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Connecting Things: Broadening design to include systems, platforms, and product-service ecologies

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Traditionally, design practice and design education have focused on giving form to physical *things*—apparel, buildings, messages, tools, and vehicles—the artifacts that constitute *material culture*. These artifacts are also the material of the traditional design disciplines—apparel design, architecture, graphic design, product design, and transportation design.

Recently, the field of cultural studies has turned much of its attention to physical *things*—not just how they are used, but also how they are designed, produced, and distributed. Somewhat paradoxically, just as the field of cultural studies is making its *material turn*, design practice is making a turn of its own—an *immaterial turn*—focusing less on physical things and more on connections between them. Increasingly, design practice is concerned with nodes *and links*—networks, systems, and communities of systems. These new concerns have given rise to new disciplines—business design, interaction design, service design, social innovation design, and trans-disciplinary design.

Design practice is not so much *turning away from things* as it is *connecting things*. Three main types of connections are involved. 1) Organizations are finding that opportunities for creating new value lie primarily in connecting products to services and experiences. 2) Design discourse increasingly recognizes that things are connected to ideas; that artifacts are tied to use, meaning, and context; and that design practice is bound up in language and conversation. And 3) New technologies are connecting things to data networks and complex systems that analyze the data, learn from it, and act on what they learn. The process of *connecting things* has already begun to broaden design practice from its traditional focus on stand-alone products to also include systems, platforms, and product-service ecologies.

From scarcity to commodity

For most of history, people made *things* by hand, one at a time, for themselves or their neighbors. They fit *the-thing-they-were-making* to a particular purpose, within a particular context, using materials and tools ready-at-hand. And because *making-things-by-hand* takes a great deal of time, for most of history, for most people, *things* were scarce and expensive. People had to work hard to gather materials and make what they needed to survive. (For many people, that is still true. Whether we can extend the economy of abundance to everyone is unclear. Even less clear is whether the earth can sustain the attempt.)

As production increased, an individual *thing* could be replaced by another *thing* that was almost the same. Substitution became possible. As *things* became interchangeable, they lost some of their particularity. They became less attached to particular people and particular places. They became not *things-in-their-own-right* but rather examples of a *class-of-things*. They became less individually recognizable, less special, and less valuable. A long and accelerating process unfolded. As trade developed, specialization became possible, and standardization followed. Standardization can increase efficiency, reduce cost, and create competitive advantage. Eventually, craftsmen who had designed as they made a particular thing, for a particular person, turned to producing many copies of the "same" thing, for "the market"—they began to manufacture. That shift separated *planning-for-making* from making itself. And design emerged as a "profession."[1]

Harnessing waterpower and then steam power dramatically increased the speed of *the-making-of-things*; it turned craft-production into mass-production, and brought about the industrial revolution. The industrial revolution led to unprecedented rates of production, turning more and more things into *commodities*—things that are essentially the same and differ only on price.

At first, when a new *thing* is manufactured, it's relatively rare, it commands a relatively high price and thus manufacturers are able to make a profit easily. This situation often tempts other manufacturers to begin making the "same" things, increasing quantities available for purchase. With more goods available, competition increases, and prices fall. Continuing to manufacture more of the "same" things becomes a losing proposition, and in order to survive, businesses have to look elsewhere to find value and difference.

Many sectors have gone through this process. Personal computers are a classic example. In 1981, IBM offered its first PC for $1,565 (more than $4,000 in 2015 dollars), featuring a 4.77 MHz processor, 16 KB of RAM, and no hard disk. Its PC line earned billions of dollars and became the industry standard. Nevertheless, twenty-four years later, IBM recognized it could no longer compete and sold its PC business to Lenovo. Today, Lenovo offers a $99 PC featuring a 1.33 GHz processor, 2 GB of RAM, and a 32 GB hard disk[2]—nearly 300 times faster, with 125,000 times more RAM, and the added benefit of a hard disk, for about 6 percent of the cost of the original IBM PC (less than 3 percent when adjusted for inflation). That's a once scarce thing becoming a commodity.

