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Introduction of Interactive Architecture and Its Role in the Adaption of Architecture

Mohammadmehdi Moulaii[a], Mohammadreza Pourjafar[b], Mohammadreza Bemanian[c]

[a] *PhD of Architecture, Department of Architecture, Faculty of Art and Architecture, Tarbiat Modares University, Tehran, Iran.*
[b] *Professor, Department of Urban Design, Faculty of Art and Architecture, Tarbiat Modares University, Tehran, Iran.*
[c] *Professor, Department of Architecture, Faculty of Art and Architecture, Tarbiat Modares University, Tehran, Iran.*

Abstract

This essay tries to introduce the importance and efficiency of interactive architecture, also tries to clarify, what the meaning of interactive architecture is and how it can affect our lives in the near future. Interactive architecture depicts a viewpoint for the future via composition of emerging technologies with architecture. This viewpoint has been constructed by the convergence of embedded computation and kinetic counterpoint that make adaptability between interaction of human being and environment. The reason of making these systems is for creation of objects and spaces that can afford variable necessities of individual, social and environmental demands. Progress will be accomplished if the interactive systems can be part of wide spreading systems not being individual. Prediction of this matter that how long does it take that interactive architecture would be accepted by the people is very hard to say but it is not hard to say that they will be integrated part of construction in the future. Future of architecture will employ novel methods and unique utilization of smart technologies that can respond properly to the dynamic, adaptable and growing functions. It is up to architects and professionals to conceive the matter appropriately that can depict and predict successful future for the architecture.

Keywords: INTERACTIVE ARCHITECTURE, ENIVIRONMENTAL DEMANDS, ADAPTABILITY

1. Introduction

Society has gradually changed during the years. People's daily lives is full of predefined repetition, all things have their defined meanings. In the past, architecture could do its duty in the predictable environment obviously. Now it is obvious that those periods are gone. Social and technological progress is going forward fast. Architectural built environments are not following previous predefined purposes and functions. Architecture should adopt itself with these speedy discourses of changes in contemporary societies. Architecture should respond to its environment as speedy as its environment talks to it in real time. Architecture should create spaces that are dynamic and can find appropriate responses to variable needs of people; spaces that not only able to sense but also can afford the role of a partner in the environment and

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learn from environment and have their independent responses in different issues. Architecture has to interact with its surroundings and make constant dialogue with its rich and active environment. Fundamentally, all the architectural spaces that we encounter have been interactive but in lower level. Without considering its scale, architecture as a city, building or a bench in the park, makes a mutual relationship with its surrounding clearly. From the viewpoint of communication theory, existence of these communications is the reason for the interaction. Architecture all the time being informed and inversely, it itself act as a source of information, although, it depends on the information that already received. This interaction often happens slowly and we need to see the slow-motion of time during years for perceiving that. So architecture only has to increase its speed of interaction that we can see the interaction more vividly. Architectural process such as education, variation and communication of information that took many years in the past, today should happen faster. By the application of technologies and methods that already strongly influenced other aspect of life and caused them to grow fast, now make it possible to create architecture that is more logical, sensitive, sustainable and real time. All of these events are for existence of digital technologies that prepare the ability of generating building elements that are capable of gathering information, processing them and respond dynamically in real time [5, 7].

1.1 architectural constructions

Architectural constructions are getting changed all the time. Constructions are such shifts that always happen as outcomes of many forces. In order to involve with dynamical architectural constructions in a real discourse, we have to adopt universal certain models. We have to accept this issue that creation of interactive architecture is not going well if the objects design not as transitory objects. Dynamical building constructions are the natural results of interactive architecture that today is a new branch of architectural design that its popularity is to information processing and application of new materials; give the permission to the building to promote itself via information processing, emotional and sensational characteristics. In opposition to traditional architecture, the essence of design of elements of interactive architecture is not embedded in its physics but in its behaviours that are integrated with their physics. For creation of architectural elements in this way, spatial and behavioural fabrics of them should design in a way that has the capability to interact with their environment. This environment is the spatial, cultural, ecological, social and economic context of designed objects.

Fig 1. **Electroland, Target Interactive Breezeway, Rockefeller Center, New York, 2006**
LED lights programmed to track visitors' movements line Electroland's breezeway atop Rockefeller Center in Manhattan. The breezeway leads to an observation deck that reopened in autumn 2005 as Manhattan's second-highest observatory, renovated for $75 million under the direction of designer/architect Michael Gabellini of Gabellini Associates (Ref: Hart, H., I'm a camera: Electroland, 4dsocial interactive design environments, Architectural design, vol 77, No 4, P 90, 2006).

