ONTARIO COUNCIL FOR TECHNOLOGY EDUCATION

DRILL AND TAP BLOCK

Manufacturing Technology
TMJ2O
Grade 10
June 2020

ONLINE RESOURCE

takeTECH

Table of Contents

Introduction

Course Code: TMJ2O
Broad base Technology: Manufacturing
Destination: Open
Grade Level: 10
Prerequisite: None
Online Project Name: Drill and Tap Block

Project Outline

This project will teach students how to drill and tap various size holes on a milling machine. They will be required to cut a piece of rough stock aluminum and mill the ends of the block square. They will then layout 3 different hole positions on the block using the height gauge and surface plate. The student will finish the project by use the milling machine to drill and tap 3 different size holes.

By the end of this project the student will…

- Learn the various designations of drill sizes
- Learn how taps are identified
- Be able to read a tap drill chart
- Understand the importance of proper drill size selection when tapping
- Demonstrate how to drill and tap a hole properly

Prior Knowledge

Students should have some basic knowledge from the grade 9 TIJ1O Exploring Technologies course which is suggested but not mandatory. This includes,

- General shop safety
- Layout techniques using height gauge
- Band saw operation
- Milling machine operation

Student Activities

Activity 1 – The 4 Designations of Drill Sizes

The goal of this activity is for students to learn the ways in which drill sizes are designated. Students will be able to identify the 4 different designations (fraction, letter, number, metric) and be able to locate the drills in a standard drill set.

Time required: 30 minutes

Materials/equipment needed: Standard drill set, various drills to pass around to students

Activity 2 – Tap Identification

The goal of this activity is for students to understand how taps are identified. They will learn about different types of taps and why it is important to choose the right tap for the job required.

Time required: 30 minutes

Material/equipment needed: Tap set, various taps to pass around to students

Resources: Hand Tap Handout (Appendix A)
Video #1 - Tapping Essentials (13:20)

Activity 3 – Reading a Tap Drill Chart

The goal of this activity is for students to learn how to read a tap drill chart. They will learn how to select the proper size drill depending on the tap size required. The students will complete a quiz to assess their understanding form Activities 1, 2 and 3.

Time required: 90 minutes

Material/equipment needed: Tap drill chart

Resources: Tap Drill Chart (Appendix B)
Tap Drill Quiz (Appendix C)
Video #2 - Tap Drill Chart (4:10)
Twist Drill Comparison Placemat

Activity 4 – Project: Drill and Tap Block

This project will allow the students to use their knowledge of drilling and tapping to manufacture an aluminum block with various sized tapped holes.

The students are required to cut a piece of rough stock aluminum (size can vary depending on available material) and mill the ends square. They will then layout out 3 different hole positions spaced out equally on their material. The students are then tasked with selecting 3 different size taps (tap sizes can vary depending on available tooling) and, using the provided tap drill chart (Appendix B), select the proper size drill for each tap.

The students will use the milling machine to drill and tap the 3 different size holes in their piece of material. They will hand in their project for evaluation using a rubric (Appendix D)

Time required: 180 minutes

Material/equipment needed: Aluminum stock, center drills, drills, taps, end mill, height gauge, surface plate, band saw, milling machine

Resources: Drill and Tap Block Rubric (Appendix D)

Planning Notes

The following are suggestions when planning to perform this project,

- Prepare lessons for drill designation, tap identification and tap drill chart reading
- Set-up projector to show videos
- Make copies of all handouts for students or have them available on online learning management system for students
- Prepare all materials for demonstration prior to class or prior to videotaping
- Have various drills and taps placed around the room for students to look at and socially distance
- Have all machines and tools set up to use safely, ensuring guarding is in place
- Prepare material for students to cut

Resources

Handouts

Hand Taps Handout (Appendix A),
Tap Drill Chart (Appendix B)
Tap Drill Quiz (Appendix C)
Twist Drill Comparison Placemat (Appendix D)

Pictures/Blueprints

Hand Taps picture (Appendix A)
Starrett Inch/Metric Tap Drill Sizes & Decimal Equivalents (Appendix B)
Project Drawing/Blueprint (Appendix F)
Project Reference Pictures (Appendix G)

