



Catching The Third Wave

The Design Process – Architectural Thinking

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In his breakthrough book, *The Innovator's Dilemma*, MIT professor Clayton Christensen observes that technologies move through a performance life cycle that can be represented by an S-curve. Early in a technology's development, performance gains are slow, but as the it is better understood and diffused, the rate of improvement accelerates. As the technology matures, progress once again slows, eventually reaching a natural limit where little additional performance improvement is possible. (See Figure 8.1) When technologies reach that point of maturity, they are ripe for overthrow by new, disruptive technologies.

After a fifty year run, the architectural design process, when viewed as a technology, has reached maturity. Signs of disruptive change are increasingly evident across the field of architectural practice. Architects are using new digital tools to imagine new building possibilities, and to collaborate with project stakeholders in new ways. For the first time since R. Buckminster Fuller was practicing, large numbers of architects are actively involved in the design and development of new materials. Architectural firms are staging participatory design experiences where project stakeholders co-create the design. And architects are engaging in acts of creative leadership on

behalf of clients and communities as those groups struggle with increasingly complex social and environmental challenges.

The architectural design process is poised at the brink of a new wave of evolution in the way architects design and think. This wave is being driven by four disruptive trendsⁱ:

- new digital design tools and technologies
- new materials and methods
- the experience economy
- creative leadership and the challenge of adaptive work

As it accelerates, the wave will transform where and how design takes place, who is involved, redefine the architect's role in the process, and shape a new theory of architectural design. This new design process promises to quickly outperform the current model of practice, creating significant new forms of value for clients, communities, and society.

Four Major Disruptive Trends

New Digital Design Tools And Technologies: Exponential growth in computational performance, digital memory and storage, digital communication, and the Internet explosion continue to disrupt and change society. These information technologies are also yielding a growing array of next-generation digital design tools and technologies. Digital modeling, simulating, and experimenting tools offer architects new opportunities to engage in what technologist Michael Schrage calls “serious play” as part of the design process.ⁱⁱ Serious play occurs when individuals, teams, and organizations use digital technologies to spark creative thinking, foster new creative conversations and interactions, and energize team performance. Schrage has noted that, “the most important raw material of innovation has always been the interplay between individuals and the expression of their ideas.” Change the media and you change the way people think, interact, and design.

In the past, architects relied on sketches and the occasional hand crafted model as the primary media for expressing and communicating design ideas. Now, equipped with a wide array of digital design and modeling technologies, from 3-D design to building information modeling (BIM), to energy-use simulators, to quantity take-off and cost databases, architects are transitioning to new mixed-media design environments. The combination of traditional sketch techniques with these new digital modeling tools offers a potent new creative engine for architects and project teams.

The work of architect Frank Gehry is a powerful illustration of this combination. To turn his design vision into reality for projects ranging from the Guggenheim Museum in Bilbao to the Disney Concert Hall in Los Angeles, Gehry married sophisticated digital modeling software and rapid prototyping tools to his idiosyncratic drawing style. The synergy of these techniques allows an iterative design and modeling process that supports both his personal creative search as well as his ongoing creative dialogue with members of his design team. Using digital models, he has extended the boundaries of who is involved in the design process to include a wide range project stakeholders including builders, subcontractors, and fabricators.ⁱⁱⁱ

Engineers supporting the architectural design process are also applying new digital modeling tools. The global engineering firm ARUP has deployed a variety of software packages to help its staff develop solutions for the increasingly complex designs being generated by architects it works with. ARUP staff took software originally developed by the automobile industry for crash test simulations and reprogrammed it to help engineer solutions for complex seismic and vibration problems that could not otherwise be addressed by traditional structural engineering processes. For a project in seismically active Japan, ARUP engineers used this software to simulate their way to a base isolation structural scheme that ultimately made the architect's glass curtain-wall design possible.

