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A Research on the Proposal of U-Pavilion Adopted in Korean Residential Development

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Abstract Over the past two decades following the 1990s, South Korea's IT industry has developed rapidly. In keeping with this trend, the architectural and urban planning sectors have also converged with IT and achieved advancement in new directions. This evolution includes a variety of conceptual terminologies such as 'home automation', 'home network', 'smart home', and 'ubiquitous-city'.
However, smart homes and U-cities simply represent a conceptual extension of home networks, and there is little real difference in the technologies involved. In particular, U-cities remain focused on infrastructure rather than on the development of specific content; consequently, they have failed to demonstrate distinctive features to clearly differentiate themselves from conventional cities.
In such a context, this research aims at the proposal of a 'ubiquitous pavilion' as a component of the efforts to develop a range of architectural contents that utilize ubiquitous technologies. By grafting the pavilion, one of the most basic forms in architecture, with cutting-edge ubiquitous technologies, this paper intends to suggest a multi-purpose architectural space readily and simply available not only in newly emerging U-cities, but to conventional cities as well.

Keywords: Ubiquitous-Pavilion, U-City, Scenario, Technical Roadmap

1. INTRODUCTION

1.1 Research Problems & Aims

Over the past two decades following the 1990s, South Korea's information technology(IT) industry has developed rapidly through concerted efforts on the part of both the government and the private sector, serving, in turn, as a powerful driving force behind national development. In keeping with this trend, the architectural and urban planning sectors have also converged with IT and achieved advancement in new directions. This evolution, as it relates to major terminologies and functions, is going to be examined briefly in the following.

'Home Automation' was a new idea that started, in its early stages, with simple devices such as wall-mounted telephones equipped with remote door opening and intercom functions, then progressed with the addition of video functions allowing the viewing of visitors. Around the late 1990s, 'Home Network' was introduced and soon extended to encompass the Internet (including broadband Internet), enabling at-home sharing of information from around the world, and the installation of local area network(LAN) -functional home appliances. This has recently moved on to the emergence of 'Smart Home' adopting the ubiquitous concept, transcending time and space and evolving into the concept of 'Ubiquitous-City or U-City', based on the extension of space into entire cities.

Strictly speaking, however, smart homes and U-cities simply represent a conceptual extension of home networks, and there is little real difference in the technologies involved. In truth, these dual initiatives, despite the grandiose verbiage that often accompanies government-related efforts, have yet to offer tangible results. In particular, U-cities remain focused on infrastructure rather than on the development of specific content; consequently, they have failed to demonstrate distinctive features to clearly differentiate themselves from conventional cities.

In such a context, this research aims at the proposal of a ubiquitous pavilion (hereafter "U-Pavilion") as a component of the efforts to develop a range of architectural contents that utilize ubiquitous technologies applicable to both U-cities and other existing cities. By grafting the pavilion, one of the most basic forms in architecture, with cutting-edge ubiquitous technologies, this paper intends to suggest a multi-purpose architectural space readily and simply available not only in newly emerging U-cities, but to conventional cities as well.

The pavilion has been singled out among all possible structures since the greatest alteration in terms of space triggered by the employment of ubiquitous technology is spatial integration,

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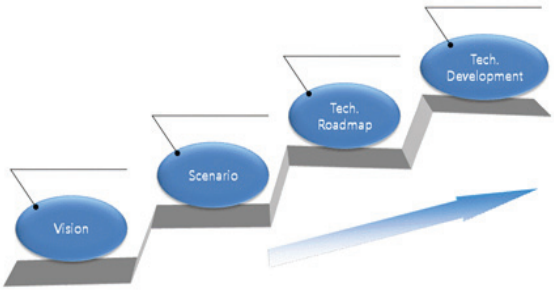
or "convergence." Namely, ubiquitous technologies enable the establishment of a multi-purpose space serving multiple functions, sweeping away the limitations of space serving a single function. Taking this feature into consideration, it was decided that the ideal outdoor building used for a myriad of purpose would be the pavilion.

