ASME Center for Education

Vision 2030
Creating the Future of Mechanical Engineering Education

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ASME Director Education & Professional Development

June 19, 2010

ASME Asia-Pacific District Operating Board
Sydney, Australia

ASME
SETTING THE STANDARD

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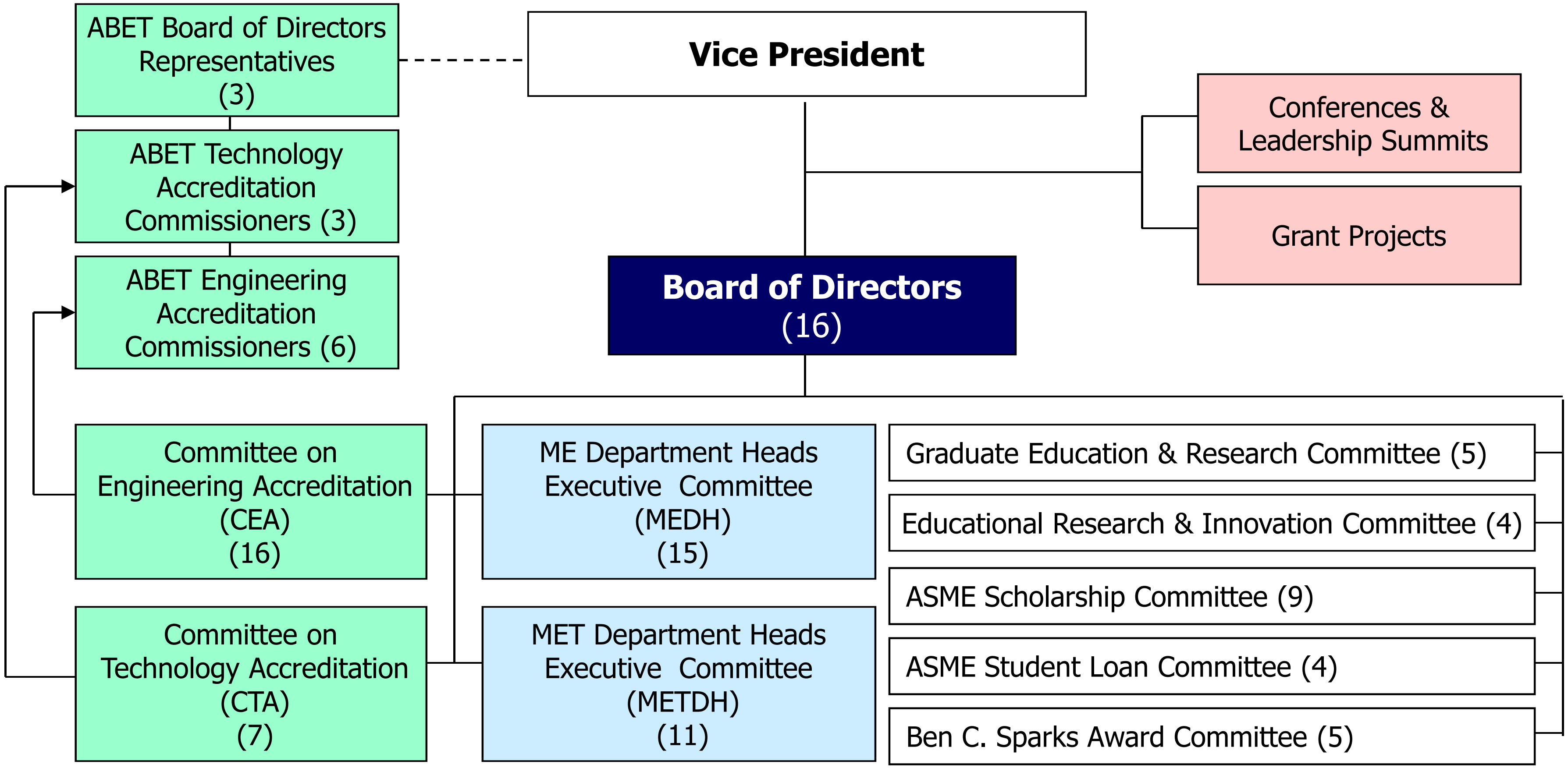

2010-11 ASME/ABET
(439) Degree Programs
(174) Program Evaluators

~230 Volunteers

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Board of Directors

- **ABET Accreditation** (and related)
  - What is ABET?
  - ASME Degree Program Responsibility
  - Domestic & International Visits
  - ASME Program Evaluators
- **Department Head Programs & Services**
  - ME Education Conferences
  - Leadership Summits
  - Benchmark Studies
  - DH Forums
  - ME/MEDH Listservs
- **Grant-Funded Projects**
  - **Vision 2030 – ME Education**
  - Gender Equity/Climate Study Projects
- **Faculty Development**
  - Tips for Tenure Workshops
- **Graduate Education**
  - Grad Teaching Fellowships
  - Grad Student/Post Doc Brochure
  - Grad Students' Reception
- **Financial Aid**
  - ASME Scholarships
  - ASME Student Loans
- **Awards**
  - Ben C. Sparks Award

