INCOSE International Symposium
Las Vegas, NV
June 30 - July 3, 2014

Integrating Systems Engineering with Project Management: a Current Challenge!

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Purpose

- Too many projects still fail even using best practices in each domain (engineering, project management, marketing, cost management…)
- Project managers rely on standards which sometimes use practices not in line with those of the System Engineering domain
- To improve the companies 'competitiveness, a close cooperation between processes related to system development and project management is key to achieve performance and success.
- This paper develops this theory and present two ongoing projects that aim at integrating both domains.

Contents

1. Current situation and motivations for integrating Systems Engineering with Project Management
   - State of industrial practices
   - Needs: methods and tools supporting cooperation between systems engineers and managers
2. State of the art in research
3. A first methodological step: cooperation of processes through standards
4. An initiative towards a tool: the DECWAYS project
5. Conclusion and perspectives

1. Current situation

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- Several issues to lead a project in the extended enterprise context: numerous participants & stakeholders, various objectives, many disciplines and technologies.
- Systems Engineering (SE) and Project Management (PM) are two critical aspects in the success of projects (Boarder 1995, Chaos 2013, Sharon et al. 2011).
- Companies pay attention to SE and to PM processes separately, but rarely consider both jointly.
- Systems engineers and project managers think their works are separate (Conforto et al. 2013).
- Compartmentalization of processes => incoherencies

Urgent need of cooperation between SE and PM !

Sate of industrial practices

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- Companies need methods and tools to guide their industrial processes

- They already use some:
  - Many of them rely on standards and PLM tools. However, PLM tools only help for technical activities (Christi 2011).
  - Some major industrial groups developed their own (AIRBUS, Dassault Systems). However they do not consider PM and SE jointly, neither they offer decision support to drive the project

- This is not sufficient for tomorrow ’s competiveness:
  - The goal by 2025 is to reduce expenses in the domain of "Work of the automated knowledge" (management, engineering, finance…) by an order of 5000 billion U.S. dollars annually! (McKinsey Global Institute 2013)

A close attention has to be paid to the integration of SE with PM because it is fully in line with current concerns.

Motivation and research approach

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- **Objectives**: improve processes cooperation to help project managers during system development
  - avoid and early detect inconsistencies
  - make joint and coherent decisions

- **To make processes cooperate**:
  - analyze the adequacy of processes between SE and PM
  - develop a method and tool to bridge the gap between domains

- **Approach**:
  1. study SE and PM standards to evaluate the compatibility/gap between them,
  2. select those with the highest level of compatibility.

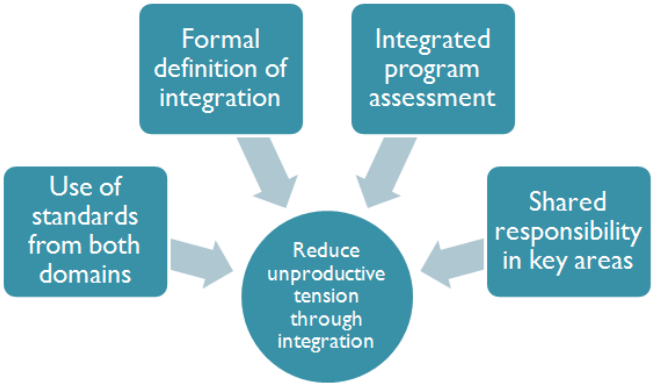
- This paper presents a first step toward this goal: analyze of SE standards and evaluation of their ability to manage processes

2. State of the art of research

- Integrating systems engineering and project management has only been considered in the beginning of 21th Century (Sharon et al. 2011).
- In January 2011, INCOSE and PMI (Project Management Institute) decided to strengthen the integration of SE and PM to overcome barriers between systems engineers and project managers.
- In May 2012, a guide to lean enablers for managing engineering program was published (Oehmen et al 2012).
  - Section 3: “integrating project management and systems engineering” Identifies 10 challenges, 43 enablers, 268 sub-enablers
- In October 2012, INCOSE, PMI and MIT conducted a survey to better understand the responsibilities of systems engineers and project managers (Conforto et al. 2013).
  - 680 chief system engineers and program managers
  - Findings: see next slide

State of the art of research

- Results of (Conforto et al. 2013):
  - Identified sources of "tension" between SE and PM:
    - lack of integrated planning,
    - authority not clearly defined & understood
    - conflicting practices,
    - Job position not clearly defined & understood…
  - highlighted how critical SE and PM integration is to reduce tensions
  - Identified 4 ways of improvement:
    - Use of standards from both domains
    - Formal definition of integration
    - Integrated program assessment
    - Shared responsibilities



3. A first way: cooperation of processes through standards

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- To improve cooperation between processes, we explored the first way 'Use standards from both domains'
  - As several standards exist, which one to choose?
  - The ones that are the most compatible….