More broadly, architects are on the verge of replacing the 2-D CAD software with new 3-D building information modeling software (BIM). For the most part, 2-D CAD never made a serious contribution to the architectural design process, because it was primarily used to convert

from hand drafting construction documents to producing them using the computer. Using BIM software, architects can design and document at the same time, opening up new possibilities for reconfiguring the overall design process, which since the 1950s has been constrained by the five phases specified in the AIA's master agreement between architects and owners. This process assumes that the bulk of design is completed during the first two phases, schematic design and design development, leaving the work of detailing and specifying the design to the construction document phase. Formally, no design was supposed to take place during the last two phases of bidding and construction. BIM technologies can be used to move from phases toward a continuous process, combining design and construction documentation efforts. Architects will spend less time on details and specifications that can be handled by other parties (suppliers and fabricators), and more time on creating value through design.

Digital tools also are being used to create new integrated processes that provide end-to-end support for owners during the life of a project, from site acquisition, through programming, design, construction, and occupancy. The Beck Group, a Dallas-based architecture, construction, and real estate consulting company has developed proprietary software that allows it to offer exactly this type of integrated project delivery process. At the front end of a project's life, Beck's process combines 3-D modeling with quantity take-off and cost estimating software to facilitate in-depth site feasibility analysis. After a site is selected and design begins, the software supports direct collaboration between architects, construction managers, and subcontractors. This type of team collaboration early in the design process has radically changed the type and timing of information that needs to be generated by the firm's architects, allowing them to design more and draw significantly less.

New Materials and Methods: The construction industry is witnessing an explosion of new, technologically-enhanced building materials, equipment, and manufacturing processes that are transforming both the "what" and "how" of building. New composite materials offer significant advances in structural strength while radically reducing weight. Embedded processors are buried in materials and equipment to better monitor and control the performance of building structures and environments. New green building materials and energy conserving equipment help clients

achieve sustainability goals. And new computer-aided design and manufacturing techniques allow the mass-customization and pre-fabrication of building products.

Rather than wait for manufacturers or others to develop these new products, architects are extending their design domain to include research, design, and development of building materials and methods. They are embracing this new design role, acting both independently and in collaboration with other industry stakeholders--for specific projects, and also as part of independent product development efforts. Architects are reclaiming territory previously abandoned to manufacturers and contractors.

William McDonough is at the leading edge of architects pushing a “green” design agenda through active engagement in the development of new materials and methods, that move beyond resource efficiency to eco-effectiveness. Along with Michael Braungart (a environmental chemist), McDonough co-founded the MBDC Group to design and develop eco-intelligent building products. In collaboration with manufacturers such as DesignTex, Rohner Textil AG, and Ciba-Geigy Ltd., MBDC has helped create a series of new fabrics, carpets, and building products that reduce the environmental burden created by their production, use, and disposal. They have developed carpets and fabrics that use only a fraction of the chemicals normally required in a manufacturing process. Moreover, when these products wear out they can be removed and composted, becoming mulch to nourish the soil rather than languishing in landfills for centuries waiting for their chemical composites to break down.^{iv}

Boston-based Kennedy & Violich Architecture (KVA) established a separate research business called MATx (short for materials) to develop products such as a “luminous curtain,” and a desk that eliminates messy cabling and wiring by embedding ultra-thin polymer films that carry electricity and data into a plywood surface. The Office for Metropolitan Architecture has developed a series of products that help create unique shopping experience for customers at retail clients like Prada.

RDG Planning & Design, a Midwestern architecture and design firm, is capitalizing on this new attention to materials by folding artists and artisans directly into their organization. By merging the Dahlquist Art Studio into their operations, they now offer a range of artworks and public art through the firm. Taking the process a step further, the firm is setting up new collaborations between its architects and artisans to “push the limits of design by integrating new materials and techniques into every level of project development...from concept to fabrication and installation.” RDG’s efforts recall a time when architects and artisans were natural collaborators, for example in the hallmark terra cotta tiles and bronze screens designed by Louis Sullivan for Chicago skyscrapers of the 1890s.

