstoves:* Video/Quest (7 Minutes) to your students.**
   The video can be found by going to **sdpb.pbslearningmedia.org**. Type the name of the video in the search bar. Students will complete the video worksheet.

2. **Minnesota Manufacturing Career Tool**
   Students will take the Career Assessment Quiz found at **www.mnmfg.org**. Click on the students tab. Choose manufacturing career tool. Upon completion of the Career Assessment Quiz, students should analyze their results by researching the top three suggested careers. Students can print their results and provide you with a copy.

3. **Place students into Manufacturing Research & Design Teams based on their Career Assessment Quiz.**

4. **Once students have been assigned a position on the design team, have the students research their position.**

5. **Identify the Problem**
   - **Strategy Maps**
     Teacher video - Watch the Strategy Map video from NOVA Education available at **sdpb.pbslearningmedia.org** by searching Strategy Map. Strategy mapping assists students through the design thinking process.
   - **Strategic Process through Strategy Mapping**
     Teacher video - Watch the Generating Ideas video from NOVA Education available at **sdpb.pbslearningmedia.org** by searching Generating Ideas.
   - **Students will:**
     - Skim through newspapers and magazines and look at visual art pieces.
     - Find a problem that needs a solution.
     - Write their identified problems on Post It Notes.
     - Review all of the identified problems.
     - Choose what the problem solving challenge will be.
   - **Problem Solving Examples**
     - Improved lightweight tent that you can carry on your back or be used by a homeless person.
     - Mobile Home skirt that prevents the wind and weather elements from decreasing the temperature of the home floor (easy to install, lightweight).
     - Portable water purifier using everyday items.
     - Design a shoe using recycled products.
     - Design a retail store fixture that would be made with metal.

Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

TEACHER INSTRUCTIONS CONTINUED

6. **Brainstorm & Design:**

   - Students will record their brainstorming ideas on Post-it® Notes

   Discussion questions:

   - What are some ways to tackle the challenge your group has chosen?
   - How creative can you be?

   Provide each team with the remainder of the listed materials. Discussion questions:

   - Which of the ideas are really possible, given your time, tools and materials?
   - What are some problems you need to solve as you build your project?
   - Would it help to sketch the design?
   - Choose one design.

7. **Build, Test, Evaluate, and Redesign (2 class periods) (Instructors may want to ask local professionals to work with students to enhance the projects)**

   - Will you need additional materials besides what you have been provided?
   - What can you learn by looking at other students' projects?
   - Why is it a good idea to keep testing a design?
   - What specific goal are you trying to achieve and how will you know if you've been successful?

8. **Share Solutions with the Class: Teacher Video - Watch the Communicating Ideas video from NOVA Education available at sdpb.pbslearningmedia.org by searching Communicating Ideas.**

   - What is the best feature of your design? Why?
   - What was the hardest problem to solve?
   - Did you have to do something a few times to get it to work? What did you do?
   - If you had more time, how would you improve your project?

Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

ENERGY & RESOURCES VIDEO WORKSHEET - ANSWER KEY

Engineering is Saving the World with Cookstoves: Video/Quest

1. **Where is Senior Scientist Ashok Gadgil from and where does he work?**
   Lawrence Berkeley National Lab, Berkley California
2. **What country needed his help?**
   Darfur, Africa
3. **What were the women in Darfur gathering?**
   Firewood
4. **What were the women of Darfur cooking on?**
   A round pot on a three stone fire
5. **Why is a three stone fire inefficient?**
   Efficiency is 5-6%. Poor combustion. 95% heat loss.
6. **What did Scientist Gadgil create?**
   A more efficient stove for cooking.
7. **How did that help the people of Darfur?**
   Less wood is needed to cook which means a decrease in rape for women and decrease in death for men.
8. **List the positives from the newly designed stove.**
   Inexpensive ($20), Shipped flat (flat packs), Easy to put together, More efficient (30 – 35% efficient), Match their cooking style.
9. **List the five things to consider when making the stoves**
   Cook knows how to tend the fire correctly, Understand what kind of cooking is taking place and with what kind of pot, Make sure the pot fits over the fire on the stove, Oxygen supply is controlled but adequate, Stove works with the right kind of fuel (wood) that is found locally.
10. **Dr. Ken P Chow assisted in getting the prototype to manufacturing. What kind of engineer is he?**
    Mechanical Engineer

Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

STUDENT NAME _____

STUDENT: VIDEO WORKSHEET

Engineering is Saving the World with Cookstoves: Video/Quest

1. **Where is Senior Scientist Ashok Gadgil from and where does he work?**

2. **What country needed his help?**

3. **What were the women in Darfur gathering?**

4. **What were the women of Darfur cooking on?**

5. **Why is a three stone fire inefficient?**

6. **What did Scientist Gadgil create?**

7. **How did that help the people of Darfur?**

8. **List the positives from the newly designed stove.**

9. **List the five things to consider when making the stoves**

10. **Dr. Ken P Chow assisted in getting the prototype to manufacturing. What kind of engineer is he?**

Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

VIDEO WORKSHEET - ANSWER KEY

Wyoming Machine Company Profile

1. **Where is the Wyoming Machine located?**
   Stacy, MN
2. **What is their specialty?**
   Metal Fabrication Company
3. **When was Wyoming Machine formed?**
   1974
4. **Name two products that they make.**
   Doors, hoods, boxes, electrical enclosures, retail store fixtures
5. **List two interesting facts about the company.**
   The company values their community.
   They partner with colleges.
   They offer high paying jobs that pay a living wage.
   Minnesota has a strong supply chain.

Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

STUDENT NAME _____

STUDENT: VIDEO WORKSHEET

Wyoming Machine Company Profile

1. **Where is the Wyoming Machine located?**

2. **What is their specialty?**

3. **When was Wyoming Machine formed?**

4. **Name two products that they make.**

5. **List two interesting facts about the company.**

Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

STUDENT NAME _____

STUDENT INSTRUCTIONS

Challenge:

Find and solve a problem that can be resolved through manufacturing.

1. **Minnesota's own Wyoming Machine is located in Stacy, Minnesota!**
   Wyoming Machine is a Precision Sheet Metal Fabrication Company owned and operated by two sisters, Lori and Traci Tapani (Co-Presidents)
   - Watch the video "Wyoming Machine Company Profile".
   - Complete the video worksheet.

2. **Watch the video *Engineering is Saving the World with Cookstoves: Video/Quest*. The video is an example of how a social issue was solved through manufacturing and engineering.**
   - Complete the video worksheet.

3. **Minnesota Manufactured Career Tool**
   Complete the Career Assessment Quiz found at **www.mnmfg.org**. Click on the students tab. Choose manufacturing career tool. Upon completion of the Career Assessment Quiz, analyze your results by researching the top three suggested careers. Print and provide your instructor with your assessment results.

4. **Your instructor will divide you into Manufacturing Research and Design Teams.**

5. **Strategic Process through Strategy Mapping**
   - Skim through newspapers and magazines and look at other visuals your instructor has provided.
   - Find a problem that needs a solution.
   - Each team member will write problems that need a solution on a Post-it ®Notes. Write down as many problems as you can.
   - As a team look at all of the problems and select the problem you are going to solve as a team through manufacturing.

6. **Brainstorm**
   - Write your problem/challenges on Post-it ®Notes.

Discussion Questions

- What are some ways to tackle the problems your group has identified?
- How creative can you be?

Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

STUDENT NAME _____

STUDENT INSTRUCTIONS CONTINUED

7. **As a group choose one problem to solve.**

8. **Design & Brainstorm**

   Your teacher will provide you with materials to assist you in your design and brainstorm session.