When products become commodities, manufacturers look for ways to differentiate them—ways to make them unique again. For a time, quality materials, quality manufacturing, and quality product design offered differentiation. As competitors begin to match quality, businesses must look elsewhere for differentiation and value.

From products to services

In 1998, Pine and Gilmore described the "experience economy." For example, raw coffee beans are a commodity worth only a penny or two per cup of brewed coffee. Roasting and grinding the beans creates a *product* worth $0.05 to $0.25 per brewed cup. Converting coffee beans from a *product* to a *service*—brewing and serving a cup of coffee at a diner—increases the value to $0.75 to $1.50. And wrapping a cup of coffee in a Starbucks *experience*—treating oneself to something special—increases the value to $2.00 to $5.00.[3]

As the economy has moved from manufacturing to services, products have not disappeared. Instead, services have become a way to deliver products, in part because services are a way to differentiate products and increase their value. GE, for example, builds jet engines *and* sells aircraft "up-time"—leases for engines and their maintenance that guarantee uninterrupted service. Auto industry experts report that almost 25 percent of new cars are leased.[4] Personal computer software used to be sold in *shrink-wrapped* boxes, but now boxed software is rare. Increasingly, software applications are *leased* (by Adobe, Autodesk, Microsoft, and many others) rather than sold.

Former *Wired* editor Kevin Kelly puts it well:

> commercial products are best treated as though they were services. It's not what you sell a customer; it's what you do for them. It's not what something is; it's what it's connected to, what it does. Flow becomes more important than resources. Behavior counts.[5]

Complex hybrids are forming. Services are delivering hardware; hardware is connecting to applications; and applications are connecting to each other—all at increasing speed—giving rise to what John Rheinfrank and Jodi Forlizzi have termed "product-service ecologies." Forlizzi writes, "networks of products, services, technology, people, and collective and collaborative interaction are generating value for the populations they serve."[6] For example, unlike Samsung MP3 players, iPod was not a stand-alone product; it was an integrated system of hardware, software, networked applications, and *content*—a dynamic *product-service* ecology. Apple has cautiously opened its ecology to others, teaming with Nike to extend the iPod system—and more recently publishing its HealthKit, HomeKit, and ResearchKit APIs (Application Programming Interfaces), enabling broader access and turning smart-phones into hubs of body-area networks and home-management networks.

Amazon's Kindle-Reader-Whispernet-Store system is another *product-service* ecology. At the launch of a new Kindle Fire, Amazon CEO Jeff Bezos said, "I think of [the Kindle] as a service. Part of [it] is of course the hardware, but really, it's the software, the content, it's the seamless integration of those things."[7]

Systems thinking is not new to business. Kodak created an early product-service ecology, offering cameras, film, and processing services. Mass-production has long included assembly lines, supply chains, distribution networks, and inventory management systems. Infrastructure—physical networks, such as canals, roads, and telephone lines—have been vital to economic growth.

The idea that utility arises through connections may be applied not only to the special class of things that are systems and infrastructure but also to all human-made *things*. Several critics have suggested that *things* exist within a complex social-technical-linguistic matrix (a web of relationships connecting people, things, and ideas). For example, Humberto Maturana and Francisco Varela developed the theory of autopoiesis (literally "self-making"—the processes through which living systems create and maintain themselves), later with Niklas Luhmann and others extending the idea to social systems. And Michael Callon, Bruno Latour, and John Law proposed Actor Network Theory (ANT), a method in which artifacts are described as participants in social and semiotic systems.

Archeologist Ian Hodder uses the term "entangled" in describing relationships between humans and their things. And in exploring these relationships, he discusses Heidegger's notion of "assembly" or "gathering," made famous through the example of a simple *thing*—a jug. Hodder explains:

> for Heidegger there is an aspect of the jug that is not captured by describing it as an entity or an object. The jug takes what is poured into it, and then pours the liquid out. The water and wine come from a rock spring or from the grape growing in the earth. The pouring out can quench thirst for humans or be a libation to the gods. So the jug connects humans, gods, earth and sky. It is this 'gathering' that makes the jug a thing. Heidegger refers to Old High German in which a thing means a gathering to deliberate on a matter under discussion. The jug, as thing, gathers together for a moment humans, gods, earth and sky.[8]

