PLTW COMPUTER INTEGRATED MANUFACTURING AND AUTOMATION (CIM)/ROBOTICS	
CURRICULUM/CONTENT AREA	COURSE LENGTH
Applied & Technical Education (ATE)	*2 Terms*
GRADE LEVEL	DATE LAST REVIEWED
9-12	*2023*
PREREQUISITE(s) *if applicable*	BOARD APPROVAL DATE
Intro to Engineering recommended but not required	*9/10/2024*
PRIMARY RESOURCE *if applicable*	
Project Lead the Way resources	

DESIRED RESULTS

COURSE DESCRIPTION AND PURPOSE

Manufacturing transforms ideas into products. Manufactured items are part of everyday life, yet few people understand the excitement and innovation that is used to transform ideas into products. This course provides an opportunity for students to recognize many of the exciting career opportunities in the manufacturing industry. Students learn about manufacturing processes, product design, robotics, and automation. Students apply the knowledge and skills gained in this course as they collaborate to design, build, and program factory system models. This course culminates with a capstone project where students design, build, program, and present a manufacturing system model capable of creating a product.

ENDURING UNDERSTANDINGS *Students will understand that...*	ESSENTIAL QUESTIONS *Students will keep considering...*
Creativity, innovation, and critical thinking are essential for success in a technologically advanced world.	Why is creativity and innovation important? How is creativity and innovation used in robotics and automation?
	How do teams efficiently and effectively solve problems in an increasingly complex world?
	What strategies and processes can I use to become a more effective creator, thinker and problem solver?
The ability to communicate and collaborate with people with diverse backgrounds and perspectives is key to participation in a global economic society.	Why is communication and collaboration important? How do positive work behaviors and personal qualities impact communication and collaboration?

	What is effective teamwork? What strategies can I use/teams use to work better together? How can perspectives and experiences of a diverse group develop innovative solutions to a given problem?
Career and technical education provides pathways to high-demand, high-wage career opportunities, and personal fulfillment.	Why is career and life readiness important? What jobs and careers are available to meet individual and societal needs locally, regionally, and nationally?
	How might technical knowledge and skills influence one's employability and advancement opportunities within various work settings?
	What are employability skills? How do I prepare myself for a career that is in demand now and in 5, 10, or 20 years from now?

PRIORITY CAREER & TECHNICAL STANDARDS
Students will be skilled at...

Creativity, Critical Thinking, Communication and Collaboration
4C2: Students will formulate and defend judgments and decisions by employing critical thinking skills.
a: I develop effective resolutions for a given problem, decision or opportunity using available information.
b: I develop and implement a resolution for a new situation using personal knowledge and experience.

Career Development
CD4: Students will identify and apply employability skills.
a: I identify and demonstrate positive work behaviors and personal qualities needed to be employable.
b: I demonstrate skills related to seeking and applying for employment to find and obtain a desired job.
c: I identify and exhibit traits for retaining employment.
d: I develop positive relationships with others.

Information, Media, Technology
IMT1: Students will access, interpret and evaluate information from a variety of sources in order to inform and support premises, arguments, decisions, ideas and initiatives.
a: I choose appropriate sources of data and information for a given purpose.
b: I determine the relevance, validity and timeliness of data and information.
c: I select relevant information necessary for making decisions and solving problems
d: I apply data and information to communicate ideas and create new opportunities.

PRIORITY CONTENT STANDARDS
Students will know...

Standard: BB1: Students will analyze the core concepts of technology.

Standard: ENG1: Students will analyze and demonstrate the attributes of design.

Standard: ENG3: Students will demonstrate and analyze the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.
Standard: ICT1: Students will analyze, select and use information and communication technologies.
Standard: MNF1: Students will be able to select and use manufacturing technologies.

Potential INDUSTRY-RECOGNIZED CREDENTIALS (IRCs) Opportunties associated with the course	Potential WORK BASED LEARNING (WBL) opportunities associated with the course
CAD Autodesk Inventor	CNC Machine Operator
CAM	
Potential DUAL CREDIT Opportunties associated with the course	
College Credit Eligible see PLTW for eligible schools.	