1. **A first step** is evaluating "How do SE standards consider the management of processes?"
   ⇒ We analyzed 3 SE standards (ANSI/EIA-632, IEEE-1220 and ISO/IEC-15288)
   ⇒ We defined 4 comparison criteria: coverage, level of abstraction, focus and added the ratio of SE management processes.

2. **Second step** is: "How compatible are SE standards with PM standards?"
   ⇒ We compare SE standards with PM standard (PMBoK)

1st step: comparison of SE standards

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- We defined 4 comparison criteria based on the 3 defined by (Sheard 1998):
  - **Coverage** of system life-cycle phases or stages: only development or larger?
  - **Level of abstraction**: generic processes or specialized procedures?
    ⇒linked to flexibility and expendability
  - **Focus**: consider system, product, process, hardware, software, human, procedures…?
  - **Part of processes dedicated to management**: percentage of processes dedicated to management?

Comparison of SE standards

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	ANSI/EIA-632:1998	ISO/IEC-15288:2008	IEEE-1220:2005
System life cycle	• Assessment of opportunities • Investment decision • System concept development • Subsystem design and pre-deployment • Development, operations, support and disposal	• Conception • Development • Production • Utilization • Support • Retirement	• System definition • Preliminary design • Detailed design • FAIT [fabrication, assembly, integration, and test] • Production • Support
Level of abstraction	Medium level	Highest level - process description	Lowest level - task description level
Focus	Enterprise-based systems	Product-oriented systems	Engineering activities necessary to guide product development
% SE Mngt Processes	3/13	12/25	1/14

Comparison of SE standards

- Considering the comparison of norms with respect to general criteria, no standard seems to be the best

- Each standard has a specific profile and addresses different features

- The ISO/IEC-15288:2008 seems to consider most the management of SE processes

2nd step: Comparison of ISO with PMBoK

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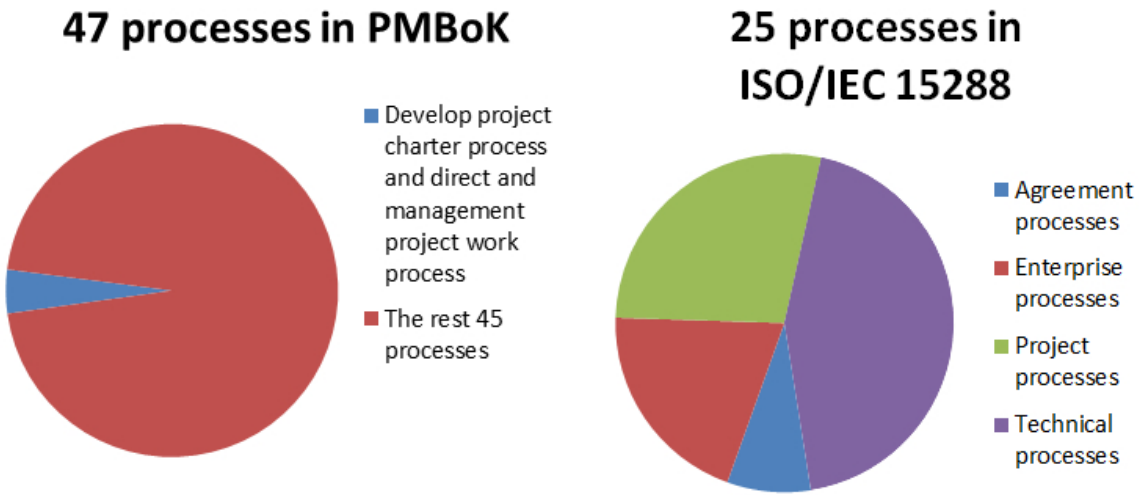
- Early findings:
  - **PMBok → ISO 15288**: all processes of PMBoK are related to the 3 non technical process groups of ISO 15288
  - **ISO 15288 → PMBok**: no obvious process or activity in ISO 15288 corresponds to develop project charter process and direct and management project work process of PMBoK