Today, we are witnessing a big change in the architectural design in the cotemporary era. Traditional design process is getting replaced by the parametric and digital design processes. While we are defining digital and virtual spaces like physical space, it means that there are not too much differences among architectural elements that are physically interactive and their virtual corresponding that interact with us by computer interface [11].

Extensive researches have been done all around the world for employing information technology in architecture. Advanced techniques are being developed and applied in architecture, let us design generative and parametric, then architecture can be dynamic and interactive. This should be mentioned that many facilities have been generated by applying information technology in the field of architecture in

contemporary era. These novel concepts have caused the architectural design approach to be reconsidered again.

This novel architecture that has emerged from social necessities to have dynamic spaces, and have got feasible by recent digital technologies, is on basis of information processing and integration among design performance and maintenance processes. Opposed to traditional architecture, these three processes can come together and work with each other and keep dynamic and interactive all the time. It means that design process never get the end, because while building elements erect, they are dynamic and can redesign themselves partly. If this way gets successful, these advancements lead to kind of architecture that can interact with its environments like an alive object. Application of more sciences in creation of process-drive architecture can leads to get smaller architectural elements and create more closeness between architecture and biology [4].

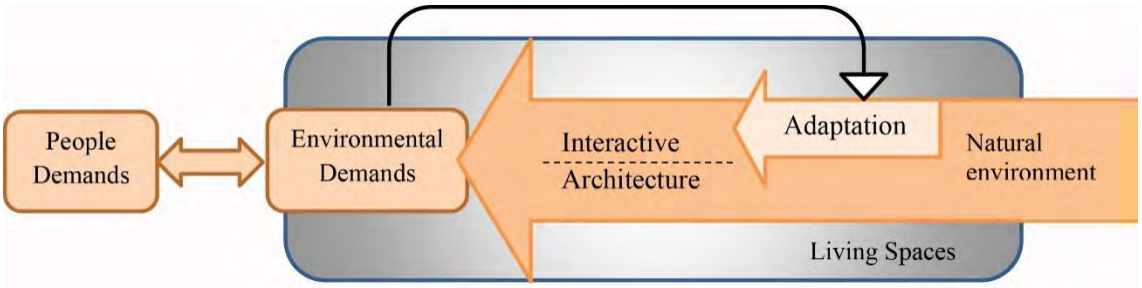

Fig 2: **How interactive architecture can respond to environmental and user demands**

2. Interactive architecture

With the intention of generating a chronological outline of interactive architecture in this essay, it is essential to explain its meaning at first. The present term abounds with terms such as “intelligent environments,” “responsive environments,” “smart architecture,” and “soft space.” interactive architecture is, by description here, a two-way road. As Usman Haque says these systems should have the ability of interaction as a circle, except these systems are just reactive not interactive [10]. A real interactive system is a multi-loop system that enters to a conversation, which people interact with architecture, they should not consider as users. They are architectural patterns in the space. Marcos Noak use the term "Transactive Intelligence" to define architectural intelligence that not only interact but also transform and transact users and it [18]. We begin with general looking through the theoretical work of people in cybernetics in the early of 1960 that established the subsurface of interactive architecture. These ideas that rooted into cybernetics subsequently employed by the few architects in particular time, the architects who translated those ideas into architecture. Although computational devices didn't develop properly in that time, but variations of these ideas left a significant footstep by themselves. In that time computational world began to develop more rapidly and caused the architectural field to be more pragmatic and market-driven. Cultural and corporation interests had a main role in entrance of interactive architecture into development discourse of numerous market-driven and systems.