UNIT ONE: PRINCIPLES OF MANUFACTURING		
Manufacturing has a long history of innovation and continuous improvement. While improvement once focused on refining individual manufacturing processes, more recently manufacturing has been considered a system. Sustainable manufacturing organizations focus on safety while improving material, financial, and time efficiency. The integration of hardware and software solutions is transforming worldwide manufacturing into predominantly computer integrated manufacturing. In this unit students will explore the history of manufacturing and understand how manufacturing components are interconnected within a system. Students will learn to use input and output devices as a foundation to model manufacturing processes. The design of a model is refined through the introduction of financial consideration.		
STAGE 1: Desired Unit Results What will students understand as a result of the unit?		**STAGE 2: Assessment Evidence** By what criteria will performances of understanding be assessed? Through what authentic performance tasks will students demonstrate the desired unit results?
ESSENTIAL QUESTION (s) What thought-provoking questions will foster inquiry, understanding, and transfer of learning?		**Success Criteria with Standards** The criteria for evaluating performance on standards is constant.
How do teams efficiently and effectively solve problems in an increasingly complex world?		CTE standards-based Rubric: Throughout the course, students and teachers use the rubric for communication of success criteria, reflection, goal setting, and feedback. Students journal and reflect in their engineering notebook which contains contains all design work completed for a specific design project. It is a chronological documentation of all tasks completed during a design process. Note that an engineering notebook is different from a course binder or portfolio. These reflections align to all priority standards. Essential questions are used throughout the course as reflective prompts.
What are employability skills? How do I prepare myself for a career that is in demand now and in 5, 10, or 20 years from now?		
PRIORITY CAREER & TECHNICAL STANDARDS & Learning Targets		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.
Career Development **CD4: Students will identify and apply employability skills.**		Students may opt to engage in earning CAD Autodesk Inventor Certification (Industry Recognized Certification)
d: I develop positive relationships with others.	CD4.d.5.h: I can participate in cocurricular and community activities to enhance the school experience.	Activity 1.1.0 Origami Balloon
Information, Media, Technology **IMT1: Students will access, interpret and evaluate information from a variety of sources in order to inform and support premises, arguments, decisions, ideas and initiatives.**		
a: I choose appropriate sources of data and information for a given purpose.	IMT1.a.6.h: I can justify the selection of various information sources for a given purpose.	Activity 1.1.1 History of Manufactoring
	IMT1.a.7.h: I can explain the level of objectivity for a given source of information.	Activity 1.1.1 History of Manufactoring
b: I determine the relevance, validity and timeliness of data and information.	IMT1.b.7.h: I can use raw data and information appropriately to support an argument, idea or initiative.	Project 1.1.3 Manufacturing Research: Students conduct research for the class. The goal is not only to learn about a topic, but to teach classmates as well. Students will be asked to cite several sources for their findings to justify validity.

PRIORITY CONTENT STANDARDS & Learning Targets		Performance Tasks Options/ Assessment Strategies by Standard Students may be given options to show their learning in varied ways.
Standard: BB1: Students will analyze the core concepts of technology.	BB1.a.6.h Describe how the outputs of one subsystem are the inputs of another subsystem.	Actvitity 1.1.2 Enterprise Wheel
Standard: ENG1: Students will analyze and demonstrate the attributes of design.	ENG1.a.9.h: Examine how the design needs to continually be evaluated and the ideas of the design must be redefined and improved.	Project 1.3.2 Transfer systems: Students create a transfer system to simulate an assembly line while keeping costs to a minimum.
SUPPORTING STANDARDS AND LEARNING TARGETS		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.
Standard: ENG2: Students will analyze and demonstrate engineering design.	ENG2.b.3.m: I can modeling, testing, evaluating and modifying are used to transform ideas into practical solutions.	
	ENG2.b.4.h: I can create a prototype as a working model used to test a design concept by making actual observations and necessary adjustments.	

Stage 3: Learning Activities

A brief summary of the key learning activities- How will students build knowledge & develop skills? How will learning be relevant, accessible, and engaging? How will the learning unforld in a natural flow?

