

More skills, more retention? Reexamining the effectiveness of a pre-Capstone lab course

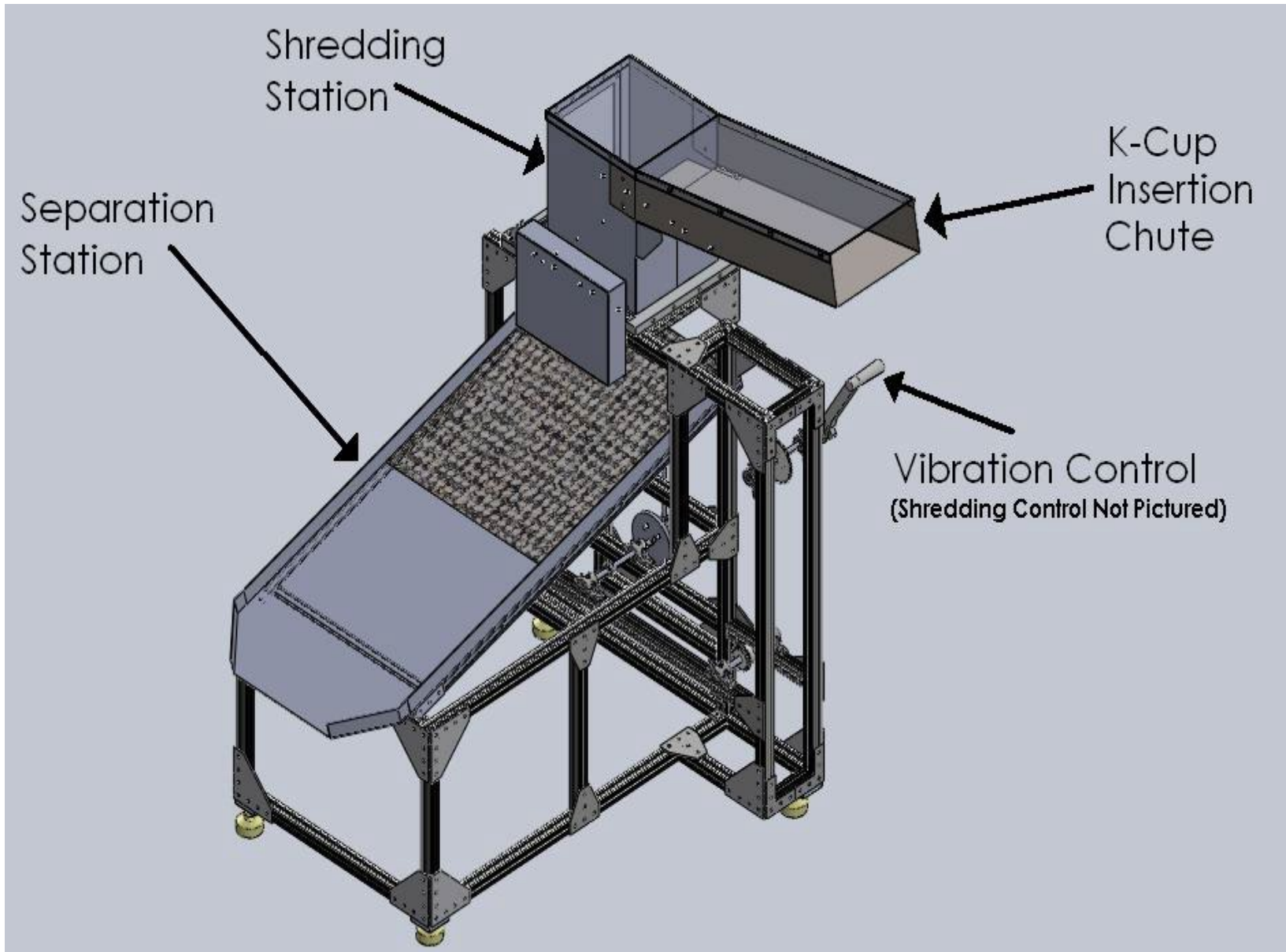
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Big idea: Students typically take a lab course in Measurements and Analysis before Capstone Design. The Measurements course was redesigned in 2011 which led to an increase in the use of measurements and analysis skills during Capstone Design. The Measurements course was redesigned again in 2020. Results show a further increase in the use of experimental design and data analysis skills in Capstone Design projects as indicated by examination of final project reports.

