Circularity for Educators

02. Contextualizing circularity in the architectural discourse

Introducing systems theory

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Scientific Reductionism

The dominant approach of modern science ever since Descartes was that of breaking down complicated problems into their constituent components. Scientists would then have to look into the different parts and then sum up their understandings to explain the whole. This approach is known as scientific reductionism. What's intrinsic to scientific reductionism is the concept of linearity and additivity: understanding of the whole comes from *adding* the understanding of the constituent components of the whole in a *linear* way. The whole is just the sum of its parts.

There are at least two major implications for this assertion. The first is *repetitionality*: same analysis performed by different individuals in different locations will always produce the same results. The second is inherent in the first and is *predictability*. Once the starting point of a problem or a phenomenon is identified, and one identifies and understands its parts, then she can accurately predict how it will evolve.

Scientific reductionism was severely challenged throughout the 20th century by scientific discoveries such as relativism and the study of complex phenomena such as climate, societal behaviour across politics, economy and culture and communications networks. These phenomena often exhibited non-linear, unpredictable behaviour and therefore could not be fully explained when reduced to their parts. They required a different explanatory approach, an *interdisciplinary* approach, where different domains of knowledge would be brought together to produce new understandings of the world. Systems theory was born out of this necessity. Whereas analytical (reductive) thinking concentrated on describing things, systems thinking is synthetic and therefore focuses on explaining. Its contribution was that it shifted attention from identifying elements to how they relate. And in doing so, it contradicted scientific reductionism, claiming that the whole is more than the sum of its parts. Put more formally: *a system has holistic properties not manifested by any of its parts and their interactions. The parts have properties not manifested by the system as a whole.*

General Systems Theory

General Systems Theory made its debut around the 1940's, when biologist Ludwig von Bertalanffy argued that most phenomena in the universe can be seen as webs of relationships between elements. He then coined the term *system* in the 1950's as: "a collection of interacting elements that together produce, by virtue of their interactions, some form of system-wide behaviour".

General Systems Theory offered the basis for integrating disciplines in one unified scientific language and therefore branched into multiple knowledge domains from biology all the way to humanities. It was not a new discipline, only a theory that integrated similarities and relations within science and promoted communication across disciplines. That explains how study of systems became the subject of research for mathematicians like Anatol Rapoport and biologists like Humberto Maturana and Francisco Varela alike. These three in particular helped identify four of the major systems properties: *autopoiesis,* and by that we mean how systems construct themselves; *identity*, as in how systems become identifiable; *homeostasis*, as in how they maintain their stability; and lastly, *permeability*, which refers to how systems interact with their environment.

The world as a system

The world as a self-regulating system (autopoietic) came to centre stage in the early 1970s with the outburst of what was then called a *global* environmental crisis. And by that time, computers -tools that are by nature synthetic and therefore are part and parcel of systems thinking- had become the central means for performing research. Jay Forrester, a systems scientist who had become famous for using computers to build models of cities as systems became involved with a group of scientists known as the Club of Rome. Together they built a computer model of the world, the World3 model using a method called system dynamics. Based on predictions of various maxima and minima they simulated interactions of five global economic subsystems, namely: population, food production, industrial production, pollution and consumption of non-renewable natural resources. In 1972 they published a report called "Limits to Growth". What they discovered was that in one of these scenarios, called the "standard run scenario," the global system would collapse by the year 2070.

Although the results of the simulations of World3 model caused a massive sensation, they did not lead to a major policy reform. Nevertheless, the model provided with a better understanding of the behaviour of the world economic system. And more importantly, for the first time, it linked world economy with the environment showing that if the economic model of continuous growth conceptualized in the 1950's persisted, it would eventually lead planetary limits to the verge of collapse.

Systems theory and circularity

Climate change and depletion of planetary resources continue to be largely unresolved. In this regard, circularity represents one of the notions that can help us restructure our understanding of the world and provide us with ways out of this predicament. Thinking in systems allows for these notions to be tested against the many domains of interest and to explore their potential. For designers, architects and engineers, knowledge of the opportunities and the limitations of any given concept, is the only way to better planning.