GUIDING UNIT QUESTIONS Using Costas Level of Thinking, what questions will hook and hold students so that they develop a deep understanding of the desired results? The guiding questions are more topic-specific to the particular unit. They guide the exploration of the essential questions and rigor of the standards. This may include questions that guide project based/ problem based learning	STRATEGIES/ACTIVITIES What learning strategies and experiences will authentically engage students so that they gain understanding the desired results? This includes strategies and activities that help learners acquire targeted knowledge and skills, make meaning of important ideas, and transfer their learning to new situations. Consider how the learning will be tailored and flexible to address the interests and learning styles of all students.	RESOURCES/MATERIALS This includes an applicable textbooks, software, industry recognized certification software/tools, subcriptions (such asPLTW), etc.
How is manufacturing made to be more efficient?	Design Process: 1. Define Problem 2. Generate Concepts 3. Develop Solution 4. Construct and Test 5. Evaluate Solution 6. Present Solution	PLTW student resources
How does manufacturing affect the economy and society?		Students may opt to engage in CAD Autodesk Inventor Certification
How can mechanical, electrical, and software systems be integrated t		
How does team diversification enhance a design process?		
How is your life affected by micocontrollers with inputs and outputs?		
How do decisions related to cost, product quality, and safety interrelate?		
How can a model be used to help design a full-scale system?	activities and projects	

UNIT TWO: MANUFACTORING PROCESS		
The goal of unit 2 is to introduce students to manufacturing processes as discrete steps within a manufacturing system. Students analyze a product to consider design improvements, perform calculations to make manufacturing decisions, and recommend processes. Students explore manufacturing machines while learning to develop machine language called G&M code. Students create G&M code manually to understand how machine code controls a CNC device. Students then practice workflow.		
STAGE 1: Desired Unit Results What will students understand as a result of the unit?		**STAGE 2: Assessment Evidence** By what criteria will performances of understanding be assessed? Through what authentic performance tasks will students demonstrate the desired unit results?
ESSENTIAL QUESTION (s) What thought-provoking questions will foster inquiry, understanding, and transfer of learning?		**Success Criteria with Standards** The criteria for evaluating performance on standards is constant.
Why is creativity and innovation important? How is creativity and innovation used in robotics and automation?		CTE standards-based Rubric: Throughout the course, students and teachers use the rubric for communication of success criteria, reflection, goal setting, and feedback. Students journal and reflect in their engineering notebook which contains contains all design work completed for a specific design project. It is a chronological documentation of all tasks completed during a design process. Note that an engineering notebook is different from a course binder or portfolio. These reflections align to all priority standards. Essential questions are used throughout the course as reflective prompts.
Why is career and life readiness important? What jobs and careers are available to meet individual and societal needs locally, regionally, and nationally?		
PRIORITY CAREER & TECHNICAL STANDARDS & Learning Targets		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.
Creativity, Critical Thinking, Communication and Collaboration **4C2: Students will formulate and defend judgments and decisions by employing critical thinking skills.**		Students may opt to engage in earning CAD Autodesk Inventor Certification (Industry Recognized Certification)
a: I develop effective resolutions for a given problem, decision or opportunity using available information.	4C2.a.13.h: I can predict how an action could result in unintended consequences, both positive and negative.	Activity 2.1.1 Design Flaws: analyze products to identify design flaws and suggest improvements
	4C2.a.14.h: I can analyze the impact of a decision using a systems thinking model.	Activity 2.1.2 Mass Properties Analysis: make informed decisions about an approach to manufacturing, packaging, shipping, and finishing.

