

Lean Management of Complex Programs **= integrated Lean + SE + PM**

INCOSE IW Transportation WG
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Bohdan "Bo" W. Oppenheim is a Professor of Systems Engineering at LMU. He is the founder and Co-Chair of the Lean Systems Engineering Working Group of INCOSE, co-leader of the effort developing Lean Enablers for Systems Engineering, author of *Lean for Systems Engineering with Lean Enablers for Systems Engineering* (Wiley, 2011) and the second author of the *The Guide to Lean Enablers for Managing Engineering Programs* (INCOSE, PMI, MIT LAI, 2012). His engineering degrees include Ph.D., Southampton, U.K.; Naval Architect, MIT; MS, Stevens Institute of Technology; and B.S. (equiv.) from Warsaw University of Technology in Aeronautics. His credits include five books, 20 journal publications, \$2.5 million in externally funded grants, and a 30 year industrial and consulting experience spanning naval, space, software and mechanical engineering. He is the recipient of 2011 Shingo Award, 2012 Shingo Award, 2010 INCOSE Best Product Award, 2011 Fulbright Award, and 2008 LACES Best Teacher Award. IAE Fellow. Lives in Santa Monica, California. Two sons. Ocean sailor. Collector of modern art.



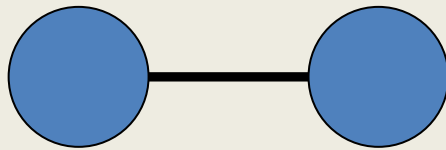
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1. Back to Basics: Why do we need SE?

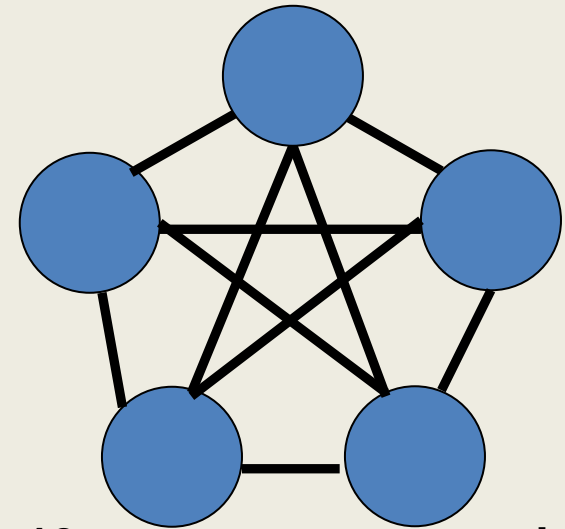
Back to basics: Why do we need SE?

Simplest system: $N = 2$



1 connection

Slightly more complex system: $N = 5$



10 one-to-one connections

becomes

$$\frac{N(N-1)}{2}$$

J.Thomas, INCOSE

With millions of parts, tens of thousands of people in hundreds of cooperating firms...both traditional engineering and management fail.

They usually fail in *soft* areas (interfaces, human factors, lack of coordination, lousy requirements...)

What is Systems Engineering?

- SE must involve huge amount of careful human coordination, communication, great human relations and great holistic thinking
- This is done terribly inefficiently
- Driven by sick incentives from defense programs

