ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Engineering for Social Good

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ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

OUTLINE

- Brief ASEE Overview
- What is Social Good?
- What are Global Challenges?
- What are Human Needs?
- What is Engineering and How Does it Address Human Needs?
- Therefore, how do we Prepare Graduates?
- TUEE Phases I, II, III, and IV
- A Concluding Video

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

ASEE – why we exist

"As engineering education stakeholders our first priority is to graduate the highest potential, career-ready engineers for a diverse workforce that enhances our capacity to innovate solutions to most pressing challenges in our communities, nations, and world."

Key Stakeholders

- Employers (public/private/NGO)
- Academic Vendors
- Faculty
- Governments (local/national)
- Engineering Societies
- Students

Engaging Stakeholders

- Clarify "What's In It For Me" for each community and culture
- Demonstrate a systemic (versus piece-meal) vision
- Departments are key loci of change and the faculty are key to change in departments
- View non-academics as more than funding sources (e.g., define learning outcomes from work experiences)

Ref "Achieving Excellence in Engineering Education: The Ingredients of Successful Change" – RAE and MIT, 2012

Engaging Stakeholders

- Compromise for continuity across communities and institutionalization
- Develop incremental milestones
- Assess and assess so more
- Communicate, communicate, communicate

Ref “Achieving Excellence in Engineering Education: The Ingredients of Successful Change” – RAE and MIT, 2012

Major Challenges for Sustainability

- Faculty are rewarded for discovery and innovation, not adapting/adopting and maintaining.
- Funders like novelty, innovation, and “proofs of concept”, not steady-state continuity.
- Employers must live with business cycles and want “choice” of potential employees.
- Government funding cycles rarely align with student “lifetimes.”

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Approved by the ASEE Board of Directors June 2016.

Our Mission

ASEE advances innovation, excellence, and access at all levels of education for the engineering profession.

Our Vision

ASEE is the pre-eminent authority on the education of engineering professionals.

Our Values

Excellence, engagement, innovation, integrity, diversity and inclusion.

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Our Goals

- Innovation
- Excellence
- Communities
- Communication
- Access
- Diversity & Inclusion
- Financial Sustainability
- Internal Organization
- Advocacy and Public Policy

To be the definitive voice of engineering education

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ASEE – what we do (thematic)

- Promote excellence in instruction, research, public service, and practice;
- Exercise worldwide leadership;
- Foster the technological education of society;
- Provide quality programs, products, and services to members; and
- Provide a forum for exchanging ideas and sharing of information among the populace at-large.

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ASEE – what we do (practical)

- Professional Development
  - Deans
  - Chairs
  - Faculty
  - University Academic Staff
  - K-12 teachers
- Research, Evaluation & Information
  - Student data
  - Faculty data
  - Institutional research volume data
  - Legislative monitoring
  - News about E&ET education and research
- Operations of Programs for Others
  - (Federal) Government entities
  - Private entities (e.g., ECOcar)

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ASEE – what our stakeholders value

- Networking with close peers
- Maintaining the currency of their knowledge
- Publishing and presenting findings
- Access to resources affecting their professional success (e.g., grants, public policy, employer and vendor initiatives, etc.)
- Demand for their knowledge and skills
- Advancing the Society's mission
- Productivity and Impact of (technical and educational) research

International Branches

- Lebanon
- India
- Baghdad, Iraq
- Working on
  - South America

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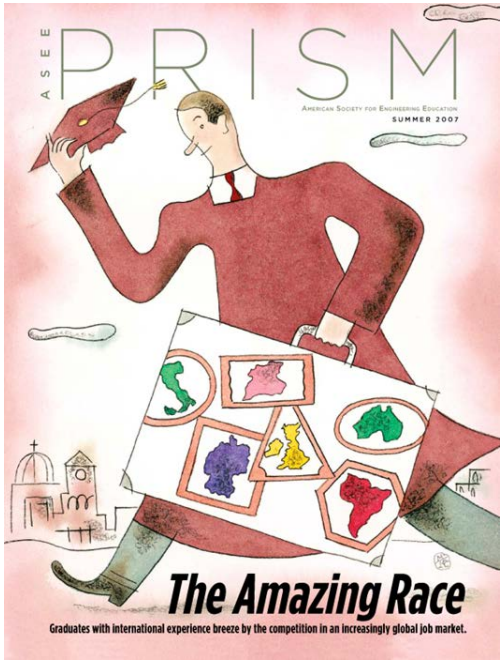
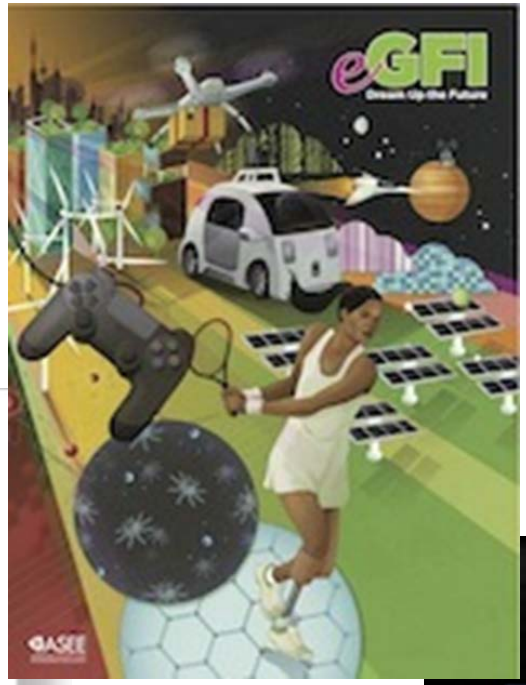
Member Resources





Advances in Engineering Education

Projects

- Fellowships/Research Opportunities
  - NDSEG
  - SMART
  - NRIEP/SEAP
  - GRFP
  - Post Doctoral Fellowships
- Data Collection/ Assessment
  - STEP Meeting
  - I-CORPS Team Member Analysis
- Community Leadership
  - Advancing Engr Ed.
  - Innovation with Impact
  - TUEE
  - EcoCAR 3
  - Maker Summit

Engineering for Social Good

The Commonly Assumed Activities

- Engineering for Change
- Engineers without Borders
- Engineers for International Development
- RedR – engineers for humanitarian emergencies
- Humanitarian engineering programs and centers on various campuses

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NAE's Grand Challenges for Engineering

- Make Solar Energy Economical
- Provide Energy from Fusion
- Develop Carbon Sequestration Methods
- Manage the Nitrogen Cycle
- Provide Access to Clean Water

- Secure Cyberspace
- Prevent Nuclear Terror
- Restore and Improve Urban Infrastructure

- Engineer Better Medicines
- Advance Health Informatics
- Reverse Engineer the Brain

- Enhance Virtual Reality
- Advance Personalized Learning
- Engineer the Tools of Scientific Discovery

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NAE's Grand Challenges for Engineering

Foster Sustainable Energy, Agriculture And Environment (air, water, etc.)

Reducing Vulnerability to Human and Natural Threats

Improve Medicine and Healthcare Delivery

Expand and Enhance Human Capability And Joy

Global Context of Engineering

- Population Growth ➔ desire for economic development
- Population Contraction ➔ desire to maintain standard of living and level of services
- Global Climate Change, Pollution, Limits to Natural Resources

Engineering drives modern societies forward within the above constraints.

UN Sustainable Development Goals

www.un.org/sustainabledevelopment/education/

What are human needs?

What is engineering?

"The mission of engineering is creating solutions serving people and society"

-- Dan Mote, President, NAE

What is Engineering?

Engineering professional*s** do systems for the manipulation of stuff.

- Do = conceive, design, analyze, realize, produce, modify, operate, oversee, maintain, and retire
- Systems = products, processes, or services
- Manipulation = transformation in form, state, or location
- Stuff = matter, energy, and/or information

*Includes engineers, engineering technologists, and engineering technicians

Common Global Desires are for Engineers Better Able to

- Straddle uncertainty, disciplines, cultures, evolving technologies, etc.
- Define as well as solve problems
- Create, manage, lead in technology and policy, capitalize
- Blend theory and practice
- Blend technical and professional skills
- Exhibit global awareness and intercultural competence (national, ethnic, religious, etc.)

Producing "Socially Good" Engineers

"To transform engineering education to produce an engineering workforce that is diverse, creative, innovative, and understands the impacts of its solutions on both technical and social systems, and possesses the ability to: (a) adapt to the rapidly evolving technical environment in industry, academie, and society; and (b) play a leading role in advancing technology."

-- Gary Gabriele (then director of NSF/EEC), "Future of Engineering Education Programs", Presentation to grantees meeting, February 2005.

