LA-UR-15-25886
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Title: Tool and Fixture Design

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Intended for: Poster session for student symposium

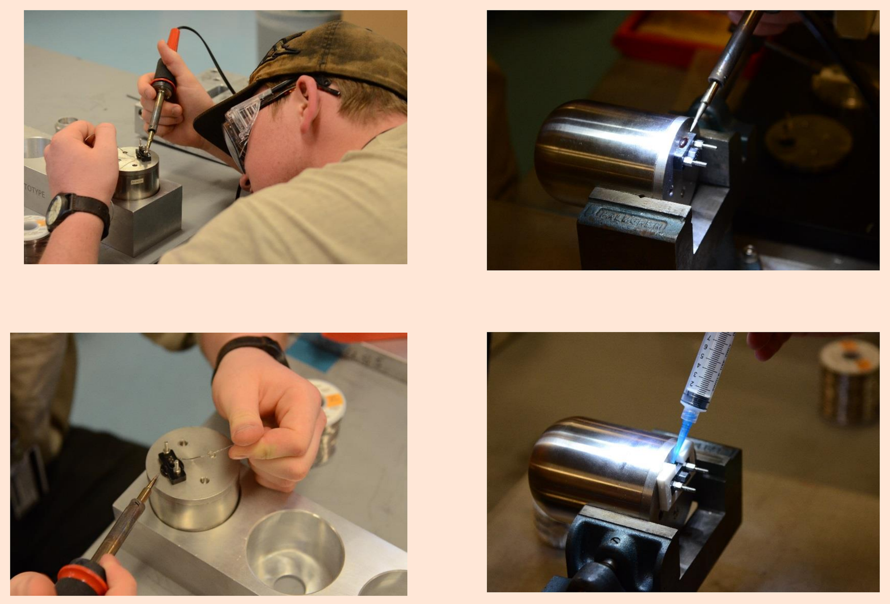
Issued: 2015-07-28

Introduction

In a manufacturing process, a need is identified and a product is created to fill this need. While design and engineering of the final product is important, the tools and fixtures that aid in the creation of the final product are just as important, if not more so. Power supplies assembled at the TA-55 PF-5 have been designed by an excellent engineering team. The task in PF-5 now is to ensure that all steps of the assembly and manufacturing process can be completed safely, reliably, and in a quality repeatable manner. One of these process steps involves soldering fine wires to an electrical connector. During the process development phase, the method of soldering included placing the power supply in a vice in order to manipulate it into a position conducive to soldering. This method is unacceptable from a reliability, repeatability, and ergonomic standpoint. To combat these issues, a fixture was designed to replace the current method. To do so, a twelve step engineering design process was used to create the fixture that would provide a solution to a multitude of problems, and increase the safety and efficiency of production.

The Issue

The current procedure (below) shows the current method of soldering.



This technique has been notably inconsistent and not ergonomic.

Any fixture that would replace the current fixtures must fit the requirements (below)

Requirements for Soldering Fixture
General:
Design a fixture to hold power supply while it is soldered
Details: Needs
Holds power supply axis parallel, perpendicular, and at a 45 degree angle down to table top
Allows full rotation around power supply axis
View to connector pins should be clear for use of microscope
Details: Optional
Incorporation of lighting
Minimize footprint to save space
Should be easily picked up

This fixture can also be used for potting, a process that requires putting resin in the gap surrounding the newly soldered wires and baking in a furnace to cure the resin. To also be useful for completing this process the fixture must fit the requirements (below).

