# Curriculum Framework – Computer Integrated Manufacturing
# Unit 2 Manufacturing Processes – Lesson 2.3 Product Development

## Desired Results *(stage 1)*

***ESTABLISHED GOALS***

*It is expected that students will…*

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.

### Transfer

***TRANSFER:*** *Students will be able to independently use their learning to …*

- T1 – Design a part with consideration to manufacturability. (NGSS Engineering Practice 2)
- T2 – Transform a concept into a physical product and analyze its effectiveness. (NGSS Engineering Practice 4)
- T3 – Adapt existing knowledge to unfamiliar tools. (ABET 2014-2015, criterion 3i)
- T4 – Evaluate merits of developing a model manually before advancing to complex software. (NGSS Engineering Practice 2)

### Meaning

***UNDERSTANDINGS:*** *Students will understand that …*

- U1 – Many machines exist to perform manufacturing processes.
- U2 – Products manufactured today have been greatly influenced by the advancement of machines and technology.
- U3 – Machine code is an essential tool used to communicate with some machines.
- U4 – Computer Aided Manufacturing (CAM) programming tools make it possible to manufacture physical models using Computer Aided Design (CAD) programs.
- U5 – Several variables in machining operations affect the final product in manufacturing.
- U6 – Jigs and fixtures are essential in maintaining consistency and quality control.
- U7 – Profit margins are essential to a company's survival in a competitive market.

***ESSENTIAL QUESTIONS****: Students will keep considering …*

- Q1 – How does manufacturability affect a design of a product?
- Q2 – How does the capability of a machine affect a manufacturing process?
- Q3 – How does material selection affect a manufacturing process?



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<td rowspan="3">
<ul>
<li>G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</li>
<li>G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.</li>
<li>G7 – Demonstrate an understanding of professional and ethical responsibility.</li>
<li>G8 – Demonstrate an ability to function on multidisciplinary teams.</li>
<li>G9 – Demonstrate an ability to communicate effectively.</li>
<li>G10 – Gain knowledge of contemporary issues.</li>
<li>G11 – Recognize the need for, and develop an ability to engage in life-long learning.</li>
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<li>U8 – Prototyping is a major step in the design cycle of manufactured goods and has been greatly advanced with the advent and use of rapid prototyping processes.</li>
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<td colspan="2">Acquisition</td>
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KNOWLEDGE: Students will…
<ul>
<li>K1 – List examples of common CNC machines. U1, U2, U3, U4</li>
<li>K2 – List common robot applications used in manufacturing. U1</li>
<li>K3 – Identify common cutting tools. U1, U5</li>
<li>K4 – Describe parts and functions of common machines used in manufacturing. U1, U4, U5, U6</li>
<li>K5 – Select formulas which are used to determine milling machine settings. U3, U4, U5</li>
<li>K6 – Describe common G & M Codes. U3, U4, U5</li>
<li>K7 – Describe a procedure to operate a milling machine. U3, U5, U6</li>
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SKILLS: Students will…
<ul>
<li>S1 – Identify a machine which can be used to perform a process. U1, U2, U5</li>
<li>S2 – Calculate settings needed for a milling machine. U3, U5</li>
<li>S3 – Interpret the actions that will be performed given a sample of machine code. U3, U5</li>
<li>S4 – Manually create machine code required to manufacture a product. U3, U5</li>
<li>S5 – Create machine code to manufacture a product using Computer Aided Manufacturing (CAM) program. U3, U4, U5</li>
<li>S6 – Test machine code accuracy using simulation software. U3, U5</li>
<li>S7 – Create a model using Computer Aided Design (CAD) software. U3, U4, U5</li>
<li>S8 – Create a product using a CNC milling machine. U1, U3, U4, U5, U6</li>
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| Evidence *(stage 2)* | | | Learning Plan *(stage 3)* | |
|---|---|---|---|---|
| Activities (A)<br>Projects (P)<br>Problems(B) | Assessment FOR Learning | Assessment OF Learning | Activities (A)<br>Projects (P)<br>Problems(B) | Knowledge and Skills |
| 2.3.1.A Introduction to Machines | • Essential questions<br>• Responses to prompts for machine names | • Conclusion questions | 2.3.1.A Introduction to Machines | K4, S1 |
| 2.3.2.A Speeds and Feeds | • Essential questions<br>• Responses to speeds and feeds questions | • Responses to speeds and feeds questions<br>• Conclusion questions | 2.3.2.A Speeds and Feeds | K5, S2 |
| 2.3.3a.P G&M Code Absolute | • Essential questions<br>• Accurate drawing of initials<br>• Accurate coordinates | • Accurate G&M code statements | 2.3.3a.P G&M Code Absolute | K6, K7, S3, S4, S5, S6 |
| 2.3.3b.P G&M Code Relative | • Essential questions<br>• Accurate drawing of initials<br>• Accurate coordinates | • Accurate G&M code statements | 2.3.3b.P G&M Code Relative | K6, K7, S3, S4, S5, S6, S8 |
| 2.3.4.P Practice Machining Flange | • Essential questions<br>• Accurate CAD model<br>• Appropriate feature identification<br>• Appropriate tool selection<br>• Correct spindle speed rate calculation<br>• Correct feed rate calculation<br>• Accurate tool paths | • Accurate CAD model<br>• Appropriate feature identification<br>• Appropriate tool selection<br>• Correct spindle speed rate calculation<br>• Correct feed rate calculation<br>• Accurate tool paths<br>• Error free NC code<br>• CNC device operated efficiently and safely | 2.3.4.P Practice Machining Flange | K6, K7, S3, S4, S5, S6, S7, S8 |



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| | | • Physical part produced matches model dimension requirements<br>• Conclusion questions | | |
| 2.3.5.P Container Design | • Essential questions<br>• Accurate part sketch including dimensions<br>• Accurate CAD model<br>• Accurate CAM tool path model<br>• Successful simulation produced using CNCMotion | • Operation meets all constraints<br>• Accurate CAD model<br>• Accurate CAD drawing<br>• Accurate CAM tool path model<br>• Successful simulation produced using CNCMotion<br>• CNC device operated efficiently and safely<br>• Physical parts produced matches model dimension and clearance requirements<br>• Conclusion questions | 2.3.5.P Container Design | K6, K7, S3, S4, S5, S6, S7, S8 |
| 2.3.5a.P Tic Tac Toe (Optional) | • Essential questions<br>• Accurate CAD model<br>• Accurate CAM tool path model<br>• Successful simulation produced using CNCMotion | • Operation meets all constraints<br>• Accurate CAD model<br>• Accurate CAD drawing<br>• Accurate CAM tool path model<br>• Successful simulation produced using CNCMotion<br>• CNC device operated efficiently and safely | 2.3.5a.P Tic Tac Toe (Optional) | K6, K7, S3, S4, S5, S6, S7, S8 |



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| | | • Physical parts produced matches model dimension and clearance requirements<br>• Conclusion Questions | | |
| 2.3.5b.P Triangle Puzzle (Optional) | • Essential questions<br>• Accurate CAD model<br>• Accurate CAM tool path model<br>• Successful simulation produced using CNCMotion | • Operation meets all constraints<br>• Accurate CAD model<br>• Accurate CAD drawing<br>• Accurate CAM tool path model<br>• Successful simulation produced using CNCMotion<br>• CNC device operated efficiently and safely<br>• Physical parts produced matches model dimension and clearance requirements<br>• Conclusion questions | 2.3.5b.P Triangle Puzzle (Optional) | K6, K7, S3, S4, S5, S6, S7, S8 |



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