It was in the 1990s, that interactive architecture could prove itself as an idea and be technologically and financially possible. It was in these years that the long history of kinetic in architecture reconsidered again on this presumption that if the architecture could employ processing and computational information for controlling physical adaptability of itself, then performance could be optimized. Most of the recent achievements have begun to move from mechanical adaptability paradigm to organic paradigm. Conceptual model that we use for environmental design and perception has been changed by outspreading of organic

paradigm. Organic theory originates from nature and has the evolutionary paradigms that create behavioural strategies and optimize the entire personal paradigm in its environmental conditions. Finally, organic paradigm of kinetic adaptability has caused impressive developments in materials, independent robots, mimetic paradigm of nature and evolutionary systems [3]. In the 1960s, Gordon Pask and other professionals have done progression into understanding and identifying interactive architecture via matematicalization of their theories. Pask cooperated subsequently with the architects, in 1970s through 1980s, developed conversation theory as a basis of numerous developments in the interactive architecture. He believed that environment should let the users to have a role from down to up to shape their environment flexible and impersonally [20]. Usman Haque referred that embodying of these ideas have faced with many difficulties, especially in finding materials for proving physical models of the ideas. Emergence and development of these models that produced for proving ideas has been accelerated by development of digital computers. Until the middle of 1960s, investment in down to up approaches in cybernetic and interactive sciences such as neural nets, evolutionary programming, cybernetics, biological computations, bionics and others had decreased. Most researches in these fields had to incline to some way that could implement digitally then could be invested [12]. It was in that time that architect William Brody published a promising essay in 1967 that suggested that we first make our environments to be complex, self-organized and intelligent then they can emerge active and interactive gradually [2]. Founder of M.I.T media lab, Nicholas Negroponte, discuss about some ideas in his book, "The architecture machine", although, applications that he discuss is more about digital media and process design than make a physical built environment [11].

Charles Eastman has developed a adaptive-conditional architectural model in 1972 by expansion of primary ideas of Pask and Norbert Weiner in cybernetics. In that model architects interpreted spaces and users as responsive systems. Eastman suggested employing feedback for controlling architecture that adapts itself with user necessities [6]. These cybernetics' ideas fundamentally define responsive actions of users and architectures as "Dynamic Stability" that is similar to the ship in the ocean that adjust its motion with different climate change like wind and water to keep its direct way. In 1969 Andrew Rabeneck proposed to apply cybernetics technologies for creation of adaptable architecture that could increase life-cycle of building via adaptability [21].

Fig 3. **Son-O-House**, **Nox** The metal beam structure, intended for meetings and general relaxation, at night. Its design is based on choreographed sets of visitors' movements inscribed on paper bands as cuts, while a sound piece activated by sensors registers these movements. Through van der Heide's programming, new sound patterns are continually evolved as a 'memoryscape'. (Ref: Bullivant, L., Son-O-House, Nox, 4dspace: interactive Architecture, Architectural design, vol 75, No 1, P 70, 2005).

Cedric Price is among the first architects that took the most influence from theoretic works in cybernetics and extended it to a architectural theory "Anticipatory Architecture". Many of his unconstructed projects like "Fun Palace" in 1961, were kinds of processing architecture that were instable, flexible and responsive to the changeable demands of users in various times [14]. His "generator project" was an important research in intelligent architecture that any object in the context should learn from environment and promotes and develops itself to interact with that. John Frazer that was the systems advisor in that project, expanded the Price ideas and claimed that architecture should be alive and evolutionary. This theory is summarized in the book "evolutionary architecture" that included thirty years of his cooperation with his students and with Pask. These works are mostly relied on scientific, biologic similarities and also cybernetics, complexity and chaos. Frazer depicts

eight aspects of evolution that make the changes in different scales; and the basis of all that changes, is information [9]. He said natural ecosystems comprise complex biological structures. They recycle their materials, adapt themselves and change, also utilize from environmental energy, efficiently. In that time maybe these expansions had a contradiction with stable architecture. Until now, we have looked to primary theoretical ideas, and numerous architects that afforded to convert these ideas to architectural horizon. By going through the history of computers and their integrations with architecture profoundly, we can say in the 1980s through 1990s, we had an explosion in development of computer science. Theories like intelligent environment have shaped for studying spaces with embedded computation and communication technology then create environments that input computation in the physical world. Intelligent environments are defined as spaces that computations are frequently involved for simplifying small actions [16]. Michael Mozer, who developed pioneer adaptable houses in the late of 1990, speak about house intelligence as a capability of behavioural and demand prediction of occupants via monitoring them in a particular period of time. Instead of being programmed for doing particular actions, adaptive house, program itself by monitoring environments and occupants actions, supervising the occupants and their behavioural paradigm then learn to predict the future condition of the house [13]. Another approach was the smart house in the M.I.T that guided by Michael Coen, and examined the interaction between people and computers via embed of smart computational elements in all the places that users had connection with the project. The purpose was to let computers to participate in actions that hadn't considered before and also to let people to interact with computerized systems like people. Progress in intelligent environment has developed with the "Ubiquitous idea" (this idea has been populated by Mark Weiser as model of interaction between human being and computer in 1988) [4].