Product-service ecologies, like Heidegger's jug, gather together people, smart devices, software applications, and human services. These gatherings must be designed. In 1969, cybernetician Gordon Pask noted that a

> building cannot be viewed simply in isolation … structures make sense as parts of larger systems that include human components and the architect is primarily concerned with these larger systems; they (not just the bricks and mortar part) are what the architect designs.[9]

Systems of manufacture and infrastructure have been explicitly designed, refined, and iterated. For a few designers, systems and infrastructure have always been *things-to-be-designed*—the material of design. Systems and networks can be treated as *sets-of-elements* and as *wholes*—just as stand-alone products are often both *collections-of-components* and *wholes*. A pot, lid, handle, whistle, and spout, for example, comprise a teapot, which we tend to see as a whole, until one of the parts breaks, thrusting itself into our view. This notion applies to systems of manufacture and infrastructure as well. ANT describes the process of parts forming wholes as *punctualization* and the process of wholes decomposing into parts as *depunctualization*. Indeed, mediating *between* the parts and whole—and the whole and the larger systems in which it is enmeshed—is a key element of what designers have always done.

Until recently, however, the vast majority of designers did not explicitly design systems. That situation began to change with the advent of the internet, which is making stand-alone products less and less viable. Oracle product manager Tim Misner argues that, "All products want to be web-sites." That is, they want to be systems for collecting information. And soon, most web-based applications will be connected.[10]

From increasing power to adding information

In the mid-nineteenth century, Western economies shifted from an agricultural basis (using human and animal power) to a manufacturing basis (using the power of falling water or steam). Adding power to *things* increased their value. A lot. As electric power emerged, motors were incorporated into many *things*, creating "powered" devices—air conditioners, cameras, electric toothbrushes, vacuum cleaners, and washing machines, for example.

In the late twentieth century, Western economies began to shift from products to services and from manufacturing work to knowledge work—to an *information economy*. In part, adding information to things meant incorporating microprocessors—the chips at the core of personal computers—creating "smart" devices. For example, the average car includes at least thirty microprocessors; some luxury cars include as many as 100[11]. Most new devices that include a motor are now likely to include a microprocessor—air conditioners, cameras, robot vacuum cleaners, smart toothbrushes, and washing machines, for example.

The move from industrial economy to information economy might appear to be a sequence—an evolution. Former *Wired* editor Kevin Kelly points out, however, that the industrial revolution "was not a preliminary primitive stage required for the hatching of the more sophisticated information revolution." The industrial revolution could not have moved forward without harnessing information to regulate manufacturing devices. Almost from the beginning, James Watt applied the fly-ball governor to regulate steam pressure in his engines and avoid explosions. Kelly adds, "The difference between a car and an exploding can of gasoline is that the car's information—its design—tames the brute energy of the gas."[12] Kelly's observation is important. Designing is not only making things. Designing is *adding information* to things. Designing is building-in what we have learned. In other words, designing is learning—a series of experiments, a trial-and-error process directed toward a goal, a *first-order* feedback loop.[13]

Many designers describe a four-step process: 1) analyzing the current situation; 2) framing the situation and representing it in a model; 3) reconfiguring the model to improve the situation; and 4) realizing the model in a tangible form—making something. This four-step process corresponds with organizational learning expert Ikujiro Nonaka's iterative model of "knowledge creation"—known as SECI—1) Socialization or "empathizing" (moving from tacit to tacit); 2) Externalization or "articulating" (moving from tacit to explicit); 3) Combination or "connecting" (moving from explicit to explicit); and 4) Internalization or "embodying" (moving from explicit back to tacit). The parallels between these models suggest that designing is creating knowledge and that design organizations are learning organizations.[14]

Chris Argyris, Stafford Beer, Peter Senge, and others describe organizations as systems that learn. Learning systems are *second order*; they don't merely achieve a pre-set goal, they also discover their own goals through conversations. When learning systems interact, they have "conversations" during which they learn from one another. Philosopher Donald Schön has described design as "a conversation with materials" and "a conversation with situations."[15] Architect Ranulph Glanville has described design as "conversation for action."[16]

The "conversations" that designers have help them learn—whether that means solving problems or facilitating agreement on goals—and then designers embody what they've learned in *things* they make. They connect ideas and *things*. That is, they add *information to things*.

