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Space Planning Guidelines for the Installation of Multi-purpose Convergence Facilities in Universities as Regional Research Facilities

- Focused on the Analysis of Domestic and Foreign Cases -

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Abstract

Currently, convergence research is being conducted in various research facilities in Korea, but it is true that there are very few multi-purpose convergence research facilities that can support such convergence research in universities, which are the most basic research group. In the case of multi-purpose convergence research facilities installed in universities, human resources from more diverse fields gather to conduct various studies than general research facilities, so the facilities should be planned to reflect these characteristics, and the space should be planned to promote human exchanges. The basic guidelines for planning multipurpose convergence research facilities installed in universities are as follows. First, multi-purpose convergence facilities in universities should be based on the habitability and convenience of users who use the facilities, and functionality, promotion of human resource exchange, symbolism, and eco-friendliness should be set as major planning factors. Second, in the case of internal planning, it is necessary to secure a efficient research and public space, a short and clear movement and evacuation plan, a future-oriented image and symbolism, an eco-friendly facility plan, efficiency through zoning and modularization, and future expansion. Third, in the case of size setting, it is appropriate to plan around 18,000㎡ of total floor area, and considered safe to plan around 45% of research & education area, 6% of support area, 5% of convenience area, 4% of exhibition area, and 40% of public areas by use, but additional reviews should be conducted according to the situation of each university or local region.

Keywords : Munti-purpose, Convergence, Research Facility

1. Introduction

1.1 Background and Purpose of Study

Modern society is very complex and diverse, so it is very difficult to solve problems simply with research results in one field, and convergent research covering various fields is needed as a solution to it. In this situation, advanced countries such as the United States, the EU, and Japan recognize the convergence of various fields such as humanities, society, and science and systematic research on it as the most urgent key task for solving problems that may arise in the future society and are preparing various strategies and support measures. In the case of Korea, although it is a rudimentary stage, policies and support are being implemented for convergence research in various fields based on cooperation between industry, schools, and research institutes.

This study aims to identify the concept and recent trends of convergence research, analyze planning characteristics, scale, and programs of domestic and foreign convergence research facilities, and present basic planning guidelines for the installation of multipurpose convergence facilities in universities.

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1.2 Research scope and methods

In this study, the concept and trend of convergence research, which is the theoretical basis of the study, were summarized using the results of existing research and literature. And the case study for multi-purpose convergence facilities in universities was targeted at overseas and domestic cases such as the United States, Germany, and Japan among convergence research facilities installed at major universities and research institutes at home and abroad. In addition, this case study specifically targeted facilities that are promoting cooperative research between industry, universities, and research institutes, fostering convergent talents, and forming convergence networks. Based on existing case analysis, the planning guidelines for convergence research facilities present optimal facility guidelines for the integration and convergence of various research fields, as well as programs for pleasant research activities, communication, and exchange of residents in the facility.

2. Concept and Research Trends of Convergence

2.1 Background and Purpose of Study

The dictionary meaning of convergence is defined as "the melting of different types of things and combining them into one so that they are indistinguishable from each other"[1] and refers to phenomena

and activities in which technologies, studies, products, and industries in different fields are mixed as well as simple physical and chemical reactions. More specifically, convergence refers to a method in which each specialized field, such as humanities, society, science, and technology, is integrated or converged into one to solve a specific topic or task, and in this case, the existing distinction disappears, and a new complex form is created.

The types of convergence can be largely divided into academic convergence, technology convergence, product convergence, and industrial convergence, and furthermore, it can be divided into multilateral convergence that encompasses all technologies, studies, products, and industries. Academic convergence refers to the creation of new academic fields through convergence between different disciplines, and technological convergence is a representative fusion at the technology or engineering level, led by the United States, Nano/Information/Bio/Cognitive Technology (NIBC). Product convergence is a fusion that creates new functional products or improves the functions of existing products through the combination of different products and services, and industrial convergence refers to physical convergence between different industrial fields that traditionally exist, as well as convergence that creates added value or pioneers new markets through technological or management strategy convergence.[2)]

In addition, convergence technologies can be classified into three types according to the convergence field. It can be divided into original technology creation (technology convergence promotion) convergence that combines new technologies with existing studies such as humanities, society, and art/culture, new industry creation convergence that creates new industries through technology convergence, and industrial advanced convergence that combines new technologies and existing traditional industries to advance industries and services that can meet current market demand.[3)]

Convergence technology is expected to develop further through technological innovation and R&D in the future, and it is also expected to have a significant impact on the education of R&D personnel in various fields.

