16.810: Engineering Design and Rapid Prototyping

(IAP 2004 course number: 16.682)

SolidWorks, CosmosWorks, Omax, and Water Jet Manual

Version 1.0 12/16/2003

Purpose

The purpose of this document is to provide a rough procedure of how to perform many of the tasks required of students in 16.810 (temporary class number 16.682 in IAP 2004). Basic procedures of how to model a part in *SolidWorks*, perform structural analysis using *CosmosWorks*, and how to use the computer-aided manufacturing (CAM) tools for manufacturing with a water jet cutter are detailed in this document. This document is not meant to be complete and questions should be referred to the instructors or to another reference document. A flow chart of the various tasks covered in this document is shown below in Figure 1.

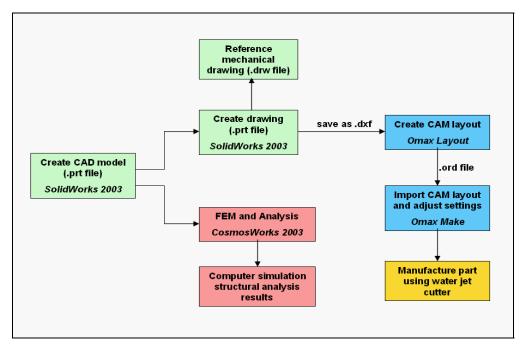


Figure 1 Flow chart

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Procedure for Creating SolidWorks CAD Model of a 2-D Part

- 1. Open SolidWorks 2003
- 2. File>New>Part>OK
- 3. Make sure units for the part are in inches
 - a. To verify what unit system is being used, click on Tools>Options>Document Properties tab>Units (in the tree) and verify that "Linear Units" are in inches.
- 4. Click on "Front" plane in model tree

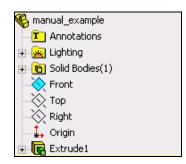


Figure 2 SolidWorks model tree window

- 5. Click on "Sketch" icon (upper right-hand corner)
- 6. Sketch part (see "40 minute start" section in *SolidWorks* manual for reference)
 - a. Use lines, arcs, etc. (icons found on right-hand side of window)
 - b. Dimension the sketch appropriately using the dimension icon \swarrow
 - i. Lines in the sketch will turn black (initially blue) when fully dimensioned
 - c. When finished, click on the sketch icon with the arrow in the upper right-

hand corner of the sketch window

- 7. Extrude the sketch to create a 3-D model of the bicycle frame design
 - a. Click on the "Extrude" icon in the top of the left-hand side column of icons
 - b. In the "Extrude" dialogue box, input the desired thickness of the part
 - c. Click on the green check mark to complete the extrusion

Extrude1
Direction 1
🔁 Blind 💌
🔥 0.50in
Direction 2

Figure 3 Extrude dialog box

- 8. How to manipulate the view of the part in the SolidWorks window
 - a. To spin the part, hold down the middle mouse button and move the mouse
 - b. To zoom in on the part, point the cursor on the desired area to zoom in/out and scroll the mouse wheel up/down
 - c. To translate the part, hold down CTRL and the middle mouse button and move the mouse
- 9. Save the part to file
 - a. File>Save As...>partname.prt

Procedure for CosmosWorks Structural Analysis of CAD Model of a 2-D Part

- 1. Open CosmosWorks 2003
- 2. File>Open>partname.prt>OK
- 3. Click on "CosmosWorks Manager" tab at the bottom of the FeatureManager tree
- 4. Right-click on the part in the FeatureManager tree and select "Study..."
- 5. Fill out Study dialog box
 - a. Type in a desired name for the study under "Study Name"
 - b. Select "Static" in the box under "Analysis Type"
 - c. Select "Solid mesh" in the box under "Mesh type"

Study name	Analysis type	Mesh type	Properti
static-1	Static	Solid mesh	
- ALALIA ALALIANA DALAM			Delet
			ОК
-			
			Cano
			Help