4. An initiative towards a tool: the DECWAYS project

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- **Aim**:
  - A tool for project management
  - For better project monitoring and control:
    - Help in early detection problem
    - Support decision making

- **Based on:**
  - a formalization of an integrated project and system evaluation process
  - ISO 15288 and PMBok standards
  - a supervision based on shared indicators aggregating SE and PM information for a joint assessment of options, diagnosis and decisions
  - a pro-active decision model

- **Previous project** : ATLAS Project (2008-2011)
  - Feasibility study
  - Industrial interest

DECWAYS project

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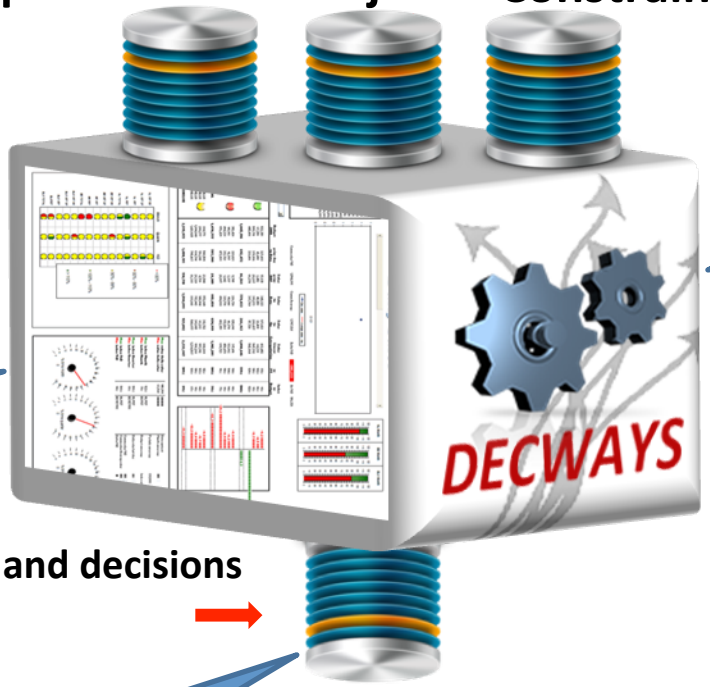
Shared responsibilities

Data from requirements tools (DOORS, Reqtify, …)

Shared data

Requirements **Project** **Constraints**



interoperability monitoring

Dashboards, visualize indicators & conflicts

Validate data consistency, detect and manage conflicts

indicators

Data base : events and decisions history

storage

Joint evaluation

General conclusion

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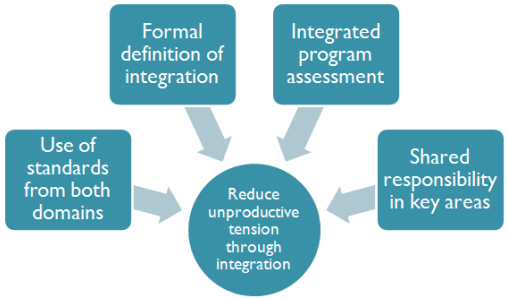
- Cooperation between SE and PM processes is necessary for the success of projects.
- Integrating SE and PM now lies at the very heart of current research and economic / industrial concerns.
  - Recently INCOSE & PMI have devoted much attention to this
  - The DECWAYS project also addresses this issue
- A first means to make processes cooperate is to use standards from both domains.
  - Choosing standards is not trivial…
- On the tool side: DECWAYS aims at facilitating the management of projects by providing
  - visibility to the progress of project to all stakeholders,
  - a formal decision-making process and choice traceability.

Perspectives

- Extend the analysis to other references (guide or compendium of best practices) such as SEBoK or INCOSE Handbook, and ISO 21500 for PM
- Patent registered for DECWAYS: development to continue
- Explore other ways among those suggested by the project INCOSE-PMI and consider how to associate them to improve performance and coordination in SE projects

