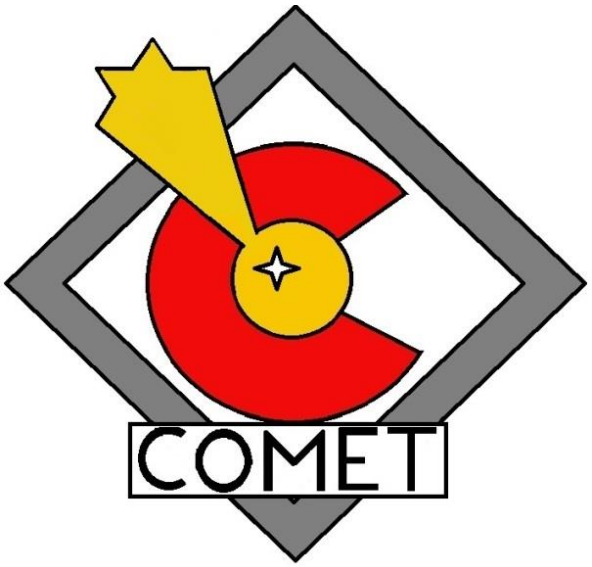
COMET:
Colorado Mini Engine Team
Manufacturing Status Review
February 3, 2014

Team members:

Julia Contreras-Garcia
Eric James
Matthew McClain
Benjamin Woeste
Emily Ehrle
Jonathan Lumpkin
Megan O'Sullivan
Kevin Wong

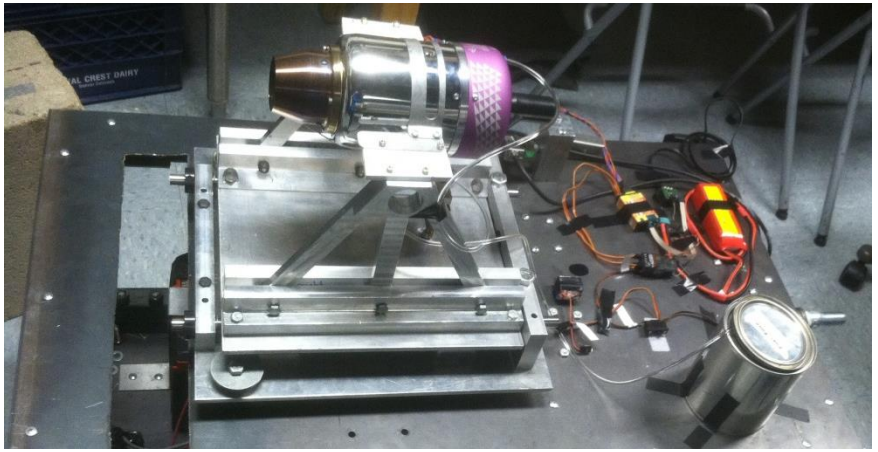
Customer: Lt. Joseph Ausserer, USAF

University of Colorado



Outline

- Project overview
  - Specific objectives
  - Review of critical project elements
  - Updates on critical issues from CDR and FFR
- Schedule
  - Changes since CDR and FFR
- Manufacturing
  - Relevant tasks
- Budget
  - Procurement status
  - Budget status



Project Overview

Project Description

- Design and build a Power Extraction Unit (PEU) for a JetCat P90-RXI mini-turbojet engine that will generate 500 Watts of electrical power at 24 VDC.
- Sponsored by Air Force Research Laboratory's Aerospace Propulsion Outreach Program (APOP)

Objectives

- Level one
  - PEU must generate 500 Watts of power at 24 Volts DC
  - PEU must produce this power after the engine has been running no longer than 1 min 20 s, twice the average start up time
  - Engine and PEU must be compatible with the WPAFB test stand
- Level two
  - Reducing thrust by no more than 25%
  - Increasing specific fuel consumption by no more than 50%
- Level three
  - Adding no more than the weight than an equivalent battery pack with 30 minutes of power (8 lbs)
  - Producing 500 W throughout the engine's RPM operating range
- Level four
  - PEU to be entirely external to the JetCat engine, making the most modular solution.

