LECTURE

SE typical process

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SYSTEMS ENGINEERING – BASIC FACTS

Systems Engineering is responsible for creating a product and also a process for producing it

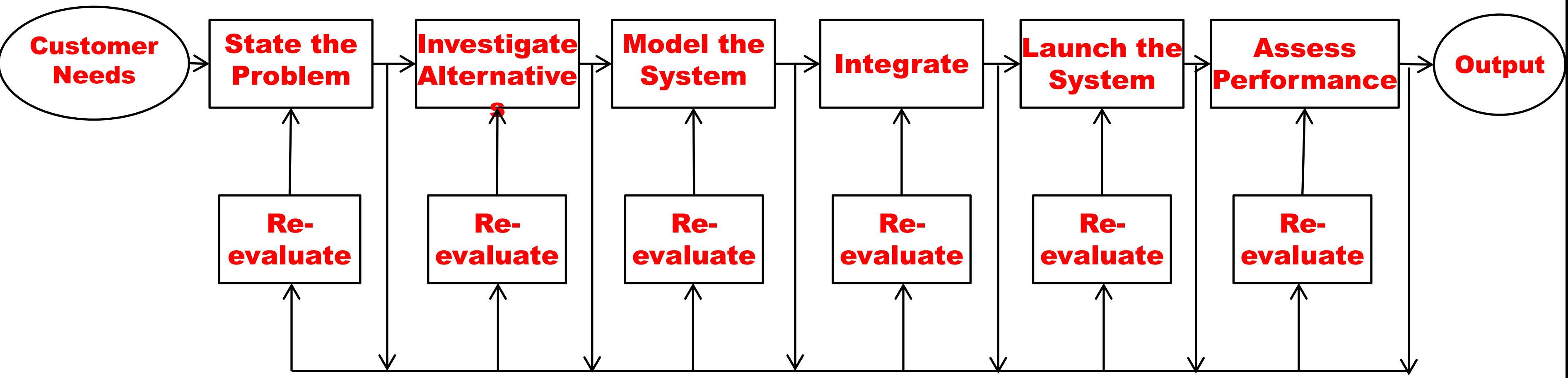
Many processes have been proposed to map the basic recommendations

Some are bigger, some are smaller

The SIMILAR process (consensus of the INCOSE - International Council on Systems Engineering) consolidates the most important - most processes are *similar* to it

BASIC SYSTEMS ENGINEERING PROCESS

The SIMILAR Process



Source: INCOSE

The Systems Engineering Process is not sequential: it is **parallel and iterative!**

BASIC SYSTEMS ENGINEERING PROCESS

Description of phases of SIMILAR process

INPUT – CUSTOMER NEEDS

Very important

Demanding:

Necessary to find out all involved customers

To collect all the needs and requirements
(necessary to find mutual language with the customer)

STATE THE PROBLEM

description of the top-level functions, e.g. using:

- mission statement,
- concept of operations
- description of the deficiency that must be ameliorated.

Most mandatory and preference requirements should be traceable to this problem statement.

Acceptable systems must satisfy all the mandatory requirements.

***what* must be done**, not *how* to do it.

in functional or behavioral terms

Inputs come from end users, operators, maintainers, suppliers, acquirers, owners, regulatory agencies, victims, sponsors, manufacturers and other stakeholders.

INVESTIGATE ALTERNATIVES

Alternative designs created and evaluated - based on

- performance,
- schedule,
- cost
- risk

multicriteria decision-aiding techniques used

Analysis redone whenever more data are available

Models constructed and evaluated, simulation data should be derived, prototypes built and measured

Alternatives judged for compliance of capability against requirements

alternative designs reduce project risk

helps clarify the problem statement

MODEL THE SYSTEM I.

Models will be developed for most alternative designs.

The model for the preferred alternative will be expanded and used to help manage the system throughout its entire life cycle.

types of system models

- physical analogs,
- analytic equations,
- state machines,
- block diagrams,
- functional flow diagrams,
- object-oriented models,
- computer simulations
- mental models

Models constructed for both the product and the process.

MODEL THE SYSTEM II.

Models constructed for both the product and the process.

Process models allow

- to study scheduling changes,
- create dynamic PERT (program evaluation and review technique) charts
- perform sensitivity analyses to show the effects of delaying or accelerating certain subprojects.

Running the process models reveals bottlenecks and fragmented activities, reduces cost and exposes duplication of effort

It is not sequential: it is parallel and iterative! - models must be created before alternatives can be investigated

INTEGRATE

Means bringing things together so they work as a whole

Interfaces between subsystems designed

Subsystems defined along natural boundaries

Remember Topological decomposition

Subsystems should be defined to minimize the amount of information to be exchanged between the subsystems

Feedback loops around individual subsystems are easier to manage than feedback loops around interconnected subsystems

Result: system that is **built and operated using efficient processes**

LAUNCH THE SYSTEM

Launching the system means allowing the system do what it was intended to do

Might mean buying hardware or software, or might mean actually making things

preferred alternative is designed in detail; the parts are built or bought (COTS – commercial off-the-shelf), the parts are integrated and tested at various levels leading to the certified product.

In parallel, the processes necessary for this are developed and applied

Consideration is given to its interfaces with operators (humans, who will need to be trained) and other systems with which the product will interface

Result: running the system and producing outputs

ASSESS PERFORMANCE

Figures of merit, technical performance measures and metrics are all used to assess performance.

Figures of merit are used to quantify requirements

Technical performance measures are used to mitigate risk during design and manufacturing.

Metrics (including customer satisfaction comments, productivity, number of problem reports, ...) are used to help manage a company's processes.

Measurement is the key

- **If you cannot measure it, you cannot control it.**
- **If you cannot control it, you cannot improve it.**

RE-EVALUATE

Re-evaluate is arguably the most important of these functions.

Using **feedback** to help control systems and improve performance

Continual process with many parallel loops

Means observing outputs and using this information to modify the system, the inputs, the product or the process.

VARIATIONS

Ideally Systems Engineering process at any company should be

- documented
- measurable
- stable
- of low variability
- used the same way by all
- adaptive
- tailorable

- May be a contradiction!

GENERAL RECOMMENDATIONS
by Briar Mar

Understand the whole problem before you try to solve it

Translate the problem into measurable requirements

Examine all feasible alternatives before selecting a solution

Make sure you consider the total system life cycle. The birth to death concept extends to maintenance, replacement and decommission. If these are not considered in the other tasks, major life cycle costs can be ignored.

Make sure to test the total system before delivering it.

Document everything.

Thank you for your attention