Architects are also engaged in the design and development of new ways of constructing architecture. In the past twenty years, manufacturers such as Dell Computers have learned to deliver a mass-customized product to their customers, combining the cost, delivery, and quality advantages of factory assembly with attributes tailored to specific customer preferences. Manufacturers serving the construction industry are collaborating with architects to move in the same direction, developing building components, systems, and entire structures around mass customization concepts. Architects such as Kieran Timberlake in Philadelphia are working with manufacturers to develop prefabricated assemblies that can be used in a variety of project types. By taking advantage of factory-fabricated components, Kiernan and Timberlake designs offer clients cost, schedule, and quality gains not possible when these elements are stick-built on site.^y

On the West Coast, architect Michelle Kaufman is working with Britco, a manufacturer of “factory-built buildings” in British Columbia, Canada, to fabricate and erect a set of new home designs using the manufacturer’s prefabrication capabilities. This work has included her “Glidehouse” and “Breezhouse” modular housing lines that have now generated over 125 orders for homes. Within the constraints of these building systems, customers can tailor modules to their particular site, and customize materials, roof styles, floor plans, and finishes that turn this assembly line product into premium housing, featuring a distinctive modern aesthetic and sustainable design features.

The Experience Economy: In *The Experience Economy*, Joseph Pine and James Gilmore argue that our economy is shifting toward a new class of economic offerings – memorable “experiences.” According to Pine and Gilmore, experiences stand atop a hierarchy of economic value, which moves upward from commodities to goods, from goods to services, and from services to experiences. The willingness of consumers to pay top dollar for coffee concoctions served at Starbucks is an illustration of the power of experiences to change the economic value of products and services. Many service companies, including retail, restaurant, hotel, resort, hospitality operations are using buildings and interiors designed by architects to create similar high-value experiences.^{vi}

Architects are also realizing that the design process itself offers an opportunity to create memorable experiences. The industrial design firm IDEO has pioneered the application of this concept, staging a variety of experiences for clients as part of its product design and development process. These experiences range from office tours that bring clients backstage to witness IDEO’s unique approach to design, to inclusion in the firm’s internal Monday morning show-and-tell sessions, to active participation in brainstorming sessions. Some clients even move staff into IDEO offices for extended periods of time to work in tandem with IDEO designers and to experience the IDEO culture. Electronics giants Matsushita and Samsung sent teams to live and work in IDEO’s offices to absorb a new creative mindset that could be used to enhance their own corporate product development processes and organizational cultures.^{vii}

Participatory programming processes and design charrettes for clients and project stakeholders are being reconceived to not only generate a work product (program or design), but to leave participants changed in some way--more knowledgeable about themselves or some issue central to the project. William McDonough offers a wide range of learning experiences that help clients not only implement eco-effective projects, but also extend this green philosophy to other aspects of their businesses and operations. These include facilitated visioning sessions that help industry leaders think outside-the-box about eco-effective design opportunities, collaborative design processes to design new products and materials, educational workshops, and collaborative design processes. McDonough set up a “peace room” (versus war room) in the basement of Ford’s

Rouge River manufacturing plant to support the reinvention of that enormous old factory site. It provided a place where representatives from all parts of the company could to interact with the design team, help Ford set goals and strategies for the project, and change the mindsets of people throughout the company about sustainability and the need for eco-effective design and manufacturing practices.^{viii}

Creative Leadership and the Challenge of Adaptive Work: Susan Harris, my co-author for *Value Redefined: New Models for Professional Practice*, has noted that rising social and technological complexity is driving a need for new leadership capacities that can help clients, communities, and society cope with the escalating adaptive challenges. Architects are responding to this by moving beyond the limitations and mental models of traditional “design” work, toward a new stance that recognizes the need for creative leadership, mobilizing clients and stakeholders to tackle the tough problems they face, and guiding them through the difficult changes that are necessary to successfully adapt to changing conditions.

In the mid-1990s Ronald Heifetz, who teaches leadership at the JFK School of Government at Harvard, offered key insights into this shift in leadership stance. He redefined the work of professionals, directly linking their efforts, and the value they create, to the type of leadership challenges his or her clients face. Heifetz makes a distinction between two different types of situations clients face. The first type of situation, “technical work,” involves problems that are easily diagnosed and fixed by professionals with little involvement by the client. The second type of situation, “adaptive work,” arises when circumstances are significantly more complex, precluding both easy diagnosis and straightforward problem solving. Adaptive work requires the professional to assume a leadership role, guiding the client to confront, understand, and respond to an adaptive challenge, in the best way possible.^{ix}

In the last 20 years or so, a significant portion of what used to be considered technical work for architects has migrated into the adaptive work category, driven by growing complexity and interdependence in the client’s social and technological environments. An airport terminal expansion provides a good example. Project definition, planning, and design efforts demand

significant involvement and consultation with countless project stakeholders ranging from the airport authority to airlines, unions, vendors, the flying public, the FAA and homeland security representatives, and the broader community (to name a few). Beyond creative design, the situation demands creative leadership: leadership to inspire, mobilize, and guide this social constellation through a long, involved project delivery process.

