Applying Lean Principles to Program Management

Results from a Joint Study by PMI, International Council on Systems Engineering and MIT's Lean Advancement Initiative

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Session # TRN04

Josef Oehmen, MIT, Lean Advancement Initiative and
Eric Norman, Project Management Institute

Global Congress 2012
EMEA

Agenda

- Challenges in engineering programs
- Working toward a solution - The Lean in Program Management Community of Practice
- Background
  - Program Management
  - Systems Engineering
- Integrating Program Management and Systems Engineering
  - Lean Thinking and the Lean Enablers
  - Guide to Lean Enablers for Managing Engineering Programs
  - Lean Enablers and Program Success
- The Road Ahead: Implementing the Lean Enablers

Partnering Organizations

Project Management Institute

LAI MIT
LEAN ADVANCEMENT INITIATIVE ™

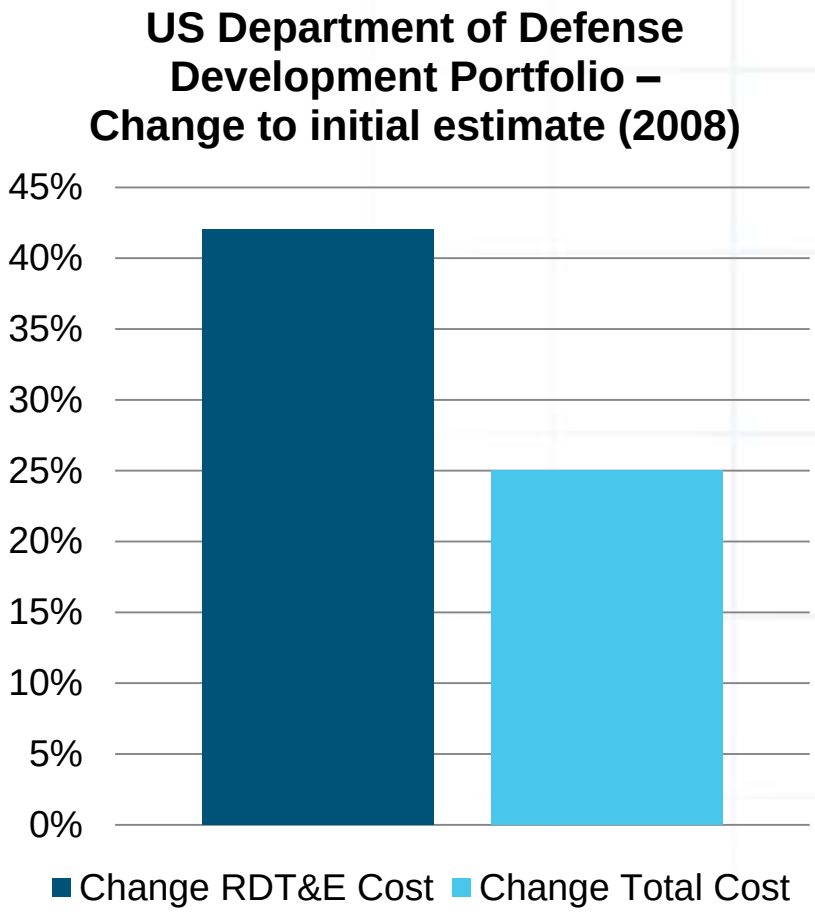
INCOSE
International Council on Systems Engineering

CHALLENGES IN ENGINEERING PROGRAMS

How are we doing in the management of large-scale engineering programs?

- Regarding cost?
- Regarding schedule?
- Regarding delivering the benefits we promised?

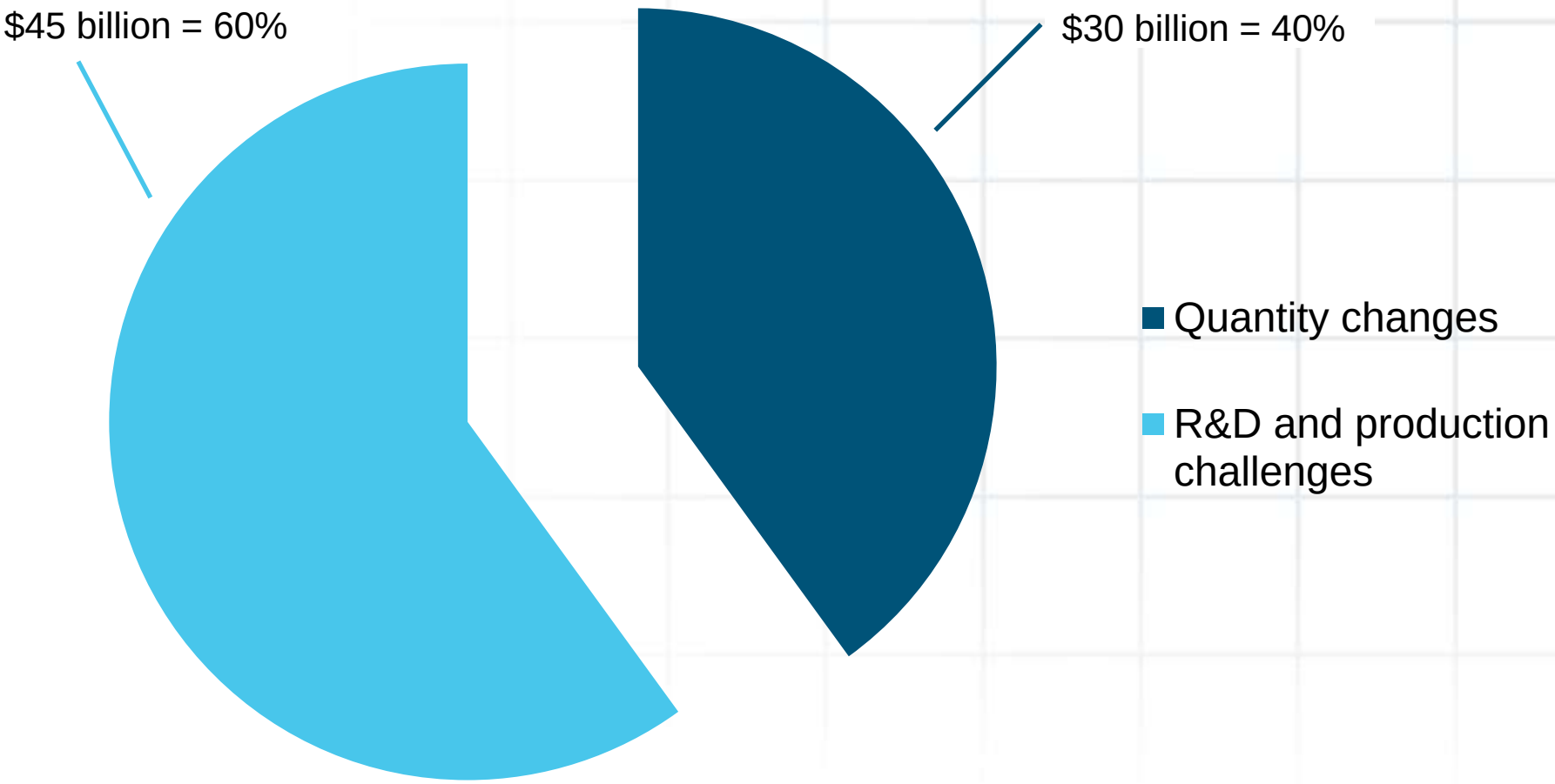
Management of Large-Scale Engineering Programs: The US Department of Defense Example



- Total cost growth (until 2010): **$296 billion**
- Average schedule overrun: **22 months**
- Cost overrun 2011 alone due to program management challenges (RDT&E, production): **$45 billion**
- Similar situation in other industries

Sources: GAO 06-368, Bloomberg, GAO 10-374T, GAO-12-400SP

DoD Cost Growth 2011: $75 billion



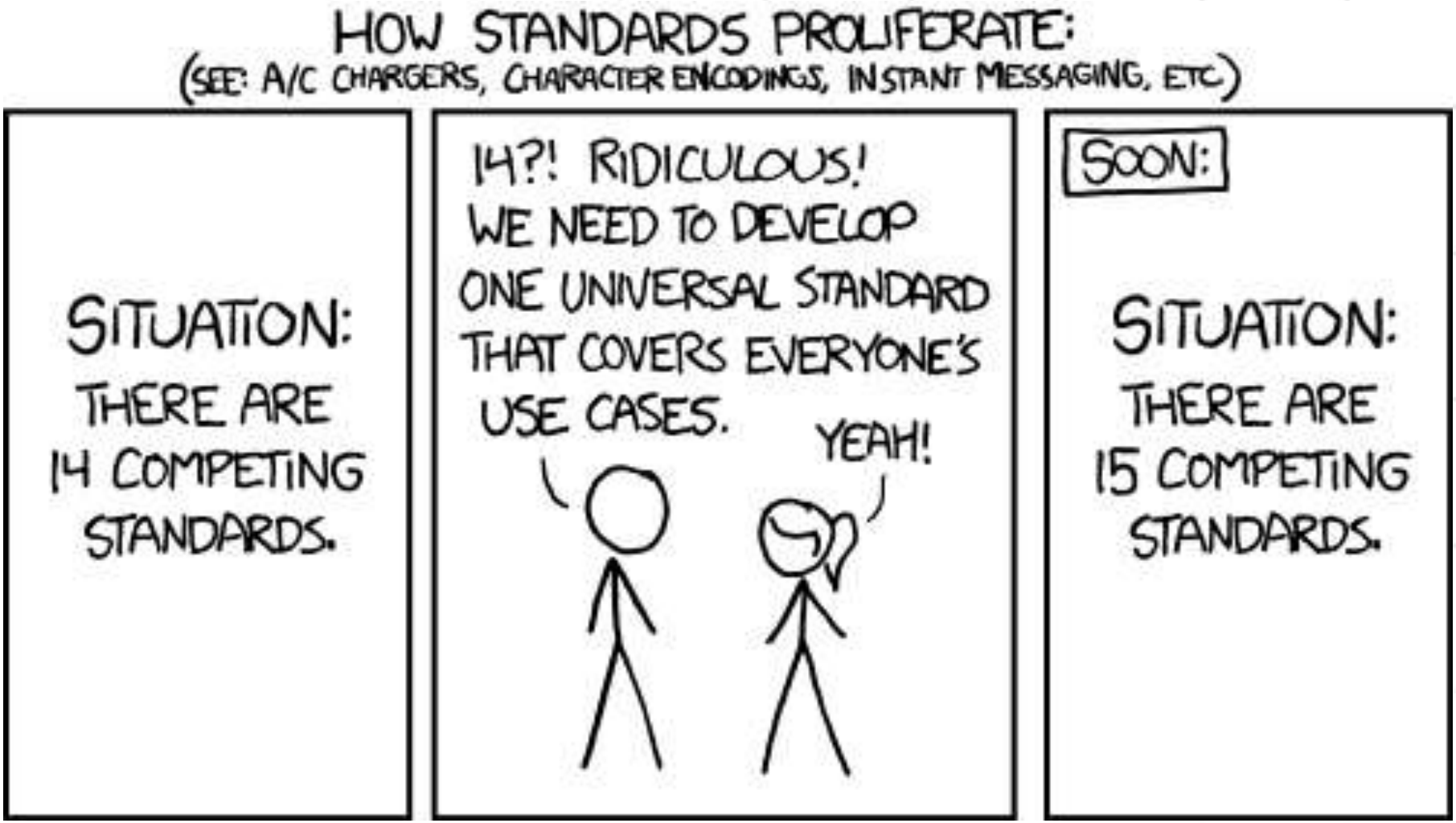
Source: GAO-12-400SP

What is a serious engineering program challenge in your organization? Hands up!

1. Reactive Program Execution
2. Lack of stability, clarity and completeness of requirements
3. Insufficient alignment and coordination of the extended enterprise
4. Value stream not optimized throughout the entire enterprise
5. Unclear roles, responsibilities and accountability
6. Insufficient team skills, unproductive behavior and culture
7. Insufficient Program Planning
8. Improper metrics, metric systems and KPIs
9. Lack of proactive management of program uncertainties and risks
10. Poor program acquisition and contracting practices

WORKING TOWARD A SOLUTION

Goal: Supporting Existing Standards



Source: Randall Munroe, www.xkcd.com

Study Design:
Innovation by Bridging Knowledge Domains

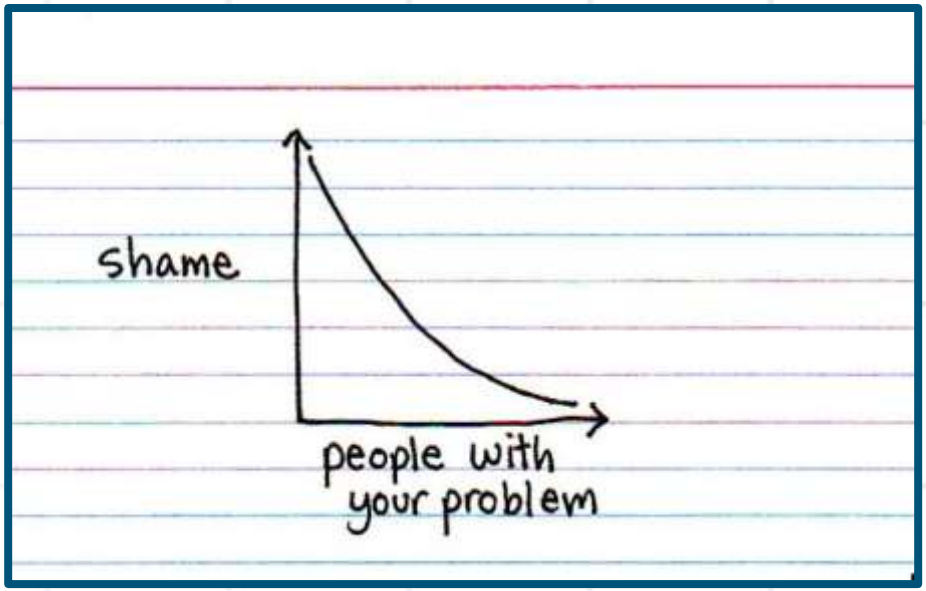
Unique	Relevant	Actionable
• Three world-class organizations and thought leaders joined forces • Industry, government and academia participation	• Massive challenges in program execution: Cost and schedule overruns • Integration of knowledge and professional domains • Extensively validated	• Concrete advice • Mapped to known challenges and existing standards • Guidance for implementation