Figure 4 Study dialog box

- 6. Set material properties for the part
 - a. Right-click on the part name under "Solids" in the model tree
 - b. Click on "Apply/Edit Material..."
 - c. Make sure library file source is **Coswkmat.lib**
 - d. In the material tree, open Aluminum Alloys and select 6061 alloy
 - e. Make sure the "Type" under "Material model" is set to "Linear Elastic Isotropic"
 - f. Click OK when finished

ect material source	Material r	nodel		
Input	Type:	Linear Elastic Isotropic 📃 🔄	-	
User Defined	Units:	English (IPS) 👻		
Centor library Launch	orika. j			
Library files	-	-		
	Property	Description	Value	Units
oswkmat.lib 👻	EX	Elastic modulus	10009317	psi
	NUXY	Poisson's ratio	0.33	NAN
🚇 Aluminum Allo 🔨	GXY	Shear modulus	3771626.7	psi ho
B Aluminum	DENS	Mass density	0.097543705	lb/in^3
B 1345 Alloy	SIGXT	Tensile strength	17999.943	psi
- 🗈 1350 Alloy	SIGXC	Compressive strength		psi
- 1330 Alloy	SIGYLD	Yield strength	7999.9828	psi
- 19 2018 Alloy	ALPX	Thermal expansion coefficie	1.3333333e-005	/Fahrenheit
	KX	Thermal conductivity	0.0022743866	BTU/(in.s.F)
	C	Specific heat	0.31055901	Btu/(Ib.F)
- 🗈 3003 Alloy	20	1152		

Figure 5 Material dialog box

- Define boundary conditions

 Right-click on "Load/Restraint" in the tree
 - b. Select "Restraints"
 - c. Under "Type," select "Reference Plane or Axis"

Restraint
Туре
Reference plane or axis 💌 Selected entities
Face<1> Face<2>
Selected reference
Front
Displacement
Units: in 💌
in [0] in [7]

Figure 6 Restraint dialog box

d. Hold CTRL and pick the inside surfaces of the two fixed holes (in green)

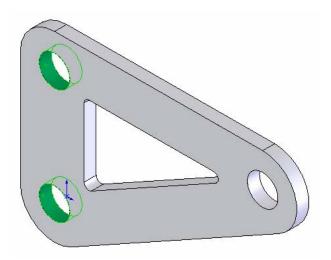


Figure 7 Selection of restraint surfaces

- e. In the restraints dialog box, click on each displacement icon and leave the value of the displacement set to 0 (fixed in X,Y, and Z directions)
- f. Click the check mark when done

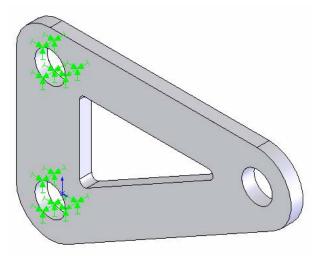


Figure 8 Restraints defined

- 8. Define loads in the model
 - a. Right-click on "Load/Restraint" in the tree

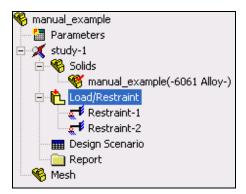


Figure 9 Load/Restraint in model tree

- b. Select "Force"
- c. Click on the inside surface of the hole at which to apply the load
- d. In the "Force" dialog box, click on the icons in the "Force" section to "turn on" the force in specific directions (X, Y, or Z)
 - i. Note that the X, Y, and Z directions of force depend on the default coordinate system orientation in your model. To verify the coordinate system orientation with respect to your model, look at the orientation of the coordinate system in the lower left-hand corner of the model window.
- e. Input the desired load magnitudes in the desired directions (loads should be in English units [Lbf])

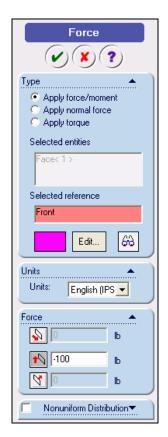


Figure 10 Force dialog box for load on 2-D part

- f. Click the green check mark when finished
- g. Repeat steps a through f for the second hole at which load is applied

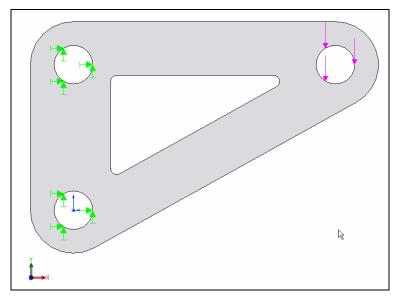


Figure 11 Result of force and restraint definitions (2D view)

