University of Idaho

IDAHO CSC

OLD DYNO NEW TRICKS (ODNT)

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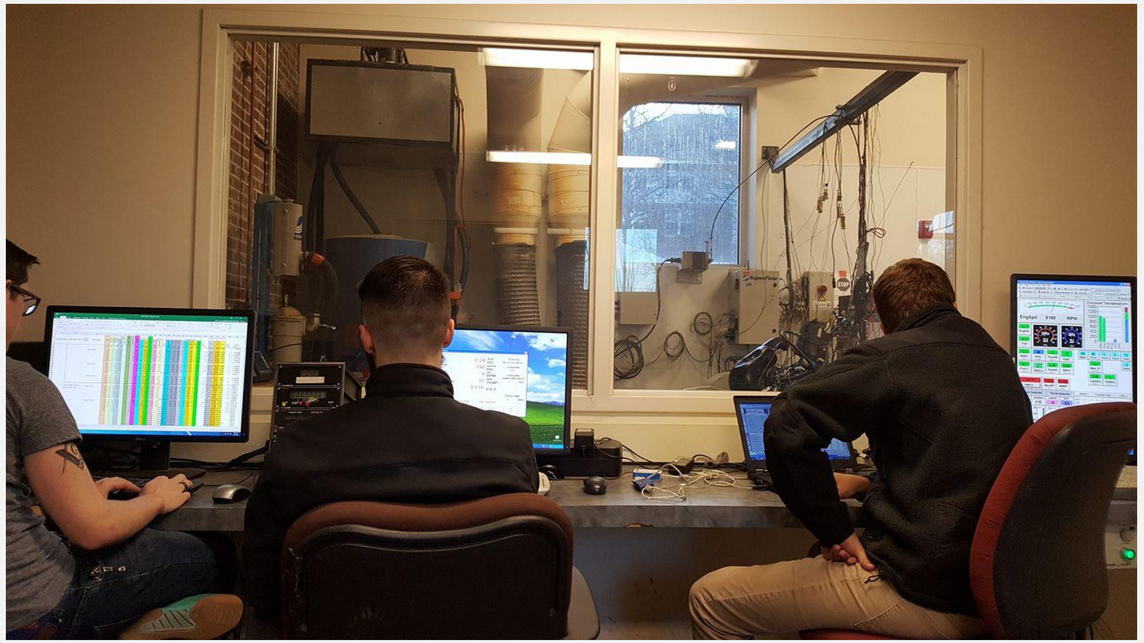
OVERVIEW

- Problem definition, requirements, and metrics
- Data collection
- Combustion analysis
- Cooling system
- Recommended path
- Budget & funding

PROBLEM DEFINITION

OVERVIEW

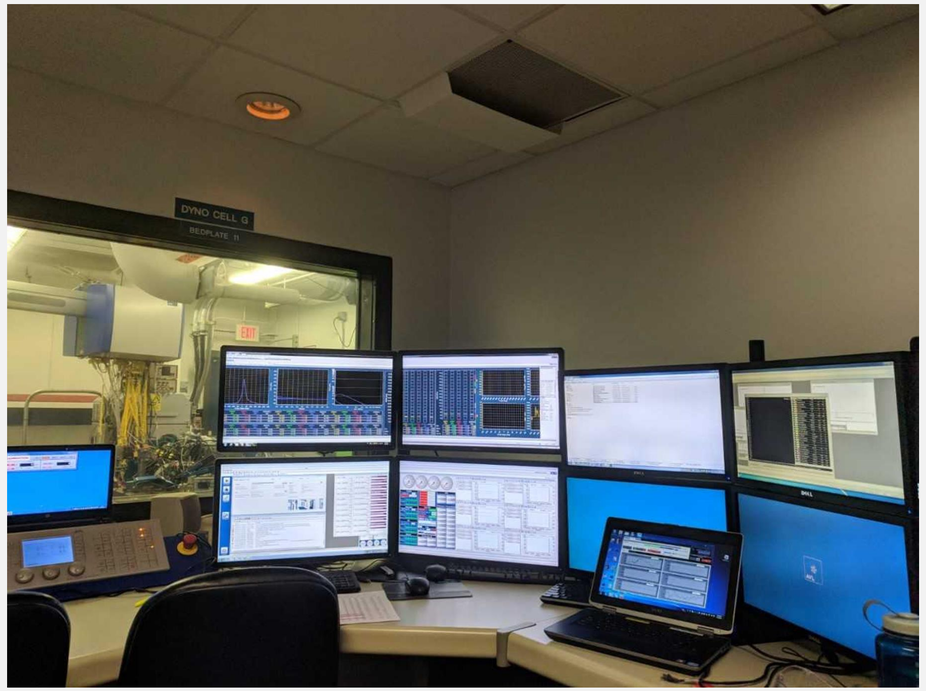
- Manual data entry
- Inaccurate
- Time-intensive process
- Cooling system is insufficient
- No combustion analysis capabilities
- Lack of clear documentation