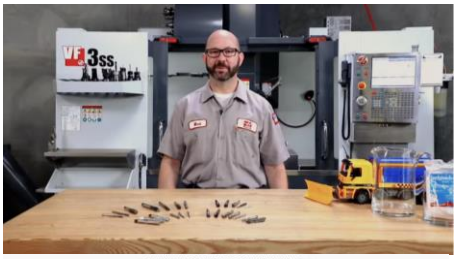
Tools/Equipment

End mills, center drills, drill set, various taps, height gauge, surface plate, band saw, milling machine

Materials

Aluminum stock

Videos



Video #1 – Tapping Essentials (13:20)
This video explains different types of taps and the uses of each.

https://www.youtube.com/watch?v=bkrUzGooA9k

Video #2 – Tap Drill Chart (4:10)
This is a short video explaining how to properly read a tap drill chart.

https://www.youtube.com/watch?v=68U_ONuLVKk

Websites

NC Cutting Tools - 7 Differences between HSS and Cobalt Drill Bits
Powertool Addict - Cobalt Drill Bits vs Titanium Drill Bits: What Material is the Better Choice?
RD Barrett - The Difference Between HSS and Cobalt Drill Bits
Regal Cutting Tools on Twist Drills
Vermont AmericanTwist Drill Bit Types – How to Choose the Right Twist Drill Bit

Instructional Strategies

Teachers may use any of the following instructional strategies; 3-Part lesson, lecture, storyboard, word wall, think-pair-share, placemat activity, rapid write, K-W-L, anticipation chart, ABC taxonomy, think aloud, analyzing text, Cornell note taking, exit ticket/ticket out the door, plus/minus/delta, etc. to effectively introduce an activity or teach their students.

The Hook / Motivational Strategies

Start the class with a discussion about threads (what are they, how do they work, where are they used etc.). Ask the students to think of some places that threads are used and have them share their thoughts. Talk about the importance of having international standards when it comes to manufacturing threads and why it is necessary. Explain how threads are made and introduce the students to taps, demonstrating how they are used the create threads.

Learning Goals and Success Criteria

Learning goals and success criteria are the foundation on which students base their ability to monitor their learning and determine next steps**.** Applicable learning goals may include any of the following,

- Students will learn about the various designations of drill sizes
- Students will understand how taps are identified
- Students will discover the importance of proper drill size selection when tapping

Success criteria may include any of the following,

- I will demonstrate their ability to read a tap drill chart correctly
- I will be able to identify taps and dies
- I will accurately machine to a specification
- I will accurately machine to within a tolerance
- I will demonstrate how to drill and tap a hole on the milling machine
- I will be able to identify and explain how various materials, tools, and equipment are used in the manufacture of products
- I will develop and use a manufacturing process to produce a product
- I will safely use the correct machines and tools to manufacture a product

Overall and Specific Expectations in Support of Ontario Curriculum Grades 9 - 10 Technological Education

Overall Expectations

A3 Identify and explain how various materials, tools, and equipment are used in the manufacture of products;

B2. Develop and use a manufacturing process plan to produce a product;

B3. Use hand tools, machine tools, power tools, materials, and equipment safely and correctly in the manufacture of a product;

B4. Demonstrate the use of metrology skills to measure, lay out, and inspect a product.

Specific Expectations

A3.1 Identify and describe the hand tools, machine tools, power tools, and equipment (e.g., saw, drill, engine lathe, vacuum forming machine, computer hardware and software) used in the design and fabrication of a variety of projects (e.g., robotic challenge, design challenge, fabrication project);

B2.1 Identify and select appropriate materials required to manufacture a product;

B2.3 Use correct procedures to prepare materials for the manufacture of a product (e.g., layout, cutting to rough length, squaring, drilling, weld preparation, deburring);

B3.1 Set up hand tools, machine tools, power tools, and equipment (e.g., jigs and fixtures, clamps, engine lathe, welding equipment, milling machine, drill press, injection-moulding machine) properly in preparation for the manufacture of a product (e.g., robotic challenge, design challenge, fabrication project);

B3.2 Use various hand tools, power tools, machine tools, and related equipment (e.g., saws, grinders, milling machine, engine lathe, welding equipment, vacuum-forming machine) safely and correctly to manufacture a product;

B3.4 Demonstrate safe workplace practices and behaviours (e.g., follow instructions, keep work area clean and dry, don't distract other workers) when using materials, tools, and equipment to manufacture a product;

B4.2 Perform proper layout procedures.

