The relevance of cybernetics to design and AI systems

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Knowledge of cybernetics is increasingly relevant to both *what* and *how* designers design.

Cybernetics is the science of feedback, information that travels from a system through its environment and back to the system. A feedback system is said to have a goal, such as maintaining the level of a variable (e.g., water volume, temperature, direction, speed, or blood glucose concentration). Feedback reports the difference between the current state and the goal, and the system acts to correct differences. This process helps ensure stability when disturbances threaten dynamic systems, such as machines, software, organisms, and organizations.

Simple feedback systems have goals imposed on them. Second-order systems, which observe themselves, may adjust their goals. Second-order systems don't just react; they may also learn. When two first-order systems engage, the result is *interaction.* They push each other. When two second-order systems engage, the result may be *conversation,* an exchange about both goals and means. As discourse on cybernetics expands to second-order systems, issues of ethics emerge.

Cybernetics offers a language (both vocabulary and frameworks) that enable scientists (and designers and others) from different domains of knowledge and practice to communicate—to describe the structural similarities of systems and to recognize patterns in information flows. This shared language is especially useful in analyzing, designing, and managing complex, adaptive systems, which are intertwined with many of today's wicked problems.

What designers design In the past 30 years, design practice has expanded from a focus on the form of objects to a broader concern for interaction with systems and product-service ecologies (systems of systems).

Today's products are often smart (controlled by microprocessors), aware (full of sensors), and connected (to each other and to cloud-based services). These products and services, and our interactions with them, generate increasing volumes of data—just when computer processing is becoming an on-demand utility and pattern-finding software (AI) is advancing.

Today's designers must consider how information flows through these systems, how data can make operations more efficient and user experiences more meaningful, and how feedback creates opportunities for learning. Knowledge of cybernetics can inform these processes.

How designers design Traditionally, designers delivered plans-for-making, which clients approved before manufacturing large quantities of finished things. In mass production, risks are high (set-up costs, costs of materials, and costs of fixing mistakes), causing designers to obsess about perfecting their plans-for-making.

Designing for systems and product-service ecologies is different. Today's information systems are not mass-produced. In the language of systems, they are emergent. They are rarely defined *a priori*

and *in toto;* rather, they grow over time and key features evolve through interaction with users and the environment.

Now, instead of finished plans, designers must create possibilities for others to design and make; designers must build flexible platforms, defined by patterns and rules for interaction *and* rules for changing the rules. Instead of making decisions about *what* and *how,* designers facilitate conversations about *why* and *who.*

In sum, designers are now engaged in designing first and second-order cybernetic systems, and sometimes, systems for conversation—using methods that draw on cybernetics. These changes suggest that knowledge of cybernetics and other aspects of systems thinking, such as systems dynamics and complexity theory, is a prerequisite for practicing design going forward.