Ratcliff Architects, based in the San Francisco Bay Area, has responded to this need for creative leadership by developing and learning to lead new collaborative design processes. In these collaborative processes, the architect's creative role shifts from doing the design, to facilitating the design process. For a four-building science center for a major university, Ratcliff, along with associate architects Moore Ruble Yudell, led a collaborative design effort consisting of five major workshops to address site investigation, massing and site use, departmental organization, spatial layouts, and image. Each workshop process lasted from two to three days, was preceded by significant preparation, and involved a core team plus groups of users ranging from thirty to almost one hundred people.

Although the client had originally established relatively conventional goals for the project, the collaborative design process yielded a new, more compelling vision for the science facility, calling for the creation of a research center that would attract and retain world-class scientists and investigators. Facilitation included:

- designing the overall process as well as individual workshops
- identifying and engaging project stakeholders
- guiding teams through design workshop activities, including site assessment, using simple modeling materials to imagine and express preferences in building massing, departmental layout, and the functioning of key spaces, as well as exploration of images appropriate to the facility and site
- surfacing differences and resolving conflicts
- helping the group reach closure around key design ideas and decisions
- synthesizing and crystallizing design concepts and ideas in finished designs and drawings

The result of this creative leadership was a set of buildings that fulfilled the group's vision, enabling cutting edge, interdisciplinary scientific research in laboratories that are adaptable and flexible (in ways that allow scientists to stretch their research dollars as far as possible), safe, productive, and enjoyable work in.

Beyond a need for this type of collaborative leadership, a client may face an even more daunting situation where there really isn't a solution. In these situations diagnosis may not be possible; at best the client can hope to learn more about the problem and better understand its different facets. The client may also learn that they can't fix the problem either. Rather, their only viable option may be to adapt and change in deeply held values, beliefs, and behaviors. In these cases, the role of the professional becomes one of transformative leadership helping the client engage in, and move through, this difficult change process.

The City of San Jose and San Jose State University faced such an adaptive challenge when they decided to build the first joint-use library in the United States, combining a new public library for the city with a new academic library for the University. Both clients needed to build new library structures at the same time and in roughly the same location. They realized that by combining their resources into one project, sharing funding, and eliminating the duplication inherent in constructing two buildings the resultant library could be bigger and better equipped than either party could afford separately. However, mixing public and academic library cultures was like mixing oil and water. To develop the "seamless-service library" the mayor and university president had in mind would require a new culture, values, and operating practices. To facilitate the planning and design of this joint operation the client turned to Anderson Brule Architects (ABA).

ABA designed and facilitated a process that included dozens of meetings involving hundreds of staff members from both organizations over a twelve-week period. At the end of the process, ABA had helped the library staff not only define a new "seamless" operations plan, but also transform themselves into a single high performance team, unified around a shared vision, culture and values. Although ABA would go on to be part of the architectural team that designed

the library structure, their greatest achievement flowed from the transformative leadership they provided that helped their client design and create a new organization. Commenting on ABA's performance, one library leader commented, "ABA's process made the potential of a combined facility believable for staff members from both sides...It's facilitation allowed staff to think outside the box and enabled participants to reflect more on real possibilities...and to understand staff concerns on each side...The process improved communication and created stronger relationships that have only begun to serve us well." The process generated buy-in from staff at both libraries, and supported a rapid evolution of the new organization that paid significant operational dividends once the new building was occupied.