Information, Media, Technology **IMT1: Students will access, interpret and evaluate information from a variety of sources in order to inform and support premises, arguments, decisions, ideas and initiatives.**		
b: I determine the relevance, validity and timeliness of data and information.	IMT1.b.7.h: I can use raw data and information appropriately to support an argument, idea or initiative.	Activity 2.3.2 Speeds and Feeds: calculate the feed rates for specific scenarios.
c: I select relevant information necessary for making decisions and solving problems	IMT1.c.6.h: I can interpret and select appropriate information to develop a resolution for a given situation.	Actvity 2.3.1 Introduction to Machines: identify the machines in the classroom and classify them according to their purpose.
PRIORITY CONTENT STANDARDS & Learning Targets		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.
Standard: ENG1: Students will analyze and demonstrate the attributes of design.	b.5.h: I can develop and produce a product or system using a design process	Project 2.3.7 Container Design: design and manufacture a container base and lid using constraints provided
Standard: ICT1: Students will analyze, select and use information and communication technologies.	f.10.h: I can demonstrate the principles of design utilizing commercial software	Project 2.3.5 CAM Strategies: use a CAD model to develop CAM strategies, and then verify the strategy and remark using CNCMotion® software
SUPPORTING STANDARDS AND LEARNING TARGETS		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.
Standard: ENG6: Students will develop the abilities to assess the impact of products and systems.	a.2.m: I can design and use instruments and technology to gather data.	project based learning activity
Stage 3: Learning Activities A brief summary of the key learning activities- How will students build knowledge & develop skills? How will learning be relevant, accessible, and engaging? How will the learning unforld in a natural flow?		
GUIDING UNIT QUESTIONS Using Costas Level of Thinking, what questions will hook and hold students so that they develop a deep understanding of the desired results? The guiding questions are more topic-specific to the particular unit. They guide the exploration of the essential questions and rigor of the standards. This may include questions that guide project based/ problem based learning	**STRATEGIES/ACTIVITIES** What learning strategies and experiences will authentically engage students so that they gain understanding the desired results? This includes strategies and activities that help learners acquire targeted knowledge and skills, make meaning of important ideas, and transfer their learning to new situations. Consider how the learning will be tailored and flexible to address the interests and learning styles of all students.	**RESOURCES/MATERIALS** This includes an applicable textbooks, software, industry recognized certification software/tools, subcriptions (such asPLTW), etc.
How is a product design enhanced by considering its manufacturability?	research	PLTW text

How do mathematical models improve manufacturing decision making?	simulators	Students may opt to engage in CAD Autodesk Inventor Certification (Industry Recognized Certification)
Why do engineers use a code of ethics?	hands on learning activities and projects	
How do manufacturing processes affect product cost and quality?		
How can the creation of a prototype be used in a design process?	Design Process: 1. Define Problem 2. Generate Concepts 3. Develop Solution 4. Construct and Test 5. Evaluate Solution 6. Present Solution	
How does manufacturability affect the design of a product?		
How does a design and simulation software affect a product design process?		
How does material selection affect a manufacturing process?		

UNIT THREE: ELEMENTS OF AUTOMATION		
The goal of this unit is to introduce students to robotic automation within a manufacturing system. Robots as a form of automation have improved manufacturing by performing tasks that may be too mundane, impossible, unsafe, or inefficient for humans to perform. Robot effectiveness is impacted by factors such as robot geometry, controlling program, and robot power sources.		
STAGE 1: Desired Unit Results What will students understand as a result of the unit?		**STAGE 2: Assessment Evidence** By what criteria will performances of understanding be assessed? Through what authentic performance tasks will students demonstrate the desired unit results?
ESSENTIAL QUESTION (s) What thought-provoking questions will foster inquiry, understanding, and transfer of learning?		**Success Criteria with Standards** The criteria for evaluating performance on standards is constant.
What strategies and processes can I use to become a more effective creator, thinker and problem solver?		CTE standards-based Rubric: Throughout the course, students and teachers use the rubric for communication of success criteria, reflection, goal setting, and feedback. Students journal and reflect in their engineering notebook which contains contains all design work completed for a specific design project. It is a chronological documentation of all tasks completed during a design process. Note that an engineering notebook is different from a course binder or portfolio. These reflections align to all priority standards. Essential questions are used throughout the course as reflective prompts.
What is effective teamwork? What strategies can I use/teams use to work better together? How can perspectives and experiences of a diverse group develop innovative solutions to a given problem?		
PRIORITY CAREER & TECHNICAL STANDARDS & Learning Targets		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.
Creativity, Critical Thinking, Communication and Collaboration **4C2: Students will formulate and defend judgments and decisions by employing critical thinking skills**		Students may opt to engage in earning CAD Autodesk Inventor Certification (Industry Recognized Certification)
a: I develop effective resolutions for a given problem, decision or opportunity using available information.	4C2.a.11.h: I can determine the information needed to address an identified problem.	Activity 3.1.2: identify teach position for a robot
	4C2.a.15.h: I can determine the best resolution for a problem, decision or opportunity based on given criteria.	Activity 3.1.2: program a robot to effectively stack objects by incorporating roll angles in the robot position.
Information, Media, Technology **IMT1: Students will access, interpret and evaluate information from a variety of sources in order to inform and support premises, arguments, decisions, ideas and initiatives.**		
d: I apply data and information to communicate ideas and create new opportunities.	IMT1.d.7.h: I can synthesize data and information from multiple sources to identify new trends.	Project 3.1.1 History of Automation: research a topic of your choice that relates to automation and share your findings with your class.
PRIORITY CONTENT STANDARDS & Learning Targets		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.