Updates on Critical Project Elements

- Electronics
  - Combine motor controller and power regulation circuitry into one PCB
- Software
  - Motor controller microcontroller
    - No longer using microcontroller, controlled with LabVIEW code and implemented with DAQ I/O module
  - LabVIEW testing VIs
    - Using JetCat's Jetronics software for additional measurements
  - Add rotor dynamic analysis

Updates on Critical Project Elements

- Mechanical
  - Attaching starter to engine housing
    - Rigid harness to hold starter/generator in line with engine, no longer using brackets
  - Mounting engine to test stand
    - No longer manufacturing our own clamps
    - Will use clamps that came with JetCat engine
- Off-ramp using low speed alternator attached to engine with flexible shaft coupling
  - Spin up engine with compressed air

Schedule

Current Schedule Status

- Systems:
  - Preparing for baseline characterization test
  - At risk – precipitation may prevent test
  - Allotted 7 day margin

- Mechanical subsystem:
  - 17% of scheduled tasks completed (23 tasks total)
  - Procure P200 starter generator – at risk
    - Must receive starter generator from Germany by Monday, February 24
  - Must complete 6 tasks prior to TRR
    - Assuming starter generator arrives: 6 tasks
    - Off-ramp: 11 tasks

Current Schedule Status

- Electrical subsystem:
  - 22% of scheduled tasks completed (10 tasks total)
  - Preparing for baseline characterization test and manufacturing circuit boards
  - Must complete 7 tasks prior to TRR
  - On track

- Software subsystem:
  - 34% of scheduled tasks completed (7 tasks total)
  - Preparing testing VI, rotor dynamics, and power regulation/motor controller system
  - Must complete 7 tasks prior to TRR
  - On track

Work Breakdown Structure (WBS)

Structures

- ~~Manufacture engine clamps for CU test stand~~
- Baseline characteristic test
- Manufacture engine harness
- Manufacture coupling system
- Rebalance engine with starter generator attached

- [Off-ramp]
  - Update engine harness
  - Attach purchased coupling system

Electrical

- ~~Updated test stand with load cell, flow meter, DAQ~~
- ~~Power dissipation system~~
- Calibrated load cell and flow meter
- Power regulation and motor controller system

Software

- ~~MATLAB model of JetCat engine~~
- ~~Testing VI for load cell and flow meter~~
- Rotor dynamics
- Power regulation/motor controller system

Schedule Changes

- Delay in procuring engine at beginning of semester due to JetCat P80-SE being discontinued
- Waiting for confirmation from Air Force to use P90-RXI
- Waiting to receive starter generator from JetCat in Germany
- Outsource manufacturing the key slot of the coupling system (need sinker electric discharge machining)
- Account for manufacturing engine/starter harness
- Account for off-ramp schedule
- Create PCB for power regulation/motor controller

Manufacturing

Scope

- Electronics components
  - Power regulation/ motor controller board
  - Power dissipation board
  - Starter/ alternator
- Software components
  - Testing VIs
  - Controller programming
  - Rotor dynamics analysis
- Mechanical components
  - Alignment harness
  - Pin and slot shaft coupling

Electronics Manufacturing: Components

Component or Subsystem	Make vs. Purchase
Power regulator / motor controller PCB	Purchase (Outsource)
Power dissipation board	Manufacture
Motor controller	Purchase
NI data acquisition hardware	Borrow
Starter / Generator	Purchase
Motor (to be used as alternator)	Purchase
Three phase rectifier	Purchase

- Note: text in purple denotes off-ramp items

Electronics Manufacturing: Details

- PCB manufactured by Advanced Circuits
  - Based on schematics supplied by COMET in PCB Artist software
- Once COMET receives the board, components will be soldered on in soldering lab
- For power dissipation board
  - Manufactured in house
  - Brought to presentation