Safety Concerns

Students must follow previous instruction and learned machine safety instructions while operating the band saw and milling machine. Safety passports or equipment instruction, testing and demonstration signoffs maybe utilized to track student training on pieces of equipment. Students must also wear proper PPE (safety glasses, proper footwear, etc.) while completing this project.

Applicable SAFEDocs and ToolSAFE videos

Please refer to the SAFEDocs for Manufacturing Technology on the OCTE website for safety documents in order to properly address and instruct this project.

Project Challenges

Challenges that may arise during this project may include:

- Students not understanding how to read a tap drill chart properly
  - ✓ More one on one time may be needed to support students learning
  - ✓ Additional worksheets may be provided for practice
- Students will break taps while completing the project
  - ✓ Teach students how to remove a broken tap
  - ✓ Have extra taps ready to use if needed
- The machines may get backed up by students needing to work
  - ✓ Have half of the students work on quiz while other half uses machines
  - ✓ Have them switch places when they are complete
- Students may have difficulty completing the project
  - ✓ Have students partner with a more knowledgeable classmate
  - ✓ Spend more one on one time with students who require it

Differentiation of the Project / Activity

This project can be differentiated by:

- Using various size material, depending on availability
- Using various size taps, depending on availability
- Assigning students specific size holes to tap or having them choose their own sizes
- The quiz could be completed as a fill-in-the-blank worksheet with the entire class
- This projected could be completed entirely in class over 2 or 3 days or it could also be a combination of online and in person work.
- The project could also be completed entirely online if needed, with the exception of Activity #4

Teachers can also refer to the Differentiation Scrapbook to take into account for learner ability, multiple intelligences, exceptional students, and ESL learners.

Assessment and Evaluation

Assessment As Learning

- Ask questions and make suggestions based on daily observation
- Assess students' cognition about their learning
- Students monitor their own learning and ask questions as needed

Assessment For Learning

- Provide feedback to students about their learning and how to improve
- Create differentiated teaching strategies and learning opportunities
- Identify particular learning needs of students

Assessment Of Learning

- Students will complete a quiz to assess their understanding of the lessons
- Evaluate each project according to the rubric

Career and Industry Extensions

Students can explore career opportunities in the Manufacturing Industry including:

- General Machinist
- Millwright
- Welder
- CNC Operator
- Engineer
- Ironworker
- Metal Fabricator

Reflection or Design Report

Teachers may wish to have the students complete a design report, reflection or create a foldable to consolidate their learning. This would be a nice way to capture the student's understanding in a summative format and be used in preparation for their examination, entering post-secondary education or the workforce.

Appendix A – Hand Taps Handout

Hand Taps

- Used to cut internal threads.
- The top end of the shank is square so a tap wrench or tap handle can be used to turn the tap into a hole which then produces a thread.
- When cutting, use cutting oil to lubricate the metal as it cuts.
- After a full complete turn, back the handle half a turn to break chips.
- Keep the tap straight and parallel with the workpiece.

Preparing Workpiece for Internal Threads

- A hole must be drilled first. The drill bit must be smaller than the size of the tap so there is room for the threads to be cut. Use a “Tap Drill Chart” to find the right drill size.
- Add a chamfer to the end of the workpiece. This is to help start the tap.
- Use cutting oil to help cut and to keep the metal from heating up.