- 9. Create desired mesh on part to analyze
 - a. Right-click on "Mesh" in the tree and select "Preferences"
 - b. Edit mesh preferences
 - i. Under "Mesh Quality," select "High"
 - ii. Under "Mesh Control," select "Smooth Surface"
 - iii. Under "Mesher Type," select "Standard"
 - iv. Set "Jacobian Check" to "4 Points"
 - v. Click OK

	juage i	7 Plot
General Units Ma	terial Mesh	Results
Mesh quality C Draft • High	Mesher type Standard Alternate	
Jacobian check: 4 Points Mesh control Automatic transition Smooth surface		
Automatic looping Enable automatic looping for s No. of loops: Global element size factor for each Tolerance factor for each loop:	3	
Visual settings		
Boundary color Shell bottom face color	Edit	

Figure 12 Mesh preferences dialog box

- c. Create mesh
 - i. Right-click on "Mesh" in the tree and select "Create"
 - ii. "Mesh parameters" dialog box will appear1. Adjust mesh properties if desired

Mesh	
()	
Mesh Parameters:	
Coarse ^ Fine	
0.18848463 in	
110.0094242315 in	
Reset to default size	
🗖 Run analysis after meshing	
Preferences	

Figure 13 Mesh properties dialog box

d. To display detailed information about the mesh, right-click "Mesh" in the tree and select "Details"

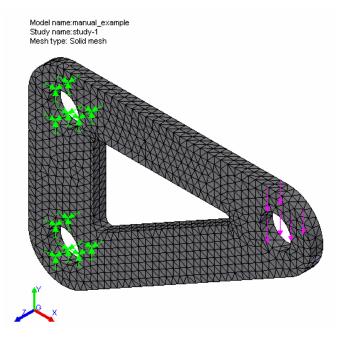


Figure 14 Mesh result with restraints and loads displayed

- 10. Perform structural analysis
 - a. In the model tree, right-click on the study created and click "Run"

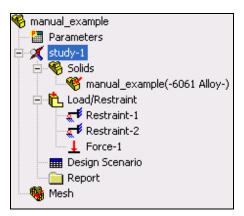


Figure 15 Model tree highlighting study to select to run analysis

- 11. Display results of analysis
 - a. After analysis has been run, additional folders will appear in model tree

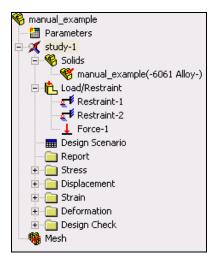


Figure 16 Model tree after analysis with result folders

- b. Display von Mises stress results
 - i. Click the plus sign beside the "Stress" folder
 - ii. Double-click on "Plot1" and the stress plot is displayed

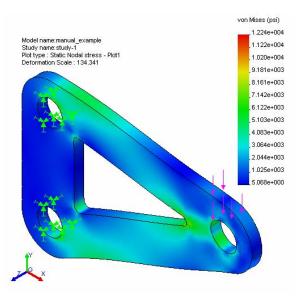


Figure 17 Stress analysis result plot

- c. Display resultant displacement
 - i. Click the plus sign beside the "Displacement" folder
 - ii. Double-click on "Plot1" and the displacement plot is displayed
 - iii. Read displacements at surface being measured during the structural testing phase (surface circled in figure below)

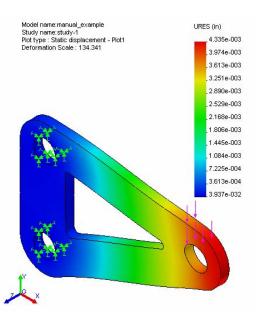


Figure 18 Displacement analysis result plot

- d. Procedure to display displacements (magnitudes) at specific nodes on the part
 - i. Create a new displacement plot
 - 1. Right click on "Displacement," click "Define..."
 - 2. Click on the "Display" tab, select plot type to be "Vector," and select fringe type to be "point"
 - 3. Select component as the displacement in the desired direction (X, Y, or Z) and click "OK"

Displacement plot	×
Properties Display Settings	
Mode shape no.: 1	
Plot Type	
C Fringe C Vector C Section C Iso	
Fringe type: Filled, Gouraud 💌	
Selected reference geometry	
N/A	
Component	
UX: Displacement(X-dir.)	~
UZ: Displacement(Z-dir.)	
URES: Resultant displacement RFX: Reaction force(X-dir.)	
RFY: Reaction force(Y-dir.) RFZ: Reaction force(Z-dir.)	~
OK Cancel Apply H	elp

Figure 19 Displacement plot definition dialog box

- ii. Right-click on new displacement plot and click "List Selected"
- iii. In the model window, click on a surface, edge, or vertex on which to determine the displacements at the nodes on that entity
 - 1. Please note that you will need to select a surface, edge, or vertex on the *non-deformed* part. This part may not be visible, but the available surfaces, edges, and vertices on the non-deformed part can be selected from the screen. They will be outlined in red when the cursor is over one of the entities that can be selected. See figure below.

