Lean SE: Who Can Afford to Ignore it?

Moderator: Deborah Secor, Rockwell Collins, USA
Panelists: Bohdan "Bo" W. Oppenheim, LMU|LA, USA
Niels Malotaux, N R Malotaux – Consultancy, Netherlands
Hillary Sillitto, Thales Land & Joint Systems Division, UK
Avigdor Zonnenshein, RAFAEL, Israel

Abstract

In the last several years the emerging field of Lean Systems Engineering has matured to a actionable body of knowledge. The Lean SE Working Group of INCOSE is one of the fastest growing Working Groups, now at 115 members. In 2009, 14 experts from the WG released a major product called Lean Enablers for Systems Engineering (LEfSE). It is a list 194 best SE practices, the do's and don'ts of SE.

SE is regarded as a sound practice but not always delivered efficiently. Lean SE applies the wisdom of Lean Thinking, the management paradigm of hugely successful Toyota, to SE.

Lean SE does not mean "less SE"; it means "more SE, better SE, for streamlined execution of the program". The Value in Lean SE is "Flawless Mission Assurance delivered with minimum waste in the fastest possible time".

The four panelists will present differing perspectives on Lean SE, and the challenges that inhibit the implementation.

1) A summary of Lean SE and LEfSE
2) Human behaviors that inhibit Lean implementation
3) The need for urgency in applying Lean, and open questions;
4) Experiences from applying Lean elements in SE

The presentations will be followed by a short discussion among the panelists, and by a Q&A session.

Biographies

Moderator

Deb. SECOR, Principal Project Manager, Lean Master, Rockwell Collins. Key lead of enterprise Lean Electronics mentoring and implementation for Rockwell Collins; an initiative recognized throughout the aerospace industry. Supported LAI "Lean Now" projects and training for the Air Force. Enthusiastic contributor in the improvement and delivery of the teaching simulation for Lean Enterprise Product Development, developed by McManus and Rebentisch. Presented Lean Product Development and Knowledge Management Strategies papers at various LAI, AME and AIAA conferences. Areas of specialization: Lean, Engineering/Intellectual Property Development and Enterprise Value Stream Mapping, Business Integration and Process Improvement, Knowledge Management, and Change Management. Member of INCOSE, LAI. Resides in Cedar Rapids, IA. Interests include horses and all things outdoors.

Panelists

Bohdan W. OPPENHEIM

- Professor of Mechanical and Systems Engineering at Loyola Marymount University, Los Angeles
- Graduate degrees from MIT, SIT, PhD from Southampton University in UK, undergraduate degree from Warsaw Technical University (eqv.).
- Graduate Director of Mechanical Engineering
- Fellow, Institution for the Advancement of Engineering
- Former Director of the US Department of Energy Industrial Assessment Center, assessed 125 plants for Lean manufacturing
- "Lean Product Development Flow", Journal of Systems Engineering, 7 (4), 2004
- 15 years of industrial experience (Northrop Electronics, The Aerospace Corporation, Global Marine, consultant to 50 companies in U.S. and Europe.
- Lead Instructor of Lean Advancement Initiative EdNet Lean Academy.

Niels MALOTAUX is an independent Project Coach specializing in optimizing project performance. He has over 35 years experience in designing electronic hardware and software systems, at Delft University, in the Dutch Army, at Philips Electronics and 20 years leading his own systems design company. Since 1998 he devotes his expertise to helping projects to deliver Quality On Time: delivering what the customer needs, when he needs it, to enable customer success. To this effect, Niels developed an approach for effectively teaching Evolutionary Project Management (Evo) Methods, Requirements Engineering, and Review and Inspection techniques. Since 2001, he taught and coached over 100 projects in 25+ organizations in the Netherlands, Belgium, China, Germany, India, Ireland, Israel, Japan, Romania, South Africa and the US, which led to a wealth of experience in which approaches work better and which work less in the practice of real projects.

Hillary SILLITTO graduated in Physics from St Andrews University in 1976, and started his career with Ferranti (now Selex) in Edinburgh as an optical engineer. He worked on many laser system projects, developed design, integration and test techniques for multi-spectral optical systems, led the optical design team for the UK's first airborne multi-spectral electro-optical pod (which involved successfully resolving several key issues and risks to transition new technologies into a production and in-service environment), and played a key role in developing the company's infra-red countermeasures business.

