

# Reconstruction of Campus Learning Space Driven by Computer Science

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**Keywords:** Campus, Learning Center, Learning Space, Computer Science.

**Abstract:** Under the trend of the transformation of higher education pattern driven by computer science, the campus learning space is also continuously reconstructed and iterated. The most typical phenomenon is that the conventional university library is gradually replaced by the complex learning center. As a campus complex, the configuration of the learning center in terms of function orientation, composition and indicators has been greatly improved compared with the library. The reconstruction of functional positioning will inevitably lead to the reconstruction of the spatial pattern of learning center, forming typical spatial characteristics that are different from library buildings, such as sharing, openness, flexibility, and individuality.

## 1 INTRODUCTION

The concept of Learning Space was first proposed by German philosopher and sociologist Jürgen Habermas, which refers to the place formed by people's interaction, and people exchange culture and knowledge reserves in the learning space to realize knowledge sharing (R-W Miller, 1983). In the theory of pedagogy, learning space is different from traditional teaching space to support innovative education patterns such as autonomous learning, collaborative learning and blended learning based on learners' experience. Under the trend of the transformation of higher education pattern driven by computer science, the campus learning space is also continuously reconstructed and iterated. The most typical phenomenon is that the conventional university library is gradually replaced by the composite learning center.

## 2 FROM UNIVERSITY LIBRARY TO UNINVERISITY LEARNING CENTER

### 2.1 Overview of Learning Centers in Colleges and Universities

The learning center of colleges and universities discussed in this paper refers to the learner-centered learning center, which is supported by information

technology and provides learners with a place for autonomous learning, educational assistance and innovative experiments to promote different types of cooperation and interdisciplinary research. It is a campus building complex integrating traditional library, teaching place, learning exchange, leisure and social interaction (Miguel Barahona., 2007).

In the information age, the transformation of university libraries into learning centers mainly comes from the following two driving forces. On the one hand, the means by which students obtain knowledge has transcended the bounds of conventional archives and libraries. Consequently, novel demands are placed on the functional design and architectural configuration of these institutions. The research in the field of library science points out that the transformation to the learning center is the main trend of the future development of libraries. Shulin Yan and other scholars proposed that the function of the new generation of libraries is education in the first place, followed by information, and the corresponding paradigm is "Learning Center" (Wulin Yan, 2013). On the other hand, the emergence of various innovative learning patterns requires colleges and universities to provide corresponding learning places. As the public center in the traditional sense of campus, the library is more adaptive in the adjustment of functions and spaces compared with other types of teaching buildings. This adaptation process involves transforming traditional library spaces into interactive and collaborative environments that

prioritize active learning principles. Therefore, driven by the development of computer science, architectural design and computer science must now converge to create novel educational settings that foster engagement and interaction among students.

## 2.2 Development of Learning Center in Colleges and Universities

As early as in the 1970s, libraries named "Learning Centers" appeared in foreign universities; The first real replacement of the traditional library is The Biological Sciences Learning Center of the University of Chicago, which was built and opened in 1993. It is positioned as a "comprehensive school building" built for the 21st century. Since then, the development of university learning centers in North America, Europe, Australia, Asia and other developed countries has accelerated, and has gradually become popular after 2000. Not only a considerable number of university learning centers have been built, but most colleges and universities have also realized the transformation to learning centers by upgrading the original library.

In China, at the beginning of the 21st century, some universities have begun to add the function of learning center to the newly built or reconstructed libraries. A large number of university libraries built after 2006 have already had the characteristics of typical learning centers in terms of function and space. The representative ones include the library of The Chinese University of Hong Kong (Shenzhen Campus), Lynn Library of Southern University of Science and Technology, Library of Shanghai University of Science and Technology, Kangquan Library of Fudan University, etc. Due to the construction evaluation standards of domestic universities and other reasons, these campus complexes basically still adopt the name of "library"; Those directly named "learning centers" mainly appear in Sino-foreign cooperative universities, such as the learning resource center built by Beijing Normal University-Hong Kong Baptist University United International College in 2010, and the new library and learning center built by the University of Nottingham Ningbo in 2020.