2.2 Overseas and Domestic Research Trends

(1) Overseas

Recently, major countries such as the United States, the EU, Japan, and China are seeking technological development through strategic convergence between disciplines under the leadership of the state beyond progress through natural convergence between disciplines and are expanding their targets to society as a whole, including technology, humanities, society, and art, away from similar convergence between disciplines and technologies. And as the 4th Industrial Revolution emerges, convergence research is developing around technologies that are easy to integrate with other fields such as the Internet of Things (IoT), artificial intelligence, and unmanned vehicles.

Convergence research in the United States is being conducted in the first and second rounds, focusing on NIBC (Nano/Information/Bio/Cognitive Technology) technology. The first NBIC (2003-2012) aimed to improve human performance based on advanced convergence technology, and the second NBIC (2013-present) aims to establish human-centered values and utilize problem-solving by mobilizing the capabilities of human-technology-society-nature. And recently, it is expanding its scope to various technology fields such as materials, energy, environment, health information systems, smart grids, eco-friendly vehicles, and ICT (Information & Communication Technology).[4)] NASA, DOD, and DOE are participating in convergence research in the United States, led by the National Science Foundation (NSF), and support programs include NSF-Wide ('06 onwards), Cross-cutting ('09 onwards), Small Business Innovative Research (SBIR), Small Business Technology Transfer (STTR), and Advanced Technology Program (ATP).[5)]

The EU is promoting convergence research in member countries through CTEKS (CTEKS: Conversing Technologies for the European Knowledge Society, 2004), and expanding the participation of convergence-related researchers through Horizon 2020 (2013), a representative R&D program, to solve human-centered social problems. Convergence research in Europe has established a comprehensive framework that encompasses humanities, society, and cultural areas beyond the convergence of basic nano, bio, and information and communication technologies. Based on this, it operates continuous R&D programs and conducts 'Horizon 2020' (FP8), a high-tech research and innovation program that invests 80 billion euros over the next seven years since 2014.[6)]

Since 2013, Japan's convergence research has been preparing an annual Japanese revival strategy for economic revival since the 2011 earthquake. The Ministry of Education, Culture, Sports, Science and Technology has established the 4th Basic Science and Technology Plan to set key areas aimed at solving problems rather than individual policies, and the Ministry of Economy, Trade and Industry proposes the creation of a new social system through IT convergence in the Action Plan Report (11.8). In 2015, the core strategy of the 4th Industrial Revolution, 'New Industrial Structure Vision: Japan's Strategy to Lead the 4th Industrial Revolution', was announced to create products and services by combining the above common infrastructure technology with industrial fields or data such as finance, medicine, and production. In 2016, under the subtitle 'Towards the 4th Industrial Revolution', it reflects a number of contents related to the 4th Industrial Revolution such as big data, artificial intelligence, robots, and IoT.[7)]

At the government level, China is very actively supporting convergence research, focusing on the IoT, cloud computing, and big data. In 2013, China announced the 12.5 plan for smart

manufacturing and service robot science and technology development, which includes integrating information and communication technologies such as cloud, computing, big data, and the Internet of Things of 11 key areas (start-up, manufacturing, agriculture, energy, finance, people's livelihoods, logistics, e-commerce, transportation, ecological environment, and artificial intelligence). In the end, it aims to lead the fourth industrial revolution by connecting the Internet and the manufacturing industry, as well as the financial and government public sectors to the Internet. Recently, the Chinese government announced the 13.5 Plan (2017), which contains strategies for robot industry development, smart manufacturing development, and big data industry development.[8)]