REQUIREMENTS

CLIENT/TEAMS NEEDS

- Instantaneously collect all current data points
- Add In-Cylinder Pressure to data set
- Improve data usability
- Improve cooling system
- Comprehensive documentation
- Improve fuel cart functionality
- Safety: E-Stop, status lights, etc



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METRICS

Metric	Acceptable	Ideal
Exhaust, Coolant, SuperFlow, Fuel flow, Lambda, Horiba sampling frequency	1 Hz	10 Hz
Run 100% throttle 100% load	5 min	10 min - ∞
Fuel Pressure	-	44 psi
Fuel delivery rate	42 kg/hr	85 kg/hr
New user to self learn	5 hrs	1 hr
Encoder position sampling	100 kHz	200 kHz
Encoder resolution	360 ppr	720 ppr
CAN/Inca signals	Time-stamped	Same data file

DATA COLLECTION

EXISTING HARDWARE

- Horiba MEXA-584L 5 gas analyzer
- Max Machinery 710 fuel measurement system
- Innovate wideband O2
- SuperFlow dynamometer, control, and data acquisition
- WinDyn 2.8 software

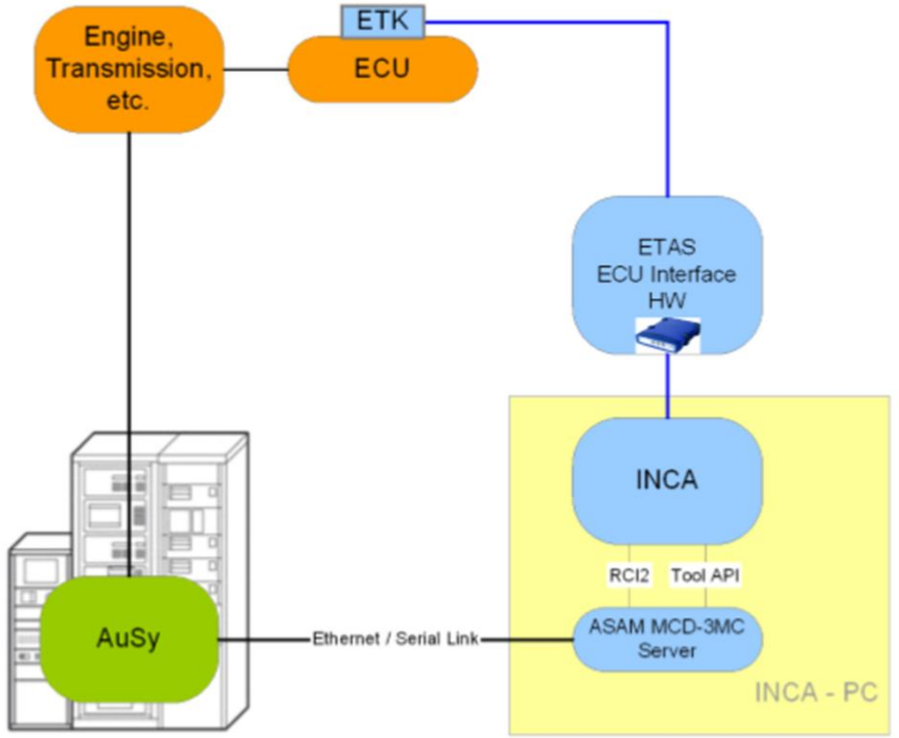
www.horiba.com

www.superflow.com

DATA COLLECTION OPTIONS

LABVIEW-BASED DATA COLLECTION

- SuperFlow API
  - Can export live data
  - Communication issues with old system
- Inca
  - LabVIEW VIs available for ASAP3 protocol
  - Challenges with TCP IP communication
- Project suitable for C.S. majors
- High cost for NI DAQs