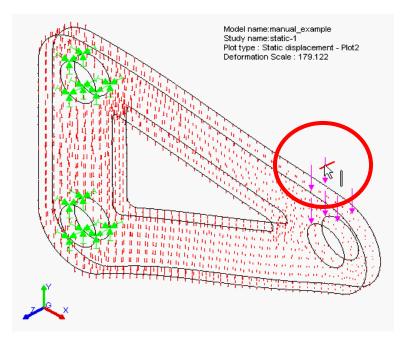


Figure 20 Selection of part feature on which to measure displacement

- iv. Click "Update" in the List Displacements dialog box
- v. Displacement results are then displayed for the nodes on the surface, edge, or vertex selected along with the sum and average of the calculated displacements.

List Selec	:ted	×
	Static displacement on Scale : 134.341 UY (in) -0.0038974 -0.0038977 -0.0038956 -0.0038963 -0.0038961 -0.019483	nt - Plot5 Selected reference: N/A Selected items: 1 Edge Sum:
		-0.019483
		Average:
		-0.0038966
Save	Update	Close Help

Figure 21 "List Selected" dialog box displaying node displacements

- e. Procedure to determine mass properties of the part
 - i. In the top toolbar, click on Tools>Mass Properties
 - ii. Check to make sure correct density is being used to calculate mass properties

🚺 Mass Proj	perties				>
Print	Сору	Close	Options	Recalculate	
Output coordin	ate system: 🖳	default			-
		anual_example.SLD	PBT		
Sele	cted Items:				
	•	Include Hidden Bo	dies/Componei	nts	
Show outp	ut coordinate s	ystem in corner of w	vindow		
Mass properties	of manual_exa	mple			ġ
Output coordina	ate System: c	lefault			
Density = 0.10 p	ounds per cub	ic inch			
Mass = 0.29 pou	inds				
Volume = 2.85 c	ubic inches				
Surface area = 3	30.20 square in	iches			
Center of mass: X = 1.64 Y = 1.61 Z = 0.13	(inches)				
		ncipal moments of ir	nertia: (pounds	* square inche:	s)
Taken at the ce	nter of mass. 0.34, 0.00)	Px = 0.23			
	0.34, 0.00)	Pv = 0.23			
lz = (0.00,	0.00, 1.00)	Pz = 1.01			
Moments of iner			r		
Lxx = 0.29	nter or mass ar	nd aligned with the o Lxv = 0.18		te system. z = 0.00	
Lyx = 0.18		Lyy = 0.72	Lyz	2 = 0.00	
Lzx = 0.00		Lzy = 0.00	Lzz	2 = 1.01	
Moments of iner					
Taken at the ou lxx = 1.04	tput coordinate	e system. Ixv = 0.93	luz	= 0.06	
lyx = 0.93		1xy = 0.00		= 0.06	
lzx = 0.06		lzy = 0.06		= 2.52	į.
UP I					21.

Figure 22 Mass properites window

iii. If density is wrong, click on the "Options" button at the top of the mass properties window and change the density in the options window

Measurement	Options		×
Units Length unit —	Inches	•	2
and the second second	Denominator: nearest fraction	2 .	
- Angular unit -	Degrees Decimal places:	• 2 ÷	
 View measure View globa View system 	-		
- Material Propert Density:	ies 0.1 lb/in^3	_	
	ss/section property roperty precision (S Cancel		

Figure 23 Mass properties options dialog box

- f. Procedure to display critical regions of part (check part factor of safety)
 - i. Click the plus sign beside the "Design Check" folder
 - ii. Double-click on "Plot1" and a design check wizard dialog box appears
 - iii. In step 1, make sure the criterion is set to "Maximum von Mises stress"
 - iv. In step 2, make sure stress limit is set "to Yield strength" (determined from materials database)
 - v. In step 3, to see unsafe regions in the part, make sure "areas below factor of safety" is selected and input a desired factor of safety limit that you are using for your design
 - 1. A factor of safety distribution can also be displayed by selecting "Factor of Safety distribution" in the "Plot Results" section of the step 3 dialog box.
 - 2. Notice that in the step 3 dialog box a factor of safety for the part is displayed in the "Safety result" section of the window. This factor of safety is a good indicator of the structural performance of the part being analyzed.