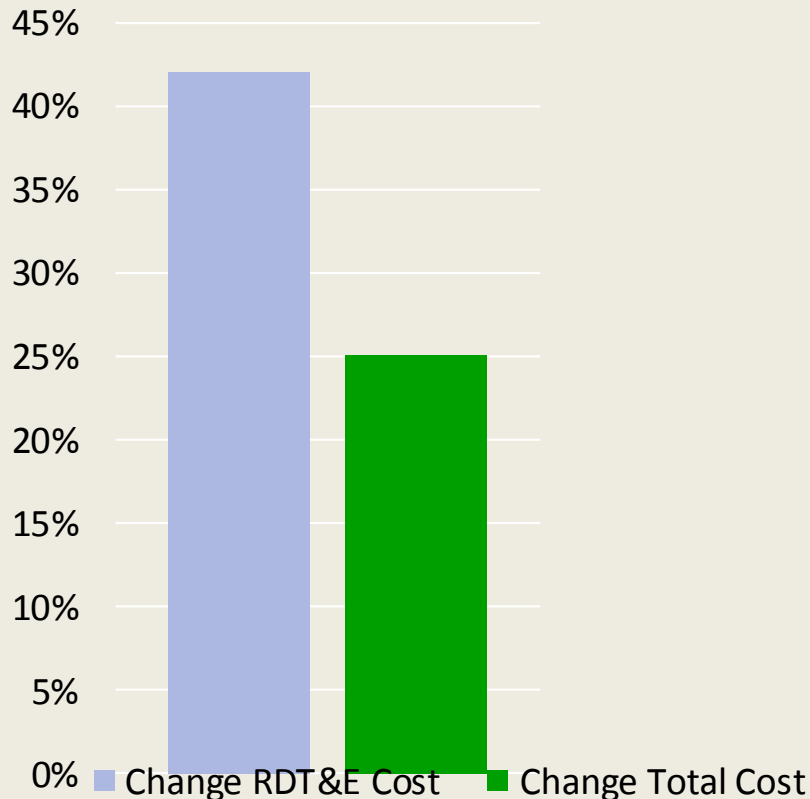


J.Thomas, INCOSE

2. Staggering Amount of Waste in Programs (for which SE is unjustly blamed)

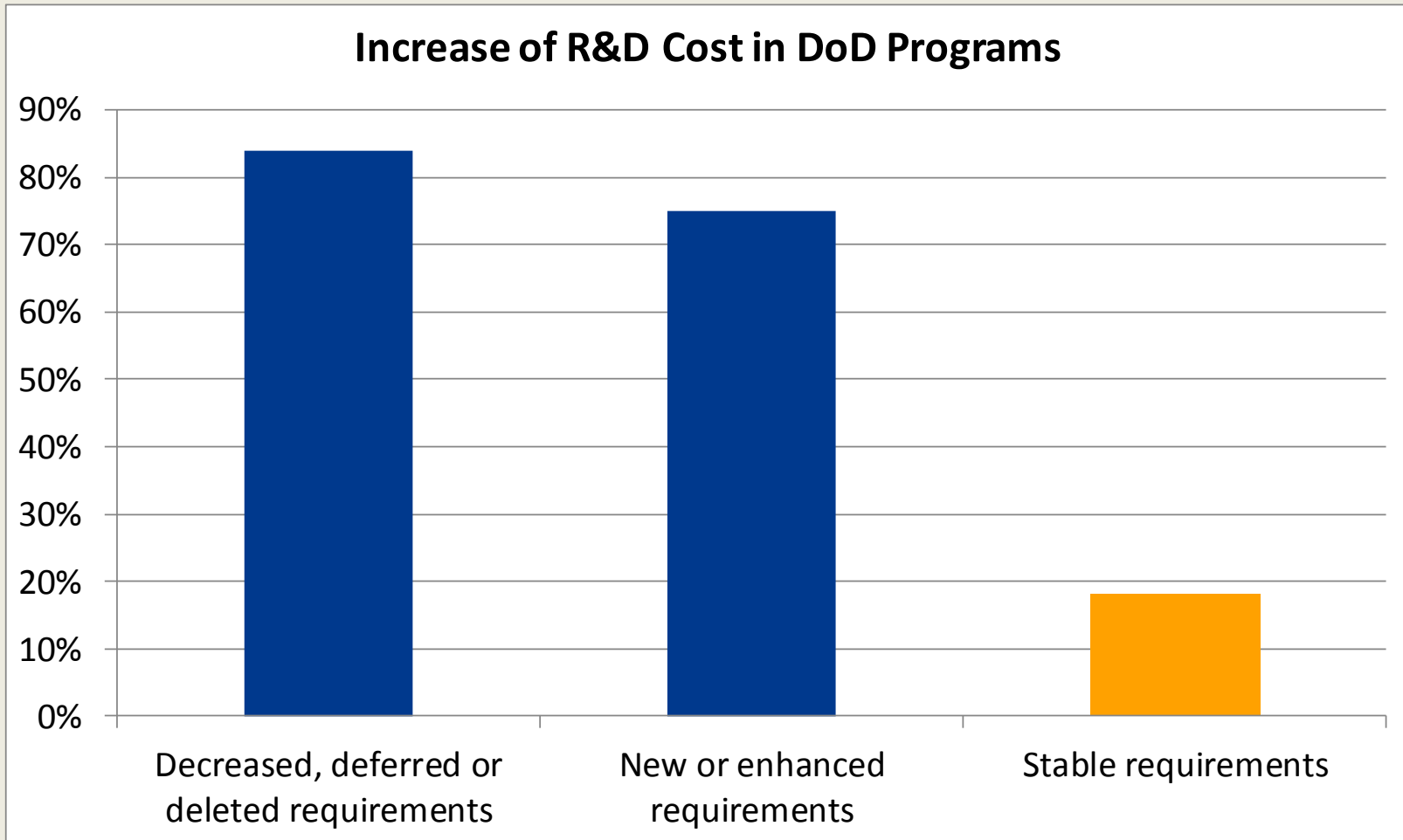
The Amount of Waste is Staggering...

