This book looks at the potential of interactive architecture: what it is, how it can impact our lives, what is necessary in its design, and where we are headed in the future. Interactive Architecture outlines a vision for the future through contextualizing and understanding the current landscape of projects and trends in IA, and its integration of new emerging technologies. The current landscape of interactive space is built upon the convergence of embedded computation (intelligence) and a physical counterpart (kinetics) that satisfies adaptation within the contextual framework of human and environmental interaction. Rather than explicitly explaining why interactive systems are necessary, meaningful, or useful, we state that the motivation to make these systems is found in the desire to create spaces and objects that can meet changing needs with respect to evolving individual, social, and environmental demands.

Advancement will only be accomplished when interactive architectural systems are addressed not primarily or singularly, but as an integral component of a larger vision that takes advantage of today’s pervasive, constantly unfolding, and far-reaching technology.

In order to create a historical outline of interactive architecture as put forth in this book, it is necessary to first clarify its definition. The current terminology abounds with terms such as “intelligent environments,” “responsive environments,” “smart architecture,” and “soft space.” This book is concerned with only the physical and tangible, which automatically eliminates a wealth of digital media projects that are in fact “interactive” but which are not considered here as “interactive architecture.” Additionally, interactive architecture is, by definition here, a two-way street. As Usman Haque puts it, such systems must utilize a definition of interaction as circular, or they are merely “reacting” and not “interacting.” A truly interactive system is a multiple-loop system in which one enters into a conversation: a continual and constructive information exchange. As people interact with architecture, they should not be thought of as “users” but instead as “participants.” Marcos Novak uses the term “transactive intelligence” to define architectural intelligence that not only interacts, but that transacts and transforms both the user and itself.

We begin with an overview of the theoretical work of a number of people working in cybernetics in the early 1960s who laid much of the groundwork in interactive architecture. These early ideas rooted in cybernetics were picked up at the time by a few architects who solidly translated them into the arena of architecture. Although the computational means were not quite evolved to the extent that proliferation of concepts in cybernetics could take a strong foothold. The computational world did begin to evolve quite rapidly however, tangentially skirting the field of architecture in a much more pragmatic and market-driven fashion. Cultural and corporate interests played major roles in influencing interactive architecture through the development of numerous market-driven products and systems that directly involved users in the real world. In the 1990s, interactive architecture began to take a foothold as ideas became both technologically and economically feasible. It was also at this time that the long history of kinetics in architecture began to be reexamined under the premise that performance could be optimized if it could use computational information and processing to control physical adaptation in new ways to respond to contemporary culture. More recent developments have begun to signal a shift from a mechanical paradigm of adaptation to a biological paradigm. The prevalence of the organic paradigm is beginning to alter the conceptual model that we apply in order to comprehend our environment and, consequently, design in our environment. Organic theory emerges from nature, and possesses evolutionary patterns that produce forms of growth and strategies of behavior, optimizing each particular pattern.
In the 1960s, Gordon Pask and other cyberneticians made advancements toward understanding and identifying the field of interactive architecture by formulating their theories on the topic.

To the contextual situation. Consequently, the organic paradigm of kinetic adaptation has driven a profound set of developments in materials, autonomous robotics, biomimetics, and evolutionary systems, whereby the adaptation becomes much more holistic, and operates on a very small scale.

In the 1960s, Gordon Pask and other cyberneticians made advancements toward understanding and identifying the field of interactive architecture by formulating their theories on the topic. Pask, who later collaborated with a number of architects in the 1970s and 1980s, developed a “Conversation Theory,” which served as the basis of much of the architectural development in interactive architecture at the time. Rather than an environment that strictly interprets our desires, he says, an environment should allow users to take a bottom-up role in configuring their surroundings in a malleable way without specific goals. Usman Hague points out that such early theoretical foundations had difficulties establishing much of a foothold; Pask’s trouble, in particular, was a lack of marketing potential in his physical proof-of-concept models. The realm of such proof-of-concept prototypes was essentially driven out by the development of the digital computer. By the mid-1960s, in fact, funding was waning for bottom-up approaches to AI and cybernetics such as neural nets, evolutionary programming, cybernetics, biological computation, bionics, and so forth. Most research in these areas had to adapt to what could be implemented digitally in order to be funded. Around the same time, the architect William Brody published a rather visionary article in 1967, which proposed that we teach our environments first complex, then self-organizing, intelligence that could eventually become evolutionary. Nicholas Negroponte, the founder of the MIT Media Lab, also speaks of similar ideas in his seminal book called The Architecture Machine, although the applications he described were more concerned with digital media and design processes than the physical built environment. Charles Eastman further developed the model of Adaptive-Conditional Architecture in 1972 by expanding upon the earlier ideas explored in cybernetics by Pask and Norbert Weiner, in which architects interpreted spaces and users (participants) as complete feedback systems. Eastman proposed that feedback be used to control an architecture that self-adjusts to fit the needs of users. These cybernetic ideas essentially describe such responsive actions of users and architecture as “dynamic stability,” which can be visualized with the often-cited analogy of a boat at sea constantly manipulating its rudder against the variable environmental conditions of wind and current to maintain a straight course. However, it is important to note that Eastman’s model was essentially that of a machine-led approach.