For the convenience of description, the learning center and the new libraries with the characteristics of the learning center are collectively referred to as "Learning Center", and "Library" refers to the regular library.

## 3 FUNCTIONAL RECONSTRUCTION OF LEARNING CENTER IN CAMPUS

As a campus complex in the information age, the configuration of the learning center in terms of function orientation, composition and indicators has been greatly improved compared with the library.

### 3.1 Change of Functional Orientation

The basic function of university library is mainly to serve the positioning of "book-centered", forming the system of book collection, borrowing, reading, internal business and external service. Although it contains some open learning places, its functions are still relatively single. The university learning center aims at multiple and individual learning types and scales in the information age. Therefore, it emphasizes the orientation of campus public space with "learner experience as the center", and reading is only one of the basic functions.

### 3.2 Expansion of Function Composition

The differences between the modes of running schools in different universities lead to the different functions of learning centers in colleges and universities, but they still have certain common rules. Through the statistical analysis of the cases of learning centers in twenty universities in the past thirty years, seven common functions can be summarized, including: book collection, learning and communication, experimental research, education and training, leisure activities, service housing and transportation space, and reflect the following main characteristics:

1. Learning and communication is the core function of learning center, including open learning, multimedia learning, discussion area, seminar room, individual learning unit, lecture hall (salon, multi-function hall), lecture hall, screening room and other types. In the traditional library, the borrowing area is mainly for students' self-study activities, which is integrated into the open learning area. As interdisciplinary and collaborative learning have become an important trend in the development of higher education, learning seminar rooms and shared discussion areas supporting collaborative communication have also become the standard configuration of learning centers.

2. Most of the functions of the collection of books (including stacks and open bookshelves) are still retained, but the proportion of its area has been greatly reduced due to the electronic use of books and materials and the expansion of learning center functions.

3. The proportion of experimental research functions in foreign universities is higher than that in China, which are mainly general-purpose high-tech facilities for various students' innovative activities, such as 3D printing room, robot laboratory, maker space, digital media studio, student studio, research room, comprehensive laboratory, etc.

4. Some learning centers are equipped with education and training functions, mainly including writing training, vocational skills training and employment guidance, language centers, comprehensive counseling classrooms, teacher development centers, teacher seminar rooms, etc. In addition to training students' comprehensive ability, it is more important to provide support for the interaction among students, teachers and researchers.

5. The leisure activity function is the supporting guarantee for the effective development of rich learning activities of different types, different times and different personalities. The common ones include coffee, light meals, shops, game rooms, sports and fitness, dance rooms, sleeping cabins, meditation rooms, club/society activity rooms, exhibitions and other spaces and facilities;

6. Service functions include consulting services, internal office, equipment room and auxiliary space, etc. The adoption of automation and intelligent equipment greatly reduces the area of logistics, consulting and other necessary service space in the library;

7. Traffic space usually refers to stairs, elevators, aisle space, etc., but the traffic space of learning center is often compatible with learning, communication, exhibition and other comprehensive functions, and the area is greatly increased.

### 3.3 Improvement of Area Index

The expansion of the functions of learning centers in colleges and universities has also brought about a significant improvement in the area index. Excluding the differences in enrollment scale between different universities, this paper mainly uses the two key indicators of the average floor area per student and the average number of seats per student to compare the five typical learning centers completed in China in recent years (Table 1).

Table 1: Sorting out the average floor area of the research objects per student.

