Why do Systems Engineering?

Manage Complexity. Reduce your Risk

Systems Engineering is about coping with complexity. Systems Engineering helps avoid omissions and invalid assumptions, helps to manage real world changing issues, and produce the most efficient, economic and robust solution.

The Systems Engineering process delivers a better understanding of the client needs and helps program managers to manage change and configuration effectively through the project lifecycle.

By using the Systems Engineering approach, project costs and timescales are managed and controlled more effectively by having greater control and awareness of the project requirements, interfaces and issues and the consequences of any changes.

Systems Engineers work with program managers to achieve system and project success.

Systems Engineering techniques can be scaled to adjusted to suit the size and complexity of the project.

Research shows effective use of Systems Engineering can save 10-20% of the project budget. It is not hard to know when System Engineering fails, because when something important goes wrong it usually makes the news fast. People get hurt, programs are delayed and over-budget, the law becomes involved.

But when System Engineering goes right, no-one notices - which is just how it should be. The computer works when you switch it on, trains run on time, your flight lands on time and no one gets angry.

This guide has been produced to help transportation professionals to understand how systems engineering can help them meet their objectives.

Not using Systems Engineering results in Failure...

- Over one-third of all projects fail.
- Over two-thirds will not achieve all their goals.
- Failure is usually obvious only when the project is overdue and over budget.

... But decisions and plans made earlier in the project can reduce your risk, sometimes dramatically.

Don't rely on luck – Use Systems Engineering

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For further information on systems engineering within transportation please visit:
www.incose.org/practice/techactivities/wg/transport

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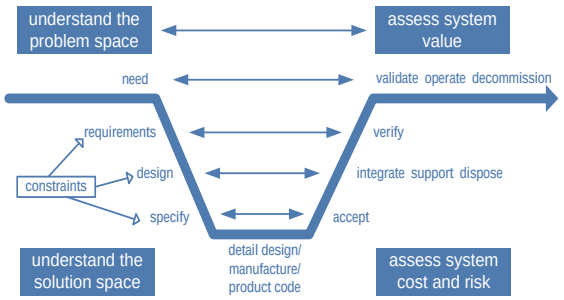
What is Systems Engineering?

Systems Engineering is an interdisciplinary team process aimed at creating successful systems. It starts by defining customer needs and functionality, before going on to create a holistic design.

It considers both the business and the technical needs of all customers, with the ultimate goal of providing a quality product that meets the user needs.

"Build the right transportation system; and build the system right". Systems Engineering links the economic benefits of the new transportation system, its high level design down to the sub-system requirements across the whole system lifecycle – from initial concept to system retirement.

The 'V' project lifecycle model, below, shows the logical relationship between the different Systems Engineering activities or 'processes'.



7 Steps to Success

The 7 Steps:

1. Understand the problem

Understand and write down the expected benefits of the transportation system and how it will be used. Identify how the effectiveness of the system will be measured – economic benefits, journey times, capacity, carbon reduction. Determine the improvement expected from the new system. Identify the stakeholders and agree the system boundary.

Think! How will the environment change between now and when the system is ready? ***Think!*** How will the environment and end users respond to the new system? ***Think!*** What other inputs or metrics might change during the project?

2. Investigate alternative solutions

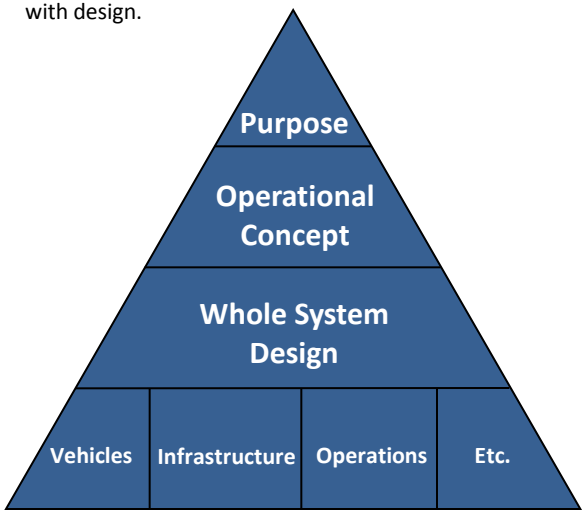
Consider, model and evaluate both novel solutions and improvements to existing ones. Work out how you will choose between the alternatives. Record your decision process and rationale in case things change later and you need to re-visit the analysis. Also this process will promote the review of the schedule and economic impacts to the project.

3. Define and agree upon the system architecture

Describe and/or define the relationship between the system, its environment and its sub-systems. Make sure the architectures shows how command and control, vehicles, infrastructure, power and stations work together to deliver the required performance and effectiveness.

Half of all project failures could be prevented by more effective Systems Engineering

The Triangular hierarchy below shows the definition of system purpose - then preparation of the Operational Concept to iterate with stakeholders before proceeding with design.



Increase Project success
Reduce your Risk

Systems Engineering integrates the technical effort across the development project:

- Functional disciplines – such as operators, economists and program managers
- Technical disciplines – such as vehicle engineers, civil engineers and command and control engineers
- Cross-cutting issues such as risk management, asset management and change control

7 Steps to Success

4. Agree and manage the requirements

Requirements form the basis for contracts and acceptance. Starting from the desired effect of the new system, balance requirements with budget and technical feasibility. Identify and consult relevant stakeholders. Identify and manage assumptions. Assess impact of proposed changes and trade-offs. Undertake testing of the system against its requirements.

5. Agree and manage the interfaces

Manage interfaces to make sure the parts of the solution combine with each other and the operational environment to create an effective whole – and to allow teams to work in parallel confident that all the pieces they are developing will fit and work together. Identify who is responsible for and involved in each interface.

6. Prepare the test and support systems

Prepare the test, training and support capabilities in parallel with the "operational system". Make sure they are all compatible and ready when they are needed to test, commission, deploy and use the system.

7. Track progress against a plan

As well as the traditional project management measures of cost, schedule and resources, it is important to track skills, decisions and technical performance. Adapt to changes and be prepared to backtrack on decisions. Failure to agree upon requirements or interfaces may be symptoms of deeper problems.