Producing "Socially Good" Engineers

- Must acknowledge unintended consequences of engineering work.
- Must understand ethics at the level of the profession and not just the individual. (Wulf called this "macro-ethics")
  - The global auto industry has created millions of jobs and improves the quality of life for billions, but results in 1.3M deaths and 20M injuries globally each year?
  - Facial recognition to identify bank robbers and be re-purposed by an authoritarian state to identify protesters.
  - Cracking phones to stop terrorists could have prevented the "Arab Spring" and other social change movements.
  - Your examples?

Engineering Impact

- "… the things engineers do have *consequences,* both positive and negative, sometimes unintended, often widespread, and occasionally irreversible."

  – Norman Augustine

  "Ethics and the Second Law of Thermodynamics", The Bridge, Fall 2002

Virtually all Engineering Work is for Social Good

It is a social ill when

- Planes fall out of the sky
- Bridges collapse
- Consumer products cause injury
- Industrial products failures result in financial losses
- Etc.

Producing "Socially Good" Engineers

A well intentioned engineer is not necessarily a "good" engineer. The practicing engineer must be well trained and maintain her professional competence.

– After Samuel Florman

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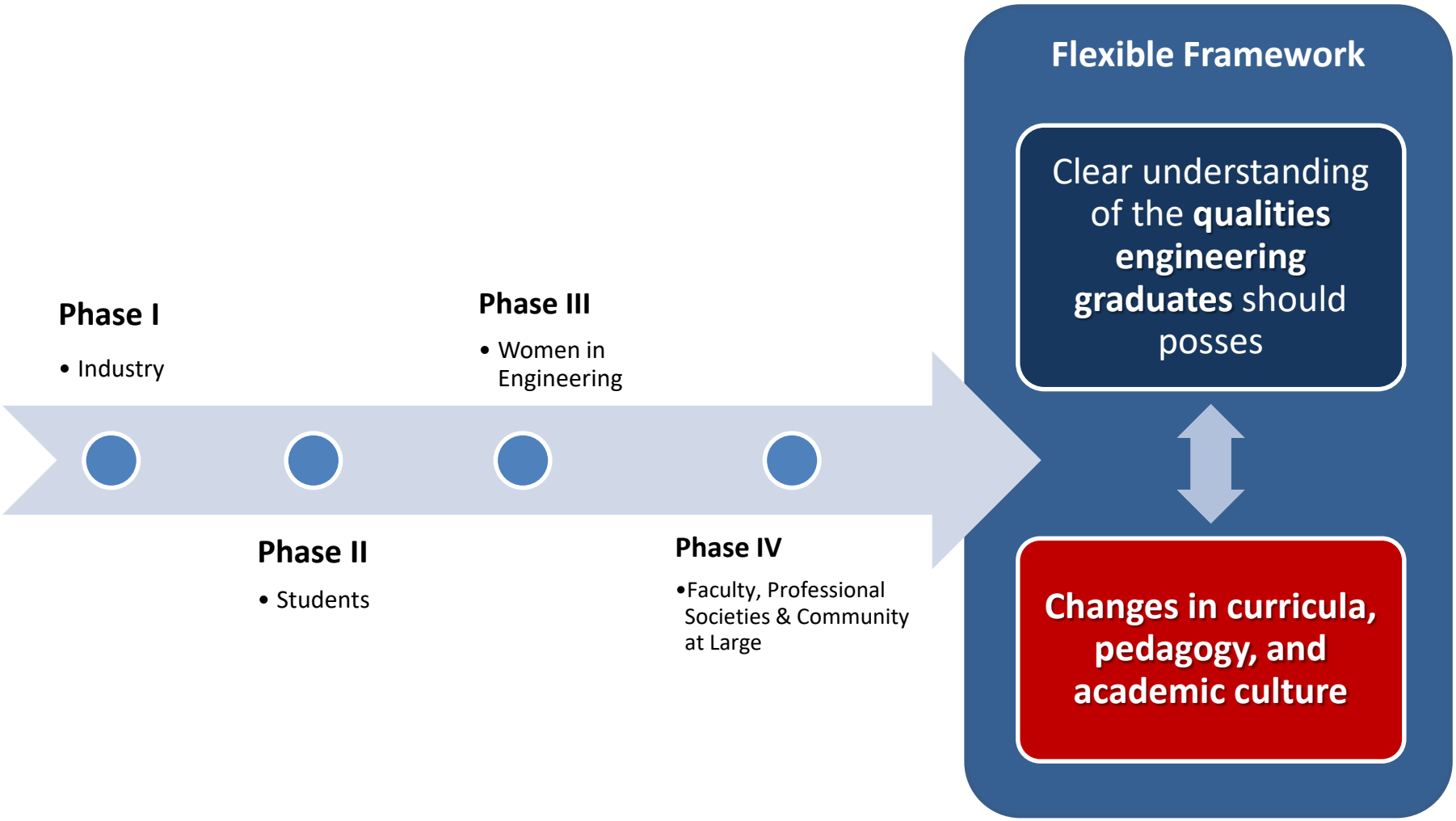
Transforming Undergraduate Education of Engineers (TUEE)

Transforming Undergraduate Education in Engineering (TUEE) is a multi-phase initiative that seeks to identify the critical components of engineering curricula, pedagogy, and educational culture necessary to transform the education of engineers over the next decades of the 21st century.

Transforming Undergraduate Education of Engineers (TUEE)

- Phase I – industry views on desired KSAAs
- Phase II – students views on desired KSAAs
- Phase III – achieving gender equity
- Phase IV – views of faculty & professional societies

Transforming Undergraduate Education in Engineering (TUEE)



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Preparing Next Generation Engineers

We asked employers and students:

What	• Knowledge, Skills, and Abilities (KSAs) they desire in continuing employees and new hires?
Who	• should be responsible for developing the KSAs (learners, parents, teachers, faculty, mentors, employers, etc.)?
When	• along the educational and lifelong learning continuum specific KSAs should be learned and reinforced?
Where	• specific KSA developments should take place (at home, in school, in informal settings, at internship sites, at work sites, etc.)?
How	• strategies that should be used to engender specific KSAs within learners; and • the culture of engineering education should change to influence these changes?

Defining KSA Competencies

"Can Do" Competencies

- **Knowledge**—acquaintance with or knowing/understanding something
  (See cognitive taxonomies)

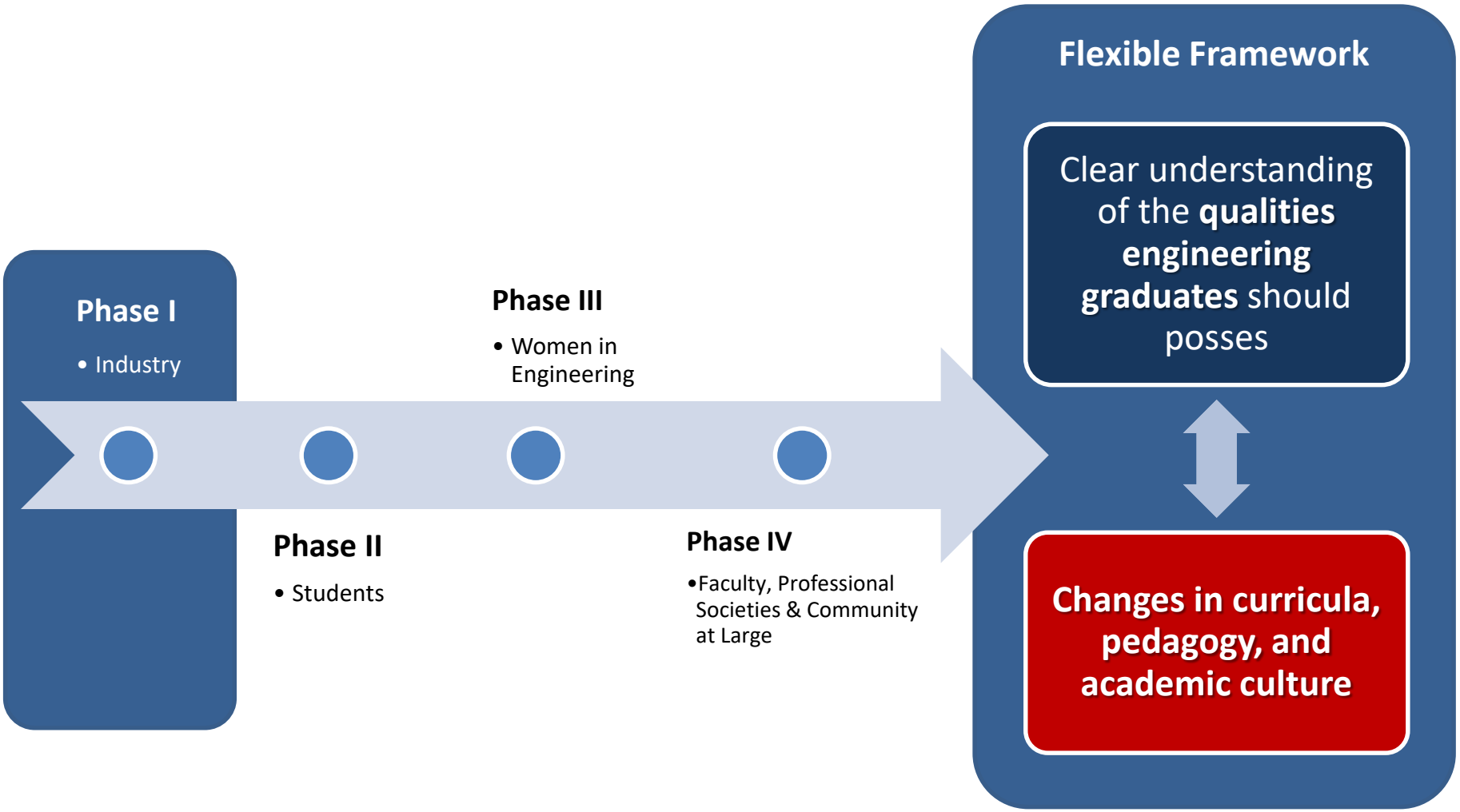
- **Skills**—ability to use one's knowledge effectively, especially in the performance of a task
  (See psychomotor skills taxonomies)

