

Re-conceptualizing the Work of Systems Engineers

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Outline

- Challenges of Systems disciplines
- Sociological view of professions
- Challenges for Systems Engineering as a Profession
- Empirical evidence for *work*
- Implications for engineering systems

What We Heard at ESD Symposium...

- Engineering systems programs,
 - “...academic units are relatively new”
 - “...industry leading academia”
 - “...lack common identity”
 - “...opposition from engineering science”

What We Have Been Hearing...

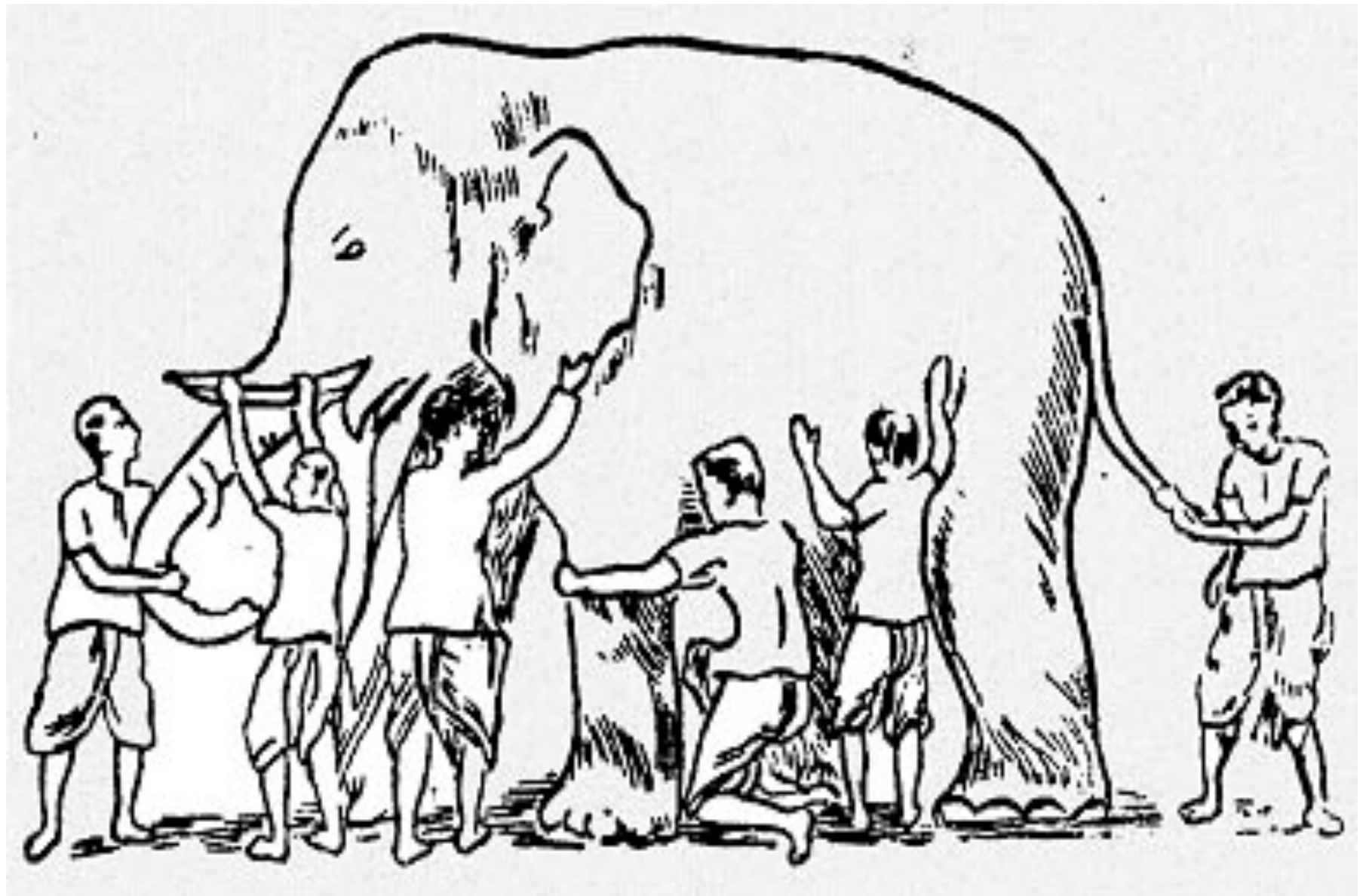
- Systems Engineering is mistakenly known as:
 - “PowerPoint Engineering”,
 - “Not Engineering”
 - “Good Engineering Practice”
 - “What we’ve been doing all along”
- **No unified theory of Systems Engineering**

