Capstone Design Course Survey Overview

Selected Results from the 2012 AIChE Education Division Survey

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Survey Background

- AIChE Education Special Projects Committee conducted surveys from 1957–1993
  - Examined demographics/statistics
  - Probed for innovative and effective teaching methods
- Topics were curricular and pedagogical
- Surveys resumed in 2009 following that model
  - Freshman Introduction (2009), Kinetics and Reactor Design (2010), Material & Energy Balances (2011)

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Methodology

- Implemented via the Web using LimeSurvey, an open source survey software package
- Questions designed to generate
  - Statistical demographic data
  - Examples of effective teaching methods in use
- Department chairs asked to request appropriate faculty members to respond
- Faculty members teaching the course in 2011-2012 based on public records asked to respond

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Summary

- 158 schools in the U.S. invited to respond
  - Institutions in Canada invited
  - Selected institutions internationally invited
  - 69 usable responses
    - 5 institutions had multiple responders
- 64 institutions represented
  - 58 in US
  - 6 international
  - 37% US Institutional Response Rate
    - 42% in 2011
    - 38% in 2010

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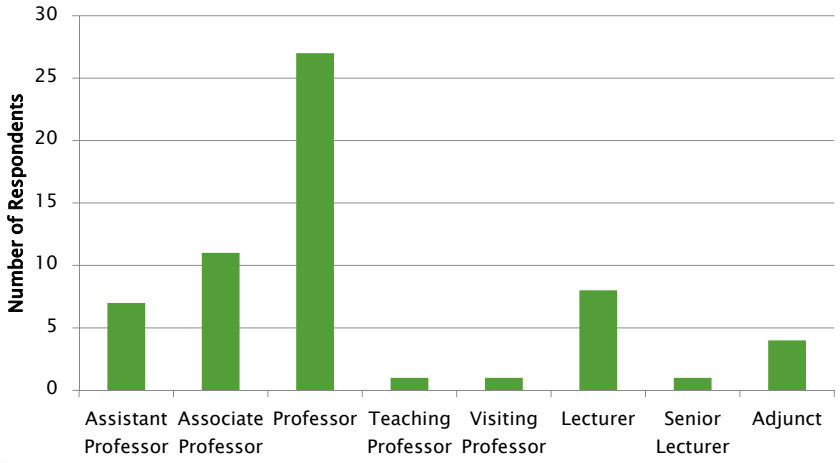
Who's Teaching?



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Industrial Role

- 68 instructors responded
  - 15 indicated no industrial experience (22%)
  - Average industrial experience
    - 9.0 y amongst all instructors
    - 11.6 y amongst those with experience (σ = 11.2)
- 36 indicated use of industrial partners or adjuncts in one of several roles:
  - Guest lectures
  - Advisors/mentors
  - Consultants
  - Evaluators
  - Problem sources
  - Webinars

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Quantity of Instruction

- Number of courses
  - 30 institutions had 1 course
  - 28 had 2 courses
  - 4 had 3 courses
  - 1 reported 4 courses
- Hours/wk on task
  - 2.5 on lecture
  - 1.8 on simulation/problem laboratory
  - 0.1 on experimental laboratory
  - 4.1 hours total
- 1.8 exams given on average by the 47 (of 68) instructors who give exams

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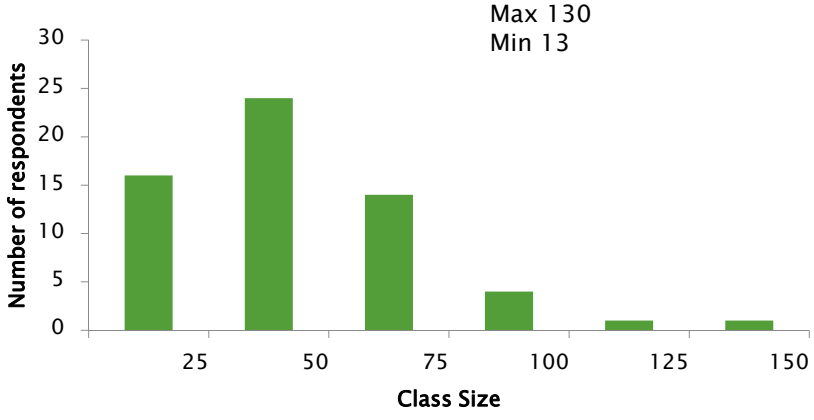
Class Size