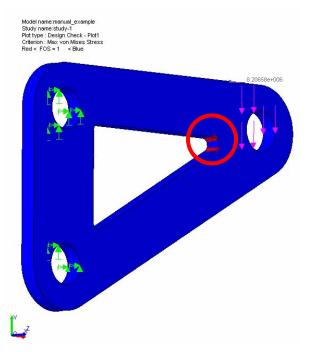


Figure 24 Design check plot showing areas with a factor of safety below 1 (red, circled)

- g. A report can be generated by right-clicking on the "Report" folder in the model tree and clicking "define"
 - i. Fill out the required fields and click "ok" to generate an HTML report of the part structural analysis.

Design Check Wizard Step 1 of 3 🛛 🔀	Design Check Wizard Step 2 of 3 🛛 🛛 🔀
Component:	Material: 6061 Alloy Source: COSMOS
 Maximum von Mises stress Maximum shear stress (Tresca) 	Yield strength: 8000 lb/in^2 Ultimate strength: 1.8e+004 lb/in^2
Mohr-Coulomb stress Maximum normal stress	Set stress limit to Yield strength to Ultimate strength
Information Design goal: $\frac{\mathcal{O}_{walkdases}}{\mathcal{O}_{timit}} < 1$	C to: 8000 lb/in^2 Max stress result von Mises stress: 1489
< Back Next > Cancel Help	Von Mises stress: 1465 ID/in 2 Kext > Cancel Help

Design Check Wizard Step 3 of 3	×
Safety result	
Based on the maximum von Mises stress criterion;	
Factor of safety = 5.374	
Plot results	
C Factor of safety distribution	
C Non-dimensional stress distribution	
Areas below factor of safety 1	
< Back Finish Cancel Help	

Figure 25 Design check wizard dialog boxes

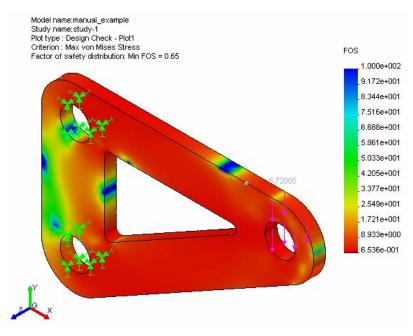


Figure 26 Factor of safety distribution plot

Procedure for Creating SolidWorks Drawing of a 2-D Part

- 1. Open SolidWorks 2003
- 2. File>New>Drawing>OK
- 3. Click OK for default drawing template
- 4. Insert>Drawing View>Standard 3 View
- 5. Right-click in drawing and then select "Insert from file"
- 6. Pick desired SolidWorks part to import into drawing
- 7. Move desired view of part (top-down view) into the center of the drawing (make sure it is not being overlapped by any other lines in the drawing)
 - a. Click on the desired drawing view
 - b. When a green line surrounds the view, click on the green edge and drag the view to a location of your choice

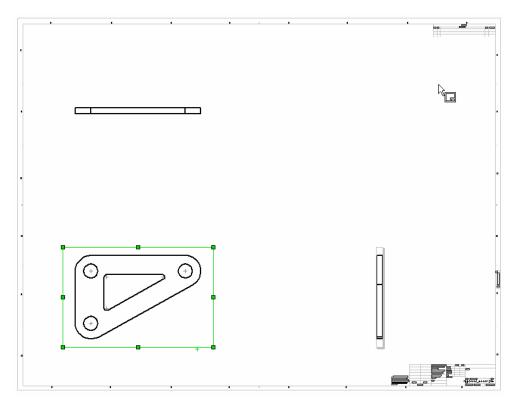


Figure 27 SolidWorks drawing view with desired view of part selected

8. File>Save As...>(choose *.dxf as file type)>*filename*.dxf

Procedure for Creating Omax Layout of a 2-D Part

- 1. Open Omax Layout
- 2. File>Open>filename.dxf
- 3. Erase all lines except for desired water jet cutting pattern
 - a. Right-click on the "Erase" icon (bottom of screen)>click "window"



b. Delete all lines on screen using the erase window until only the desired cutting path for the water jet remains

