What is Systems Thinking?

The concepts, principles, and patterns of systems thinking have arisen both from the work of systems scientists and from the work of practitioners applying...
the insights of systems science to real-world problems.

Holism has been a dominant theme in systems thinking for nearly a century, in recognition of the need to consider a system as a whole because of observed phenomena such as emergence. Proponents have included Wertheimer, Smuts, Bertalanffy, Weiss, (Ackoff 1979), (Klir 2001), and (Koestler 1967) among many others.

A more detailed discussion of the most important movements in systems theory can be found in History of Systems Science.

Identifying Systems of Interest

When humans observe or interact with a system, they allocate boundaries and names to parts of the system. This naming may follow the natural hierarchy of the system, but will also reflect the needs and experience of the observer to associate elements with common attributes of purposes relevant to their own. Thus, a number of systems of interest (SoIs) (Flood and Carson 1993) must be identified and they must be both relevant and include a set of elements which represent a system whole. This way of observing systems wherein the complex system relationships are focused around a particular system boundary is called systemic resolution.

Systems thinking requires an ongoing process of attention and adaptation to ensure that one has appropriately identified boundaries, dependencies, and relationships. Churchman (1968) and others have also considered broader ethical, political, and social questions related to management science with regards to the relative power and responsibility of the participants in system interventions. These are seen by critical systems thinkers as key factors to be considered in defining problem system boundaries.

A system context can be used to define a SoI and to capture and agree on the important relationships between it, such as the systems which it works with directly and the systems which influence it in some way. When this approach is used to focus on part of a larger system, a balance of reductionism and holism is applied. This balance sits at the heart of a systems approach. A systems context provides the tool for applying this balance and is thus an essential part of any systems approach and hence, of systems engineering (SE) as well. Approaches for describing the context of the
different types of engineered systems are discussed in
the Engineered System Context topic within the Systems
Approach Applied to Engineered Systems KA.

Thoughts on Systems Thinking

Senge (1990) discusses systems thinking in a number of
ways as

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\text{a discipline for seeing wholes ... a framework for seeing interrelationships}
\text{rather than things ... a process of discovery and diagnosis ... and as a}
\text{sensibility for the subtle interconnectedness that gives living}
\text{systems their unique character. (Senge 2006, 68-69)}
\]

Churchman came to define a systems approach as
requiring consideration of a system from the viewpoint
of those outside its boundary (Churchman 1979). There
are many demonstrations that choosing too narrow a
boundary, either in terms of scope or timeline, results in
the problem of the moment being solved only at the
expense of a similar or bigger problem being created
somewhere else in space, community, or time (Senge
2006) and (Meadows 1977). This is the “shifting the
burden” archetype described in Patterns of Systems
Thinking topic.

Churchman believes that an important component of
system knowledge comes from "others" or "enemies"
outside the system; the systems approach begins when
first you see the world through the eyes of another
(Churchman 1968). In this famous phrase, Churchman
suggests that people can step outside a system they are
in and mentally try to consider it through the lenses of
other people's values. Churchman (1979) identified four
main enemies of the systems approach namely: politics,
morality, religion and aesthetics.

To Churchman, the "enemies" of the systems approach
provide a powerful way of learning about the systems
approach, precisely because they enable the rational
thinker to step outside the boundary of a system and to
look at it. It means that systems thinkers are not
necessarily just involved within a system but are
essentially involved in reasoning and decisions "outside"
of systems rationality.
Some additional perspectives on systems thinking definitions are as follows:

- “Systems thinking requires the consciousness of the fact that we deal with models of our reality and not with the reality itself.” (Ossimitz 1997, 1)
- “…what is often called ‘systemic thinking’ …is …a bundle of capabilities, and at the heart of it is the ability to apply our normal thought processes, our common sense, to the circumstances of a given situation.” (Dörner 1996, 199)
- “Systems thinking provides a powerful way of taking account of causal connections that are distant in time and space.” (Stacey 2000, 9)

Chaos and complexity theories have also impacted the development of systems thinking, including the treatment of such concepts as emergence. According to Gharajedaghi:

> Systems thinking is the art of simplifying complexity. It is about seeing through chaos, managing interdependency, and understanding choice. We see the world as increasingly more complex and chaotic because we use inadequate concepts to explain it. When we understand something, we no longer see it as chaotic or complex. (Gharajedaghi 1999, 283)

Kasser considers systems thinking to be one element in a wider system of holistic thinking. Kasser defines holistic thinking as follows: "...the combination of analysis [in the form of elaboration], systems thinking and critical thinking" (Kasser 2010).

**Systems Thinking and the Guide to the Systems Engineering Body of Knowledge**

From these discussions, one can see systems thinking as both a set of founding ideas for the development of systems theories and practices and also as a pervasive way of thinking needed by those developing and applying those theories.

The SEBoK is particularly focused on how systems
thinking can support a systems approach to engineered systems.

In order to examine a SoI in more detail, to understand, use, or change it in some way, practitioners are faced with an apparent “systems thinking paradox.” One can only truly understand a system by considering all of its possible relationships and interactions, inside and outside of its boundary and in all possible future situations (of both system creation and life), but this makes it apparently impossible for people to understand a system or to predict all of the consequences of changes to it.

If this means that all possible system relationships and environmental conditions must be considered to fully understand the consequences of creating or changing a system, what useful work can be done?

In many ways this is the essence of all human endeavors, whether they are technical, managerial, social or political, the so-called known knowns and unknown unknowns. The systems approach is a way of tackling real world problems and making use of the concepts, principles and patterns of systems thinking to enable systems to be engineered and used.

The systems principles of encapsulation and separation of concerns in Principles of Systems Thinking relate to this issue. Some of the detail of complex situations must be hidden to allow focus on changes to a system element. The impact must be considered of any changes that might be made across sufficient related system components to fit within the acceptable commercial and social risks that must be considered. Engineering and management disciplines deal with this by gathering as much knowledge as necessary to proceed at a risk level acceptable to the required need. The assessment of what is enough and how much risk to take can, to some extent, be codified with rules and regulations, and managed through processes and procedures; however, it is ultimately a combination of the skill and judgment of the individuals performing the work.

References

Works Cited


Primary References


Additional References


