

Modular System in Chinese Academic Library Buildings: Its Occurrence and Development

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Abstract: The modular system has taken on a greater significance in recent years as Chinese academic library building has undergone constant improvement and development. This essay's goal is to examine and debate how modular system has appeared and evolved in Chinese academic library architecture. We can comprehend the origin, development, and application of the modular system by examining its occurrence throughout Europe and America. The evolution of modular system, which contains three types: transitional, exploratory, and new paradigm, will next be examined as it relates to the field of Chinese academic libraries.

Keywords: Modular system, Academic library, Library buildings, Chinese, Architecture

1. Introduction

Since the 1960s, modular system as grown in popularity as a cutting-edge architectural design idea. Through the pursuit of efficiency, flexibility, and sustainability through modular and standardized construction, it has evolved into the perfect option to satisfy the ever-changing needs. Academic libraries have evolved into the central focus of knowledge sharing and innovation with the advent of the digital age, going beyond their traditional role as places to store books. In the current setting, where "user" is the design concept, "book" is seldom ever referenced. However, over the past 20 years, the field of Chinese academic library architecture study has continued to produce numerous descriptions of modular system. Therefore, it is crucial to investigate how modular system is being introduced and developed in China.

Since its introduction to China, the modular system has been transformed into the "3 unifications" concepts of uniform column networks, uniform floor heights, and uniform loads in the study of Chinese academic library architecture. However, the academic library design has displayed various traits in each of the three construction booms following the Reform and Opening due to the influence of technology, culture, and economy.

2. Review of Modular System for Academic Library buildings

The "fixed-function" paradigm was challenged in the late 1930s, primarily as a result of changes in higher education and societal norms. For instance, alterations to structural systems were a result of new construction technologies that emerged from the architectural perspective. The decline of the Beaux Arts traditions, the popularity of the Bauhaus style of planning, and the use of welded steel skeletons with non-bearing interior walls allowed planners to experiment with new spatial arrangements, artificial lighting, and forced ventilation to expand the range of activities for users. In higher education, modular library planning was made possible by these developments ^[1].

The Cooperative Committee on Library Building Plans members were enthusiastic after Macdonald, at his own expense, produced a full-scale model in 1945. The Library Building Plans Committee. The meeting's minutes were used to plan the Academic Library Building in 1949, and architect John W. Maloney wrote a report on the topic in 1948. At Hardin-Simmons College in the US, the first modular library building was constructed in 1947^[2]. The University of Washington Library, designed by Murphy & Mackey and considered to be the "highest achievement" in modular architecture, completed in 1962^[3].

Metcalf summarizes the flexibility of modular academic library buildings into six elements: 1. Floors must be capable of bearing live loads up to 150 pounds per square floor (7.182kN/m²), which is the bookstack requirement in all areas of the building; 2. Floor heights must be adequate for any of these

purposes, preferably not less than 8 ft 4 in. (2.540); 3. Atmospheric and other comfort conditions, such as ventilation and lighting, must be adaptable to any of these purposes with minimal change, but ceiling and floor treatments need not be identical throughout a building; 4. All library areas must be readily accessible; it is undesirable to have load-bearing interior walls in places where they might interfere with later traffic patterns; 5. Security and access will need careful consideration to permit reasonable flexibility; 6. The building module should be economical in handling shelving dimensions, as well as carrel, study, office, and reading area dimensions^[4].

Most buildings are constructed in a "Modern" or "International" style from the outside. The facades of these structures typically reveal the building's skeleton, making them good examples of modular architecture³. With its ample resources, extensive library, and knowledgeable staff (including librarians and architects), the American academic library constructed more than 600 new academic library projects between 1966 and 1976, several of which were substantial⁵. The concept of ornamental boxes emerged because buildings designed in a "modern" or "international" style lacked visual attractiveness^[3]. This era produced many unique projects, some of which were extremely tall, wide, deep, underground, etc.^[5]

A number of conferences and prizes tended to support the modular system and practice, which helped the concept expand and be used in the UK. The modular system process in British academic library design was influenced by theories and practices from the American side. More professional academic library buildings started to appear between 1964 and 1980, and a tendency towards modular or adaptable building design persisted until the 1980s. Additionally, during this time, almost all buildings relied heavily on government (the University Grants Committee) funding^[6], and the "square box" style of construction demonstrated its "economic" The "square box" structure has partially demonstrated its "economy" benefits. Even though British librarians were aware of the latest U.S. concepts, they continued to construct "fixed function" structures. To put it another way, it could be more realistic to think of modular system as a solution to a particular issue at a particular time^[7].