He moved to Thales Optronics in Glasgow in 1993, contributing to the strategy and early definition for many of the current generation of its products, and subsequently held appointments as Chief Systems Engineer and Chief Engineer. He was active in the international Thales Systems Engineering network, contributed to the development of the Thales Systems Engineering Method (SysEM), deployed Requirements Management and piloted UML system modelling techniques in Thales Optronics, and wrote a guide on Product Line Architectures.

Seconded to Thales UK Corporate in 2003-4 as Engineering Director Prime Contract Support, he made important inputs into major bids and programmes including Soldier Systems, the Future Carrier, UAV and C2 systems, and led the development of the Systems Engineering part of the Thales Prime Contract Management Handbook and associated training. From 2005 to 2008 he was seconded to UK MOD as head of the Integration Authority, responsible for managing system-of-systems interoperability across the whole scope of the MOD's acquisition programme and promoting the development of systems engineering skills and culture in the acquisition organisation. He then became the Chief systems Architect for Thales Land & Joint Systems Division in the UK and on 31st March 2009 was appointed Systems Engineering & Architects (SEA) manager for the UK part of the division.

He has been a member of INCOSE since 1996. He contributed to INCOSE's Systems Engineering 2020 Vision, and presented 5 papers at INCOSE International Symposia from 1999 to 2009, winning a Best paper award in 2005. He was president of INCOSE's UK Chapter from 2004 to 2006. He was lead author of the UK Chapter's "Systems Engineering Annual State of the Nation" report published in June 2009, which aimed to baseline the national systems engineering capability, and played a key role in establishing effective INCOSE engagement with other professional bodies to move forward the systems engineering professional recognition agenda in the UK. He has submitted 9 successful patent applications, is a Thales Expert, a Chartered Engineer, a Fellow of the Institute of Physics, and a visiting Fellow at the University of Bristol. He was elected an INCOSE Fellow in 2009.

Dr. Avigdor ZONNENSHAIN is currently the Senior Research Associate, Ordnance & Protection Division, at RAFAEL – Advanced Defense Systems Ltd, Israel.

Dr. Zonnenshain is a Ph.D. for Systems Engineering from the University of Arizona, Tucson.

Formerly, Dr. Zonnenshain holds several major positions in the quality and System engineering arena:

- Director for Quality & Productivity of RAFAEL.
- Director of the Quality of Excellence Center, in the Prime Minister Office.
- Director of Quality & Certification Department, in the Standardization Institute of Israel.
- The first president of the World Quality Council (WQC).
- Director of Systems Department , RAFAEL
- President of INCOSE_IL

Dr. Zonnenshain is an active member of the Israel society for quality (ISQ).

He is the leader of the assessment team for the National Quality Award for Industry. He is the chairman of the standardization committee for management & quality. He is active in the community as the chairman of steering committee of RAFAEL for Social Responsibility.

Dr. Zonnenshain is an active member of INCOSE_IL by chairing several National Conferences for Systems Engineering , by leading several of its committees and by publishing a lot of professional papers. Also, Dr. Zonnenshain is an active member of INCOSE by being highly involved in the International Conferences and several Working Groups.

Dr. Zonnenshain is a senior lecturer in the Technion, the Israeli Technology Institute. He is guiding students for higher degrees in quality, management & Systems Engineering.

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Introductions and Moderation by Deb Secor

Deb will introduce the Lean SE WG, the first major product called Lean Enablers for SE, the panel title, and the panelists, as follows:

1. Lean SE WG: established 2006, 120 members, web page
2. Lean SE: "Non-negotiable Mission Success with Minimum Waste". "Lean SE does not mean less SE; it means more and better SE for streamlined program execution"
3. First Major Product: "Lean Enablers for SE", 3 years in the making, 14 experts, validated by surveys and benchmarking with NASA and GAO studies.
4. Introduction of Panelists
5. Invitation to the attendees to review the displayed materials:
   - Power Point presentation
   - LSE Brochure
   - Desktop QUICK GUIDE TO LEfSE
   - Article in CrossTalk
   - Article in Journal of SE

