



Engineering Graduates: Shortage or Glut?

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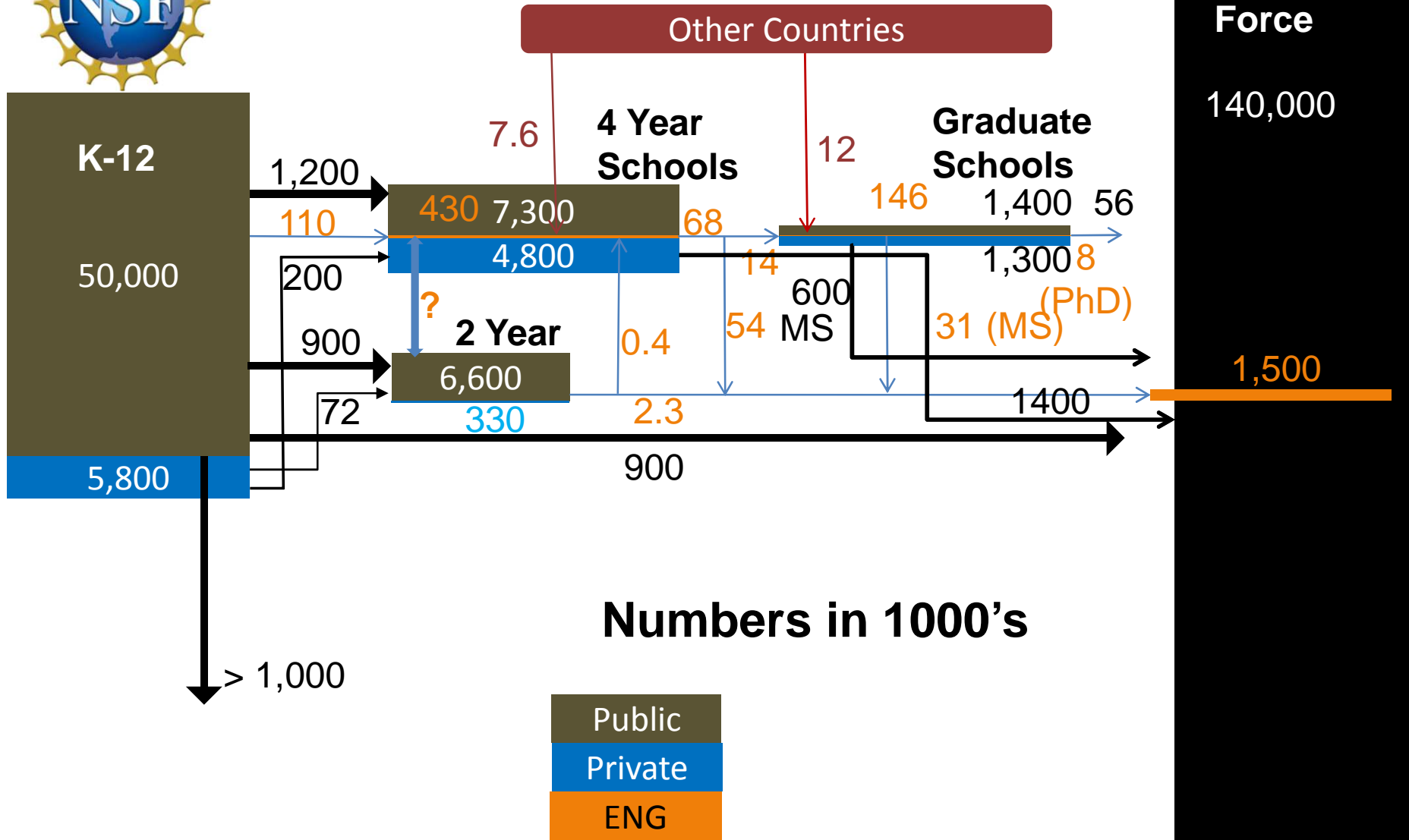
An “Engineered System”

A Chemical Engineering Perspective

A Material Balance Problem

- Volume of each unit operation
- Flows in/out
- Constraints/enhancements to flow
- Reactions/conversions
- Separations, both intentional and inadvertent
- **WHAT IS THE DESIRED OUTPUT?**







Volumes

- K12 – 60 Million
 - 50 million public schools
 - 10 million private schools
- 2 year schools – 6.6 million
- 4 year schools – 12 million
 - 7 million public
 - 5 million private
- Graduate schools – 2.7 million
- Labor Force – 140 million





Volumes

- 4 year schools – 12 million
- Graduate schools – 2.7 million
- Labor Force – 140 million





Volumes - Engineering

- 4 year schools – 430,000 Engineers
- Graduate schools – 146,000 Engineers
- Labor Force – 1.5 million Engineers





Flow Rates (per year)

- K12 → 2 year: 1 million
- K12 → 4 year 1.4 million
- 2 year → 4 year ??
- 4 year → Graduate school ??

- 4 year → Labor Force 1.4 million
- MS → Labor Force 0.6 million
- PhD → Labor Force 56,000





Flow Rates - Engineering

- K12 → 4 year 110,000 to Eng
- 2 year → 4 year 1,000 to Eng**
- 4 year → Graduate school 14,000 Eng
- International → Grad Schl 12,000 Eng
- 4 year → Labor Force 54,000 Eng
- MS → Labor Force 31,000 Eng
- PhD → Labor Force 8,000 Eng

** With Associates Degrees





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- Retention within Curriculum, switching majors
- Under-representation, gender biases, diversity
- **WHAT IS THE DESIRED OUTPUT?**





An Optimization Problem

- What is the Objective Function?
- What is the state variable space?
- What are the constraints?





What is the Objective Function?

- Meet all current Industry needs for Engineers
 - At the least expensive cost?
 - With the most creative engineers?
 - With the most ‘well rounded, prepared’ engineers?
- Develop the strongest labor force capable of expanding economic growth in US
 - Innovators/entrepreneurs
 - Creative thinkers/collaborators





What is the Objective Function?

- Make the Engineering Profession the most Attractive for the Individual Engineer
 - Creative, flexible, meaningful
 - Lucrative salaries
 - Societal respect
 - Job security





Conflicting Objective Functions!

- There will *never* be one clear solution because there is not a clear objective function.





NSF Perspective

Primary focus: Enhancements to Flow (*all levels*)

- K12 Pre-college programs – EHR, EEC, RET
- Recruitment of undergraduate Engineers
 - GI Bill, PEEC
- Encouragement to pursue Graduate degrees
 - REU
- Support during graduate studies
 - GRF, IGERT
- Support for transition to Academia and Industry
 - Innovation Fellows, BRIGE, CAREER





Overall NSF Strategy

- NSF focuses on programs offering greatest potential *societal* benefit
- NSF program strategies are basically *independent of* number of engineers produced elsewhere internationally
- NSF can be ‘thought leaders’ and catalysts for change and improvement, but
- IDEAS for engineering education and outreach come primarily from the Engineering community.