(2) Domestic

In Korea, the '23rd National Science and Technology Committee' announced the 'National Convergence Technology Development Basic Policy' in 2007, and as a follow-up measure, the 'National Convergence Technology Development Basic Plan' was established in 2008. The "National Convergence Technology Development Strategy" classified major convergence technologies among 120 strategic technologies in the "3rd Basic Science and Technology Plan"(13.8) and presented an analysis of technology level goals, detailed technologies, and R&D-led subjects in five years. The basic plan specifically includes projects such as new industry creation projects, creative economy portals, convergence technology impact assessment systems, convergence talent education (STEAM), and the convergence research policy center (KIST), as well as promoting joint international research and joint research by contributing research institutes and operating regular consultative bodies related to convergence between ministries.[9)]

2.3 Development and Expected Effects of Convergence

In modern society, lifestyle and global consumption environment are rapidly changing, and accordingly, consumers' desires and expectations for products or services are also rapidly changing. Accordingly, companies are choosing a strategy to respond with a relatively short development period and low-risk convergence method instead of technological innovation that takes a long time and takes a high risk to meet the rapidly changing needs of consumers. In other words, from a supply-side perspective, convergence is a process of creating new value by creatively recombining technologies, ideas, etc. that have already been verified in various industries and businesses in response to changing consumer trends. As such, convergence provides consumers with new opportunities and challenges, such as increasing satisfaction with products and services, creating high-value-added business sectors for companies, and changing competitive paradigms in the market, allowing them to evolve and develop into new trends in future industries and technologies.[10)]

3. Case Analysis of Domestic and Foreign Convergence Research Facilities

In this study, a case study was conducted on overseas and domestic cases such as the United States, Germany, and Japan among convergence research facilities installed in major universities and research institutes at home and abroad to present planning guidelines for multi-purpose convergence facilities in universities. In particular, it targeted facilities that are promoting industry-academic cooperation research, fostering convergent talents, and forming convergence networks.

3.1 Abroad Facilities

(1) MIT Media Lab[11)]

① Facilities Overview

MIT Media Lab is located east of the MIT campus in Boston and houses the List Visual Art Center, the Okawa Center for Future Children, and various art and technology-related research institutes. MIT Media Lab began in 1985 at the Wiesner Building and was designed by architect I. M. Pei with one basement level and five floors above ground. Since then, the existing building has been expanded by Fumihiko Maki to have one basement level, six floors above ground, and about 15,000 square meters in 2009.

Fig. 1. Perspective View

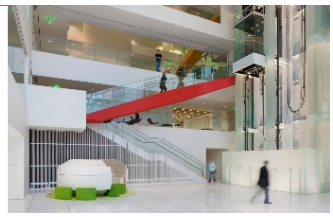

Fig. 2. Staircase in Atrium

② Space Program

The existing Wisner building has few external windows, but consists of an inner atrium and a "Cube" that forms the center of the building. "Cube" is a research space planned as an open plan with two floors high and is spatially connected to the surrounding laboratory. This space is used for various purposes, such as lectures, exhibitions, events, and rest, as well as research, and becomes the main space where ideas of media labs are born through interaction. This space composition provides a people-centered research environment to promote internal exchanges and help increase external exchanges such as sponsors' visits and various interdisciplinary convergence events and meetings. Unlike the Wisner Building, the new building is a transparent building made of glass and improves the living environment through natural lighting. The new building

has various sizes (465-790㎡) of laboratories, conference rooms, lobbies and galleries, rest areas and cafes centered on the atrium, and has an administrative support room (about 300㎡), a 100-seat auditorium used as an event space, a multipurpose space (325㎡), a large conference room (230㎡) connected to an external terrace, a restaurant and reception hall (325㎡), and a catering kitchen (167㎡).