2011 Changes:

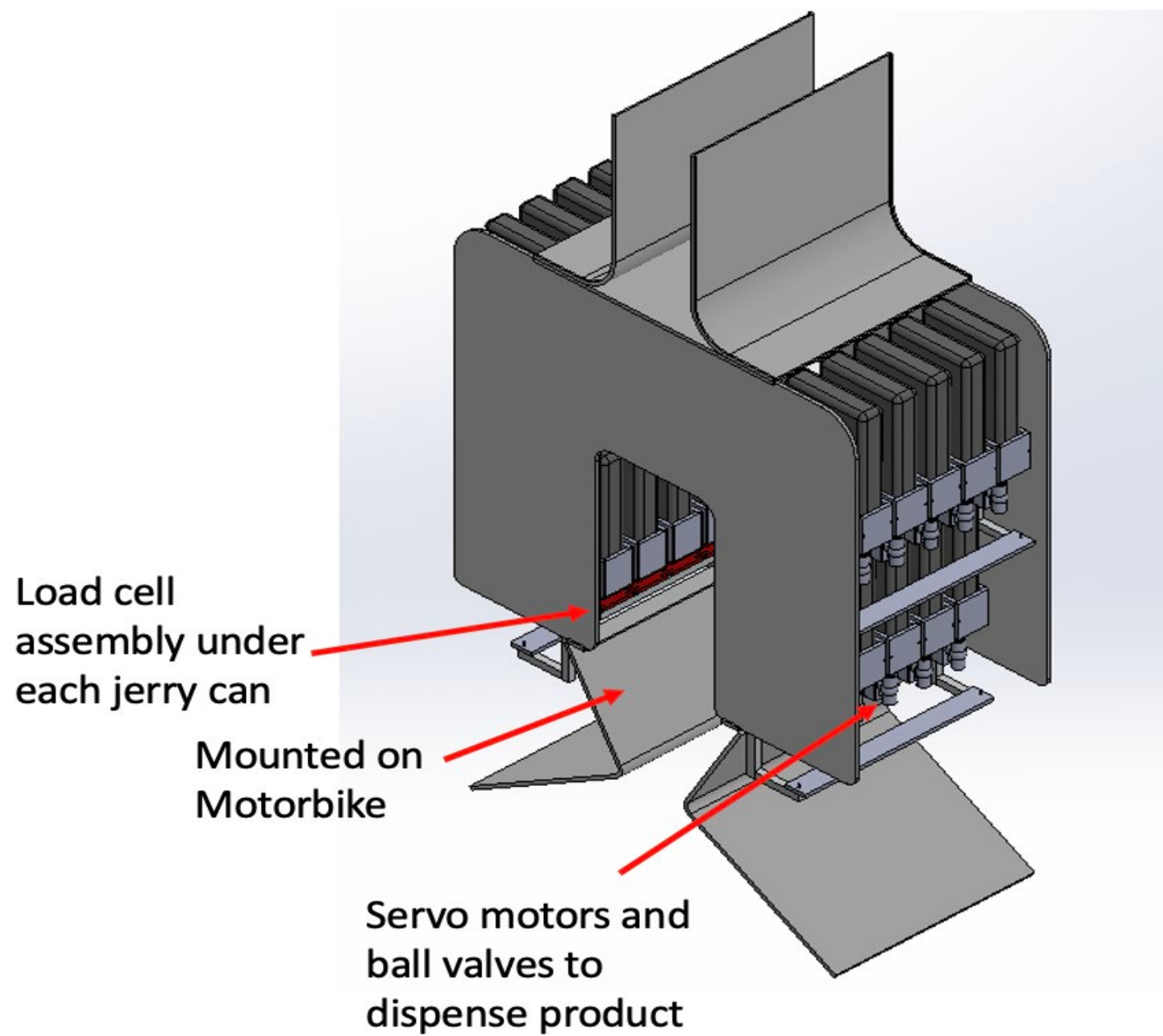
- Redesigned all experiments to use hands-on, low cost sensors and equipment rather than one single large piece of equipment
- Made labs progressively more open-ended with scaffolded experimental design.
- Added term project requiring teams to design, execute, and report on an experiment of their choosing.
- Scheduled topics so that students would receive homework feedback on pre-lab homework prior to the related experiment.