"Will Do" Competencies

- **Attitude**—a feeling or emotion toward something
  (See affective taxonomies)

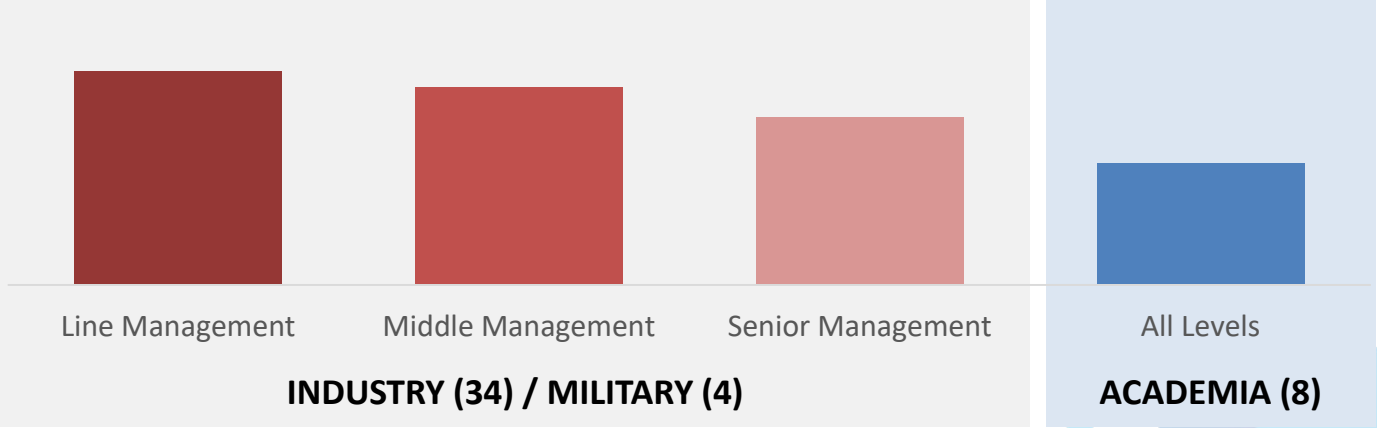
Definitions from
https://www.merriam-webster.com

TUEE Phase I: Synthesizing and Integrating Industry Perspectives



Phase I: Synthesizing and Integrating Industry Perspectives

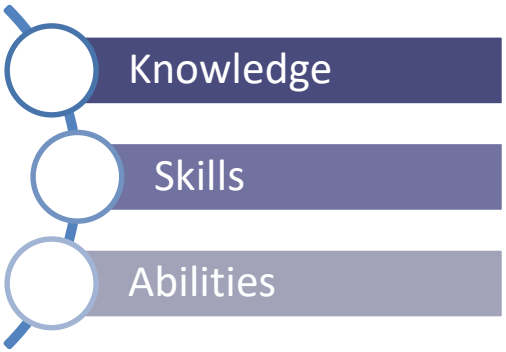
PARTICIPANTS (46)



3-Stage PROCESS

PRE-WORKSHOP SURVEY	WORKSHOP	POST-WORKSHOP SURVEY
• Online • 33 responses • KSAs importance, and quality of today's education	• Face-to-face • 42 attendees • Identification of desired KSAs	• Online • 25 responses • Stakeholder responsibility for development of KSAs .

Phase I: Pre-Workshop Survey



List **derived from literature** addressing engineering skillsets for the 21st century.