   ### Discussion Questions

   a. Which of the ideas are really possible, given the time, tools, and materials?

   b. What are some problems you need to solve in order to build your project?

   c. Would it help to sketch your design?

9. **As a group pick one design or a combination of designs to solve the problem.**

Energy & Resources

MINI CHALLENGE 4

Women in Manufacturing

STUDENT NAME _____

STUDENT INSTRUCTIONS CONTINUED

10. Build, Test, Evaluate, and Redesign

a. Will you need additional materials besides what you have been provided?

b. What can you learn by looking at other students' projects?

c. Why is it a good idea to keep testing a design?

d. What specific goal are you trying to achieve and how will you know if you've been successful?

11. Share Solutions with your Peers

a. What is the best feature of your design? Why?

b. What was the hardest part of the problem to solve?

c. Did you have to do something a few times to get it to work? What did you do?

d. If you had more time, how would you improve your project?

Answer Key

CHAPTER 1 / WHAT IS MANUFACTURING?

ACTIVITY 1: Manufacturing Terms & Definitions

NOTES FOR CHAPTER 1, ACTIVITY 1

1. F
2. B
3. I
4. H
5. L
6. G
7. A
8. C
9. D
10. E
11. J
12. K

HANDOUT 1: The Manufacturing Cycle

Provide students with a copy of the Manufacturing Cycle.

ACTIVITY 2: The Manufacturing Cycle

NOTES FOR CHAPTER 1, ACTIVITY 2

The manufacturing cycle is something that is repeated throughout the manufacturing process — manufacturers not only need to follow the process to create new products, but also stay on top of new regulations, market studies, how their product compares to similar products, and the most productive ways to make their goods.

You can also note that the Design & Development stage includes the "test" stage. For MaxBat, their process begins by monitoring their wood drying process, then testing the moisture content, selecting the best "blanks," then testing it again for weight and flaws. After the second inspection, the wood is sanded, and then inspected before staining. After staining, it is again inspected before finishing the bat. It is then again weighed and inspected before reaching the Distribution state.

Note: For the items with multiple answers, the order doesn't have to matter as the students are applying these items to the manufacturing cycle.

1. Distribution (E)
2. Production (C)
3. Marketing (D)
4. Research & Marketing Analysis (A)
5. Marketing (D)
6. Research & Marketing Analysis (A)
7. Design & Development (B)
8. Design & Development (B)
9. Production (C)
10. Distribution (E)
11. Product Support & Sales (F)
12. Marketing (D)

The sources for this activity can be found at:

www.maxbats.com
www.woodworking.com

ACTIVITY 3: Machining & Welding in Minnesota - Applying the Manufacturing Cycle

NOTES FOR CHAPTER 1, ACTIVITY 3

The purpose of the activity is to demonstrate to students the types of equipment that are used in manufacturing in Minnesota.
Students can also play a welding game at: Trades Gamer **(tradesgamer.com)**.
This website provides students a way to learn about welding through the TIG welder game.

ACTIVITY 4: Applying the Manufacturing Cycle

NOTES FOR CHAPTER 1, ACTIVITY 4

Students should work in groups. Students should be given the supplies for the project but not the instructions on how to make the project. Student focus is on Design & Development.
Project instructions can be found at: **pbskids.org/designsquad/build/rubber-band-car/**.

DIRECTIONS:

1. **Make the body.**
   Hold the cardboard so the corrugations (tubes) run side to side, not up and down.
   Cutting across the corrugations, cut out a 2 inch wide and 1 ½ inch deep rectangle, making a notch in the center of one side.
   Throw away the piece you cut out.

2. **Make the axle.**
   Slide the skewer straight through one of the corrugations so it crosses the middle of the notch.
   Make sure the axle sticks out the same amount on each side of the body.