In some cases, the architect's creative leadership may not lead to either a design or a building. Rather, the architect may help the client identify other opportunities for change and organizational development that solve the presenting problem without the need to build. The Las Vegas firm of Lucchesi Galati worked with a public utility services division, which had come to them with a commission for a new warehouse facility. Before proceeding into the traditional architectural design process they had been commissioned for, Lucchesi Galati convinced their client to open up their time and organizational boundaries in order to facilitate a 20-year analysis of not only the division, but also the city's entire public works department. This effort showed that operational improvements, staffing changes, and other efficiencies would allow the agency to satisfy its needs without building anything. The firm lost a design commission, but gained credibility and the city's trust through this act of leadership, ultimately becoming the agency's exclusive design consultant.

Convergence and Change

Architectural practice in the United States has moved through two previous waves of evolution (See Figure 8.2.) The first wave gathered through the middle of the 19th Century and crested in Chicago during the 1890s, where Burnham and Root, Adler and Sullivan, and other architects transformed the city skyline as they invented and refined the skyscraper. From his studio in Oak Park, a young Frank Lloyd Wright was laying the groundwork for his Prairie Style of

architecture. And, in 1893, Chicago's "White City" of the Columbian Exposition dazzled throngs of Americans with new concepts of urban order, amenity, and aesthetics.

A second wave began to swell just prior to the start of World War Two, with the arrival of European refugees such as Walter Gropius and Mies van der Rohe on America's shores. They brought with them a new approach toward design that, in post-war years, was married to a new model of practice pioneered by practitioners such as Skidmore, Owings (SOM), and Merrill and Caudill, Rowlett, and Scott (CRS). This shared model of practice, including a common approach to the architectural design process, held sway for the next fifty years. Styles might vary, from functional, to Brutalist, to Post-Modern, but that underlying model of practice and design process remained relatively fixed.

Now, at the start of a new century, the architectural design process has reached another tipping point. Driven by the convergence of these disruptive trends, a third wave is poised to radically transform the way architects design and think.

Setting: Traditionally architects have designed behind closed doors, in relative isolation from clients and other project stakeholders. During the first wave, the American Beaux-Arts, the setting for design was the master's atelier. Architects were artists who worked in the creative isolation of their studios. Clients were patrons and beneficiaries of this public art and waited until the design composition was complete and ready for display. With the rise of the Modern Movement during the second evolutionary wave, the setting for design shifted into the corporate studio or office, but the activity of design still took place out of sight. Although occasionally involved in programming activities, clients continued to be recipients of finished designs, not active participants in the design process.

As the third wave swells, design is moving to new collaboration spaces--both literal and virtual--where architects, clients, and other project stakeholders can co-create designs. These collaborative environments support a wide range of creative activities for the team, including low-tech brainstorming and idea generation spaces, "caves and dens" for individual reflection

and synthesis, and high-tech workstations that can be used to display and manipulate digital models and simulations.

Participants: In the atelier, the architect-master was attended by a small number of acolytes. Design was an elite endeavor, confined to those that had been prepared either through extensive schooling at institutions like the L'Ecole des Beaux-Arts in Paris or through long apprenticeships to American masters. The ateliers of Richard Morris Hunt and H. H. Richardson were widely emulated by architects across the country. In the second wave, participation remained exclusive, design principals continued to lead a small team of gifted subordinates in the development of the design, from programming through concepts and schematic designs. As work progressed into design development and construction documents, larger numbers of production-oriented architects could be engaged in detailed design of building components and systems.

The third wave is opening up the design process to active participation by growing numbers of project stakeholders, from clients to contractors to community representatives. Architects are beginning to act as creative leaders, facilitating movement of team members through collaborative design processes.

Roles: In the 19th Century, the role of the architect in design was structured around the “artist-master” of Beaux-Arts instruction. By the 1950s, that role had evolved, becoming the autonomous “design principal,” responsible for understanding the client’s program, conceptualizing and elaborating the design scheme, and maintaining the integrity of the design ideas through subsequent construction document and building phases.

In the third wave, architects are evolving from being the “designer” to being the “creative leader” of a design team. As creative leaders, architects will facilitate growing numbers of team members through a collaborative design process; the design will be co-created by the team, not generated and controlled by a lone creative genius. He or she will “design the design process” and facilitate the team’s work as it moves from defining goals and setting the vision through concept generation and refinement of the design. The creative leader will also continue share

personal insights and synthesize, express, frame, and develop key design concepts. However, he or she will do so as an active team member, not the sole design authority.

