Computer Integrated Manufacturing

	Performance Objectives	Show-Me Content	Show-Me Goals	National Standards	Alignment
1.1	**Fundamentals**				
1.	Demonstrate the ability to store, retrieve copy, and output drawing files depending upon system setup.		1.4	17:9-12L	A
2.	Utilize instructor identified 2D computer sketching functions.			11:6-8J	B
3.	Incorporate various coordinate systems in the construction of 2D geometrical shapes.	MA2		11:6-8J	A
4.	Calculate the x and y coordinates given a radius and angle.	MA2		11:6-8J	A
1.2	**Object Construction**				
1.	Produce 2D sketches using available sketching features.		2.5	11:6-8J	B
2.	Apply editing techniques to produce accurate sketches.		2.5	11:6-8J	B
3.	Understand and apply sketch constraints.		1.7	11:6-8J	B
4.	Analyze drawings with appropriate inquiry functions.		2.5	11:9-12P	B
1.3	**Parts Modeling**				
1.	Define sketched objects with dimensions and geometric constraints.	MA2	2.5	11:6-8J	B
2.	Apply necessary sketched features to generate a solid model.		2.5	11:6-8J	B
3.	Demonstrate the application and modification of placed features.		2.1	11:6-8J	B
1.4	**Creation of Drawing Views**				
1.	Develop multi-view drawings such as top, front, right side, isometric, section, and auxiliary views from the solid model.	FA1	2.5	11:6-8J	C
2.	Demonstrate the proper application of annotations and reference dimensions while conforming to established drafting standards.		2.1	17:9-12Q	C
3.	Update model and drawing views using revision specification sheets provided by the instructor.		2.5	11:9-12O	C
1.5	**Assembly Modeling**				
1.	Create assembly models through the integration of individual parts and sub-assemblies.		2.5	11:6-8J	D
2.	Generate an assembly drawing, which include Views, Balloons, and Bill Of Materials (BOM).	CA4	2.5	11:6-8J	D

1.6	**Rapid Prototyping**				
1.	Describe the wide array of industry-wide prototyping methods in use.	CA1		9:9-12K, 11:9-12O	E
2.	Identify the need for rapid-prototyping.	CA1, SS4		9:9-12K, 11:9-12O	E
3.	Prepare a prototype model from a drawing database.		2.5	9:9-12K, 11:9-12O	E
2.1	**History of Programmable Machining**				
1.	Explain the history of computer controlled machines charting the growth of NC and how it has been implemented into private industry.	CA1, SC8		7:9-12G	F
2.	Explain how the application of CNC machines has impacted manufacturing.	CA1, SC8, SS4		7:9-12H, 7:9-12N	F
3.	Explain the advantages and disadvantages of CNC machining.	CA1		19:9-12O	G
4.	Chart the evolution of machine tools, controllers, and software used in programmable machines.	CA4, SS2	1.8	7:9-12O	F
5.	Explore career opportunities and educational requirements within the field of programmable machines.		4.8	19:6-8H	Q
2.2	**CNC Characteristics**				
1.	Identify the axis relative to various CNC machines.	MA2			G
2.	Contrast open and closed loop control systems.	CA1		2:6-8O	G
3.	Identify the types of drive systems used in CNC machines.	CA1			G
4.	Use a CNC control program to indicate the machine position and then contrast that position to the relative position of the part origin (PRZ).				J
5.	Identify and explain the function of the major components of a CNC machine tool.	CA1			G
6.	Examine and apply various work holding devices commonly used for CNC machining.				G
7.	Identify various types of tool changers used in CNC machine tools.	CA1			G
8.	Define the three primary axes used in CNC machining and explore the remaining axes used in advanced machining.	CA1			G
9.	Explain the importance of cutting tool materials and how they affect the speed and feed rates used by machine tools.	CA1, MA1	1.10	19:-9-12M	G
10.	Examine different types of tool holding devices used in CNC machine tools.				G
11.	Select appropriate cutting tools to efficiently, safely, and accurately cut parts using a CNC machine.		4.7	2:9-12AA, 4:6-8D	G, J
2.3	**CNC Programming**				