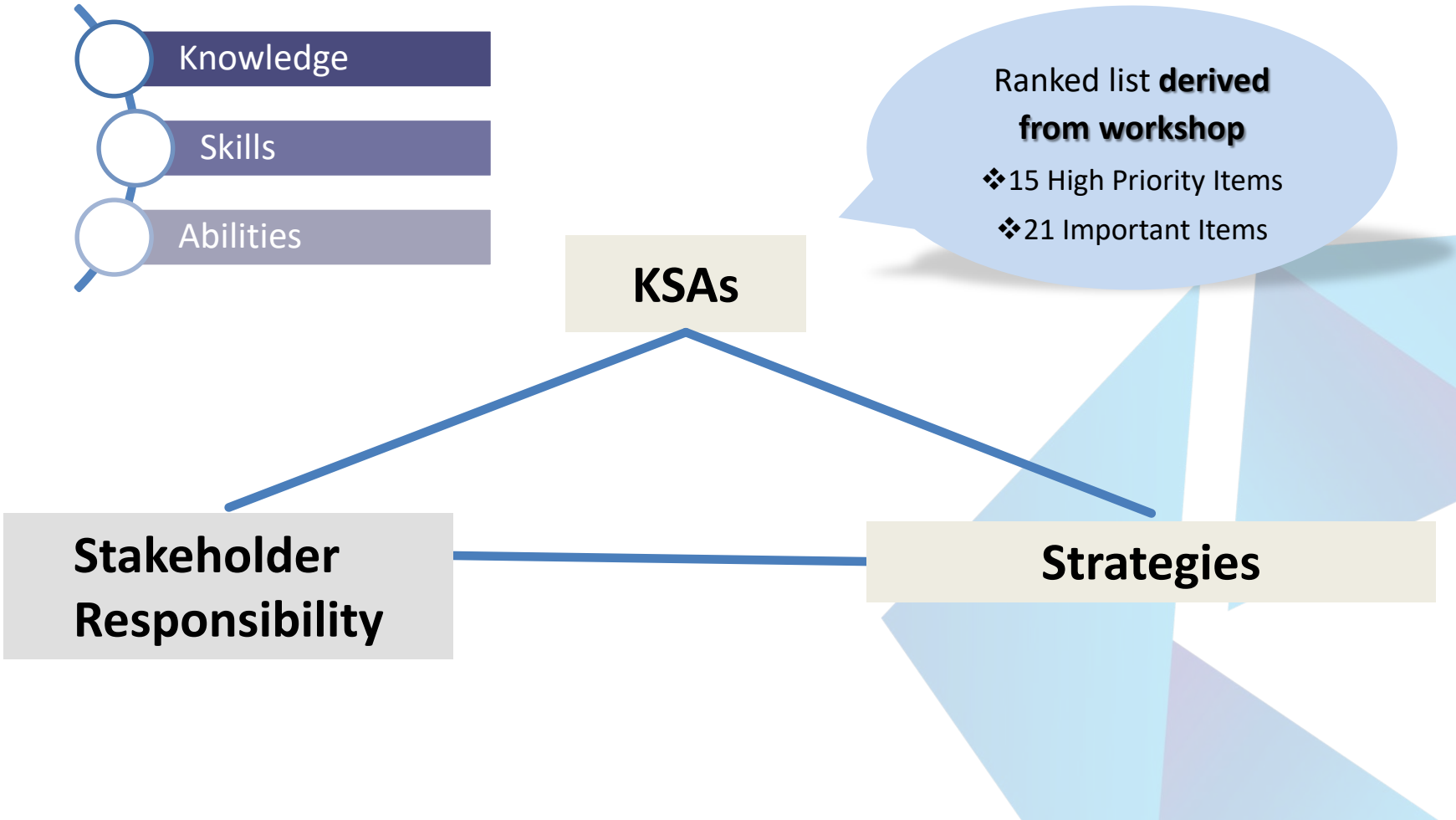
KSAs

Importance

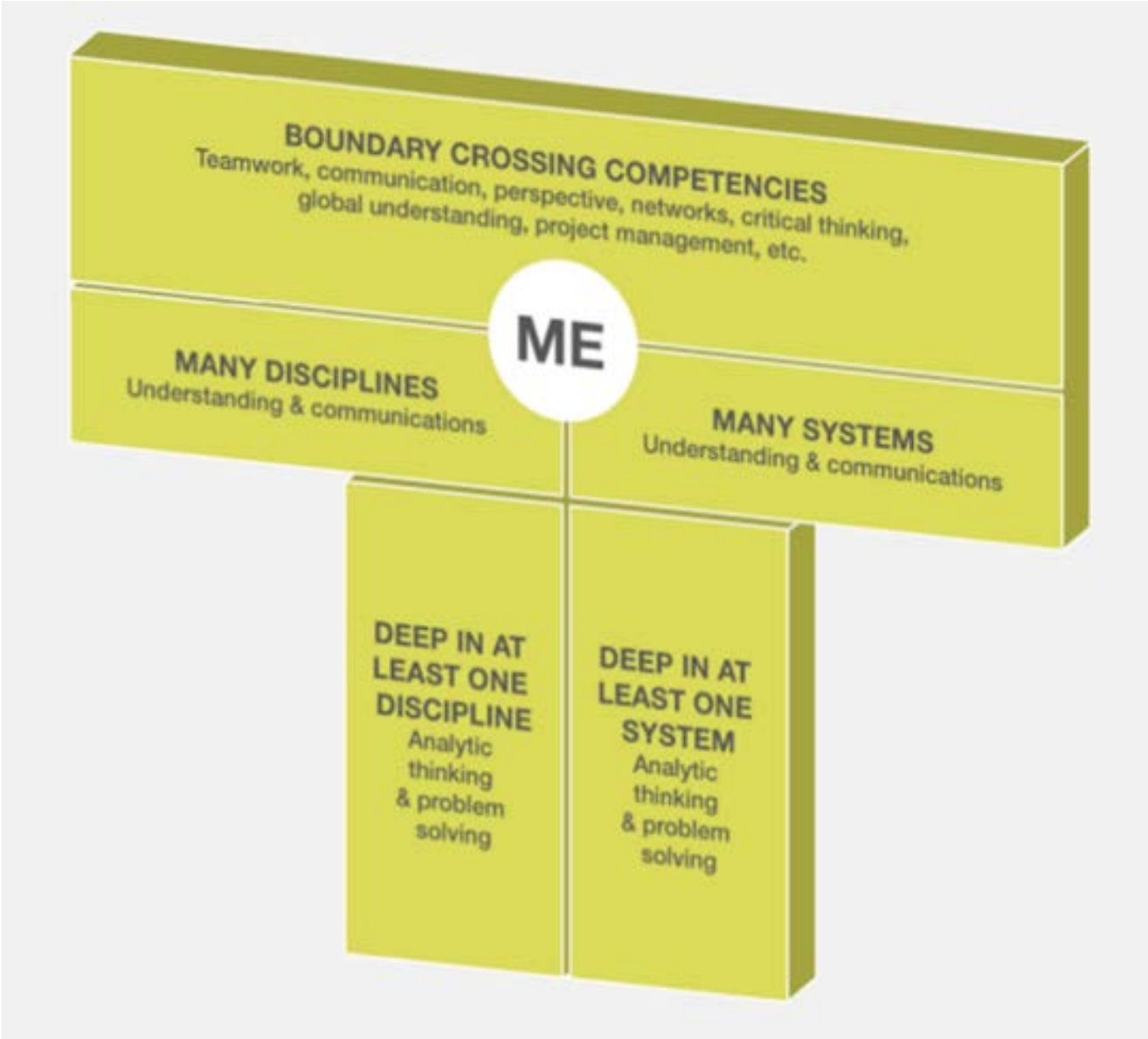
Quality of Education

Current ability of education to produce graduates

Phase I: Post-Workshop Survey



Phase I: General Observations



Phase I: General Observations

Ideal Student is…

- Ethical
- Curious
- Persistent
- Motivated
- Critical thinker
- Good communicator
- Economically- & Business-Minded

HIGH PRIORITY KSAs

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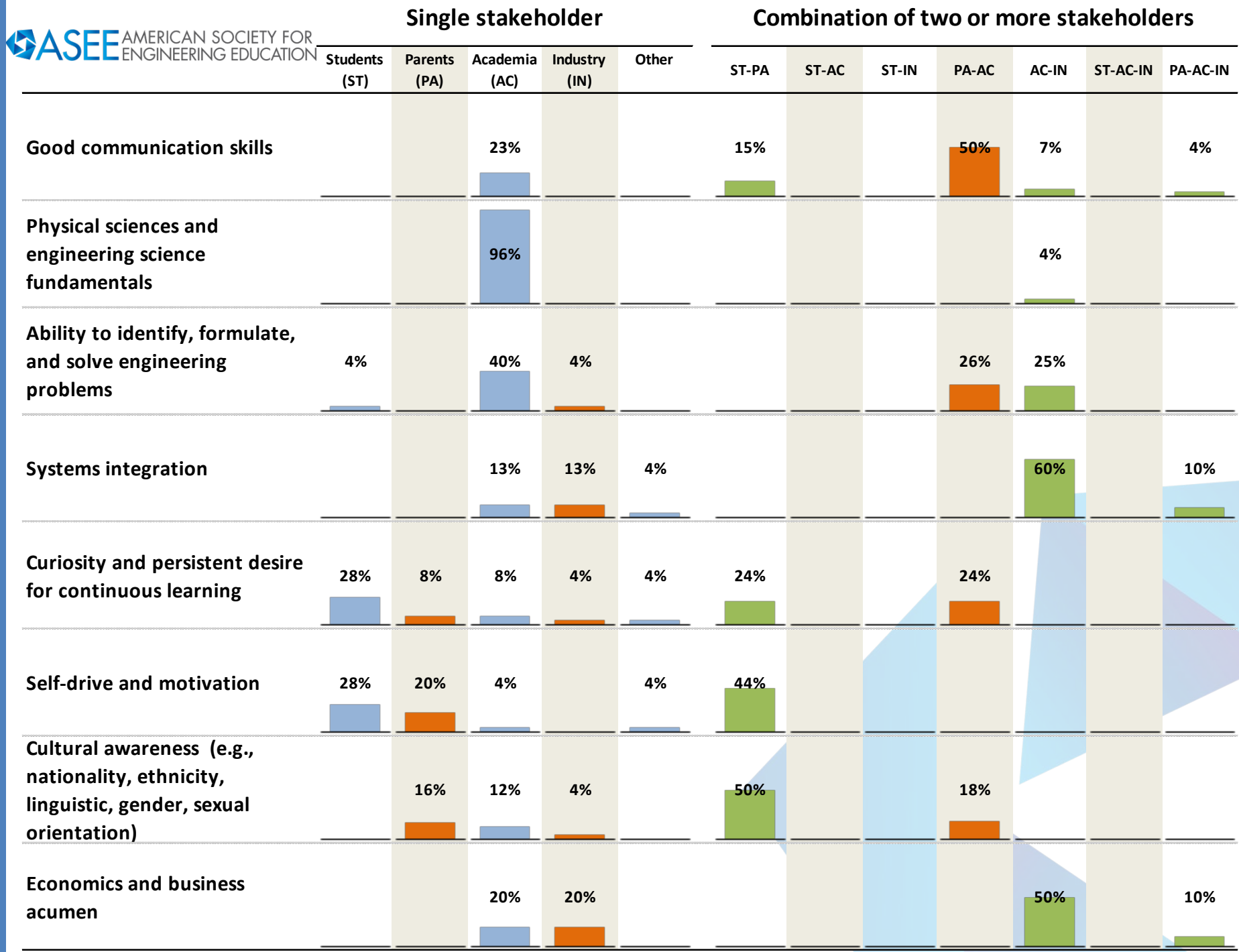

HIGH PRIORITY KSAs

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	Single stakeholder					Combination of two or more stakeholders						
	Students (ST)	Parents (PA)	Academia (AC)	Industry (IN)	Other	ST-PA	ST-AC	ST-IN	PA-AC	AC-IN	ST-AC-IN	PA-AC-IN
High ethical standards, integrity, and global, social, intellectual, and technological responsibility	4%	12%	12%			4%			68%			
Critical thinking	4%	4%	71%						15%			5%
Willingness to take calculated risk	8%	4%	8%	29%	4%	23%						23%
Ability to prioritize efficiently	8%	17%	17%	8%					50%			
Project management (supervising, planning, scheduling, budgeting, etc.)	4%		21%	29%						46%		
Teamwork skills and ability to function on multidisciplinary teams	13%		33%	4%			12%	12%			26%	
Entrepreneurship and intrapreneurship	17%		17%	4%	9%		12%	12%			28%	