In ubiquitous computing, users involve with numerous systems and computing components in their way of ordinary actions and maybe they don't aware of how the work is done. Having located in the middle of computer science and architecture, developed the first works of machine group in M.I.T that they developed numerous primary projects in the Medias, interface design and expanded environment in 1970 to 1980 [22]. We can say cultural and social interest obviously has had important marketing roles in developing interactive architecture. These marketing roles were very important; due to the reason they included users directly in the real world. In the 1970s, tendency toward environmental efficiency emerged, while architects were convincing technologies that could optimize building performance and finally decrease its cost. Subsequently, architectural academies began to perform integrated projects on the basis of real world. Many of university projects such as "smart workplace" and "smart house" began in 1990s that heavily relied on accessible technological advancements, which was the time that wireless networks, embedded computations and sensors became feasible economically and technologically [23]. It was in that time that economy let cheap computational hardware be constructed and efficiency of smartness of this hardware were examined by the architects repeatedly. In the early of 1990s, interactive architecture group in the Bartlett architectural school began to work under the supervision of Stephen Gage as a pioneer in architecture. Moreover, application of internet, without doubt, have had important role in advancement of this field intelligently and technologically. Various architectural schools have developed their programs in interactive design in architecture from 1990s [8]. In

Fig 4. **LIGHTSCRAPER -Melbourne City Council**
The LightScraper is a towering vortex of visuals and sound feeding off its surroundings. Featuring real-time 3d graphics and a motion tracking system, the LightScraper explores new forms of engagement with technology and ultimately each other. (Ref: http://www.eness.com/?r=Project&p=3&c=)