3. **Make the wheels.**
   Plug up the holes in the CD's with the pieces of Styrofoam. Make sure they stick out on each side of each CD by about half an inch. These are your wheels.
   Slide each wheel onto the axle, poking the end of the skewer into each piece of Styrofoam. Push the skewer straight through the hole of the CD and out the other side.
   Slide the wheel so that the Styrofoam doesn't rub on the cardboard.

4. **Create a "catch".**
   Find where the skewer goes across the notch.
   In the middle of this section, wrap a small piece of tape to make a "catch" for the rubber band.

5. **Attach the power source.**
   Tape your rubber band to the end of the cardboard opposite the catch.

6. **Power your car.**
   Wrap the unattached end of the rubber band over the catch.
   Spin the axle a few times to wind up your car.
   Set your car on the floor.

7. **Release it.**

ACTIVITY 4: Optional Activity

NOTES FOR CHAPTER 1, ACTIVITY 4 (OPTIONAL)

Students should work in groups.

Students should be given the supplies for the project but not the instructions on how to make the project.

Student focus is on Design & Development.

Project instructions can be found at: **pbskids.org/designsquad/build/2-wheel-balloon-car**.

DIRECTIONS:

1. **Make the jet.**
   Put the long end of a flexible straw into a balloon.
   Attach the straw and balloon so that no air can escape, using either a rubber band or tape.

2. **Attach the jet.**
   Tape the jet to the top of the tongue depressor or craft stick (i.e., the body).
   Make sure the jet is parallel to the floor or tabletop as much as possible.
   If it points up, down, or to the side, your car won't move as fast or far as if the jet points straight back.

3. **Make the axle and wheels.**
   Slip two candy mints onto the straw.
   Bend back the tips of the straw so the candy can't fall off. Tape the tips in place.

4. **Attach the body.**
   Tape the axle to the bottom of the body, at the front. The end with the wheels is the front.
   Make sure the wheels spin freely.
   Make sure the wheels line up with the direction you want the car to move.

5. **Power the jet.**
   Blow up the balloon. Put your finger over the end of the straw to stop air from escaping.
   Make sure the balloon doesn't flop over onto the floor or tabletop. If it does, it will act like an anchor and will stop the car from moving.
   Put the car on a smooth surface and let it go!

ACTIVITY 5: True/False

1. **True**
   Minnesota manufacturing creates 1.9 jobs in supporting industries, has over 3,300 job openings every year, and 13% of Minnesota jobs are in manufacturing, approximately 292,000 careers.
2. **False**
   It is Minnesota's third largest industry.
3. **True**
4. **True**
5. **True**
6. **False**
   Today's manufacturing jobs require skills like programming, design, and electronics to operate and be competitive. While there may be some parts that are repetitive, it is not a job that requires you to punch the same button over and over again.
7. **True**
8. **True**
9. **False**
   Minnesota has over 9,000 manufacturing companies.
10. **False**
    Manufacturing supports an estimated 17.2 million jobs in the U.S., with nearly 12 million Americans being employed directly in manufacturing.
11. **True**
12. **False**
13. **False**
    The average annual salary is around $56,000, although it can vary in different regions.
14. **True**

More facts can be found at MPMA:
www.mpma.com

ACTIVITY 6: Discover MN Manufacturing

NOTES FOR CHAPTER 1, ACTIVITY 6

- Large Minnesota map will be needed in the classroom for visualization of manufacturing in Minnesota
- Students can work in groups or individually.
- Companies can be divided amongst the students.
- Students could also check to see if there are any job openings at the company and list that information.

ACTIVITY 6: Discover MN Manufacturing
(Page 1 of 3)

There are over 9,000 manufacturers in Minnesota. The following are 44 of them.

