Lean Enablers for Systems Engineering…

LEfSE are grouped into the six Lean Principles summarised as follows:

Value Principle: promotes a robust process of establishing the value of the end-product or system to the customer with crystal clarity. The process should be customer-focused, and align the enterprise employees accordingly.

Value Stream Principle: emphasises waste-preventing measures, solid preparation of the personnel and processes for subsequent efficient workflow, detailed program planning, frontloading, best decision making processes, and use of leading indicators and quality metrics.

Flow Principle: promotes the uninterrupted flow of robust quality work and first-time right, steady competence instead of hero behaviour in crises, excellent communication and coordination, concurrency, frequent clarification of the requirements, and making program progress visible to all.

Pull Principle: provides a powerful guard against the waste of rework and overproduction. Promotes pulling tasks and outputs based on need and rejecting others as waste.

Perfection Principle: promotes excellence in the Systems Engineering and enterprise processes, the use of lessons learned from previous programs, the development of perfect collaboration policy across people and processes, and driving out waste through standardisation and continuous improvement. A category of these enablers calls for a more important role for systems engineers, with responsibility, accountability and authority for the overall technical success of the program.

Respect-for-People Principle: promotes the enterprise culture of trust, openness, respect, empowerment, cooperation, teamwork, synergy, good communication and coordination, and enables people for excellence.

This leaflet is intended to provide an introduction to the principles of Lean Thinking as it applies to Systems Engineering.

For further information, advice and links to helpful websites, go to: www.incoseonline.org.uk
Download copies of this leaflet and other Systems Engineering resources online at: www.incoseonline.org.uk
For more information about the worldwide Systems Engineering professional community, go to: www.incose.org

Major publications about LSE and Lean Enablers:
1. Lean Enablers for Systems Engineering, B. W. Oppenheim, CrossTalk Defense Journal, July-Aug.2009
2. Lean Enablers for Systems Engineering, B. W. Oppenheim, E. Murman and D. Secor, Journal of SE (submitted in 2009)

LSE Working Group of INCOSE:
initiated in 2006, the Working Group has grown to 113 members (as of Sept. 25, 2009). All are invited.

The web page:
www.incose.org/practice/techactivities/wg/leansewg/
includes our Charter, leadership & contacts, major products, definitions, recommended readings, and meeting announcements.

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Leaflet prepared and published by the UK Chapter of the International Council on Systems Engineering in collaboration with the LSE Working Group.

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Lean Systems Engineering …an introduction

*PLEASE READ THIS GUIDE IN PAGE NUMBER ORDER*

The Need:
Systems Engineering (SE) is an established practice capable of delivering technically complex systems. However, it is not always delivered effectively. Recent studies have identified a significant amount of waste in government programs - averaging 70 percent of charged time. This waste represents a vast productivity reserve and offers major opportunities to improve program efficiency.

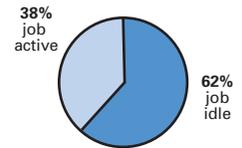**Wasted Effort and Time in Programs**

Wasted Effort
40% of PD* effort "pure waste", 29% "necessary waste" (workshop opinion survey) 30% of PD* charged time "setup and waiting" (aero and auto industry survey)

- 29% necessary non-value added
- 40% pure waste
- 31% value added
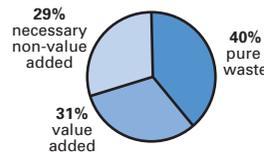
Wasted Time
62% of tasks *idle* at any given time

50-90% task idle time found in Kaizen-type events

- 38% job active
- 62% job idle

Source: McManus, H.L. "Product Development* Value Stream Mapping Manual", LAI Release Beta, April 2004

Lean Thinking to the Rescue:
Lean Thinking is credited for the extraordinary success of Toyota. It is the dynamic, knowledge-driven, and customer-focused process through which all people in a defined enterprise are aligned to continuously cut out waste with the goal of creating value. Three concepts are fundamental to the understanding of Lean Thinking:
1) Value
2) Waste
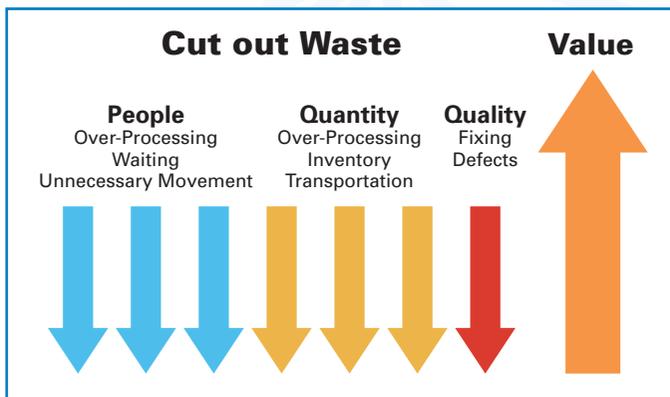3) The process of creating value without waste, known as the Six Lean Principles.