3. The Development of Modular System in Chinese Academic Library buildings

3.1 Transitional Modular System -From 1980s to Early 1990s

3.1.1 Background

In the 1970s, the development of library architecture in Chinese universities was almost at a standstill. After the resume of college entrance exams in 1978, Chinese higher education was gradually formalized, and the state put forward new requirements for higher education. The gross enrollment rate of higher education in China increased from 1.7% in 1978 to 5% in 1993, which means the higher education entered the "elite" stage.

During this period, the construction of academic libraries also saw a high tide, and some scholars believe that Chinese academic libraries are experiencing a great development similar to that of the United States in the 1960s. According to statistics, more than 80% of colleges and universities built new libraries during 1980-1994^[8]. Large state-owned design institutes and university design institutes continue to dominate the construction of these buildings because they have an advantage in public construction projects for state and university campuses^[9].

The National Conference on Academic Library Work was held in 1981, following which "The Regulations on Academic Library Work of the People's Republic of China" were issued, and the National Committee on Academic Library Work was established, as well as some provinces and cities establishing expert advisory groups on academic library buildings, all of which effectively promoted the development of academic library building planning and design. Professor Lu Zhenying of Tsinghua University introduced foreign modular system library architecture for the first time in 1982^[10], and foreign library architecture construction projects and research literatures were gradually introduced, sparking a research surge on academic library building planning and design in the 1980s.

In addition, with the accession of China to the World Organization for Standardization in 1978, the national standards began to enter a flourishing stage. In 1987, the former Ministry of Urban and Rural Construction and Environmental Protection, the Ministry of Culture and the State Education Commission issued "Code for Design of Library Buildings-JGJ38-87"; in 1979, the former Ministry of Higher Education proposed the "Planning Area Quotas for General Higher School Buildings (for Trial Implementation)", and later in 1992, the former Ministry of Construction, the State Planning Commission and the State Education Commission issued the "Planning Area Index for General Higher

Education School Buildings (Jianbiao [1992] No. 245)". All these provided the basis for the construction of library buildings in Chinese universities at that time. However, given the social evolution at the time, the specification retained "closed shelf" as the primary administration and usage mode, and the area for reading electronic documents was deemed insufficient, and the functions of exhibition, conference, and relaxation were not included.

3.1.2 Architectural Characteristics

Despite the influx of new ideas, the quality of the new buildings built in the 1980s was still uneven. Considering the backward modern technical conditions, energy shortage, lack of design theory, the new libraries in this period appeared to be somewhat indecisive in their planning ideas. Some are forward-thinking and partially realize the transition from traditional to modern, such as increasing the share of large reading rooms on the basis of the fixed-function model, which is a hybrid model of "fixed-function" system and "modular" system. According to data, of the 20 new academic libraries built in Beijing between the late 1970s and 1993, ten were of the "fixed-functional" variety, nine were of the "transitional" variety, and only one was of the modular system^[11]. It wasn't until the early 1990s that Beijing Agricultural University's new library, which was created with the modular concept, was eventually completed and became a typical representative of modular academic library.

This "transitional" variety is reflected in the following aspects: (1) The "3 unifications" architectural paradigm of "uniformed column net", "uniformed floor height", and "uniformed load" is adopted only in the specific space. For example, the uniformed load design of 500~600kg/m² is adopted only for book collections, reading, catalogues and cashier spaces where functional changes may occur, and 1000kg/m² is adopted for dense bookstores, while other types of rooms, including technical rooms, adopt lower load design indexes(Figure 1); (2) The building depth is generally small, with just a few exceptions of large depths, and patios and inner courtyards are mostly employed to alleviate natural ventilation and lighting difficulties; (3) Forced ventilation systems are rarely adopted, some buildings applied them only in spaces such as computer rooms, treasured book depositories, lecture halls, conference rooms and audiovisual rooms, other buildings got the problem of unsustainable funding after a larger application of forced ventilation systems; (4) Heating settings are influenced by national integrated planning, so that buildings in the north of the Yellow River have centralized heating in the winter, whilst heating in the south is sometimes insufficient. (5) Due to a lack of acoustic treatment, terrazzo, hard-painted walls, and flat ceilings are most commonly employed, with carpeting being relatively rare.