2 Core Results:

- 10 **Program Management Challenges** (with 160 “sub challenges”)
- 43 **Lean Enablers** (= Management Best Practices) (with 286 “sub enablers”)

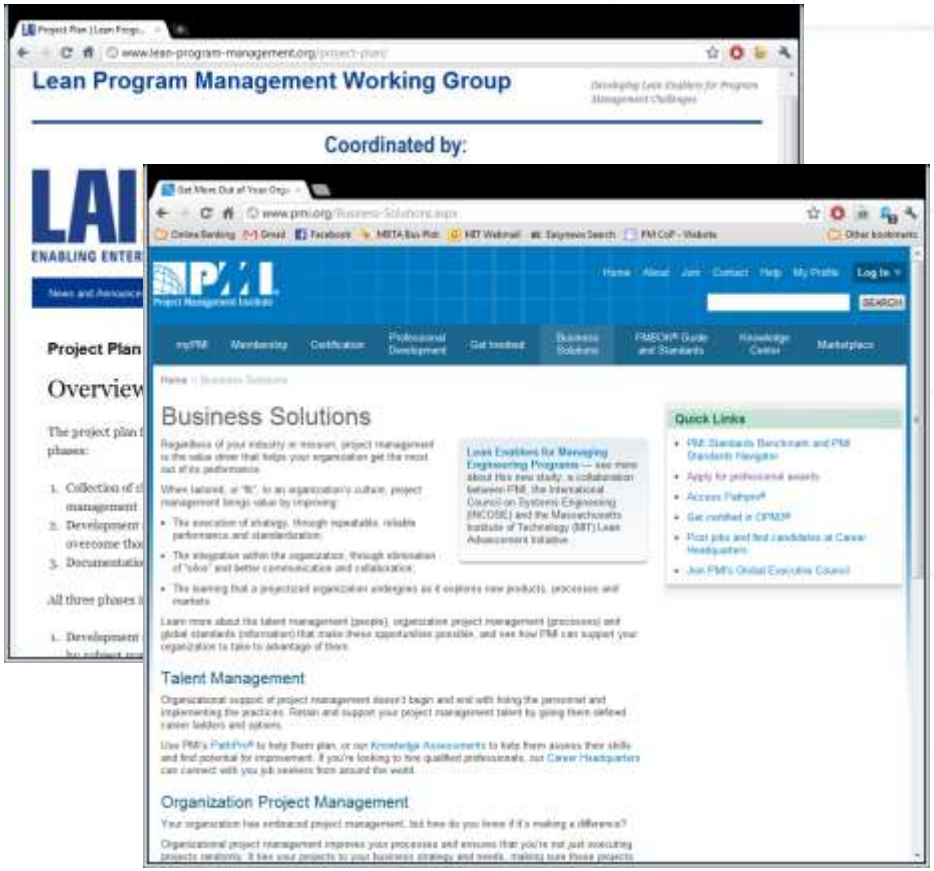
Engaging in the PMI-MIT-INCOSE Partnership

- Approximately 15 subject matter experts
- Fast growing community of practice (currently 160 people)
- Professionals in program management, systems engineering and lean management (and some academics where nobody was quite sure what they had to contribute)



Source: indexed.com

“Guide to Lean Enablers” and Joint CoP Websites



- www.pmi.org → Business Solutions → Guide to Lean Enablers (Box)
- To sign up: www.lean-program-management.org → Connect
- lean.mit.edu
- www.incose.org

Extensive validation

- Based on **concrete challenges**, not thin air
- Incorporates **start-of-the-art knowledge** from literature
- Developed by group of 15 **subject matter experts** through year-long, weekly meetings
- Feedback through wider **community of practice** (160+ members)
- Discussed at **4 large and very successful workshops**, involving both PMI and INCOSE members
- Backed-up by **two validation surveys**
- Validated by **content analysis** management practices of highly successful programs

Integrating Program Management, Systems Engineering and Lean Thinking

Domain	Representation of "the stakeholder problem"	Example: New aircraft development
Lean Thinking	Value	Increased flight economy by 20% / passenger
Program Management	Benefit	Global market leadership in hub-to-hub connections
Project Management	Deliverable	Deliver engine for $16 million on May 10
Systems Engineering	Requirements	The new engine must have over 300kN take-off thrust, weigh less than 6 tons, must be manufacturable on existing assembly lines, cost not more than $15 million to produce and FAA certified May 9.

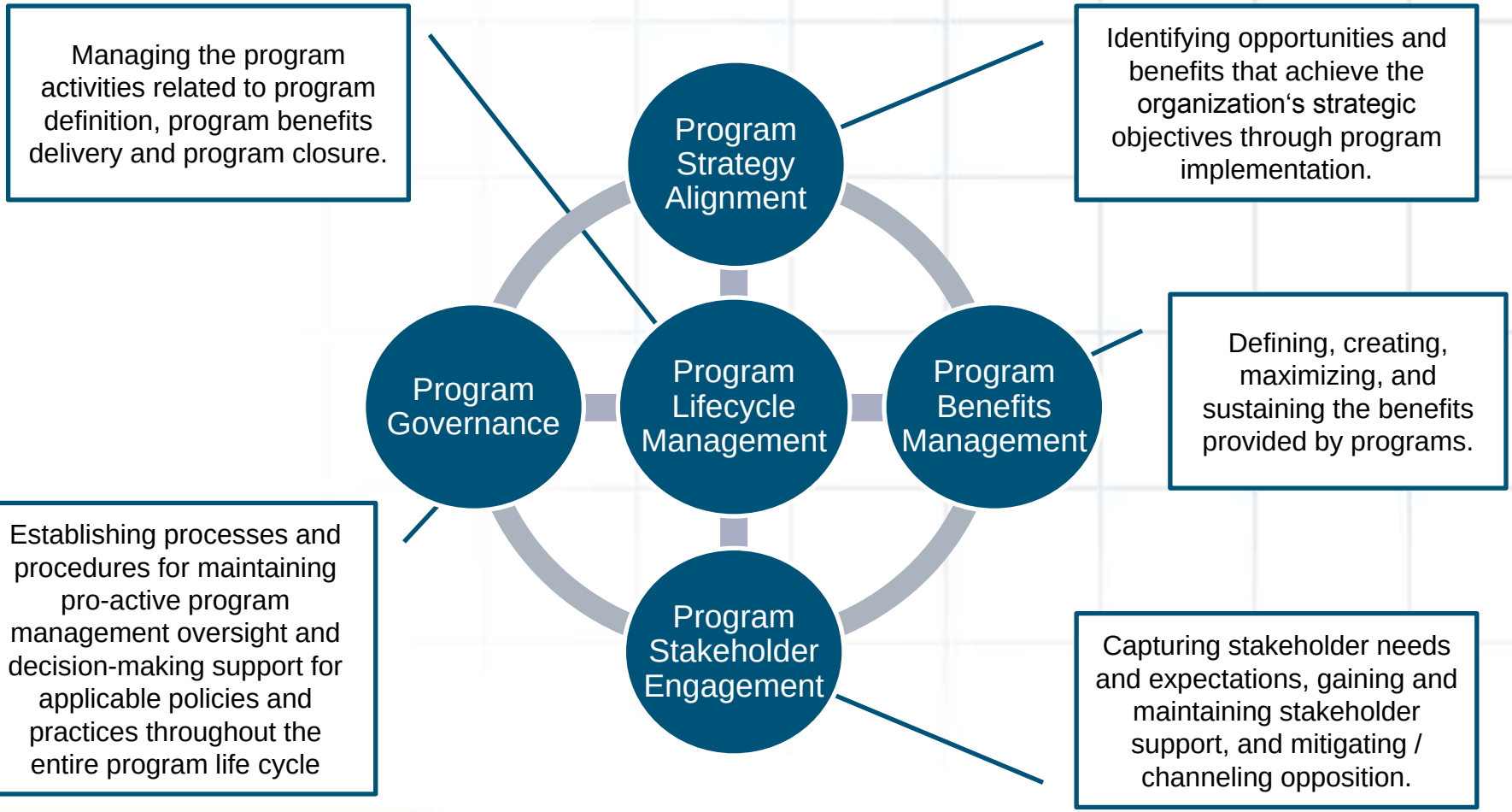
BACKGROUND: PROGRAM MANAGEMENT

Applicability – Program Types

Focus

Technology, engineering, infrastructure	Business transformation	Community & Society
• Large-scale engineering programs (e.g. aerospace, defense, civil engineering, product line)	• Organizational change programs (e.g. institutionalizing continuous improvement, implementing cost cutting measures)	• Public management programs (e.g. reducing childhood obesity, reforming military healthcare)
• Large-scale IT development and implementation programs (e.g. change of ERP system, virtualization of entire software)		

5 Program Management Performance Domains



Programs and Benefits Management

PMI defines a program as:

> "A group of related projects, subprograms, and program activities, managed in a coordinated way to obtain benefits not available from managing them individually."

- Programs and projects perform different roles
  - Projects deliver outputs (individual products, services)
  - Programs deliver outcomes (financial, technical, organizational, social)

- To achieve the program's intended outcomes, the program manager and program team must plan and manage the benefits that are to be generated by the program

Programs and Benefits Management

- Program benefits are aligned with organizational and constituent strategies/objectives

- Benefits Management focuses program stakeholders on outcomes rather than process
  - What will be changed/improved (different) by the end of the program?
  - Who's behavior must change – and how must it change?
  - After the program ends, how do we sustain the improvements achieved?

- Benefits may serve:
  - The organization performing the program
  - The customer's of the organization performing the program
  - People and organizations (intended beneficiaries) outside the program

Applicability – Project vs. Program

- If your project executes program-level activities, the corresponding Enablers apply to your program.

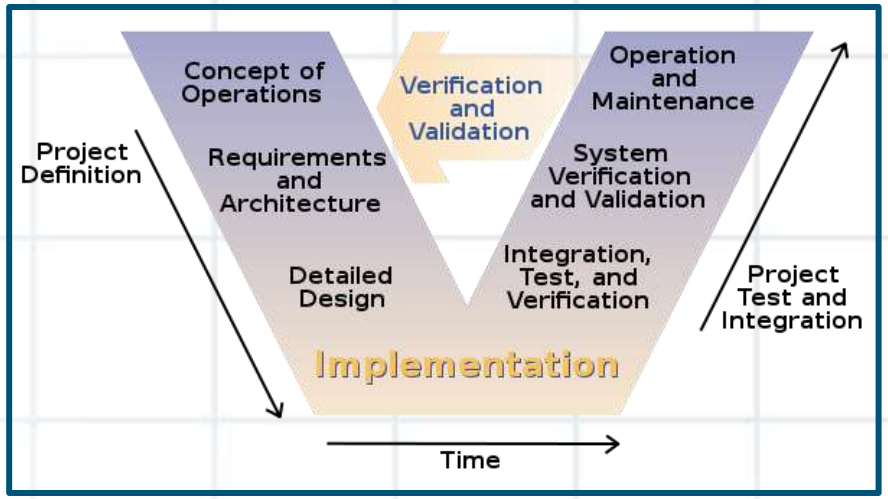
- The Enablers address dependencies and interfaces between projects and programs.

BACKGROUND: SYSTEMS ENGINEERING

Systems Engineering: Not just “engineering”

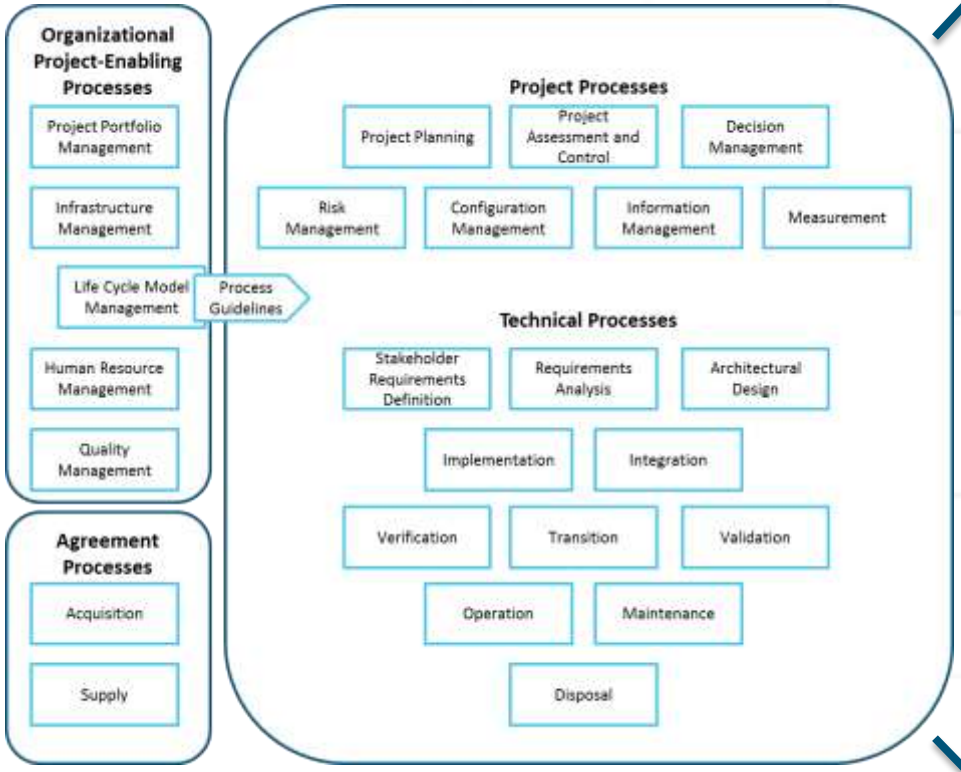
Systems engineering is

- an **interdisciplinary approach** and means to enable the realization of successful systems.
- It focuses on **defining customer needs and required functionality** early in the development cycle, documenting requirements, and then
- proceeding with **design synthesis and system validation** while **considering the complete problem**: operations, cost and schedule, performance, training and support, testing, manufacturing, and disposal.
- SE considers **both the business and the technical needs** of all customers with the goal of providing a quality product that meets the user needs.