Fig. 3. Lab Interior

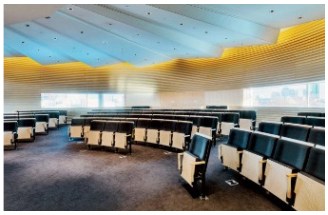

Fig. 4. Lecture Room

(2) Korea Institute of Science and Technology (KIST) European Research Institute[12)]

① Facilities Overview

The European Research Institute of the Korea Advanced Institute of Science and Technology was established in Jabrucken, Germany, with the aim of internationalizing science and technology through field research, securing technological exchanges and joint research bases with EU and Eastern European countries, and establishing a forward base for Korean companies' European activities. The land area is 9,274㎡ and consists of 5,275㎡ in 1 Research Building (2000.04), 2,096㎡ in 2 Research Building (2010.04), and 1,800㎡ in guesthouses (2021.11).

Fig. 5. Perspective View

Fig. 6. 1st Research Building

② Space Program

The first research building, completed in 2000, consists of a three-story research area divided into several squares and a long rectangular common area connecting them, and consists of a simple and efficient space configuration optimized for research activities. Each segmented research area houses the Global Knowledge Research Center, the Interdisciplinary Human Biotechnology Group, and the Microfluidics & Clinical Diagnostics Group. The common area is separated from the ground floor by the piloti, so the external garden is drawn deep into the building, and the upper floor secures a sense of openness through a long skylight. This common area is used for various purposes such as exhibitions, events, and rest by utilizing the long corridor space, and in particular, it plays a role in promoting interaction among researchers. The second research building, completed in 2010, is pursuing a spatial plan that is faithful to the basic functions of the research facility while maintaining the simple geometric design characteristics of the first research building. Most of the design elements that make up the building, such as the height and size of the building, as well as the long planned horizontal window and segmented ratio of the building, were planned to fit together without any sense of alienation from the existing research building 1, and the existing external garden is finally being completed in the form of a centered garden with the completion of the second research building.

Fig. 7. 2nd Research Building

Fig. 8. Guest House Building

(3) Environmental Studies Research Institute Building, University of Tokyo Kashiwa Campus[13)]

① Facilities Overview

The University of Tokyo Kashiwa Campus, established in 1998, is located in Kashiwa City, Chiba Prefecture, Japan and the area is an eco-friendly new city linked to the private, government, and academic research facilities centered on the campus of Tokyo University and Chiba University. The University of Tokyo Kashiwa campus has four research centers including Life Science Research Institute, Fundamental Science Research Institute, Transdisciplinary Science Research Institute, and Environmental Studies Research Institute.

Fig. 9. Perspective View

Fig. 10. Environmental Studies Research Institute

② Space Program

Among the buildings on the Kashiwa campus, Environmental Studies Research Institute Building was planned in consideration of a pleasant living environment and nature-friendly aspect by applying eco-friendly concepts such as geothermal power generation system, rainwater recycling, and natural ventilation system. The Environmental Studies Research Institute Building is an S-shaped building facing the square of the campus, and the building is arranged in an L-shape

centering on the central atrium. On the first floor, a lobby, gallery, auditorium, administrative office, and laboratory were planned, and on each floor, a human environment major (2nd floor), a sustainability program (3rd floor), an environmental system major (4th floor), a natural environment major (5th floor), a socio-cultural environmental science major (6th floor), a professor's office of marine technology environmental science and international cooperation major (7th floor), a graduate research room, and a reception are planned. In the building, natural light is introduced into the building through the central atrium, and a glass box is installed at the top of the atrium that allows natural ventilation by using temperature differences, atmospheric pressure differences, and wind inflows. The shading louver of the outer wall of the building adjusts the amount of sunlight flowing into the building by applying different vertical, horizontal, and shape according to the orientation and insulation conditions, and the external finishing material is finished with an insulating steel plate panel considering the energy load. Eco-friendly factors were introduced, such as using underground heat obtained by circulating water for heating and cooling of buildings, and using raindrop water as horticultural water for the rooftop's aquatic garden, central garden, and skip balcony.

