



MANUFACTURING

Scenario #1: What went wrong?

By now, we're all familiar with the ills plaguing the supply chain since the beginning of the pandemic: factory shutdowns, geopolitical instability, and shipping bottlenecks have created shortages of critical components and materials across sectors.

Note: If this scenario isn't a good fit for your manufacturing program, we offer three additional scenarios which ask students to consider trends in manufacturing, based on product or process. See end of document.

Resource:

Forbes: The Supply Chain Solution Is Tapping into Manufacturing Talent at Home:
<https://www.forbes.com/sites/daveevans/2021/10/01/the-supply-chain-solution-is-tapping-into-manufacturing-talent-at-home/?sh=f0a9ece2f189>

With these lesson ideas, teachers have the kernel information to complete short activities. Given that teachers will need to use state-approved course outlines, we encourage teaching in context of your program. However, if teachers wanted to expand this into formal project-based learning, allow the scenario to help you get started. We strongly encourage teacher feedback on these activities, if implemented, as well as success stories and examples of your completed work. Reviews may be sent to Darren Morris, Instructional Designer, CTECS, dmorris@ctecs.org.

Activity #1

a. Identify a company that is changing or considering change and attempting to bring manufacturing back the U.S. Describe the strategies that you think will be the most successful to that company.

b. Propose a product to manufacture in the U.S. and/or a manufacturing process that might improve profit margins by producing it in the U.S.. Consider the following:

- How can U.S. manufacturing compete and beat China at the manufacturing game? What does this mean and why is it the U.S.'s best interest?
- What are other benefits of manufacturing in the U.S.?
- What is the downside of bringing manufacturing home? Think about costs.
- On which key products or sectors should U.S. manufacturers focus in order to gain a competitive advantage?
- What are the main differences between U.S. and Chinese manufacturing solutions?

- What are the advantages of manufacturing in China? What are the disadvantages?
- How can those in the manufacturing industry use the first five Workplace Readiness Skills to successfully impact their operations and career readiness? See the following:

1. Creativity and Innovation—We define creativity and innovation as:

- Discussing the importance of creativity and innovation in the workplace
 - Brainstorming and contributing ideas, strategies, and solutions
 - Developing and/or improving products, services, or processes
 - Identifying and allocating available resources.
- What are the best ideas for successfully bringing U.S. manufacturing back home?
 - How did you come up with your idea of product and process? What was your creative process?
 - Is this a new idea (as far as you know) or does it come from something put into practice?
 - How are you innovating from an original idea that already exists?
 - What are your resources for communicating (pitching) your idea?
 - What is improved: a product or a process or both?
 - What resources are needed to help bring your idea to life: time, people, technology, funding?
 - What is the personal career benefit to you from working through these questions? How does answering these questions affect your career choice?

2. Critical Thinking and Problem Solving—We define critical thinking and problem solving as:

- Recognizing and analyzing problems
 - Evaluating potential solutions and resources
 - Using a logical approach to make decisions and solve problems
 - Implementing effective courses of action.
- What problem are you trying to solve? Define it clearly.
 - How can a manufacturer maintain participation in global markets without manufacturing outside of the U.S.?
 - What regulations do U.S. manufacturers face that manufacturers in China do not? Tariffs? Worker/human rights?
 - What are the environmental and economic impacts of moving manufacturing back to the U.S.? How might it affect shipping costs? Jobs?
 - How did you choose a company on which to focus for part A? What was your process for choosing a product or process in part B?
 - Is your solution in part B feasible? How much time would it take your company in part A to move its manufacturing back to the U.S.?

- What are the potential weaknesses or risks in your part B solution? Think about sourcing resources and competition.
- Which aspects of your program of study (current CTE course) were helpful in understanding the current and future direction of the manufacturing industry?
- Aside from cost-reduction benefits, what are positive factors of keeping manufacturing in other countries?

