Unit 4 – Lesson 2

What's New in Manufacturing?

Lesson Duration: Five (5) hours.

Standards

- Students will develop an understanding of and be able to select and use manufacturing technologies. (ITEA-*STL* 19)
- Students will develop an understanding of the designed world. (Materials and Manufacturing) (AAAS-*BSL*)
- Students will develop an understanding of mathematics processes. (Communications) (NCTM)

Benchmarks

ITEA – Benchmarks for Technological Literacy	AAAS – Benchmarks for Science	NCTM – Benchmarks for Mathematics
• Manufacturing systems may be classified into types, such as customized production, batch production, and continuous production. (19-O)	• Manufacturing processes have been changed by improved tools and techniques based on more thorough scientific understanding, increases in the forces that can be applied and the temperatures that can be reached, and the availability of electronic controls that make operations occur more rapidly and consistently.	• Use the language of mathematics to express ideas precisely.

Learning Objectives

Students will:

1. Explain how communication and information systems impact manufacturing processes.
2. Prepare an annotated diagram of an integrated communication system serving a human enterprise.
3. Describe how mechanical, electrical, and informational subsystems are combined to produce integrated automated process technologies.
4. Identify and describe the common attributes of integrated automated process technologies.
5. Identify and describe the role computers play in integrated automated process technologies.
6. Explain the functions of centralized databases in integrated automated process technologies.
7. Describe the benefits reported from companies using integrated automated process technologies.
8. Create a concept map that analyzes integrated automated process technologies.

Student Assessment Tools and/or Methods

(See assessment instruments at end of lesson.)

1. Selected Response Items
2. Brief Constructed Response Items
3. Extended Response Items
4. Performance Rubrics

Resource Materials

Print-Based Sources

1. Hannam, Roger. (1997). *Computer Integrated Manufacturing: From Concepts to Realisation* (1st ed.). Prentice Hall. ISBN: 0201175460.
2. Lin, Grier C. I. & Nagalingam, Sev V. (2000). *CIM Justification and Optimization.* CRC Press. ISBN: 0748408584.
3. Biekert, Russell, Berling, David, Evans, Richard J., Kelley, Donald G., Palmgren, Dale E., Pelphrey, Michael W., Richardson, Joe, Thorson, David L. & Twelves, W. Van, Jr. (1998). *CIM Technology: Fundamentals and Applications.* Goodheart-Wilcox Company. ISBN: 156637426X.

Internet Sites

1. Bergen County, (NJ) Technical Schools & Special Services. M*anufacturing Systems.* www.bergen.org/technology/manuf.html
2. Defense Acquisition University, Acquisition Knowledge Sharing System (AKSS). *What is the relationship between Lean Manufacturing and CIM?* – http://akss.dau.mil/askaprof-akss/normal/qdetail2.asp?cgiSubjectAreaID=6&cgiQuestionID=10036
3. ECI. *Computer Integration for Streamlining Your Manufacturing Processes.* www.ecicomplete.com/lean_manufacturing.html

Purpose of Lesson

To familiarize students with the functioning of integrated automated process technologies and their impact on quality control and productivity.

Required Knowledge and/or Skills

Students should have some understanding that manufacturing is a production system that uses technological resources to transform ideas into products that meet human needs and desires. They should have some basic graphic and research skills. In the engagement and exploratory phases of instruction, the teacher will identify student misunderstandings and/or misconceptions about the influence of technology on history.

Lesson 4-2

Engagement

1. The teacher will assess prior knowledge and possible misconceptions related to the functioning of integrated automated-process technologies.
2. The teacher will ask students to imagine a school where the classrooms are located in four separate buildings, with clocks that are all individually set—there is no intercom or public address system, memos are inefficiently distributed, and there are only two phone lines for the whole complex.
3. The teacher will ask students to speculate how efficiently the school would operate.
4. The teacher will ask students to imagine a football team where the head coach could not talk to the offensive or defensive coordinators, the quarterback could not receive signals from the sideline, and the scoreboard was not visible from the team's bench area.
5. The teacher will ask students to speculate on how this football team might perform.

Exploration

1. The teacher will state that good communication is critical to the success of any organization.
2. Students working in small groups will design an integrated communication system for either of the scenarios presented above.
3. The teacher will provide a brief review of techniques for producing an annotated diagram.