Phase I: Recommendations

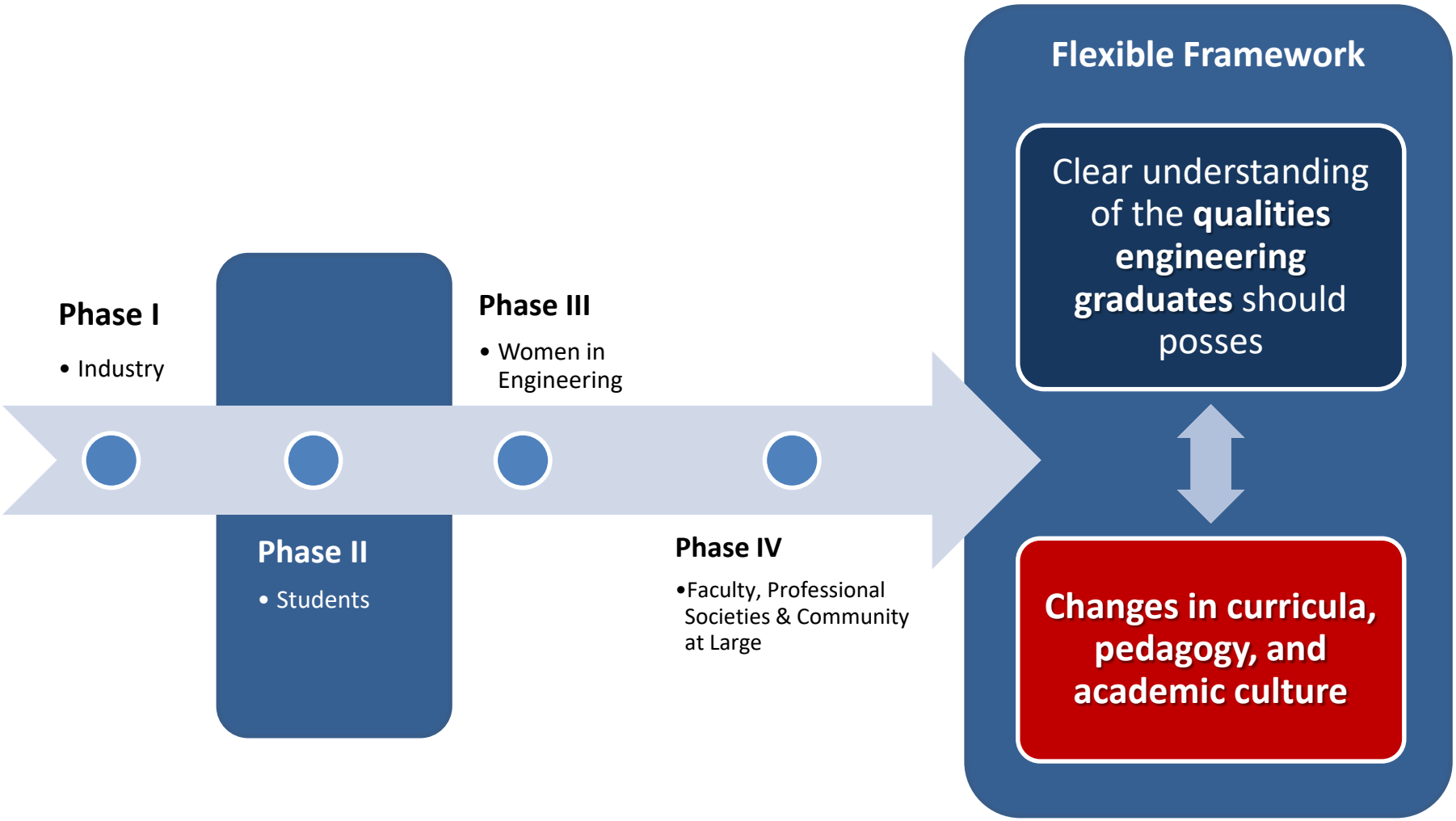
Industry

- Share responsibility with universities for developing engineers
- Create internships in industry for students and faculty

Universities

- Place greater premium on teaching (adjust faculty award structures)

TUEE Phase II: Insights from Tomorrow's Engineers



AIM: Better understanding student perspectives on two key questions

- How the culture of engineering education could better adjust to the strengths of individual engineering students?
- How the engineering education experience be transformed into an exciting program of study that will draw students in thereby reducing the need for requiring massive recruitment initiatives and retention programs?

Series of Four Breakout Sessions to Explore

- What are students' views and reflections on the KSAs identified by the industry groups?

- In what formal classroom, social and/or family environment are they being exposed to and learning the KSAs identified by the industry?

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Series of Four Breakout Sessions to Explore

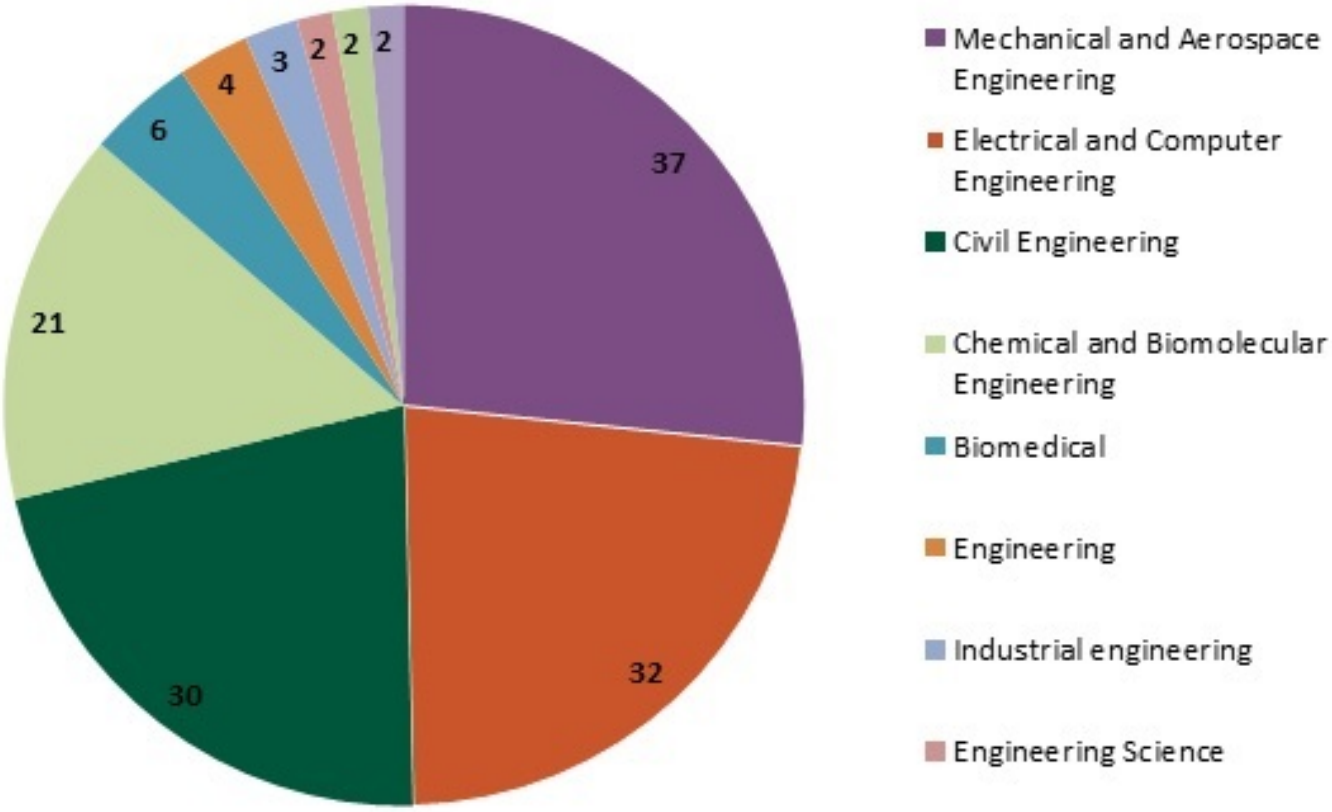
- What are gaps in what industry expects graduates to have and what students are being provided in the formal classroom setting?

- What students believe are the most effective mode of learning environments for them to gain the necessary KSAs resulting in their success and retention in the engineering programs and how formal academic setting must change to facilitate this learning?