The ASAM ASAP3 interface, illustrated with the general expression ASAM MCD-3MC Interface, listens at its Ethernet port (or Serial Link (RS232)) for commands sent by the Automation System (AuSy). These commands are translated into several calls to the Tool API / RCI2 interface of the INCA core and also logged into the ASAM MCD-3MC interface window by the ASAM MCD-3MC Server of INCA.

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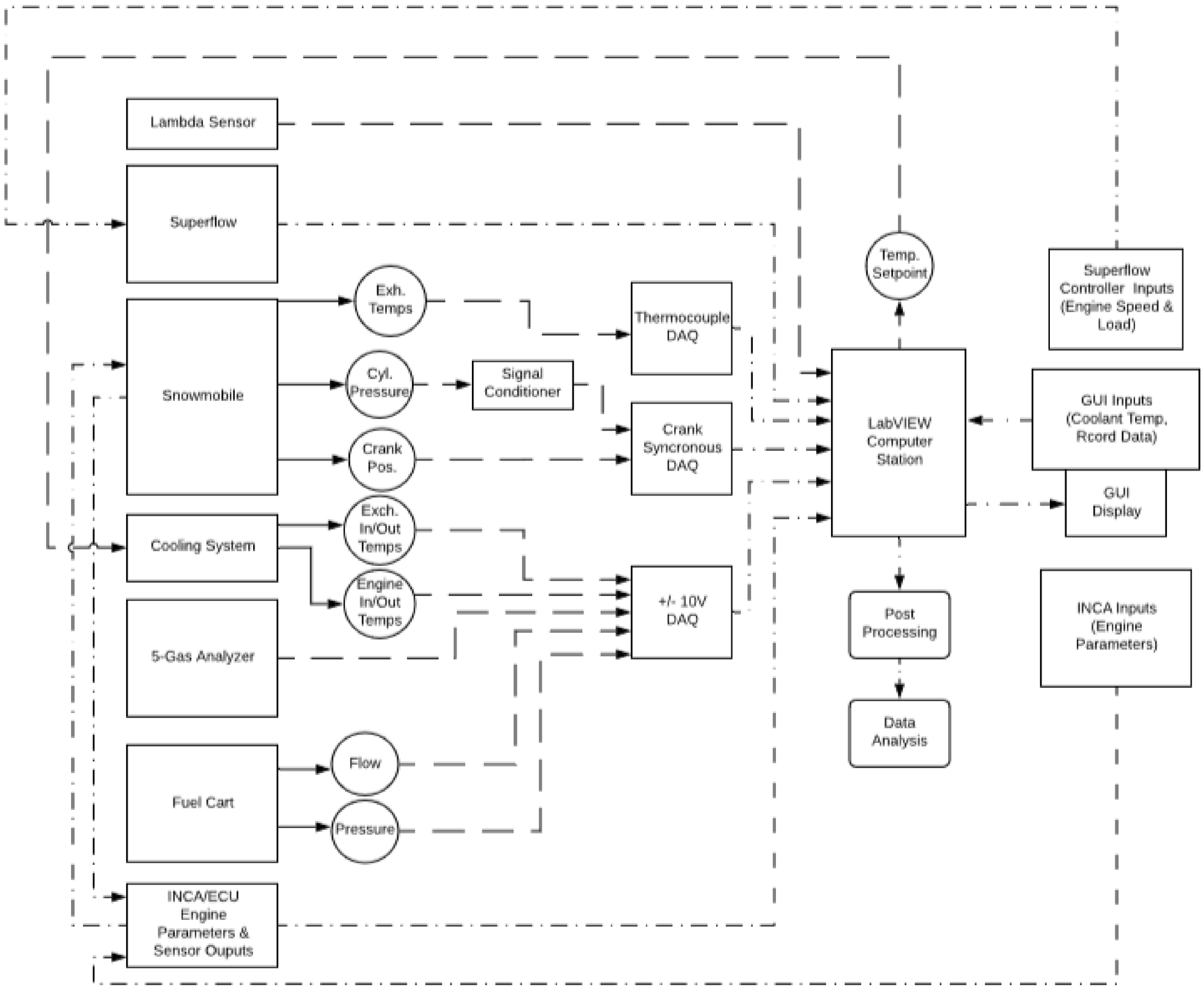
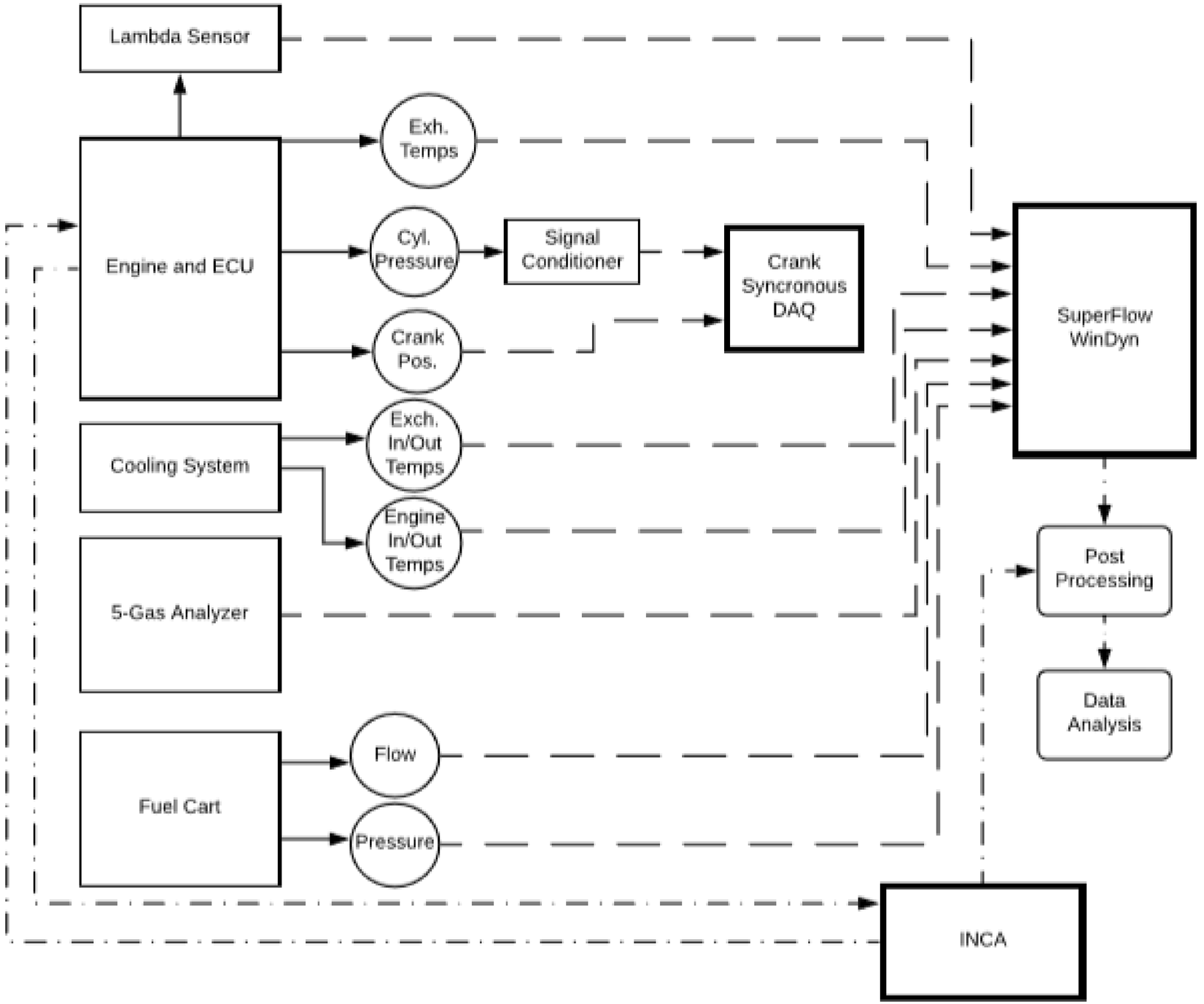