Source: INCOSE SE Handbook 2011 ; wikimedia

Systems Engineering and program management



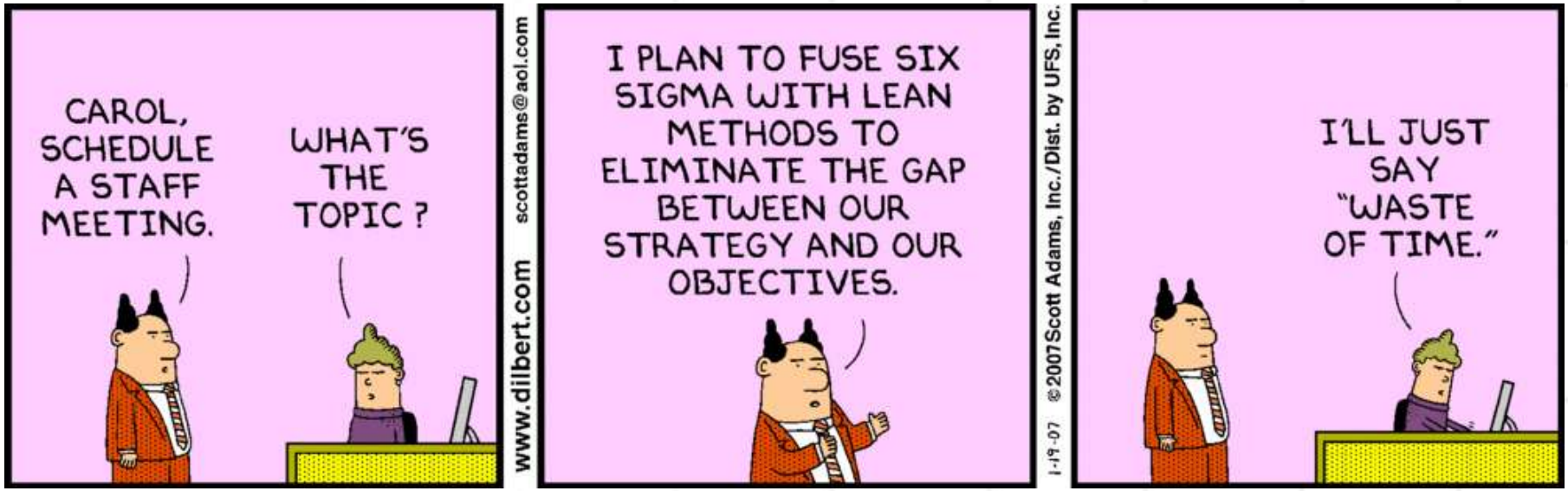
Source: INCOSE SE Handbook 2010; Langley & Robitaille 2011

INTEGRATING PROGRAM MANAGEMENT AND SYSTEMS ENGINEERING: LEAN THINKING AND THE LEAN ENABLERS

Who has experience in Lean Thinking?
(Production / Engineering / Project Management / …)

- Did it work for you? What did you achieve?
- What were the challenges?

Lean Management: Buzz-Word and Firing People?

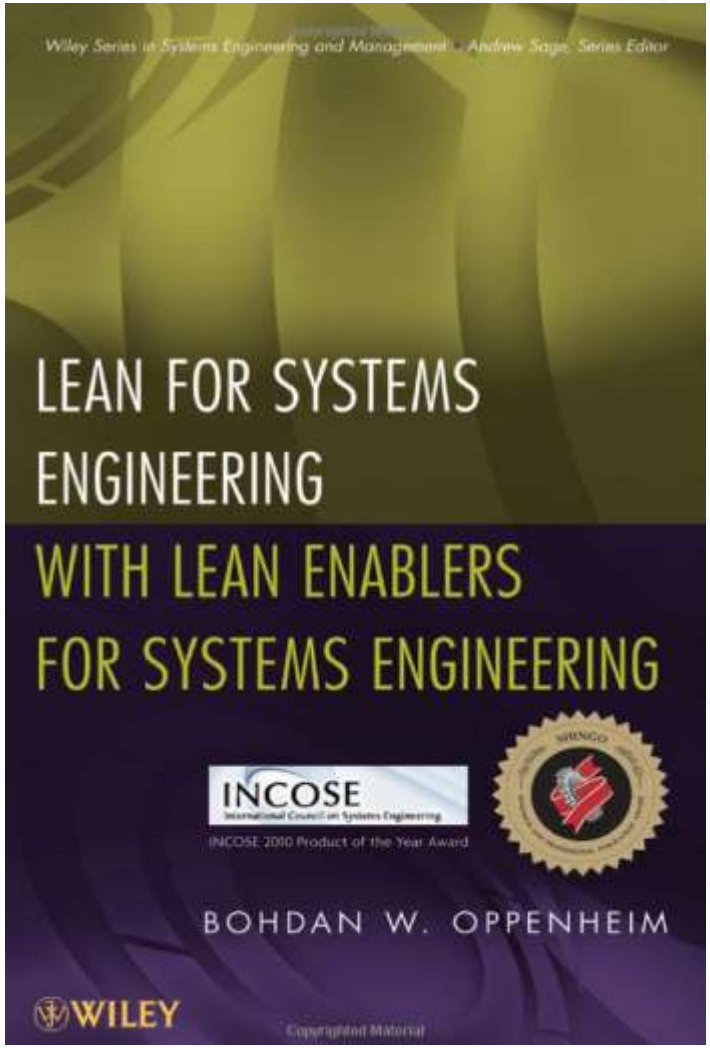


Source: dilbert.com

Why Lean Thinking?

Lean Principle	Result
Define value to the program stakeholders	Builds the engineering program around benefits
Plan the value-adding stream of work activities during the product lifecycle, from the need to product delivery, until disposal, while eliminating waste	Focuses on cross-organizational and cross-functional integration
Organize the value stream as an uninterrupted flow of predictable and robust tasks, proceeding without rework or backflow	Establishes clear responsibilities, resilient interfaces, effective communication pathways
Organize the pull of the work-in-progress as needed and when needed by all receiving tasks	Simplifies information exchange
Make all imperfections visible and pursue perfection, i.e. the process of never ending improvement	Improves the engineering program (efficiency) and adapt to a changing environment (effectiveness)
Base human relations on respect for people	Creates an energetic and positive environment by developing skills, behavior and culture

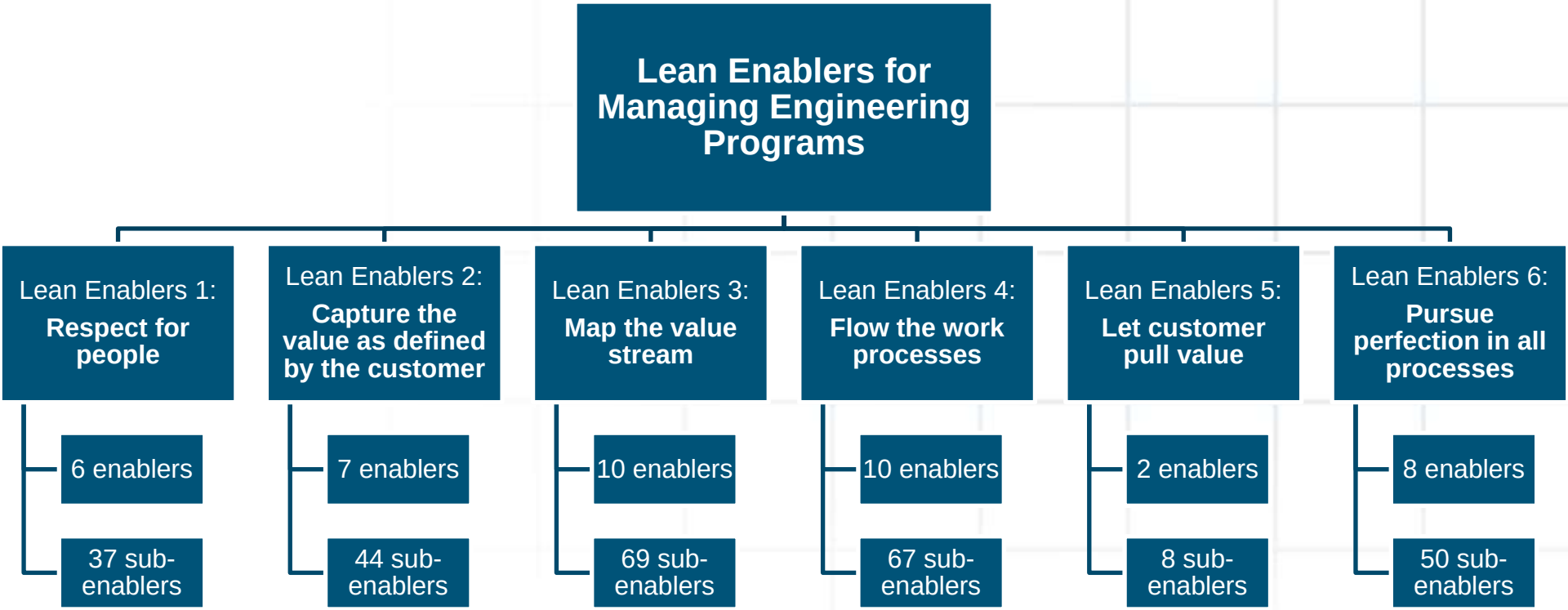
Lean Enablers for Systems Engineering



Bo Oppenheim:

Lean for Systems Engineering with Lean Enablers for Systems Engineering, Wiley 2011

6 Categories, 43 Lean Enablers, 286 Sub-Enablers = A whole lot of best practices!



Some Examples

- Enablers
- Challenge they address
- Tools and methods

Programs fail or succeed primarily based on people, not processes or tools. (that includes smart bosses)

- What is the key to motivating knowledge workers? Money! Really?

Source: danpink.com

Watch Dan Pink at

http://www.youtube.com/watch?v=u6XAPnuFjJc
(or Google “Dan Pink RSA”)

Example 1: Treat People as Your Most Important Asset (LE 1.x.x)

1.1.x Build a program culture based on respect for people

1.2.x Motivate by making the higher purpose of the program and program elements transparent

1.3.x Support an autonomous working style

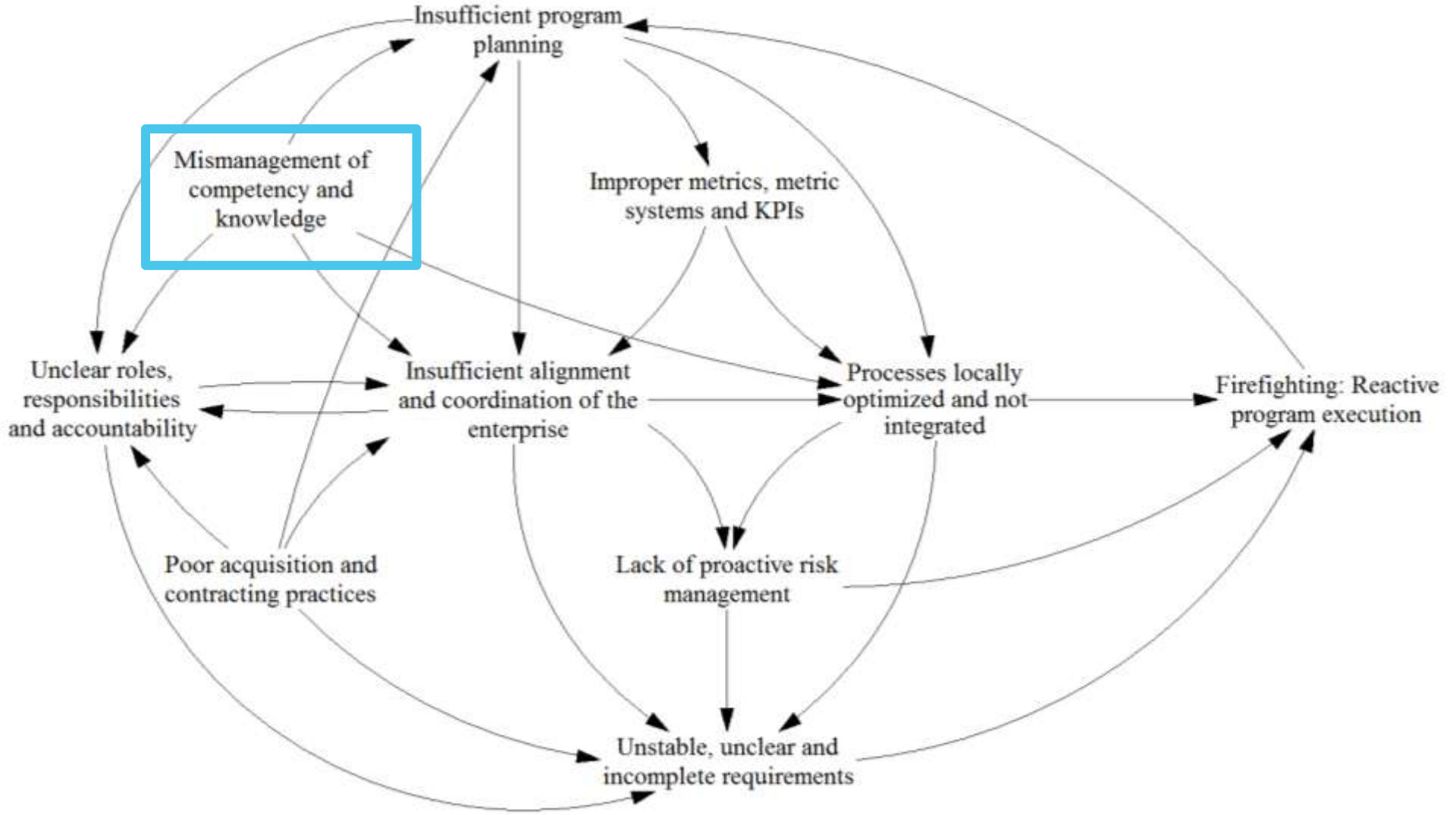
1.4.x Expect and support people in their strive for professional excellence and promote their careers

Source: danpink.com

1.5.x Promote the ability to rapidly learn and continuously improve

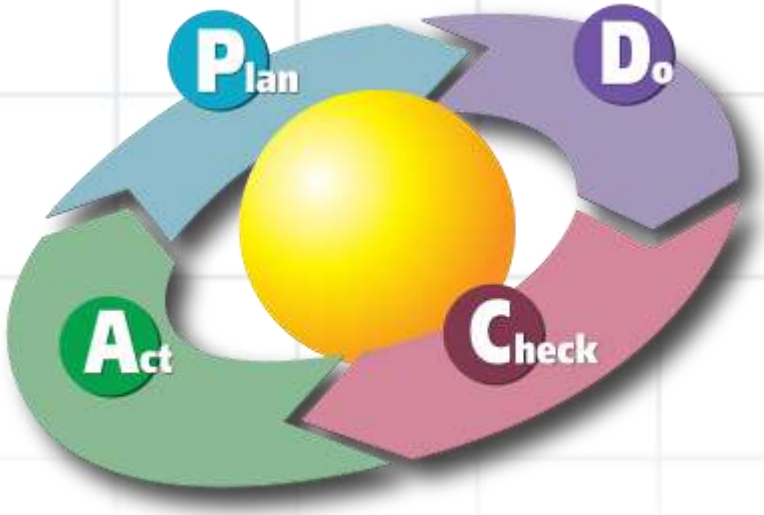
1.6.x Encourage personal networks and interactions

What challenges do you address by helping people to become highly capable and motivated?