Average 45.1
Max 130
Min 13



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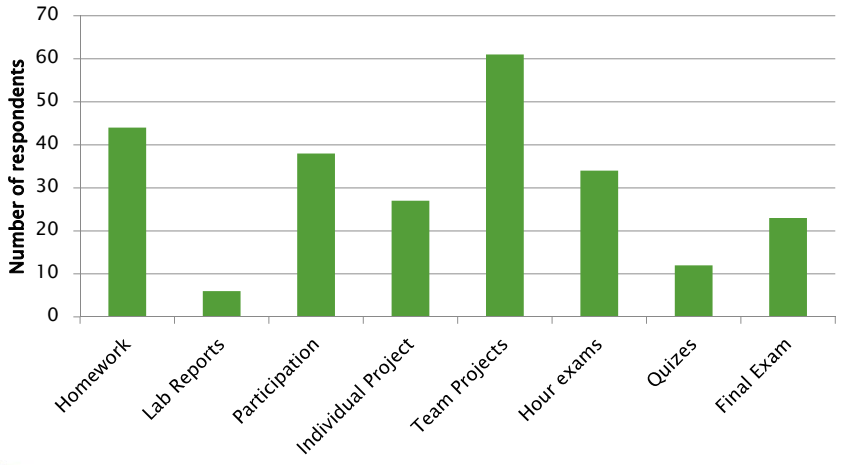
Grade Components



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Other Assessments

- Presentations
- Teamwork
- Safety training
- Peer review
- Status reports
- Journals
- Mock FE Exam

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Beyond the Instructor

- Average of 3.5% of all contact with TAs
  - 15 instructors reported TA role as lecturer, recitation leader, or oral report evaluator
- 36 respondents indicated use of industrial partners or adjuncts
  - Guest lecturers
  - Advisors/Mentors
  - Consultants
  - Evaluators
  - Problem sources
  - Webinars

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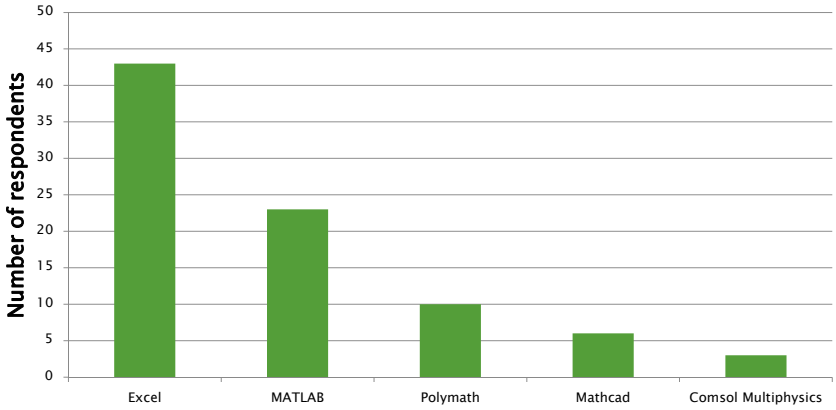
Software Usage



Others mentioned: Mathematica, Maple, TK Solver, Project, HSC Chemistry, GAMS, Capcost, Visio