Study project	Learning center of UNNC	Library of CUHK (Shenzhen)	Lynn Library of SUSTech	Library of Shanghai Tech	Kangquan Library of Fudan University
Floor area (square meters)	28125	20000	10000	17770	15500
Actual floor area per student (square meters per person)	3.42	3.42	2.18	4.27	4.90
Number of seats per student (per person)	0.33	0.58	0.29	0.46	0.85

As can be seen from the above table, the size of the learning center is mainly between 10000- 30000 square meters, and the average floor area per student varies from 2.18-4.9 square meters, with a median value of 3.42 square meters per person. This standard has greatly broken through the upper limit of 1.56~2.00 square meters per person in the *Index of Building Planning Area for Ordinary Higher Education Institutions*, and also exceeds the full score standard of 2.0 square meters per person in the *Evaluation Indicators of Ordinary University Library*. The average number of seats per student is concentrated between 0.29 and 0.46 square meters per person (individual reaches the ultra-high value of 0.85), which also exceeds the full score of 0.25 in the *Evaluation Indicators of Ordinary University Library*.

## 4 SPATIAL RECONSTRUCTION OF UNIVERSITY LEARNING CENTER

The reconstruction of the functional orientation will inevitably lead to the reconstruction of the spatial model of the learning center, forming the typical spatial characteristics that are different from the library building, such as sharing, openness, flexibility and individuality.

### 4.1 Compound Shared Space

Whether in the mode of "separation of borrowing, reading and collecting" or "integration of collecting and reading", the library mainly forms functional partitions with clear boundaries around the main body of "books", such as dynamic, static, internal and external. The function expansion of learning center is not only to provide support for diversified learning activities such as personalized learning and collaborative learning, but also to promote mutual trigger and open integration between different learning activities, to effectively support learners'

interactions (Michael Frizell, 2018); This can not only exercise students' cooperation ability, but also greatly improve the efficiency of learning and the depth and breadth of knowledge acquisition (OBLINGER D G., 2012). Therefore, most of the learning centers are weakening or even canceling the clear boundaries of conventional functional partitions to create a shared learning community with more complex functions.

Common practices include the use of open atrium, gray space and other ways to construct a three-dimensional shared learning place. For example, the learning center of Ryerson University has a rich open space such as large steps, platforms and galleries in the atrium, which can accommodate learning activities such as self-study and discussion, leisure

activities such as coffee and tea breaks, and public activities such as academic reports and exhibitions in addition to transportation functions (Figure 1). Or the "Flat Design" mode divided by fuzzy space grade, forming a free-flowing plane and three-dimensional space. A typical case, such as the Swiss Rolex Learning Center designed by SANAA, the whole building is spread out horizontally, and there is no partition wall inside except for some rooms for specific purposes. Learners can walk, stay and observe freely inside and outside the building, and choose different learning activities and learning states freely in the large space.

