Managing complexity with Systems Thinking

The key principles of Systems Thinking – a simple explanation of how to tackle complex problems.

Overview

Systems Thinking is becoming increasingly recognised as a key means to succeed in a complex, joined-up world. Faced with wide ranging societal, environmental and technical challenges, governments and policy makers of our time are now frequently calling for a Systems Approach to be taken to solve such complex challenges.

What is a Systems Approach? In short, using Systems Engineering to apply Systems Thinking to a development is commonly referred to as taking a Systems Approach. Systems Engineering applies Systems Thinking to the development of any sort of complex system. It involves a wide range of techniques, methods and processes to achieve this in a manner intended to minimise risk, development time and cost, whilst providing clarity on the nature of the Problem and how a Solution can be agreed to be acceptable. It provides the detail of how Systems Thinking can be applied successfully to any type of complex Problem that involves a developed system as the key element in providing a Solution.

What is Systems Thinking

Systems Thinking is a way of tackling complex problems that complements scientific thinking by addressing holism*, emergence** and intentionality***.

There are 4 main areas in which the Principles of Systems Thinking apply:

1. **Problem**
2. **Design**
3. **Integration & Solution**
4. **Process**

*Holism: Systems Thinking aspires to deal with the whole of a problem and whole solutions to that problem. It aims to deal with it in a balanced way from all viewpoints – a Systemic approach.

**Emergence: as parts of a system interact with each other, behaviour occurs that wasn't present in the parts by themselves. Some of this is wanted, necessary to fulfil the purpose and achieve the intended solution – the functions and performance of the system providing the means of achieving the solution. Other behaviour that emerges as inevitable or unintended side effects need to be managed to limit or prevent negative effects, such as power consumption, wild heat and electro-magnetic interference.

***Intentionality: Systems Thinking espouses a Systematic approach, first establishing and clarifying Purpose through careful examination of the Problem, then tackling the development of Solution through deliberate development Process. This creates a structured Design and implements the design by integrating its parts to form a complete System that can be brought into operation to provide the Solution.

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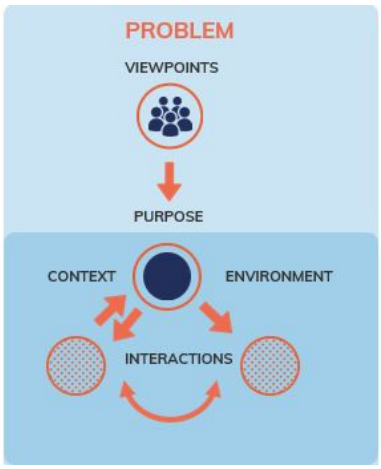
1. The Problem Space

"We fail more often because we solve the wrong problem than because we get the wrong solution to the right problem." – Russel Ackoff

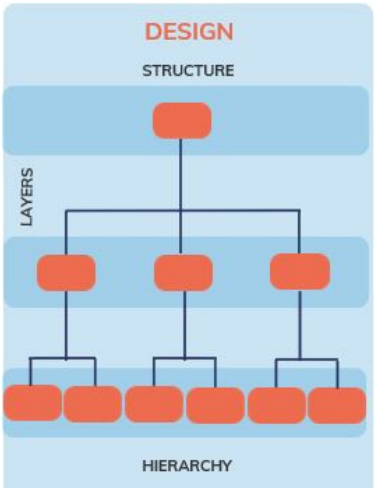


Rushing to solution is a very common human trait – we all like to have the answers! However, this tendency risks addressing the wrong problem, or neglecting key aspects of the problem – often with dramatic consequences. It also tends to limit the extent of innovation that could be applied, as it often leads to adopting very similar solutions to predecessors. As a result, it tends to miss opportunities for more significant improvement, and ultimately can lead to stagnation or being made prematurely obsolete.

Systems Thinking suggests focusing on the Problem first, gaining insights from the Viewpoints of a wide variety of Stakeholders concerned with the Problem and aspects of potential Solutions, in order to reach a rich understanding of the Problem itself.

It recognises the importance of exploring Purpose deliberately, and doing so with an understanding of the Context in which the Problem and potential Solution systems exist. Recognising the Environment relevant to the situation and the Interactions that are necessary to achieve the Purpose in the real world.

2. Design



Systems Thinking does not set out full design methodologies, but does establish some high-level principles for the design of Complex Systems. The key elements involved are a Structure to the design, with organisation provided in Layers for differing levels of detail, and a Hierarchy describing the decomposition/integration relationship of elements at each layer into the elements in the next layer.

Such organised Structure to design is a fundamental enabler for its specification and description in order to provide collective understanding and the progressive pursuit of implementation of the Solution.

It is also an excellent framework for gaining understanding of naturally occurring or pre-existing systems, not just to establish new designs.

