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3.6. Three Systems Models that Portray Design Outcomes

The product of design is an organized description, a representation or model of the system we created. Models of social systems are built in view of systems concepts and principles that represent the context, the content, and the process of a particular system. The relational arrangement of these concepts and principles can be organized into systems models. A couple of examples highlight the above statements. Input, transformation, and output are familiar systems concepts. Their relational arrangement gives us the following systems principle: input is transformed into output. Feedback and adjustment are also systems concepts. Their relational arrangement gives us two principles: feedback informs us about the adequacy of output, and based on feedback, adjustments might be introduced in the system. The three systems principles formed above can be arranged into a simple image of a very low resolution general model of systems, depicted in Fig. 3.5.

3.6.1. Building Models of Social Systems

By observing various types of social systems and studying their behavior, we recognize characteristics that are common to them. Once we have identified and described a set of systems concepts that are common to social systems, and observed and discovered between them certain relationships, we can construct systems principles. A systems principle emerges from an interaction and integration of related systems concepts. Next, we can organize related principles into certain conceptual schemes, called systems models.

Following the line of reasoning described above, I constructed three systems models (Banathy, 1973, 1992a). The first, the systems-environment model, defines social systems in relationship to their environment. The second, the functions/structure model, focuses on what the system is. And the third, the

![Diagram of Systems Model](image)

**FIGURE 3.5.** A general model of systems.

The Products and Processes of Design
signed, upon which the system depends for its support and into which it sends its output.
- A description of the boundaries of the system, such as the spatial/physical, geopolitical, economic, social, sociocultural, sociobiological, psychological, temporal, ethical, technological. We also define the nature of boundary judgments to be made: who makes them and how they are made.
- A definition of all input entities that enter the system as well as the output entities that the system sends to its environment. (The source of some of the input–output entities, such as expectations, include not only the environment but also the system as a whole and people in the system.)
- A definition of the relationship and interaction patterns between the system and its environment, including characterization of how these patterns operate and the open or closed nature of the system.
- A description of the processes by which differentiation is made between adjustments within the system and changing the whole system. A description of the arrangements whereby organizational learning is assured in interaction with the environment.

The primary source of description of the systems-environment model is the exploration and definition of the systems environment, which is accomplished in the course of the last spiral of the design process.

3.6.2.2. The Functions/Structure Model

This model provides us the lens through which we can focus our attention on what the system is and what it does. The source of describing this model comes primarily from the resolution of design solutions we generated in the course of working through the spirals of the core definition, specifications, systems functions, and the enabling systems. This model is a snapshot of the system, projecting a still picture image of the system at a given moment in time.

In presenting this model, we describe (1) the mission and the purpose of the system, (2) the specifications that characterize the system, (3) the functions that the system carries out to attain the mission and the purpose, (4) the components and their parts that are engaged in attending to functions, and (5) the relational integration of the components into the structure of the system.

3.6.2.3. The Process/Behavioral Model

This model provides the designers with a lens that focuses on what the social system does through time. It projects a motion picture image of the system we designed. It helps to represent how the system behaves as a changing, living social system in the context of its environment. The process/behavioral model describes how the system does the following:

- Processes input, and more specifically, how the system identifies, receives, screens, and assesses incoming information and resources and how it sends the input on for transformation.
- Transforms input to output, and more specifically, how the system carries out transformation production, transformation facilitation, and transformation guidance.
- Processes output; how the system develops and applies the output model, how it facilitates and guides the output process and dispatches the output into the environment.
- Carries out the assessment of output by testing for, and collecting evidence of, the relevance and adequacy of the output; how the system analyzes and interprets evidence, and, if indicated, how it constructs models of adjustment and how it introduces adjustments. This process also describes operations that should be activated in case there is a need for changing the whole system.

The above description of the three models gives us only an orientation in the use of the three systems models.

Activity #16

Identify core ideas that might guide you to model the design of a system of your interest. Then, use those ideas in sketching out an imaginary model. Enter your findings in your workbook.

Reflections

People who begin to work with the three models often ask: Which model is a true representation of a social system? Which is the most important? The answer is: No single model or even a combination of two is sufficient in portraying social systems. Each has its own function. The systems-environment model maps the space in which the system lives. It portrays systems-environment relations and tells us why the system exists. The functions/structure model depicts what the system is at a given moment in time and how it is structured. The process/behavioral model tells us how the system operates and lives through time. Only if considered jointly, as if superimposed on each other, do these models tell us the real story of a social system. Only if we integrate them do they reveal a system's true nature.