Associated Lean Methods and Tools

- Mastery:
  - Create Specialist Career Path to develop towering (technical) competence
  - Communities of Practice (internal and external)
  - Mentoring
  - Hire for attitude, train for skill
- Autonomy:
  - Kaizen: Bottom-up continuous improvement processes
  - Responsibility-based planning and control
- Purpose:
  - Create a shared vision that draws out the best in people (e.g. through value stream mapping)

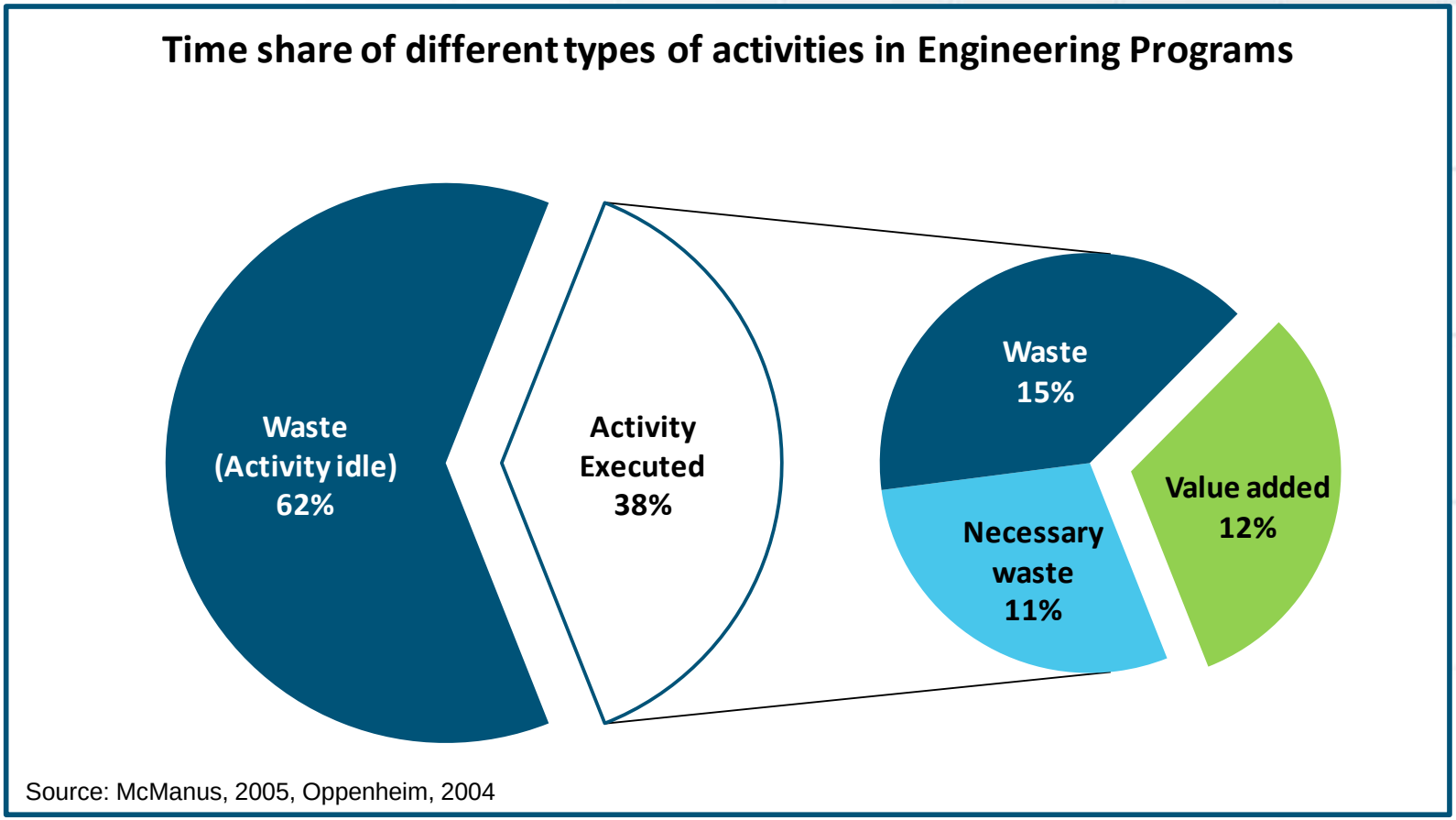


Source: Wikipedia

Example 2: Optimize the value stream (LE 3.x.x) and create flow (LE 4.x.x)

- Use formal value stream mapping methods to identify and eliminate management and engineering waste, and to tailor and scale tasks. (LE 3.1.4)
- Use Lean tools to promote the flow of information and minimize handoffs. Implement small batch sizes of information, low information in inventory, low number of concurrent tasks per employee, small takt times, wide-communication bandwidth, standardization, work cells, and training. (LE 4.1.19)

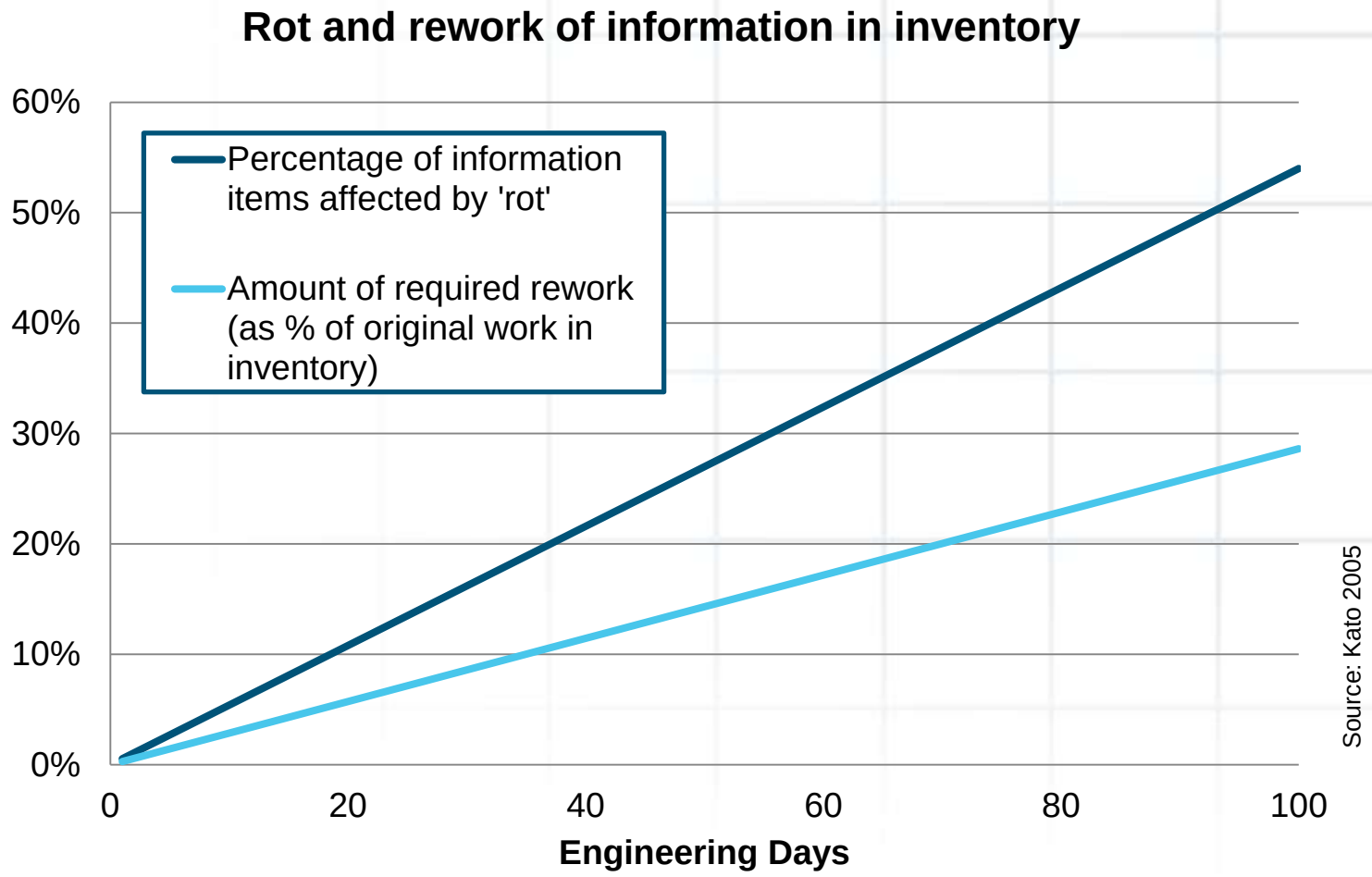
Addresses challenge of value stream not being optimized throughout the entire enterprise



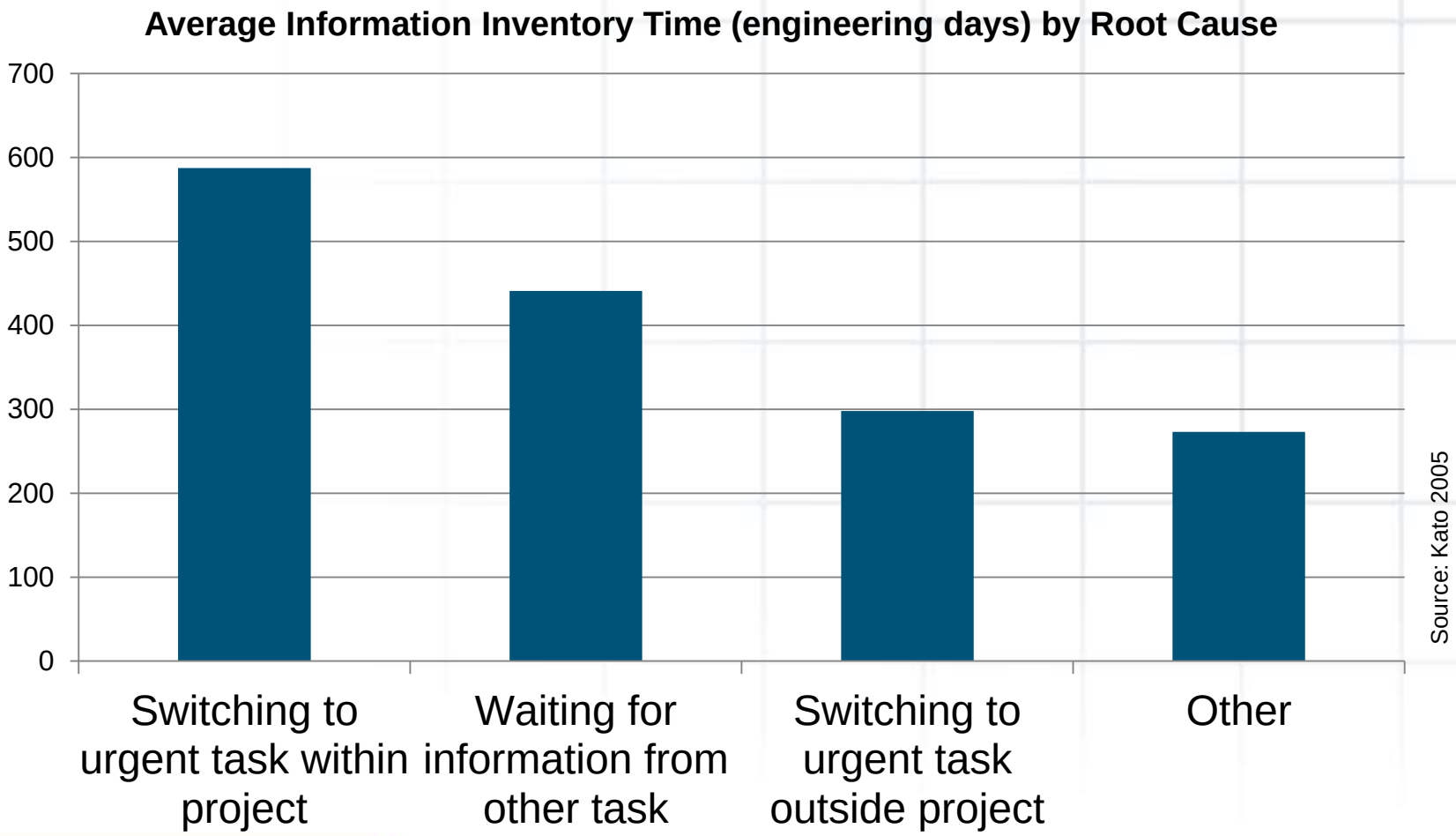
Waste in Engineering Programs - Examples

Seven Wastes	Engineering Program Examples
Waiting	• **Waiting for information or decisions** • **Information or decisions waiting for people to act** • Large queues throughout the review cycle • Long approval sequences • Unnecessary serial effort
Over-Processing of Information	• **Refinements beyond what is needed** • **Point design used too early, causing massive iterations** • Uncontrolled iterations (too many tasks iterated, excessive complexity) • Lack of standardization • Data conversions
Inventory of Information	• **Keeping more information than needed** • **Excessive time intervals between reviews** • Poor configuration management and complicated retrieval • Poor 5 S's (sorting, straightening, systematic cleaning, standardizing, and sustaining) in office or databases
Rework, Defects	• **The killer "re's": Rework, Rewrite, Redo, Re-program, Retest...** • **Unstable requirements** • Uncoordinated complex task taking so much time to execute that it is obsolete when finished and has to be redone • Incomplete, ambiguous, or inaccurate information • Inspection to catch defects
...	