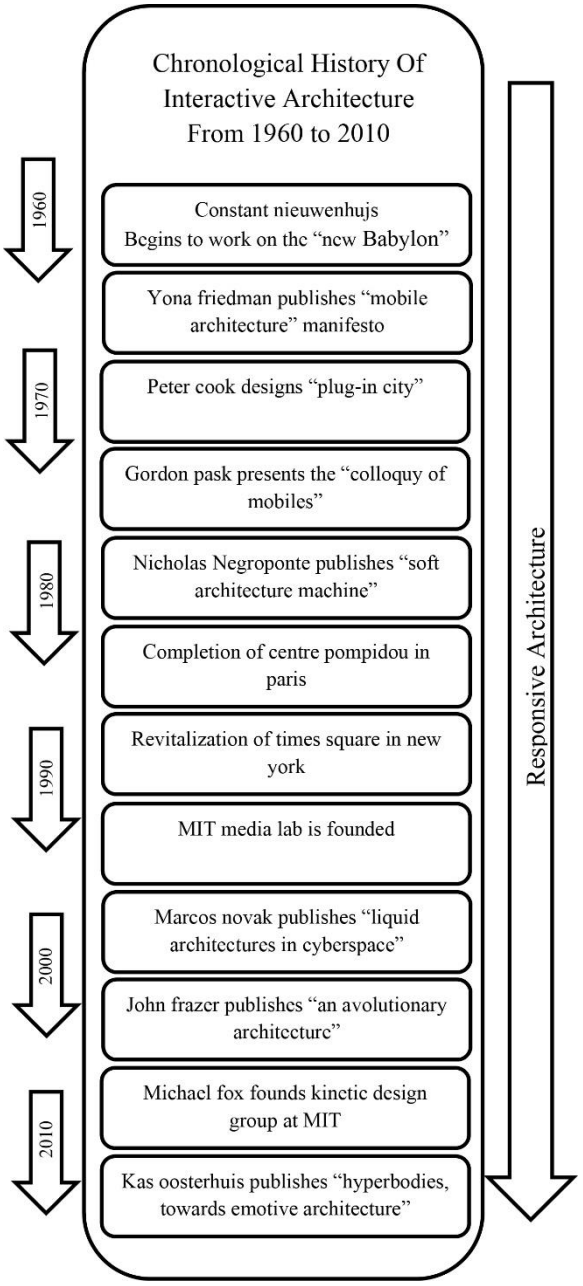

Fig 5**: Chronological History of Interactive Architecture**

the late 1990s, long history of kinetic in architecture began to reconsider under the new theories of intelligence and novel technologies. Architecture began to review historical kinetic aesthetics in addition with novel technological innovations by Robert Kronnenberg via performing range of conferences and exhibitions in the field of "Transportable Environment". Traditional problems of motion, balance and order have been challenged and have redefined by new facilities; also depicted strategies in the field of new technologies, particularly, new technologies and approaches in motion and transportation that referred to contemporary nomadic culture [7]. Contemporary social and cultural changing necessities, with taking responsibilities in problems like sustainability, increase requirements of interactive architecture solution. In the field of architecture, tendency toward obtaining ability to adapt to changeable needs in contemporary society is an essential issue. Organic theory derive from nature, it is evolutionary paradigm that create forms of growth and behavioural strategies. Prevalence of organic paradigm is a beginning for interaction of perceiving model that we use for perceive and subsequently design our environment. Technology creates recent unprecedented viewpoint that is about microscopic natural mechanism and construction of kinetic advanced components via new materials such as fabrics, ceramics, polymers, gels, shape memory alloys and compositions [15].

In this discourse we cannot ignore discovery of constructions and systems that are in very small scales (nanoscale). Nano composite materials have been developed to be sensible and self-actuator and be able to develop their capability of performance, actions and independence. Composition of new materials and robots in the very small scales offer attractive field that is related to interactive architecture in organic nanotechnology. Interactive architecture can utilize from combination of biological functions and nano scale accuracy. Technology transportation from integrated interactive advances into other fields will help to grow, advance and promote interactive architecture. This technology transportation is obvious in innovations in airspace and automobile industrial design and digital Medias. Considerably, most of the innovations are in industry areas not architecture [1]. Whether or not we will see the "live by wire" or "work by wire" technologies periods in the near future.

Recent advances in the interface design subsequently will have a role in interactive architectural environments. Prosperity in innovation and construction of sensors is promising accessibility to devices for gathering information and data that were unbelievable in the past. Biological paradigm of interactive architecture not only needs to have technological perception and understanding on the basis of function and performance but also needs to have awareness of philosophical, perceptive and aesthetic issues in connection with human being and its environment. It should be said that many of the primary case studies of interactive architecture were on the basis of digital Media's advancements. Basis of interactive architecture is on physical changeability and embedded computation. This field is in its infancy period and there are many significant ways that should be discovered and researched [24].

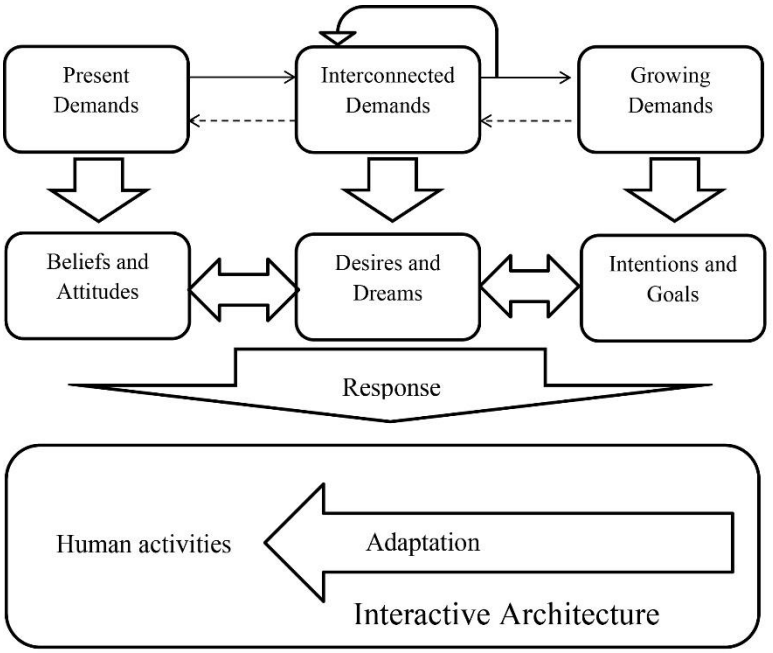

Fig 6: **Interactive Architecture respond to humans changeable necessities spontaneously [26]**

3. Architectural Adaptation via Interaction

Adaptability is referred to the potential of space for being flexible in order to respond to the changeable needs of people in a space. In the majority of cases, adaptability is referred to the potential of structure to accommodate a specific action via transforming its physical shape. Kinetics are physical devices for providing an inherent potential in a system for having physical movements and these are not necessarily interactive. For having an interactive adaptability, we need both physical changeability and embedded computation. The fundamental difference between adaptable spaces that we have in this text and what we had in the past is that these spaces have some level of interaction. In the past, architectural spaces were adaptable in order to change in the time of demand but they weren't interactive, today, spaces can receive information from users or environments and adapt themselves spontaneously.

