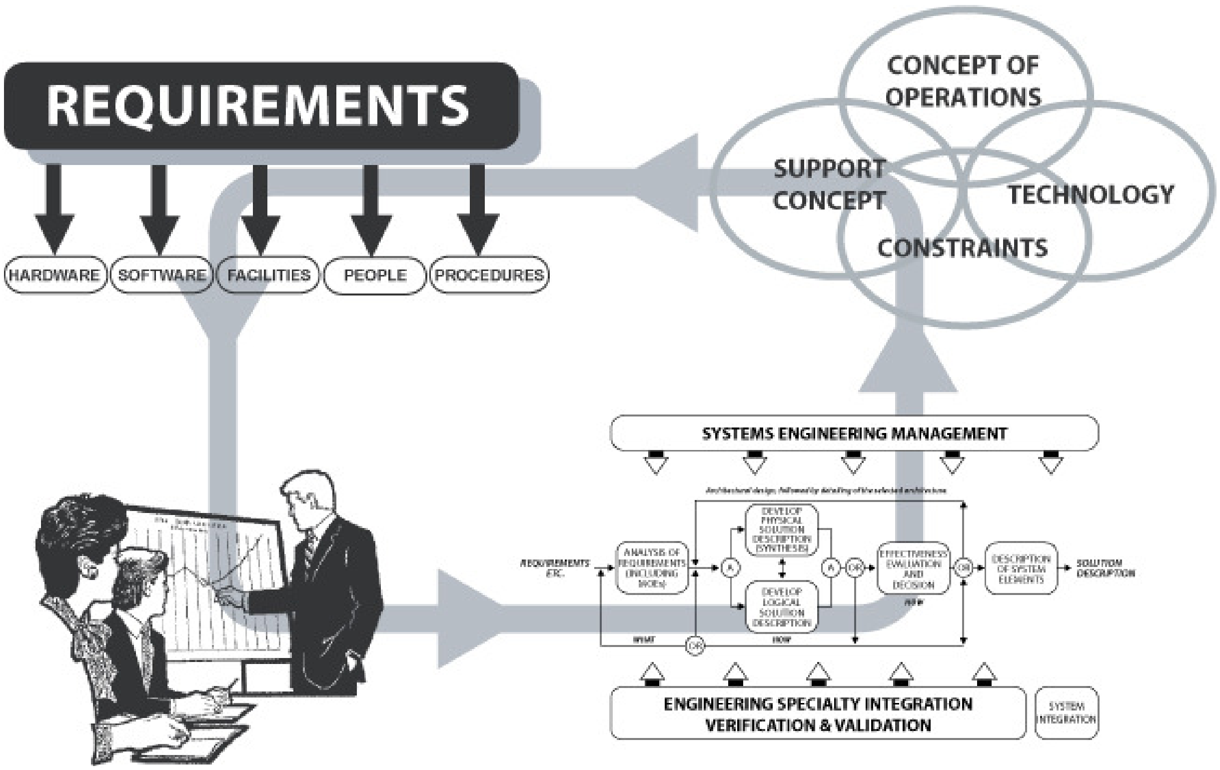
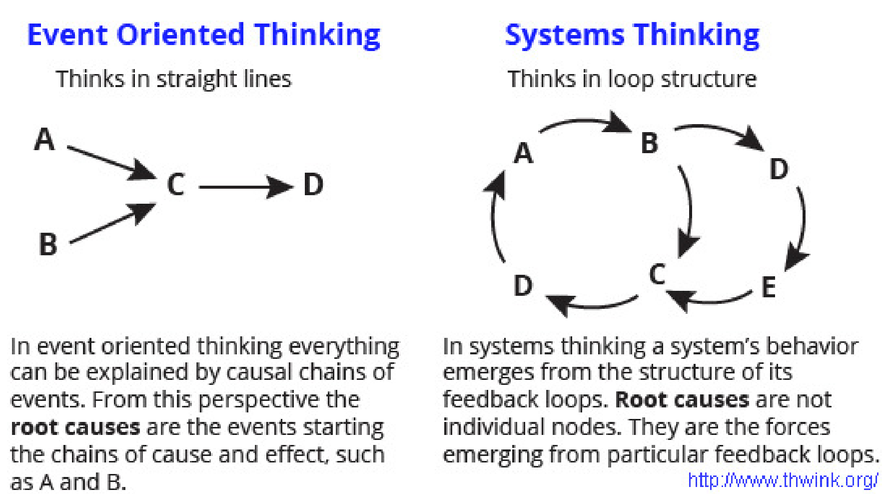
Systems Thinking