Lambda Sensor
Superflow
Snowmobile
Exh. Temps
Cyl. Pressure
Crank Pos.
Signal Conditioner
Thermocouple DAQ
Crank Syncronous DAQ
Cooling System
Exch. In/Out Temps
Engine In/Out Temps
+/- 10V DAQ
5-Gas Analyzer
Fuel Cart
Flow
Pressure
INCA/ECU Engine Parameters & Sensor Ouputs
Temp. Setpoint
LabVIEW Computer Station
Superflow Controller Inputs (Engine Speed & Load)
GUI Inputs (Coolant Temp, Rcord Data)
GUI Display
Post Processing
Data Analysis
INCA Inputs (Engine Parameters)

DATA COLLECTION OPTIONS

CURRENT SUPERFLOW SYSTEM AS DAQ

- Cost: ~$0
- Use existing SuperFlow PC (c. 2008/Windows XP)
- No direct integration of ECU via CAN or Inca
  - Can still be recorded separately
  - Synchronization signal?
- Time for documentation, test automation, & data post processing


Lambda Sensor
Exh. Temps
Engine and ECU
Cyl. Pressure
Signal Conditioner
Crank Syncronous DAQ
Crank Pos.
SuperFlow WinDyn
Exch. In/Out Temps
Cooling System
Engine In/Out Temps
Post Processing
5-Gas Analyzer
Data Analysis
Flow
Fuel Cart
Pressure
INCA

DATA COLLECTION OPTIONS

UPDATE COMPUTER AND SOFTWARE

- Cost: $700-2770
- Windows 7 (32 bit) and WinDyn 3.2
- No longer DOS based
- Still using outdated netbeui protocol
- Windows 7 end of support: January 2020

DATA COLLECTION OPTIONS

UPDATE SUPERFLOW HARDWARE & SOFTWARE

- Cost: $15,125
- New electronics
- Windows 10 PC
- WinDyn 4.0
- CAN integration
- Includes on-site setup and training
- Long term value to University

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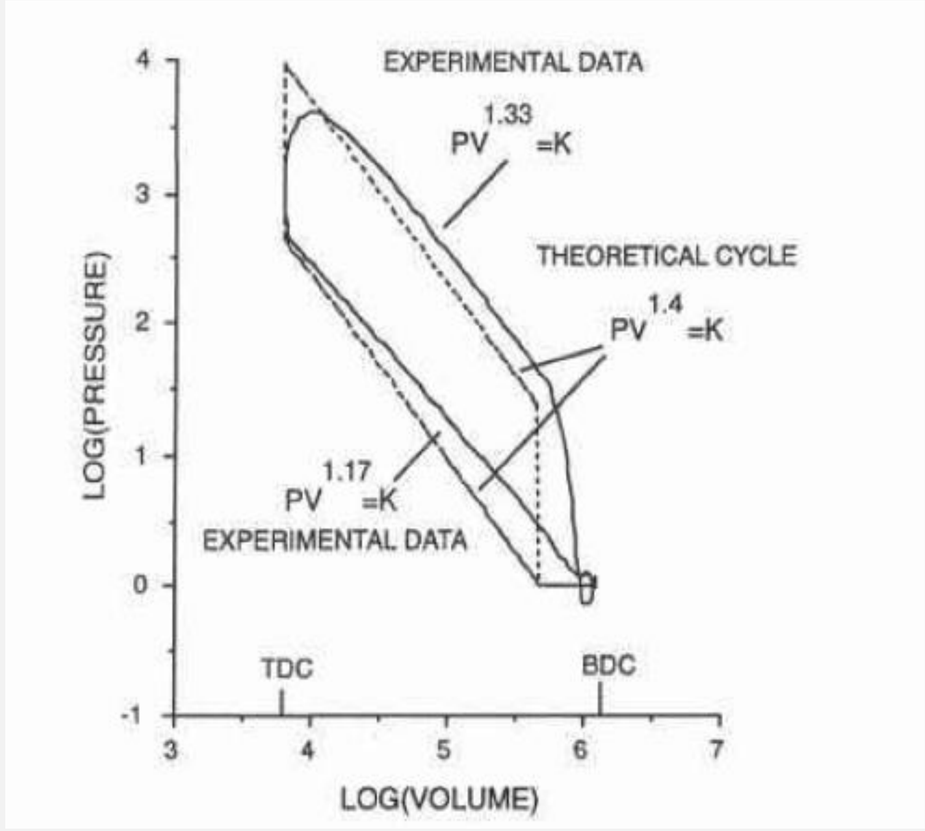
COMBUSTION ANALYSIS