Process: Adhering to Beaux-Arts principles of composition and method, the architectural design process in the 19th Century was formal, artistic, academic, and hierarchical. The process moved from development of the basic “parti” or concept, to sketches, to formally rendered plans, sections, and elevations. Construction documents were minimal; much of the design intent was communicated by the presence of master architect on-site during construction. By the height of the Modern Movement, the design process had evolved into set of highly prescribed phases, memorialized in master contracts used by professionals. The process was linear, segmented, and expert. Formal phases were structured to take full advantage of an increasingly specialized workforce, with design segmented from drafting (whether by hand or by computer), construction, and administrative work. Design was to be substantially complete by the end of design development phase, and it was formally assumed that almost no design happened during construction.

The third wave is transforming architectural design into an iterative, participatory, and emergent process. Increasing numbers of project stakeholders are joining architects in increasingly collaborative design experiences. The process uses a mix of media, ranging from traditional sketches and rough physical models, to advanced 3-D and 4-D digital models to engage participants in serious play and to make critical design decisions. Phases of work are being replaced by continuous processes, enabled by BIM and other digital software, that allow architects to program, design, and complete building instructions and specifications simultaneously. Design work will stretch from project initiation through construction, revolving around new building information models.

A New Design Theory Inspired By Living Systems

Driven by powerful disruptive forces, the third wave is shaping a new theory of design for architectural practice. Early indications suggest that this emergent design theory will be inspired and informed by a deep understanding of nature, life, and living systems.

During the Beaux-Arts wave, design theory was built upon a foundation of immutable artistic principles drawn from classical art and the great architectural monuments of classical Greece, Rome, and Baroque Europe. In the second wave, Modern Movement design theory was inspired by industrialization and built around a new machine aesthetic. Design emphasized planning, technical problem solving, and honest expression of materials. This new theory preempted, but did not entirely replace the first wave's commitment to composition and artistic expression; the old design theory still existed in practice, residing in the shadow of a new dominant theory. With the advent of Post-Modernism, the stylistic imperative of the Beaux-Arts theory resurfaced, giving architects renewed license to practice the art of design.

“Living systems theory,” and parallel developments in chaos and complexity theory, evolved as a reaction to the closed, Newtonian paradigm that has dominated much of scientific thinking.^x Living systems theory is having profound impacts on knowledge disciplines ranging from the sciences (biology, ecology, and brain sciences) to sociology, business management, leadership, the arts...and now, architecture and the architectural design process. We are beginning to understand that:

- Buildings are nested within larger living systems and design needs to serve those larger societal and environmental systems at the same time it satisfies the immediate needs of a particular client.
- Designers can draw inspiration from, and work in harmony with, nature, natural systems, and nature's economics.
- Living systems stay alive by partnering with and learning from their environments. Design needs to fully engage and learn from the organization and environmental ecosystems surrounding their clients and communities.
- Living systems are most creative when on the edge of chaos, the sweet spot between order and disorder. Design can leverage the power of self-organization and emergence by moving to this edge and involving the client and other project stakeholders in new collaborative creative processes.

This new design theory will, once again, not entirely replace the old. Architectural design will continue to be informed by artistic and functional imperatives from the past. However, living systems theory will move to the forefront and directly link architectural design to stewardship of the larger societal and environmental ecosystems within which buildings exist. Empowered by this new design theory, architects can play a pivotal role how we deal with increasingly serious adaptive challenges, exercising creative leadership on behalf of clients, communities, and society.

I would appreciate your feedback about this essay. Please send your thoughts or comments to:

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Figure 8.1
Technology S-Curve