In terms of column network, the column network of the building constructed in the 1980s is generally small, mostly below 7.00m. By the 1990s, the column network of 7.50m is welcomed to some extent due to its economy. The floor height of a single-story bookshelf building ranges between 3.60m and 4.20m, whereas the floor height of a double-story bookshelf building ranges between 4.50m and 6.00m^[12]. Some buildings consider future renovation such as reserving enough space in the ceiling for the installation of pipes, as well as providing a coordinated plan for the future addition of various equipment and layout changes.

In 1989, the library of Northwestern University, designed by China Northwest Architectural Design and Research Institute, was completed, which has the characteristics of a typical "transitional modular" building, that is, although the design drawings still reflect the layout pattern of separation of collection and reading, the architectural design has adopted the "3 unifications" design, i.e., 7.50m x 7.50m column network, 4.20m floor height, and unified load, to set aside the prerequisites for future functional adjustment(Figure 2).

In 1991, the library extension project of Tongji University designed by Tongji Architectural Design was completed, which is a typical representative of high-rise library buildings in this period. It is an eight-story building with a height of 50m added to the inner courtyard of the original two-story building. The central barrel of the two towers is equipped with a traffic core surrounded by open reading spaces.

The Beijing Agricultural University library, designed by the Beijing Institute of Architectural Design, was completed in 1990 and is regarded as a model of a modular system academic library at the time. It adopts a 6.6mx6.6m column network, with a ground load of 650kg/m² (1100kg/m² for dense bookstore), a floor height of 3.9m. From conception to implementation to use, the modular concept is fully reflected, and after a period of operation, it has garnered accolades from all areas of life(Figure 3).

In terms of aesthetics, the academic library architecture of this period is still dominated by simple modernism, and gradually emerged some buildings with regional characteristics, and others with "in-between" style. The former can be traced back to the architectural principle of "Economical, Utility, and

Attention to aesthetics under possible conditions" proposed in 1953^[13], which showed the coincidence with the modernism of "form following function"(Figure 4, Figure 5). The 1980s saw a surge in Chinese architectural theory, and the incorporation of Western modern architectural theory resulted in works of pure abstraction, regional expression, and "in-between" style. The new library of Tsinghua University (completed in 1991) combined traditional elements with modern structures, reflecting the fusion of traditional Chinese culture and modern technology (Figure 6).

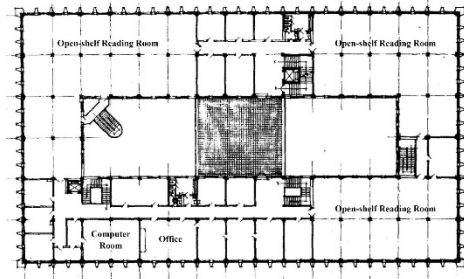


Figure 1: Fourth Floor Plan of Library of Harbin Engineering University. Redraw according to Wenyou W., Guoyao SH., Jiongqi M. (1996) [14]

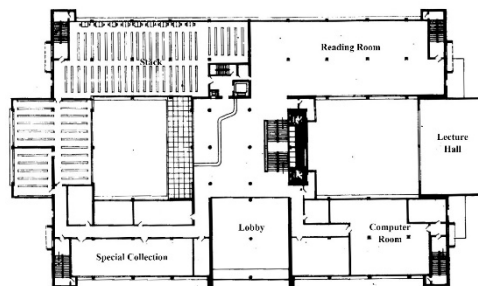


Figure 2: Second Floor Plan of Library of Northwestern University. Redraw according to Wenyou W., Guoyao SH., Jiongqi M. (1996) [14]

