Sponsor: UCI MAE Dept. /Air Force Research Laboratory

Schedule: Fall 2016 to Spring 2017

UCI MAE Faculty: Prof. J. C LaRue and Dr Khalid Rafique
AFRL Project Liaison: Derek Hengeveld

Prof, LaRue and Dr Rafique acquired hardware funding from AFRL for senior design projects. The first phase of the design was completed during academic year fall 2015 to spring 2016. The second phase starts in fall 2016 and will be completed in spring 2017. A new team will be formed at the start of fall 2016 quarter. Phase II will start by testing single axis Phase I built hardware. Using Phase I test data a second axis design will be added and tested. Following is a summary of Thermal-Orientation Test Bed project:

The Air Force Research Laboratory (AFRL) Thermal Systems group (Kirtland AFB) develops and tests next-generation thermal control systems (TCS). Many of these systems rely on two-phase technologies that are gravity/orientation dependent. Examples include classic heat pipes, loop heat pipes, and oscillating heat pipes. There is a need within AFRL Thermal Systems to test these TCS at a variety of orientations with high-accuracy.

Objective

The primary objective of this project is the design, development, fabrication, and testing of a test frame (i.e. mounting frame, rotation mechanisms, and data acquisition) capable of precise orientation adjustments.

Description

This project includes the design, development, and fabrication of a thermal-orientation testbed for use in both ambient and vacuum environments. The test bed will be used for testing TCS such as classic heat pipes and oscillating heat pipes (e.g. flat-plate) and will consist of the following primary components:

- **Mounting frame:** The mounting frame will rigidly hold test articles and also thermally isolate test articles from parasitic heat loss/gain. Materials will be vacuum compatible; 80/20 hardware (8020.net) provides a good option. The mounting frame should be scalable to accommodate a wide-range of test article shapes/sizes.
- **Thermal sink:** A thermal sink will be provided via a cold-plate connected via fluid paths to a refrigerated bath. The thermal-orientation testbed will include the capability to attach cold-plates of various sizes. Attachment will be thermally isolated from the mounting frame.
- **Thermal source:** A heat source will be provided via patch heaters or equivalent connected to a DC power supply.
- **Rotation mechanisms:** Electronically-controlled rotation mechanisms will provide accurate orientation of the test specimen about a primary and secondary axis. Orientation will be evaluated via measurement.
- **Data acquisition:** A data acquisition system will be used to control rotation, monitor orientation, and monitor thermal performance.

. **Interested students** should contact Dr Khalid Rafique at **krafique@uci.edu**
Basic components are illustrated in Figure 1. This figure is only provided to illustrate primary components; it is one of many potential design concepts.

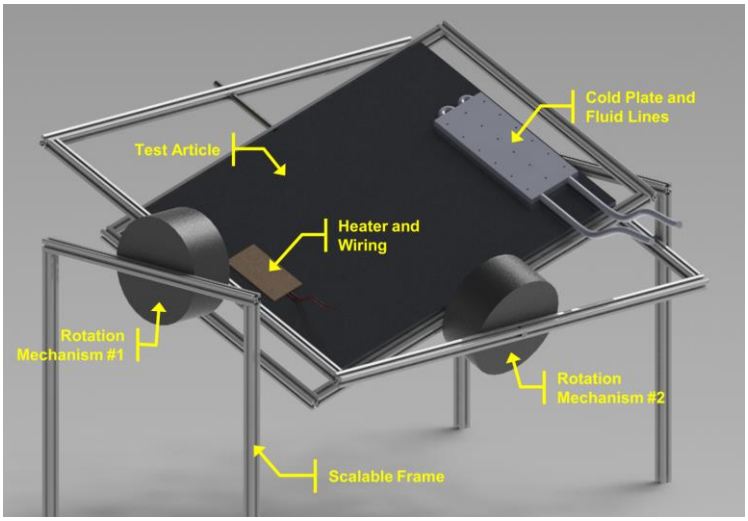
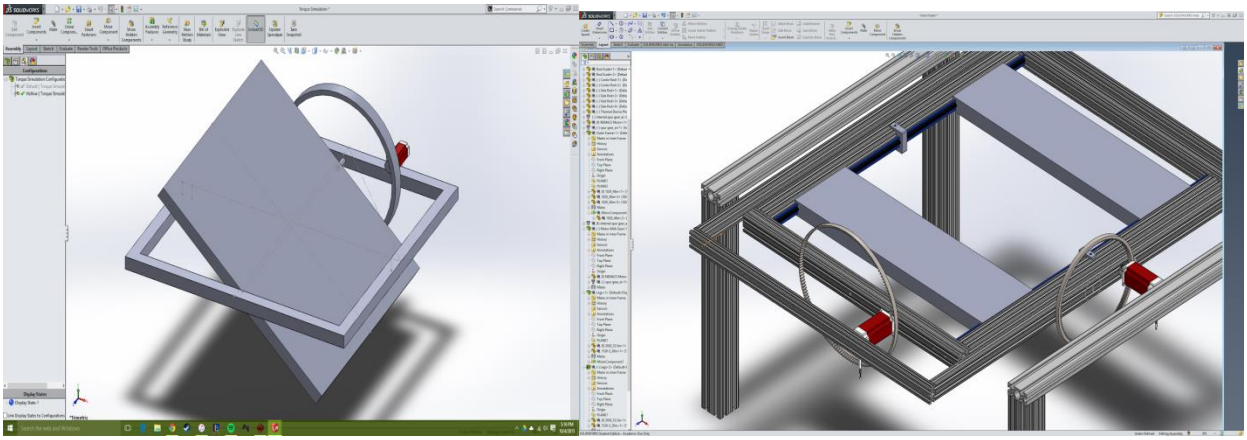