Fig. 11. Life Science Research Institute

Fig. 12. Transdisciplinary Science Research Institute

3.2 Domestic Facilities

(1) Advanced Institutes of Convergence Technology[14)]

① Facilities Overview

The Advanced Institutes of Convergence Technology is a research city with a land area of about 100,000 square meters, a total floor area of about 60,000 square meters, two basement floors and 16 ground floors in Gwanggyo Techno Valley in Suwon, Gyeonggi-do, and is a cutting edge knowledge cluster with research institutes such as Gyeonggi R&DB Center, Gyeonggi Small and Medium Business Support Center, Nano Device Specialized Fab Center, Gyeonggi Bio Center, Seoul National University Graduate School of Convergence Science and Technology, 32 related institutions and tenant companies in addition to the Creative Convergence Research Institute.

② Space Program

For rational zoning considering efficiency and connectivity according to functions, the Advanced Institutes of Convergence Technology horizontally connected the lower floors and planned public amenities such as joint special labs, large lecture rooms, international symposiums, restrooms, and libraries. And upper floors, research centers, industry-academic cooperation facilities and administrative support facilities were arranged for each research field. In addition, special facilities such as motion capture studios, high-load laboratories, and animal laboratories are equipped with specialized facilities that have secured expertise to suit the characteristics of each research institute. For the welfare of researchers, dormitories and various convenience and rest facilities were provided, and eco-friendly elements such as atrium and indoor gardens were actively introduced for a pleasant research environment. Public spaces such as atrium, grand lecture rooms, and restaurants linked to the central square are efficiently used for internal events as well as external events such as workshops, forums, cultural concerts, exhibitions, and various educational programs.

Fig. 13. Perspective View

Fig. 14. Central Atrium

Fig. 15. Connection Area

Fig. 16. Lecture Room

(2) KAIST Institutes KI Building[15)]

① Facilities Overview

The KI Building, which was completed in 2010 with a building area of about 5,700㎡, a total floor area of about 21,000㎡, and one basement floor and six ground floors, is located within Daejeon's KAIST campus and serves as a place for exchange and communication for convergence research.

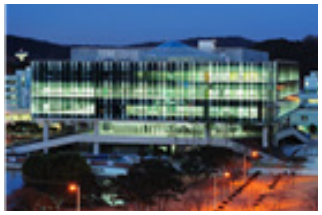

Fig. 17. Perspective View

Fig. 18. Inner Court

② Space Program

Considering the fact that it is located at the entrance to the KAIST, the KI Building is planning an open floor to actively attract beautiful external environments such as plazas and open the space for anyone to use. The first floor consists of an open space used as a cultural and rest area, and a small stand is planned to enjoy small-scale performances, and the second floor has an outer deck and a meeting room. A rest area and an open conference room are provided on each floor to help active exchanges between research institutes and to allow convergence research to take place across various fields. In addition, the atrium across all floors is planned to be connected to each rest area in a curved shape to control lighting and ventilation.

Fig. 19. Glazed Roof

Fig. 20. Conference Room

(3) POSTECH Institute of Convergence IT[16)]

① Facilities Overview

The Institute of Convergence IT is located within the POSTECH campus and used part of the nanotechnology integration center before moving to the C5 Convergence Research Center Building completed at the end of 2014. The C5 Convergence Research Center Building has a land area of about 17,000 square meters, a total floor area of about 16,000 square meters, and a ground floor and 7 floors, and houses laboratories dealing with creative IT convergence engineering such as energy, sensors, semiconductors, and medical devices.

Fig. 21. Perspective View

Fig. 22. Community Hall

② Space Program

The C5 Convergence Research Center Building has an open plan that provides infrastructure that can respond to various needs no matter what research field moves in, and establishes a spatial system with a structure that can organically induce communication between professors, researchers, and students. Visual exchange and openness were expanded by using transparent walls, low partitions, and vertical void spaces, and rest and discussion spaces were organized at major intersections of the route to provide a space for the communication. The 1st to 3rd floors are used by the Department of Convergence IT Engineering, and the 4th to 7th floors are designed as large-scale open spaces so that various research teams can freely rearrange and utilize the space for research purposes, optimizing the promotion of convergence research projects. Exhibition and exchange events are possible in the exhibition hall and community hall in the lobby planned on the first floor, and design rooms, media rooms, and project rooms function as spaces for industry-academic cooperation and convergence research.