Phase II: Insights from Tomorrow's Engineers

	PRE-WORKSHOP SURVEY	WORKSHOP
2-Stage PROCESS	• Online • 33 responses • KSAs importance, and quality of today's education	• Face-to-face • 42 attendees • Identification of desired KSAs
Participants	**139**	**41**

Phase II: Insights from Tomorrow's Engineers



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Survey Respondents

Survey Respondents by Field

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Table 1. Students' perceptions of KSAs' importance for the engineering profession and quality of education received in each area

Knowledge, Skills and Abilitites (KSAs)[1]	A. Importance for the engineering profession								B. Quality of education[4]			
	Very Important*		Moderatly Important		Unimportant**		Not sure					
	Personal perception[2]	Conveyed by Institution[3]	Personal perception[2]	Conveyed by Institution[3]	Personal perception[2]	Conveyed by Institution[3]	Personal perception[2]	Conveyed by Institution[3]	VG-G	F	P-VP	NS
KSA 1: Good communication skills	100%	82%	0%	16%	0%	2%	0%	0%	44%	43%	13%	1%
KSA 2: Hard sciences fundamentals	90%	96%	8%	3%	2%	1%	0%	0%	46%	46%	7%	1%
KSA 3: Ability to identify, formulate, and solve engineering problems	99%	94%	1%	6%	0%	1%	0%	0%	48%	40%	12%	0%
KSA 4: Systems integration	79%	44%	12%	40%	1%	9%	8%	8%	10%	38%	39%	13%
KSA 5: Curiosity and persistent desire for continuous learning	96%	58%	4%	29%	0%	12%	0%	1%	35%	39%	25%	1%
KSA 6: Self-drive and motivation	99%	62%	1%	27%	1%	11%	0%	0%	32%	38%	30%	1%
KSA 7: Cultural awareness in the broad sense linguistic, gender, sexual	68%		24%		1%		0%		29%		30%	

Note. N=141

[1] KSAs are ordered by priority as initially defined by industry representatives at the TUEE Phase I Workshop, see report at http://www.asee.org/TUEE_PhaseI_WorkshopReport.pdf

[2] Level of importance as perceived by students.

[3] Level of importance communicated to students through orientation, advising, classes and other activities at their institutions.

[4] Quality of curricular and extra-curricular activities to help develop each area.

VG-G = very good/good; F = fair; P-VP = poor/very poor; NS = Not Sure

**Combines Extremely Important and Important. **Combines Relatively Unimportant and Completely Unimportant*

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KSA 13: Project management (supervising, planning, scheduling, budgeting etc.)	93%	74%	6%	17%	2%	10%	0%	0%	37%	37%	26%	1%
KSA 14: Teamwork multidisciplinary work	99%	93%	1%	10%	0%	2%	0%	0%	58%	31%	10%	0%
KSA 15: Entrepreneurship and intrapreneurship	61%	39%	33%	39%	5%	20%	2%	2%	20%	31%	46%	3%
KSA 16: Use new technology and modern engineering tools necessary for engineering practice	93%	69%	7%	21%	0%	10%	0%	1%	19%	47%	32%	2%
KSA 17: Public safety	97%	85%	2%	12%	0%	2%	1%	2%	33%	47%	15%	6%
KSA 18: Informational technology (IT)	67%	48%	26%	34%	5%	15%	2%	4%	5%	53%	32%	10%
KSA 19: Applied knowledge of engineering core sciences for the real world	91%	88%	7%	7%	1%	4%	1%	2%	40%	42%	18%	1%
KSA 20: Data interpretation and	92%	78%							29%	45%	25%	

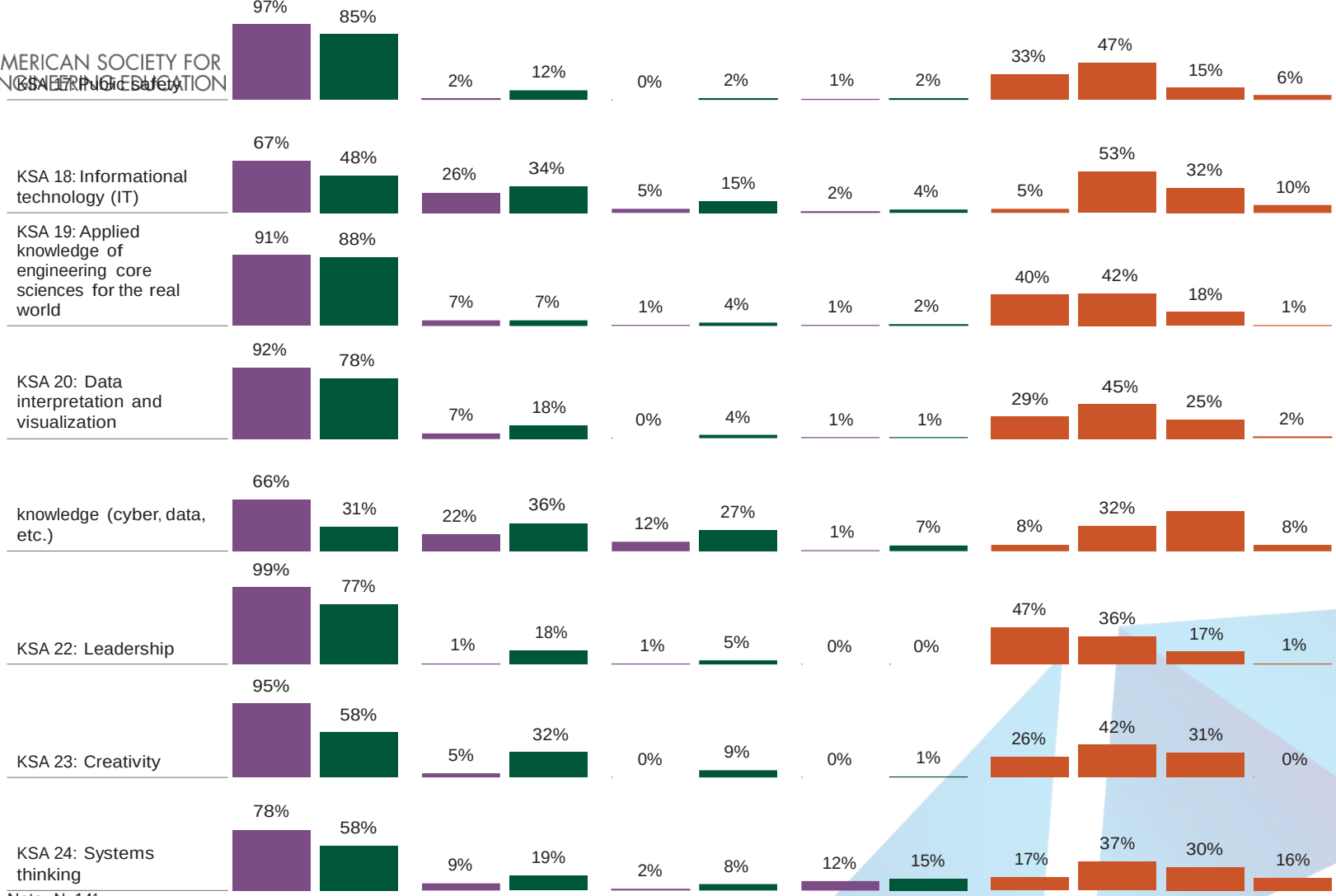

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Table 2. Industry vs. Students: Perceptions of the importance of high priority* KSAs for the engineering profession**

**These high priority KSAs were initially selected by industry representatives at the TUEE Phase I Workshop, see report at http://www.asee.org/TUEE_PhaseI_WorkshopReport.pdf*

***Percentage totals may exceed 100% due to rounding*

[1] 8% of Students responded with 'Not Sure'

[2] 2% of Students responded with 'Not Sure'

Specific Recommendations from Students 1/4

- Early access to mentoring, engineering experiences, and advising, with an entire community.
- Open-ended, interdisciplinary projects undertaken by groups that change composition over time, forcing students to adapt to new partners.
- A focus on real-world impact - The impact could be illustrated by case studies and reinforced with internships, coops, and guest speakers.
- Enhancing the connection between students and professors, thus creating a sense of community.

Specific Recommendations from Students 2/4

- Team design projects starting in freshman year that benefit someone or some organization.
- Building design projects into upper-level courses.
- A diversity of professors' gender, ethnic background, and experience in industry or academe.
- Show the applications to engineering in first-year math and science courses – calculus, physics, and chemistry.

Specific Recommendations from Students 3/4

- Encourage faculty to be creative in supplying real-world examples.
- Incorporate writing and presentations in various courses to build students' communication skills.
- Offer minor credit or certificates of proficiency in soft skills.
- Redistribute grading to increase the value of project-based learning as opposed to exams.

Specific Recommendations from Students 4/4

- Offer a single course combining ethics, business, and entrepreneurship.
- "Actually make it required for professors to learn how to teach."
- Follow the example of one school that holds a "startup weekend" twice a year, including alumni and business representatives.
- A course, already offered at one school, called Concepts of Professional Practice, that includes resume writing and career-oriented instruction.