1. **Aagard Group**
   www.aagard.com
   Alexandria
   Designs, engineers and manufactures automated packaging machinery

2. **Aitkin Iron Works, Inc.**
   www.aiw.com
   Aitkin
   Machining and metal fabrication

3. **Altec HiLine, LLC**
   www.altec.com
   Duluth
   Manufacture aerial lift trucks

4. **Andrew Tool & Machining**
   www.andrewtool.com
   Plymouth
   Land Rover sent to Mars

5. **Arrowhead Product Development, Inc.**
   www.arprodev.com
   Hermantown
   Engineering & consulting, 3D solid modeling, FEA services, drafting and BOM development, machine, fixture

6. **ATEK Access Technologies**
   www.atekcompanies.com
   Brainerd
   Manufactures electro-mechanical devices

7. **Badger Foundry Company**
   www.badgerfoundry.com
   Winona
   Gray iron and ductile castings

8. **Buhler, Inc.**
   www.buhlergroup.com
   Minneapolis
   Machines that process chocolate

9. **CAST Corporation**
   www.castcorporation.com
   Hibbing
   CAD/CAM services

10. **Cedar Lake Engineering**
    www.cedarlakeeng.com
    Maple Lake
    Metal stamping, laser cutting, metal manufacturing

11. **Chappell Central, Inc.**
    www.chappellcentral.com
    Willmar
    Sheet metal job shop, laser cutting, forming, welding

12. **Crystal Cabinet Works**
    www.crystalcabinets.com
    Princeton
    Manufacture medium to high end kitchen and commercial cabinetry

13. **Custom Products of Litchfield, Inc.**
    www.cpcabs.com
    Litchfield
    Design, test and manufacture cab enclosures and roll over protective structures for off-highway vehicles and equipment

14. **Dee, Inc.**
    www.deeinc.com
    Crookston
    Aluminum foundry and machine shop

ACTIVITY 6: Discover MN Manufacturing
(Page 2 of 3)

15. **Doodle Town Toys**
    www.doodletowntoys.com
    Big Lake
    Classic wooden toys

16. **DS Manufacturing, Inc.**
    www.dsmfgmn.com
    Pine Island
    Metal fabrication, welding, tube bending, polishing, plating, and packaging

17. **DyCast Specialties Corporation**
    www.dycastspec.com
    Starbuck
    Manufacture precision zinc and aluminum die casting

18. **Erickson Metals of MN, Inc.**
    www.ericksonmetals.com
    Coon Rapids
    Aluminum service center: slitting, leveling & cut to length, precision plate sawing & shearing

19. **Extreme Panel Technologies, Inc.**
    www.extremepanel.com
    Cottonwood
    Manufacture structural insulated panels

20. **Falcon Industries, Inc.**
    www.falconindustries.com
    Cosmos
    Manufacturer of augers and auger flighting

21. **Homark Company, Inc.**
    www.homark.com
    Red Lake Falls
    Custom built manufactured and modular homes

22. **Industrial Finishing Services**
    www.industrial-finishing.com
    Perham
    Powder, liquid, e-coat and commercially applied rhino coatings

23. **Industrial Molded Rubber Products**
    www.imr-inc.com
    Big Lake
    Manufactures rubber components and rubber covered rollers

24. **Innova Industries, Inc.**
    www.innovaind.com
    Fergus Falls
    Flat laser cutting, MIG & TIG welding

25. **Massman Automation Design, LLC**
    www.massmanllc.com
    Villard
    Automated packaging (case packaging, palletizing, robotics, cartoning)

26. **Metro Mold and Design**
    www.metromold.com
    Little Falls
    Rapid mold, custom plastic injection molding, thermoset molding (surgical instruments and medical devices)

27. **New Flyer of America**
    www.newflyer.com
    St. Cloud
    Builder of metro transit busses

28. **Northland Machine, Inc.**
    www.northlandmachine.com
    Grand Rapids
    Machined parts and production tooling

ACTIVITY 6: Discover MN Manufacturing
(Page 3 of 3)

29. **Plastics International**
    www.plasticsintl.com
    Eden Prairie
    Bioscience technology

30. **PPG Industries**
    www.ppg.com
    Savage
    Industrial coatings manufacturing