3.7. Developing a Plan for Bringing the Design to Life

The design program reaches its climax in the display of the models of the system. These models are descriptions, conceptual representations of the desired
Design as a Multidimensional Inquiry

The topic of this chapter is social systems design as a multidimensional human activity of disciplined inquiry. First we inquire into the cognitive aspects of systems and design thinking, systems and design knowing and understanding. Then, we unfold multiple perspectives that extend the scope of design inquiry. We explore how values and ethics underlie our actions and our aspirations as we seek to envision and pursue the ideal. Then, we find that creativity and communication are two distinctive and unique properties of the design experience. These dimensions are explored to examine their special role in adding value to social systems design.

The sections of this chapter are organized as follows: (1) systems thinking as the enfolded context of design thinking; (2) design's own special way of thinking and knowing; (3) the use of multiple perspectives in social systems design; (4) the ethics of social systems design; (5) design in search of the ideal; (6) creativity and its central role in design; and (7) design communication and design as conversation.

From an integration of these domains we see design emerging as a system of activities that touches all domains of the human experience.

5.1. Systems Thinking

Our interest in this work is systems design and, in this chapter, design thinking. As we explore the conceptual realm of design thinking, our first task is to draw the boundaries of our exploration. Design is one of several disciplined inquiry modes we use in the domain of social systems. Thus, the boundaries of our inquiry into design thinking must be extended to include the ways of thinking we employ in viewing and working with social systems. We call this way of thinking systems thinking.

Laszlo (1972) views the history of science as an alternation between atomis-
tic and holistic thinking. He suggests that while early scientific thinking was holistic but speculative, modern scientific thinking is empirical but atomistic.

Neither is free from error, the former because it replaces factual inquiry with faith and insight, and the latter because it sacrifices coherence at the altar of facticity. We witness today another shift in ways of thinking: the shift toward rigorous but holistic theories. This means thinking in terms of facts and events in the context of wholes, forming integrated sets with their own properties and relationships. (p. 19)

Flood and Jackson (1991) suggest that the concept of "system" does not refer to things in the real world but to a particular way of organizing our thoughts about the world. I always shock incoming students at their orientation when I say that there is no such thing as a system out there. Systems exist as mental pictures in our minds. Saying this another way, systems thinking structures thinking about whatever entity or phenomenon we become aware of and assign meaning to. Systems thinking is the conceptual environment of design thinking and design thinking is embedded in systems thinking. In this section we paint a broad-stroked picture of systems thinking as the conceptual parent of design thinking.

By studying and working with social systems in the course of the last several decades, we developed an increasing realization of the inquiry power we can gain from systems theory and systems philosophy and their application through systems methodologies. We have liberated ourselves from the constraints and limitations of the analytically oriented and reductionist inquiry mode of traditional science. Systems inquiry enables us to orchestrate the findings of various scientific disciplines within the framework of systems thinking and to develop and apply systems approaches, models, and methods in working with social systems. Systems thinking, and its relevance to design thinking, is explored here by (1) exploring systems thinking in social systems inquiry, (2) reviewing the evolution of systems thinking, and (3) considering how the ideas of systems philosophers have shaped systems thinking.

5.1.1. Systems Thinking in Social Systems Inquiry

Systems thinking is a property of the thinker, who organizes internalized systems ideas, systems concepts, and principles into an internally consistent arrangement, using a systems way of viewing and understanding, in order to establish a frame of thinking. As we observe what is "out there," this frame of thinking enables us to reflect upon what we experience; thus we construct our own meaning. We create our own cognitive map, which is our own interpretation of the out there. As we view and work with social systems, systems thinking enables us to create our own cognitive map of the systems of our interest. It enables us to explore and understand those systems, and describe:

- The characteristics of embeddedness of social systems as they enfold their component systems, and as they are nested in the community and in the larger society.

5.1.2. The Evolution of Systems Thinking

The evolution of systems thinking during the last four decades or so is mirrored in the evolution of design thinking. The evolution of systems thinking is elaborated in the work of Jackson (1992). The various stages of this evolution are briefly outlined here, showing how they have been manifested in the evolution of design thinking.