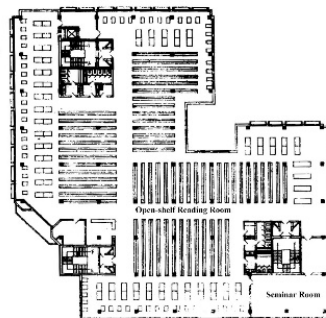


Figure 3: Third Floor Plan of Library of Beijing Agricultural University. Redraw according to Wenyou W., Guoyao SH., Jiongqi M. (1996) [14]



Figure 4: Library of Beijing Agricultural University. Cited from Ke D. (1996) [15]



Figure 5: RUN RUN SHAW Library of Zhejiang University. Cited from Ke D. (1996)[15]



Figure 6: Library of Tsinghua University (3rd Phase). Cited from Wenyou W., Guoyao SH., Jiongqi M. (1996) [14]

3.2 Modular System in Exploration—From Late 1990s to Early 21st Century

3.2.1 Background

Two significant projects, "211" and "985", were proposed by the government in the 1990s, and in August 1998, the Standing Committee of the Ninth National People's Congress voted to adopt the Law of the People's Republic of China on Higher Education, which went into effect on January 1, 1999. The "Action Plan for Revitalizing Education in the Twenty-First Century," adopted by the State Council and produced by the Ministry of Education in January 1999, presented a plan for the reform and development of education in the twenty-first century^[16]. In June 1999, the National Education Work Conference put forward "industrialization of education", hoping to achieve the expansion of higher education scale by stimulating economic growth through education investment. Since then, the scale of colleges and universities began to expand, and the number of enrollment and students in colleges and universities increased significantly. By 2002, China's gross enrolment rate in higher education had surpassed 15%, and there were 2738 general colleges and universities with 328,529,000 students, indicating that China has reached the stage of popularizing higher education^[17].

Aside from scale expansion, an important element of this age is the "merger" of universities. Since the CPC Central Committee and the State Council adopted the "co-construction, adjustment, cooperation, and merger" strategy in 1993, 708 colleges and universities have merged to become 302 multifunctional or comprehensive colleges and universities as of September 2002^[18]. The growth and consolidation of general colleges and universities has resulted in a scarcity of educational resources, particularly for larger schools, with the average number of books per student (undergraduates and postgraduates) falling from 177 to 124 in 1999 compared to 1995.

Additionally, a succession of private universities and higher vocational and technical schools have appeared. By 2019, there were 614 private colleges and universities established after 2000 (out of a total of 756) and 1047 institutes of higher learning established after 1999 (out of a total of 1423)^[19].

As a result, higher education institutions have increased their infrastructure expenditure. The construction paths are as follows: (1) campus extension or renewal in situ, and (2) development of branch campuses or relocation to other areas. The latter was used in conjunction with innovative urban planning concepts to build large-scale "university town." The massive development of new campuses has resulted in the second academic library construction boom.

The former Ministry of Construction issued the "Library Building Design Code JGJ38-99" in 1997, and the new code increased the contents of the "3 unifications" (unified column net, unified floor height,

unified load), proposed the recommended reinforced concrete structure modulus of 1.20m or 1.25 (7.20mx7.20m or 7.50mx7.50 column network system can be formed), increased the content of computer technology, and have more detailed regulations on indoor sound, light environment. In addition, regulations on energy conservation have been gradually implemented, such "Design Standard for Energy Efficiency of Public Buildings (GB50189-2005)", the "Standard for Lighting Design of Buildings (GB50034-2004)", and the "Technical Specification for Interior Thermal Insulation on External walls (JGJ/T261-2011)".

According to the CNKI database, research on "modular system in academic library buildings" has been ongoing since the 1980s. The study reached a pinnacle between 2001 and 2013, and then declined in the following decade. This period clearly marked the pinnacle of research into the proposed theory (Figure 7).