1.	Understand the difference between reference and position points.				H
2.	Understand that CNC machine movements are identified by axes.	MA2			H
3.	Understand that the axes system is a worldwide standard for machine movement.			17:9-12M	A
4.	Plot points using absolute, relative (incremental), and polar coordinates.	MA2, MA5			H
5.	Identify significant points on geometric shapes (e.g., center point and end point).	MA2		11:6-8J	H
6.	Identify the optimum location for the Program Reference Zero (PRZ) point.	MA2			H
7.	Identify the three categories of machine movement: straight line, curved line, and non-regular shape.				H
8.	Complete a preliminary planning sheet to identify necessary work holding devices, cutting tools, reference points, machining sequences, and safe operation.	CA4	1.8	11:9-12N	A
9.	Define the term “Alphanumeric Coding.”	CA1			A
10.	Define the term “G codes.”	CA1			A
11.	Define the term “M code.”	CA1			A
12.	Identify the three sections of a program: Initial Commands, Program Body, and Program End.				I
13.	Write a basic NC part program using necessary G and M codes including remarks that describe the function of each code.	CA4	1.10, 2.5	17:6-8K	I
14.	Describe the advantages and disadvantages of shop floor programming as well as off line programming.	CA1	3.8		A
15.	Create a simple NC part program using a text editor and a CAM package.	CA4, MA2	1.10, 2.5	11:6-8J	I
16.	Apply a CAD/CAM/CNC software solution to create a part.		1.10, 2.5	11:6-8J	I
17.	Identify, analyze and correct errors found in NC part program files.	MA2	3.1, 3.2, 3.3, 3.7	11:9-12O	I
18.	Use simulation software to graphically verify NC program operation.			11:9-12O	I
19.	Perform a “dry run” to verify the machine setup and program operation.		3.7	11:9-12O	J
2.4	**CNC Operations**				
1.	Demonstrate the ability to safely setup, maintain, and operate a CNC machine center using appropriate documentation and procedures.	CA3	1.10, 4.7	12:9-12O	J
2.	Analyze part geometry to select appropriate cutting tools and fixturing devices needed to create the part using a CNC machine.	MA2	3.1, 3.2, 3.3	11:9-12P	J
3.	Setup and edit the tool library of a CNC control program providing offset values and tool geometry.		1.10	11:6-8J	J

4.	Calculate and verify appropriate spindle speeds and feed rates specific to each cutting tool utilized in an NC part program.	MA1		11:6-8J	J
5.	Safely and accurately fixture a part in a CNC machine and set the Program Reference Zero (PRZ).		4.7	12:9-12O	J
6.	Verify NC part programs using simulation software before machining the part on a CNC device.		3.7	11:6-8J	J
7.	List and demonstrate all possible methods of disabling a CNC machine in the event of an emergency.	CA1	4.7	12:9-12O	J
8.	Follow a safety checklist prior to running an NC part program on a CNC machine.	CA3	4.7	12:9-12O	J
9.	Perform a "dry run" to verify the machine setup and program operation.		3.7	11:9-12O	J
10.	Operate a CNC machine to cut a part to specifications.		2.5	11:6-8J	J
2.5	**Precision Measurement**				
1.	Measure using standard and metric systems.	MA1		3:6-8F	A
2.	Convert measurements between metric and standard inch systems.	MA1		3:6-8F	A
3.	Read and understand technical drawings that identify the dimensional tolerances and limits.	CA3	1.10	17:9-12Q	A
4.	Make precision measurements to the degree of accuracy required by plan specification using appropriate instruments.	MA1	1.10	3:6-8F	A
5.	Describe how comparison instruments can be used to check dimensions, compare shapes, indicate centers, and check parallel surfaces.	CA1			A
6.	Describe advanced and automated measurement systems that are applied in industry (e.g., Coordinate Measuring Systems, Digital Probes, and Optical Scanners).	CA1		17:9-12Q	A
7.	Explain the importance of precision measurement in SPC and quality control.	CA1, SS4		2:9-12DD	A
2.6	**CAM Software**				
1.	Define the acronym CAM and explain the purpose of a CAM package.	CA1			A
2.	Demonstrate the ability to operate the user interface of a CAM package and access help using appropriate documentation and help screens.			12:9-12O	K
3.	Perform basic file operations using a CAM package such as save, open, print, and edit part program files.			12:9-12P	A
4.	Demonstrate the ability to import and export CAD files using a CAM package.			12:9-12O	A
5.	Setup a CAM package by editing the material and tool libraries, defining stock sizes, selecting the appropriate post processor, and defining the units of measure to be used.		1.10	12:9-12O	K