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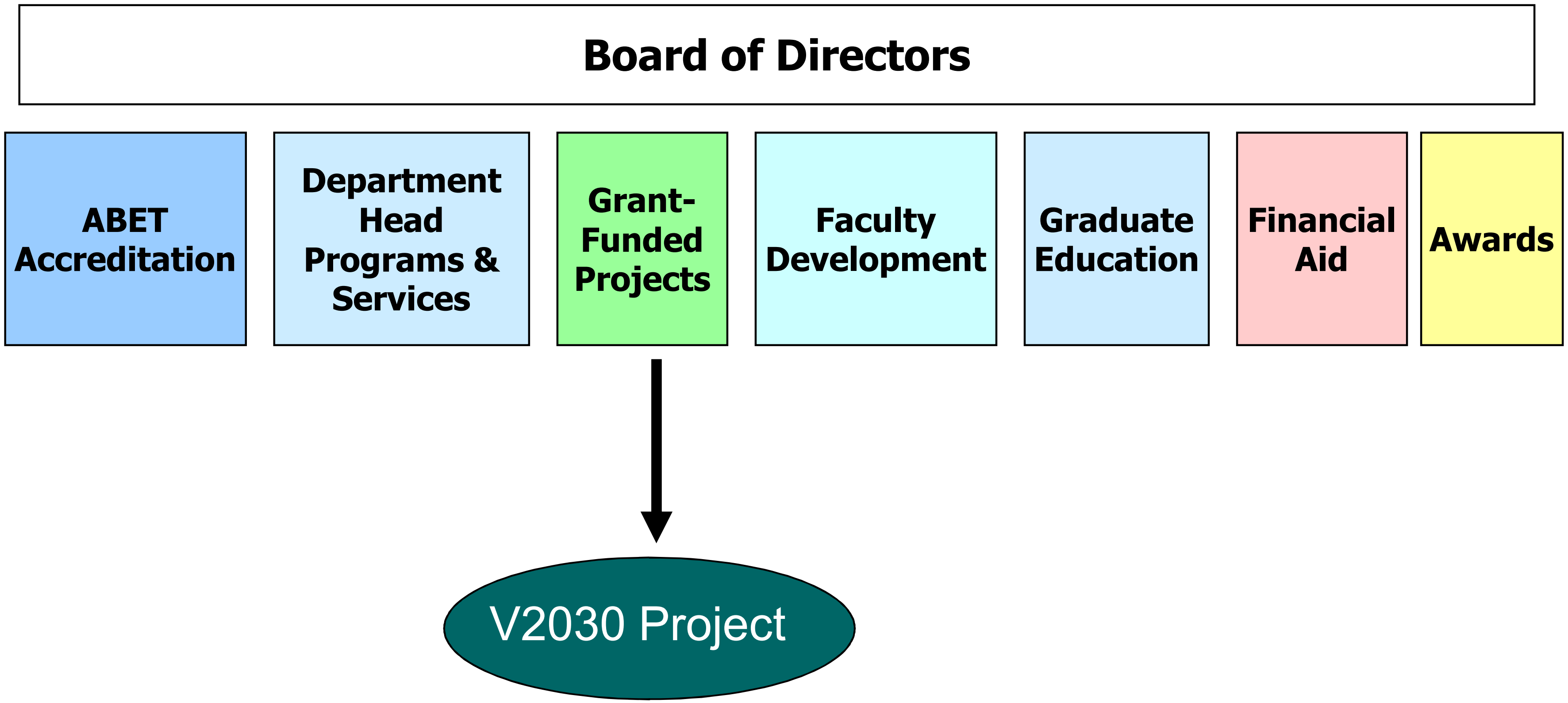
Impact Areas



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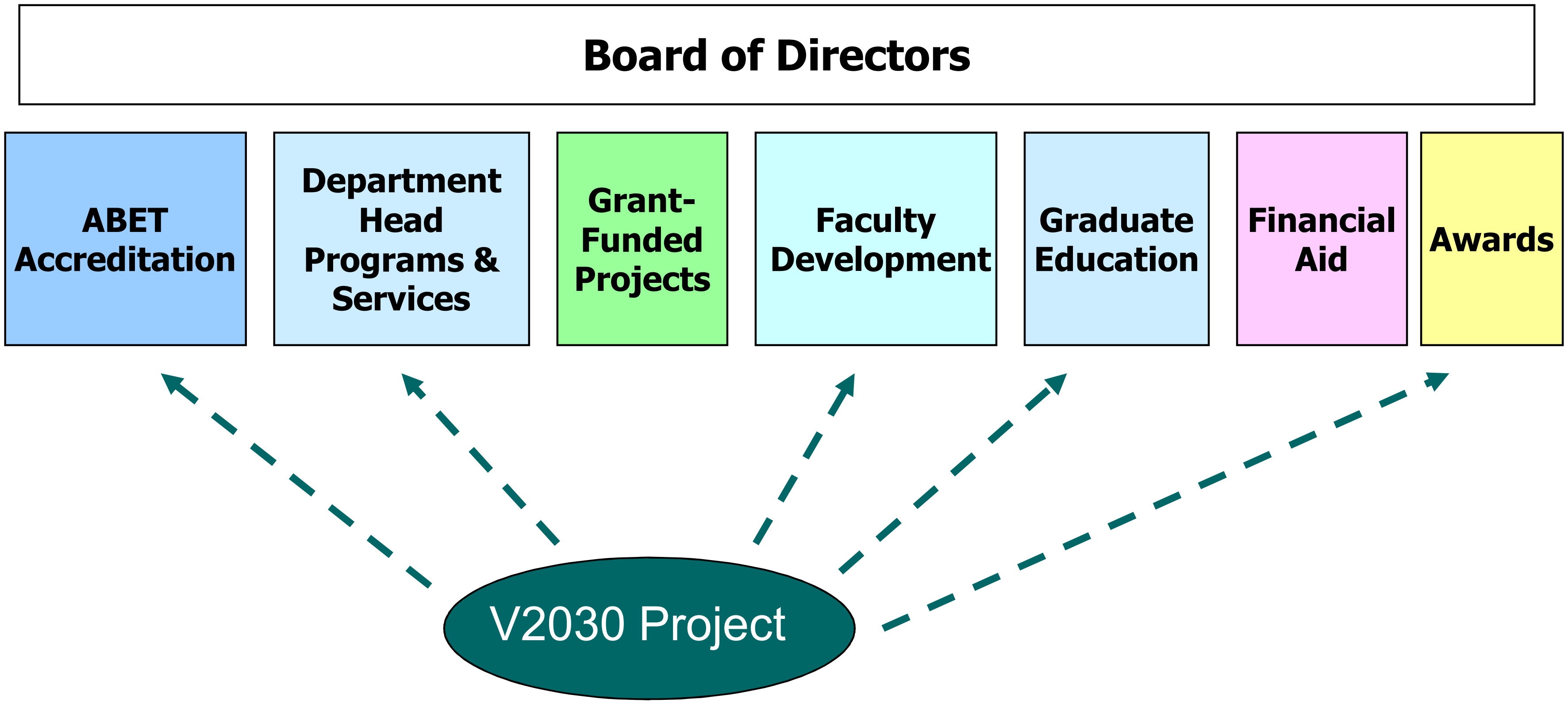
Impact Areas



Vision 2030 – Mechanical Engineering Education Project *(Phase I)*

- ASME Foundation supported assessment of entry-level graduate skills and future needs in ME degree programs
- Data and recommendations from100 ME departments and 1,000+ engineers & managers in industry
- ASME Sustaining Innovation Proposal Submitted *(Phase II)* …. Drill-down research and advocacy. International validation.