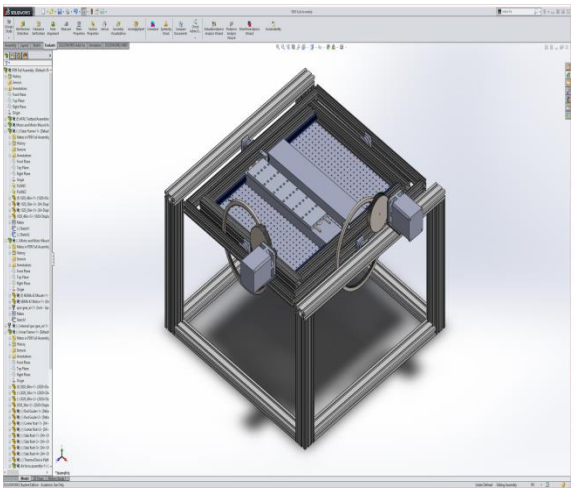
Figure 1: Illustration of Basic Components

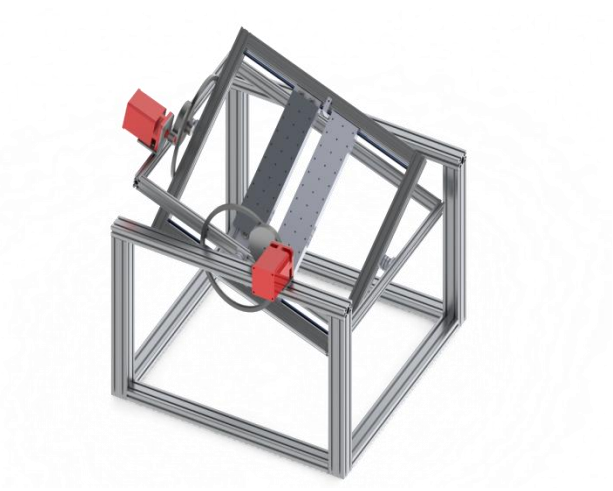
PHASE I EVOLUTION OF DESIGN

The Initial Concept

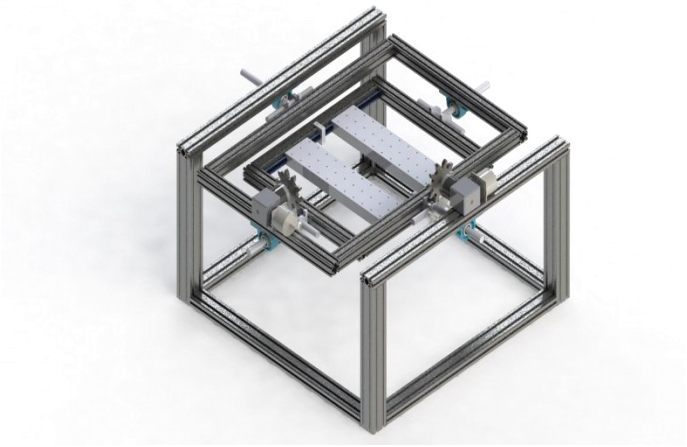


The initial designs were designed using a large interior geared ring which would allow the most torque on the test frames. As a result, a smaller motor can be used, and consequently, the total cost would be lowered.





The Adoption of Gears



Requirements

Specific requirements include the following.

Environment: Vacuum
Minimum Rotation About Primary Axis: 180°
Orientation Accuracy: 0.1° or better
Minimum Rotation About Secondary Axis: 90°
Max Testbed Size: 39.5” x 71” x 40” (components must fit within 30” x 30” opening)
Min Test Article Size: 2” x 6” x 0.08”
Max Test Article Size: 24” x 24” x 30”

Deliverables and Milestones

Design Reviews (e.g. PDR/CDR)
Thermal-Orientation Testbed (e.g. hardware, DAQ GUI, operator’s manual)
Summary Report/Presentation