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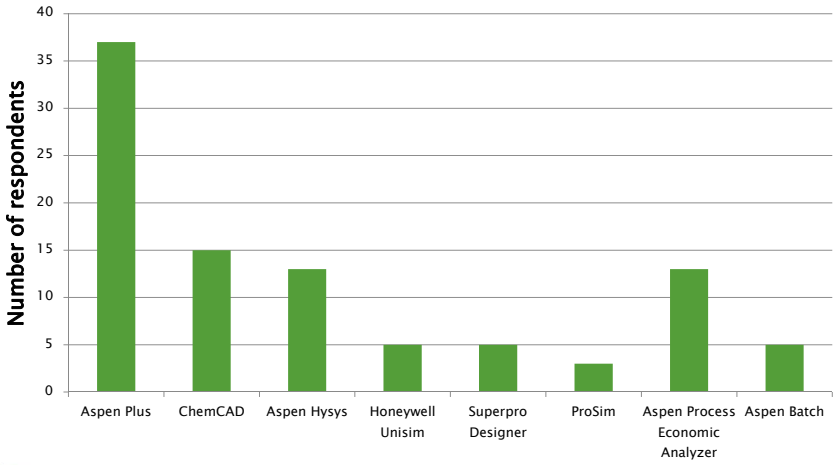
Simulator Usage



Others mentioned: Pro/II, Aspen Dynamics, ChemSEP, Aspen Energy Analyzer

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Computing Facilities

- Who maintains computing laboratories:
  - 42 maintained at the department level
  - 30 maintained at the college level
  - 18 maintained at the university level
  - 1 did not maintain a computing lab
- Platform
  - 94% Windows
  - 4% MacOS
  - 2% Linux

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Online integration

- Extensive use of CMS (Blackboard, Moodle, etc)
- SACHE materials
- CACHE materials
- Use of online resources for research

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Textbooks

- Biegler, Grossmann & Westerberg, *Systematic Methods of Process Design*, Prentice Hall, 1997
- Cussler & Moggridge, *Chemical Product Design*, Cambridge, 2011
- Luyben, *Distillation Design and Control using Aspen Simulation*, AIChE/Wiley, 2006
- Peters,Timmerhaus,& West, *Plant Design and Economics for Chemical Engineers*, McGraw Hill, 2002
- Seider, Seader, Lewin, & Widagdo, *Product and Process Design Principles*, Wiley, 2008
- Towler & Sinnott, *Chemical Engineering Design*, Butterworth-Heinemann, 2012
- Turton, Baillie, Whiting, & Shaeiwitz, *Analysis, Synthesis, and Design of Chemical Processes*, Prentice Hall, 2012
- Ulrich, *Product Design and Development*, McGraw Hill, 2011

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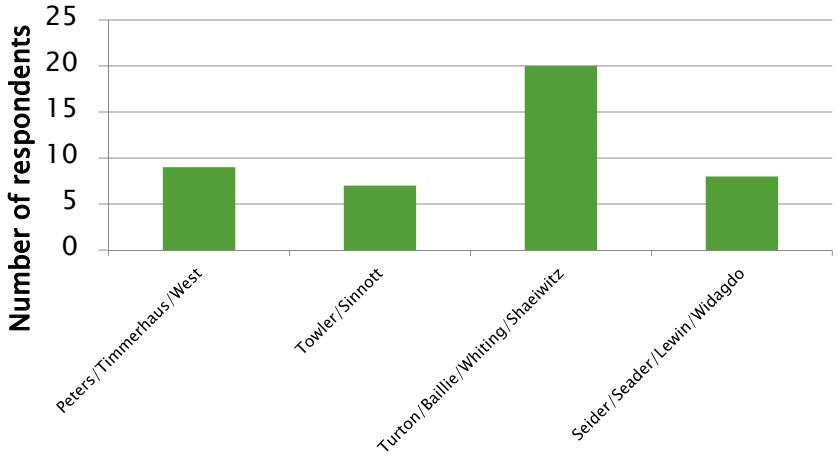
Textbooks



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Project Assignments

- Team Projects: Average team size 4.3
  - Skewed by several large (max 26) teams
    - Without large teams, average is 3.5
  - Minimum team size 1 (?)
- Average of 11.8 concurrent (parallel) projects
  - 25 respondents indicated they were all unique projects
- Students participated in an average 2 total projects during their design sequence

