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.
  – 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”?

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Engineering</th>
<th>Medicine</th>
<th>Law</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barriers to entry</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Formal education and/or advanced training</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>Some</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Technical expertise within a specific domain</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Autonomy in practice</td>
<td>Some</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Informational asymmetry with the client</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Institutional and social legitimacy</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Collegiality as a regulatory mechanism</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>An ethics code</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Academic journals</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Local/National societies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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## Systems vs. Industrial vs. Software Engineering

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Systems Engineering (SE)</th>
<th>Industrial Engineering (IE)</th>
<th>Software Engineering (SWE)</th>
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<tbody>
<tr>
<td>Academic Programs</td>
<td>Yes. BS, MS, PhD</td>
<td>Yes. BS, MS, PhD</td>
<td>Yes. BS, MS, PhD</td>
</tr>
<tr>
<td>Professional Society</td>
<td>Yes. INCOSE</td>
<td>Yes. IIE</td>
<td>Yes. IEEE, ACM</td>
</tr>
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<td>Certified Professionals</td>
<td>Yes.</td>
<td>Yes.</td>
<td>Yes.</td>
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<tr>
<td>Journals</td>
<td>Yes. Journal of SE</td>
<td>Yes. IIE Transactions</td>
<td>Yes. IEEE Transactions on SWE</td>
</tr>
<tr>
<td>Conferences</td>
<td>Yes. Several.</td>
<td>Yes. Several.</td>
<td>Yes. Several.</td>
</tr>
</tbody>
</table>
The System of Professions

Profession A

Profession B

Problem

Objective

Subjective

Profession C

Profession D

Profession E
What is Professional Work?

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?