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Vision 2030
Mechanical Engineering Education

1. Background – Building on recent significant work
2. Grand Challenges & Opportunities – 21st century needs
3. Changes in Industry and the ME Profession – What ME's should know and be able to do
4. Current Assessment of Mechanical Engineering Education
5. Recommended Curricula and Outcomes for 2030
6. Advocacy and Action Agenda for Academic Change
   - Academic Drivers/Impediments
   - Industry Drivers/Support
   - Government Drivers/Support
   - ASME Drivers/Support
7. Global Challenges, Opportunities and Leadership

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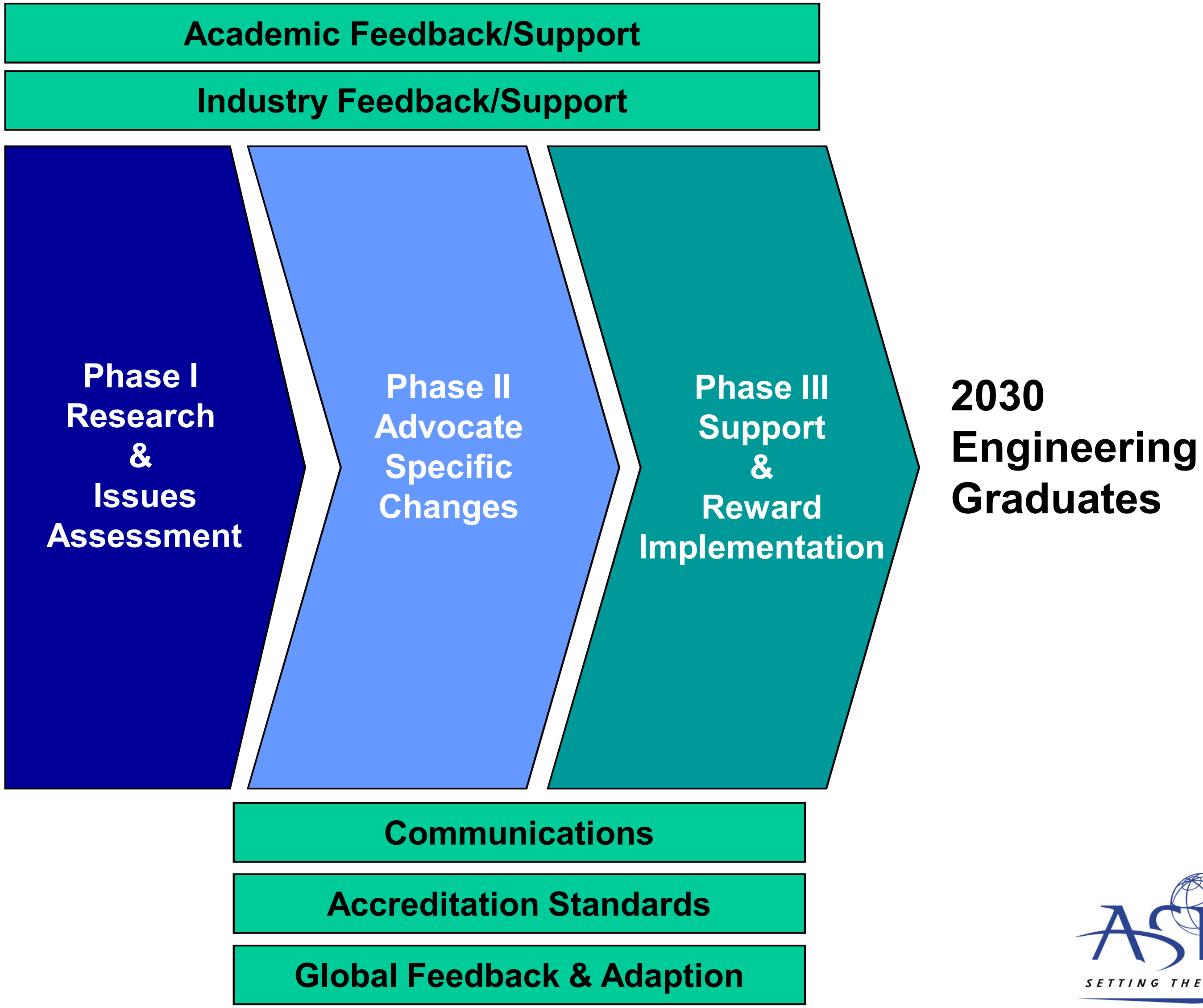

Vision 2030 Mechanical Engineering Education

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Background Thinking *(50,000 foot-level)*

- NAE, 2004, The Engineer of 2020
- NAE, 2005, Educating the Engineer of 2020
- NAE, 2008, Changing the Conversation
- NSF, 2007, The 5XME Workshop: Transforming ME Education and Research
- ASME, 2008 Global Summit on the Future of Mechanical Engineering
- Duderstadt, 2008, Engineering for a Changing World
- ASCE, 2008, Civil Engineering Body of Knowledge for the 21st Century
- Carnegie Foundation 2008, "Educating Engineers: Designing for the Future of the Field"
- ASEE 2009, "Creating a Culture for Scholarly Systematic Innovation in Engineering Education", Phase I report
- CDIO Methods/Advocacy

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Strategic Implications for:

Center for Education – ABET Accreditation activities, department head and faculty developments programs, honors & awards, even (conceivably) student financial aid

Center for Career & Professional Advancement – Early career engineer development, student design competitions & expositions, *ME Today/PPC*

Strategic Management – *I-Show*

Center for Public Awareness – Career Guidance information (eg. *What is a Mechanical Engineer*, *ME/MET: Whch Path will you choose?*)

…..Others?

V2030 Project Goals

- Make the research-based (or at least research-informed) case for change
- Recommend improvements to the mechanical engineering and technology education curricula
- Provide ME/MET graduates with the needed expertise for successful professional practice, and
- Develop engineering leadership to solve technical and societal challenges

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Drivers for Change

Our Students are Creative and Inventive but not necessarily innovative.

"Innovation occupies our attention today because the solution of almost every major problem is thought to depend on innovation. How will we raise the quality of life for every citizen? The answer is through innovation."