Projects do not exist in isolation; neither do project issues or problems. Crafting successful outcomes and solutions needs a broader framework than simply delivering outputs or solving the current problem. Systems thinking is one way of overcoming a narrow short-term focus in favour of a better all-round solution.



Systems thinking is a discipline for seeing wholes, a framework for seeing interrelationships rather than things. Systems engineering is the discipline for applying systems thinking; there is almost nothing that must be done within systems engineering. There are mainly things that system engineers choose to do, or choose not to do, for exactly the same reason – achieving the best result in the circumstances, based on the balance of probabilities.



Within this framework, a system is viewed as an organised collection of parts (or subsystems) that are highly integrated to accomplish an overall goal[1]. The system has various inputs, which go through certain processes to produce certain outputs, which together, accomplish the desired goal for the overall system. Systems range from simple to complex and there are numerous types of systems:

- Biological systems (for example, the heart),
- Mechanical systems (for example, a thermostat),
- Human/mechanical systems (for example, riding a bicycle),
- Ecological systems (for example, predator/prey) and
- Social systems (for example, communities and project teams).

By definition, a system is systemic, meaning relating to, or affecting, the entire system. This should not to be confused with systematic, which can mean merely that something is methodological. Methodological thinking (systematic thinking) does not necessarily mean systems thinking.

Systems engineering can be thought of as the problem-independent, and solution/technology-independent, principles and methods related to the successful engineering of systems, to meet stakeholder requirements and to maximize value delivered to stakeholders in accordance with their values. Systems thinking provides a rigorous way of integrating people, purpose, process and performance and:

- Relating systems to their environment.
- Understanding complex problem situations
- Maximising the outcomes achieved.
- Avoiding or minimising the impact of unintended consequences.
- Aligning teams, disciplines, specialisms and interest groups.
- Managing uncertainty, risk and opportunity.

The role of Systems Engineering and Systems Engineers is to turn thinking about systems from an abstract concept, into building and adapting systems to deliver value, by turning the ideas into actionable outcomes through a coordinated plan and schedule for the work; which Subject Matter Experts implement.

Within this broad framework, systems thinking is a framework based on the belief that the component parts of a system can best be understood in the context of their relationships with each other and with other systems. Its focus is on cyclical interactions rather than linear causes and effects. The approach incorporates several tenets:

- **Interdependence** of objects and their attributes - independent elements can never constitute a system
- **Holism** - emergent properties not possible to detect by analysis should be possible to define by a holistic approach
- **Goal seeking** - systemic interaction must result in some goal or final state
- **Inputs and Outputs** to the system - in a closed system inputs are determined once and are constant; in an open system additional inputs are admitted from the environment
- **Transformation** of inputs into outputs - this is the process by which the goals are obtained
- **Entropy** - the amount of disorder or randomness present in any system
- **Regulation** - a method of feedback is necessary for the system to operate predictably and counteract entropy
- **Hierarchy** - complex systems are made up of smaller subsystems
- **Differentiation** - specialised units perform specialised functions within the system

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[1] Peter Senge wrote a seminal book about systems thinking, ***The Fifth Discipline*** (Doubleday, 1990).

- **Equifinality** - there are alternative ways of attaining the same objectives (convergence)
- **Multifinality** – it is possible to attain alternative objectives from the same inputs (divergence)

Complex systems usually interact with their environments and are, thus, open systems[2]. A reasonable sized project is an open, complex, social system made up of many subsystems including administrative and management functions, sub-groups (teams) and individuals, and operates within the larger system that comprises the performing organisation.