4. The teacher will encourage students to be as creative as possible in identifying and describing the elements of their system.
5. Students will prepare an annotated diagram of their system and be prepared to present their ideas to classmates and other audiences.

Explanation

1. The teacher will review elements of the students' systems from the exploratory activity, with particular emphasis on those elements that are found in contemporary manufacturing systems.
2. The teacher will state that managers of manufacturing enterprises have adopted a striking array of integrated automated-process technologies.
3. Computer-Integrated-Manufacturing (CIM) – The teacher will explain that:
   a. The umbrella acronym (pronounced "sim") covers a variety of automated manufacturing technologies.
   b. CIM integrates functions that traditionally have been separate, seeking "to streamline with quality control and just-in-time manufacturing, and to give every machine and employee the ability to talk with each other and 'watch' a product as it moves through the entire corporate pipeline."
   c. CIM systems rely on the integration of mechanical, electrical, and informational subsystems.
   d. CIM does not refer to one specific technology, but to the integrated use of computers in all sections of the enterprise.
   e. The benefits reported from CIM users include: lower energy bills, less scrap and rework problems, better quality control, higher competitive standing, faster product introduction; and increased flexibility in design, product mix, production volumes, and process routings.
4. Just-In-Time (JIT) – The teacher will explain that Just-In-Time:
   a. Is a manufacturing philosophy that attempts to eliminate waste throughout the system, including inventory at both ends of production and all machinery and manpower not adding directly to the value of the product.
   b. Focuses on achieving integrated, highly consistent, short-cycle operations requiring minimal work in process inventory.
   c. Requires the steady purchase of parts in small lot sizes as opposed to conventional purchasing practices in which raw materials are ordered from suppliers in anticipation of future production.
5. Concurrent Engineering (CE) – The teacher will explain that:
   a. Concurrent Engineering is a way of integrating many aspects of product design, development, and manufacture so that critical phases of product design proceed concurrently within the boundaries of the manufacturing system infrastructure.
   b. The key element in CE is increased communication between the different stages of the design process.
   c. The goal is to reduce the product cost by designing a product that can be manufactured from the beginning without any problems.
6. Lean Manufacturing – The teacher will explain that Lean Manufacturing:
   a. Means "manufacturing without waste."
   b. Improves material handling, inventory, quality, scheduling, personnel, and customer satisfaction.
   c. Encourages workers to stop production if they find a defect and work together to solve any problems.
   d. Was developed in Japan by Toyota.
7. Rapid Prototyping (RP) – The teacher will explain that Rapid Prototyping:

   a. Makes use of prototypes early in the development stage to identify errors in design and make necessary modifications.
   b. Allows designers to produce a prototype within minutes of completing a computer-aided-design (CAD) drawing of a part.
   c. Avoids the lengthy process of traditional design using conventional tooling and casting processes.
   d. Uses data from a three-dimensional CAD file to construct a model.
   e. Systems have increased in recent years and include stereolithography, laser modeling systems, solid ground curing, and laminated object manufacturing.
8. Cellular Manufacturing – The teacher will explain that Cellular Manufacturing:
   a. Is a method of equipment layout in which the machines are grouped into cells rather than being placed on an assembly line or divided into different functions.
   b. Uses Group Technology (GT) to maximize production efficiency, grouping together similar and recurring tasks, procedures, problems, and bottlenecks.
   c. Has attracted a great deal of interest from manufacturing firms because of its proven capacity to simplify material flow on the production floor.
   d. Uses a formal coding system in which each part receives a numeric or alphanumeric code describing specific characteristics or attributes.
9. Total Quality Management (TQM) – The teacher will explain that:
   a. The management of productivity and quality has emerged as a major business strategy in numerous organizations.
   b. Three forces driving this trend are global competition, the need to improve the productivity of labor, and the increased awareness of quality by consumers.
   c. TQM is a regulatory process through which performance is first measured and then compared with pre-established standards.
   d. In TQM corrective action is taken, if necessary.
   e. The foundation of TQM is the internal, national, and international standards that organizations work toward.

Extension

1. Students working in groups will conduct research and identify common attributes of integrated automated process technologies.
2. Student groups will develop concept maps that illustrate the common attributes of integrated automated process technologies.
3. The student groups will present their concept maps to the class and other audiences.