– *Dan Mote, President, University of Maryland*

We also need:

the Implementation of Invention …… **Innovation**

Innovation Requires Leadership

Drivers for Change

The Big Picture

by the Millennium Project of WFUNA
www.millennium-project.org

Drivers for Change

Increased Professional Expectations

- Engineering expertise will be required at a higher level than “routine” engineering *(although large numbers of these engineers will continue to be needed)*.
- Greater expertise in communications, innovation, leadership, and creativity will be required *(but these topics are not typically a significant part of engineering curricula)*.

New Knowledge and the Blurring/Widening of Disciplinary Boundaries

- Complex ‘Engineered Systems, Multi-disciplinary Engineering, …

The Grand Challenges & Unsustainable Growth – Call for Engineering Leadership

Drivers for Change

About entry-level mechanical engineers ….

"*Afraid to get hands dirty and learn how products are made and assembled','*, *'have never disassembled and reassembled anything substantial'* -→ **Practical experience**

' Lack of ability to transfer engineering knowledge to practical problem solving', *'Knowing which problem to solve', 'Inability to get to the root of even basic problems', 'clueless as to what a reasonable answer should be to any computational question, instead they say – the computer says'* → **Problem solving**

Closer to the ground … from the V2030 industry survey

V2030 Industry & ME Department Surveys

Four ME Department Head Forums, 2008-2010

Three Surveys of ME Department Heads (1) and engineering managers in industry (2)

Total input to date MEDH's from 100+ universities and over 1,000 engineering managers

U.S. only….. So far.

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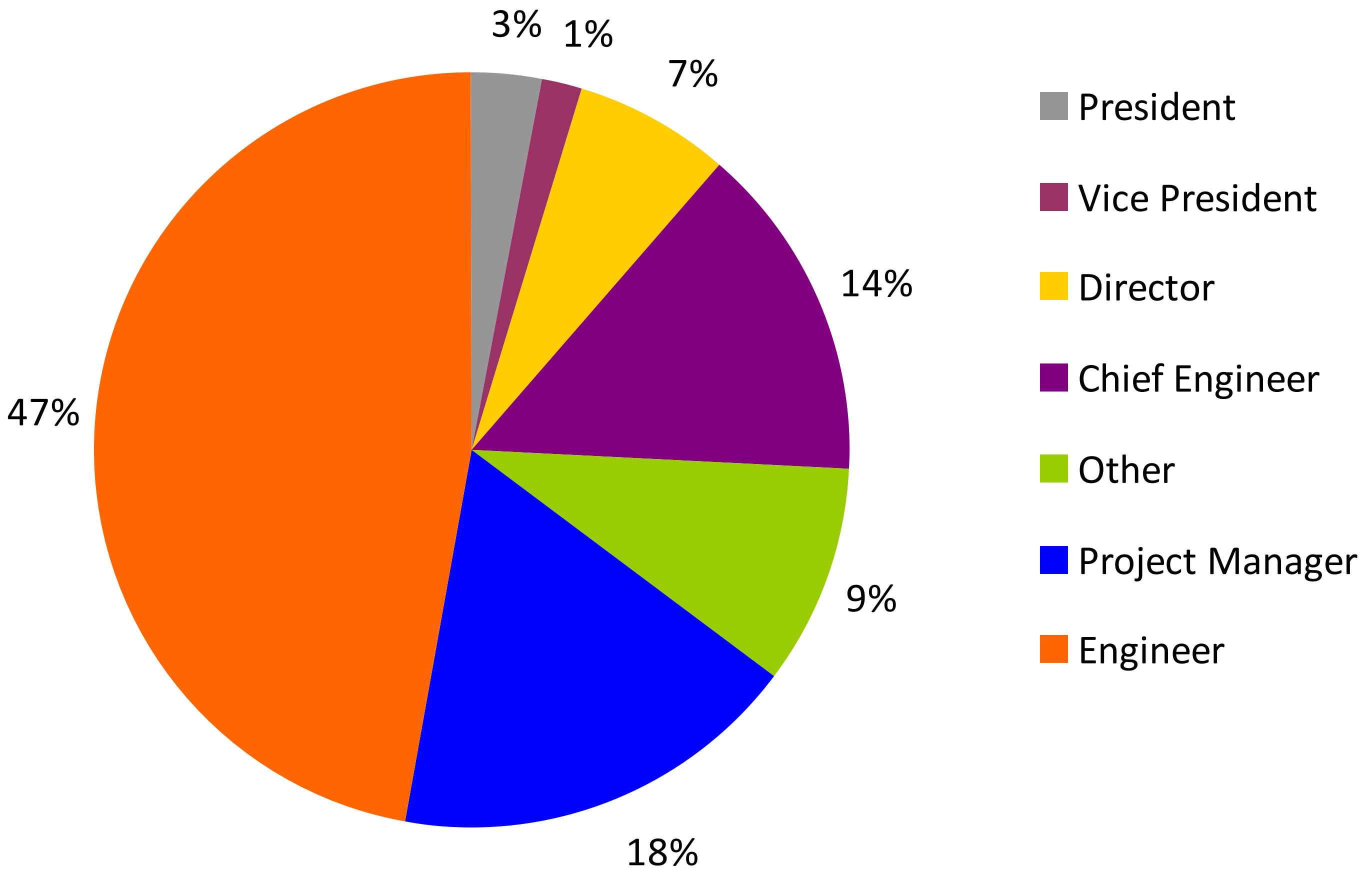
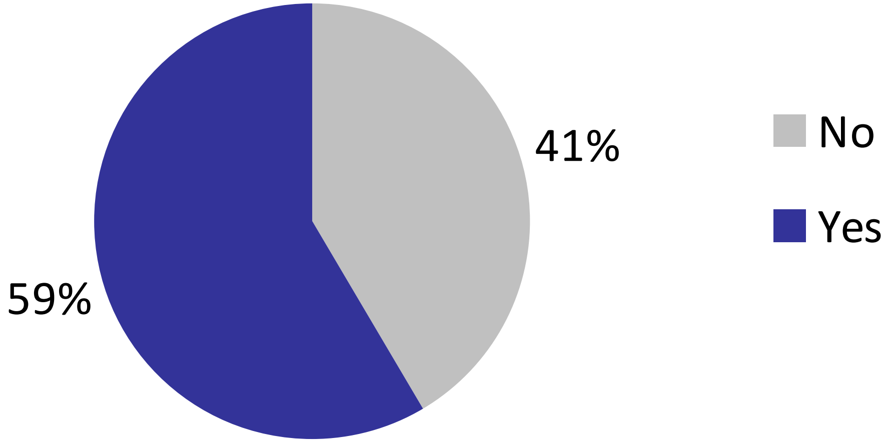
V2030 Industry Survey