Phase II: Recommendations

Curriculum

- Real world projects
- Team design projects
- Show engineering applications of science & math

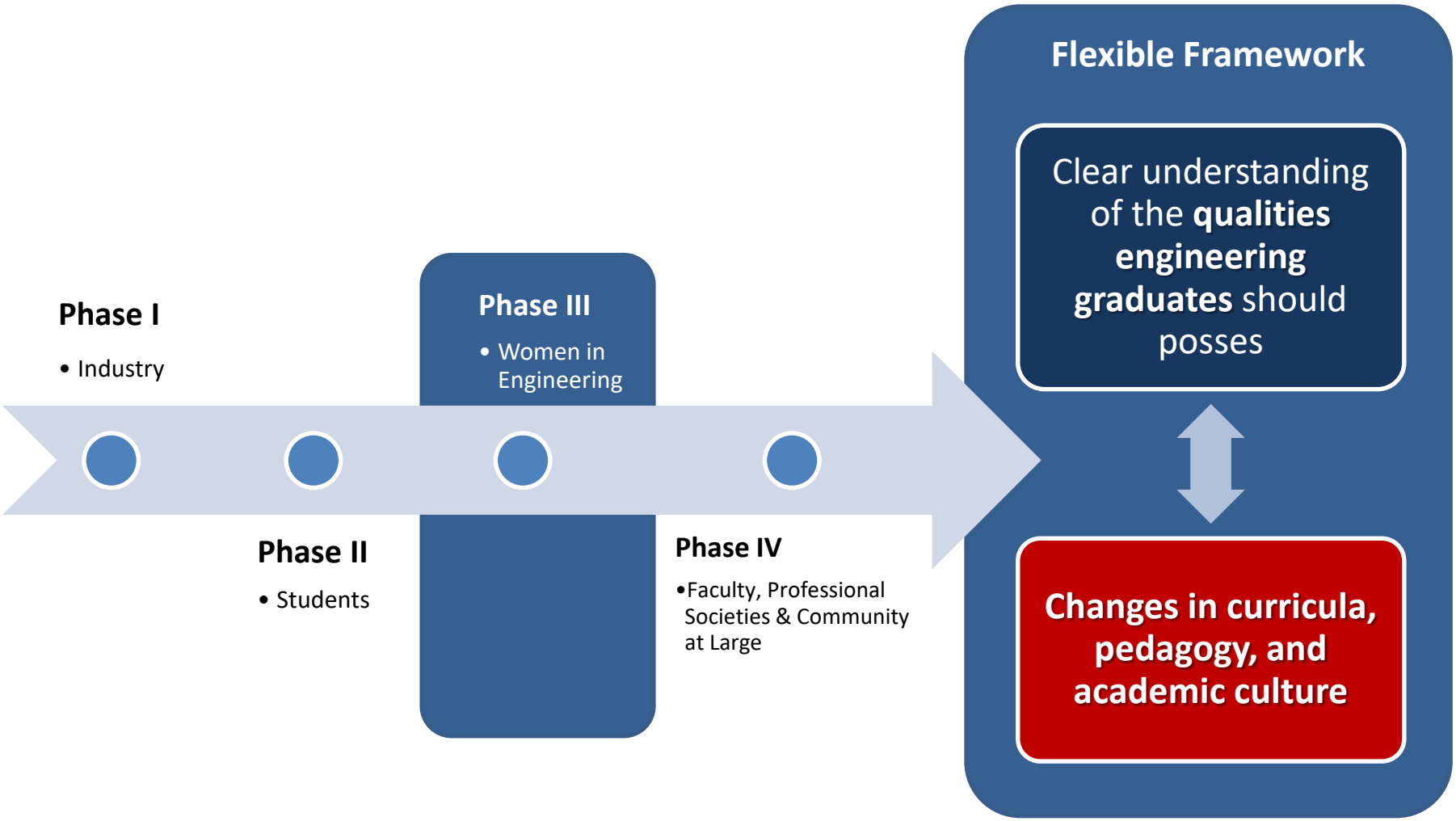
Faculty

- Use their passion and expertize
- Teaching as part of tenure
- Encourage creativity
- Improve accountability

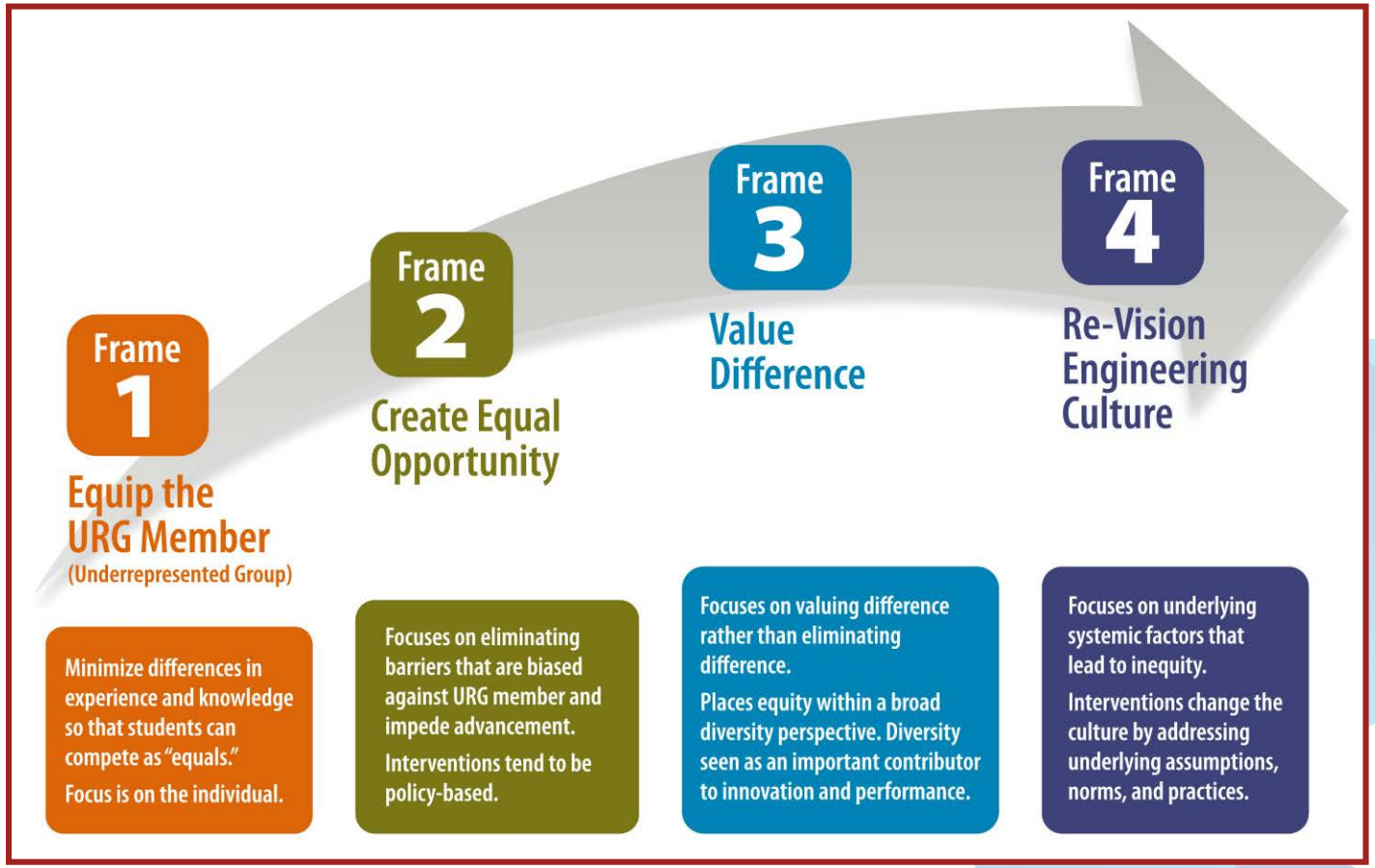
Institution

- Early access to mentoring
- Create sense of community
- Hire diverse professors

TUEE Phase III: Voices on Women's Participation and Retention



Phase III: Change Model



Source: Simmons Center for Gender in Organizations

Phase III: What Can We Do? Equip the URG Member

- Connect with professionals and female role models
- Use real-world engineering problems
- Provide research opportunities
- Emphasize the social relevance.

Phase III: What Can We Do? Create Equal Opportunity

- Base hiring decisions on objective information.
- Decentralize admissions.
- Remove gender information from evaluation scenarios.
- Institute gender-inclusive policies.

Phase III: What Can We Do? Value Difference

- Introduce diversity metrics in accreditation.
- Hiring and promote women.
- Recruit diverse candidates.
- Identify “Champions of Diversity”.