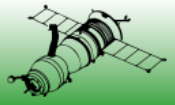


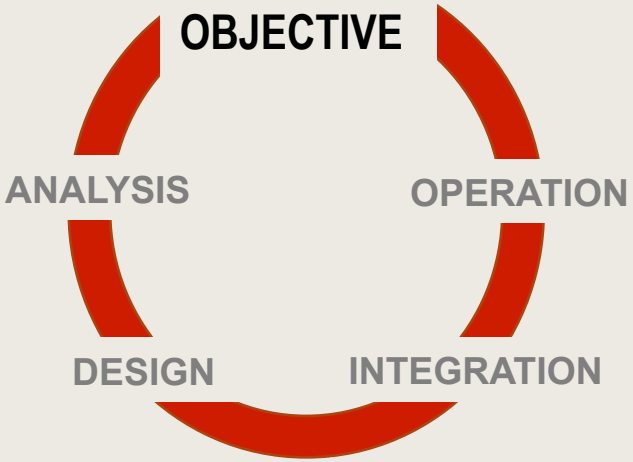
- Extend this cooperation to other enterprise processes: marketing, finance, …

To read more

- Rui XUE, Claude Baron, Philippe ESTEBAN, “Managing Systems Engineering Processes: a Multi-Standard Approach”, IEEE International Systems Conference,6 pages, 30/03/2014 – 02/04/2014, Ottawa, Canada.
- Rui XUE, Claude Baron, Philippe ESTEBAN, “Aligning systems engineering and project management standards to improve the management of processes”, 23rd international conference on systems engineering, 19-21, August, 2014 Las Vegas, USA.
- Rui XUE, Claude Baron, Philippe ESTEBAN, “Towards the success of design projects by the alignment of processes in collaborative engineering”, a Joint conference on mechanical design engineering and advanced manufacturing, 6 pages, 18-20/06/2014, Toulouse, France.
- Claude BARON, Philippe ESTEBAN, Rui XUE, Daniel ESTEVE, Michel MALBERT, “Specifications of a method and tool to support the management of systems engineering projects”, International Conference on Engineering, Technology and Innovation, 7 p. , 23-25/06/2104, Bergamo, Italy.

Thank you!
Questions?

Presentation to IS 2014

by

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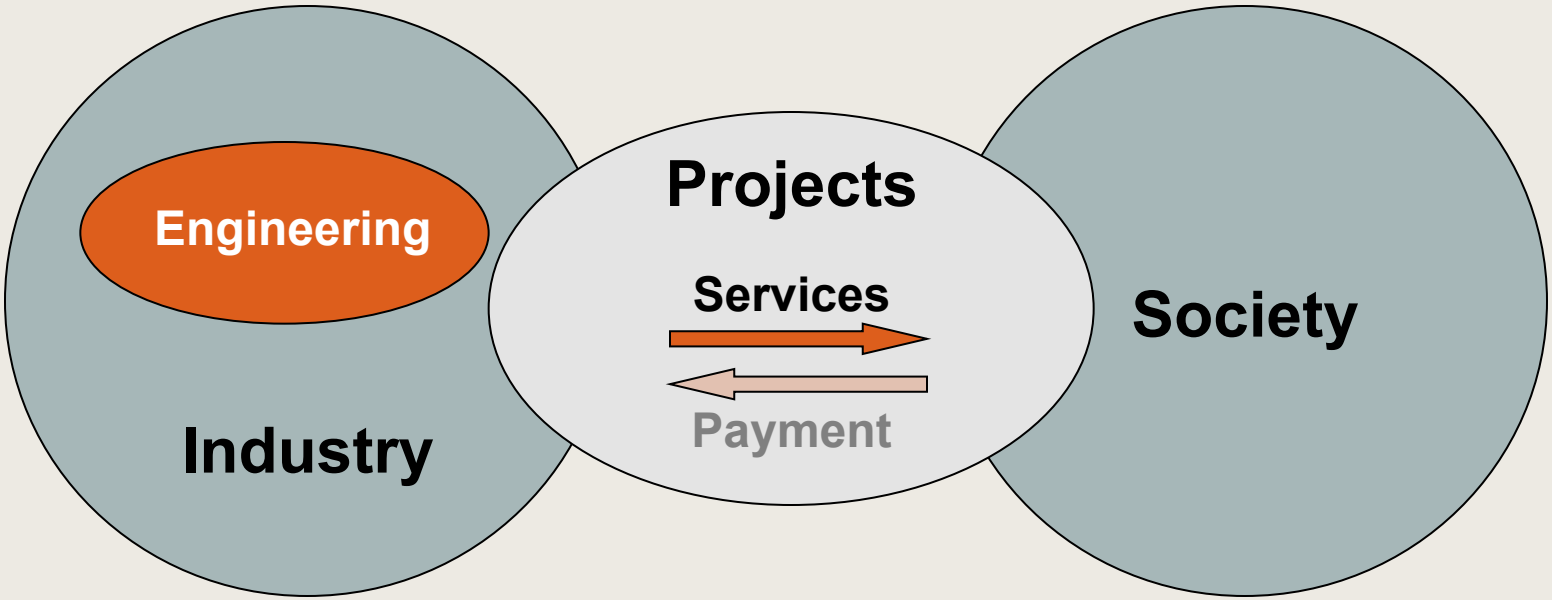
Systems and Projects