5.1.2.1. Hard Systems Thinking

The first stage of this evolution is marked with the label of "hard systems thinking," which is a mode of thinking associated with operations research, systems analysis, and systems engineering. Hard systems thinking was mirrored in design thinking. We defined design as an orderly sequence of systematic
activities, practiced by expert designers. Jones (1980) noted that systematic design keeps logic and imagination, as well as problem and solution, apart by an effort of will and by external rather than internal means. Systematic thinking, a key characteristic of engineering design, dominated the thinking of the design community during the sixties. Working in the arena where the objective of a system can be clearly stated up front, the systems engineer devises ways to improve output in the most cost-effective way. But this approach does not work in the context of ill-structured social systems.

The successes of hard systems thinking in its realm of applications led to attempts to transfer hard systems thinking into the social systems environment. This transfer was labeled social engineering. By the middle of the sixties we recognized that hard systems thinking and engineering applications were not only useless in the social systems arena, but they were dangerously counterproductive, resulting in some disastrous applications. Recognizing this state of affairs, we looked for a new orientation in systems thinking.

5.1.2.2. Organismic Systems Thinking

This orientation emerged from an open (organismic) systems orientation. It was grounded in a general theory of systems, represented in the works of the founders of the systems movement, including Bertalanffy, Boulding, and Rapoport. They recognized that organisms should be treated as wholes, that they have emergent properties that are unique to each, properties that are not manifested in the parts. This new systemic orientation was transferred into the social systems arena, and it led to a search for a systemic and holistic orientation in working with social systems. This orientation gave rise to a structuralist perspective that sought to define features of viability in dealing with sociotechnical systems. This trend was manifested in Forrester's (1969) "systems dynamics," Beer's (1979) "organizational cybernetics" and viable systems approach, and the "living systems process analysis" approach based on Miller's (1978) living systems theory.

5.1.2.3. Soft Systems Thinking

The search for systems thinking that would be more appropriate to social systems was rewarded by the emergence of soft systems thinking. Soft systems thinking brought about a sea change in design thinking in the social systems arena during the late seventies and eighties. Soft systems thinking established itself as clearly distinct and distinguishable from the two systems thinking types mentioned above. It was quickly embraced by scholars and practitioners of the design inquiry community through the works of such design scholars as Churchman, Ackoff, Checkland, Nadler, Cross, and Warfield.

Checkland (1981) suggests that "systems thinking implies thinking about the world outside ourselves, and doing so by means of the concept of system" (p. 3). Systems thinking orders our thoughts by making conscious the concept of wholeness inherent in the word "system." In Checkland's formulation the two pairs of core concepts of systems thinking are (1) hierarchy in systems and the emergent properties at the various systems levels and (2) communication and control in human systems. Based on soft systems thinking, Checkland developed the multistaged soft systems methodology, that was presented in Part I of this work.

Ackoff (1981) says that systems thinking reverses the analysis-focused machine-age thinking that aimed at understanding an entity by decomposing it, explaining its behavior by its parts, and aggregating these explanations as the explanation of the whole. In contrast, systems thinking identifies the whole that contains its parts, explains the behavior of the whole, and then explains the parts in terms of their role(s) and functions within their containing whole. Checkland's ideal systems approach to systems design is based on the thinking described above, which he calls systems-age thinking. His design model was also introduced in Part I.

5.1.2.4. Critical Systems Thinking

A new trend in systems thinking has emerged in recent years. Pioneered by Ulrich, Jackson, Flood, and others, it is called critical systems thinking (CST). This orientation challenges some of the earlier aspects of systems thinking. Critical systems thinking is reflected in Ulrich's critical systems heuristic and Flood and Jackson's total systems intervention. (These also mark a new trend in design thinking.) CST embraces a set of core commitments, such as critical awareness, social awareness, human emancipation, and complementarity (Jackson, 1992). Critical awareness closely examines the values and assumptions that enter into systems inquiry, such as systems design. It provides tools that are useful for applying critical awareness, such as Ulrich's (1983) critical systems heuristics. Social awareness recognizes social and organizational pressures that guide systems interventions. It aims to guide users of various intervention approaches to contemplate the social consequences of their planned approach. This commitment also calls for an open and free debate on the justification of the use of a proposed approach. Human emancipation aims to ensure the well-being of all individuals and the full development of their human potential. It aims to prevent coercion and exercise of power that would prevent open and free discussion (for example, in design inquiry). Complementarity and informed development of all varieties of systems approaches is another commitment of CST. Various systems trends express various rationalities and theoretical positions. CST suggests that the positions and the methodologies that arise from these theories should be respected and their development should be encouraged. CST has a commitment to the complementary and informed use of all the various
systems approaches whenever their use is appropriate to the context of various social conditions and situations. The relevance of these commitments of CST to systems design is more than obvious. Jackson (1995) sums up the aims of CST, saying that "it does not seek to recreate a unified systems theory—to overcome fragmentation through some totalizing vision. But it does want to take us beyond fragmentation by supplying means through which we can be critical in the use of various systems ideas and methods at our disposal" (p. 40).