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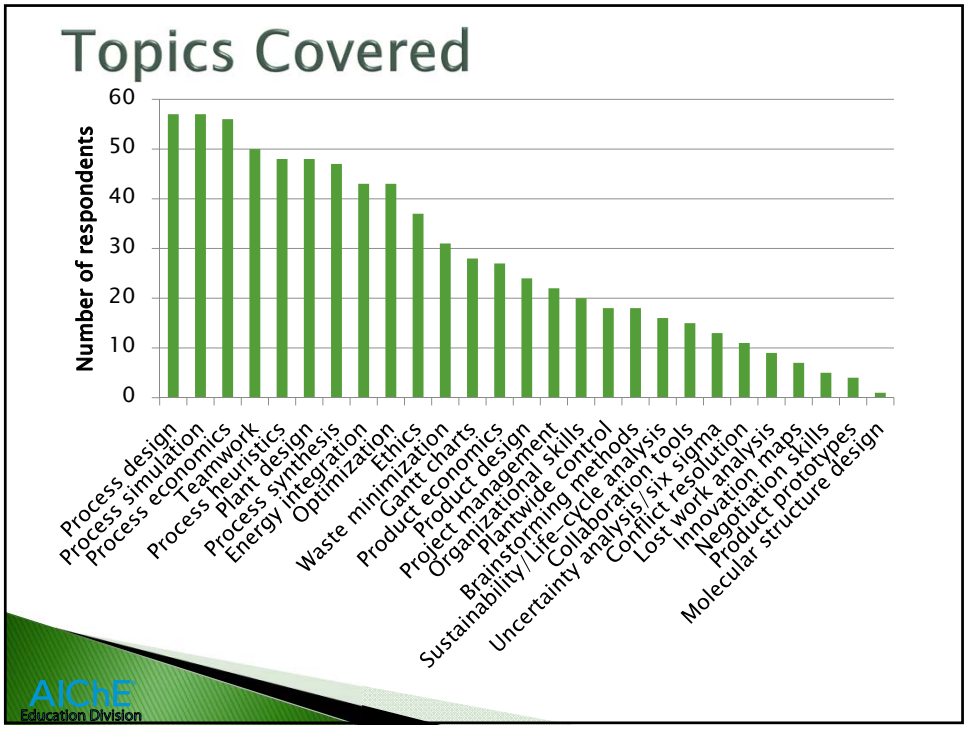
Topics Covered
Number of respondents
60
50
40
30
20
10
0
Process design
Process simulation
Process economics
Teamwork
Process heuristics
Plant design
Process synthesis
Energy integration
Optimization
Ethics
Waste minimization
Gantt charts
Product economics
Product design
Project management
Organizational skills
Plantwide control
Brainstorming methods
Sustainability/Life-cycle analysis
Collaboration tools
Uncertainty analysis/six sigma
Conflict resolution
Lost work analysis
Innovation maps
Negotiation skills
Product prototypes
Molecular structure design
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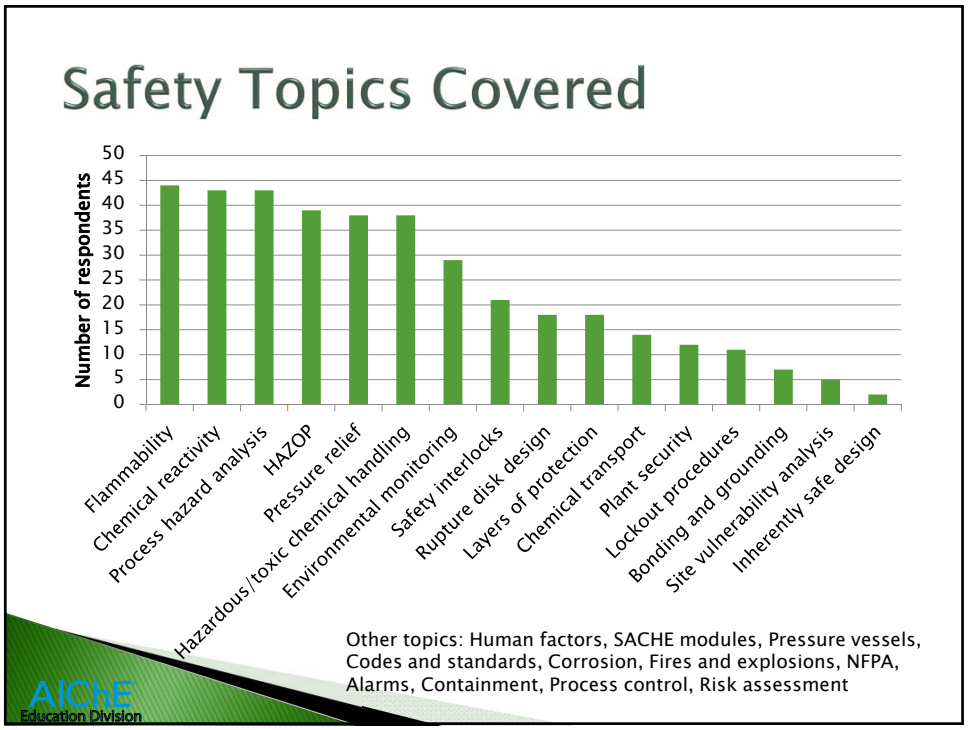
Safety Topics Covered
Number of respondents
50
45
40
35
30
25
20
15
10
5
0
Flammability
Chemical reactivity
Process hazard analysis
HAZOP
Pressure relief
Hazardous/toxic chemical handling
Environmental monitoring
Safety interlocks