- A brief description of the high-level view of engineering and systems engineering on which my paper is based
- A discussion of comments raised by the reviewers
- A further issue relevant to the reviewers' comments


Engineering
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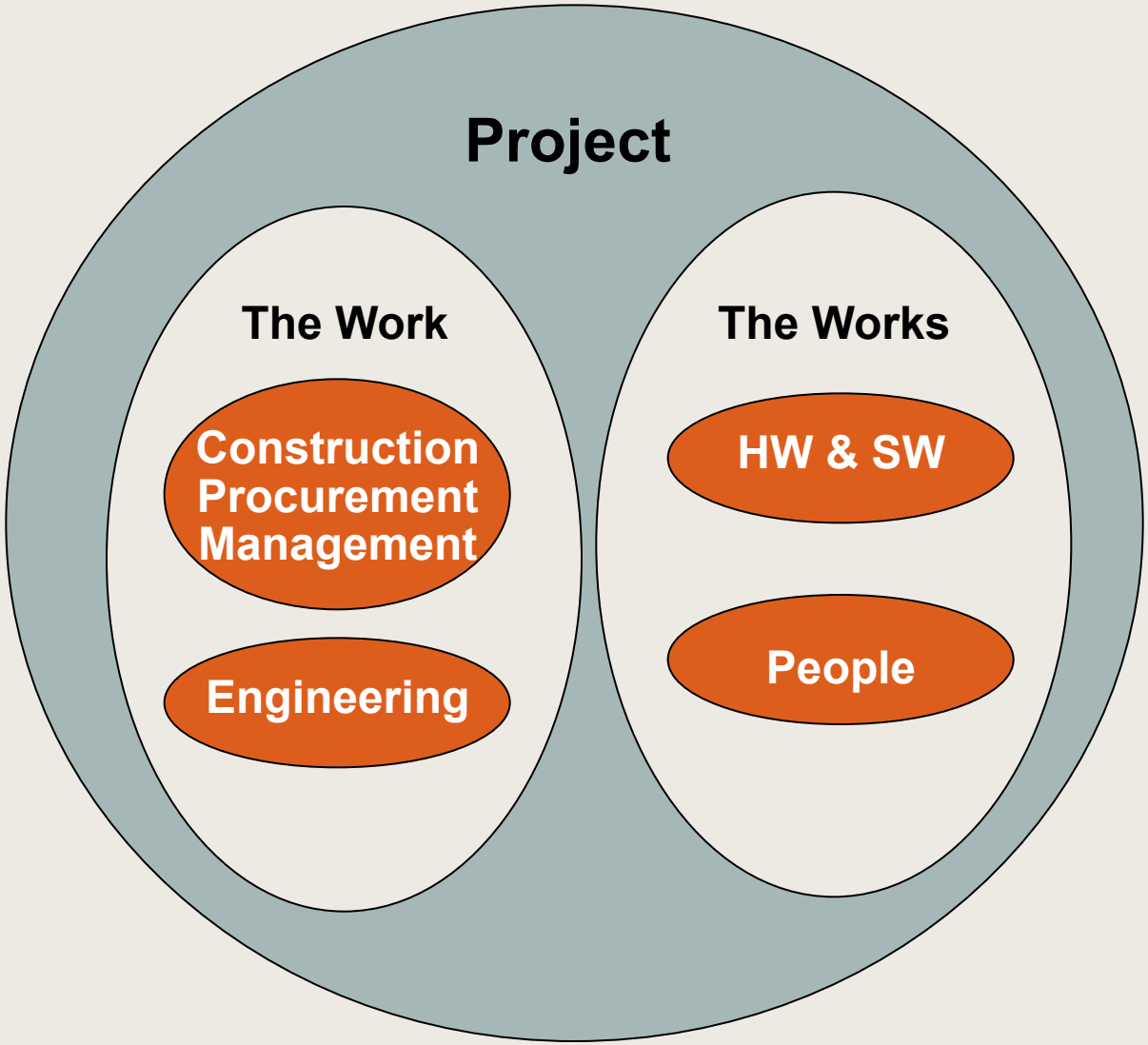
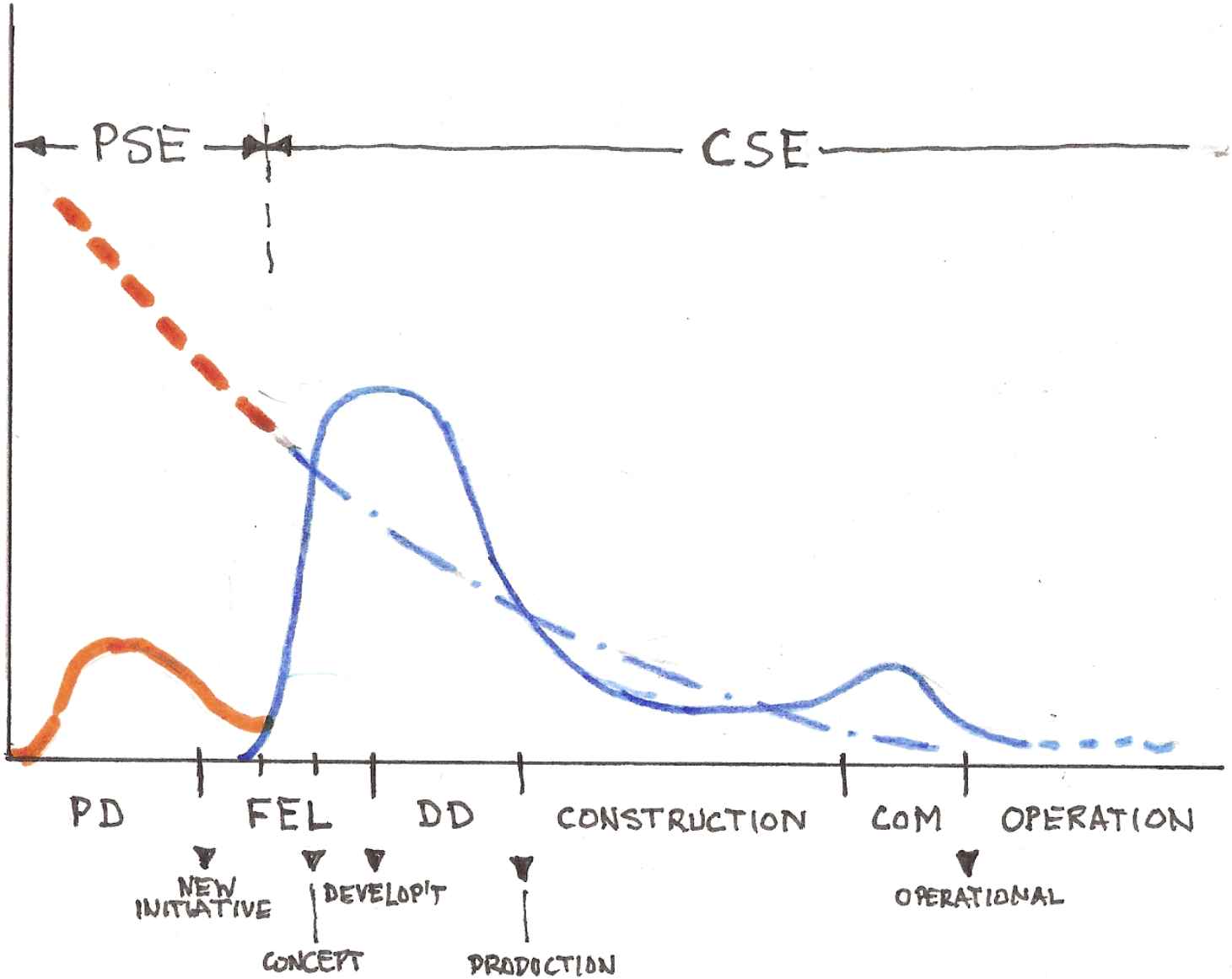
Projects
Services
Payment
Society



Service → Society


PSE
CSE
PD
FEL
DD
CONSTRUCTION
COM
OPERATION
NEW INITIATIVE
DEVELOPIT
CONCEPT
PRODUCTION
OPERATIONAL

Will introducing PSE make any significant difference?

a. It will integrate engineering into other project activities
b. It will allow optimisation of overall project cost-effectiveness
c. It will improve the scheduling of activities and information flow

Which are the barriers to implementation of PSE?

a. There are costs associated with implementing PSE that make it appear not cost-effective.
b. There are professional barriers – in particular, considerations regarding liability – that make it difficult to integrate across professions.
c. It is seen as a threat to the considerable investment in CSE.