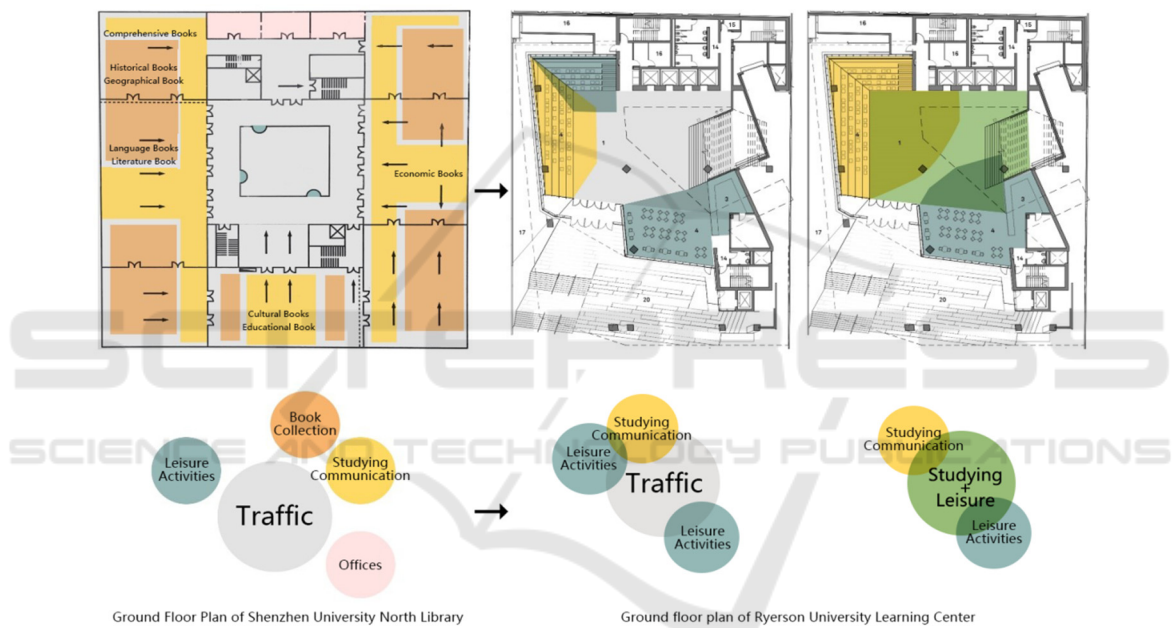


Figure 1: Analysis of function sharing mode of learning center in colleges and universities.

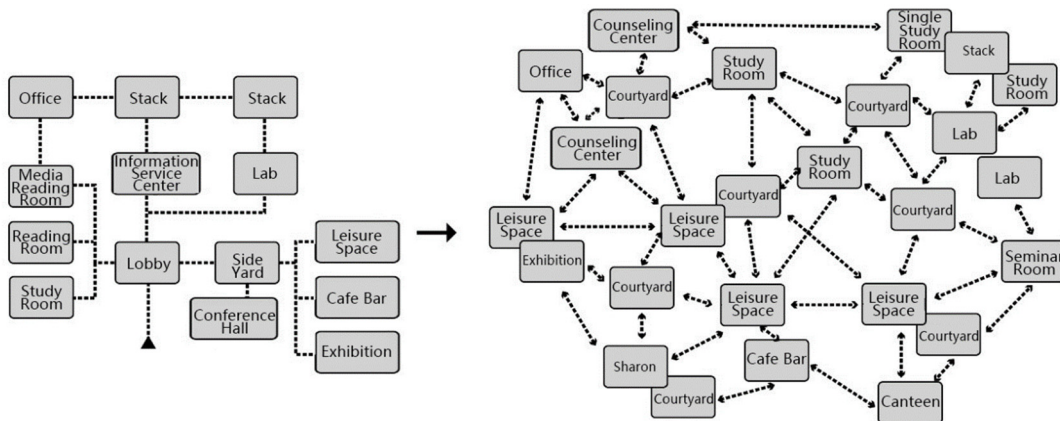


Figure 2: Spatial layout changes of learning centers in colleges and universities.