The process of learning—of adding information to things—can be seen in the evolution of a product. Consider an example from the healthcare industry. The difference between a poison and an antidote is information. A drug is not merely a *molecular entity*; a drug is chemistry *plus knowledge-in-action*. In order to bring a drug to market, a producer must document its effectiveness and safety, indications and contra-indications, and potential interactions and other risks. This knowledge must be made explicit in a series of regulated documents—filings, package inserts, product data sheets, instructions for use, and packaging. In addition, the producer must have processes for ensuring quality components and quality manufacturing, and the producer must also have knowledge about stability of the compound and how it needs to be controlled during delivery.

New products rarely exist in isolation. Making a drug usable for patients often requires development of multiple *connected* systems:

—Systems for funding research and development, creating and protecting intellectual property, and rewarding investment
—The drug–knowledge–package system
—Compound sourcing, manufacturing, and distribution systems
—Drug delivery devices
—Systems for educating physicians and patients
—Systems for helping patients integrate the drug into their lives
—Insurance and government payment systems
—Government regulatory systems and professional association practices

Adding code to smart devices is another way to *add information*. Less obvious is that mechanical devices include code of their own—the gears in a mechanical watch are a sort of program, a pre-defined process. Even less obvious, the product's form and material represent accumulated knowledge—that is, *added information*. The product's very presence in the market likewise attests to knowledge learned—and *information added* to the network of systems in which any modern product is enmeshed.

From form giving to design thinking

For most of the twentieth century, design practice focused on artifacts—on giving form to things. Psychologist and designer Steve Wilcox tells of his first job at the venerable Herbst Lazar agency. His design team went to Ford to visit an engineering team; the person ushering them in opened the door and shouted, "The skinners are here."[17] "Skin" referred to the outside of the product—the surface that encloses it. In 2000, Apple CEO Steve Jobs challenged this view of design.

> In most people's vocabularies, design means veneer. It's interior decorating. It's the fabric of the curtains and the sofa. But to me, nothing could be further from the meaning of design. Design is the fundamental soul of a man-made creation that ends up expressing itself in successive outer layers of the product or service.[18]

Steve Jobs transformed popular perception of design. He connected design with cutting-edge technology and with serious business. He demonstrated that good design could make money. He saved Apple from bankruptcy and went on to create a series of iconic products—and the world's most valuable company.

The business world noticed. Apple became an exemplar—an "existence proof" that design could make a difference in business. Apple's success opened the door for *design thinking*—repositioning design from a service that delivered renderings to a business consulting practice that promised innovation. Bruce Nussbaum beat the drums at *Business Week*. IDEO demonstrated the idea on ABC's *Nightline*. Design thinking became so fashionable that the *Harvard Business Review* ran cover stories. Dean Roger Martin even re-organized the University of Toronto's Rotman School of Business around design thinking.

In a sense, design "dematerialized". Practice moved, to an extent, from *making things* to *making money* (an abstraction) or at least from *making things* to *creating value* (another abstraction). Practice likewise shifted focus from drawing things to discovering insights and turning them into innovations, and from *form giving to design thinking*.

This "dematerialization" process didn't happen overnight; it had been underway for a long time. Challenges to the frame of design as solely about *giving form to things* began to emerge in the late 1950s. The design school HfG Ulm introduced students to semiotics and cybernetics. The design methods movement (a direct predecessor of the design thinking movement) focused on frameworks and processes. Political economist and computer scientist Herbert Simon described designing as a process that plays a role in all the professions. In the 1960s and 1970s, Scandinavian trade unions helped introduce participatory design.[19] Horst Rittel framed designing as building arguments. Later, Richard Buchanan, building on the work of Richard McKeon, framed designing as a form of rhetoric. Victor Papanek raised questions about "the moral responsibilities of the designer" and the problems of "shrouds … appearance design, styling, or design 'cosmetics'."[20] Buckminster Fuller proposed "the comprehensive designer" as "an emerging synthesis of artist, inventor, mechanic, objective economist and evolutionary strategist."[21] Lucy Suchman, Rick Robinson, and others introduced ethnography to design practice. Robert Venturi and others prodded architects to consider context, meaning, and the vernacular. And Klaus Krippendorff, Michael McCoy, and others prodded designers to consider "product semantics."