BASIS

- Pressure-volume data
- Benefits
  - Aid in calibration
  - Knock detection
- Requirements
  - In-cylinder pressure measurement
  - Crankcase absolute pressure
  - Crankshaft position
  - High speed DAQ



Logarithmic pressure-volume plot (Blair)

COMBUSTION ANALYSIS

HARDWARE

- Cylinder pressure transducer
  - Consumable
  - PCB high frequency model $570
  - Instrumented spark plug $300 + $600
- Head modifications
- Crankcase pressure sensor
- Encoder

https://www.kistler.com/en/product/type-611xc/

https://www.ptb.de/emrp/2175.html

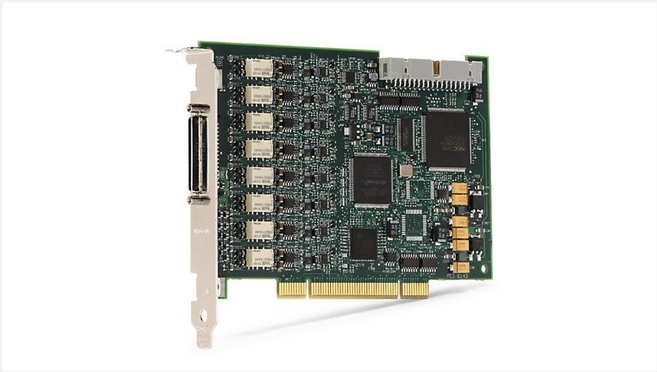
COMBUSTION ANALYSIS

DATA COLLECTION

- meDAQ
  - No purchase necessary
  - Provides necessary functionality
  - Outdated proprietary software
  - Has failed in the past

https://news.thomasnet.com/fullstory/portable-daq-system-provides-up-to-16-channels-572240

- Updated hardware
  - $1,611.90 for N.I. DAQ & associated hardware (PCI-6143)
  - LabVIEW based
  - Adaptable to future work