6.	Define and apply the fundamental and advanced milling and turning procedures used in CAM packages.	CA1	1.10	11:6-8J	K
7.	Use a CAM package to generate and edit tool paths by applying appropriate machining processes to geometry imported from a CAD program.		1.10	12:9-12O	K
3.1	**Introduction to Robotics**				
1.	Describe the chronological development of automation leading to robotics.	CA1, SS2		1:9-12K, 3:6-8F, 7:9-12G, 7:9-12M	L
2.	Investigate career opportunities in the robotics career field.		1.4, 4.8		Q
3.	Describe the development of robotics from science fiction.	CA1, CA2			L
4.	Identify a minimum of four dangerous and repetitive jobs that robots are used for.	CA1, H/PE6	4.7	1:6-8F	L
3.2	**Robotics and Automated Systems**				
1.	Formulate a definition of a robot.	CA1			A
2.	Classify different types of robots.		1.8		A
3.	Evaluate the positive impact robots have on manufacturing.	SS4	3.8		L
4.	Discuss the social implications of robots.	CA1, SS6, SC8	3.8, 4.1	6:6-8E, 6:9-12H, 6:9-12I	L
3.3	**Robot Characteristics**				
1.	Identify and compare the four classifications of robots.	CA1			M
2.	Investigate a classification of robot.		1.4		M
3.	Design and build a working model of a robot.	SC2	2.5, 3.1, 3.2, 3.3	8:9-12H, 9:9-12K, 11:9-12P	M
4.	Identify and report specifications and work envelopes.	CA1	1.8, 3.1		M
3.4	**Mechanical Components**				
1.	Identify and sketch the mechanical components to a robot.	CA1, FA1	2.5	11:6-8J	M
2.	Design and develop an end effector.	SC1, SC2	2.5, 3.1, 3.2, 3.3	8:9-12H	M
3.	Demonstrate understanding of the way end effectors are specific to a process.		1.10		M
4.	Describe the various drive systems used in robotics and analyze the advantages and disadvantages of each.	CA1, SC1, SC2	3.8		M
3.5	**Control Systems**				

1.	Describe the basic components of robot controllers.	CA1			M
2.	Demonstrate an understanding of control techniques and computer simulations.		1.10	11:9-12P	M
3.	Design and build a feed system with sensors.	SC1, SC2	2.5, 3.1, 3.2, 3.3	8:9-12H, 11:9-12P	M
3.6	**Programming Methods**				
1.	Program a robot to perform several tasks.	MA2	3.1, 3.2, 3.3		M
2.	Program a robot to solve a materials handling problem.	MA2	3.1, 3.2, 3.3		M
3.	Explain the need for end of arm tooling and how this tooling affects the robots operation.	CA1		12:9-12N	M
3.7	**Industrial Robot Applications**				
1.	Describe the necessity for specialty tooling applications in robotics.	CA1		12:3-5E	M
2.	Prepare and document a presentation on end of arm tooling.	CA1, CA4	1.8, 2.1	11:9-12R	M
3.	Analyze and generate the solution to a robotic manufacturing problem.		3.1, 3.2, 3.3	19:6-8H	M
4.1	**Rationale for CIM Manufacturing**				
1.	Describe how the individual components of a flexible manufacturing system are interrelated.	CA1	1.6	19:6-8H	N
2.	Describe the benefits and problems associated with CIM technology and how they affect the manufacturing process.	CA1, SS4	3.1, 3.6, 3.7, 3.8	19:9-12P	N
3.	Identify some basic characteristics of a manufacturing operation that lend themselves to Computer Integrated Manufacturing.	CA1	1.10, 3.8	2:9-12DD, 19:9-12P	N
4.	Identify some of the typical components and sub systems that make up an automated machining, assembly and process-type manufacturing operation.	CA1		2:9-12Y, 2:9-12FF	N
4.2	**Types of CIM Systems**				
1.	Identify the three categories of CIM manufacturing systems.	CA1		19:9-12O	N
2.	Compare and contrast the benefits and drawbacks of the three categories of CIM manufacturing systems.	CA1	3.8		N
3.	Describe the working relationship between the CNC mill and the robot.	CA1			N
4.	Identify the components of an FMS.	CA1			N
4.3	**Components of CIM Systems**				
1.	Identify and study the relationship between a CNC milling machine interface and a jointed arm robot interface through a communication handshaking process.	CA1		17:9-12M	N

2.	Describe the individual components used in selected CIM systems.	CA1			N
3.	Analyze and select components for a CIM system for a specific industrial application.		3.1, 3.2, 3.3		N
4.	Describe the various applications of a Programmable Logic Controller as related to its use in a CIM system.	CA1			M
4.4	**CIM System Applications**				
1.	Recognize and understand the necessary safety precautions associated with a fully automated CIM system.	H/PE6	4.7	9:9-12L, 12:9-12N	J
2.	Recognize and explain the significance of teamwork and communication when they combine the designs of the individual groups into a complete miniature FMS.		2.6, 4.6	11:6-8L	P
3.	Demonstrate how individual components work together to form a complete CIM system.			2:9-12Y	O
4.	Assemble and test individual component designs by integrating them into a complete miniature FMS built from the Fischertechnik models.		2.5	2:9-12Y, 2:9-12FF, 12:9-12O	O