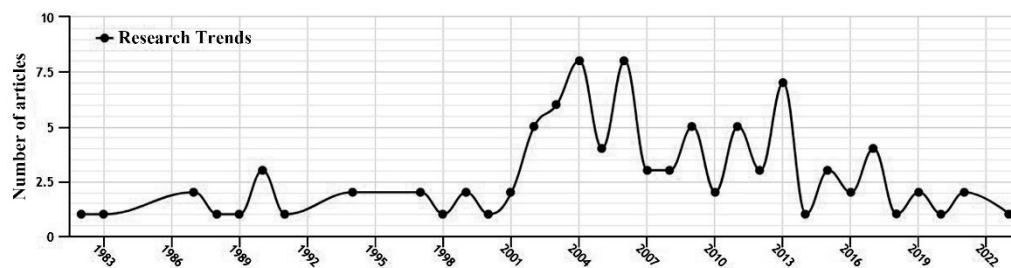


Figure 7: General Research Trends of "Modular System in Academic Library Buildings" in CNKI Database.

3.2.2 Architectural Characteristics

Although the scale of academic library buildings in this period is still based on the 1992 version of "Indicators of Building Planning Area of General Higher Education Schools (Jianbiao [1992] No. 245)", the huge scale of school population has led to the scale of academic libraries in this period to be tens of thousands of square meters, such as Nanjing Forest Police Academic library (2002) 15000 m², Beijing Academic library New Hall (1998) 26,800 m², Wenzhou Academic library (2004) 37510 m², Harbin Engineering Academic library (2008) 49,496 m², Southeast Academic library at Jiulong Lake Campus (2004) 53,828 m², etc., which has met or exceeded the relevant requirements in the above indicators.

Most libraries at the turn of the century have the following characteristics: (1) fully open layout and supermarket mode, essentially with "three unified" design, and column network modulus of over 8.0m (Figure 8); (2) use of integrated wiring system; (3) composite functions: additional multi-functional lecture halls, exhibition halls, bookstores, coffee shops, self-study classrooms, and other personalized spaces; (4) creative appearance and vibrant space, and shared atrium and outdoor courtyard are common means.

In this period, the architecture of academic libraries is still mainly in the neutral and abstract modernist style, such as the Library Information Higher Education Territory of Ningbo, the Library of Jiading campus of Tongji University and the Library of Shandong University of Technology (Figure 9). In addition, the emergence of personalized "abstract regionalism" works is also a distinctive feature of this period.

The architect registration statute was enacted in 1995. Following that, as the market economy matured, some high-profile private design firms, dubbed "experimental architecture firms" in the past, gradually participated in the creation of university campus buildings, which were previously primarily designed by large state-owned design institutions. These works include the Xiangshan Central Campus of China Academy of Art's library (Amateur Architecture Studio), the Wenzheng College of Soochow University's library (Amateur Architecture Studio), and the Huxi Campus of Sichuan Fine Arts Institute's library (Tang Hua Architect and Associates, Figure 10), all completed between 2004 and 2007. They tend to use local and national design language, which some experts refer to as "abstract regionalism" or "modern vernacular"^[20]. In addition to private design institutions, foreign design institutions began to participate in the design of such buildings at this stage, such as the library of Yanjiao Campus of Central Academy of Fine Arts (2007, SYN Architects) and Tsinghua University's Humanities and Social Sciences Library (2011, designed by Studio Architetto Mario Botta in collaboration with East China Architectural Design

and Research Institute Co., Ltd in 2011), reflecting a certain difference.

Library of Fuzhou University, designed by Architectural Design & Research Institute of SCUT, is completed in 2006. It is located in the heart of campus, is square in outline and cut diagonally to generate four primary functional spaces: the collection and reading area, the non-paper reading space, the lecture hall, and the exhibition hall. The second floor is a multi-functional space that serves the university 24 hours, including a lobby, retrieval hall, exhibition hall, cafe, and so on (Figure 11, Figure 12).

In 2009, the library of Huxi campus of Sichuan Fine Arts Institute designed by Shenzhen Tang Hua Architectural Design Co. was completed. The campus presenting a "farming civilization pastoral" landscape and intention. The design of the library is also based on the "vernacular", its prototype is taken from the brick kilns, grain silos and other industrial building texts in Chongqing's rural areas, which appear pure and grand. The exterior wall materials are washed stone veneer, wood, and clay bricks (Figure 13).