Andrew Rabeneck made a very pragmatic interpretation in 1969 by proposing the use of cybernetic technologies to produce an adaptive architecture that would increase the useful life span of a building through adaptation. Tristan d’Estreé Sterk proposes a hybridized approach of combining the two in architecture. This notion of hybridization has prevailed today in modern robotics, whereby simple automated feedback is coupled with higher-level deliberative processing.

Cedric Price was perhaps the most influential of the early architects to adopt the early theoretical work in cybernetics and extend it to an architectural concept of “anticipatory architecture.”
Intelligent environments are defined as spaces in which computation is seamlessly used to enhance ordinary activity.

Ubiquitous computing can be defined as computation thoroughly integrated into everyday objects and activities, and is often regarded as the intersection of computer science, behavioral sciences, and design.

Clearly, corporate and cultural interests also played important market-driven roles in the development of interactive architecture. These market-driven roles were extremely important as they directly involved the users out in the real world; however they were not integrated with the earlier theoretical architectural concepts of interactivity. In the 1950s, widespread developments were taking place in environmental control systems within buildings as a direct derivative of the introduction of sensors with remote signaling allowing for a central control room. The invention of the “remote control” also came along at this time, enabling the user to assume a larger role as an operator of objects in space. The 1960s saw an evolution of system control and management as the control room turned into a hardwired control panel with the capacity to record information and alert users of problematic parameters. Mahesh Senegal points out two diametrically opposed perspectives that prevailed at this time: that of a life defined by pragmatic convenience, and that of a life controlled by the machine whereby the users become dependent upon their environments. While both perspectives survive today to some extent, we have come to embrace every new technology with the promise (perhaps illusory) of convenience, but for the most part, without the fear. The 1970s signaled a turn toward a promise of environmental efficiency, when architects sought to justify technology that could improve building performance and consequently save money. Energy management systems were introduced as well as microprocessors but, for the most part, the architecture world had yet to embrace the promises of such technologies from an interactive standpoint. The 1980s, perhaps stirred by the introduction of the personal computer, heralded a shift in user thinking or outlook, whereby the connotations of “enslavement” began to be replaced by “empowerment.” The PC became the interface that replaced the central console control, distributed direct digital control replaced conventional control systems, and communication could be programmed to take place on local area networks. Such developments also clarified the problems of integration, whereby many noncommunicative independent protocols hit the market for individual products at the same time. A new need consequently arose to standardize the methods by which different types of hardware could communicate with one another; this, however, was not satisfied, as the issues surrounding integration are proprietary and economically very valuable. The result was that many noncommunicative independent protocols hit the market for individual products at the same time. Incompatibility is still a major battle being fought today, which will be discussed further in chapter 2.
Technology transfer from similarly integrated interactive developments in other fields will continue to predicate, impact, and evolve with interactive architecture.

Eventually architectural academia began to assemble comprehensive prototypical projects based on real-world, market-driven developments. Numerous academic “smart home” and “smart workplace” projects were initiated in the 1990s that relied heavily on available technological advancements. It was a time when wireless networks, embedded computation, and sensor effectors became both technologically and economically feasible to implement. This feasibility fueled experimentation with many of the ideas of the early visionary architects and theoreticians outlined above that had been stifled by the technological and economic hurdles of their day. It was at this time that the economics of obtaining cheap computational hardware and increased aptitude to integrate computational intelligence into architecture began to be reinvestigated by architects. The interactive architecture workshop at the Bartlett School of Architecture was initiated in the early 1990s as a pioneering forum for actual architectural pursuits under the guidance of Stephen Gage. Also, the use of the Internet undoubtedly played a major role in both the technological and intellectual dissemination responsible for progress in the field. Since the 1990s, numerous architecture schools have expanded their programs to incorporate interactive design.

It is relevant to note that in the late 1990s a long history of kinetics in architecture began to be reexamined under the premise that performance could be optimized if it could use this newfound computational information and processing to physically adapt. Architecture began to revisit traditional kinetic aesthetics with new technological innovations, spurred on by Robert Kronenberg with a series of exhibitions and conferences on transportable environments. The traditional problems of motion, stasis, and order were challenged, redefined, and transformed by new possibilities, and strategies opened up through technological innovation, particularly technologies and new approaches to mobility and transportation related to contemporary nomadic culture.

The driving force behind the renewed interests in adaptable architecture is in the technologically influenced and changing patterns of human interaction with the built environment. Today’s intensification of social and urban change, coupled with the responsibility of issues of sustainability, amplifies the demand for interactive architectural solutions. In the context of architectural need, the attribute of being able to adapt to changing needs is paramount in contemporary society.

These technologically driven human behavioral patterns are beginning to facilitate a paradigmatic shift from the mechanical to the biological from a standpoint of adaptation. The driving force behind the renewed interests in adaptable architecture is in the technologically influenced and changing patterns of human interaction with the built environment.
In this book, interactive architecture is positioned as a transitional phenomenon with respect to a movement from a mechanical paradigm to a biological paradigm.