Evaluation

Students' knowledge, skills, and attitudes will be assessed using rubrics for class participation, group work, brief constructed responses, and extended constructed responses summarizing the lesson. The rubrics will be presented in advance of the activities to familiarize students with the expectations and performance criteria. They will also be reviewed during the activities to guide students in the completion of assignments. The teacher may wish to develop a collection of annotated exemplars of student work based on the rubrics. The exemplars will serve as benchmarks for future assessments and may be used to familiarize students with the criteria for assessment.

Other Extension Activities

1. Student groups may be asked to research and report on the implications of integrated automated process technologies on workers and their job environments.
2. Students may be assigned to research and report on advances in robotics and their application in manufacturing enterprises.

Laboratory-Classroom Preparation

The laboratory should provide a flexible, resource-rich learning environment that includes areas for lecture and demonstrations, small group meetings, design processes, and research activities. The teacher will adapt the learning environment based on the requirements of the unit or lesson. For this lesson, areas for lecture and demonstration, design, small group meetings, and research activities should be readied.

Laboratory-Classroom Safety and Conduct

1. Students will use tools and equipment in a safe manner and assume responsibility for their safety as well as for the safety of others.
2. Students will demonstrate courtesy in regard to the ideas expressed by classmates and will show appreciation for the efforts of others.

Lesson 4-2 Assessment Instruments

Assessment Instrument - Selected Response Item

Match the terms in Column II with the statements in Column I.

		Column I		Column II
1.		The umbrella acronym for a variety of automated manufacturing technologies	A	cellular manufacturing
2.		A way of integrating many aspects of product design, development, and manufacturing so that critical phases of product design proceed concurrently within the boundaries of the manufacturing system infrastructure	B	CIM
3.		A manufacturing philosophy that attempts to eliminate waste throughout the system, including inventory at both ends of production and all machinery and manpower not adding directly to the value of the product	C	concurrent engineering
4.		Workers are encouraged to stop production if they find a defect and work together to solve any problems. Was developed in Japan by Toyota	D	just-in-time
5.		Uses data from a three-dimensional CAD file to construct a model	E	lean manufacturing
6.		A method of equipment layout in which the machines are grouped into cells rather than being placed on an assembly line or divided into different functions	F	rapid prototyping
7.		A regulatory process through which performance is first measured and then compared with pre-established standards	G	statistical process control
			H	total quality management

Assessment Instrument - Selected Response Item

Directions: Circle the T or F in the column to the left of each true (T) or false (F) statement.

T F 1. Computer-integrated manufacturing systems rely on the integration of mechanical, electrical, and informational subsystems.

T F 2. Efficient decision making is facilitated by workers being able to enter data from any location.

T F 3. Computer-integrated manufacturing systems separate functions that traditionally have been integrated.

T F 4. By separating each aspect of the manufacturing process via computer links, costly time delays and lack of communication between sales representatives and production engineers can be minimized.

T F 5. Centralized databases used in CIM systems contain files on tools, equipment detailing maintenance, and depreciation timelines.

T F 6. In CIM systems, prototypes can be prepared and tested quickly.

T F 7. CIM allows customers to acquire current data from both design and manufacturing departments, promoting centralized control of the production process.

T F 8. In the future, CIM systems may enable computers to control machine tools.

T F 9. A goal of CIM systems is the reduction in the duplication of data concerning product specifications, tolerances, order quantities, inventory, and raw materials.

T F 10. In CIM systems, computers no longer are required to execute routine clerical tasks.

Assessment Instrument – Group Work

Category	Below Target	At Target	Above Target
Contributions	Seldom cooperative. Does little work. Rarely offers useful ideas.	Cooperative. Works at assignments. Usually offers useful ideas.	Always willing to help and do more. Does more than required. Routinely offers useful ideas.
Cooperation	Rarely listens to, shares with, or supports the efforts of others. Often is not a good team member.	Usually listens to, shares with, and supports the efforts of others. Does not cause problems in the group.	Always listens to, shares with, and supports the efforts of others. Tries to keep people working together.
Focus on the Task	Does not focus on the task and what needs to be done. Lets others do the work.	Focuses on the task and what needs to be done most of the time.	Almost always focused on the task and what needs to be done. Self-directed.