What is Systems Engineering?

Different Folks, Different Strokes.

- The definition(s) of Systems Engineering:
 - Ramo: Holistic approach to system development.
 - Friedman: Complexity, interactions and components.
 - Sage: Formulation, analysis and interpretation.
 - Blanchard and Fabyrcky: Total engineering effort.
Interdisciplinary.

“What we’ve got here is... failure to communicate.”
Captain, Road Prison 36, from Cool Hand Luke (1967)



Professions

What are “Professions”?

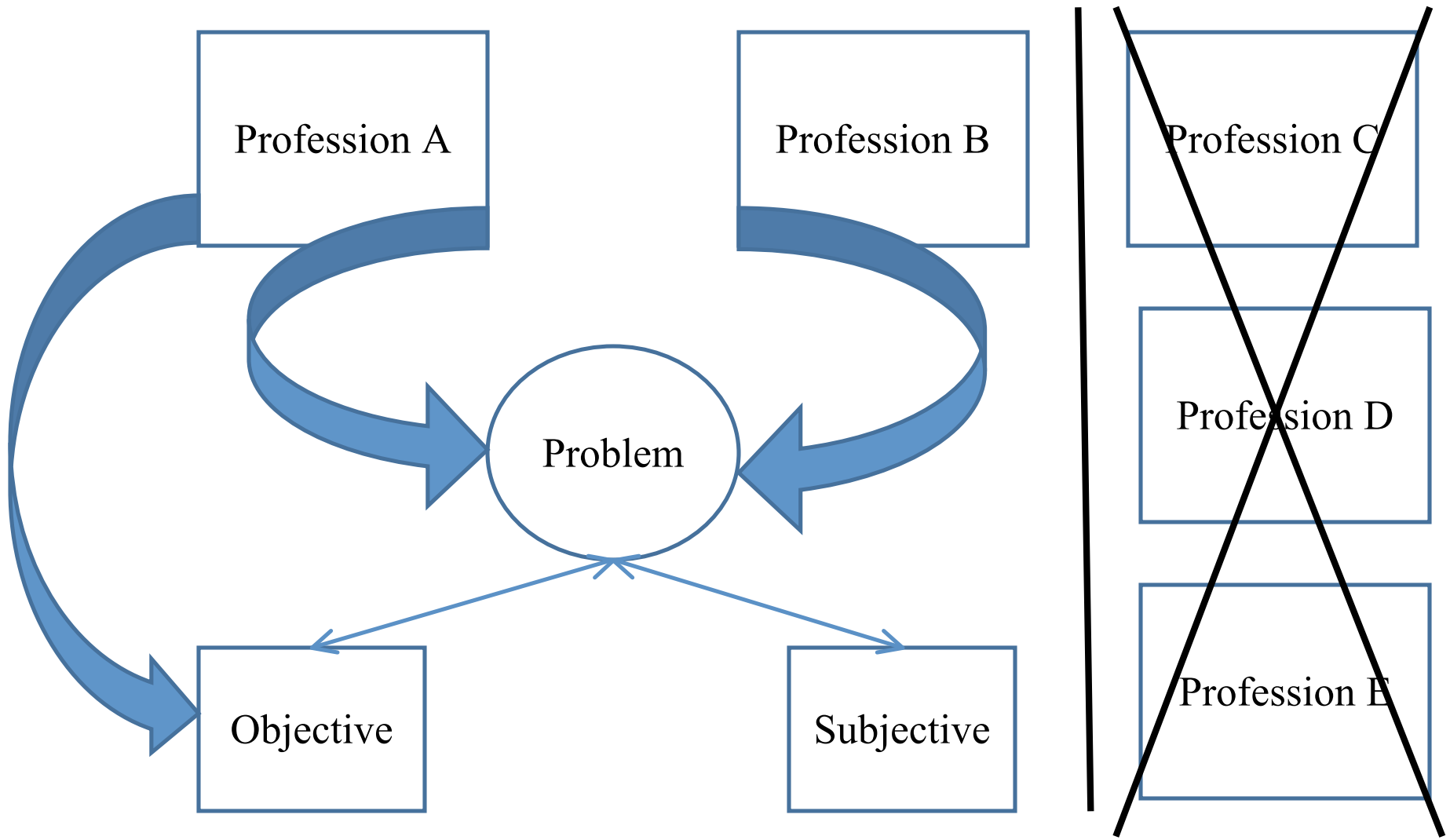
Criteria	Engineering	Medicine	Law
Barriers to entry	Yes	Yes	Yes
Formal education and/or advanced training	Yes	Yes	Yes
Apprenticeship	Some	Yes	Yes
Technical expertise within a specific domain	Yes	Yes	Yes
Autonomy in practice	Some	Yes	Yes
Informational asymmetry with the client	Yes	Yes	Yes
Institutional and social legitimacy	Yes	Yes	Yes
Collegiality as a regulatory mechanism	No	Yes	Yes
An ethics code	Yes	Yes	Yes
Academic journals	Yes	Yes	Yes
Local/National societies	Yes	Yes	Yes