Position Paper #1 - by Bo W. Oppenheim, LMU|LA

Bo Oppenheim will summarize the progress achieved to-date by the Lean SE WG:

1. The Need: The current SE process is technically sound but inefficient; Examples of recent GAO studies of notorious budget and schedule overruns (3 slides)
2. The Wisdom of Lean Thinking: Value, Waste, Lean Principles (1 slide)
3. Summary of the main product: Lean Enablers for SE (5 slides)
4. Validation of Lean Enablers by surveys ("Important, Awaiting Implementation"), and by benchmarking with NASA and GAO recommendations (2 slides)
5. Implementation (1 slide)
6. Experiences and feedback from 14 workshops delivered so far.

Position Paper #2 - by Niels Malotaux

Organizations (people, development teams, systems engineers, production) applying Lean principles like eliminating waste and optimizing value, can save 50 to 70% of cost and time while increasing the delivered quality, compared with current practice.

How is it possible that most organizations still survive while their competitors are applying Lean? Because most competitors aren't applying Lean. Once there are competitors who learn how to apply Lean and reap the benefits, then we'd better be one of them before we perish in incomprehension.

Now, why is it so difficult to reap these benefits in the first place? Why do we wait until our competitiveness is ridiculed by our customers, by the environment, by climate change, or the availability of resources? Why do we wait until it may be too late?

The reason is, I think, that humans have certain behaviors, which probably were survival strategies in some way at some time, which now impede what we should do to achieve the vast improvement of results, as displayed when applying the Lean practices.

Some typical impedimental elements are:

- No Sense of Urgency
  Apparently our overproduction capacity and wealth is so affluent, that we still can survive while trashing most of our resources by wasting 50 to 70% of what we do. Without a Sense of Urgency, nothing will happen.
- Indifference
  This can have many reasons, like:
  - Minding the shop: a manager can have fear that if he changes something, he cannot keep things in hand. Not changing anything often has the lowest risk, but stalls improvement
  - Resignation by workers, who's improvement suggestions have been ignored time over time

  - People doing their best, being ignored or even obstructed by management, may start using their wits in other quarters, at home, at the sports club, rather than in their work, stalling improvement
  - If people don't benefit themselves in some way from improvements, which means that others do, there isn't much incentive to improve, other than pride of workmanship

- (lack of) Discipline
  To keep doing the right things right all the time requires discipline. Discipline, however, is difficult for most humans. By watching over each others shoulder, helping each other, we can reduce the effect of the discipline problem. Still, this is a constant struggle
- Intuition
  If intuition would be perfect, everything would run perfectly. Everything doesn't run perfectly, so intuition apparently sometimes drives us into the wrong direction. Intuition is fed by experience, so new experience can create better aligned intuition, improving our results
- Fear of Uncertainty
  In order to improve, we have to change. Change creates uncertainty at first. People (subconsciously) don't like uncertainty and hence seem reluctant to change. Coaching (which is the first task of the manager) can help to tolerate the uncertainty temporarily, helping people quickly find out that the change is actually an improvement also for them
- Fear of Perceived Weakness
  Changing something to improve may seem admitting that until now we did something not so well.
- Fear of Failure
  People make mistakes and we are people. Therefore, when we've done something, we've made mistakes, causing problems now or later. Making mistakes is often perceived as weakness, causing disapproval of peers, superiors, and/or subordinates. Fear of disapproval and the consequences, causes that we, as a survival strategy, have leant to hide our mistakes. If we don't *use* our mistakes to do root cause analysis to make sure we learn how never to make the mistake again, then we're doomed to repeat the same mistakes, perpetuating the waste. Root cause analysis will also benefit others, because they are probably making similar mistakes as well.
  To admit and acknowledge our failures openly is a first step to doing something about them and it also allows others to help us to find solutions to improve. The strong reaction of management on failure may be caused by fear of consequential failure by management themselves. This is a pattern of counter intuitive reactions, making things worse rather than better.
- Perceived lack of time
  The Lean principles are there to do more in less time. If you don't have time now, you won't have time later either and you're probably wasting a lot of time, putting your head in the sand, hoping that things will magically improve. They won't.
- (lack of) Zero Defects attitude
  We think we don't have time to do things right the first time but when things go wrong we have all the time to do things over. Higher quality is usually perceived as being more expensive. In practice, however, quality is faster and cheaper. Again a strong counter-intuitive effect hindering improvement.
- Ignorance
  Humanity can learn from each other, so that we don't have to reinvent the wheel every time ourselves, saving a lot of time. If we don't know how to define and optimize value and minimize waste, we didn't get adequate education. After all, the basic principles are known for ages, at least practiced and proven for many decades, so there is no excuse for ignorance. If we are still ignorant it's a deficiency of the education system and of management. Ignorance creates good-willing amateurs.
- Incompetence
  It's incompetence if we *know* that applying the Lean principles, like defining and optimizing value and minimizing waste, saves more than half of the cost and time and then *keep ignoring it*. Incompetence is unprofessional. How come that in a lot of industries so many projects fail, where there is no reason for failure other than incompetence. We may have to call this lack of education as well, assuming that we are addressing *good willing* amateurs. If this isn't recognized and rectified by management, it's incompetence of management, because the first duty of management is to enable the workers to do their work professionally and well.
- Politics
  Good politics are that people openly base decisions on rightfully different choices. Bad politics are