US Department of Defense
Development Portfolio –
Change to initial estimate (2008)



- Total cost growth: **\$300+ billion**
- Average schedule overrun: **22 months**
- A number of major programs terminated for lack of progress

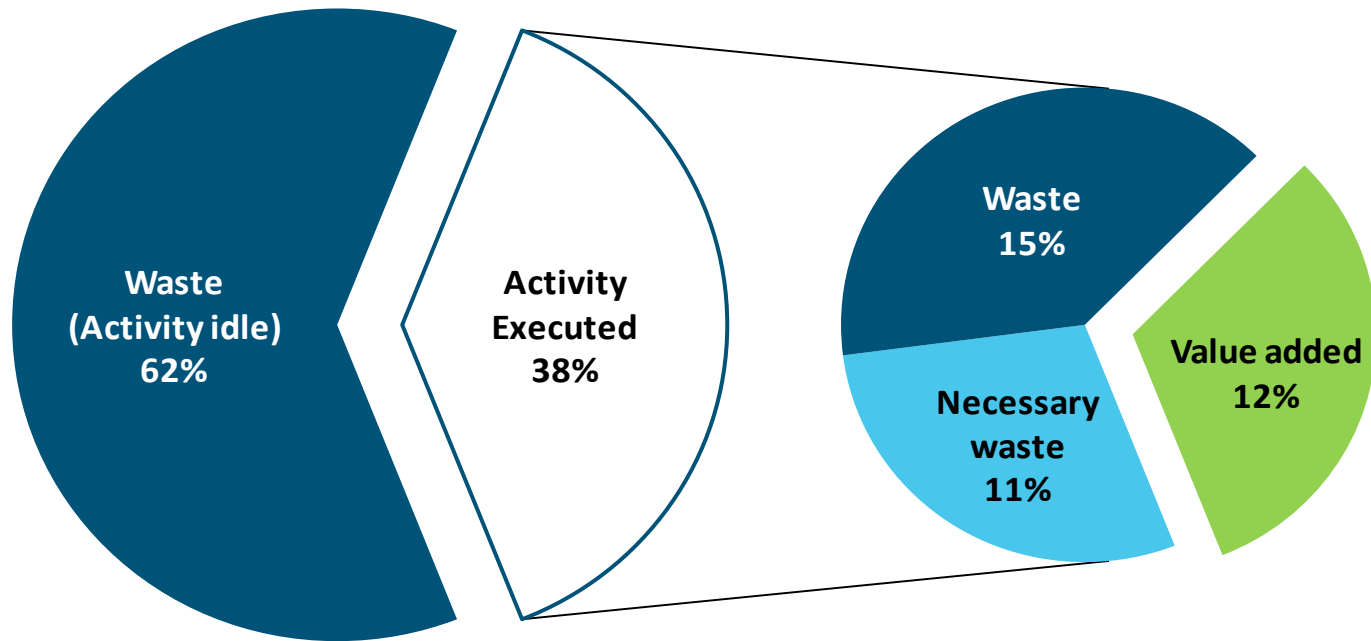
How bad are unstable requirements?



Source: GAO-11-233SP

Average of 88% of Productivity Reserve in Programs

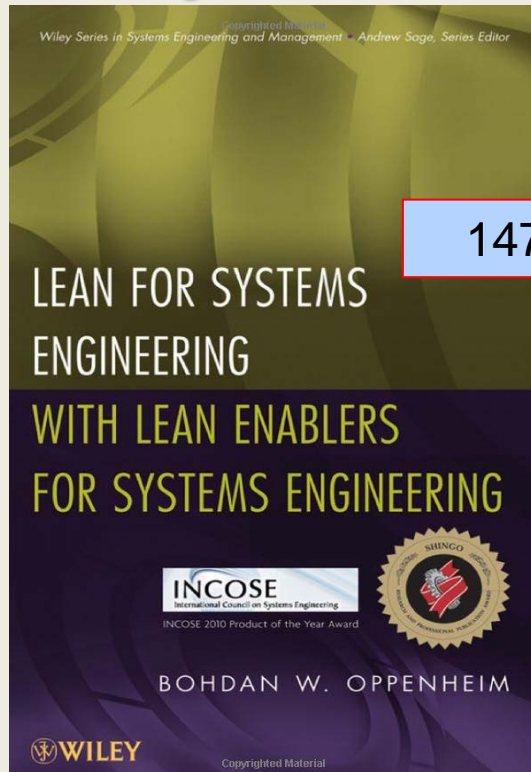
Time share of different types of activities in Engineering Programs