Often, adaptable spaces discuss along with optimization, mean that creating functional or effective spaces. In the level of spaces, this issue is referred to the potential of space for being adapted with user's necessities via adapting in discourse of an optimized condition in order to fulfill a specific action. The relation between space and an action is a changeable relationship. While an adaptable interactive connection between user and space is shaped, the experience of space would be very interesting. Adaptable space introduce this phenomenon that a dynamic changeable experience of space, alter and change both user and space. In an adaptable spaces, devices and objects can be in the case of necessity and alter or disappear in the case that they are not necessary. Evolution in architecture should encompass changeable environment that has changed human beings, so the people have the ability to promote and change their environment in a dynamic and alive circle. The distinction between interactions in architecture in comparison with what is happened

in automated building is that interaction let the architecture to adapt in an unpredictable conditions. Architectural adaptation with environment is for creating architecture that can provide the ability of proper action by its occupants. In this process, not only the environment but also the occupants' actions are dynamic and changeable. [14].

4. Conclusion

Finally, it should be mentioned that interaction is a dialogue between users and cybernetic architectural environment that determined by the digital, material and conceptual qualities of interaction. These qualities are obtained from essence of architecture that creates interwoven connection and communication among different parts of architectural elements and participants. Conceptual quality is the structural meaning and embodiment of thought in design of interactive cybernetic environment. Its importance is for involving of users in process of interaction, because it shows mutual relationships that shape alongside of the process of interaction. Quality of material impels on various paradigms that natural, digital and virtual materials are connected with each other in that and each of them play particular roles. This event is very important due to the reason it provides basis for alteration of solid and fluid states of space and introduce architectural elements as active intervention in the space. Interaction digital quality requires promotion of architectural spaces via digital elements. It is reflected on flexibility and adaptability of transformation process between different states of different material in spaces alongside of interaction process. In order to what is said about interaction qualities, it could be mentioned that interaction is an intuitive and self-actuated conversation with environment that is generated by transformation processes of flexibility and adaptability of material in different states. At last, it should be said that this interaction create a fluid space that is able to move, adjust, change and activate itself.

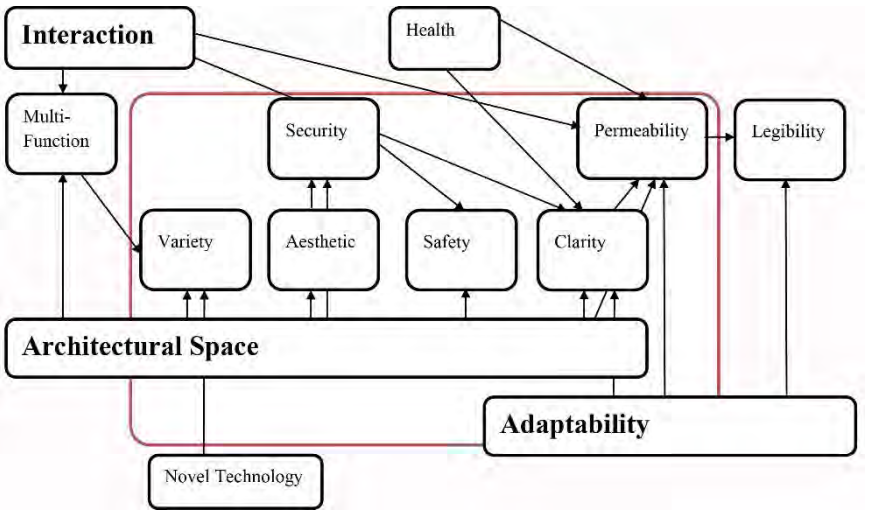

Fig 7: **The Interwoven Connection among Interaction, Adaptability and Architectural Spaces and Their Subsidiary Factors**

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