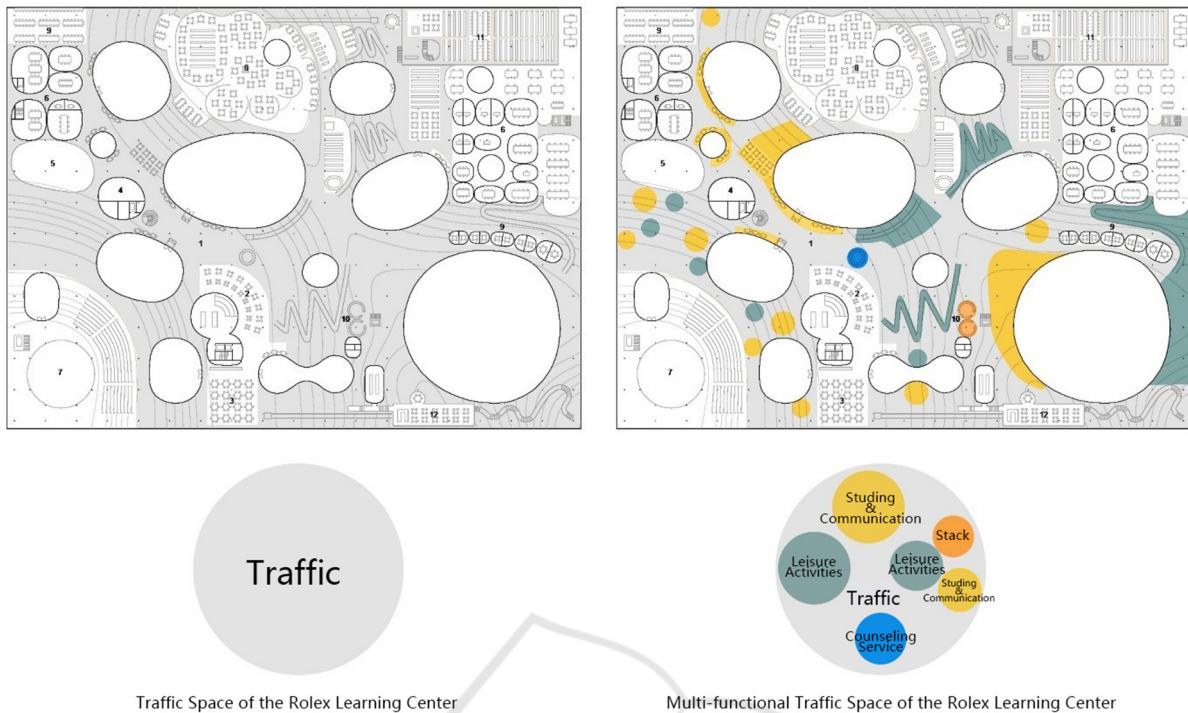


Figure 3: Analysis diagram of traffic space function of RLC.

## 4.2 Interactive Open Streamlines

The library under the functional partition presents a dendritic streamline structure with simple and clear primary and secondary relationship. The path choice of users is relatively limited, and the chance of meeting each other is greatly reduced. The learning center under the compound sharing mode has an interwoven and frequent collision network streamline structure. Students can travel flexibly between different learning groups, different learning activities and even different functional departments and obtain a wide range of information, which creates conditions for stimulating the communication and cooperation between people and between disciplines. In this streamline structure, a large number of traffic spaces in the learning center are no longer in the conventional form of corridors, but are expanded after meeting the basic functions of connection and evacuation, forming a composite space that can accommodate random activities such as discussion, communication, exhibition, rest, and social interaction (Figure 2).

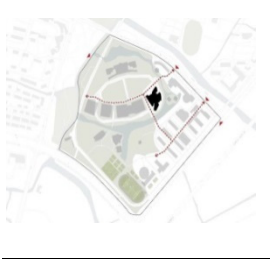







As mentioned above in the Rolex Learning Center, the flexible use of large space makes the learners' streamline more free, easier to encounter and communicate (Figure 3). Melbourne PLC Learning Resource Center uses the concept of "market" to design the collection and reading space,

change the conventional practice of simple index partition by book type, and arrange books of different disciplines with scattered reading space, so as to increase the opportunity for learners to contact with information of different disciplines and learners in the process of looking for materials. Of course, these practices directly lead to a large increase in the area of the so-called "traffic space" or "auxiliary space" that is not clear in the learning center, such as the area of this part of the Rolex center accounted for 45%.

The interactive streamline design is also reflected in the planning and location of the university learning center. The building is located in a site where the students are more likely to pass through to attract more students to enter and study inside. The Learning Center of the University of Nottingham Ningbo is a typical example. It is arranged at the intersection of the campus life axis and the teaching axis. It is close to the dormitors, dining halls, teaching buildings and other buildings, ensuring that most of the campus can be reached by walking for about five minutes. (Table 2) In a campus with a large land area and scattered living areas, the learning center can adopt a multi-center decentralized mode to facilitate the use of students in different areas, and can also form their own theme characteristics according to different needs. For example, Nanyang Technological University campus

in Singapore, which covers an area of two hundred hectares, has set up six libraries and two learning centers, The Hive and The Art, according to the service radius. The School of Social Sciences Library at Taiwan University, designed by Toyo Ito, is set up on the open border between the campus and the city to facilitate simultaneous access and interactin between learners from both inside and outside the campus.