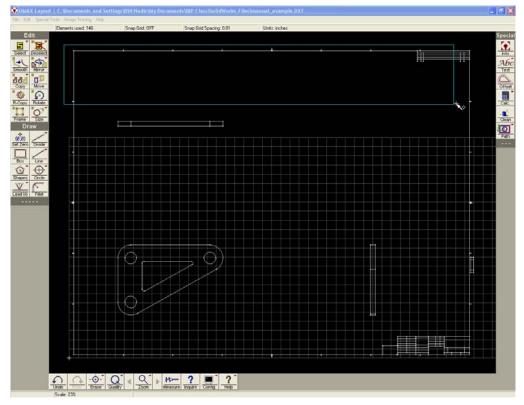


Figure 28 Erasing unwanted lines in Omax Layout

- 4. Click on the "Clean" icon (right-hand side of screen)
- 5. Make sure every item in the "Clean" dialogue box is checked, then click "OK." (The software automatically removes duplicate entities and closes small gaps)

n(¹

Setti	-		
~	Divide over	lapping entities	N
☑	Erase dupli	6	
1	Close gaps	shorter than	
	0.01	inches	
•	Remove un	necessary "dots".	
1	Remove en	tities shorter than	
	0.0001	inches	
~	Remove un	closed paths	

Figure 29 Omax Layout "clean" dialog box

- 6. Resize part due to potential scaling error of imported DXF file
 - a. Click on the "Size" icon (left-hand side of screen)
 - b. Input desired width or height of part to scale the part to the correct size
- 7. Move part into the grid in the lower left-hand corner of the workspace by



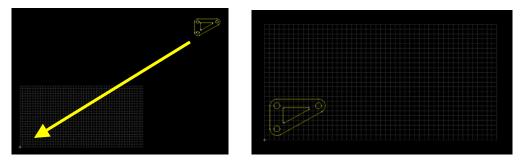


Figure 30 Before and after moving part in Omax Layout

- 8. Right-click on "Deselect" icon (left-hand side of screen)>Click "All"
- 9. Set cutting quality for part
 - a. Type "Q" then "A" (brings up quality selection dialogue window for all curves)

P	\vailable	e Qualitie	s								2		×
	T	T	1	2	3	4	5		е	S	W	$\underline{\checkmark}$	\times
1	Fraverse	H.U.Trv	<u>1</u>	2	3	<u>4</u>	<u>5</u>	Min Tpr.	Etch	Scribe	H20 Only	Lead i/o	Close

Figure 31 Omax Layout cut quality dialog box

- b. Click on "5" to set a quality level of 3 (medium quality) for all part edges (curves should change to a magenta color)
- c. Type "Q" again and click on a quality level of 5 and then click on the curves which cut the faces of the part which face the lasers for displacement measurement as well as the mounting holes (these curves should turn to a blue color)
- 10. Set water jet cutting lead-in and finishing paths



- a. Right-click on "Lead i/o" icon (left-hand side of screen) Lead i
- b. Click "AutoPath (quick)"
- 11. Modify lead-out path (The goal is to make sure nozzle moves far away from cut part when cutting is finished and to make it clear when the cutting job is complete.)
 - a. Click on the "Line" icon (right-hand side of screen)
 - b. Click on the "End" icon which appears at the bottom of the screen (this will attach the line to the end of the desired curve)
 - c. Click on the end of the tan-colored line (end of the path) and extend it far away from the part to move the water jet cutter away from the manufactured part when it is finished (make sure to not move the nozzle into a lead block or the tank side)
- 12. Set path for water jet cutter
 - a. Click on the "Path" icon on the right-hand side of the screen Path
 - b. Set the starting point by clicking on the end of the first traverse (green) line drawn
 - c. Click "Save" to save path information (saves the information to an ORD file: *filename*.ord)

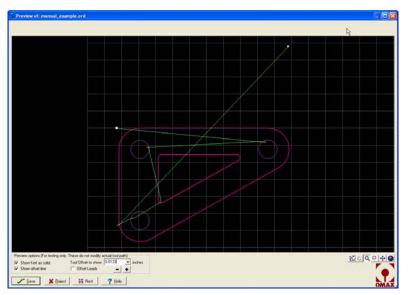


Figure 32 Omax Layout "Path" creation window

Procedure for Manufacturing a 2-D Part

- 1. Sign in and put on protective goggles when you enter the machine shop
- 2. Turn on water to water jet cutter
 - a. Located on wall behind Omax computer terminal



Figure 33 Turning water on/off to water jet cutter

- 3. Turn power on to water jet system
 - a. Turn outer metal ring on the right-hand side of the computer terminal clockwise (hidden in picture)