Electronics Manufacturing: Status

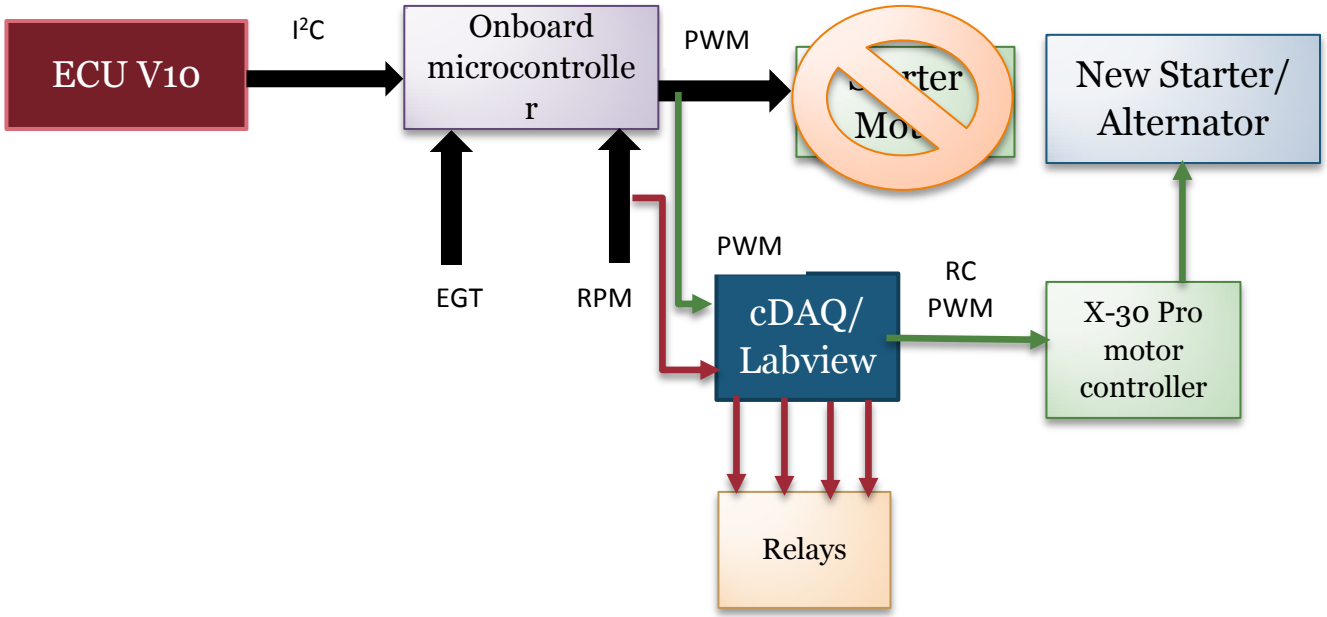
- PCB
  - Design completed
  - To be sent to Advanced Circuits February 4
  - Expect two week turn around time
  - Expected time for soldering components: 1 day
  - This subsystem will be integrated with starter/ generator for subsystem testing and final testing
- Power dissipation
  - Complete
  - Functionality test was completed Saturday
  - Will be integrated at final system test

Software Manufacturing: Components

Component or Subsystem	Make vs. Purchase
Rotor dynamic analysis	Manufacture
MATLAB model validation	Manufacture
Testing VIs	Manufacture
Jetronics	Purchase
Controller programming	Manufacture