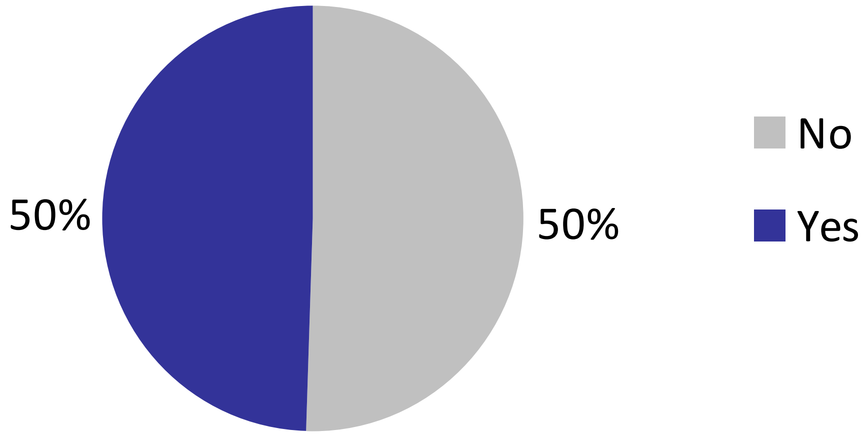


Q1. Job Function

V2030 Industry Survey



Q2. Involved in hiring entry-level engineers?



Q3. Directly supervise entry-level engineers?

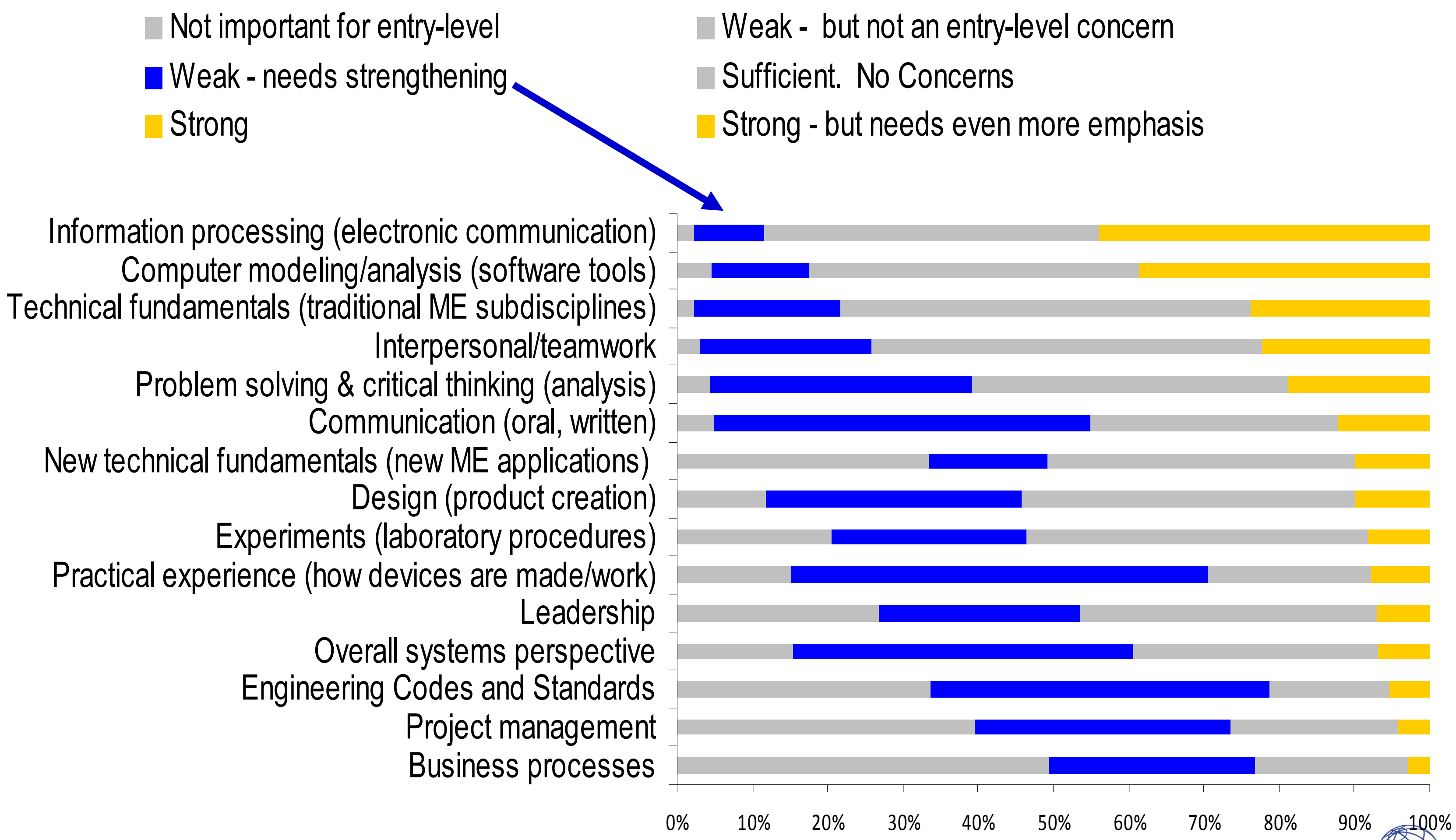
V2030 Industry Survey

- Not important for entry-level
- Weak - needs strengthening
- Strong
- Weak - but not an entry-level concern
- Sufficient. No Concerns
- Strong - but needs even more emphasis

Information processing (electronic communication)
Computer modeling/analysis (software tools)
Technical fundamentals (traditional ME subdisciplines)
Interpersonal/teamwork
Problem solving & critical thinking (analysis)
Communication (oral, written)
New technical fundamentals (new ME applications)
Design (product creation)
Experiments (laboratory procedures)
Practical experience (how devices are made/work)
Leadership
Overall systems perspective
Engineering Codes and Standards
Project management
Business processes