Keurig Recycling Device, Fall 2012, 4 total topics noted



Desktop Metal Low Cost Furnace, Fall 2019, 9 total topics noted

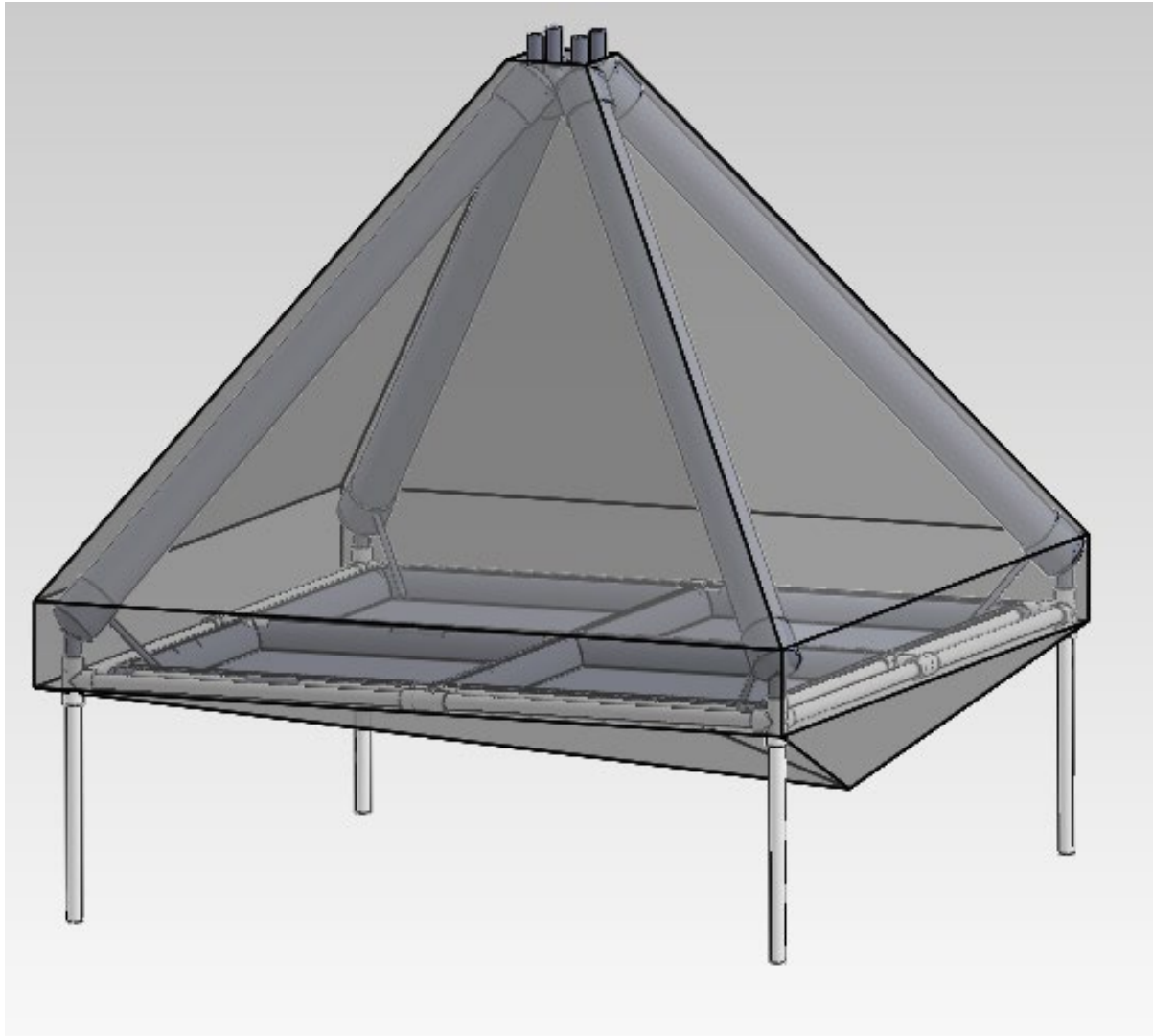


Siklus Jakarta Dispenser, Fall 2021, 12 total topics noted

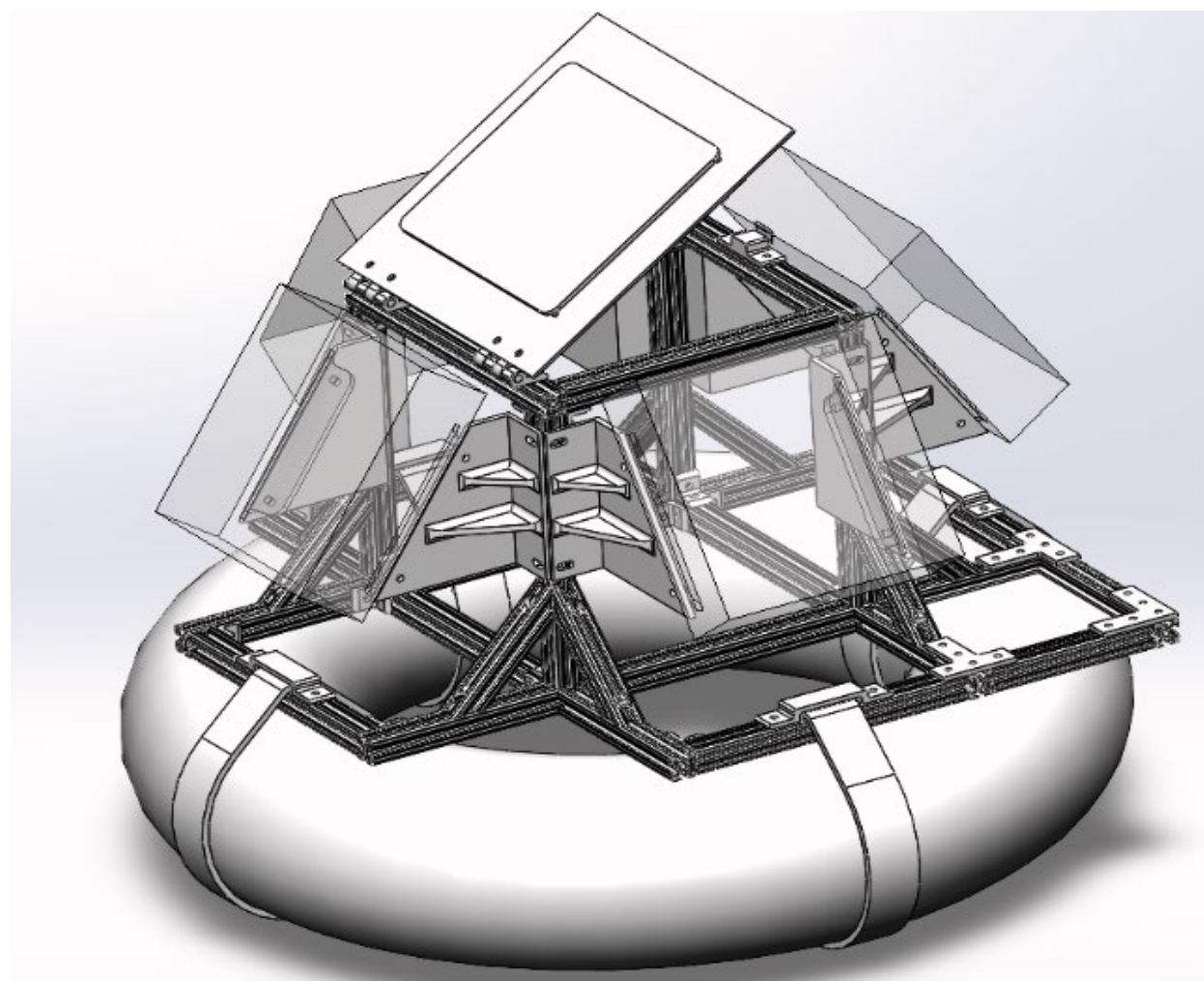
Measurement Course Topics 2013	Measurement Course Topics 2021
Fundamentals of Measurement Systems	Introduction to Measurement Systems
Characteristics of Instruments	Accuracy and Precision
Choosing sensors	Deciphering spec sheets
Calibration and Standards	Calibration and Standards
Design of Experiments	Problem Definition
1 st and 2 nd order system response	Variables and Data Analysis Design
Measurement Signal Transmission	Experiment Design
Signal Processing in LabView	1st and 2nd order system response
Data Analysis	Electrical Signals
Uncertainty	Data Acquisition
Temperature	Data Analysis
Pressure	Uncertainty
Wind speed measurement	Curve Fitting and Regression Analysis
Fluid flow measurement	Temperature Measurements
Strain	Thermodynamics Measurements
Power and Electrical Measurements	Heat Transfer Measurements
Acceleration, Load and Vibration	Pressure Measurements
Predicting outcomes using theoretical calculations	Air flow Measurements
LabView	Wind Tunnels and Wind Power
Length and distance	Pipe/ Fluid Flow Measurements
Rotational Measurement	Strain/ Load Measurement
Mass, Force, and Torque	Mechanical Power Measurement
Communicating Results	Displacement, Velocity, and Acceleration
	Smartphone Sensors
	Communicating Results
	Arduino

2020 Changes:

- Increased instruction in Design of Experiments
- Increased and expanded statistical data analysis
- Replaced LabView with Arduino
- Added experiments in thermodynamics and solar power
- Required students to create and use their own Arduino circuits for data acquisition
- Added information about using smartphone sensors for data acquisition



Solar Desalinator, Fall 2012, 1 topic noted



Solar Desalinator, Fall 2021, 9 topics noted

Conclusions: Average number of unique topics increased from 4.6 during Fall 2012 to 8.0 during Fall 2021. Topics were also used in more sophisticated ways and integrated more completely into the final reports. Anecdotal evidence based on sensor checkout logs shows that the number and variety of sensors used by the groups increased dramatically from Fall 2012 to Fall 2021. **The pre-capstone lab course, although not developed specifically as an introduction to capstone, continues to evolve in a way that supports increasingly sophisticated projects.**