1.2 Research Process & Scope

This research first takes a look at ubiquitous space, a new concept when viewed from an architectural perspective, and at basic related technologies. It also deals with social vision and a necessary scenario in order to help select requisite technologies from the array of fundamental technologies. In addition, the U-Pavilion is proposed as a structure that can be erected in a residential housing complex, in relation to such blocks that account for a relatively large portion of housing in urban spaces across South Korea.

Pavilions, as a basic type of architecture offering the flexibility to serve a range of purposes, are also explored here, identifying those pavilions internationally recognized as the most modern and offering a variety of experiments with the form.

In the end, a range of aspects of the U-Pavilion are presented in this paper, from suggestions on forms and functions to the identification of requisite technologies, resulting eventually in a roadmap for certain undeveloped technologies. This research and development of the U-Pavilion was conducted in reference to stages adopted in ubiquitous-related studies in the EU, as shown in the figure below.



Picture 1. R&D Processes related to Ubiquitous Tech. in EU.

2. UBIQUITOUS SPACE & TECHNOLOGY

2.1 Concept of Ubiquitous Space

In order to briefly explain the concept of ubiquitous space, an understanding of which is essential for the following discussion, the environment we live in can be divided into two types of space: The physical space, which is where we actually reside—in other words, the space where we have been living since birth; while the second is electronic space, or cyberspace, engendered through the invention of the computer. The following is a simple example for understanding the distinction between these different spaces: A person who is simply an office worker or student in physical space, may in cyberspace become a general or a warrior or a monarch governing a castle, as they so desire. This provides sufficient grounds to answer the question as to why so many young people are absorbed in cyberspace or computer games.

In addition there is also ubiquitous space, a notion first advocated in 1988 by Mark Weiser, a researcher at the Palo Alto Research Center, and since established as an expanded concept of space. It is a third locality that exists at the juncture of the existing physical space and the electronic space mentioned above.

The characteristics of this space are hinted at in the ubiquitous computing philosophy proposed by Mark Weiser. In ubiquitous space, technologies naturally weave themselves into the fabric of everyday life—disappearing from awareness and becoming invisible and serene. To put it another way, the basic concept of ubiquitous space is that it is not the technology but the people who reside in a space that are the main component and technology remains hidden and invisible while serving to assist people.

In a smart home, for instance, a student's room can morph into a space similar to school, becoming a space that enables homeschooling to be as effective as school learning. Of course, a few uncomplicated technologies are required here—video conferencing enabling the student to converse with teachers and other students and a means to project images from a classroom onto the wall of the room. In this regard, it should be stressed that only after a consensus is formed regarding goals and necessities should technology be in order, not vice versa.

2.2 Ubiquitous Technology

There are far too many ubiquitous technologies to enumerate here, but they may be generally classified into three types.

The first is networking technology related to communications, which may be further divided into wired or wireless.

The second is hardware technology, which is related to products, including sensors. For instance, on a small scale, there is a plethora of sensors ranging from radio frequency identification (RFID) chips for managing entity data to sensors for measuring temperature, humidity, and illumination. There are additional sensors for detecting location, behavior, and even eye gaze, as well as for measuring pulse and blood pressure. On a larger scale, "transformative" home appliances can be included in this category: refrigerators that also function as servers, since they are constantly supplied with power in the home; smart TVs interwoven with conventional personal computers; and coffee machines that brew drinks tailored to individual tastes upon recognizing who has pushed the button. In addition, middleware technologies, which will be elaborated upon later, can be included in this category: technologies that enable products, regardless of their type, to be independently linked to a central control computer.

Finally, the third type is software application technology, which includes an exorbitant number of different technologies. Here are biometric security programs that enable access control by using part of the human body; agents and personal assistant apps, recently installed on iPhones and growing in popularity; programs that notify you of bus schedules; and affective-cognitive programs that demand higher technology.

As space is limited here, this paper will briefly explain the relatively important networking and middleware technologies that may be unfamiliar to the general public, and excludes hardware and software.

- Network Technology

Firstly, wireless technologies include IEEE802.11x wireless LAN, Home Radio Frequency (RF), Bluetooth, UltraWideBand (UWB),

Zigbee, and HiperLAN. Among these, in particular, a few of the more widely-used technologies are as follows.