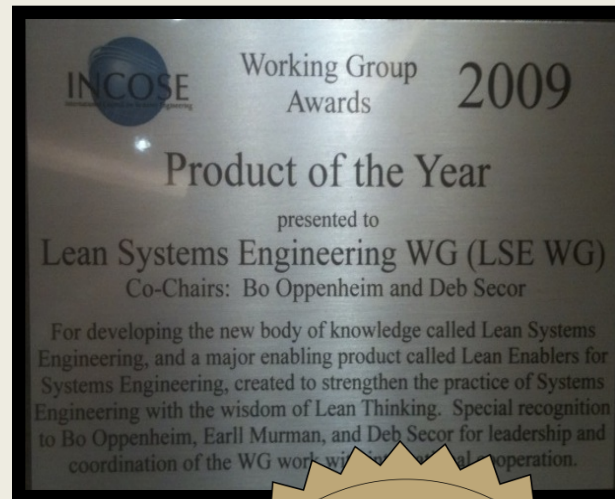
Source: McManus, 2005, Oppenheim, 2004

3. The Remedy: Lean Management of Engineering Programs

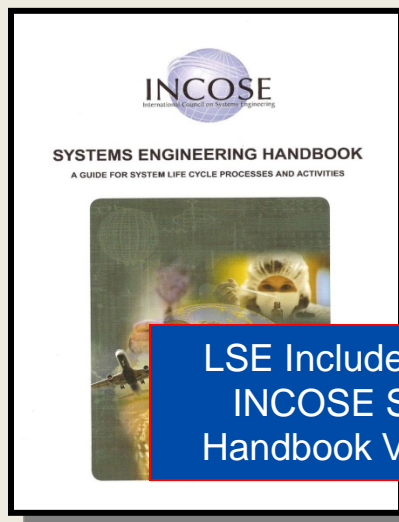
Project 1: INCOSE 2006-2010, Lean Enablers for SE



147 Lean Enablers



Fulbright
Award



Four Prestigious Awards

50 worldwide lectures, seminars

U.S:

- The Aerospace Corporation (2)
- Am. Soc. Manufacturing Engineers
- Boeing Lean Conference
- Booz Allen Hamilton
- LMU (8)
- INCOSE, USA (8)
- INCOSE-wide webinar
- Lean Software and Systems Symposium
- MIT LAI Knowledge Exchange Event
- Naval Postgraduate School (2)
- Northrop Grumman
- Partners in Business, Utah State Univ.
- Rockwell Collins, Cedar Rapids (4)
- Stevens Institute of Technology

OVERSEAS:

- China: CETCA
- China: Shanghai Jiao Tong University
- Finland: Int. Conf. Lean Ent. S/W & Sys.
- France: EADS and AFIS
- Israel (3)
- Norway: Kongsberg Defense Systems
- Norway: Industrial Forum of Kongsberg
- Poland (7 Universities, Academy of Sci.)
- Sweden: EuSec
- UK: University College, Thales
- Italy: Bari, Rome, Milano Polytechnics
- Moscow