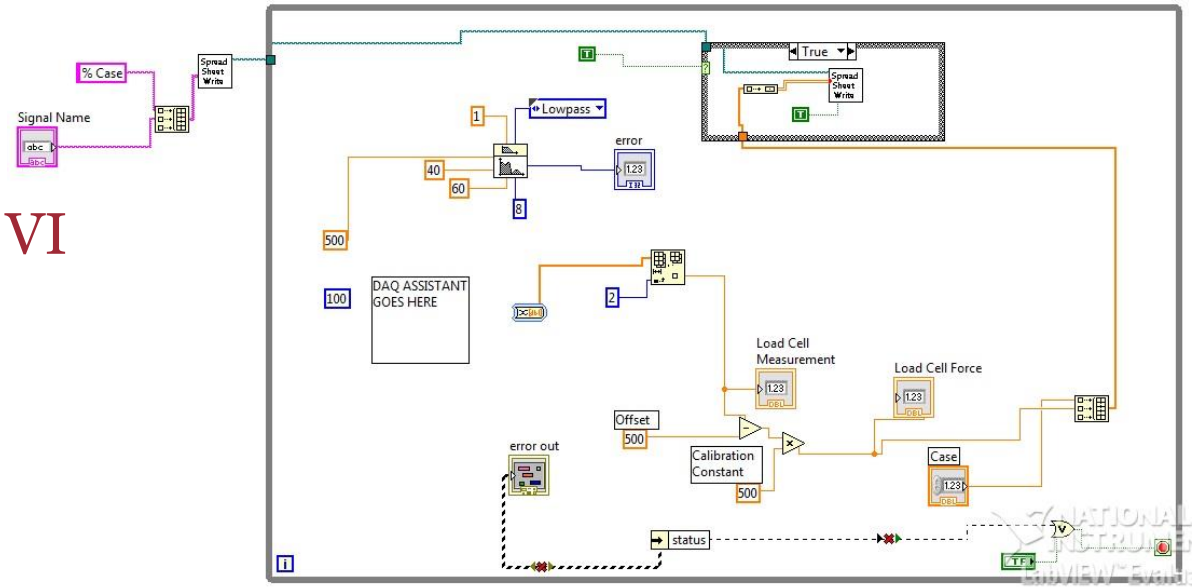
Software Manufacturing: Details

- Rotor dynamic analysis
  - Implement finite element analysis in MATLAB
- Controller programming through DAQ



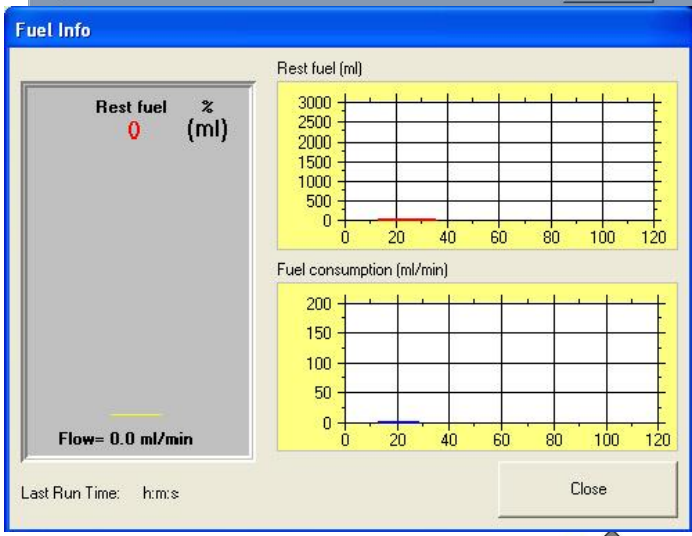
Software Manufacturing: Status

- Rotor dynamic analysis
  - Find natural modes of engine shaft and use information to ensure vibrational modes are not excited during operation
    - Will verify software using results from a Heidelberg University Doctoral Dissertation
- MATLAB model complete, only validation needed
- Testing VIs
  - Load cell testing VI complete



Software Manufacturing: Status

- Jetronics installed and operational
  - Used for fuel flow measurement
- Controller programming
  - Will use cDAQ with NI 9401 chasses
    - Chasses is bidirectional which will allow for motor control
  - Preliminary design complete
  - Necessary to switch between starting and generating circuitry and to drive the start
  - Began Labview programming this week