Appendix B – Tap Drill Chart

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DECIMAL EQUIVALENTS

INCH/METRIC TAP DRILL SIZES & DECIMAL EQUIVALENTS

DRILL SIZE	DECIMAL EQUIVALENT	TAP SIZE
19/64	.5938	
39/64	.6094	
5/8	.6250	
41/64	.6406	
21/32	.6562	3/4 - 10
43/64	.6719	
11/16	.6875	3/4 - 16
45/64	.7031	
23/32	.7188	
47/64	.7344	
3/4	.7500	
49/64	.7656	7/8 - 9
25/32	.7812	
51/64	.7969	
13/16	.8125	7/8 - 14
53/64	.8281	
27/32	.8438	
55/64	.8594	
7/8	.8750	1 - 8
57/64	.8906	
29/32	.9062	
59/64	.9219	1 - 12
15/16	.9375	1 - 14
61/64	.9531	
31/32	.9688	
63/64	.9844	1 1/8 - 7
1	1.0000	
1 3/64	1.0469	1 1/8 - 12
1 7/64	1.1094	1 1/4 - 7
1 1/8	1.1250	
1 11/64	1.1719	1 1/4 - 12
1 7/32	1.2188	1 3/8 - 6
1 1/4	1.2500	
1 19/64	1.2969	1 3/8 - 12
1 11/32	1.3438	1 1/2 - 6
1 3/8	1.3750	
1 27/64	1.4219	1 1/2 - 12
1 1/2	1.5000	

PIPE THREAD SIZES (NPSC)

THREAD	DRILL	THREAD	DRILL
1/8 – 27	11/32	1 1/2 – 11 1/2	1 3/4
1/4 – 18	7/16	2 – 11 1/2	2 7/32
3/8 – 18	37/64	2 1/2 – 8	2 21/32
1/2 – 14	23/32	3 – 8	3 1/4
3/4 – 14	59/64	3 1/2 – 8	3 3/4
1 – 11 1/2	1 5/32	4 – 8	4 1/4
1 1/4 – 11 1/2	1 1/2		

METRIC TAP DRILL SIZES

METRIC TAP	TAP DRILL (mm)	DECIMAL (Inch)
M1.6 x 0.35	1.25	.0492
M1.8 x 0.35	1.45	.0571
M2 x 0.4	1.60	.0630
M2.2 x 0.45	1.75	.0689
M2.5 x 0.45	2.05	.0807
M3 x 0.5	2.50	.0984
M3.5 x 0.6	2.90	.1142
M4 x 0.7	3.30	.1299
M4.5 x 0.75	3.70	.1457
M5 x 0.8	4.20	.1654
M6 x 1	5.00	.1968
M7 x 1	6.00	.2362
M8 x 1.25	6.70	.2638
M8 x 1	7.00	.2756
M10 x 1.5	8.50	.3346
M10 x 1.25	8.70	.3425
M12 x 1.75	10.20	.4016
M12 x 1.25	10.80	.4252
M14 x 2	12.00	.4724
M14 x 1.5	12.50	.4921
M16 x 2	14.00	.5512
M16 x 1.5	14.50	.5709
M18 x 2.5	15.50	.6102
M18 x 1.5	16.50	.6496
M20 x 2.5	17.50	.6890
M20 x 1.5	18.50	.7283
M22 x 2.5	19.50	.7677
M22 x 1.5	20.50	.8071
M24 x 3	21.00	.8268
M24 x 2	22.00	.8661
M27 x 3	24.00	.9449
M27 x 2	25.00	.9843
M30 x 3.5	26.50	1.0433
M30 x 2	28.00	1.1024
M33 x 3.5	29.50	1.1614
M33 x 2	31.00	1.2205
M36 x 4	32.00	1.2598
M36 x 3	33.00	1.2992
M39 x 4	35.00	1.3780
M39 x 3	36.00	1.4173