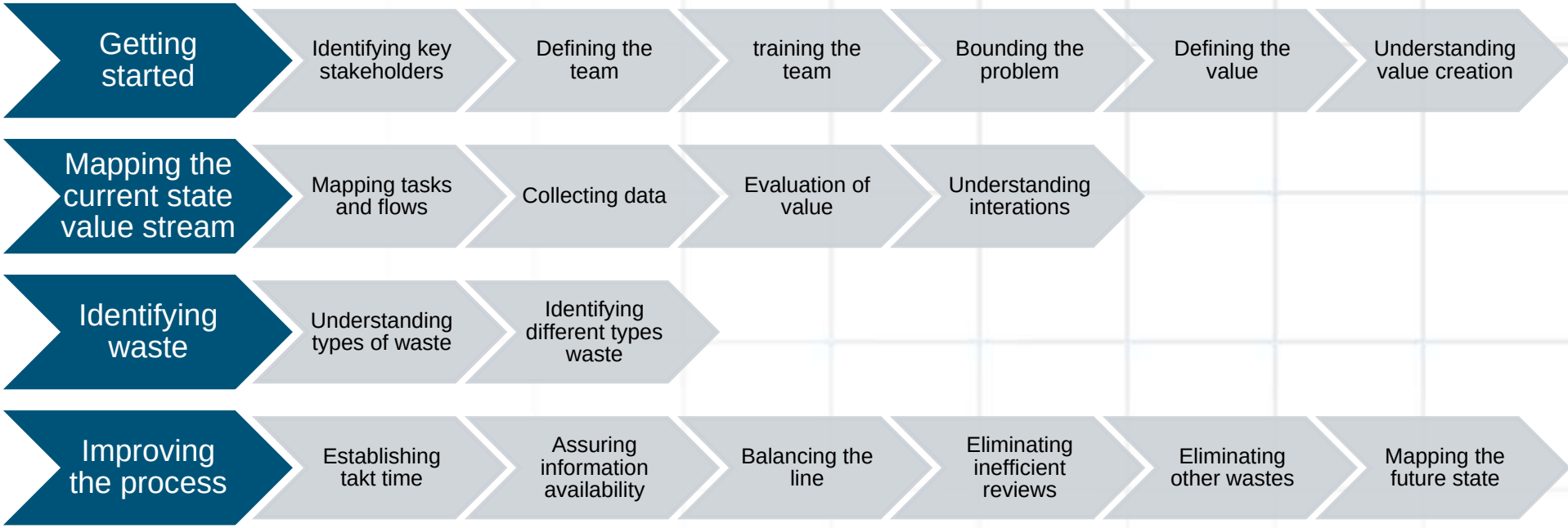
Why “Flow” is key: Information rots!



How information inventory is created: Task switching

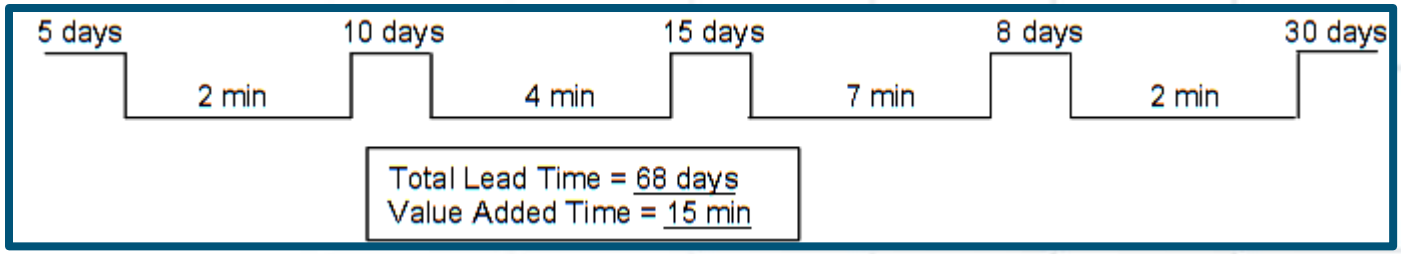


Engineering Value Stream Mapping Process



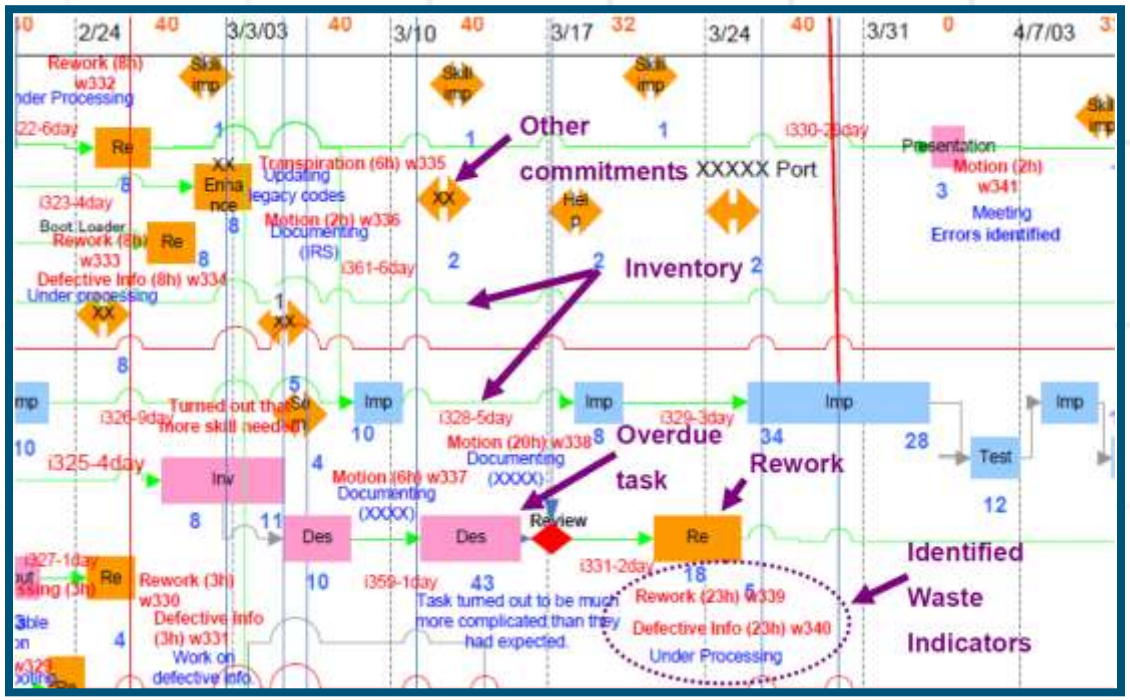
Source: McManus, 2005

Example Value Stream Maps: All shapes and sizes



Source: Wikipedia

1 type of waste, one value stream



7 types of waste, three coupled value streams

Source: Kato 2005

Reducing Work in Progress through simple visual management (and prioritization)

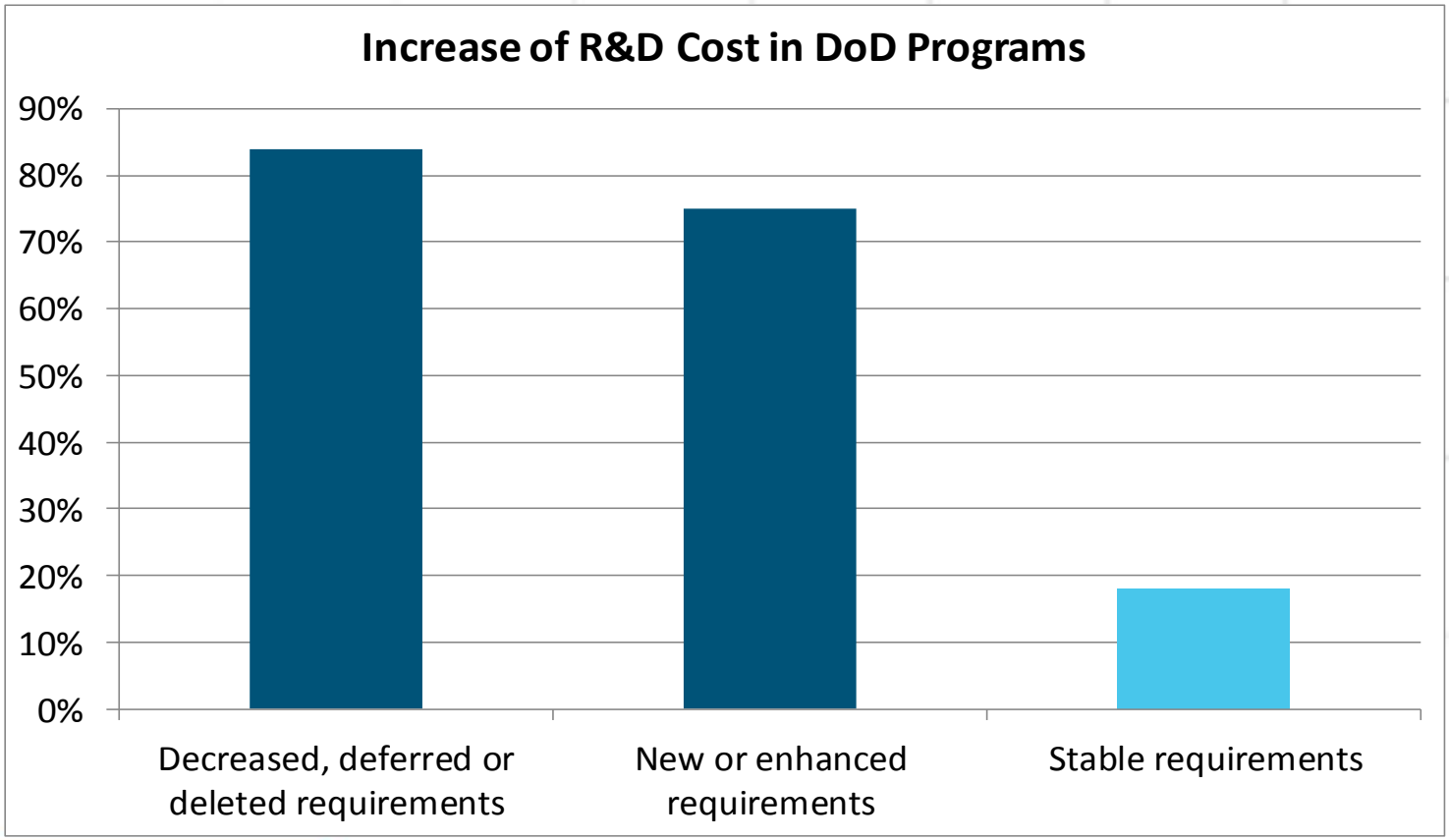
- Average from 972 cases at Boeing:
  - Reduction of work in progress: 69%
  - Improvement of quality (reduction of defects): 3.2x
  - Improvement of throughput (reduction of lead time): 3.4x
  - Time to implement method: 4 weeks

Example 3: Maximize Program Value (LE 2.x.x)

- Define value as the outcome of an activity that satisfies at least three conditions (LE 2.1.1):
  - External customer stakeholders are willing to pay for value.
  - Transforms information or material or reduces uncertainty.
  - Provides specified program benefits right the first time.
- Actively promote the maturation of stakeholder requirements, e.g., by providing detailed trade-off studies, feasibility studies, and virtual prototypes (LE 2.5.6)
- Up-front in the program, dedicate enough time and resources to understand what the key requirements and intended program benefits really are. (LE 3.5.2)
- Fail early and fail often through rapid learning techniques (e.g., prototyping, tests, simulations, digital models, or spiral development). (LE 2.5.9)
- Allow certain amount of "failure" in a controlled environment at lower levels, so people can take risk and grow by experience. (LE 1.3.3)

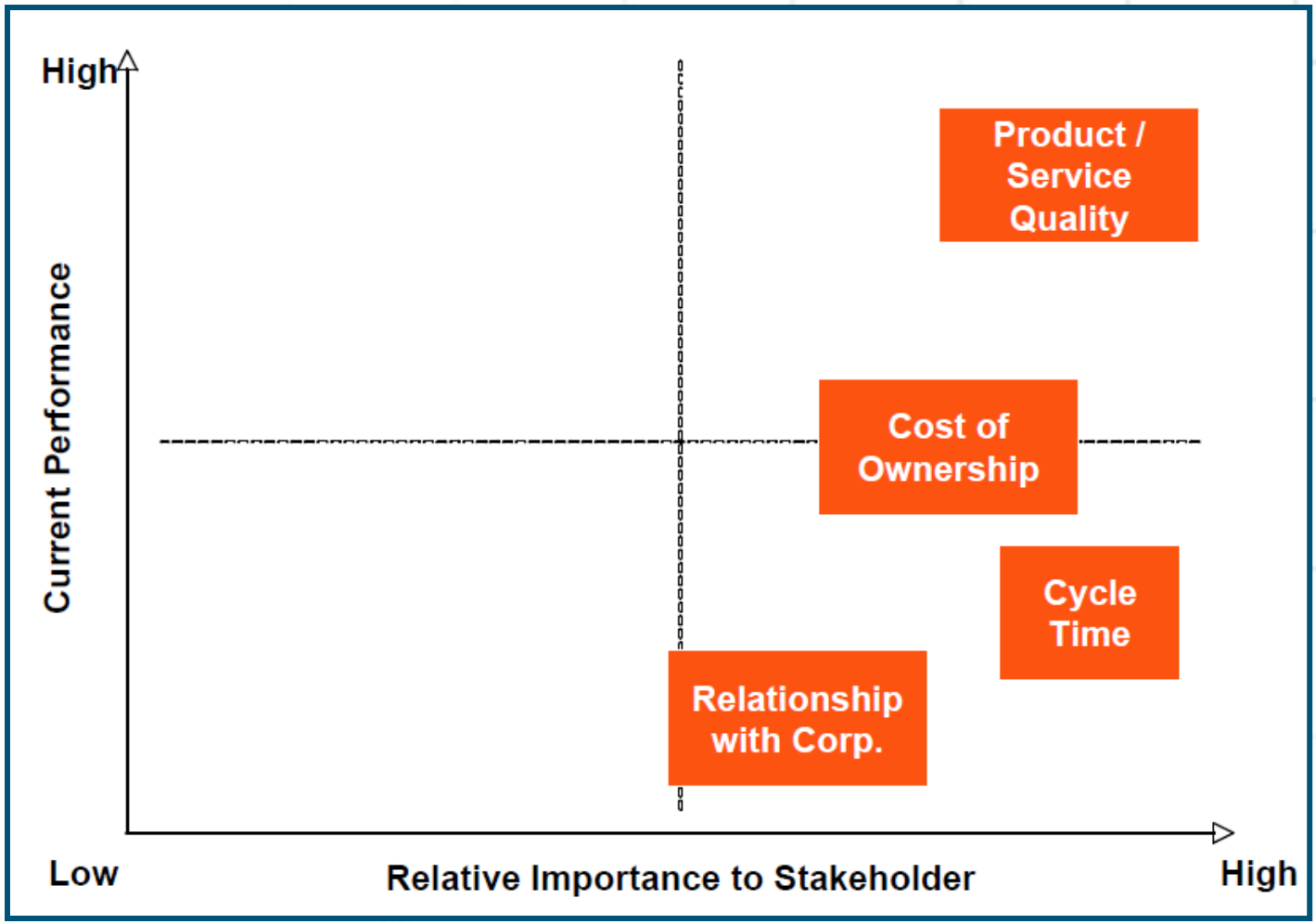
Addresses lack of stability, clarity and completeness of requirements

- How bad are unstable requirements? Very bad!