31. **RIE Coatings**
    www.riecoatings.com
    Eden Valley
    Coatings for production & performance on a variety of surfaces

32. **RITALKA, Inc.**
    www.ritalka.com
    Montevideo
    Engineering & manufacturing services and electronic service provider

33. **Windings, Inc.**
    www.windings.com
    New Ulm
    Custom motor stators, rotors, lamination stacks, and other custom wound products

34. **Woodcraft Industries, Inc.**
    www.woodcraftind.com
    St. Cloud
    Wood Components, doors, and moldings (kitchen and bath)

ACTIVITY 7: Digging Deeper - Develop a Jingle or Slogan

NOTES FOR CHAPTER 2, ACTIVITY 7

The purpose of this activity is to demonstrate to students that there are professional organizations in manufacturing and that marketing plays a role in many aspects of manufacturing.

ACTIVITY 8: Career Investigation

1. **Douglas Machine builds machines that put prepackaged goods into another case to be sold. They design machines and fabricate their own parts.**

2. **Careers discussed in the video:**
   - CNC Programmer: Develop and run programs which direct the CNC machines to cut and shape metal or plastic for such things as airplanes, automobiles and other industrial machines.
   - President and COO: President oversees all aspects of the company including day to day operations. COO stands for 'Chief Operations Officer.'
   - Sales Support: These team members cultivate new sales leads for the sales team, monitor customer accounts, help keep the sales team in the field so they can sell the products.
   - Field Support: These team members respond to customer issues and ensure quality follow up to customers.
   - Paperboard Mechanical Engineer: Mechanical Engineers that specialize in paperboard products.
   - Administrative Assistant: Usually one of the first people that you see when you enter a company. Daily tasks include correspondence, scheduling, word processing, creating presentations for others, etc.
   - CEO: Chief Executive Officer, inspires employees to do a good job, works with COO, investor relations.
   - Engineering Technician: This person is trained with skills to assist the engineer. Engineering technicians solve technical problems. They work on research and development projects.

ACTIVITY 9: Career Investigation

1. **The Dynamic Group designs injection molds and metal injection molds for the medical industry.**

2. **Careers discussed in the video:**
   - Tooling Manager: They are in charge of the tool room, ordering tools, provides tools in good working order.
   - Co-owner: Is someone that owns a company with another person.
   - Molding Manager: This person has worked in injection molding and now manages/leads the molding portion of the company.
   - IT Manager: Manages staff, data networks, computer hardware/software.

ACTIVITY 10: Careers & Education

1. B
2. E
3. A
4. D
5. C
6. A
7. B, D
8. A, D
9. C
10. A
11. B,D
12. A
13. A
14. A
15. A
16. E
17. A
18. B
19. C
20. D

21 - 27 (In any order)

- Industrial Engineering
- Mechanical Engineering
- Chemical Engineering
- Electrical Engineering
- Applied Engineering
- Manufacturing Engineering
- Additional: Biomedical

ACTIVITY 11: Career & Education

1. There are 12 career areas listed on the Marvin Windows website as of January 2022.

2-6. Student answer.

ACTIVITY 12: Professions

1. Lead safety teams within the company. Teach safety initiatives/training. Reviews worker injury cases. Keeps a database of injuries.

2. A person who keeps track of logistics, materials, ordering, shipments, planning.

3. GMAW - Also called MIG welding. Gas Metal Arc Welding.
SMAW - Called stick or arc welding. Shielded Metal Arc Welding.
TIG - Tungsten Inert Gas. Expert operators are used.
Oxy Acetylene - Used for maintenance work and gas metal cutting.

4. Student answer.

ACTIVITY 13: Manufacturing Wrap Up

NOTES FOR CHAPTER 3, ACTIVITY 13

Students can answer the question on paper, interview, and/or video each other.

THINGS TO THINK ABOUT:

Was there a Minnesota manufacturing company that intrigued you?