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DECIMAL EQUIVALENTS

INCH/METRIC TAP DRILL SIZES & DECIMAL EQUIVALENTS

DRILL SIZE	DECIMAL EQUIV.	TAP SIZE	DRILL SIZE	DECIMAL EQUIV.	TAP SIZE	DRILL SIZE	DECIMAL EQUIV.	TAP SIZE
80	.0135		37	.1040	5 - 44	D	.2460	
79	.0145		36	.1065	6 - 32	1/4 E	.2500	
1/64	.0156		7/64	.1094		F	.2570	5/16 - 18
78	.0160		35	.1100		G	.2610	
77	.0180		34	.1110		17/64	.2656	
76	.0200		33	.1130	6 - 40	H	.2660	
75	.0210		32	.1160		I	.2720	5/16 - 24
74	.0225		31	.1200		J	.2770	
73	.0240		1/8	.1250		K	.2810	
72	.0250		30	.1285		9/32	.2812	
71	.0260		29	.1360	8 -32, 36	L	.2900	
70	.0280		28	.1405		M	.2950	
69	.0292		9/64	.1406		19/64	.2969	
68	.0310		27	.1440		N	.3020	
1/32	.0312		26	.1470		5/16	.3125	3/8 - 16
67	.0320		25	.1495	10 - 24	O	.3160	
66	.0330		24	.1520		P	.3230	
65	.0350		23	.1540		21/64	.3281	
64	.0360		5/32	.1562		Q	.3320	3/8 - 24
63	.0370		22	.1570		R	.3390	
62	.0380		21	.1590	10 - 32	11/32	.3438	
61	.0390		20	.1610		S	.3480	
60	.0400		19	.1660		T	.3580	
59	.0410		18	.1695		23/64	.3594	
58	.0420		11/64	.1719		U	.3680	7/16 - 14
57	.0430		17	.1730		3/8	.3750	
56	.0465		16	.1770	12 - 24	V	.3770	
3/64	.0469	0 - 80	15	.1800		W	.3860	
55	.0520		14	.1820	12 - 28	25/64	.3906	7/16 - 20
54	.0550		13	.1850		X	.3970	
53	.0595	1 -64, 72	3/16	.1875		Y	.4040	
1/16	.0625		12	.1890		13/32	.4062	
52	.0635		11	.1910		Z	.4130	
51	.0670		10	.1935		27/64	.4219	1/2 - 13
50	.0700	2 -56, 64	9	.1960		7/16	.4375	
49	.0730		8	.1990		29/64	.4531	1/2 - 20
48	.0760		7	.2010	1/4 - 20	15/32	.4688	
5/64	.0781		13/64	.2031		31/64	.4844	9/16 - 12
47	.0785	3 - 48	6	.2040		1/2	.5000	
46	.0810		5	.2055		33/64	.5156	9/16 - 18
45	.0820	3 - 56	4	.2090		17/32	.5312	5/8 - 11
44	.0860		3	.2130	1/4 - 28	35/64	.5469	
43	.0890	4 - 40	7/32	.2188		9/16	.5625	
42	.0935	4 - 48	2	.2210		37/64	.5781	5/8 - 18
3/32	.0938		1	.2280				
41	.0960		A	.2340				
40	.0980		15/64	.2344				
39	.0995		B	.2380				
38	.1015	5 - 40	C	.2420				

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Appendix C – Tap and Drill Sizes Quiz

Name: _____ **Total:** **/17 marks**

1. List the 4 ways that drills are designated: /4 marks

_____

2. 1/4 x 20 U.N.C. thread, 20 represents the_____? /1 mark

   a) major diameter
   b) number of threads per inch
   c) tap drill size
   d) hole size

3. 3/8 x 24 U.N.F thread, 3/8 represents the_____? /1 mark

   a) major diameter
   b) number of threads per inch
   c) tap drill size
   d) hole size

4. For a 1/2 x 13 U.N.C thread, the term U.N.C. stands for? /1 mark

   a) unified national colour
   b) under no condition
   c) universal number code
   d) unified national course

Using the tap drill chart provided, answer the following questions: /1 mark each

5. What size drill is needed to make a ¼-28 thread? _____

6. Give the drill size for a 5/8-18 thread. _____

7. Name the drill size to produce a 10-32 thread. _____

8. A 5/16-24 thread needs what size drill? _____

9. What size drill is required for a 7/8-9 tap? _____

10. Give the drill size needed for a ¾-16 tap? _____

11. What drill size is needed to make a 5/8-11 thread? _____

12. Name the drill size for a 3/8-16 thread. _____

13. What is the proper size drill to make a M6 x 1.00 thread? _____

14. Name the drill size for a M10 x 1.25 tap. _____ Total /10

Appendix D – Twist Drill Comparison Placemat

Using your class textbook for Manufacturing Technology or the Internet, research high speed steel, black oxide, titanium nitride and cobalt twit drills. State the properties of each twist drill and on what materials you would use each one.