Rupture disk design
Layers of protection
Chemical transport
Plant security
Lockout procedures
Bonding and grounding
Site vulnerability analysis
Inherently safe design
Other topics: Human factors, SACHE modules, Pressure vessels, Codes and standards, Corrosion, Fires and explosions, NFPA, Alarms, Containment, Process control, Risk assessment
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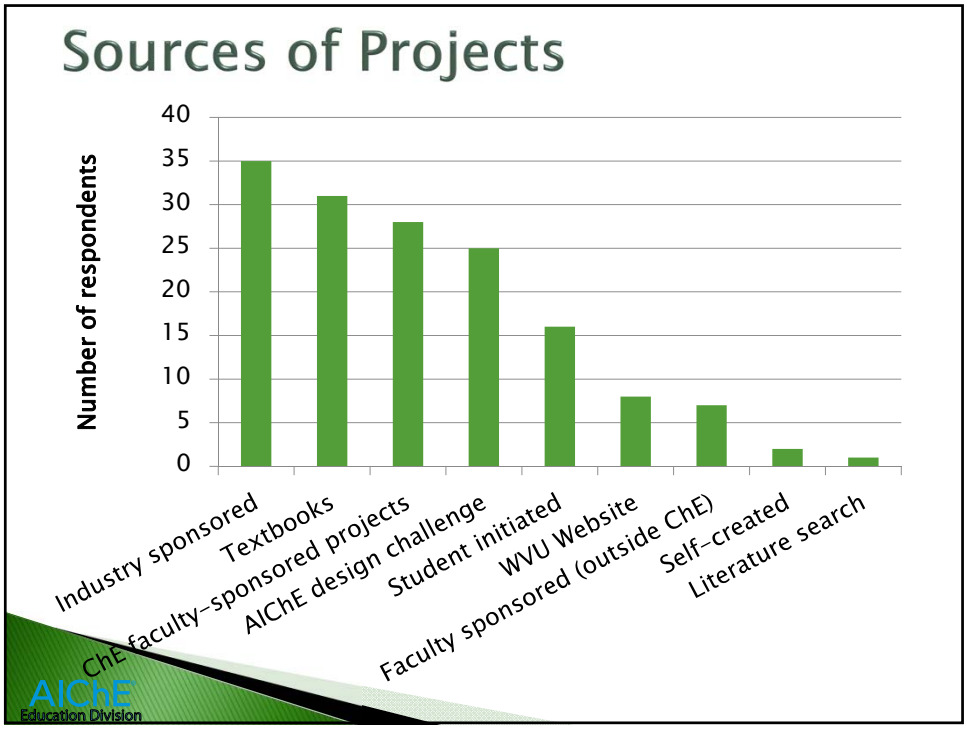
Sources of Projects
Number of respondents
40
35
30
25
20
15
10
5
0
Industry sponsored
Textbooks
ChE faculty-sponsored projects
AIChE design challenge
Student initiated
WVU Website
Faculty sponsored (outside ChE)
Self-created
Literature search
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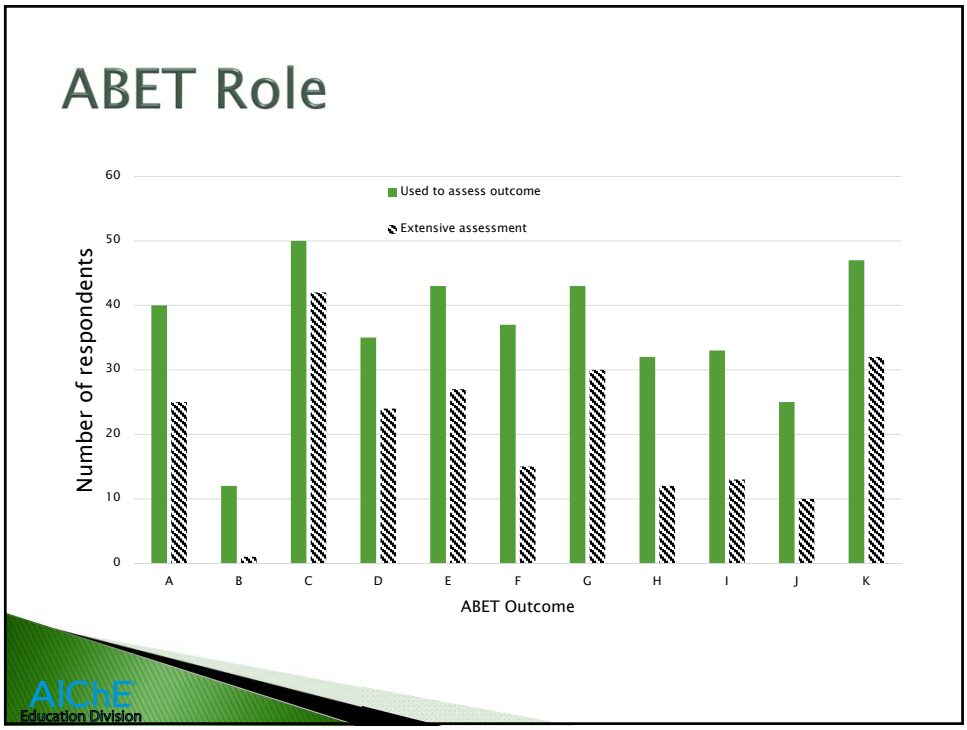
ABET Role
Number of respondents
60
50
40
30
20
10
0
Used to assess outcome
Extensive assessment
A
B
C
D
E
F
G
H
I
J
K
ABET Outcome
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Prime Goals