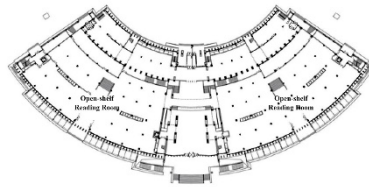


Figure 8: First Floor Plan of Library of Shandong University of Technology. Redraw according to Yingzi T., Peigen CH. (2015) [22]



Figure 9: Library of Shandong University of Technology. Cited from Yingzi T., Peigen CH. (2015) [22]



Figure 10: Library of Huxi Campus of Sichuan Fine Arts Institute. Cited from Hua T., Zheng H., Haibing H., Wei S., Weiguo Sun., Qiong D., Xing F., Zhenhuan H. (2017) [23]

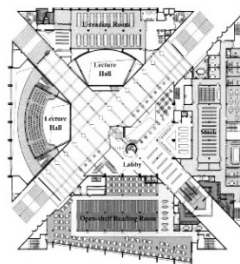


Figure 11: Second Floor Plan of Library of Fuzhou University. Redraw according to Zijian CH. (2018) [22]



Figure 12: Library of Fuzhou University. Cited from https://bbs.zhulong.com/101010_group_201817/detail10035079/

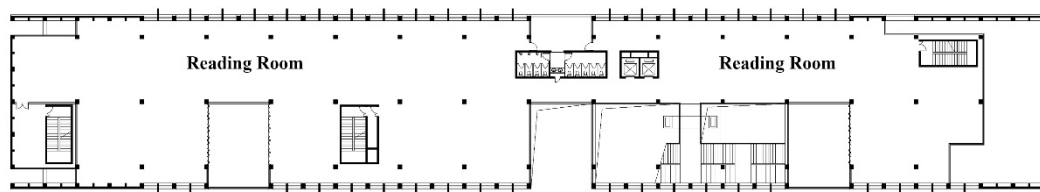


Figure 13: Fourth Floor Plan of Huxi Campus's Library of Sichuan Fine Arts Institute. Redraw according to Hua T., Zheng H., Haibing H., Wei S., Weiguo Sun., Qiong D., Xing F., Zhenhuan H. (2017) [23]

3.3 New Paradigm of Modular System - Developments in the Last 10 Years

3.3.1 Background

Table 1: Average Student Indicators($m^2/student$) in Different Editions of the "The Building Planning Area Indicators for General Higher Education Institutions" is compared.

Year of the edition	School type	Average student indicators								Graduate student subsidy index
		500	1000	2000	3000	5000	8000	10000	15000	
1979	Universities in science, engineering, agriculture, forestry, medicine, pharmacy, and physical	2.66	2.09	1.8	1.54	1.31	—	—	—	0.32~0.45
	Universities in liberal arts, politics, law and finance	—	2.41	1.91	1.71	—	—	—	—	0.39~0.51
1992	Universities in science, engineering, agriculture, forestry, medicine, pharmacy, and physical	2.91	2.45	2.07	1.82	1.54	—	—	—	0.5
	Universities in arts, law, finance, liberal arts	2.95	2.64	2.25	1.99	1.77	—	—	—	0.55
2018	Universities in science, engineering, agriculture, forestry, medicine, physical	—	2.44	1.99	1.81	1.63	1.48	1.42	1.34	0.5
	Universities in liberal arts, law, economics, foreign languages	—	2.65	2.21	2.02	1.83	1.68	1.62	1.54	0.5
	Universities in art	—	2.98	2.5	2.29	2.1	2	—	—	0.5

The number of college-age students rapidly fell as babies born in the 1980s and 1990s reached

college-going age, and the trend of decreasing number of college entrance examinations began in 2013. The government issued the General Plan for Coordinated Promotion of the Construction of World-Class Universities and First-Class Disciplines in 2015, with the goal of establishing research universities. In 2019, China's gross enrolment rate in higher education surpassed 50%, signifying China's formal entry into the stage of higher education universalization^[17].

The average building area of libraries increased from 2006 to 2014, but has since slowed, and the average building size of new buildings has basically stabilized between 20,000 and 25,000 square meters^[24], indicating that both the construction activities and scale of university libraries have slowed since 2014.