3. Initiative and Self-Direction—We define initiative and self-direction as:

- recognizing the importance of proactive, independent, decision-making
 - identifying workplace needs
 - completing tasks with minimal direct supervision
 - applying solutions.
- How does your investigation into current and future trends in the manufacturing industry impact your career decisions?
 - How can you advocate for returning manufacturing to the U.S.?
 - What education or certifications would help your chances of beginning a career in manufacturing whether at home or abroad?
 - What is your motivation to succeed in a manufacturing career, even in a shifting landscape (autonomy, mastery, purpose)?

4. Integrity—We define integrity as:

- recognizing the importance of having integrity in the workplace
 - complying with local, state, and federal laws
 - adhering to workplace policies and procedures
 - exhibiting honesty, fairness, and respect toward self, others, and property.
- Product and product integrity, or quality assurance, is crucial in manufacturing. How might this be impacted by manufacturing outside of the U.S.?
 - Why is honesty important when assessing costs and budgets for moving manufacturing back to the U.S.?
 - What are the ethical issues involved with moving manufacturing operations outside of the U.S.? Are there ethical issues involved in the research you conducted in part A?
 - What are the ethical issues involved with moving manufacturing operations back to the U.S.? Are there ethical issues involved in the product or process you proposed in part B?

5. Work Ethic—We define work ethic as:

- demonstrating diligence (e.g., working with persistence to accomplish a task)

- maintaining dependability (e.g., being reliable)
 - accounting for one's decisions and actions
 - accepting the consequences of decisions and actions.
 - How are U.S. manufacturers incentivizing work ethic?
 - Is work ethic a problem in China? Why or why not?
 - How will moving manufacturing back to the U.S. positively affect work ethic?
 - If you are working on this activity in teams, how will you assess the team's progress and handle performance problems or conflict/disagreement?
 - If you are working on this activity in teams, how do you judge your own contribution? Were you dependable? Accountable? Did you meet your obligation on time? Were you thorough?
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For short activities we offer the following suggestions:

- Identify the competency or unit in your program that would be most appropriate for teaching this activity synchronously. Students learn best in context.
- Divide the class into competitive teams (at least two).
- Have the teams brainstorm ideas and establish rules for brainstorming: all ideas are accepted.
- Have teams arrive at consensus and choose their best idea to propose.
- Teams should establish norms, roles, and expectations for team members.
- Teams will clearly define their mission and the idea of their proposals.
- The teacher should act as the judge of the quality and feasibility of the ideas.
- Teachers should also provide enough background to get students started and monitor student behavior along the way, providing helpful feedback when necessary.
- Students should share work and reflect on how well the team worked together.

For teachers who wish to expand the activity into a larger project, the following PBL Design Principles and Teaching Practices are provided

PBL Project Design Principles

- 1. A Challenging Problem or Question:** The project is framed by a meaningful problem to be solved or a question to answer, at the appropriate level of challenge
- 2. Sustained Inquiry:** Students engage in a rigorous, extended process of posing questions, finding resources, and applying information.
- 3. Authenticity:** The project involves real-world context, tasks and tools, quality standards, or impact, or the project speaks to personal concerns, interests, and issues in the students' lives.

4. **Student Voice & Choice:** Students make some decisions about the project, including how they work and what they create, and express their own ideas in their own voice.
5. **Reflection:** Students and teachers reflect on the learning, the effectiveness of their inquiry and project activities, the quality of student work, and obstacles that arise and strategies for overcoming them.
6. **Critique & Revision:** Students give, receive, and apply feedback to improve their process and products.
7. **Public Product:** Students make their project work public by sharing it with and explaining or presenting it to people beyond the classroom.

PBL Teaching Practices

1. **Design & Plan:** Teachers create or adapt a project for their context and students, and plan its implementation from launch to culmination while allowing for some degree of student voice and choice.
2. **Align to Standards:** Teachers use standards to plan the project and make sure it addresses key knowledge and understanding from subject areas to be included.
3. **Build the Culture:** Teachers explicitly and implicitly promote student independence and growth, open-ended inquiry, team spirit, and attention to quality.
4. **Manage Activities:** Teachers work with students to organize tasks and schedules, set checkpoints and deadlines, find and use resources, create products and make them public.
5. **Scaffold Student Learning:** Teachers employ a variety of lessons, tools, and instructional strategies to support all students in reaching project goals.
6. **Assess Student Learning:** Teachers use formative and summative assessments of knowledge, understanding, and success skills, and include self and peer assessment of team and individual work.
7. **Engage & Coach:** Teachers engage in learning and creating alongside students, and identify when they need skill-building, redirection, encouragement, and celebration.