- Critical thinking, problem-solving
- Demonstrate competency
- Integrate concepts throughout the curriculum
- Full system design with control, economics, safety

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Faculty Role

- Coach, mentor, team leader, guide, facilitator
- Enabler, trouble-shooter, motivator, consultant
- Teacher, instructor, deliver-er of content, assurer of product quality

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Challenges

- Class size
- Students are: ignorant, lazy, unable to motivate a semester-long project, unable to handle open-ended problems
- Students don't know as much about (x) as they should: fundamental ChemE, literature searching, team-work
- Developing good projects
- Faculty need to: have experience in plant design, be engaged, spend time grading written work, not flee the course

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Future Work

- Journal article extending the fundamental descriptive responses
  - Multidisciplinary elements
  - Entrepreneurial elements
  - Historical comparisons
  - International breakout
  - AIChE Session Discussion
- This year's topic is ChE Electives
  - Survey available at http://survey.edudiv.org
  - Led by Margot Vigeant with Ben Davis
- Coming next year… Transport Phenomena!

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Acknowledgments

- All of the instructors who completed the survey
- All of the department chairs who passed on the request
- CACHE Corporation (cache.org)
- University of Kentucky ECS
- www.limesurvey.org

- Contact David Silverstein (David.Silverstein@uky.edu) for more information

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