Bluetooth is a technology that, as one of its strengths, enables information appliances to connect over short distances, thereby providing seamless service on demand. Furthermore, dedicated efforts by manufactures have led to continual advances in providing convenient, user-friendly appliances.

Picture 2. Bluetooth device connecting iPhone with Speaker wirelessly.

Zigbee is a standard technology for home automation and networks, having a low-speed transmission rate. With just the touch of a button, this technology allows users to control lighting and home security systems, as well as turn on and off a VCR anywhere in the home.

Home RF is a home-networking technology that operates in the 2.4GHz band, similarly to Bluetooth, connecting home appliances to home computers within the residence.

In contrast, wired technologies include Home Phoneline Networking Alliance (PNA), Power Line Communication (PLC), Ethernet, IEEE1394, USB, and etc. Home PNA enables connecting information and communication devices to a network through existing home phone lines, as well as the creation of home LAN environments without additional gadgets such as a hub or router. Home PNA 2.0, which transmits data at a 10-Mbps maximum, has become the technology standard.

PLC transmits communication signals by converting them to high frequency signals ranging from 100KHz to 30MHz by means of power lines installed around homes or offices. When signals are received, a high frequency filter is utilized. This method of data transmission has already been in service for over two decades.

Ethernet is a networking technology based on the IEEE 802.3 standard and a LAN technology as well. Its performance has long been confirmed through data communication, and it has served as the foundation for not only home networks but also for business networks. It has attracted considerable attention due to its rapid speeds (currently 10Mbps and 100Mbps), extreme stability and reliability, and, most of all, for its price advantage over competing technologies.

Finally, IEEE 1394, originally developed as a hard disk interface in 1986, has begun to draw attention as a next-generation home networking interface. As part of the efforts to distribute this technology, the 1394 Trade Association was founded in 1994 and has been dedicated to promoting the standardization of specifications. The characteristics of IEEE 1394 are as follows.

First, an IEEE 1394 interface offers high-speed data transfers, with transfer speeds standardized at 100Mbps, 200Mbps, and 400Mbps depending on the mode. These speeds allow for real-time digital audio and video data transfer, as well as for multimedia devices, including scanners, digital cameras, or digital video cameras, to be connected and operable via an IEEE 1394 network.

Second, 1394 architecture boasts a considerable command of two-way communication between devices. Since Integrated Circuit (IC) able to control the IEEE 1394 interface may be embedded in peripheral devices, this interface shows excellent functionality in terms of applications such as video conferencing through personal computers.

Third, the IEEE 1394 supports Plug and Play (PnP). Fourth, by use of a serial bus interface, this interface prevents a device that is turned off from shutting down other devices as well.

In terms of network transmission standards, the main strength of IEEE 1394 is its adoption by both the home appliance industry and the personal computer industry as a next generation data transmission standard. As a result, this technology is expected to be widely and practically applied in home entertainment networks as a backbone technology within a home or residence cluster.

– Middleware Technology

Before anything else, the first is Universal Plug and Play (UPnP), which is the standard for home appliance control software focusing on personal computers. It was proposed in June 1999 by a consortium of approximately 150 consumer electronics companies (including Microsoft, Intel, Compaq, Mitsubishi, Philips, and Sony) with the objective of establishing an independent service environment for operating systems, languages, and hardware platforms in mixed-media, multi-vendor in-home networks.

In addition, Home Audio Video Interoperability (HAVi) is a standardization organization dedicated to ensuring interoperability between a range of digital audio/video devices. It was founded in 1998 by eight leading consumer electronics companies, including Sony, Thomson, Philips, Toshiba, Sharp, and Hitachi, which at the time controlled over 70 percent of the global audio/video market. HAVi announced HAVi Specification Version 1.0 in November 1998. Sony and Philips later demonstrated their own prototype systems in April 2000.

Java Intelligent Network Infrastructure (Jini) is a technology for the federation into a single system of all the kinds of devices and software components on a network. It allows users to share resources and services and provides easy access to resources on the network, regardless of a change in a user's location, while simplifying the creation, renewal, or modification of the network. Developed by Sun Microsystems in 1998, this is the home network-based resource sharing platform used in the distributed computing environment.