Source: Abbott, A., *The System of Professions: An Essay on the Division of Expert Labor*, University of Chicago Press, 1988. 8

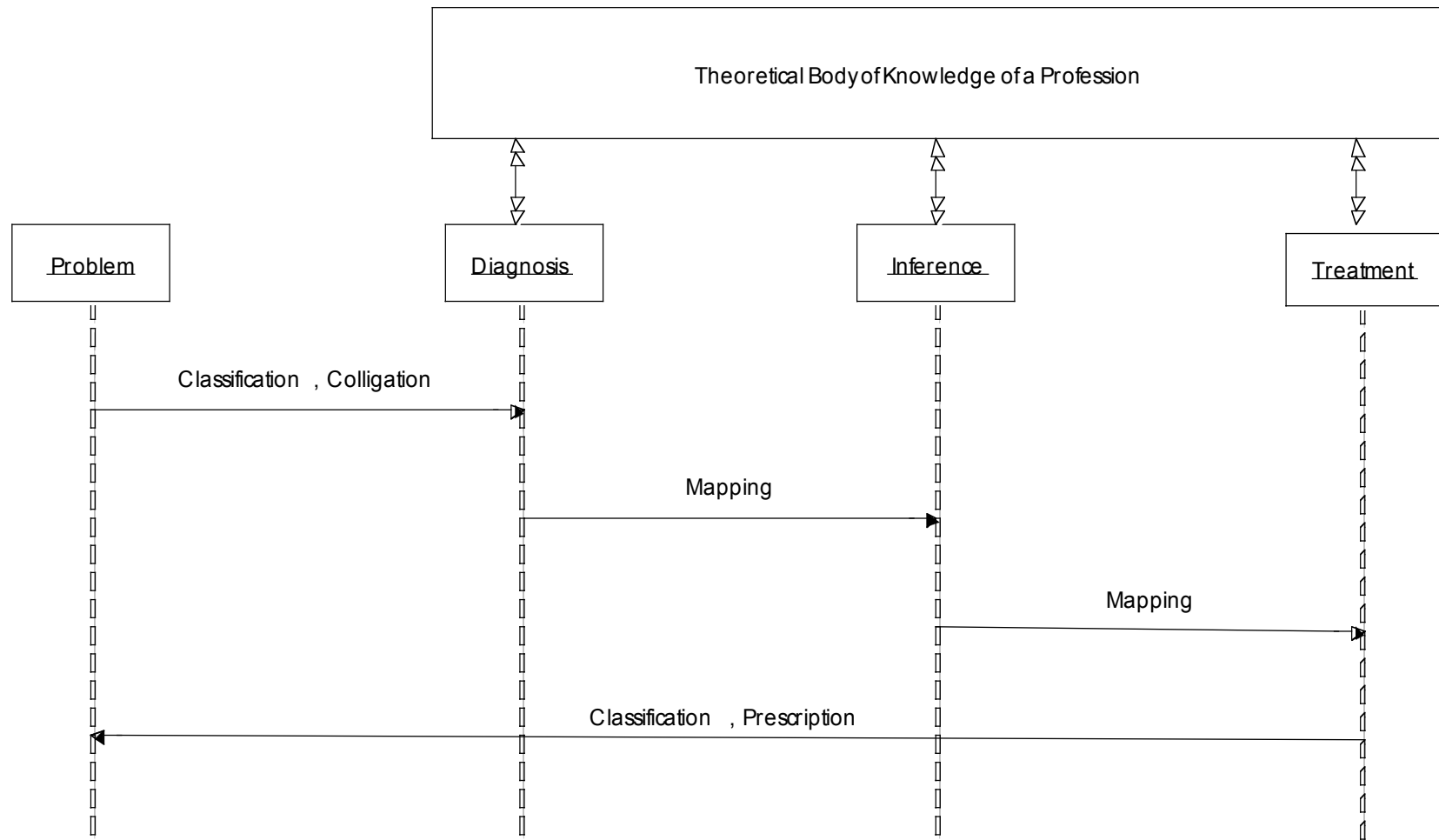
Systems vs. Industrial vs. Software

Criteria	Systems Engineering (SE)	Industrial Engineering (IE)	Software Engineering (SWE)
Academic Programs	Yes. BS, MS, PhD	Yes. BS, MS, PhD	Yes. BS, MS, PhD
Professional Society	Yes. INCOSE	Yes. IIE	Yes. IEEE, ACM
Certified Professionals	Yes.	Yes.	Yes.
Journals	Yes. Journal of SE	Yes. IIE Transactions	Yes. IEEE Transactions on SWE
Conferences	Yes. Several.	Yes. Several.	Yes. Several.

The System of Professions



What is Professional Work?



Source: Abbott, A., *The System of Professions: An Essay on the Division of Expert Labor*, University of Chicago Press, 1988.

Challenges for Systems Engineering as a Profession

1. What is a Systems Engineering problem?
2. What are the characteristics of a Systems Engineering problem?
3. “Lifecycle” perspective as a problem, not a solution?
4. Falsifying the theories of Systems Engineering
5. Lack of standard of proof in Systems Engineering

Why Study Work?

- Understanding work remains fundamental
- Previous research has focused on:
 - Dispositions
 - Knowledge
 - Skills
- Our survey aims to understand: *What systems engineers do with their time.*

Understanding Work

- Engineering disciplines rely on:
 - Mathematical techniques
 - Laws of physics, chemistry or biology (largely)
- Systems engineering:
 - No underlying mathematical foundation
 - The donut problem
 - “Center of mass”
 - The pornography criteria
 - “I know when I see it”

Empirical Evidence

- Targeting graduates of Masters in System Architecture & Engineering from USC (approximate sample size = 2000)
- Homogenous population
 - Majority of students are in engineering roles in large aerospace/defense companies
- 20-question survey aimed at understanding the context of systems engineering with respect to
 - Skills learned in the SAE program
 - Description of current role in the organization relative to systems engineering

Implications for Engineering Systems

- In the future similar questions will be asked
 - What are the first principles of engineering systems?
 - How is engineering systems work characterized in practice?
 - What is the fit between skills learned and skills needed in the workplace?
 - How do the practical application of engineering systems principles hinder/enable the advancement of the field?