Source: GAO-11-233SP

Prioritizing value and benefits: Stakeholder Value Delivery Assessment

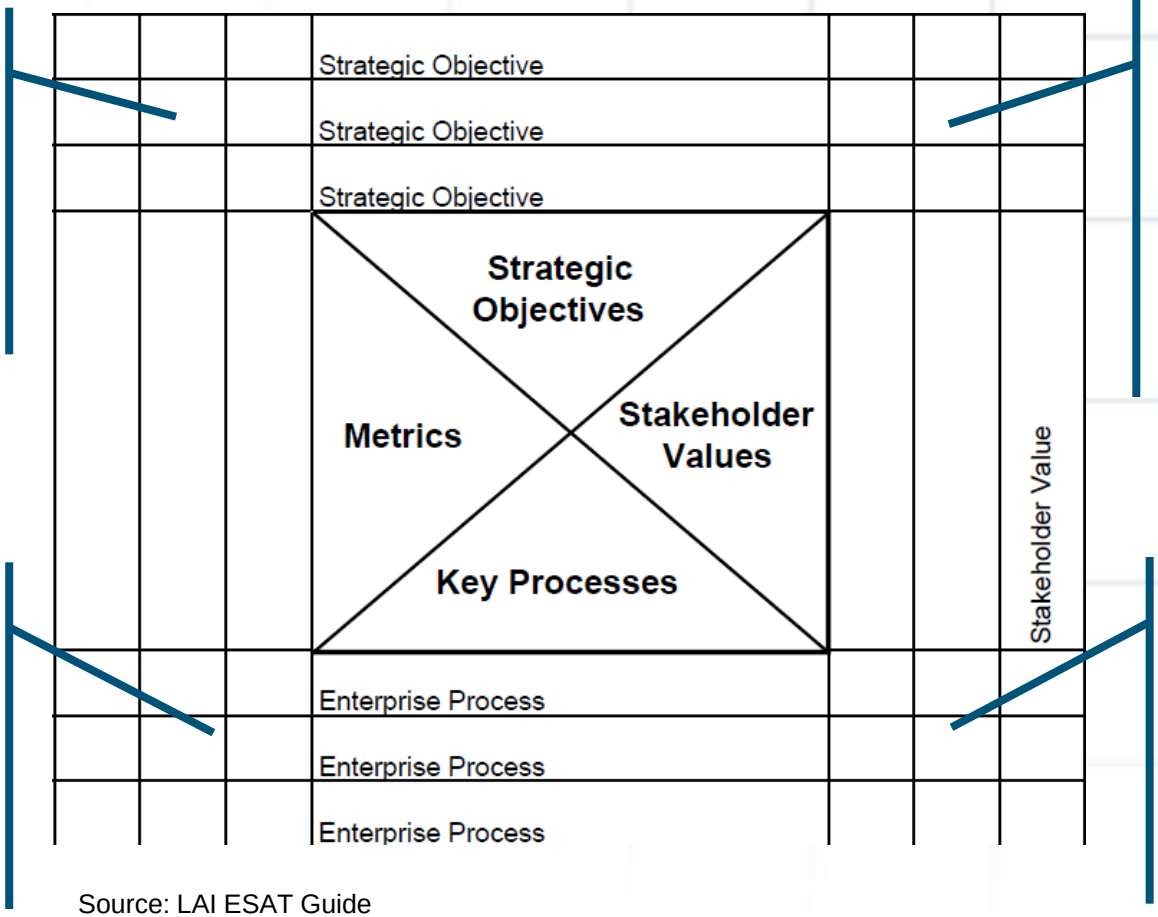


Source: LAI ESAT Guide

Aligning Value and Program: X-Matrix

1. Is this strategic objective measured by this metric?

2. Does this metric measure performance of this process?

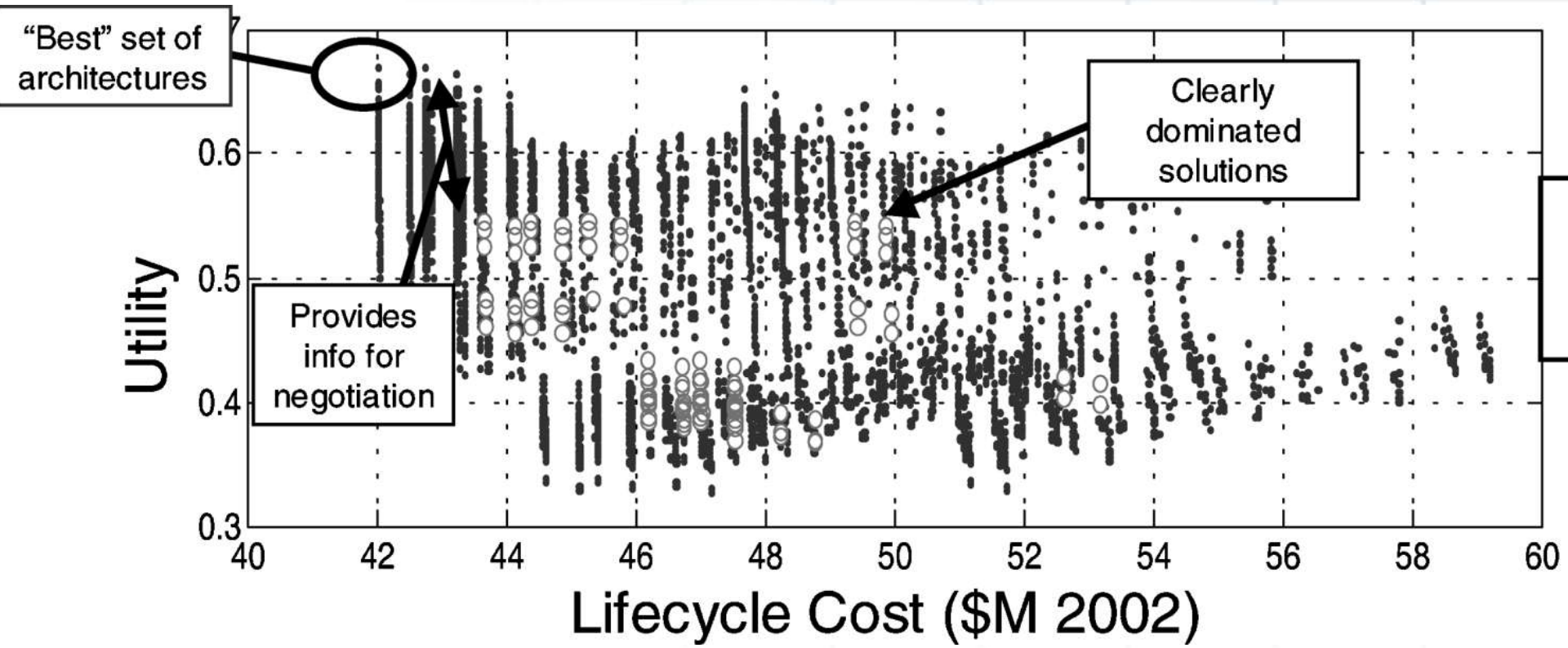


Source: LAI ESAT Guide

4: Is this stakeholder value represented by this strategic objective?

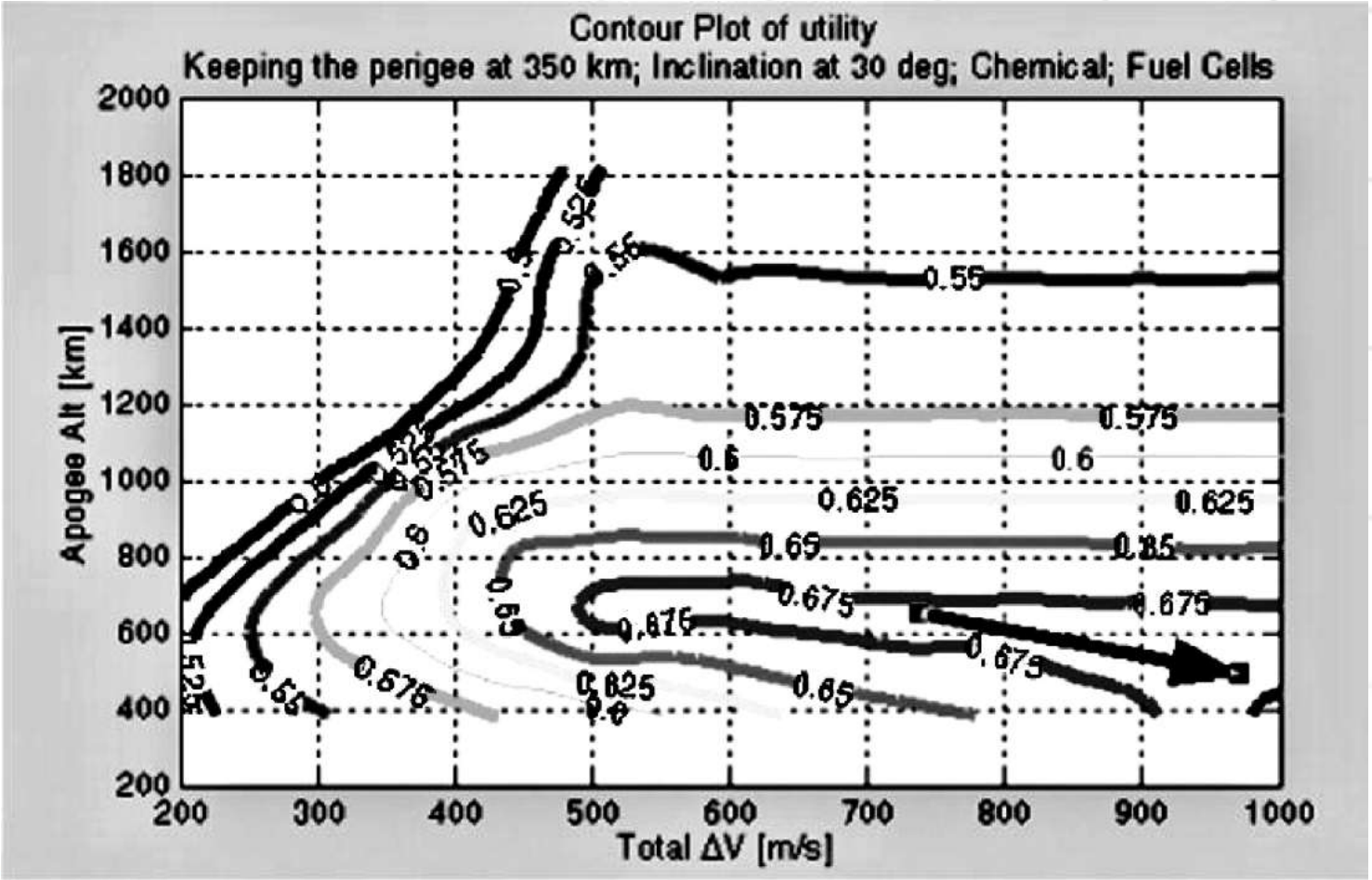
3. Does this process contribute to delivering this stakeholder value?