Last but not the least, there are low speed communication-based middleware mechanisms for building/home automation using existing power lines. These include LonWorks and CEBus. Group standard middlewares were already established by the 1990s through the efforts of related groups, including LonMark and CEBus. Among them, the LonWorks protocol was registered as the EIA 709.1 standard under US ANSI and a number of products

meeting this protocol have been introduced to markets in Europe, the United States, and Japan. It has been thereby recognized as an equivalent to an industrial standard for building automation. At present, LonMark and other groups have engaged in steady efforts to evolve toward home networking services.

3. PROPOSED U-PAVILION

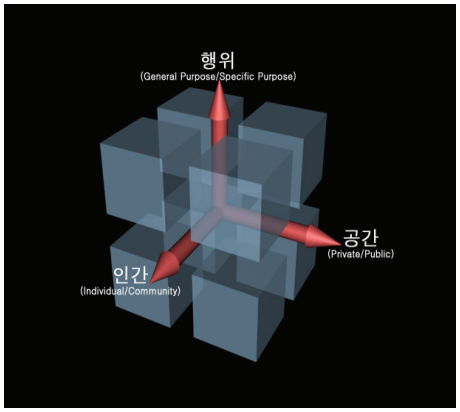
This chapter presents a vision and scenario for the U-Pavilion, the requisite and basic technologies, and a technology roadmap as well, thus encompassing all matters required for actual production while at the same time suggesting a morphological prototype.

3.1 Vision

The vision and scenario for the proposed U-Pavilion development seek to address twin challenges currently faced by the South Korean society. The first is its rapidly ageing population. South Korea crossed into aging society status in 2000, the point at which citizens aged 65 and over accounted for 7.2 percent of the total population. It is projected to become a super-aged society by 2026, with individuals aged 65 and over composing 20 percent of the population. By taking into account aging issues emerging as new concerns in Korean society, ubiquitous basic technologies are being designed to respond to the demands of elderly residents who spend the bulk of their time in residential housing complexes. Examples include enhancing health care services, emergency preparedness, and communication with children and friends. The second is the protection of children. To protect children from violence, sexual assault, and kidnapping, which are the by-products of an increasingly complicated society, the proposal for the U-Pavilion aims to help create safer residential complexes.

3.2 Scenario

In fact, previous research on the application of U-space to architecture and urban planning has been conducted for years. There is a scenario-development methodology that was first established through earlier studies, schematically illustrated in Figure 3. The scenario required for this study was also created within this framework.



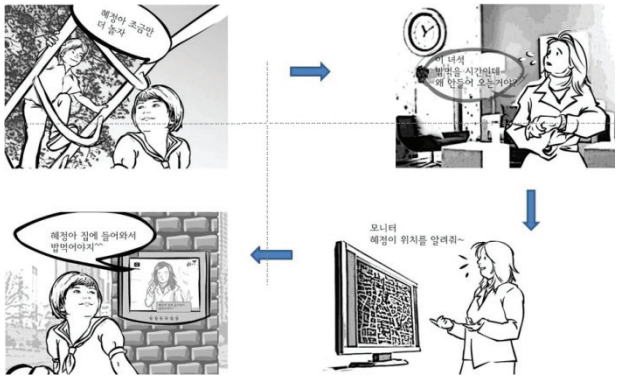
Picture 3. 3-Axes consisting of 'Purpose', 'Human being', & 'Space'.

Therefore, in this study, the space is restricted to the 'public' space of residential complexes and primary users of the U-Pavilion are 'individuals' who could be resident students and homemakers, as well as the elderly with free time. The 'general purpose' for the U-Pavilion would be to serve as a safe playground for children; as a system for enabling parents to engage in other tasks while also monitoring their children; and as a lounge and health consultation center for senior citizens.

A simple timeline scenario has been developed as follows: After breakfast, seniors go out for a stroll around the neighborhood and visit the U-Pavilion. There they are automatically checked in and can receive simple physical examinations, including weight, blood pressure and blood sugar check-up. This data is immediately transferred for storage at a related community health center where it is used as key information for the prevention of serious illness and accidents.