Fig. 23. Conference Room

Fig. 24. Open Laboratory

3.3 Sub-conclusion

Table 1. The summary of multipurpose convergence facilities

Sort	Abroad Facilities					
	MIT Media Lab		KIST European Research Institute		Environmental Studies Research Institute	
Completion	2009		2000, 2010		2006	
Floor	B1, 6F		B1, 3F		B1, 7F	
GFA	15,141㎡		9,171㎡		21,031㎡	
Cost	96 billion won		-		61.2 billion won	
Research	5,905㎡	39.0%	4,560㎡	49.7%	11,567㎡	55.0%
Support	863㎡	5.7%	560㎡	6.1%	2,040㎡	9.7%
Convenience	909㎡	6.0%	497㎡	5.4%	315㎡	1.5%
Exhibition	1,423㎡	9.4%	335㎡	3.6%	126㎡	0.6%
Public	6,042㎡	39.9%	3,219㎡	35.2%	6,983㎡	33.2%
Sort	Domestic Facilities					
	Advanced Institutes of Convergence Technology		KAIST Institutes KI Building		POSTECH Institute of Convergence IT	
Completion	2008		2010		2014	
Floor	B2, 16F		B1, 6F		B1, 8F	
GFA	59,996㎡		21,124㎡		15,960㎡	
Cost	97.5 billion won		36 billion won		315.5 billion won	
Research	27,803㎡	46.3%	8,280㎡	39.2%	7,181㎡	45.5%
Support	5,846㎡	9.8%	1,162㎡	5.5%	459㎡	2.9%
Convenience	5,484㎡	9.1%	1,141㎡	5.4%	661㎡	4.2%
Exhibition	-	0.0%	1,183㎡	5.6%	1,060㎡	6.6%
Public	20,863㎡	34.8%	9,358㎡	44.3%	6,599㎡	41.3%

The table summarizes the contents of multipurpose convergence research facilities installed at major universities and research

institutes at home and abroad(Table 1). The size and construction cost of the facility vary depending on the direction each facility pursues or research area, but the design elements planned for the facility are largely consist of research, support, public, convenience, and other areas, and the proportion of each area is similar in most facilities.

4. Planning Guidelines of Multi-Purpose Convergence Facilities in Universities

4.1 Premise of a facility plan

The plan for multi-purpose convergence facilities in universities should first be based on the habitability and convenience of users using the facilities, and functionality, exchange promotion, symbolism, and eco-friendliness should be set as major planning elements. In other words, as it is a convergence research facility, various spatial requirements that may be needed now and in the future must be met for interdisciplinary integration and convergence research, and the exchange activities of students and researchers of various nationalities and classes inevitably arising from interdisciplinary integration and convergence should be promoted and supported in terms of facilities and programs. In addition, it should be able to emphasize and promote the symbolic aspect of convergence research facilities pursued and encouraged by each university, reflecting the latest trends in facilities and structures, and actively considering eco-friendly aspects.

4.2 Space composition of facilities

In the case of multi-purpose convergence facilities in universities, the size of buildings or programs is often larger than the size initially set in the process of integration or convergence between academics, so in the case of a physical environment, a plan should be made in consideration of future expansion and a nature-friendly external space such as a campus square also be created in the space with adjacent buildings.

First of all, in the case of a movement plan, the location of the core and the evacuation floor entrance should be reasonably planned in consideration of the evacuation distance and visibility for rapid evacuation in case of fire. In addition, the user's sense of direction for each facility is planned to be clear, and convenience facilities for the disabled are installed in accordance with the standard building codes.