Additional scenarios follow. You may need to adjust the Workplace Readiness Skills questions found under the first scenario in order to help students examine the question, complete the activity, and put it into the context of the Workplace Readiness Skills areas, 1-5.

Scenario #2: Digital Printing Decisions

Your company is considering a move from traditional manufacturing to digital printing. What are the factors that will need to be scrutinized to make that decision?

- **Parts that are expensive to manufacture.** Parts with complex geometries, for example, might be less expensive in additive manufacturing. Think about parts that are bespoke, or based on stochastic or variable demand. If there are parts produced in small, odd batches, each order can have a high cost per unit. Additive manufacturing can stabilize costs to keep the price per unit low. Perhaps the solution is finding the right balance between modes.
- **Long lead time.** If long lead times are killing your ability to meet demand in real time, a solid additive manufacturing process might help.
- **High inventory costs.** If you can't afford to store parts, print them as you need them.
- **Parts sole-sourced from suppliers.** If you use a specialty machinist that goes out of business or is acquired by your competitor will your business be seriously hurt? Additive manufacturing can work like an insurance policy, managing your risk.
- **Remote locations.** Need parts on an oil rig or on a battlefield? Make parts where and when they are needed.
- **High import/High export costs.** Costs added by import and export fees can be eliminated by 3D printing.
- **Improved functionality.** Can't get what you need? Design and make it yourself.

How might the type of manufacturing process change the type of worker that companies recruit? Base your answers on the behavioral qualities in the first five Workplace Readiness Skills:

1. Creativity and Innovation
2. Critical Thinking and Problem Solving
3. Initiative and Self-Direction
4. Integrity
5. Work Ethic

Resource: <https://www.designnews.com/design-hardware-software/7-scenarios-where-additive-manufacturing-works>

Scenario #3: Create Your Own Scenario

Choose a manufactured product that was affected by supply chain shortages and follow that product from the manufacturer (and all the sources/suppliers it uses to create and finish the product) to the consumer. Next, pinpoint the main issues or disruptions that either slowed or halted production or delivery of the product to market. Next, provide the reasons these disruptions occurred. Finally, provide some solutions to the supply chain management issues.

- Describe the nature of your business.
- Present a problem-based scenario that you might encounter.
- Describe solutions used by ownership or management.
- Now as a worker, describe actions, using the first five Workplace Readiness Skills, that might positively impact your organization's solutions:
 1. Creativity and Innovation
 2. Critical Thinking and Problem Solving
 3. Initiative and Self-Direction
 4. Integrity
 5. Work Ethic

Scenario #4: Rise of the Machines

The "Terminator" movies, and however you feel about them as entertainment, are essentially based on a plot that starts with creating machines to perform human jobs. Part of the reason the plot is successful is that we fear that we are completely replaceable by that which we design. The artificial overcomes the real and asserts a new reality, one in which human emotion, intelligence and creativity are no longer required. Lives and careers are already being drastically altered by the rise of automation in manufacturing and elsewhere.

Teachers may divide the class and assign at least one of these questions to each team. As teams share their discoveries and opinions, allow the other teams to amend their information. Ultimately, create one report or presentation that incorporates all of the following ideas.

Let's research and debate.

1. What are the benefits and drawbacks from the increasing use of automation in manufacturing processes?
2. What factors should a company identify before making a move to automation?
3. How does retooling for automation impact communities where businesses are based? Provide examples where this has happened.
4. From the individual worker point of view, whose tasks might be replaced by automation, what are the appropriate courses of action to protect one's job? What are the alternatives for workers?
5. How does automation affect the individual worker? Specifically address the first five skill areas in Workplace Readiness Skills:
 1. Creativity and Innovation
 2. Critical Thinking and Problem Solving
 3. Initiative and Self-Direction
 4. Integrity
 5. Work Ethic