Project 2: Lean Enablers for Managing Engineering Programs



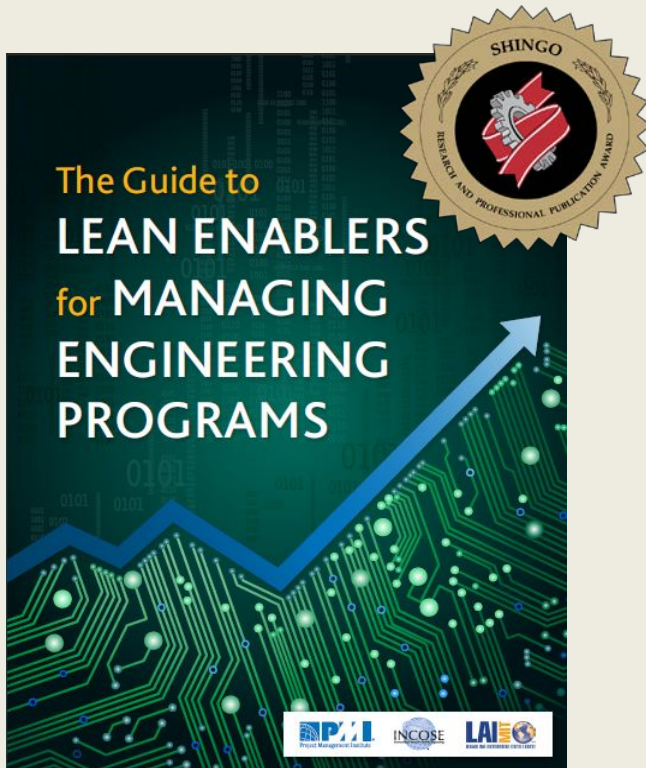
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= Lean + PM + SE



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 and [INCOSE](#)

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LEfMEP Developed by 15 experts and 180+ practitioners representing 35+ organizations

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Comprehensive INCOSE Lean SE WG web page

- **Public site: www.incose.org**
 - Click on Technical Operations
 - Click on Lean Systems Engineering

- **Products posted:**
 - Charter and organization
 - Presentations
 - Book description, book review, e-interview
 - Articles from Journal of SE, INSIGHT, CrossTalk:
 - Chapter in INCOSE SE Handbook
 - Brochure
 - Quick Reference Guide
 - Video
 - Conference Presentations and position papers

4. Sample Lean Enablers

(14 selected from the total set of 326)

Sample Lean Enablers

- 1.5.2. Provide easy access to knowledge experts as resources and for mentoring, including "friendly peer review."
Extraordinary acceleration of learning curves.
- 5.1.6. For non-routine tasks, avoid rework by coordinating task requirements and details with internal customer.
How much rework saved? You know best.
- 6.3.3. Promote excellence under "normal" circumstances and reward proactive management of risks, instead of rewarding "hero" behavior in crisis situations.
- 6.7.2. Use concise one-page electronic forms (e.g., Toyota's A3 form) for standardized and efficient communication, rather than verbose unstructured memos.
- 2.5.8. Create effective channels for clarification of requirements.
Written requirements are almost always imperfect!!!!
- 3.2.1. Keep activities during early program phases *internal* and *co-located*, as there is a high need for coordination.
Just look at SpaceX!

Sample Lean Enablers

- 3.3. Pursue multiple solution sets in parallel
Just study the Toyota PD! Their design cycle time is 3-4 shorter than the competition! They avoid iterations!
- 3.5.15. Heavily involve the key suppliers in program planning and at the early phases of program.
Seek seamless long-term partnership with commonality of the goals.
- 4.6.3. Seek and maintain independent reviews of the program (particularly the reviews of requirements). Assign teams outside of the program to observe and assess the execution and health of the program. Engage non-advocates in review process.
- 2.4.1. Ensure that the customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need, stable, complete, crystal clear, de-conflicted, free of wasteful specifications, and as simple as possible.
- 2.4.6. Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout.

Sample Lean Enablers

- 3.10. Manage technology readiness levels and protect program from low-TRL delays and cost overruns.
- 3.7.1. Permit outsourcing and subcontracting only for program elements that are perfectly defined and stable. Do not subcontract early program phases when the need for close coordination is the strongest.
Pass only mature, stable, perfect requirements to subcontractors after total design is stable, optimized.
- 1.1.4. Hire people based on passion and "spark in the eye" and broad professional knowledge, not only based on very specific skill needs (hire for talent, train for skills). Do not delegate this critical task to computers scanning for keywords.
Do you select a life partner by scanning for key words?