Table 2: Analysis of the flat streamline of the learning center in colleges and universities.

	
Learning Center of UNNC	Nanyang Technological University Master Plan
Remarks:  Learning Center	Campus Entrance  Streamline 
Remarks:  Library	Learning Center  Walking Range 

### 4.3 Dynamic Elastic Space

Different from the relatively static reading function of the library, due to the uncertainty of learning scale, mode and time, the functions carried by the learning center in the limited space are not only complex and diverse, but also show dynamic changes and carry more informationalized service. This requires that the learning center must break through the static and stable spatial layout of conventional buildings, and adopt flexible space mode to adapt to the continuous change of user needs in information age. Common approaches in the design include:

First, choose an overall space system with flexible adaptability, such as the classic universal space, by "building a practical and economical space to apply the needs of various functional changes" (Zaida R G., 2021). At the beginning of the 20th century, the modular library space model of regular column network, floor height, column network and floor load were unified. Although it was proposed based on the requirements of book collection, its principle is still applicable in the design of learning center. The large span, modular regular column network, sufficient floor height reservation, no load-bearing partition wall and other practices provide a whole

and continuous structure foundation for the flexible use of internal space.

Secondly, space separation interfaces and facilities with the characteristics of flexibility, mobility, and assembly are placed in the general space, creating a learning environment that can be tailored to the changing needs of learners at any time. This is reflected in the specific areas of most university learning centers, and the learning space can be redivided or combined by simple operation to realize the flexible adjustment of space size, layout, furniture and media equipment layout (Figure 4). For example, in the learning center of the Townsville campus of James Cook University, the movable partition wall hanging on the suspended ceiling, large furniture with rollers and demonstration baffling boards, etc. As well as the sliding track and soundproof curtain dividers in the assembly space of the student center of Rhode Island School of Design, make the space more flexible and intelligent. However, it is still necessary to continue to improve the key technical issues such as ease of use, sound insulation, construction cost and maintenance cost.



Figure 4: Analysis diagram of traffic space function of RLC.

### 4.4 Diverse Personality Facilities

As a public learning and social place on campus, learning center should not only accommodate formal learning Spaces such as libraries, but also pay more attention to the shaping of informal learning spaces, encouraging students to gather and engage in activities at any time and anywhere in a relaxed state. The open and shared spatial layout and the resulting rich spatial experience are important foundations for shaping the atmosphere of informal learning spaces. In the specific planning and design, the learning center also needs to provide more humane facilities to meet the individual needs of learners.

For example, most learning centers can provide round-the-clock open services or set up round-the-clock open learning areas for learners to support the flexible development of informal learning activities. At the same time, it must also be equipped with round-the-clock learning and living service, including seats with different sitting positions,

sleeping cabins for lunch breaks, games rooms for relaxation and entertainment, coffee bars for quick meals, and vending machines to provide round-the-clock convenience. With the increasing popularity of online and offline blended learning mode, learning centers need to be equipped with sufficient software and hardware facilities, including full-coverage WIFI network, VR/AR equipment, charging equipment, printing equipment, etc. In addition, it is also necessary to actively improve the online service support, build a synchronous virtual learning space, and provide different levels of technical services from resource sharing, online interaction, virtual simulation, data analysis and intelligent management.

## 5 CONCLUSION

Although a considerable number of learning centers have been built in China, it is also found in the preliminary discussion that the managers, builders, users and designers of most universities do not have a comprehensive understanding of this new type of campus architecture. In particular, there is no clear definition and standard of learning center in the existing university construction standards and codes. If many new projects lack in-depth functional planning in the early stage of project initiation, feasibility research and design, and simply follow the indicators and functional requirements of university libraries, it is easy to lead to huge differences in building scale, content and cost with the actual needs, which will be an important topic to be paid attention to in the future campus architectural design and research. At the same time, under the environment of constantly updating and iterating information age, how to adapt the learning center to the new needs is also a problem worth exploring.

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