Design work for the military, particularly on controls for jet aircraft, led to the study of human factors and ergonomics. It also led to the involvement of scientists in discourses about design. Psychologist James J. Gibson introduced the idea of affordances—"what [an environment] *offers* the animal, what it *provides* or *furnishes*."[22] Cognitive scientist Donald Norman brought Gibson's idea of affordances to the attention of designers, "Affordances provide strong clues to the operation of things. Plates are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for bouncing. When affordances are taken advantage of, the user knows what to do just by looking: no picture, label, or instruction is required."[23] Contemporary European philosophers, such as Asle Kiran and Peter-Paul Verbeek, have also begun to discuss affordances. They note that "what Heidegger calls the items' 'specific thingly character,' [is] a concept that roughly corresponds to affordance."[24]

Over the last fifty years, these ideas have entered design discourse, and some have seeped into design practice and design education. The contemporary mania for design thinking has also begun to bring these ideas to business. In the process, the designer's role has expanded from simply *making what's requested to participating in discussions about what should be made*. At a recent AIGA conference, the head of design for a large corporation lamented, "The worst part about my job is the politics." Yet, the designer's job *is*, in large part, politics. Design that matters has always been about coming to consensus on what matters—what we wish to conserve—and that's an essentially political question.

From applications to platforms

While commodification is bad news for the sector in which it occurs; it can be good news for other sectors. Google, for example, benefitted enormously from the commodification of the PC sector. Early internet services deployed large, expensive, special-purpose servers to handle high volumes of traffic. In 1999, Netscape (at the time by far the world's largest internet service) ran on just fifteen very large servers from Sun Microsystems (then the leading supplier of web servers). Just a few years later, Google took a very different tack, employing huge numbers of cheap personal computers. During "the internet bust" of 2000 Google quietly snapped up PCs from failed start-ups, paying pennies on the dollar and amassing a huge network.[25] Analysts estimate that Google's platform includes more than 2 million machines, and it continues to grow.[26]

Google's massive platform was a competitive advantage. Early in Google's development, its product managers and engineers were able to rely on Google's platform to quickly add capacity and launch new products almost overnight. Competitors like Apple, Microsoft, and Yahoo were slow to catch on to this change and what it meant.

Early on, Amazon founder Jeff Bezos recognized the need to take a connected systems approach to Amazon's internal applications. Former Amazon software architect Steve Yegge points out that:

> Amazon transformed internally into a service-oriented architecture … SOA-driven design enables Platforms. Bezos realized long before the vast majority of Amazonians that Amazon needs to be a platform … an extensible, programmable … repurposable computing platform.[27]

Amazon's platform eventually became a product—Amazon Web Services (AWS). AWS runs many start-ups and several large, commercial services, including Airbnb, Flipboard, Netflix, Pinterest, and Redit. (What's more: some of the services running on AWS are themselves platforms. For example, Pinterest is a platform for sharing photos and other content.) Amazon's stock price has recently shot up as investors have begun to see the value of the AWS platform. According to Yegge, "A product is useless without a platform, or more precisely and accurately, a platform-less product will always be replaced by an equivalent platform-ized product."[28]

Netscape founder and VC fund manager Marc Andreessen defines a *platform* as "a system that can be programmed and therefore customized by outside developers—users—and in that way, adapted to countless needs and niches that the platform's original developers could not have possibly contemplated, much less had time to accommodate."[29]

Smart-phones are a classic example of platforms; Apple and other manufacturers leave a "space" in which third parties can build and sell add-ons—"apps." (The device maker is the first party; the device buyer is the second party; and app developers are the third parties.)

Platforms create value by creating opportunities for others to create value. Adding users makes the platform more attractive to developers. More developers mean more "apps." More apps mean more users, which makes the platform more attractive to developers. Each new user can make the platform more useful to all users. For example, Facebook becomes more interesting as more of your friends join.