Standard: ENG3: Students will demonstrate and analyze the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.	b.5.h: I can describe how many technological problems require a multidisciple approach.	Problem 3.2 Hydraulic Part Feeder: design, build, test, and present a system that will eliminate the problem with automation
SUPPORTING STANDARDS AND LEARNING TARGETS		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.
Standard: ENG5: Students will develop the abilities to use and maintinan technological products and systems.	ENG5.a.6.h: Diagnose a system that is malfunctioning and use tools, materials, or machines to repair it.	
	ENG5.b.8.h: Troubleshoot, analyze and maintain systems to ensure proper function, accuracy and precision.	
Stage 3: Learning Activities A brief summary of the key learning activities- How will students build knowledge & develop skills? How will learning be relevant, accessible, and engaging? How will the learning unforld in a natural flow?		
GUIDING UNIT QUESTIONS Using Costas Level of Thinking, what questions will hook and hold students so that they develop a deep understanding of the desired results? The guiding questions are more topic-specific to the particular unit. They guide the exploration of the essential questions and rigor of the standards. This may include questions that guide project based/ problem based learning	**STRATEGIES/ACTIVITIES** What learning strategies and experiences will authentically engage students so that they gain understanding the desired results? This includes strategies and activities that help learners acquire targeted knowledge and skills, make meaning of important ideas, and transfer their learning to new situations. Consider how the learning will be tailored and flexible to address the interests and learning styles of all students.	**RESOURCES/MATERIALS** This includes an applicable textbooks, software, industry recognized certification software/tools, subcriptions (such asPLTW), etc.
How is manufacturing affected by the use of a robot?	research	PLTW
How can a simulation be used to plan a physical system?	simulators	Students may opt to engage in CAD Autodesk Inventor Certification (Industry Recognized Certification)
How does the ability of power be transformed into other forms affect products that you use?	prototype	
How can a system be optomized?	hands on learning activities and projects	
How can you use fluid power as part of the system that you design?	Design Process: 1. Define Problem 2. Generate Concepts 3. Develop Solution 4. Construct and Test 5. Evaluate Solution 6. Present Solution	
Why do systems need to communicate?		
How can manufacturing be improved through the use of a robot?		
How can a physical system be simulated as part of the design process?		