Trade Space Exploration: Helping your customer figure out what they want



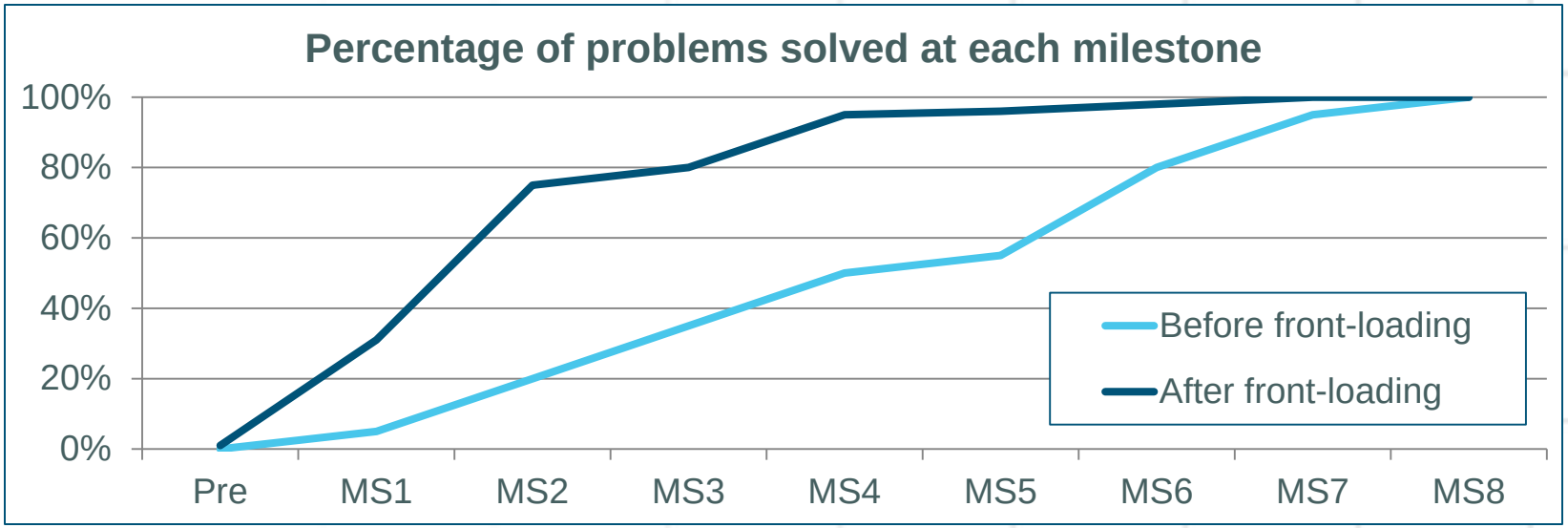
Source: Ross et al 2004

Trade Space Exploration: Helping your customer figure out what they want



Source: Ross et al 2004

Front-loading the engineering programs at Toyota: A 20 year journey



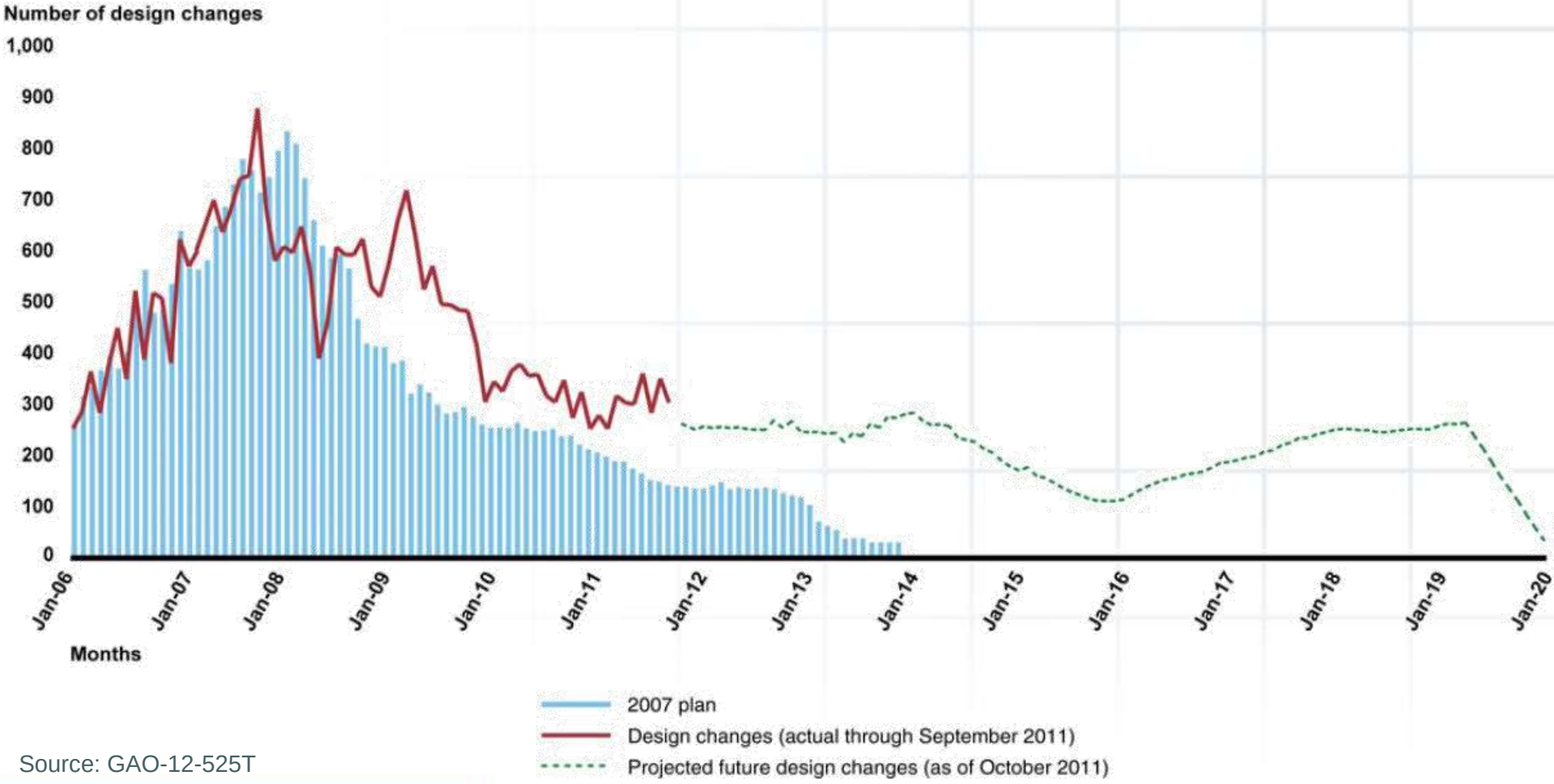
Source: Thomke & Fujimoto 2000

- Project-to-project knowledge transfer
- Rapid problem solving
  - Simulation
  - Computer-Aided Engineering
  - (cheap) Rapid Prototyping
  - Concurrent engineering
- Higher resource expenditure at front end

- **Stabilizes requirements**
- **Eliminated prototypes**
- **Avoided costly rework**
- **Reduced lead time**
- **Increased innovation**

… and what happens when you fail: 2x unit costs, ¼ of units until 2017, $140 billion (!) cost growth

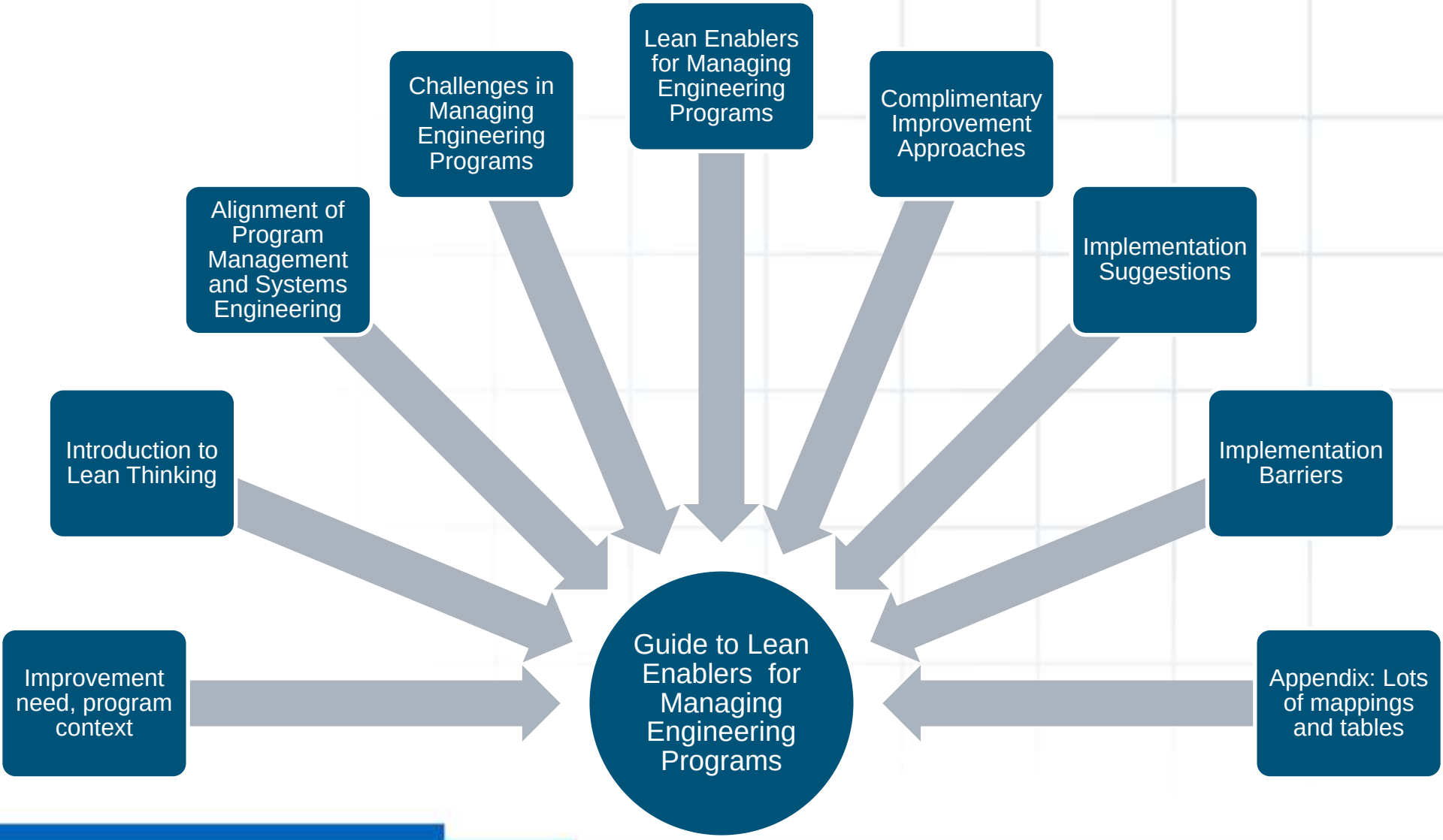
Figure 4: JSF Design Changes Over Time



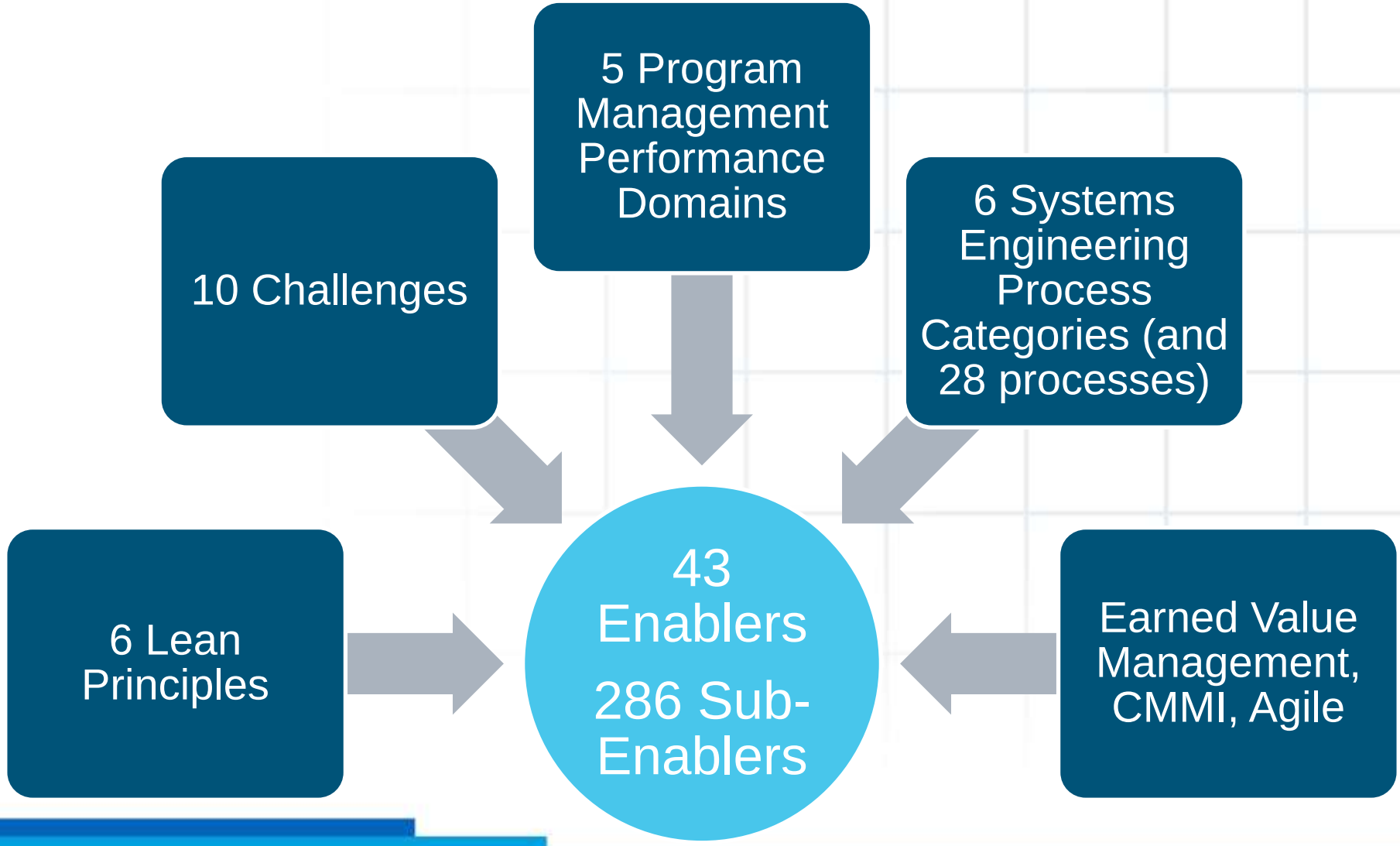
Source: GAO-12-525T

GUIDE TO LEAN ENABLERS FOR MANAGING ENGINEERING PROGRAMS

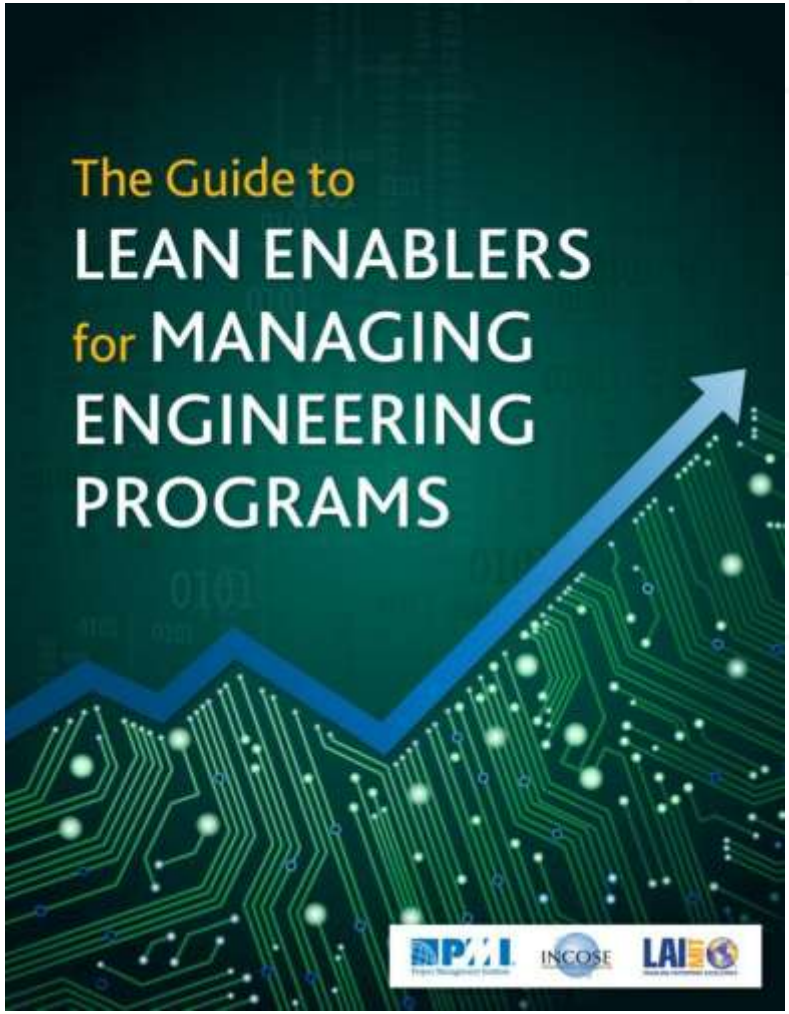
Content of the "Guide"