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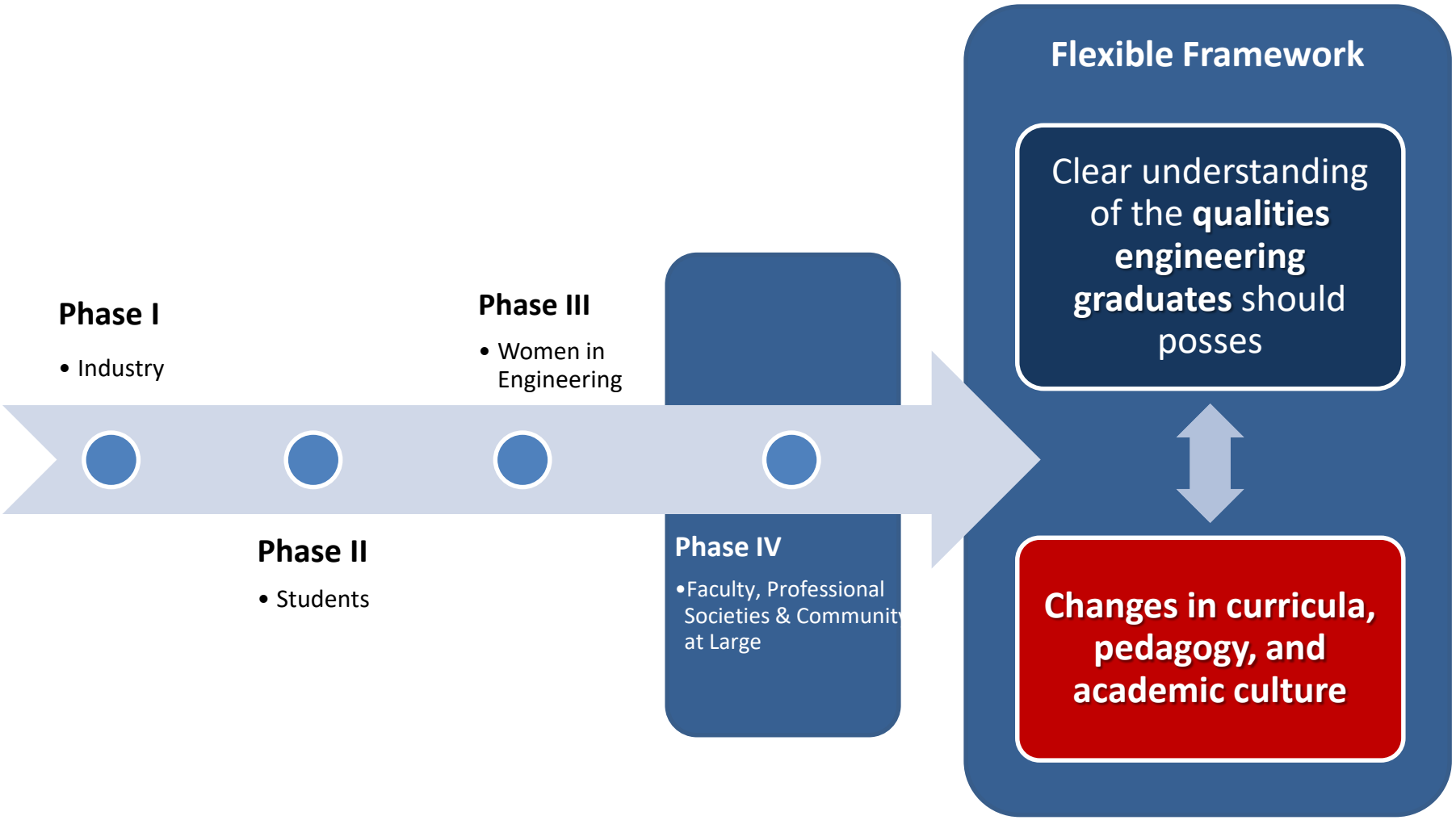
Phase III: What Can We Do? Re-Vision Engineering Culture

- Frame adversity as a common experience for everyone.
- Raise awareness.
- Use the Implicit Association Test as a university-wide tool.
- Revisit gender bias through climate surveys.
- Conduct curriculum reviews.
- Encourage innovation among faculty.
- Pair faculty mentors with new hires.

TUEE Phase IV: Views of Faculty and Professional Societies



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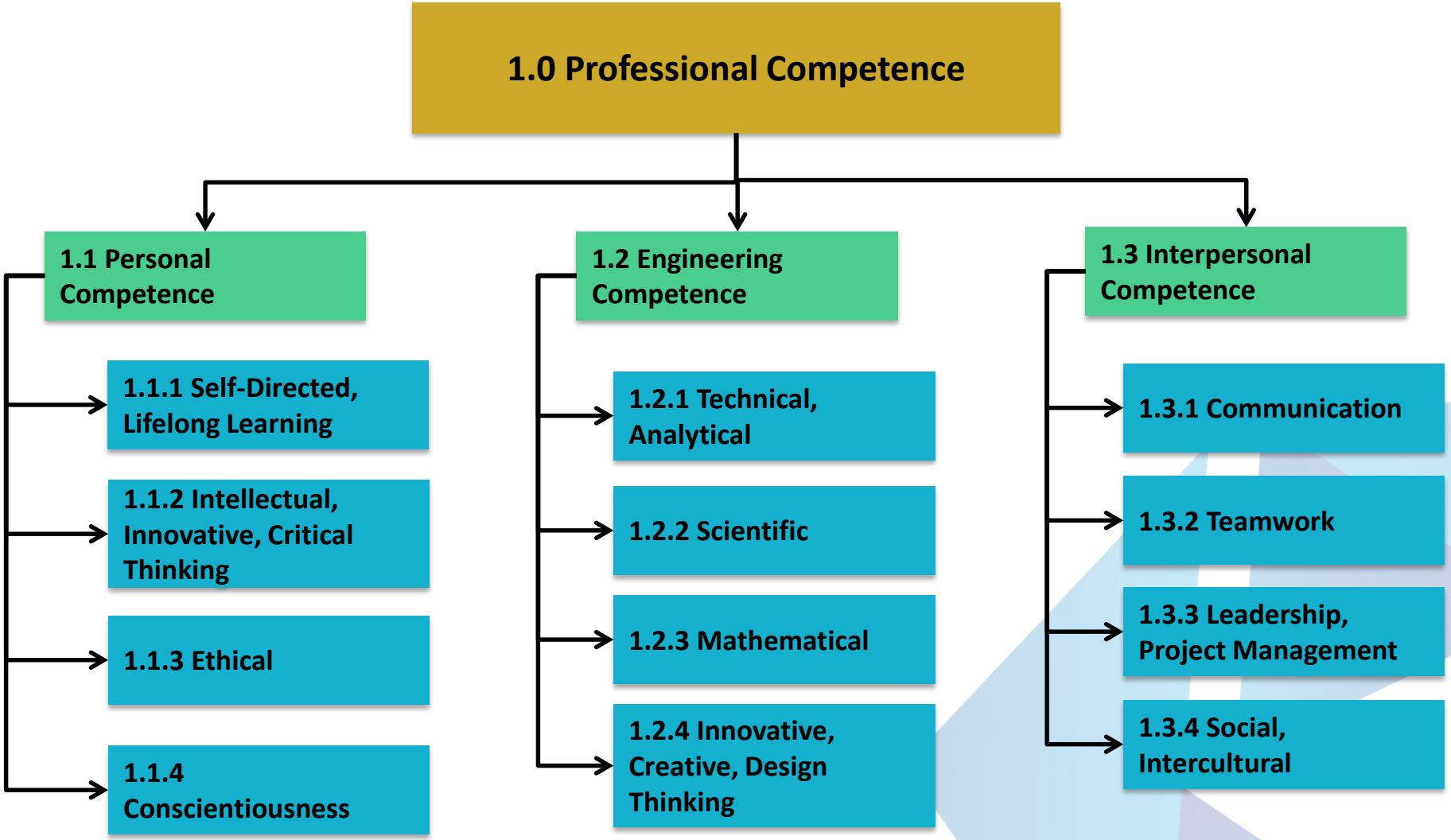
Phase IV: Competency Mapping



OVERALL COMPETENCY MAP
Working Draft 16 April 2017

Phase IV: Workshop Recommendations

Society and Inter-Society Activities

- Support technological and engineering literacy for all
- Create a secretary of education position in all societies
- Create education tracks at conferences
- Create curriculum map with BOK for each KSAs
- Create pool of technical speakers by topical and geographical areas
- Advocate for changes in ABET criteria
- De-Silo disciplinary societies
- Faculty-Industry exchange program
- Education tracks and workshops at industry conferences
- Competitions & challenges – Grand Challenges and others

Phase IV: Workshop Recommendations…. Cont.

Faculty Support

- Provide Teaching Workshops for KSAs
- Make case studies and resources available, especially in ethics – create faculty resources portals
- Develop modules faculty can use in courses
- Offer rewards & recognition for innovative ideas
- Facilitate opportunities for faculty to get industry experience
- Offer professional development on evidence-based teaching

Phase IV: Workshop Recommendations…. Cont.

Student Support

- Financially support student participation in conferences
- Integrate student activities into conferences
  - Host student competitions
  - Invite local community colleges to regional conferences
  - Run a Build-a-thon
- Provide career services, from applying and interviewing, to transitioning into the workplace
- Offer instructional videos online

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Thank you