Assessment Instrument – Graphic Organizer, Concept Map

Category	Below Target	At Target	Above Target
Arrangement of Concepts	Main concept not clearly identified; subconcepts don't consistently branch from main idea.	Main concept easily identified; most subconcepts branch from main idea.	Main concept easily identified; subconcepts branch appropriately from main idea.
Links and Linking Lines	Linking lines not always pointing in correct direction; linking words don't clarify relationships between concepts; hyperlinks don't function or fail to enhance the topic.	Most linking lines connect properly; most linking words accurately describe the relationship between concepts; most hyperlinks effectively used.	Linking lines connect related terms/point in correct direction; linking words accurately describe relationship between concepts; hyperlinks effectively used.
Graphics	Graphics used inappropriately and excessively; graphics poorly selected and don't enhance the topic; some graphics are blurry and ill-placed.	Graphics used appropriately most of the time; most graphics selected enhance the topic, are of good quality, and are situated in logical places on the page.	Graphics used appropriately; greatly enhance the topic and aid in comprehension; are clear, crisp, and well situated on the page.
Content	Contains extraneous information; is not logically arranged; contains numerous spelling and grammatical errors.	Reflects most of the essential information; is generally logically arranged; concepts presented without too many excess words; fewer than three misspellings or grammatical errors.	Reflects essential information; is logically arranged; concepts succinctly presented; no misspellings or grammatical errors.
Text	Font too small to read easily; more than four different fonts used; text amount is excessive for intended audience.	Most text is easy to read; uses no more than four different fonts; amount of text generally fits intended audience.	Easy to read/appropriately sized; no more than three different fonts; amount of text is appropriate for intended audience; boldface used for emphasis.
Design	Cluttered design; low in visual appeal; requires a lot of scrolling to view entire diagram; choice of colors lacks visual appeal and impedes comprehension.	Design is fairly clean, with a few exceptions; diagram has visual appeal; four or fewer symbol shapes; fits page well; uses color effectively most of time.	Clean design; high visual appeal; four or fewer symbol shapes; fits page without a lot of scrolling; color used effectively for emphasis.
Knowledge Gained	Student demonstrates a lack of knowledge about the content and the processes used to create the poster.	Student can accurately answer most questions related to content and the processes used to create the poster.	Student can accurately answer all questions related to content and the processes used to create the poster.

Assessment Instrument – Brief Constructed Response Items

1. Explain how communication and information systems impact manufacturing processes.
2. Describe how mechanical, electrical, and informational subsystems are combined to produce computer-integrated manufacturing systems.
3. Explain the functions of centralized databases in computer-integrated manufacturing systems.

Category	Below Target	At Target	Above Target
Understanding	Response demonstrates an implied, partial, or superficial understanding of the text and/or the question.	Response demonstrates an understanding of the text.	Response demonstrates an understanding of the complexities of the text.
Focus	Lacks transitional information to show the relationship of the support to the question.	Addresses the demands of the question.	Exceeds the demands of the question.
Use of Related Information	Uses minimal information from the text to clarify or extend meaning.	Uses some expressed or implied information from the text to clarify or extend meaning.	Effectively uses expressed or implied information from the text to clarify or extend meaning.

Assessment Instrument – Extended Constructed Response Item

1. Describe the benefits reported from companies using computer-integrated manufacturing.

Category	Below Target	At Target	Above Target
Context and Argument	Context inappropriate. Argument unsatisfactory.	Context appropriate. Argument satisfactory.	Context appropriate. Argument satisfactory. Clearly stated thesis included.
Evidence	Evidence is largely missing or generalized.	Ample and appropriate evidence provided.	Abundant, relevant specifics (names, events, legislation, court decisions, etc.) provided. Includes obscure, but important evidence. Thorough chronology.
Analysis	Minimal analysis or fallacious reasoning.	Organizes argument and uses data to support conclusions. Recognizes causation, change, and continuity.	Well-reasoned cause-and-effect arguments. Fully explained conclusions. Refers to views of others.
Historical Accuracy	Many errors.	May have a few errors. Mistakes may slightly hinder argument, but do not detract from the overall accuracy.	Virtually error-free; minor mistakes do not compromise argument.
Thoroughness	Covers question superficially. May not complete all tasks.	Covers entire question, but may be slightly imbalanced.	Covers all areas of question in approximate proportions to their importance.
Presentation	Inconsistent organization. Grammatical errors cloud argument to a major degree.	Uses clear language. Well organized. Contains few grammatical errors.	Uses clear, appropriate, and precise language. Cohesive organization. Very few grammatical errors.