Requirements for Potting Fixture
General:
Design a fixture to hold a power supply while potting
Details: Needs
Should be able to withstand 100C temperature
Should fit in 9" diameter x 11" cylinder
Should fit in thermotron, 10" tall
Holds one power supply
Should be easily removed from bottom of 9x11 cylinder
Holds power supply axis parallel to table top
Allows full rotation around power supply axis, OR locates electrical connector correctly for potting

Methods

1. Identify forces driving design
2. Identify constraints
3. Identify user needs
4. Identify design specs
5. Analyze problem and context
6. Plan design process
7. Develop concepts/best options
8. Parametric/system level design
9. Tolerance level design
10. Testing; production design
11. Evaluate/review design
12. Communicate results

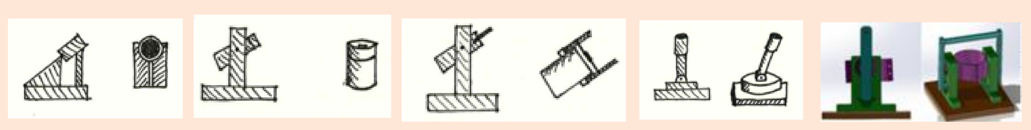
To start developing concepts, research into already existing fixtures was preformed.

To determine the best possible design, a concept evaluation matrix that compares each design with the standard (vice grip) and quantifies the results was created

Concept Evaluation

Criteria		Baseline	Fixture #1	Fixture #2	Fuxture #3	Fuxture #4	Fuxture #5
Varying Rotation	15%	Vice	-1	1	1	0	1
Rotation Along Power Supply Axis	20%		1	-1	-1	1	1
Mobility	10%		0	1	1	1	2
Minimized Size	10%		-1	1	1	0	1
Should not Obstruct Pins	20%		1	-1	1	1	1
Withstand temperatures of 100C	10%		1	1	1	1	1
Simplicity	15%		2	1	0	0	0
	100%						
	Total		3	3	4	4	7
	Weighted Total		0.55	0.2	0.45	0.6	0.95

Fixture #1 Fixture#2 Fixture#3 Fixture #4 Fixture #5



This evaluation matrix compared five general ideas that appeared in the evolution of this project. Fixture #5 received the highest numerical score and was determined to be the most efficient design.

Concept Evaluation

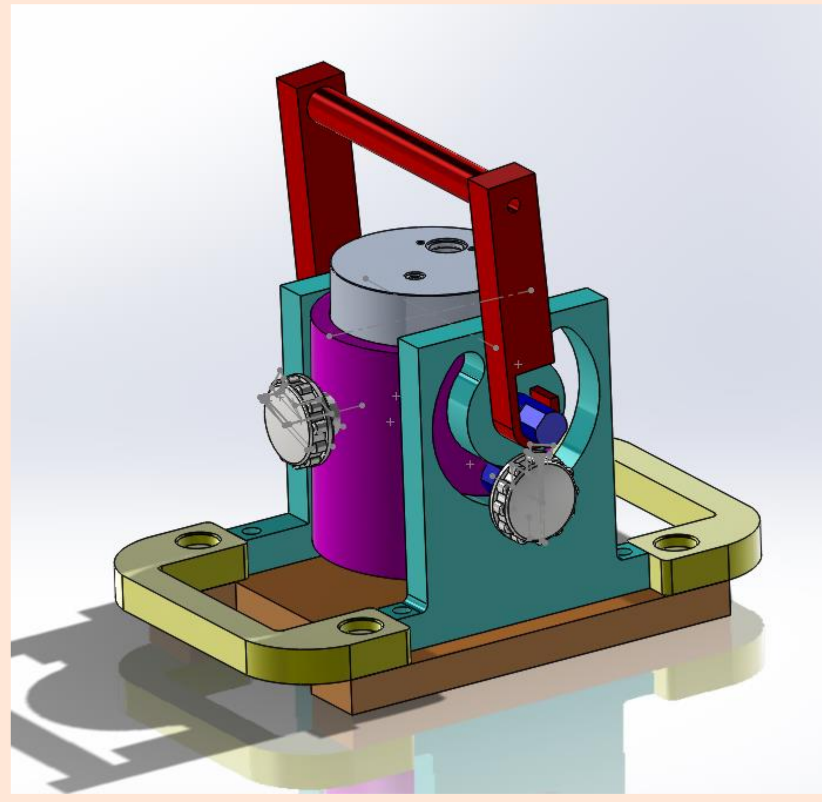
Criteria		Baseline	Handle #1	Handle #2	Handle #3
Mobility	25%	Spaces to grip vice (no handle)	1	1	1
Simplicity	25%		0	1	2
Should not Obstruct Pins	25%		0	1	2
Minimized Size	25%		-1	1	2
	100%				
	Total		0	4	7
	Weighted Total		0	1	1.75