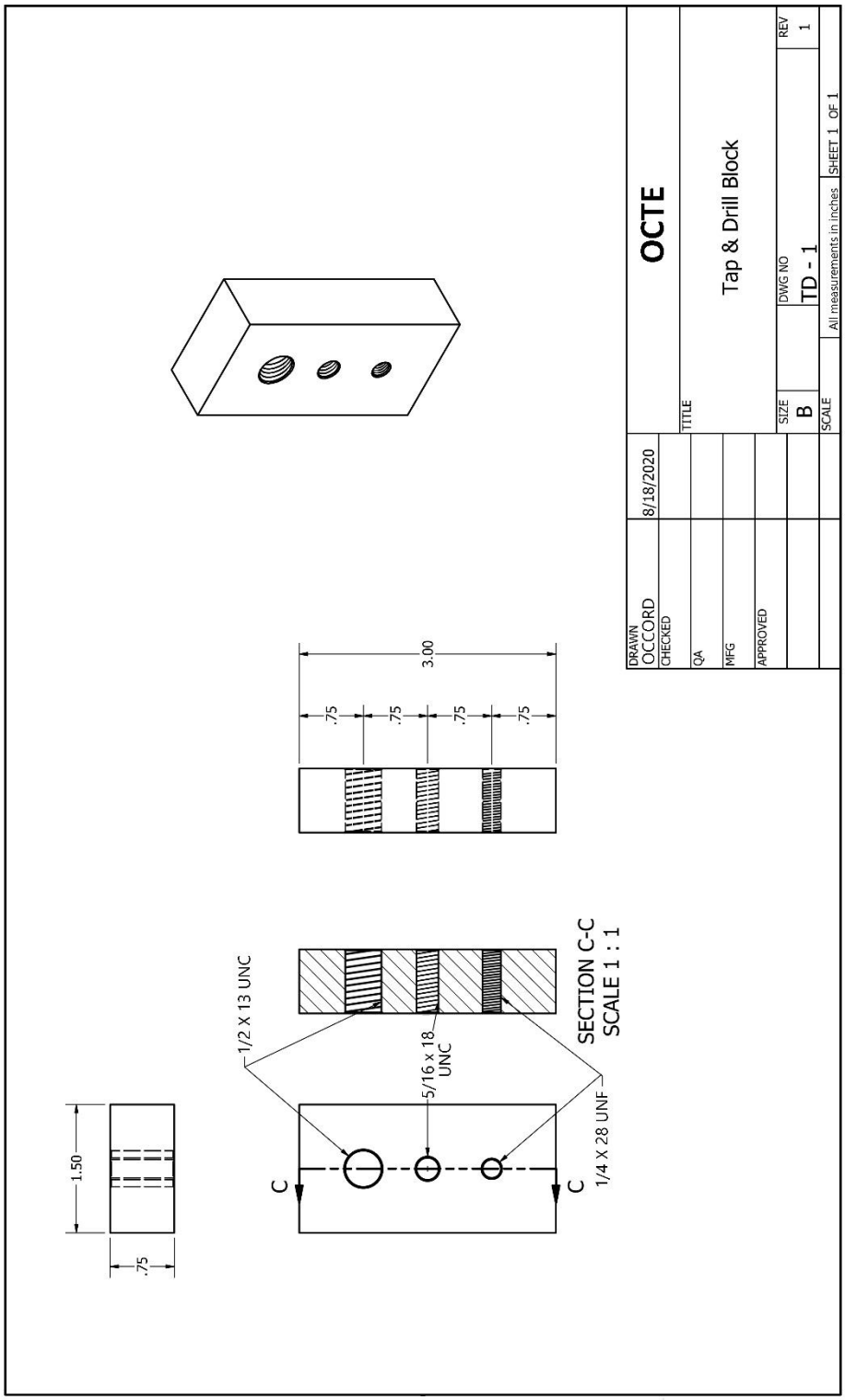
High Speed Steel (HSS)	Cobalt
Black Oxide	Titanium Nitride

Bonus: Research Carbide twist drills and cutting tools, and compare them to the list above