www.ni.com

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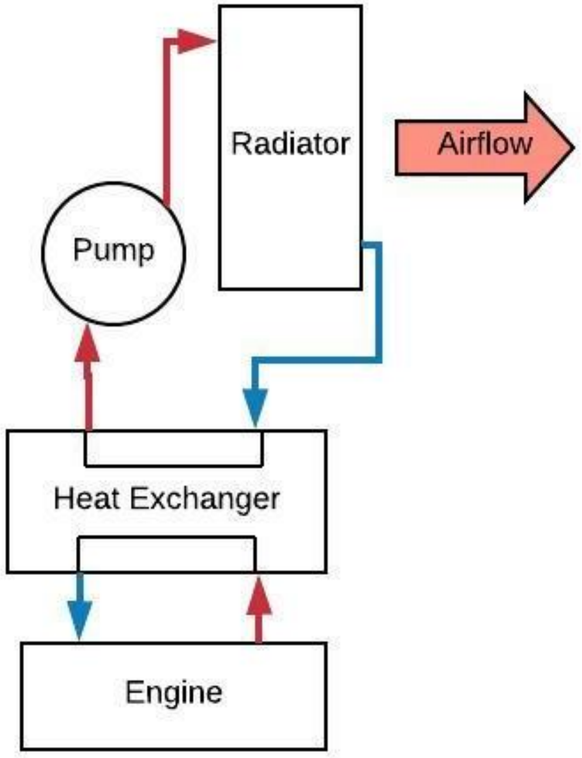
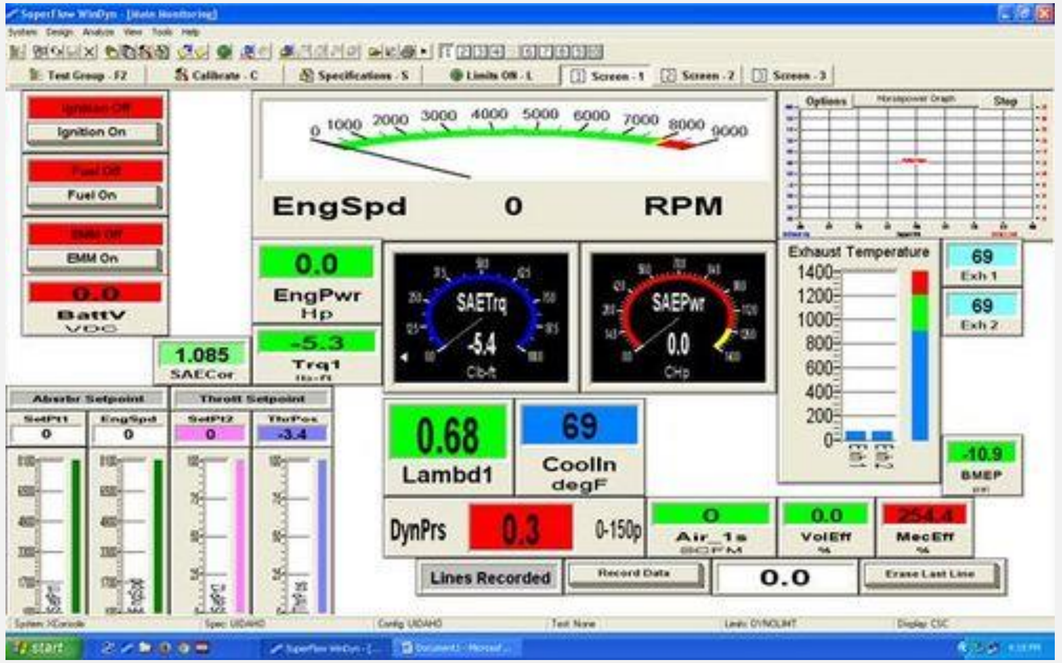
COOLING SYSTEM

- Current system
  - Shell-in-tube heat exchanger cools engine
  - Radiator & fan cool heat exchanger
  - Inadequate cooling capacity
- Determine the most cost-effective improvements
  - Effectiveness-NTU model of system to predict performance
  - Radiator location, airflow



RECOMMENDED PATH

- Data Acquisition
  - Use current SuperFlow system
  - Full refresh of dyno if funds are available
- Combustion Analysis
  - Purchase encoder & associated hardware
  - Use meDAQ
  - Transition to NI if funds are available
- Cooling System
  - Collect data for math model
  - Design once we have model results



BUDGET

HARDWARE THAT MUST BE PURCHASED

- $1500 from CSC budget (other tentative sources)
- $40 spent (fuel cart components)
- Required Costs:
  - $250 – cooling system hardware
  - $50-300 – encoder
  - ~$100 for C.A.P. sensor (x2?)
  - $100 – transducer cooling jacket
  - $200 – misc.
  - Future recurring costs: ~$600 when pressure transducers fail

ADDITIONAL FUNDING

NON-CRITICAL NICE-TO-HAVE PURCHASES

- Outreach to CSC and FSAE/FHSAE alumni
- U&I Give campaign
- Industry sponsors

PROJECT SCHEDULE

MILESTONES

- Collecting data in SuperFlow: December 14th
- Cooling system updates implemented: December 14th
- Automated ramped modal cycle testing: February 1st
- Generating P-V plots: February 15th
- Snapshot: March 5th (Will be in Michigan)
- Data post processing: March 27th
- System documentation: April 19th
- EXPO: April 26th

QUESTIONS?