5. Lean Product Development Flow (LPDF)

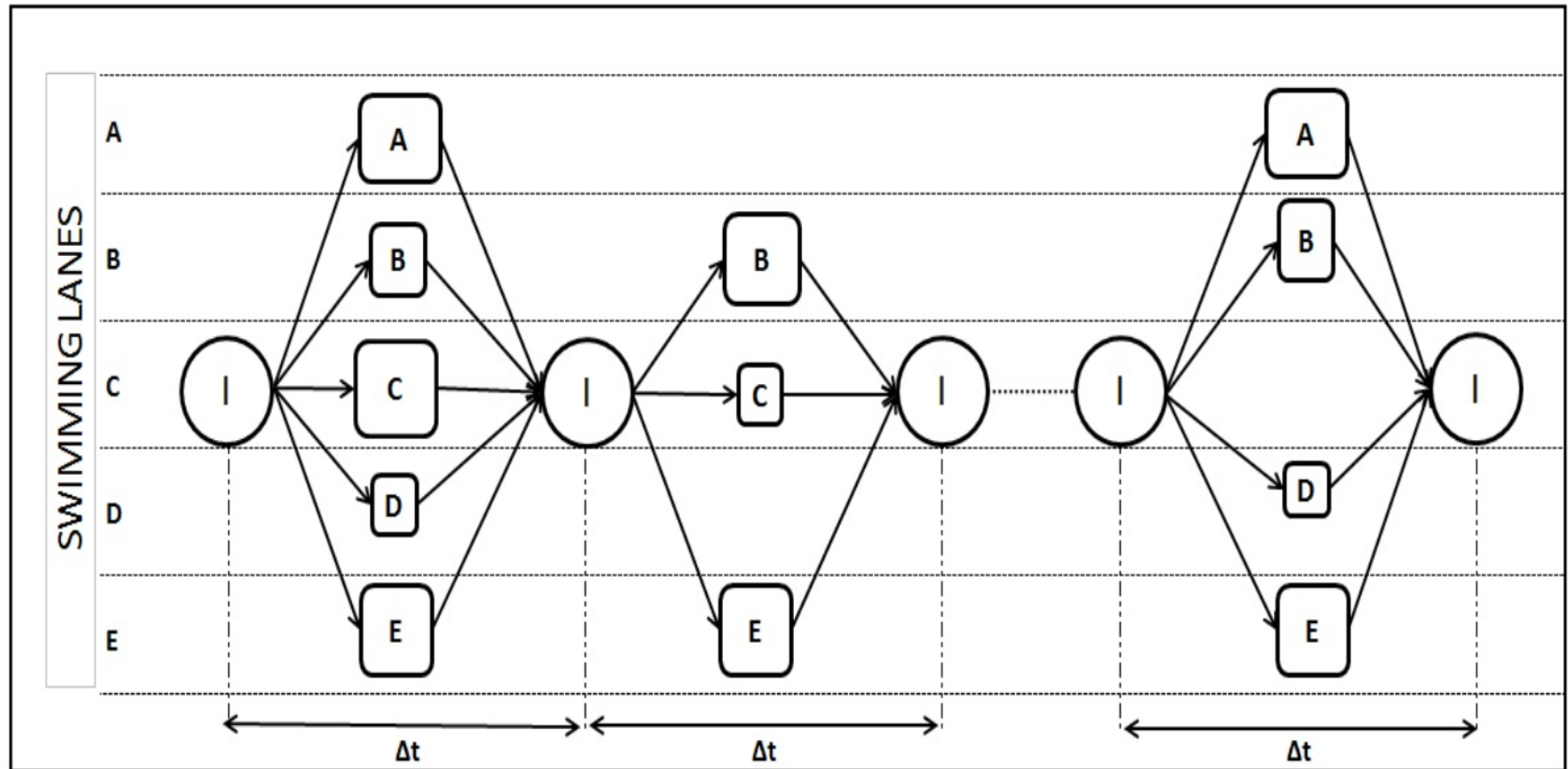
**Hyper-efficient and effective method
for projects**

Lean Product Development Flow (LPDF) Method for Projects

Is it possible to execute one-off projects as predictably and efficiently as a car assembly line?



Lean Product Development Flow (LPDF) Method for Projects



The flow proceeds through the alternating work periods called Takt Periods (short and of equal duration) and Integrative Events “I”, providing common, frequent rhythm and flow to the entire project team.

Summary

Summary

- Properly implemented SE and PM represent great bodies of knowledge.
- Degenerated via sick defense programs
- Remedy is available: Lean Enablers
- Inspired by Lean Thinking: reduce waste while promoting value
- The Enablers capture the wisdom and experience of top world experts in programs and projects
- The enablers mostly deal with human aspects, rather than algorithmic!

So, Lean does not mean this...



Or this...



Non-Lean Programs are a monstrous wasteful overkill



Q&A

Backup Chart

Validation of LEfMEP in PMI “Best Practice Programs” – The more detailed the reports, the more Enablers we found