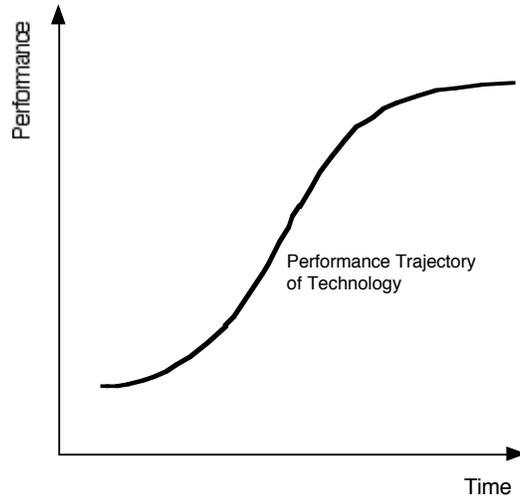
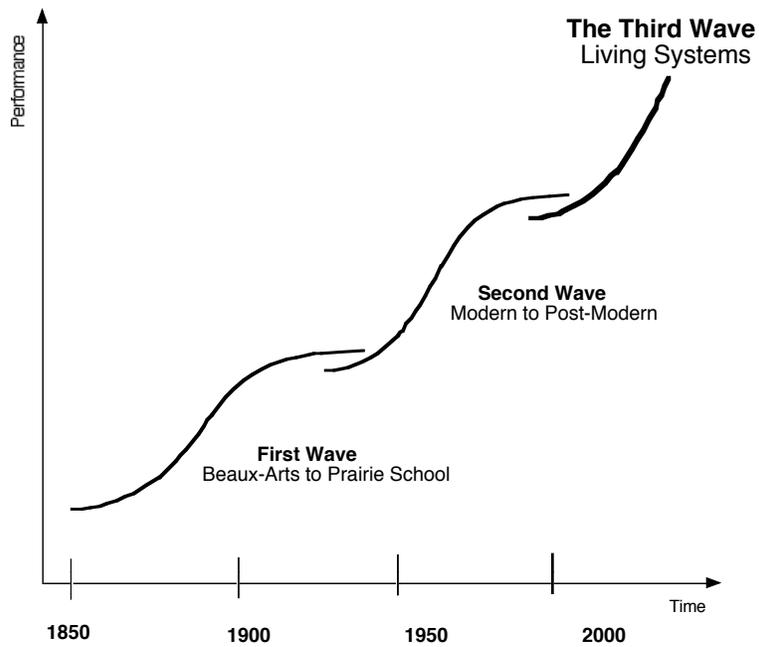


Figure 8.2
The Third Wave Of Evolution In The Architectural Design Process



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- ⁱ For a more extensive discussion of these disruptive trends and other ideas presented in this chapter readers may reference: Kyle V. Davy, AIA and Susan L. Harris, PhD, Value Redesigned: New Models for Professional Practice, (Atlanta: Greenway Communications – Ostberg, 2005).
- ⁱⁱ Michael Schrage, Serious Play: How the World’s Best Companies Simulate to Innovate (Boston: Harvard Business School Press, 2000).
- ⁱⁱⁱ Mildred Friedman, ed., Gehry Talks: Architecture + Process (New York: Universe, 2002).
- ^{iv} William McDonough and Michael Braungart, Cradle to Cradle: Remaking the Way We Make Things (New York: North Point Press, 2002).
- ^v Stephen Kiernan and James Timberlake, refabricating ARCHITECTURE (New York: McGraw-Hill, 2004).
- ^{vi} B. Joseph Pine II and James H. Gilmore, The Experience Economy (Boston: Harvard Business School Press, 1999).
- ^{vii} Robert I. Sutton and Thomas A. Kelley, “Creativity Doesn’t Require Isolation: Why Product Designers Bring Visitors Backstage,” California Management Review (fall 1997).
- ^{viii} McDonough and Braungart, Cradle to Cradle.
- ^{ix} Ronald A. Heifetz, Leadership Without Easy Answers (Cambridge: Harvard University Press, Belknap Press, 1994).
- ^x For learning more about “living systems theory” and how it is impacting leadership and management theories: Margaret J. Wheatley, Leadership and the New Science: Discovering Order in a Chaotic World (San Francisco: Berrett-Koehler, 1999); also Roger Lewin, Life at the Edge of Chaos (New York: MacMillan, 1992); also Steven Johnson, Emergence: The Connected Lives of Ants, Brains, Cities, and Software (New York: Scribner, 2001); also Richard T. Pascale, Mark Milleman, and Linda Gioja, Surfing The Edge Of Chaos (New York: Crown Business, 2000); also Janine M. Benyus, Biomimicry: Innovation Inspired By Nature (New York: Quill William Morrow, 1997).