Within the project, its subsystems are arranged in hierarchies, and integrated to accomplish the goals of the overall system (the project's deliverables). Each subsystem has its own boundaries of sorts, and includes various inputs, processes, outputs and outcomes geared to accomplish the goal for the subsystem within the larger goal of the overall system.

A high-performance system continually exchanges feedback among its various parts to ensure that they remain closely aligned and focused on achieving the goal of the system. If any of the parts or activities in the system seems weakened or misaligned, the system makes necessary adjustments to more effectively achieve its goals.

Consequently, a systems thinking approach to problem solving sees each problem as part of the overall system and recognises that if one part of the system is changed to solve one problem, the nature of the overall system is likely to be changed, as well. Rather than simply comparing its results to what we want it to achieve and then saying it is failing if it doesn't achieve them, we should look at what the system is doing well, and then study how it is designed to do that. Then, if we wish to change the outcome, we can redesign the system for the desired purpose.

Using systems thinking helps us see that what may seem an isolated problem is actually part of an interconnected network of related issues. It helps identify the positive and negative feedback cycles that may be affecting the issue and any associated time lags between the stimulus and the reaction (eg, there is a time lag between adjusting the hot water tap in a shower and the change in temperature of the water leaving the shower head – if you don't allow for the lag, you suffer!!).

Systems thinking is a part of the emerging science of 'systems theory' and offers an incredible set of problem solving tools and techniques to help us understand and optimize areas suffering due to complex problems. Time is taken to understand the 'cause of the cause' of the problem[3] and to map the likely consequences of the solution onto the other parts of the system that may be affected. This is a valuable practice for anyone involved in project management to adopt.

Soft systems methodology (SSM)

Soft systems methodology (SSM) is a systemic approach for tackling real-world problematic situations. SSM treats the notion of system as an *epistemological* entity, (ie, as a mental construct used for human understanding). Using SSM a particular organisation can be described as:

- A system to make a profit,
- A system to transform raw materials into a commercial product,
- A system to provide jobs to the local community,
- A system to pollute the environment.

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2 These ideas are closely aligned with complexity theory. For more on this subject see:
- ***Complexity Theory***: https://www.mosaicprojects.com.au/WhitePapers/WP1058_Complexity_Theory.pdf
- *A Simple View of 'Complexity' in Project Management*: https://mosaicprojects.com.au/PDF_Papers/P070_A_Simple_View_of_Complexity.pdf

3 For more on ***problem solving*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1013_Problem_Solving.pdf

Depending on what perspective we take, we will have a very different understanding of this particular organisation. SMM uses a seven stage approach:

1. Entering the problem situation.
2. Expressing the problem situation.
3. Formulating root definitions of relevant systems.
4. Building Conceptual Models of Human Activity Systems.
5. Comparing the models with the real world.
6. Defining changes that are desirable and feasible.
7. Taking action to improve the real world situation.

The dynamics of the method come from the fact that stages (2) through (4) are always an iterative process. The Conceptual Models take the form of bubble diagrams in which descriptions of activities are enclosed in bubbles and the bubbles linked to each other by arrows. The arrows are intended to represent logical dependency. SMM can be used for:

- Organizational design: Restructuring of roles, design of new organizations, creation of a new organizational culture.
- Information systems: Definition of information needs, creating an IS strategy, knowledge acquisition, evaluation of the impact of computerization.
- General problem solving: Understanding complex situations, initial problem clarification.
- Performance evaluation: Performance indicators, quality assurance, monitoring an organization.
- Education: Defining training needs, course design, causes of truancy, analysis of language teaching.
- Miscellaneous: Project management, business strategy, risk management methodology, case for industrial tribunal, personal life decisions.