Along with emergency dispatch call service, the U-Pavilion features a video telephone service which enables the elderly to engage in remote medical consultations with a health practitioner at the community health center at their convenience[1]. To exchange greetings with ease, they may also make video calls via its call function to friends registered on the U-Pavilion system.

In the afternoon, children returning from school or preschool are able to play in the area surrounding the U-Pavilion where recreation equipment has been installed. When children visit the U-Pavilion, they are automatically checked in, allowing parents at home or in the workplace to remain cognizant of the whereabouts of their children. Through an integrated video system in the U-Pavilion, parents can observe their children at play and, as illustrated in the figure below, children can communicate with their parents. In particular, parents looking after their children at the U-Pavilion can pass the time with electronic books and/or magazines provided by an adjacent library on the screen and even borrow books through a video call.



Picture 4. "Hye-jeong, let's play a little longer." "It's already dinner time." "Monitor, show me where Hye-jeong is now." "Hye-jeong, dinner is ready."

[1] Once registered in the U-Pavilion system, seniors are encouraged to measure their weight, blood pressure and blood sugar levels. The data is then transferred to the related community health center at the district office. If they have any health-related questions, they are able to place a video call to the expert in charge at the center via a remote video medical care system. Since the data transferred from the U-Pavilion is monitored at the community health center, some members could receive a direct phone call from the center to their homes if they experience radical fluctuations in weight, blood pressure and/or blood sugar levels, or even in life pattern, for example if a regular habitué does not visit the U-Pavilion for a set period of time.

In the evening, small-scale musical concerts are held for the entire family and classic films are shown on the large screen at the U-Pavilion.

3.3 Requisite Technologies & Technical Roadmap

First of all, the requisite technologies can be identified through this scenario. The element of technologies which are required for the completion of the requisite technologies or systems can be classified into those requiring upgrade and those that still need to be developed. The following table shows the results.

Table 1. Deduction of Requisite Element Technologies.

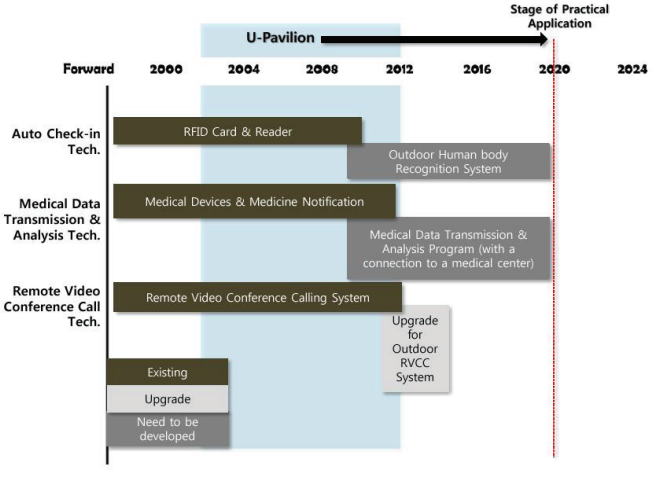
A part of Scenario	Requisite Tech. or System	Element Tech. (Upgrade or Need to be developed)
… visit the U-Pavilion, they are automatically checked in…	Location Recognition & Automatic Registration System	Auto Check-in Technology (when individuals get in designated area without any devices)
…physical examinations, including weight, blood pressure and blood sugar check-up. This data is immediately transferred for storage at a related community health center…	Medical Data Transmission & Analysis System	Medical Data Transmission & Analysis Program (with a connection to a medical center)
-To exchange greetings with ease, they may also make video calls via its call function… - Through an integrated video system in the U-Pavilion, parents can observe their children at play and, children can communicate with their parents. - …borrow books through a video call.	Remote Video Conference Calling System	Upgrade needed for system integration

To briefly explain the table above, the first requisite technology is one for locating seniors and at the same time registering them automatically with the server installed at the U-Pavilion. The technology for recognizing an individual's location is in wide use, but for a more accurate registration the system should require electronic IDs or student IDs embedded with an RF tag, which people can always carry like a transportation card, to be recognized only through a reader. In other words, when an individual enters a certain area, the system must identify and register the visitor in an automatic manner without any special device. Since this technology, which could be related to the recognition of human body, appears not to have yet been created, it is categorized as an element for development.