hidden agenda's: people say this and mean that, supporting private purposes rather than the benefit of the whole. Who do these people think they are that they can misuse their position for personal benefit, while being paid by us (civil servants, defense, or through the products we have to overpay)? Bad politics strive by vagueness, so providing facts can make most of the bad politics evaporate. *If* we provide and publish the facts.

All these issues, however, require understanding and acknowledgement by both workers and management, which, in practice requires education or coaching until they aren't issues any more.

One of the things we can do to quickly improve is not to intuitively jump into doing whatever we think we have to do, but always first think of how we can do it more effectively and more efficiently. More than half of what we do will later prove not to have created value. Recognizing this in retrospect is nice for learning, but doesn't save time (and hence cost) any more, as the time is already spent and can never be regained. The only way to save time is to *foresee* based on our wits and on what we've learnt already, to actively and constantly minimize the time spent that will later prove not to have created value, by not spending time on it.

In this panel we'd like to create more awareness, so that we can combine our efforts to learn to systematically improve the effectiveness and efficiency of whatever we are doing, in this case specifically of our Systems Engineering activities.

Position Paper #3 - by Hillary Sillitto

In manufacturing and development, Lean can save 50-70% of cost and time and increase quality. I have seen this in programmes I have been involved with. There is no reason why similar savings can't be achieved in systems engineering if we apply lean thinking with a correct understanding of value in the different lifecycle phases.

Lean makes sense, but it's difficult to apply. And what is "right first time" is not always obvious in systems engineering contexts. I want to show how to think about value and waste in the early phases of the system and product development lifecycle.

The early lifecycle phases are characterised by high uncertainty, because the problem situation and the range of acceptable and viable solutions are not understood or agreed. Document deliverables required by bids and contracts are sometimes treated as ends in themselves rather than as part of a coherent and integrated process, and become shelf-ware once the customer has accepted them. Decision delays are a major source of wasted time and money, causing waiting and rework

Here are six fundamental principles for applying Lean to systems engineering early in the lifecycle:

- Value is measured by reduction in uncertainty, establishment of consensus, and the quality of evidence required to support effective decisions
- Whether work products are fit for purpose is defined not by the person who did the work, but by the person who will use the results.
- Decision flow is the key "flow" to optimise
- Analyses are "pulled" by the evidence needed to support decisions.
- Early Systems Engineering establishes the framework for efficient delivery.
- Retain flexibility in system and process architecture to match uncertainty and rate of change in the problem domain, and risk in the solution domain.

Eight key forms of waste early in the lifecycle are:

- Choosing the wrong problem to solve, or trying to solve it at the wrong time
- Choosing the wrong (usually too small) system boundary
- Waiting time due to delays in decisions
- Rework caused by committing to the wrong or not good enough design, or setting unaffordable or infeasible requirements, and having to backtrack
- Work products not being understood by the downstream process and causing errors or needing rework - by recipients or the people who did it the first time.
- Overproduction: Carrying on with a work package until the budget is spent even though the outputs are already fit for purpose.
- Not right the first time - Stopping a work package when the budget was spent even though the outputs were not yet fit for purpose
- Staffing up for delivery before the delivery framework is in place and stable

If we can recognise waste and value added activities for what they are in the presence of uncertainty, we can make sure the up-front system design and ongoing systems engineering management activities are done efficiently (i.e. with little waste), and create value - the conditions for successful lean delivery.