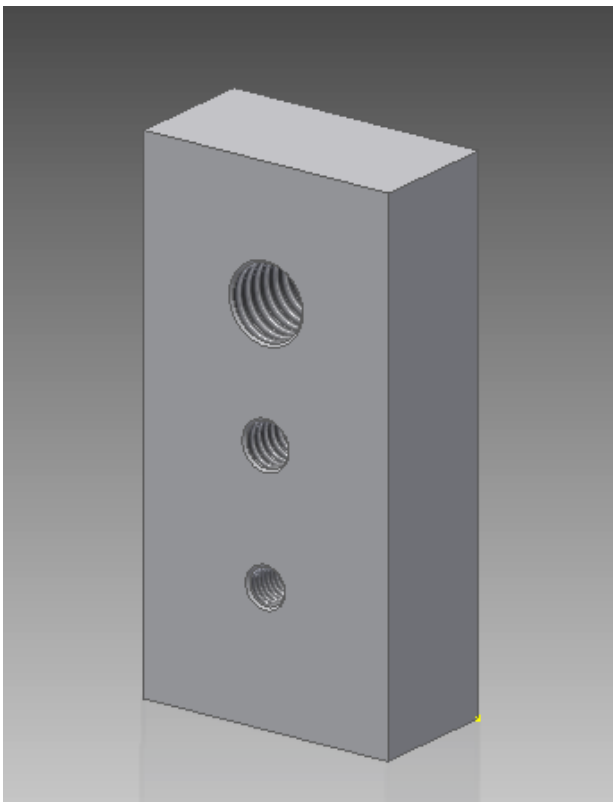
Appendix E – Drill and Tap Block Rubric

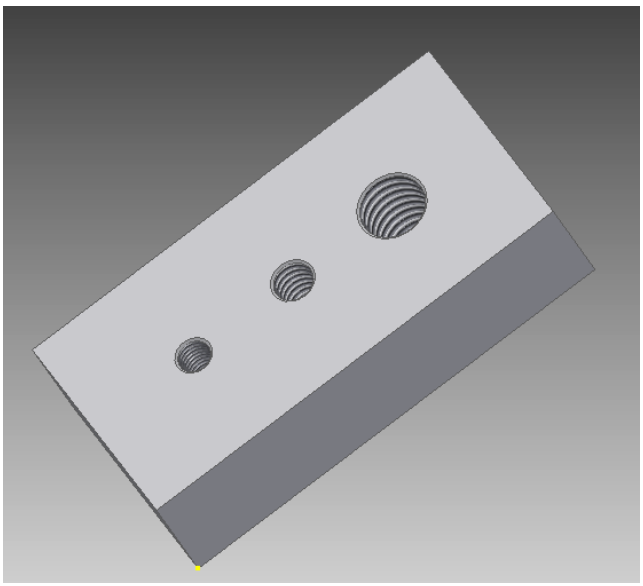
Category	Level 4	Level 3	Level 2	Level 1
Manufacturing	Student uses manufacturing processes to efficiently produce a product	Student uses manufacturing processes to produce a product	Student uses some of the manufacturing processes to produce a product	Student uses minimal manufacturing processes to produce a product
Layout	The layout of all three holes are in the correct position	The layout of two holes are in the correct position	The layout of one hole is in the correct position	All three holes are laid out but not one hole is correct
Tap Drill Sizes	All three tap drills are the correct size	Two of the tap drills are the correct size	One of the tap drills is the correct size	None of the tap drills are the correct size
Tools and equipment	Student uses tools (hand and machine), and equipment safely and to a high degree of accuracy to manufacture a product	Student uses tools (hand and machine), and equipment safely and correctly to manufacture a product	Student uses some of the tools (hand and machine), and equipment safely with assistance to manufacture a product	Student uses a limited number of the tools (hand and machine), and equipment under supervision and with assistance to manufacture a product
Overall Appearance	Project has been deburred, has no machining marks, and is accurate to 0.001" of specification	Project has been deburred, has very few machining marks to considerable accuracy (with – in tolerance)	Project has been deburred with moderate effectiveness. A few machining marks and/or rough edges are present	Project has burrs and sharp edges. Many machining marks and/or rough edges are present and is not accurate
Time Management	Class time was used wisely every day. Much time and effort went into the project	Class time was used wisely most days. Considerable time and effort went into project	Class time was used some days. The time and effort spent on the project could have been better	Class time was not used wisely. Little effort went into the project but the project was completed by due date
Comments				

Appendix F – Project Drawing/Blueprint



Appendix G – Project Reference Pictures





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