Q4. Assessment of entry-level ME skills

V2030 Industry Survey



Q4. Assessment of entry-level ME skills

V2030 Industry/Academic Comparison

	Not important for entry-level	Weak – but no concern	Weak – needs strengthening	Sufficient. No Concerns	Strong	Strong – needs more emphasis
Business Processes	14%	36%	29% (39%)	19% (17%)	1% (10%)	0.3%
Communications	0.3%	4%	52% (20%)	33% (28%)	9% (52%)	4%
Design (product creation)	2%	7%	34% (16%)	45% 29%)	11% (53%)	1%
Experiments - Lab	9%	6%	30% (9%)	44% (52%)	6% (39%)	2%
Leadership	6%	19%	29% (36%)	39% (29%)	6% (24%)	1%

Q4. Industry Assessment of entry-level ME skills
Q4. MEDH Assessment of BSME Curricula

(Note: Some values do not add to 100%; some respondents failed to provide a valid response)

Vision2030
Mechanical Engineering Education

ASME Center for Education

V2030 Industry/Academic Comparison

	Not important for entry-level	Weak – but no concern	Weak – needs strengthening	Sufficient. No Concerns	Strong	Strong – needs more emphasis
Overall systems	3%	14%	45% (47%)	34% (32%)	4% (16%)	1%
Practical experience (devices made/work)	1%	9%	59% (33%)	23% (41%)	6% (23%)	2%
Problem solving & critical thinking & analysis	1%	3%	36% (7%)	44% (33%)	14% (59%)	3%
Project management	12%	27%	33% (29%)	24% (44%)	3% (15%)	1%
Technical fundamentals	0.3%	1%	20% (3%)	53% (29%)	22% (68%)	3%
New technical areas	21%	15%	14% (40%)	40% (33%)	7% (6%)	0.5%

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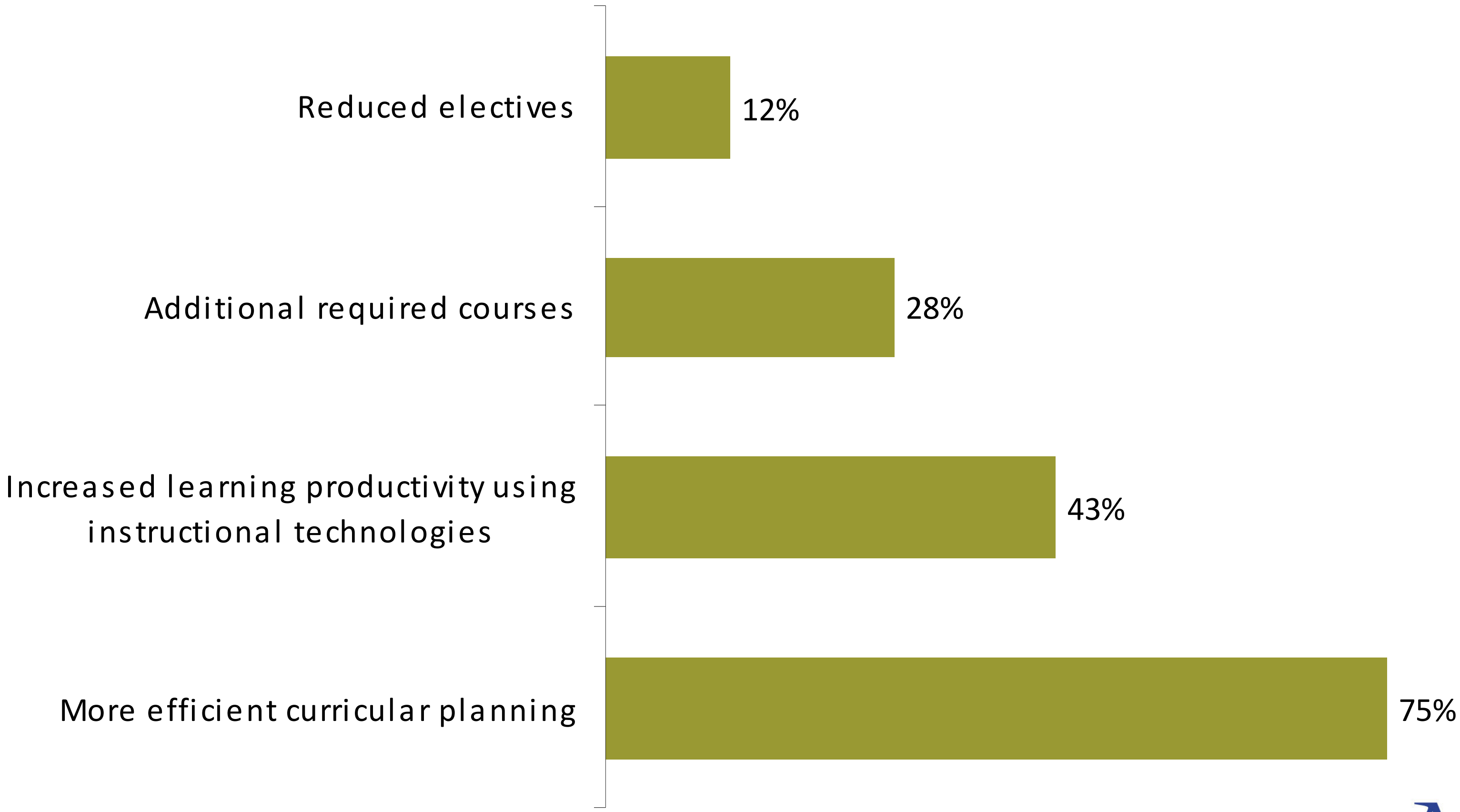
V2030 Academic Survey