In 2015, the "Code Design of Library Buildings (JGJ-2015)" was published, which complemented the old code with additional functional areas and further optimized accessibility and the inside environment. "The Building Planning Area Indicators for General Higher Education Institutions (JGJ 191-2018)" was also officially launched 26 years after the promulgation of the old code, and the scale of colleges and universities in the new code was raised from a maximum of 5,000 to 15,000, and art colleges and universities were listed as a separate category, and some of the average student indicators were optimized and improved to better meet the current development of colleges and universities. According to the indicators, it can be projected that the construction area of library building for a college with 15000 students is about 20000 m² (*Table 1*).

3.3.2 Architectural characteristics

In an atlas compiled by National Center for Schooling Development Program, which collected 30 excellent academic library buildings from 2002 to 2018^[25], the smallest building area is 15,000 m² for the library of Nanjing Forest Police College¹, and the largest building area is 78,010 m² for the library of the new campus of North China University of Science and Technology, with an average building area of about 40000 m². 73% of the design institutions were university design institutions, 20% were significant state-owned design institutions, and 7% (including a private design institution that collaborated with overseas design institutions) were private design institutions. It is easy to see the absolute dominance of university design institutions in the design of this building type.

The following characteristics defines the modal university library buildings in this period: (1) the "three unified" mode is popular, the plan layout is more efficient, and the modal number of column network is mostly 8.40m x 8.40m; (2) The functional spaces such as media audio-visual room, seminar room and other diversified study spaces have been added; (3) the "courtyard" layout mode is still popular, including indoor/outdoor courtyard and flat/three-dimensional courtyard; (4) more attention is paid to the indoor environment and ecological construction; (5) in addition to the presentation of simple modernity and locality, there are buildings with digital characteristics (*Figure 14*).

China Architecture Design & Research Group completed the Shahe Campus library of Central University of Finance and Economics in 2016. The building is split into four groups of space units by the building elevator, restrooms, and an atrium, and the law of order and symmetry is strictly maintained in the plan composition. To introduce natural light into the interior, the design employs a combination of skylights and atriums, resulting in a traditional "courtyard" plan pattern. In addition to the open reading area, there are a range of study spaces available, such as media audition and seminar rooms, which may also be used for a variety of events such as lectures and exhibitions (*Figure 15*).

The library of Tianjin University's new campus, designed by HHDesign, is completed in 2015. The building is positioned in the center of the campus's core island, and while it was supposed to be an "iconic building," after numerous comparisons, the direction of "a calm, natural, quiet, and communicative building" was chosen, with a 72.0m × 72.0m outdoor reading courtyard. A 72.0m × 72.0m outdoor reading patio is used to provide an open and inclusive cultural space (*Figure 16*).

In 2014, the library of the new campus of Beijing University of Civil Engineering and Architecture, designed by the Tongji Architectural Design (Group) Co., Ltd, was completed. The building façade adopts a double skin curtain wall approach, i.e., a lightweight GRC fiber-cement composite member is installed outside the glass curtain wall, using a new design approach to realize the cultural intention of "window leakage" in traditional Chinese architecture (*Figure 17*).

¹Except for the Chancellor's Library, whose main function is as a museum



Figure 14: Library of New Campus of Tianjin University. Cited from Li Y., Kai ZH. (2021) [26]

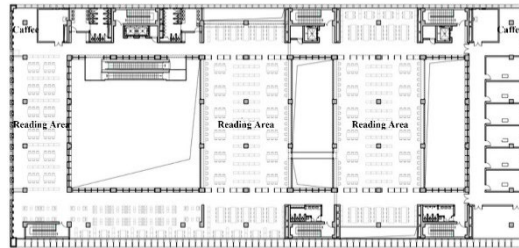


Figure 15: Typical Floor Plan of Shahe Campus's Library of Central University of Finance and Economics. Redraw according to https://www.archdaily.com/902049/not-ready-library-of-central-university-of-finance-and-economics-china-architecture-design-and-research-group?ad_source=search&ad_medium=projects_tab