Lean Systems Engineering (LSE) is the application of Lean Thinking to Systems Engineering, with the goal to deliver the best life-cycle value for technically complex systems with minimal waste.

Lean Enablers for Systems Engineering

In 2009, the Lean SE Working Group released a major online product named Lean Enablers for Systems Engineering (LEfSE) (see the LSE WG webpage). It is a list of 194 practices and recommendations formulated as "dos" and "don'ts" of SE based on Lean Thinking. They have been collected from most successful industrial practices and from the wisdom and experience of the 14 Lean and SE experts working on the project, with support from the Lean SE Working Group of INCOSE. The practices cover a large spectrum of SE and other relevant enterprise management practices. Every practice will improve program value and stakeholder satisfaction, and reduce waste, delays, cost overruns and frustrations.

LSE does not mean less SE. It means **better** Systems Engineering with higher responsibility, authority, and accountability, leading to better, waste-free workflow with increased mission assurance. Under the LSE philosophy, mission assurance is non-negotiable, and any task which is legitimately required for success must be included; but it should be well-planned, prepared and coordinated, and executed with minimal waste.

Cut out Waste / Value

People	Quantity	Quality
Over-Processing Waiting Unnecessary Movement	Over-Processing Inventory Transportation	Fixing Defects

Fundamentals of Lean Thinking:

1. Value

Value is a measure of worth of a specific product or service by a customer, and potentially other stakeholders and is a function of (1) the product's usefulness in satisfying a customer need, (2) the relative importance of the need being satisfied, (3) the availability of the product relative to when it is needed, and (4) the cost of ownership to the customer.

In LSE, Value is defined as mission assurance (the delivery of a flawless complex system, with flawless technical performance, during the product or mission development life cycle), satisfying the customer and all other stakeholders, which implies completion with minimal waste, minimal cost, and the shortest possible schedule. In early lifecycle phases, value is created by reducing uncertainty, building a stakeholder consensus, and providing clear evidence to support good and timely decisions.

2. Waste

Waste is the work element that adds no value to the product or service in the eyes of the customer. Waste only adds cost and time. Waste is classified into seven categories.
The following are examples of waste in common Systems Engineering practice, in the order of decreasing occurrence in programs:

1. **Waiting:** Waiting for supply or processing of material or information:
- Late delivery of material or information
- Excessively serial tasking; not enough concurrency
- Waiting for approvals

2. **Over-Processing:** Processing more than necessary to produce the desired output:
- Too many hands on the "stuff"
- Excessive/custom formatting or reformatting
- Excessive refinement, beyond what is needed for Value

3. **Transportation:** Moving material or information:
- Unnecessary hand-offs between people
- Communication failures

4. **Inventory:** Maintaining more material or information than needed:
- Too much "stuff" stockpiled on desks or in storage
- Complicated retrieval of needed "stuff"
- Outdated, obsolete information

5. **Defects:** Errors, mistakes and lack of communication causing work to be redone to correct the problem:
- Item delivered different from the item needed
- Incorrect information

6. **Over-Production:** Creating too much material or information:
- Creating unnecessary data and information
- Information over-dissemination (e.g. emails)

7. **Unnecessary Movement:** People moving to access or process material or information:
- Lack of direct access
- Time spent finding what you need
- Manual intervention

3. The Six Lean Principles -
creating value without waste:

1. **The customer defines value.** The value proposition must be captured with crystal clarity early in the program (applies to both external and internal customers)

2. **Map the value stream.** Prepare for and plan all end-to-end linked activities necessary to realise value, streamlined, after eliminating waste, using the best decision-making processes

3. **Make value flow continuously along the value stream.** This should happen without stopping, rework, or backflow (legitimate optimised iterations are okay)

4. **Let customers pull value.** The customer's pull/need defines all tasks and their timing (internal or external)

5. **Pursue perfection.** Constantly improve your processes, and make all imperfections visible in order to motivate continuous improvement

6. **Respect for people.** Create a system of mutually respectful, trusting, honest, cooperating and synergistic relationships of key stakeholders, motivating staff to exhibit top capabilities.