Figure 34 Location of power switch to water jet system

- 4. Turn on power to water jet pump
 - a. Located on left-hand side of computer terminal stand



Figure 35 Turning on/off power to water jet cutter

- 5. Turn on personal computer located next to the water jet cutter
- 6. Run Omax Make software
- 7. File>Open>*filename*.ord (will need ORD file on a 3.5" floppy disk to load into computer at water jet cutter)
- 8. Click on "Change Part Setup" icon
 - a. Check material, thickness, and tool offset information and change if necessary
 - b. Make sure low pressure boxes are left unchecked use high pressure setting

C:Wocuments and Setting	s\Bill Nadir\Wy Docu	ments\IAP Class\SolidWo	orks Files\manual_example.o	rd 📃 🗖 🔀
Chose tool path for machining:		Preview: (39 elen	nents) 10.1172 x 11.4515 inches	5
🖃 c: (bill) 💽				
C:\ Documents and Settings Bill Nadir My Documents IAP Class SolidWorks Files work	bicycle_frame_test1.ord bicycle_frame_test2_line: bicycle_frame_test3.ord manual_example ord waterjet_test_1.ord	e.ord		
		32 Nest		₽ ⊕ ⊕
Enter your Material Setup here:	M 11 175	Cut Settings	using Low Pressure	
Material: Metal: Aluminum (6061)	Machineability	1		
		Etch Speed: 50	In/min 🔽 Low pressure	
Thickness: 0.25	inches	Scribe Speed: 50	In/min 🔽 Low pressure	
Tool Offset: 0.0133	inches	Water Only Speed: 100	In/min 🔽 Low pressure	
Rotation: 0	degrees	Pierce Settings		
Scale: 1		Use Low Pressure	Wiggles to pierce:	
Scale: 1	×	🔲 Very Brittle Material	0	
Cancel	? <u>H</u> elp			OMAX

Figure 36 *Omax Make* "Change Part Setup" dialog box

- 9. Once the "Change Part Setup" dialog box is filled-out correctly and the "OK" button is clicked, Omax Make imports the cut path information and estimates manufacturing time, manufacturing cost, and amount of abrasive required for the cutting operation (circled in the following figure).
- 10. *Omax Make* can also display the cutting speed and cut direction along the cutting curves.
 - a. To display cut speed, click on the "Preview to Screen" icon
 - b. To display the cut directions, click on the \square icon at the bottom of the *Omax Make* window.

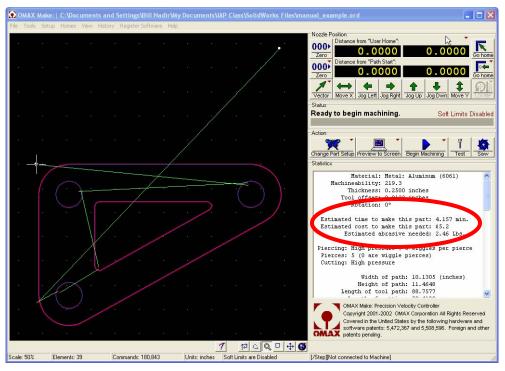


Figure 37 Omax Make window

- 11. Fill out water jet cutter machine log (2 sections)
 - a. Read machine time off of water jet power control box before starting any machining.

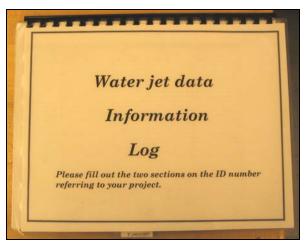


Figure 38 Water jet data information log book

- 12. Put on latex gloves before using the water jet cutter
- 13. Prepare the water jet cutter for manufacturing part
 - a. Make sure the water jet cutter has enough abrasive for desired cutting operation

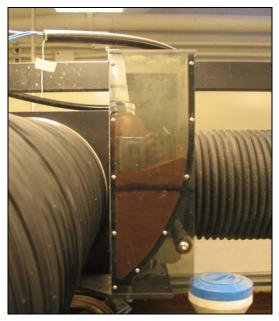


Figure 39 Abrasive container for water jet cutter

- b. Make sure water level in water jet cutter is lowered (below the metal grate)
 - i. If it is too high, lower the water level by using the lever on the computer terminal
- c. Make sure the water jet nozzle is raised up about 12 inches above the metal grate to allow room for placing manufacturing material in the cutter
 - i. Raise nozzle with the circular knob on nozzle shaft and tighten with black lever arm on upper part of shaft
- d. Place material on metal grate (your aluminum sheet)
- e. Locate and orient material so as to make the cuts as they appear in the *Omax Make* window
- f. Use lead bricks provided to weigh-down the aluminum plate to prevent it from moving (**IMPORTANT**: wear protective gloves for this step)