Picture 5. A Prototype of U-bidet for Urine Examination

Second is a system that includes emergency paging and medical data transmission and analysis. Although a great amount of interest and effort have been directed in this field over a number of years, resulting in the development of numerous devices and/or systems, no commercial system is yet available for both transmitting and analyzing medical data with a connection to hospitals or community health centers. Only a few prototypes can be shown like the figure above. As of now, a single simple system has been engineered to provide patients with information about dosage and schedules for medicine via voice through a connection to a medical institution. It appears, however, that additional time is required for the development of a technology which analyzes medical data in order to help people maintain health.

Third is a remote video conference calling system, which would be most frequently used, and for now, are available in the most advanced forms, compared to the two technologies mentioned earlier. In other words, the technology for connecting a monitor at the U-Pavilion to an external terminal via the Internet is regarded as having been fully developed and simply requires upgrading for system integration.



Picture 6. A Technical Roadmap of Three Major Requisite Tech.

Among the additional services for provision, if it is large enough, the monitor used for video calling can also serve to deliver

important notices and urgent announcements from relevant district offices and/or community service centers when it is not otherwise in use.

These three major requisite technologies and other related ones are described in chronological order in the following technology roadmap shown in the figure above.

4. ARCHITECTURAL FORM OF U-PAVILION

In this chapter, affordable architectural form of the proposed U-Pavilion and a simply interior plan are mentioned, which has both Asian image and western structural system. Especially, the form of roof structure, instead of whole structures, is dealt as an example because the each technical equipment satisfying the parts of above scenario is very flexible and a few are not even existed.

According to Wikipedia, "Pavilion may refer to a free-standing structure sited a short distance from a main residence, whose architecture makes it an object of pleasure." Displaying a diversity of characteristics as an annex, this stand-alone building is erected with the intention of providing pleasure. However, such buildings are rare in Korean architectural history and only hexagonal or octagonal gazebos, as depicted in the figure below, would fall within this concept.

Picture 7. A Typical Korean Octagonal Gazebo.

A gazebo refers to a structure placed in an open public area such as a garden or park. In certain contexts, a U-Pavilion within a residential complex as discussed in this paper displays characteristics falling between those of a pavilion and a gazebo. This is because a residential complex can be private in its spatial aspect while also viewed as a public space from the perspective of its residents. Therefore, a reflection of this dual nature is sought in the design of the U-Pavilion form.

In case of western examples, the temporary pavilions at London's Serpentine Gallery are among such structures that have recently been garnering international attention. This series of pavilions began to be constructed in the year 2000 within Central London's Hyde Park, commissioned renowned international architects on an annual basis to become a showcase for acclaimed architects who give full expression to contemporary architectural practice, as shown in the following list, which includes Zaha Hadid in 2000 and Herzog & de Meuron and Ai Weiwei in 2012.

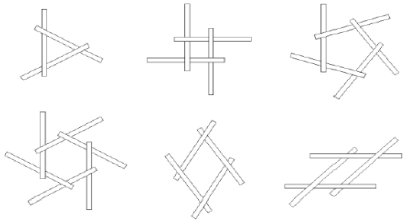
Picture 8. 2008 Serpentine Gallery Pavilion by Frank Gehry.

Table 2. Serpentine Gallery Pavilion.

Year	Architect
2000	Zaha Hadid
2001	Daniel Libeskind
2002	Toyo Ito
2003	Oscar Niemeyer
2004	N.A
2005	Alvaro Siza & Eduardo Souto de Moura
2006	Rem Koolhaas with Cecil Balmond and Arup
2007	Pre-pavilion 'Lilias': Zaha & Patrik Schumacher Olafur Eliasson, Cecil Balmond, & Kjetil Thorsen
2008	Frank Gehry
2009	SANAA(Sejima & Ryue Nishizawa)
2010	Jean Nouvel
2011	Peter Zumthor
2012	Herzog & de Meuron and Ai Weiwei

The ultimate objective of the development of the U-Pavilion would be to offer people optimal pleasure and convenience by incorporating the Asian-style gazebo and the western pavilion in its design, then applying state-of-the-art ubiquitous technologies.