Finding the Enabler that is right for you: Various mappings



The Guide to Lean Enablers for Managing Engineering Programs

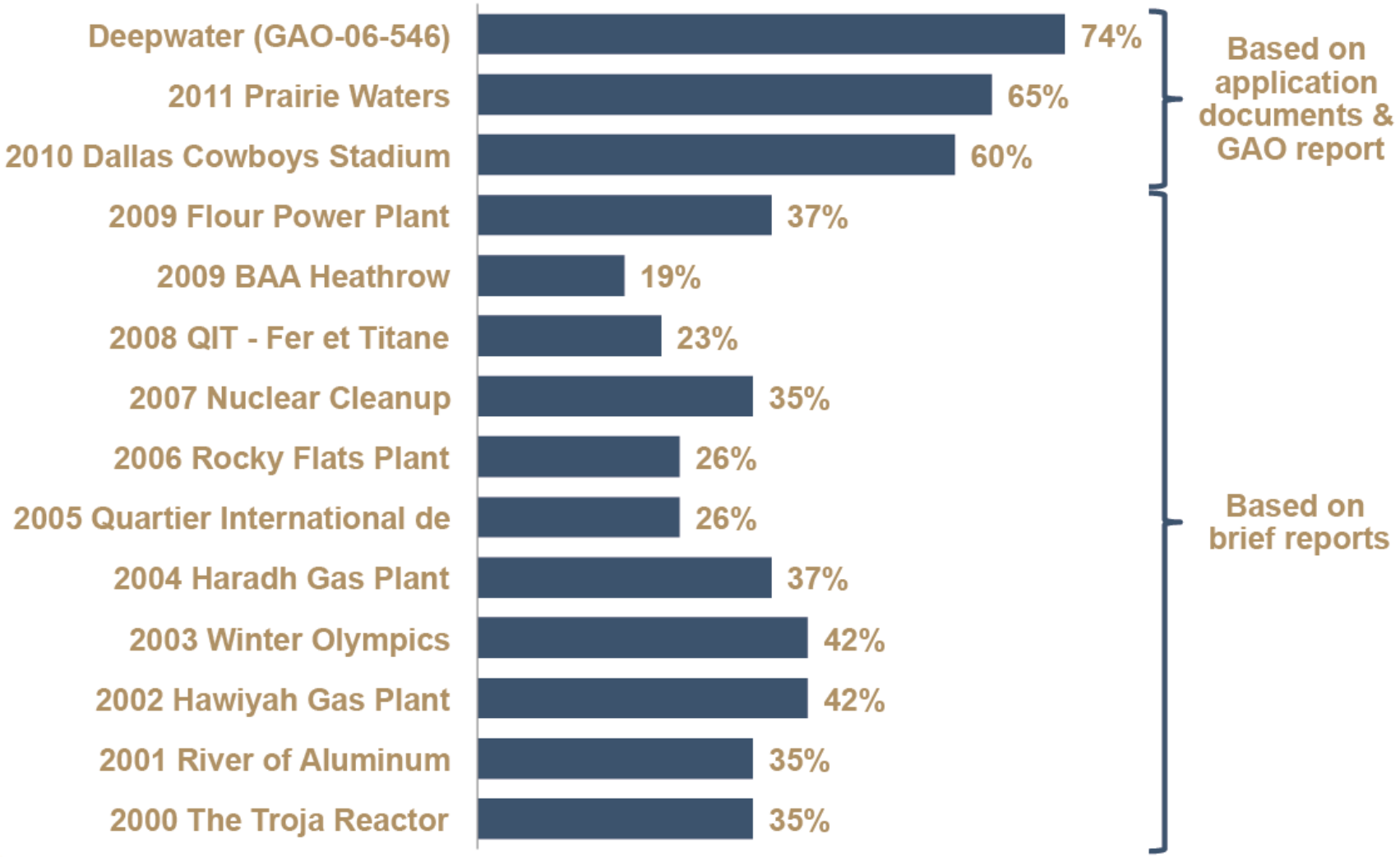


- Almost published!
- Until then: All of this is my personal opinion!
- Want to get an email notification? Sign up at www.lean-program-management.org !

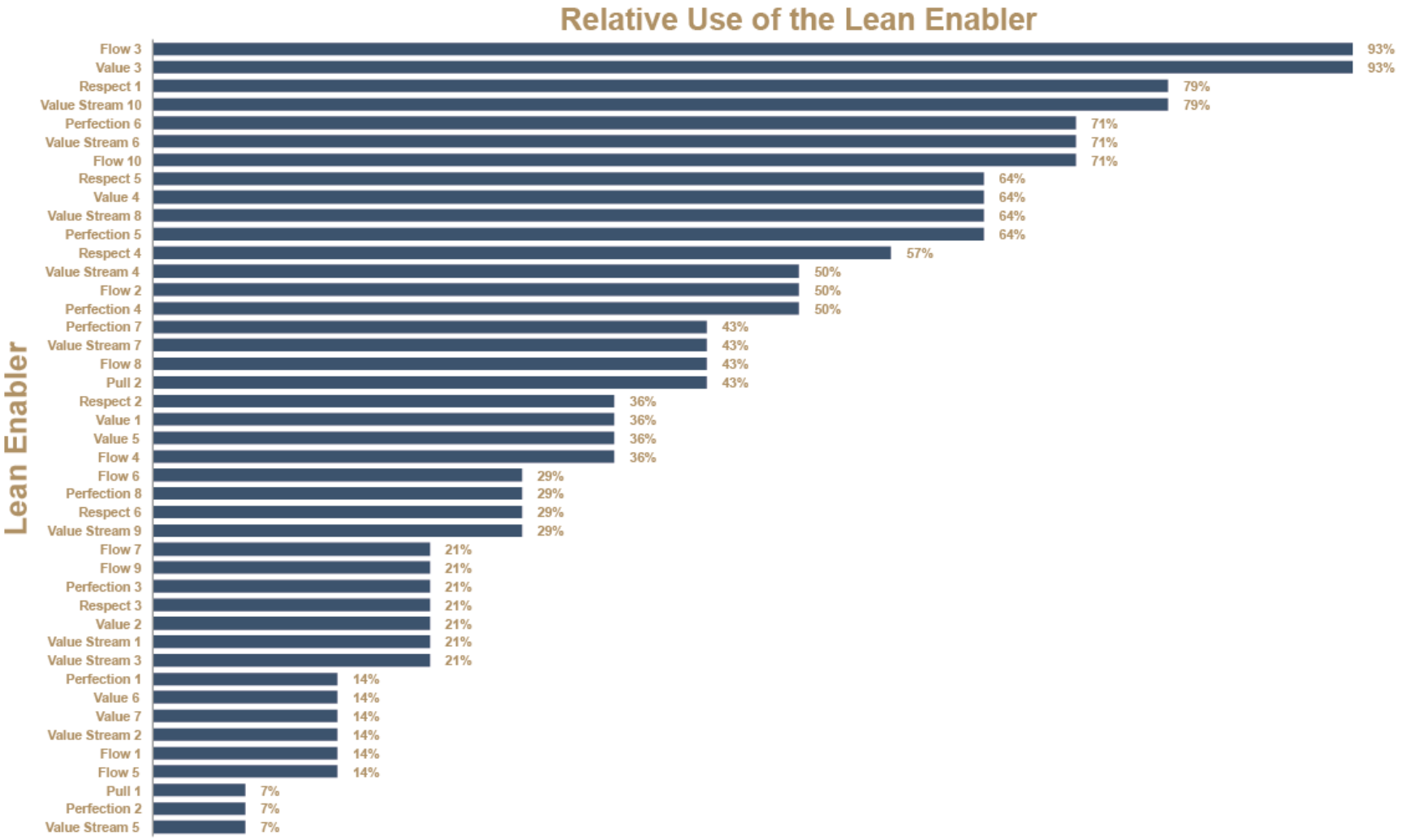
LEAN ENABLERS AND PROGRAM SUCCESS

Content analysis:
PMI Project (Program) of the Year Winners of the last 10 years

Application of Lean Enablers in "Best Practice Programs"– The more detailed the reports, the more Enablers we found



Every Lean Enabler was used at least once



Most popular vs rarely used enablers

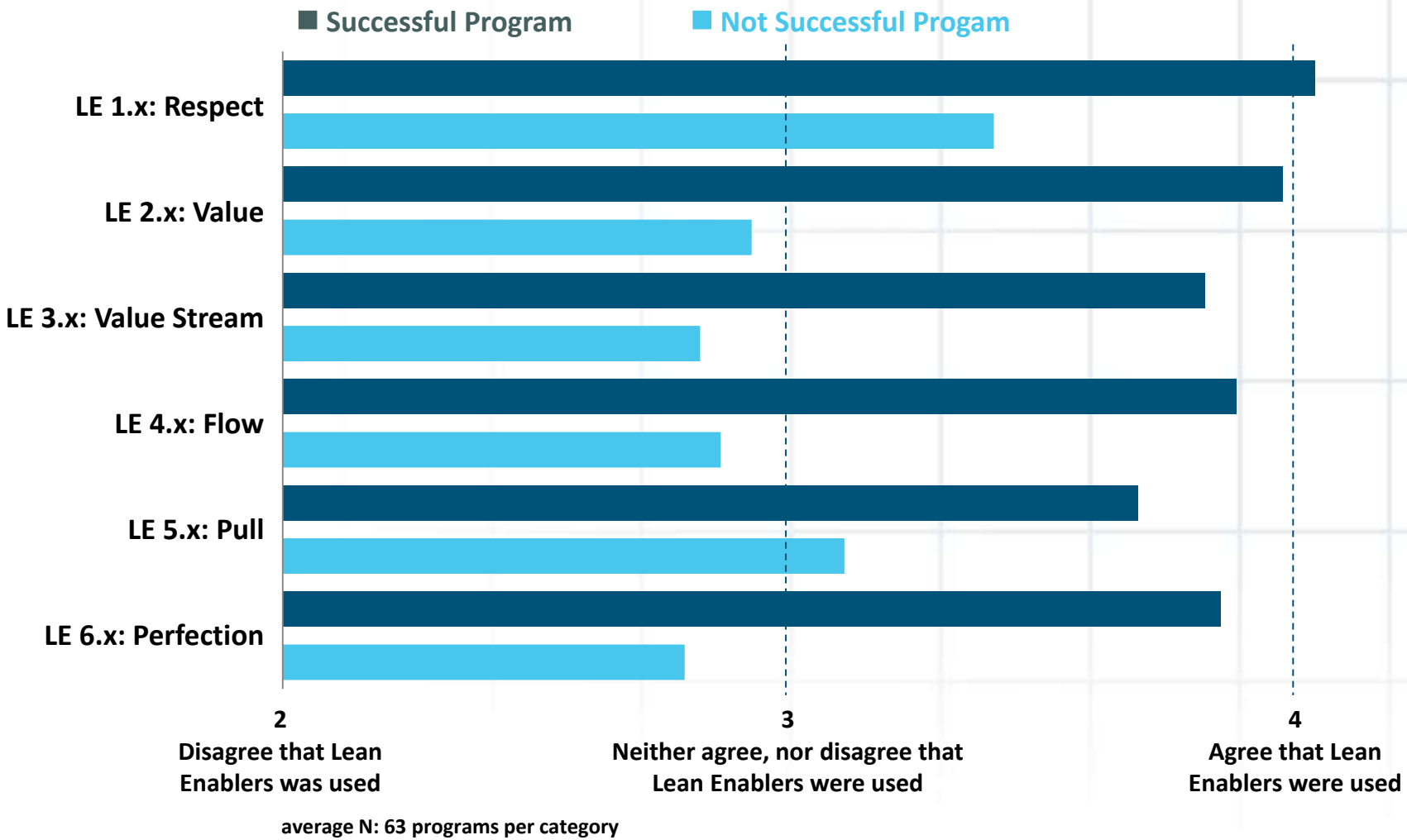
Almost always found

- Build a program culture based on respect for people
- For every program, use a program manager role to lead and integrate program from start to finish
- Frequently engage the stakeholders throughout the program lifecycle
- Develop a Communications Plan

Rarely found

- Pull tasks and outputs based on need, and reject others as waste
- Pursue Lean for the long term
- Use probabilistic estimates in program planning

Use of Lean Enablers in Successful and Unsuccessful Programs: Level of Agreement of Respondents



average N: 63 programs per category

IMPLEMENTING THE LEAN ENABLERS: THE ROAD AHEAD

Implementing Lean Enablers: Year 2 Plan

- Training and teaching material
- Smart metrics
- Extended documentation

Thank you!

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Sign up at www.lean-program-management.org !