Was the company a manufacturer of:

- Aerospace equipment
- Agricultural equipment
- Medical/Dental equipment and supplies
- Petroleum/Natural gas machinery
- Renewable energy equipment/parts
- Sports equipment
- Other

Why is the product(s) they make so cool?

"Do you consider manufacturing important to the US economy? Why?"

IF STUDENTS ARE STUCK:

- **Go to www.mnmfg.org**

  YouTube Video: Manufacturing: Your Future? www.youtube.com/watch?v=wk4SjFWD6tg

  - 17 million jobs in manufacturing

  - In 2012, manufacturers contributed $2.03 trillion to the U.S. economy

Additional Resources

Minnesota Manufactured

www.mnmfg.org

Information about manufacturing careers, including information for students and educators.

Minnesota Manufactured - YouTube

www.mnmfg.org/videos

Videos on YouTube (Click on playlists.)

MN Curriculum Frameworks

education.mn.gov/MDE/index.html

PBS Kids - Rubber Band Car

www.pbskids.org/designsquad/build/rubber-band-car

Minnesota STEM Teacher Center

www.scimathmn.org/stemtc

FIRST Robotics

www.usfirst.org

Exciting mentorship programs in science and technology.

How Stuff Works

science.howstuffworks.com/how-its-made-videos-playlist.htm

A video playlist that shows how things are made, from guitars to pinball machines.

ISEEK

www.iseek.org/industry/manufacturing/

Provides information about various careers, including an area about manufacturing.

Try Engineering

www.tryengineering.org/play-games

A website designed to engage students to learn about what engineering is by the use of games.

Trades Gamer

www.tradesgamer.com

This website provides students a way to learn about welding through the TIG welder game.

The Manufacturing Institute

www.themanufacturinginstitute.org

Affiliated with the National Association of Manufacturers, the Manufacturing Institute provides information about manufacturing in United States and the national Dream It. Do It. program.

O*NET

www.onetonline.org

Provides information about careers, including manufacturing.

Project Lead the Way

www.pltw.org and www.mnpltw.org

This national program offers pre-engineering middle school and high school curriculum.

VEX Robotics

www.vexrobotics.com

Designed for students ages 12 and up, the VEX Robotics Competition (VRC) is a small team robotics program that requires teams to build a robot using a VEX Robotics Design System kit.

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- Dynamic Group, Coon Rapids, Minnesota
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- Jones Metal, Mankato, Minnesota
- Lakeland Mold, Brainerd, Minnesota
- Marvin Windows and Doors, Warroad, Minnesota
- MaxBat, Brooten, Minnesota
- MRG Tool & Die, Faribault, Minnesota
- Pequot Tool & Manufacturing, Jenkins, Minnesota
- WSI Industries, Monticello, Minnesota

MINNESOTA MANUFACTURED SPONSORS

NOTES

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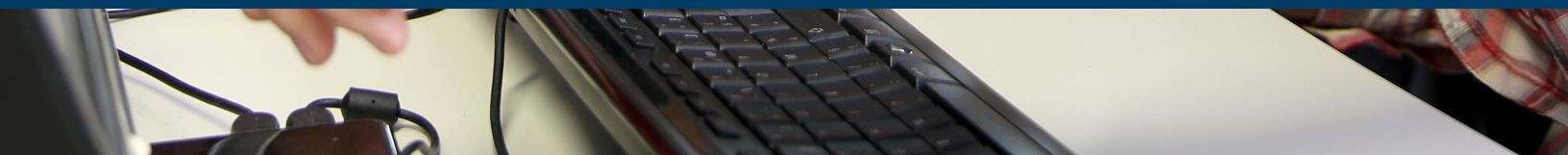
TO VIEW ALL CORRESPONDING VIDEOS AND PRESENTATIONS REFERENCED IN THIS GUIDE PLEASE VISIT:

mnmfg.org/educators/teacher-guide/



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