4.1 Wooden Roof Structure of U-Pavilion

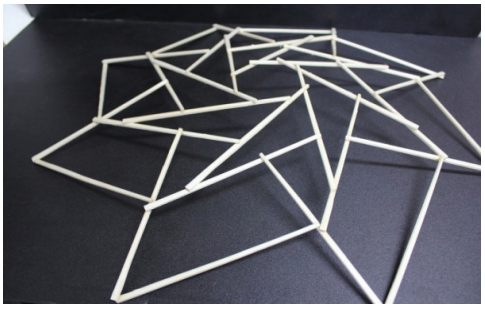


Picture 9. Various Types of Reciprocal Frames.

Among a lot of possible alternatives the wooden reciprocal frame was adopted for the basic structure of the roof because it contains both Asian and western style. This system creates a self-supporting structure with beams propping one another and requires no center column. It can be used to create a range of shapes from triangles to various polygons, depending on the initial placement of the beams, as seen in the above figure. For example, a quadrangle can be altered into applied forms such as a lozenge.

From the spectrum of possible shapes, an octagonal reciprocal frame has been suggested at this time. As might be anticipated, it was chosen because the U-Pavilion is intended from the start to adopt the basic form of an octagonal Asian gazebo and then constantly expand. In addition, the slope and weight of the roof are first determined by the size and shape of the reciprocal frame. According to experiments, an octagonal form is relatively stable and thus ideal.

Finally, the roof structure is completed with an octagonal reciprocal frame as its basis, with beams appended freely as seen in the following figure.



Picture 10. Final Shape of Roof Structure.

The interior space of the pavilion may be freely partitioned. The initial interior design recommended is to trisect the space: half of the total area can be used as a playground and concert hall by day and a movie theater by night; each remaining quarter is designed for the elderly and for homemakers, respectively. An equipment room to accommodate the ubiquitous system is placed between the hemi- and quarter-spaces.

5. CONCLUSION

As mentioned above, with the emergence of South Korea as a global IT powerhouse since the 1990s, Korean people have come to enjoy both convenience and affluence in terms of quality of life, apace with dramatic shifts in daily routines. In particular, in architecture and related fields, considerable evolution has taken place and continues to this day. The most dramatic change among these appears to be the emergence of intelligent space aimed at helping people within that space to lead healthier, safer, happier, and more convenient lives through IT and, by extension, ubiquitous technologies. As space swells in concept, from the interior of a building to its exterior and further to the entire city and then the whole nation, intelligent space is applied into an ever-expanding area.

In fact, the concept of intelligent space has already been established to a certain extent, but its reality still falls far short of expectations. Under such circumstances, this paper seeks to reveal manners to improve the efficiency of intelligent space and has come to suggest the U-Pavilion and a related social vision. Spatial convergence is induced as a selected space is transformed through ubiquitous technology in an intelligent manner to suit the needs of diverse groups of people.

The U-Pavilion is intended to create a multipurpose space within a residential complex, for example as a locus for healthcare for seniors in the morning, a safe and enjoyable playground for children in the afternoon, and a venue of cultural activities for entire families in the evening.

The proposal for the U-Pavilion aims at achieving this goal by adopting an Asian design form as its genesis, subsequently reaching out toward a more western style. In terms of function, it offers a technology roadmap that includes requisite and basic technologies, some of which remain to be developed in order to perform the full range of aforementioned functions.

Picture 11. A Sample of Proposed U-Pavilion

It should be added that a prototype for the U-Pavilion was constructed, but without installing ubiquitous technology-related products. There will be continued efforts to develop products and spaces that integrate architecture and ubiquitous technology. Continued effort will follow as well to assist smaller architectural firms and young architects in difficulty as they deviate from the existing rules to pave the way for a future architectural market through novel ideas and experimental building designs that combine virtuality with reality, such as the U-Pavilion.

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