Language issues:

- Project vs. enterprise (Handbook: enterprise = organization. Organisation can execute many projects, and has support systems that are used in all projects) Not the same *in general*.
- Service, as used here (defined by society) vs. as used in SW engineering, e.g. service-oriented architecture (= functionality of self-contained SW part)
- Service vs. capability. Service is defined by society (users), capability is the functionality the system (Works) in order to support the provision of the service.

Language issues (cont'd):

- Project architecture vs. enterprise architecture. The latter is an IT analysis function, and relates to the structure of a company's business processes and the resulting information flows. My intention is that the project architecture is a system architecture.
- SE vs. PM at the project level. I believe leaving the architecting of the project to the PMs is one of the reasons for poor project performance (cost and schedule overrun). An alternative is to teach systems architecting to PMs (can be problematic).

An important comment: “The fundamental purpose of engineers is to build things that serve a function. The author is proposing Systems Thinking rather than the engineering or technical aspects of SE.”

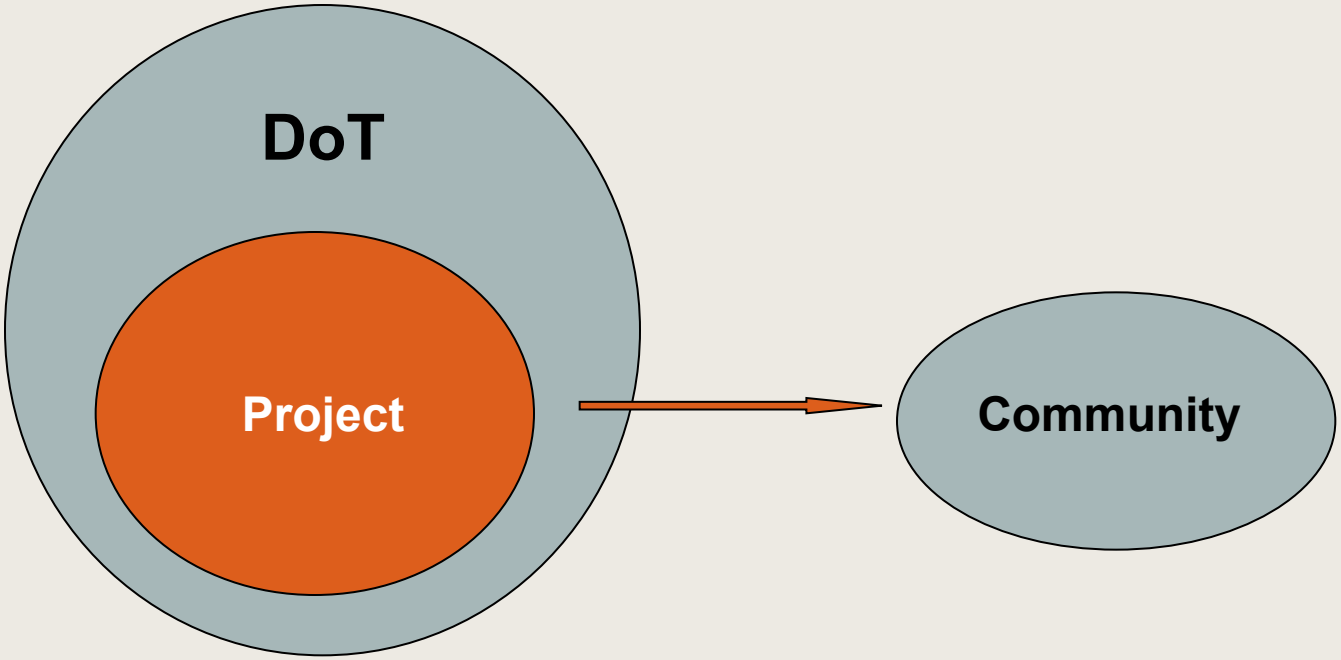
My view: Systems Thinking is the general application of the system concept to handling complexity. Systems Engineering is a formalisation and detailed development of the application of the system concept to engineering (embodied in the SEBOK and Handbook), and that same methodology (*not* Systems Thinking) can be applied at the project (top) level to “engineer” and optimise the project, considered as a complex system.