Q. If you foresee significant curricular changes, these would generally be accommodated by:



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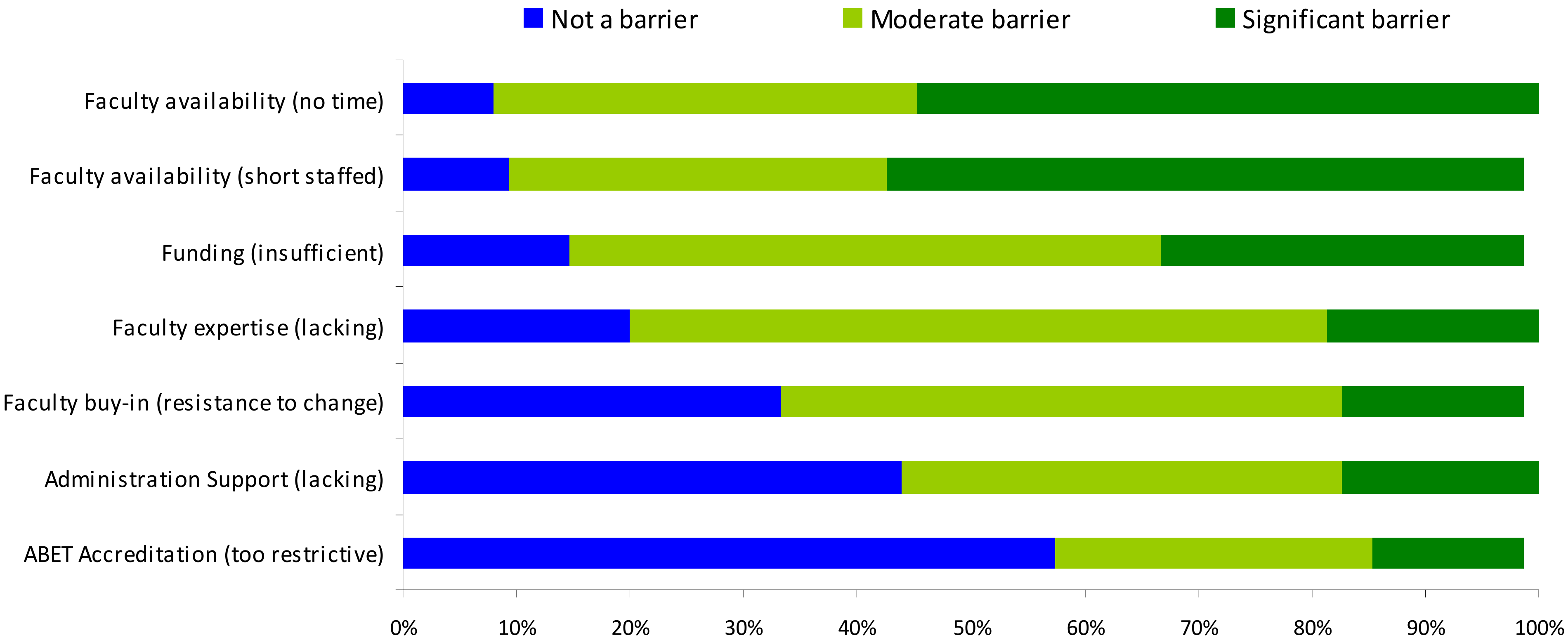
V2030 Academic Survey

Barriers to change…



Many choices for curricular structures

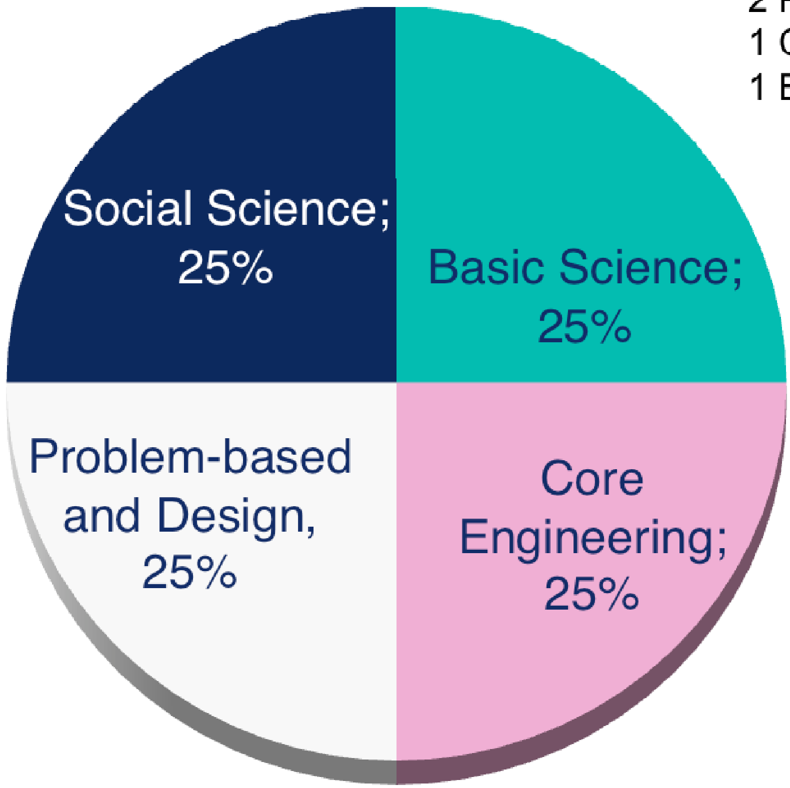
- Business as usual, with occasional introduction of new topics;
- The professional school model;
- A more flexible bachelor's degree with additional content at the master's level;
- A pervasive practice-based curriculum with CDIO emphasis;
- A broader, multi-disciplinary and flexible curriculum meeting the general ABET criteria but no disciplinary program criteria;
- An engineering curriculum that integrates content, including the humanities and social sciences, and pervasive communication skills;
- A engineering systems-focused curriculum;
- A curriculum emphasizing globalization, quality of life issues, and solving society's grand challenges;
- A curriculum emphasizing the business of engineering, leadership, entrepreneurship, innovation and creativity……….

Univ. of Michigan 5XME Sample #1

Social Science

- Arts
- Humanity
- Business
- Economics
- Cultural Diversity
- Communication
- Interpersonal Psychology
- Elective

