Design and Prototype Construction of the Eaton Power Systems Laboratory

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The Eaton Power Systems Laboratory at Pitt

Purpose of Eaton Power Systems Lab

- To create a learning environment allowing students to explore power systems related topics and to simulate real life power system events
- To provide an avenue for graduate electrical power system engineers an effective research environment with valuable practical hands on capabilities

Future Uses for the Lab

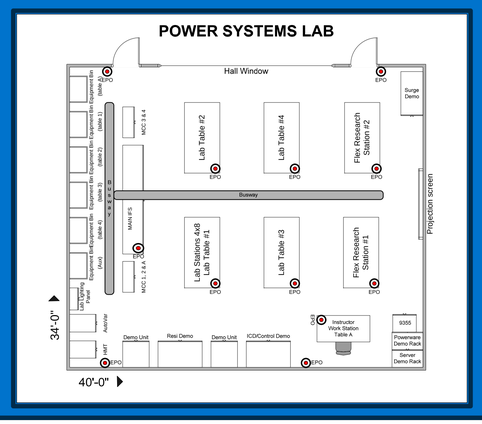
- Research applications to be affiliated with this lab:
  - Smart grid technologies: PLC, metering, industrial controls, lighting control
  - Renewables: solar panels, wind turbine and generator all on rooftop of engineering school
  - Power electronics: drives, UPS, soft start, inverters
  - Power quality: resistive, inductive, capacitive and harmonic load banks; weak source, sag generator and surge generation

Eaton and the University of Pittsburgh

- The affiliation between Eaton Corporation and the University of Pittsburgh has brought about the Eaton Power Systems Laboratory, inspired by the Eaton Power Systems Experience Center

Planned Lab Completion

- Anticipated completion is February 2013 on the electrical engineering floor in Benedum Hall



Prototype Lab Bench Work and Progress

Purpose of Prototype Bench

- To resolve a number of design questions by going through the building process for one of the six lab benches ultimately creating a prototype lab bench

Prototype Construction Completed

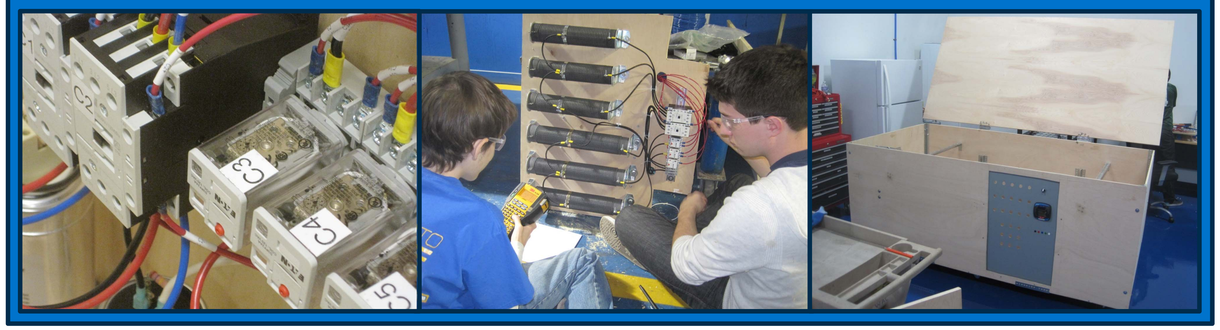
- Bench is structurally complete
- Wiring complete with the exceptions of control wiring to the front control panel and the side circuit breaker panel
- Fans for cooling installed
- Front control panel begun

Future Work Planned

- Install breaker panel and mast
- Wiring to the control panel and breaker panel
- Install clear bench top
- Finishing touches

Workforce to Make this Happen

- Construction of this prototype lab bench was performed by EPERGI graduate students and by Bill McGahey and James Lyle
- This work was performed at the Eaton Power Systems Experience Center in Warrendale, PA



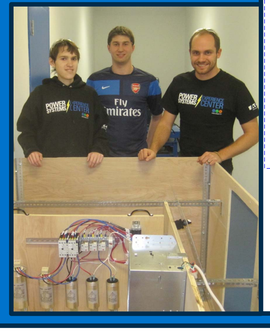
Design of the Eaton Power Systems Laboratory

Layout Designed for Flexibility

- Modular devices associated with power systems readily available: motors, harmonic filters, and UPSs placed on wheels to be able to be connected to each bench for a variety of configurations and applications
- Connections will be made using varied quick-connects to prevent harmful equipment set up
- Resistive, Capacitive, Inductive and CFL harmonic loads incorporated per bench
- Integrated metering all across the laboratory
- Emergency power trip (E-STOP) per bench

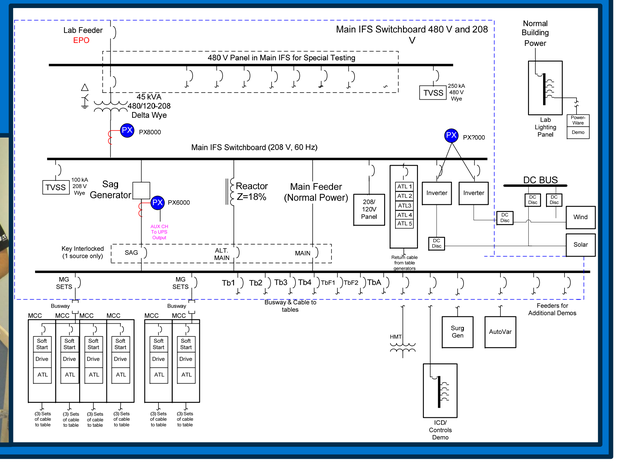
Design Structure

- IFS structure
- Motor Control Centers
- Fixed one-offs module
- Lab benches
- Portable lab modules
- Metering: at the IFS, on benches, stand-alones, and portable handhelds



Designers of the Eaton Lab

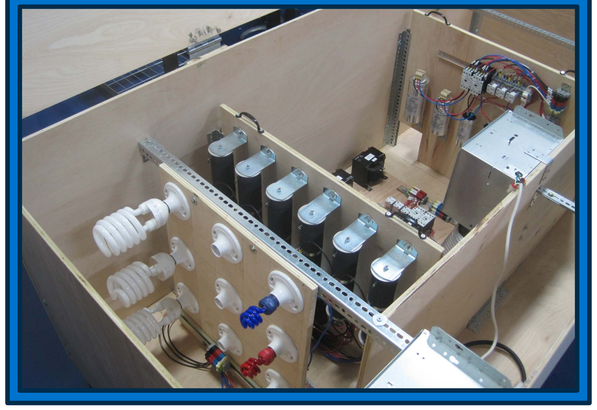
- Dan Carnavole (Senior Engineer from Eaton) has headed up the design of the lab with the help of Pitt senior design undergraduate students and more recently with help from Pitt graduate students within Dr. Reed's EPERGI group
- Senior design project created electrical one-line diagram



Design Considerations

Design Topics of Discussion

- Accessible and removable load panels
- Efficient cooling of heat generating components
- Planned space for control and power wiring
- Spatial constraints for component placement
- CFLs facing Benedum hallway for aesthetic appeal
- Transparent bench top to allow viewing components during experimentation



Component Testing

- Resistor Bank Panel
  - Measured power flow through resistors and compared with expected calculations
- Compact Fluorescent Light (CFL) Panel
  - 68W CFLs (300W equivalent)
  - Measured harmonics generated by the compact fluorescent lights (100% 3rd harm)
  - Conclusion: Lower wattage will be sufficient for intended lab experimentation