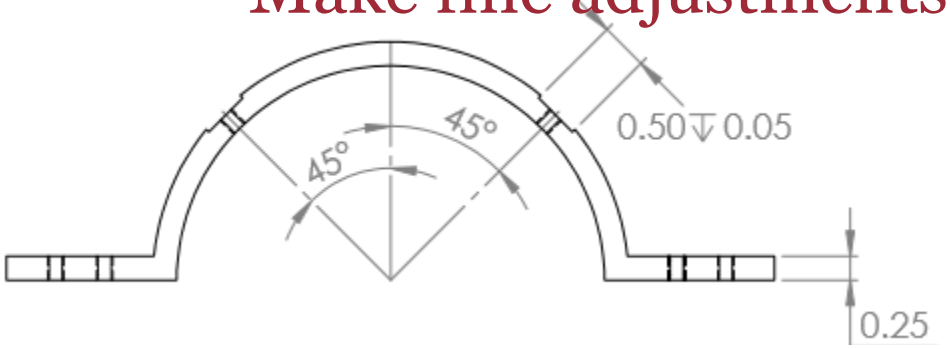
Mechanical Manufacturing: Components

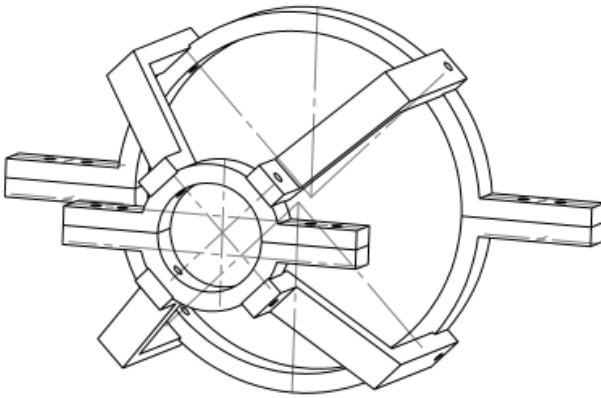
Component or Subsystem	Make vs. Purchase
Slot in engine shaft for connection pin	Outsource
Harness for alignment	Manufacture
Balance engine after shaft slot is finished	Outsource (JetCat)
Engine to alternator coupling	Purchase

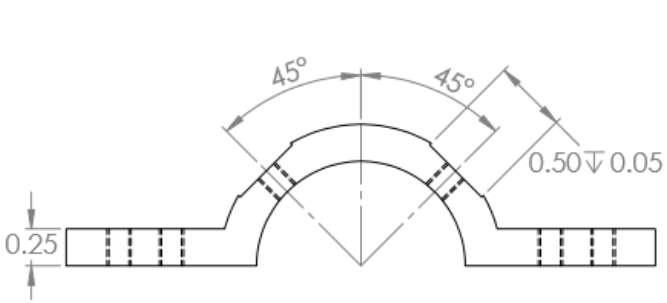
- Shaft slot will be cut using an Electric Discharge Machine by Rapid Tooling
- Engine will be rebalanced by JetCat USA
- Note that the purple text denotes part of the off-ramp system

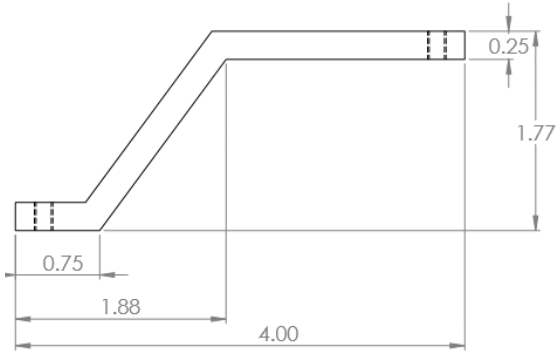
Mechanical Manufacturing: Details

- Harness
  - Manufactured in house using precision milling
  - Make fine adjustments using screws









Mechanical Manufacturing: Status

- By end of this week, will make decision to pursue off-ramp or current design
- For current design
  - Can begin manufacturing of harness next week
  - Will send engine shaft for EDM mid February
  - As soon as shaft is returned (approximately 2 weeks), get engine rebalanced (1 week)
- For off-ramp
  - COTS shaft coupler simple clamp on system
  - Only additional time constraint is shipping
  - Harness will also be manufactured, as above

Budget

Financial Budget Status

	Allocated	Current Expenditures	Future Expenses
Project Budget	$5,000	$1,283.80	$1,705.95
Engine Budget	$2,500	$2,530.0	$0.00

- Two large expenses coming up
  - Outsourcing machining of engine shaft slot
  - Starter Alternator
- Currently $78.83 over predicted budget
- Still have $1,980.25 in margin.

Procurement Status

- Item of Concern: Starter Alternator
  - Must have confirmation of shipment from Germany by 2/7/14 (Friday)
  - If this is not met, then the off ramp will be taken
- Total of 39 items expected to be purchased
  - Total of 12 remain to be purchased
  - $1705.95 of purchases (599.99 for Starter Alternator)

Questions?