BS 4 yrs. - 128 Credits



Basic Science and Math
4 Math
2 Physics
1 Chemistry
1 Biology

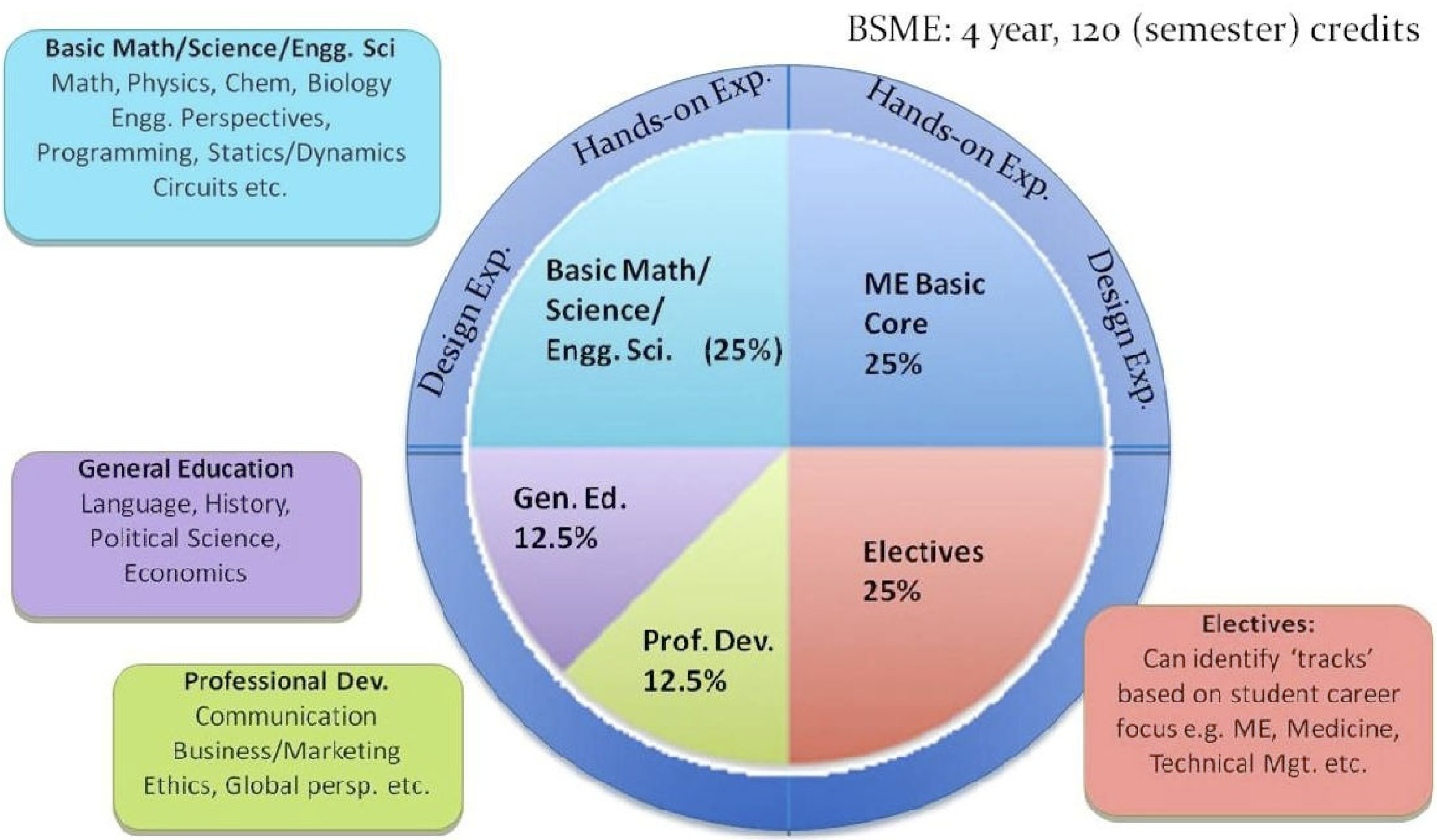
Problem Solving and Design

- Inverse Engineering
- Design concepts
- Systems engineering
- Case studies
- Modeling and simulation
- Research based
- 2 Capstone

Core Engineering

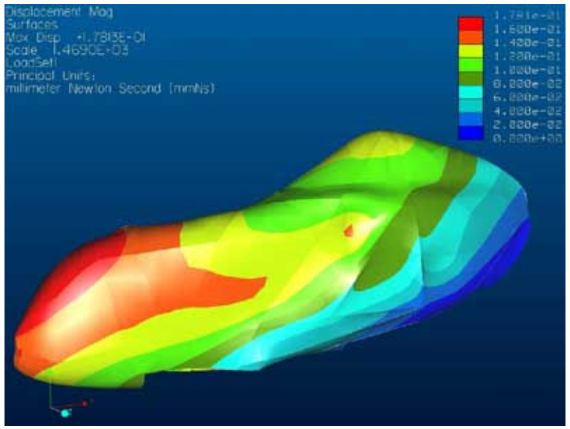
- 1 Mechanics
- 1 Electronics
- 1 Transport
- 1 Materials
- 1 System and Controls
- 1 Instrumentation, measurements & interface
- 2 Elective

Univ. of Michigan 5XME Sample #2



'Practical experience'

- strengthening the 'practical experience' component of the students' skill set,
- a significant portion of the curriculum needs to be dedicated to such activities.
- In this case, the ME curriculum should contain a design/professional spine with significant design-build



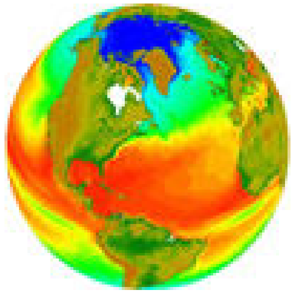
Design/Professional Spine

- Professional skills such as problem solving, teamwork, leadership, entrepreneurship, innovation, and project management would be central features of the design spine.

- These skills should be learned in the context of a structured approach to problem solving - problem formulation, problem analysis, and solution.

Incorporation of Grand Challenges into Design Spine

- ‘Grand Challenges’ can be incorporated as elements into the early design courses
- Provides a context and engineering background for students
- Indicates areas where mechanical engineers are needed to provide leadership in the development of innovative and sustainable solutions.
- Seven challenges relevant to mechanical engineering students:
  - the environment,
  - energy,
  - health,
  - security,
  - multi scale systems, and
  - global collaboration.
  - quality of life



Design/Professional Spine

- Year 1 – problem solving course, engineering computer graphics course
- Year 2 – product manufacturing course, design process course
- Year 3 – product development course
- Year 4 – two semester capstone senior design

- Reinforce the design/ professional topics are year by year, with no gap in the sophomore and junior years,
- All of the courses would incorporate group projects, teamwork, oral and written communication.
- Implementation will require both intellectual and financial resources: buy-in from the faculty, increased industrial expertise and support, increased workshop, laboratory and design studio space.

Vision 2030 - Phase II

- ASME Survey of Early Career Engineers *(self assessment)*
- Go Global *(International Validation)*
- Further develop MET and the graduate curricula implications
- Disseminate desired practices & advocate support *(ABET, Industry, Government, ASME)*
- Lead and support the change efforts of departments
- Obtain funding for outcomes assessment for recommendations
- *And…. Center for Education/IAB collaboration*

Discussion…..