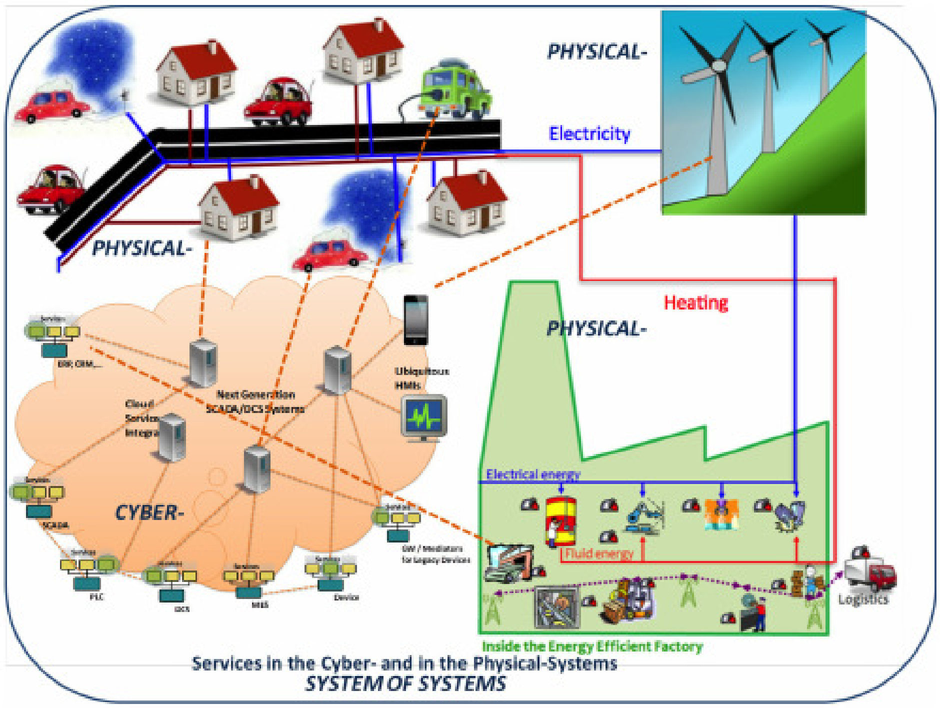
Integrative Thinking

Integrative thinking is similar. Integrative thinkers develop and utilise complex models to understand their situation and drive action. They build holistic models that include consideration of customers, employees, competitors, capabilities, cost structures, industry evolution, regulatory environment, etc. Their models capture the complicated, multifaceted and multidirectional causal relationships between the many variables in any business situation and consider the problem as a whole rather than break it down.

Integrative thinking abilities are based on the management of models, which are an image of reality (systems or processes) that gives a logical interpretation of this reality. Tensions are creatively resolve to produce a more powerful model rather than default to choosing one model over another when both are sub-optimal, but one is less so than the other. Successful thinking is focussed on visualising system, connecting people and creating futures. This approach is useful in both programme management and project management.

Systems of Systems

A system of systems (SoS) brings together a set of systems for a task that none of the systems can accomplish on its own. These interoperating and/or integrated collections of constituent systems usually produce results unachievable by the individual systems alone. For example an effective city transport system may include heavy rail, light rail/trams, underground rail, busses taxies and private cars +++ - all of the separate systems need to support each other for the best overall outcome.



But, each constituent system keeps its own management, goals, and resources while coordinating within the SoS and adapting to meet SoS goals. Understanding system of systems problems involves studying a collection of trans-domain networks of varied systems that are likely to exhibit operational and managerial independence, geographical distribution, and emergent and evolutionary behaviours that would not be apparent if the systems and their interactions are modelled separately.

System of systems are not monolithic; rather they have five common characteristics: operational independence of the individual systems, managerial independence of the systems, geographical distribution, emergent behaviour and evolutionary development. System-of-Systems Engineering (SoSE) is a set of developing processes, tools, and methods for designing, re-designing and deploying solutions to System-of-Systems challenges. It deals with planning, analysing, organizing, and integrating the capabilities of a mix of existing and new systems into a SoS capability greater than the sum of the capabilities of the constituent parts.

SoS are integrated; a similar but different grouping of systems is a Family of Systems (FoS). A FoS is defined as a set of systems that provide similar capabilities through different approaches to achieve similar or complementary effects. The family of systems does not acquire qualitatively new properties as a result of the grouping. In fact, the member systems may not be connected into a whole. For example, a program can be seen as a SoS – multiple project systems integrated into a larger whole. Whereas a portfolio of projects is a FoS, all of the project systems are similar but they do not have significant interaction. The FoS sers to transfer learning and provide overall control.

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