What platforms really do is create frameworks for cooperation, and in so doing, they speed-up evolution. These things are sometimes called engagement platforms; more generally, they are platforms for cooperation.

Organizations have always been subject to pressure from consumers. Recently, however, some are inverting this relationship, turning their organizations into platforms *through which* members can engage each other and sometimes work together for social change. The company Patagonia has explicitly embraced these transformations. Patagonia began by designing things, developing a new outlook on climbing gear and outdoor clothing. As the company grew, founder Yvon Chouinard became concerned about his suppliers' material sourcing and labor practices. He has worked to reform Patagonia's systems for qualifying vendors—and the vendors' systems. He's also shared what he's learned and worked to reform the apparel industry, developing partnerships, associations, and training and certification programs. Patagonia has also taken strong positions on environmental issues and enlisted the support of its customers.[30] More recently, Patagonia has sought to engage its customers through on-line and mobile membership programs, repair services, corporate philanthropy, and sharing stories; some of its programs even encourage members to buy fewer products.

From transactions to relationships

As *things* become more connected, they (and the systems in which they are enmeshed) are making it possible for producers and consumers to become more *connected*. Isolated transactions are giving way to on-going relationships. Even the formerly sharp line between producing and consuming is blurring.

In the *thing-focused* world of stand-alone products, the distinction between producer and consumer was clear, bridged only by a brief transaction—the *sale* of a thing. Both parties knew where they stood and stayed on their side.

In the emerging connected world of product-service ecologies, the distinction between producer and consumer is less clear. Services are co-created at the point of delivery; by definition, services require interaction between provider and user, often over an extended period. Thus, recognizing customers—remembering who they are, past interactions with them, and what they value—is becoming essential to organizations, just as it always has been essential for people to cooperate.

Once customers are recognized, relationships become possible. Organizations start to refer to customers as *members*. At first, this may be mostly aspiration. But the potential exists for membership to grow into a reality—for organizations to engage their members deeply in all aspects of their work. Engaging members—creating spaces in which relationships can grow—becomes a design task, a *thing* to be designed.

The larger context

The Economist forecasts that by 2020, more than 50 billion devices will connect to the internet. That's quite a gathering of things, people, and information. It will change the economy and social structures, and it will transform design practice.

Recently, MIT Media Lab Director Joi Ito summed up how design is changing,

> Design has also evolved from the design of objects both physical and immaterial, to the design of systems, to the design of complex adaptive systems. This evolution is shifting the role of designers; they are no longer the central planner, but rather participants within the systems they exist in. This is a fundamental shift—one that requires a new set of values.[32]

The fundamental shift that Ito mentions extends beyond designing; it is part of a larger cultural shift, from the Age of Enlightenment to "the Age of Entanglement" (as Thinking Machines co-founder Danny Hillis calls it).[33] Like the paradigm shift from the medieval, mystical view of the world to the rational Enlightenment view, this new paradigm is a fundamental change in how we explain the world. The Enlightenment replaced "unseen spirit forces" as explanation with "empirical evidence" as explanation—"A" causes "B", and "B" causes "C". The framework of "direct causality" has been spectacularly successful in improving the human condition, but it tends to view parts of the world in isolation, rather than taking a whole systems view. And over the last century, methods that rely on controlling single variables have run into challenges, as the leading edge of technology moves increasingly to complex, multivariate problems.

As linguist George Lakoff notes, in some ways, the frame of “direct causality” may hold us back and even create problems, for example, ignoring “externalities” such as those that stem from burning carbon-based fuels. The emerging frames of the Age of Entanglement embrace more complex notions of causality, such as cell signaling pathways, quorum sensing, and networks of feedback loops. “A” causes not only “B” but also a cascade of other effects, some of which loop back to cause “A”—what Lakoff calls “systemic causality.”[34]

Designing systems, platforms, and product-service ecologies requires us to “connect things”—to think and act in terms of whole systems. Likewise, the problems that really matter—the many wicked problems society faces—require us all to “gather together” and connect people and things, ideas and artifacts, products and services, hardware and software, and thinking and doing. They require us to design relationships—and to design platforms in which others can design relationships.

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