Figure 40 Setup of part to cut with water jet cutter

- g. Move the water jet nozzle above the desired starting position (home position)
 - i. Use the arrow keys on the keyboard to move water jet nozzle



Figure 41 Nozzle position window

- h. Once nozzle is in the desired home position, click on the "000>Zero" icon in the upper right-hand corner of the screen to specify the origin (0,0) of the water jet cutting nozzle
- i. Note that the "right" and "down" directions shown in arrows in the following figure are identical to "right" and "down" in the *Omax Make* window.

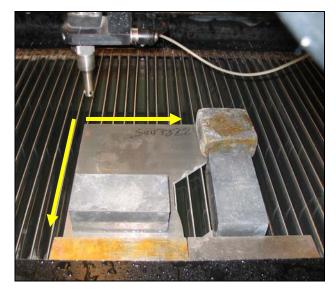


Figure 42 Nozzle positioned at desired (0,0) location (home)

- j. Place the plastic sponge on the end of the nozzle as shown in the figure
- k. Lower the nozzle to within approximately 0.030" of the material to be machined
 - i. Use .030" shim stock as a guide to measure the offset
 - 1. A large enough gap between the nozzle and material should be left such that the shim stock can slide between the two references.



Figure 43 Positioning the height of the water jet cutter nozzle

ii. Tighten the nozzle firmly at the correct height offset



Figure 44 Location of lever to lock-in desired height of water jet cutter nozzle

- 1. Raise water level to just below overfill valves along the inner sides of the water jet cutting tank
 - i. Water should be covering the material to be machined and the nozzle end
 - 1. The water reduces the noise level during machining
 - 2. If the machining noise level is intolerable, hearing protection is provided.

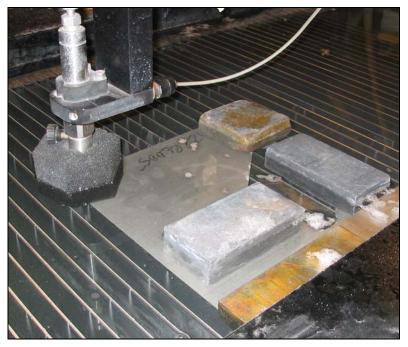


Figure 45 Water level raised - ready to begin machining

- 14. Double check everything
- 15. **IMPORTANT**: Emergency stop of the water jet cutter can be accomplished by hitting the spacebar on the computer keyboard or tripping the master power switch
- 16. Once you are certain everything has been setup properly, click on the "Begin

Machining" icon on the right-hand side of the screen Begin Machining

17. If you are sure you are ready to start cutting, click the "Start" icon (This will start the cutting process!)

OMAX Path	Control			
Warning: Operations here may activate the cutting head.	Elapsed:00:00:00:00 Cycles remaining: 1	Remaining: 00:00:00:00 Wiggles to pierce: 0		
	Backup Start	Ahead Pause		
X Close	? Help	OMAX		

Figure 46 Begin machining dialog box



Figure 47 Water jet cutter in operation

- 18. Once the cutting is finished, lower the water level below the cut material
- 19. Raise the water jet cutting nozzle to a height above the sides of the tub and sure it is tightened well
- 20. Wash all materials in water tank off with water from hose
 - a. Hose is located on left side of water jet cutter (near computer)
- 21. Remove material, cut piece, and weights in such a way as to not drop any pieces through the metal grate into the water tank
- 22. Take cut piece over to the right-hand side of the water jet cutter and clean the piece using the compressed air gun
- 23. Debur all edges of the finished part using tool provided
 - a. Simply scrape the deburring tool along the edge of the part TOWARDS YOU until edges are no longer sharp
- 24. Clean up any mess you have made around the water jet cutter
- 25. Complete water jet cutter log book entries (2 sections)
- 26. Remove your disk from the computer
- 27. Turn power off for water jet system (metal ring on right-hand side of computer)
 - a. This will shut down the computer and turn off the water pump
- 28. Turn off water to the water jet cutter
- 29. Congratulations, you are now finished!