In terms of plan, a space suitable for the function should be planned, and an appropriate shared space such as a hall, lobby, and lounge shall be secured, and the related annex space should be planned in consideration of the size and location to support the functions of major facilities as much as possible. Appropriate module that can be applied consistently throughout the research facility should be set up, while variability and openness are considered, and the short and long-term variable ratio of each space is determined in consideration of energy conservation and lightning. Stairs, toilets, shafts, etc. shall be intensively arranged to facilitate control and operation, and internal and external stairs or elevators shall be selected in size and location to prevent congestion.

In the case of the elevation plan, symbolism should be emphasized as a future-oriented image that matches the purpose and function of the multipurpose convergence facility in the university, while considering the eco-friendly aspect.

In the case of sectional planning, independence and interconnection should be secured through zoning by function. In addition, preventing raindrop penetration and natural lighting should be considered, and an appropriate floor and ceiling height should be planned to enable the setting of various spaces supporting interdisciplinary convergence research.

4.3 Size and programs of facilities

Considering the data on the size and program of various domestic and foreign convergence research facilities, it would be appropriate to plan a total floor area of about 18,000㎡, which is the same size as the new MIT Media Lab, assuming that it has an appropriate land and considering the possibility of future expansion. In more detail, it is considered appropriate to plan the size of each use to be around 45% of research education facilities, 6% of support facilities, 5% of convenience facilities, 4% of exhibition facilities, and 40% of public areas, reflecting the results of analyzing the cases examined in the previous chapter.

However, since this is the average value of the size of each use of the various domestic and foreign cases examined above, it is considered that additional reviews should be conducted in accordance with the situation of each university when planning a multipurpose convergence research facility. In general, most research facilities undergo physical changes such as repairs and expansion over time, so even these parts need to be set as elements of scale setting.

In the case of multi-purpose convergence research facilities, an appropriate space plan that meets basic functions is required first, but it is important to actively reflect convenience and exhibition facilities in the program in consideration of the characteristics of convergence research facilities, and to plan each detailed facility at a scale suitable for use. It is also very important to plan in a way that promotes program exchange with researchers in accordance with the characteristics of convergence research facilities.

5. Conclusion

Convergence research is currently being conducted at various

research facilities at home and abroad, but in Korea, there are few multi-purpose convergence research facilities that can support such specialized research in universities that generally perform basic research tasks. In the case of multi-purpose convergence research facilities installed in universities, in addition to meeting the basic functions of research facilities, human resources from more diverse fields gather to conduct various studies than general research facilities, the facility should be planned to reflect these characteristics and the space should be planned to further promote exchanges.

The basic guidelines for planning multipurpose convergence research facilities installed in universities are as follows.

First, multi-purpose convergence facilities in universities should be based on the habitability and convenience of users who use the facilities, and functionality, exchange promotion, symbolism, and eco-friendliness should be set as major planning factors.

Second, in the case of internal planning, in addition to short and clear movements and evacuation plans, facility plans that consider future-oriented images and symbolism, ensuring functional, pleasant research space and adequate sharing space, efficiency through zoning and modularization, the elevation and eco-friendly aspects representing future-oriented image and symbolism and future expansion and research program changes are needed.

Third, in the case of size setting, it is appropriate to plan around 18,000㎡ of total floor area, and to plan around 45% of research education area, 6% of support, 5% of convenience, 4% of exhibition, and 40% of public areas by use, but additional reviews should be conducted according to the situation of each university or region.

Multipurpose convergence research facilities established in universities aimed at base research facilities in the region can serve as a venue for communication for convergence research specialized in the region and can be reborn as the center of regional convergence research networks through exchanges of local researchers. In addition to the basic contents of this study in the future, if more systematic research secures specific data on multipurpose convergence research facilities in universities, it is thought that it can serve as a facility that can promote convergence research and development and produce talent through active industry-academic cooperation with local venture companies and convergence-related companies.

Notes

1) Reference 13)
2) Reference 14)
3) Reference 15)
4) Reference 12)
5) Reference 2)
6) Reference 4)
7) Reference 9)
8) Reference 8)
9) Reference 3)
10) Reference 7)
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