<table>
<tr><th colspan="3">UNIT FOUR: INTEGRATION OF MANUFACTURING</th></tr>
<tr><td colspan="3">The goal of this unit is to apply the course concepts to a capstone problem. This opportunity will allow students to develop teamwork and presentation skills. The unit also explores career opportunities available in the manufacturing industry</td></tr>
<tr><td colspan="2">STAGE 1: Desired Unit Results
What will students understand as a result of the unit?</td><td>STAGE 2: Assessment Evidence
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What thought-provoking questions will foster inquiry, understanding, and transfer of learning?</td><td>Success Criteria with Standards
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Students journal and reflect in their engineering notebook which contains contains all design work completed for a specific design project. It is a chronological documentation of all tasks completed during a design process. Note that an engineering notebook is different from a course binder or portfolio. These reflections align to all priority standards. Essential questions are used throughout the course as reflective prompts.</td></tr>
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<tr><td colspan="2">Career Development
CD4: Students will identify and apply employability skills.</td><td>Students may opt to engage in earning CAD Autodesk Inventor Certification (Industry Recognized Certification)</td></tr>
<tr><td>a: I identify and demonstrate positive work behaviors and personal qualities needed to be employable.</td><td>CD4.a.9.h: I can use positive workqualities typically desired in each of the career cluster's pathways.</td><td>Activity 4.1.2: Manufacturing and Automation careers</td></tr>
<tr><td rowspan="2">b: I demonstrate skills related to seeking and applying for employment to find and obtain a desired job.</td><td>CD4.b.5.h: I can use multiple resources to locate job opportunities.</td><td>Activity 4.1.2: research what it would take to become a manufacturing and automation professional.</td></tr>
<tr><td>CD4.b.6.h: I can prepare a resume, cover letter, employment application.</td><td>Prepare a resume with relevant skills, certifications, and work experiences.</td></tr>
</table>

c: I identify and exhibit traits for retaining employment.	CD4.c.5.h: I can maintain appropriate dress and behavior for the job to contribute to a safe and effective workplace/jobsite.	Safety and proper dress for working with manufacturing machinery.
d: I develop positive relationships with others.	CD4.d.8.h: I can use a systematic approach to academic and career planning for students to achieve their learning, socio-cultural and work goals.	Activities 4.1.2 Careers in Automation: Students will prepare a presentation to communicate the details of a field of manufacturing or automation.: What companies offer training programs? Describe program details, including entrance requirements, commitments, and schedule. What are positive and negative aspects of this career? What are the most difficult courses that one takes beyond high school to earn a degree in this field? Why does this career interest you? What other manufacturing careers would you consider?
PRIORITY CONTENT STANDARDS & Learning Targets		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.
Standard: ENG3: Students will demonstrate and analyze the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.	a.7.h: I can research and develop a specific problem solving approach to prepare device and systems for marketplace.	Project 4.2.1 Process Flow: choose a product and create a process flow diagram for it. Envision the production and make necessary modifications.
SUPPORTING STANDARDS AND LEARNING TARGETS		**Performance Tasks Options/ Assessment Strategies by Standard** Students may be given options to show their learning in varied ways.
Standard: ENG5: Students will develop the abilities to use and maintain technological products and systems.	ENG5.a.6.h: I can diagnose a system that is malfunctioning and use tools, materials, or machines to repair it.	
	ENG5.b.2.e: I can use computers and technology to access and organize information.	
	ENG5.b.8.h: I can troubleshoot, analyze and maintain systems to ensure proper function, accuracy and precision.	
Stage 3: Learning Activities A brief summary of the key learning activities- How will students build knowledge & develop skills? How will learning be relevant, accessible, and engaging? How will the learning unforld in a natural flow?		

GUIDING UNIT QUESTIONS Using Costas Level of Thinking, what questions will hook and hold students so that they develop a deep understanding of the desired results? The guiding questions are more topic-specific to the particular unit. They guide the exploration of the essential questions	STRATEGIES/ACTIVITIES What learning strategies and experiences will authentically engage students so that they gain understanding the desired results? This includes strategies and activities that help learners acquire targeted knowledge and skills, make meaning of important ideas, and transfer their learning to new situations. Consider how the learning will be tailored and flexible to address the interests and learning styles of all students	RESOURCES/MATERIALS This includes an applicable textbooks, software, industry recognized certification software/tools, subcriptions (such asPLTW), etc.
How can a product be analyzed to suggest the manufacturing processes used to produce it?	simulators	PLTW
How would you want to be remembered as a professional?	research	Students may opt to engage in CAD Autodesk Inventor Certification (Industry Recognized Certification)
Who and what are credible sources for career advice?	hands on learning activities and projects	
How is computational thinking applied to solving a problem.	Design Process: 1. Define Problem 2. Generate Concepts 3. Develop Solution 4. Construct and Test 5. Evaluate Solution 6. Present Solution	
How can a design process be used to optimize a solution to a problem?		
How the effectiveness of a presentation affects the acceptability of a solution?		