5.1.3. Systems Philosophers and Their Systems Thinking

Contemplation of systems thinking is the primary domain of systems philosophers. A review of the contribution of several systems philosophers will enlighten our understanding and appreciation of systems thinking. Jackson (1995) notes that many of the ideas we associate today with systems thinking, such as rationality, comprehensiveness, human well-being, emancipation, and progress, are closely related with Kant's notion of "enlightenment." Kant's concern was with man's release from "self-incurred tutelage," with people freely thinking and deciding for themselves.

5.1.3.1. Churchman and Company

A most salient contribution to systems thinking in the social systems arena has been made by West Churchman. His contributions present an internally consistent set of core ideas of systems thinking and social systems inquiry. His major works (Churchman, 1968b, 1971, 1979, 1982) are grounded in the ideas of the philosophers of the Enlightenment (e.g., Kant). Churchman sets forth several core themes of systems thinking, such as whole systems judgment, the ethics of whole systems, unbounded systems approach, unfolding, the sweep-in process, and consideration of future generations. (These core ideas will be discussed later.) Churchman suggests that in social systems inquiry problems are unbounded and tightly connected. Every problem is an aspect of all others. This notion, he says, was already advanced in the fifth and sixth centuries by Greek scholars. One of them, Anaxagoras, said that no matter how far one goes in breaking an object down to parts and subparts, a resulting piece still contains everything—"in everything is everything." But the reductionist Western scientific community rejected this notion and promoted bounded inquiry. Churchman (1982), a student of the Greek scholars, believes that "we need an 'unbounded' systems approach which sweeps-in all that is relevant to our inquiry. The ethics of the whole system includes a study of the ethics of humanity, not within a problem area, but universally" (p. 8). All issues in the social domain are inherently ethical and not factual. They are first of all prescriptive and not descriptive. He calls for determining the ethics of the whole system. For example, someone concerned about education should first consider the nature of an ideal society and then ask how education can serve it. In our arrogance we often assume in our inquiries that we, the stakeholders of the present, are what counts. Churchman passionately asks: What are the implications of our inquiry for future generations? This forward-looking sweep-in is one of his primary imperatives. He also calls for a focus on the invariants of humanity, the aspirations, the values, and the hopes of our collective humanity. All the core ideas mentioned here are germane to social systems design. You will be asked to explore these later.

Many of us consider ourselves to be in Churchman's company. Here I refer to the recent work of Mitroff and Linstone (1993). They follow Churchman's thinking as they put forth the notion of unbounded systems thinking (UST) as the new thinking called for in the information/knowledge age. They found that in UST "all branches of inquiry depend fundamentally on one another, and the widest possible array of disciplines, professions, and branches of knowledge—capturing distinctively different paradigms of thought—must be consciously brought to bear on our problems" (p. 91). UST is not governed merely by conventional logic or rationality. It involves "considerations of justice and fairness as perceived by various social groups and consideration of personal ethics or morality" (p. 91). The idea of UST becomes one of the imperatives of design thinking.

5.1.3.2. Vickers

The systems philosopher Geoffrey Vickers (1981) presents a broad-based view of systems thinking. He suggests that although all systems have common characteristics, there are significant differences between them as there are between biological and social evolution. His main interest lies with the ecology of systems ideas as they relate to social systems—"the effect of systems thinking on our outlook on life and our philosophy of life" (p. 19). This focus tends to correct some of the "illicit" extensions of ideas (to the social realm) that have been derived from the natural sciences. In Newton's world, inert objects stayed put unless moved by some force. By contrast, our world is one of active and dynamic reactions "in which stability, not change, requires explanation" (p. 19). The interface between a social system and its environment distinguishes inner relations from outer. Inner relations hold social systems together and enable the system to act as a whole in the context of its environment. The scope of the system's "external relations depends on the coherence which its internal reactions secure. We are accustomed to regard 'relating' as something which entities do, rather than something which they are. Should we rather view all entities as systems, created by their relations which sustain them?" (p. 20.) Exploring identity, continuity, and change, Vickers asks: When does a system retain its identity and continuity through change and when does it itself vanish or become something new? These questions are of great practical concern in the context of systems design.