Position Paper #4 - by Avigdor Zonnenshein, RAFAEL

"Time is the most precious resource of systems designers"
In my part of this panel I would like to report on the efforts we have done in our company to identify the activities of the systems designers that are with added value and those that are "time wasters". The following table summarizes the outcome of such a sample analysis according to design stage:

DESIGN STAGE	ACTIVITIES WITH ADDED VALUE	TIME WASTERS	CORRECTIVE ACTIONS
System Spec	Studying the requirements & needs of the customers, the stakeholders & market	-The customers & the stakeholders are not available -The customers & stakeholders is not clear	Initiate a QFD session with customers & stakeholders
System Concept	-Refine system requirements -Create alternatives for system solutions	-Experienced systems engineers are not available -Too many alternatives are proposed	-Launching the process only if the systems engineering team is well staffed - focus & propose only viable solutions
Sytem Design Review (SDR)	-Presenting system design decisions -An effective peer review	-Long SDR process -Too many people are involved in the SDR -The SDR recommendations are not clear	-Focus on system design decisions -The SDR team is experienced & small -The SDR recommendations are focused & related to the proposed system decisions
Sub System Spec.	Studying the system spec.	-Studying & understanding only part of the system requirements -The system spec. is not clear & is not consistent -System Engineers are not available -System engineers are not experienced in preparing specs for subsystems -The spec. is going through long process of comments	-Invest needed resources (time, people) for fully understanding the system requirements -Train system engineers in writing subsystems specs -Provide online feedback for the system designer on "holes" in the system spec. -Define an effective process of confirmation the spec.
Designing & Development of the sub- system	-Planning the design & development process -Make/ Buy decisions -Preliminary design	-Planning without taking in account the design & development risks -Arguing the M/B decisions -Not providing a	-Introducing risk management throughout the designing process -Managing a decisive M/B process -Educate the engineers for

	-PDR -Detailed design -CDR	feedback to the spec . -A long PDR process with too many participants -The PDR recommendations are not clear -Bad Multi Tasking of the design team -Experts are not available for analysis tasks -Prototypes are not available -A long CDR process with too many participants -The CDR recommendations are not clear	providing feedback to the spec. in order to eliminate over spec -Introduce an effective, short & focused DR processes -Planning the design team with no BMT -Planning & scheduling the experts to support the design -Planning & budgeting for enough prototypes -Introduce an effective, short & focused DR processes
DESIGN STAGE	ACTIVITIES WITH ADDED VALUE	TIME WASTERS	CORRECTIVE ACTIONS
Integration	-Define integration process & plan -Prepare & built integration infrastructure -Receive subsystems for integration -Integrate system elements	-Policies & processes for integration are not available -Too long process for preparing the integration facilities -Some of the subsystems are supplied late -Lengthy integration process due to surprises & problems	-Introduce upfront the policies for the integration & train the engineers -Invest early in integration infrastructure -Plan very careful the supply of subsystems -Implement early simulations for the integration process
Verification & Validation	-Define strategy & plan for V&V -Prepare the equipments & facilities for V&V -Conduct the V&V to demonstrate compliance with requirements -Analyze & record V&V findings , data &	-Policies & processes for V&V are not available -The facilities for V&V are not ready on time -Lengthy V&V process due to rejects & problems -Lengthy process of analyzing the data &	-Introduce upfront the policies for the V&V & train the engineers -Invest early in integration infrastructure -Implement early simulations for the V&V process -Automate the data analysis process

	information	findings	

Based on the above sample analysis we collected the amount of time wasted for each stage, and launched improvement process & implemented specific corrective actions as proposed above. The time saved at the first improvement cycle was about 20% of the design process. These results encourage us to continue with introducing the lean approach to our design & systems engineering processes. This support our panel statement- Who can afford ignoring the Lean approach for design & engineering?