The fundamental purpose of engineers is to contribute to the best of their abilities to ensuring project success.

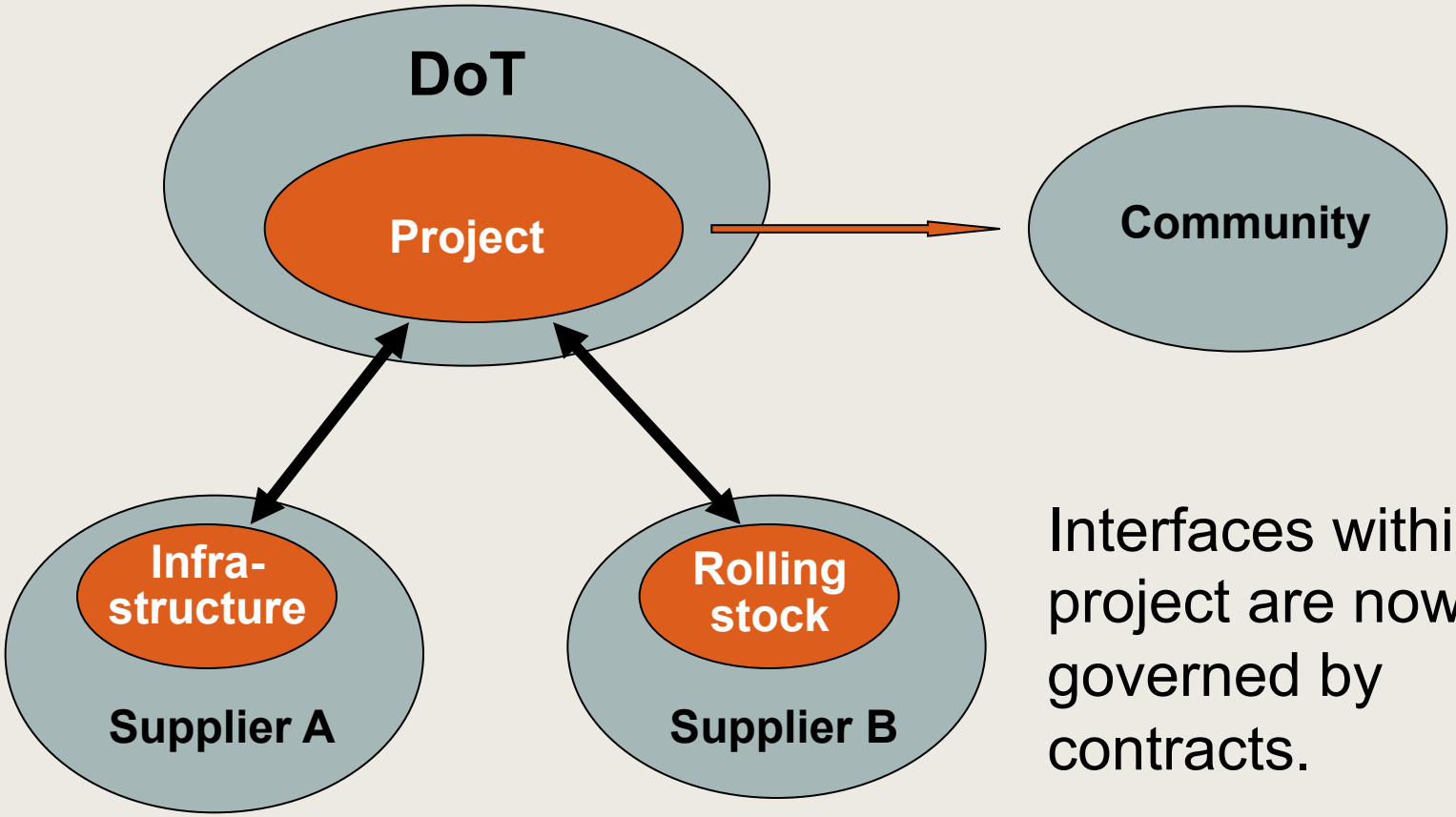
The importance of contracts

An example: Providing public transport services to a (new) suburb.

One (very unlikely) approach:



A more likely approach:



Interfaces within the project are now governed by contracts.

Questions and Discussion