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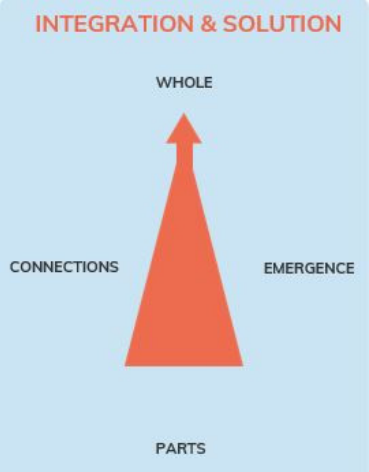
3. Integration & Solution

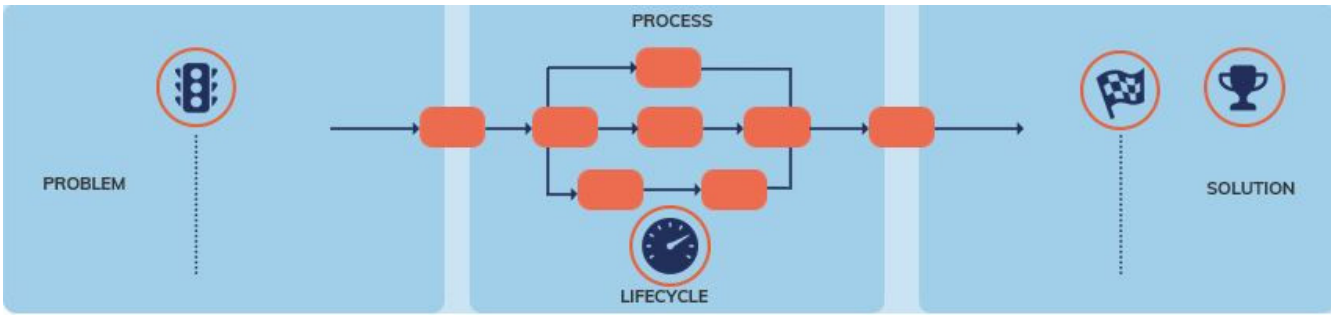


Systems Thinking recognises that Complex Systems are brought about by collating a wide variety of Parts to create a whole System that can then be operated to provide a Solution. As the Parts are brought together, Connections are made, and these give rise to Emergence – behaviour and characteristics that were not previously possible or exhibited by the Parts when they were not yet Connected.

The type of Parts involved are not just hardware or equipment but also software, materials, even users that interact with the sub-systems or system in order to operate it, and information that may be processed during operation. Just as the type of Parts may vary considerably, so do the forms of Connection between Parts. The choices made in Structured Hierarchical Design about decomposition between Layers are reflected in the Integration of Parts to form the Whole System.

Emergence reveals the characteristics of the System as Integration proceeds. Systems Thinking intends that Emergent properties of the System achieve the Purpose and resolve the Problem, with minimal unwanted emergent characteristics, and so provide a full and acceptable Solution.

4. Process



Systems Thinking suggests that the activities involved in developing Solutions to complex Problems should be organised as an overall Process, as a set of series and parallel activities with inputs and outputs arranged to create a set of dependencies between the activities.

It also recommends that the overall Process should be governed within a Lifecycle which provides collective understanding and expectation on the sequencing and maturity of such activities as the development progresses. Such a Lifecycle provides the key checkpoints and reviews that are entailed in assuring and communicating the growth in maturity.

Whilst Systems Thinking holds that the development process starts with Problem-focussed activities and ends with the provision of an accepted Solution, it does not in itself suggest further details of the development Process or the Lifecycle to be used.

SYSTEMS THINKING PRINCIPLES

PROBLEM

VIEWPOINTS

PURPOSE

CONTEXT

ENVIRONMENT

INTERACTIONS

DESIGN

STRUCTURE

LAYERS

HIERARCHY

PROCESS

LIFECYCLE

INTEGRATION & SOLUTION

WHOLE

CONNECTIONS

EMERGENCE

PARTS

PROBLEM

SOLUTION

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Summary

Systems Thinking sets out a way of tackling the whole of a complex Problem by focussing first on the Problem itself, developing a structured Design and integrating the Parts to create a System that provides a Solution, all controlled within a development Process in accordance with a Lifecycle.

About Optima Systems Consultancy

Optima Systems Consultancy is an independent Systems Engineering and Management consultancy based in Thornbury, North Bristol. We specialise in the Defence, Aerospace, Transport and Nuclear sectors, combining in-depth technical expertise with broader business consultancy disciplines to scope and solve clients' complex problems.

A fresh approach based on Systems Thinking is at the heart of everything we do, with an intrinsically end-to-end viewpoint that ensures every aspect of the landscape is taken into account.

Our way of working mirrors the solutions we deliver for our clients, with sharp methodology, minimal red tape and a genuine drive for quality. Our team is made up of exceptional, curious people with a passion to get things done better. If that sounds like you too and you'd like to work with us, please contact us to find out more.