Handle #1 Handle #2 Handle #3

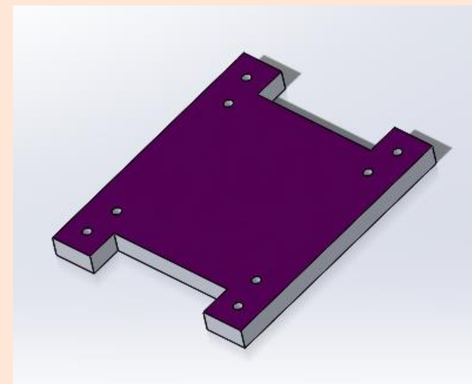
A second evaluation matrix was created to determine the best handle. Both option two and three were chosen; they both make the fixture easier to handle in different ways.

Results

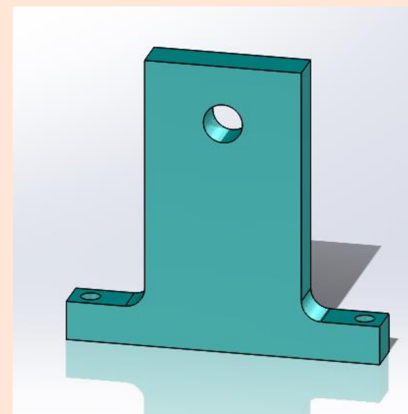
Parts designed for machining



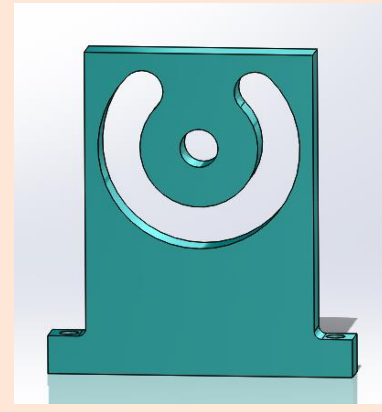
Full Assembly



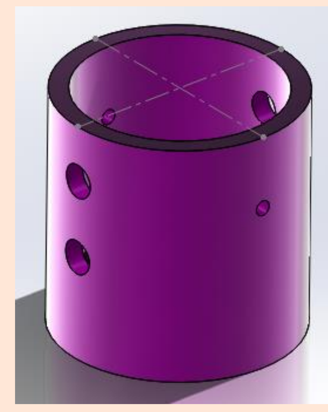
Base



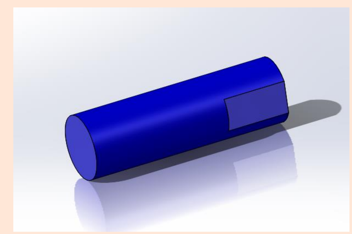
Arm A



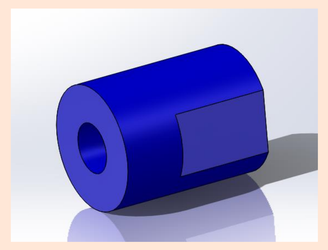
Arm B



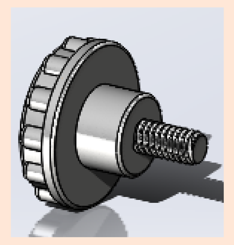
Power Supply Holder



Axle

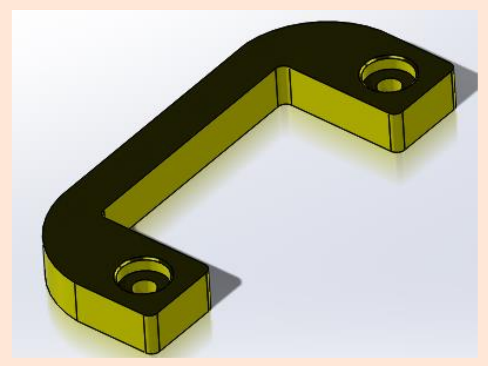


Slot Pin

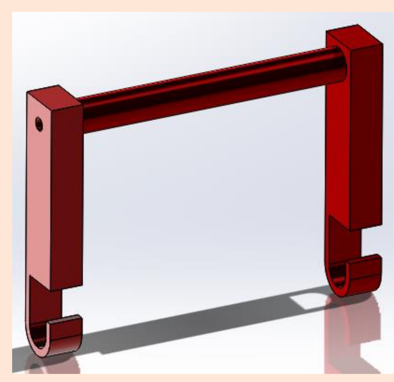


Fastener

Handles



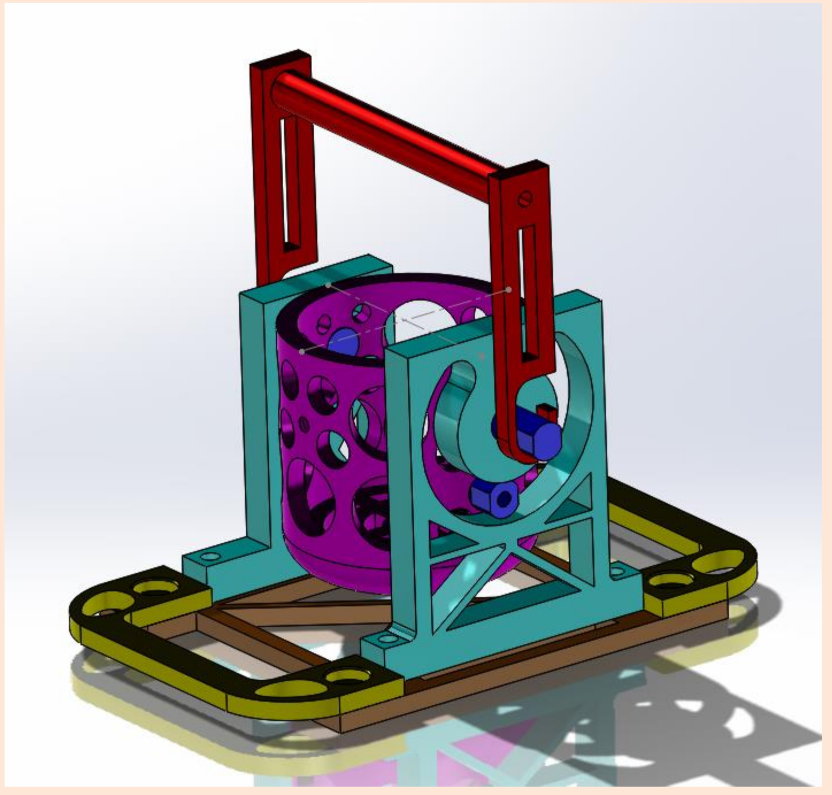
Base Handle



Handle Assembly

3D Printing

A MakerBot Desktop 3D printer was used to produce a prototype of the fixture. The model was adapted to account for this special process. Many of the parts were thinned and had material removed to reduce the amount of plastic used, thereby reducing the fabrication time. Some of the threaded holes had to be resized in order to fit the detachable axles, because the plastic material could not be threaded externally



Adapted Assembly

Fabrication

Conclusion

The prototype has worked to all expectations. The 3D printer did allow for faster fabrication time than by a machine shop. The material did cause complications, such as deformations, morphed dimensions, as well as the plastic material not being able to be threaded. Also, the plastic material does not allow for the conformation of all requirements. The plastic is not able to withstand the temperatures of the furnace, as it exceeds the 'glass temperature' and would deform and stretch, and does not allow for completion of the potting process. Despite this, the fixture does work for its original purpose, soldering.

In the Future

- Continue to review and test prototype
- Produce a final, aluminum, fixture

Acknowledgements

I would like to thank those who helped me on this project and during my time at LANL

Timothy Schollenberger
Robert Wingo
Kent Abney
Jolene Hatler
Pat Reardon