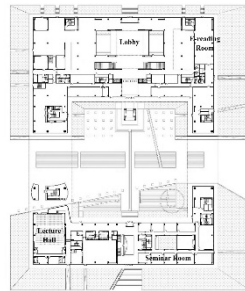


Figure 16: First Floor Plan of New Campus's Library of Tianjin University. Redraw according to Li Y., Kai ZH. (2021) [26]

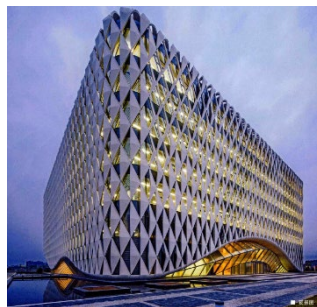


Figure 17: Library of New Campus's Library of Beijing University of Civil Engineering and Architecture. Cited from Center for School Planning and Construction Development, Ministry of Education. (2018) [25]

4. Conclusion

The emergence and development of "modal" design concept in college library architecture is closely related to social conditions, especially higher education and economic development factors, similar to the West. The increasing attention of the state to the field of higher education has contributed to the rapid

transformation of higher education from elitist to mass and popularization, which has given rise to a large scale of campus construction projects of higher education institutions, including the construction of academic libraries. The concept of modular system was introduced to China under such a background, and evolved in several college construction booms, and finally developed into an architectural type with Chinese characteristics.

After decades of evolution, Chinese modular system design of academic library has evolved into a unique phenomenon characterized by "courtyard," with few "large depths" or "windowless" structures. This trait arose from the country's lack of economic development during the early stages of reform and opening up, and it was a kind of care for energy conservation. Following that, the concepts of "sustainable building" and "green building" grew popular, as did the "courtyard" (indoor/outdoor), which gives natural light and ventilation while retaining a traditional Chinese architectural style.

In addition, unlike foreign countries, Chinese academic libraries are mostly above-ground buildings, and there are a few high-rise buildings, but it is rare to see buildings with the main collection and reading space on the underground space. This may be because that higher education in China is still in the expansion stage, and many academic libraries are located in the core of new campuses, and all sectors have certain expectations for the iconic image of library buildings.

References

- [1] Ellsworth R. E. (1975) *Some Observations On the Architectural Style, Size and Cost of Libraries*. *Journal of Academic Librarianship* 1, 16–19.
- [2] Kaser D. (1984) *Twenty-five years of academic library building planning*. *College & Research Libraries* 45, 268-281.
- [3] Kaser D. (1997) *The Evolution of the American Academic Library Building*. Scarecrow Press.
- [4] Metcalf K. D. (1965) *Planning academic and research library buildings*. McGraw Hill Book Company.
- [5] Orne J. (1976) *Academic library buildings: A century in review*. *College & Research Libraries* 37, 316–331.
- [6] Vaughan A. (1980) *British academic library buildings since 1964: a comparative study*. *Journal of librarianship* 12, 179–198.
- [7] Vaughan A. (1979) *The ideology of flexibility: a study of recent British academic library buildings*. *Journal of librarianship* 11, 277–293.
- [8] Minghua L. (2010) *A Summary of University Library Building's Changes in 60 Years*, *Journal of Academic Libraries* 28, 84-95.
- [9] Ding G. & Xue C. Q. (2019) *Mediating production, teaching, and research: the role of university-run design institutes in Chinese architectural practice*. *arq: Architectural Research Quarterly* 23, 73–86.
- [10] Zhenying L. (1982) *A Brief Discussion on the Preliminary Work of College Library Building*. *Journal of Library Science in China*, 71–74.
- [11] Yue W. (1990) *Review of New Libraries in the 1980s*. Southeast University.
- [12] Wenyong W. (1997) *On Average University Libraries*. *Architectural Journal*.
- [13] Sicheng L. (1959) *From "application, economy and, where possible, aesthetics" to tradition and innovation*. *Architectural Journal*, 1–4.
- [14] Wenyong W., Guoyao SH., Jiongqi M. (1996) *Academic Library Architectural Design Atlas*. Southeast University Press.
- [15] Ke D. (1996) *Chinese Library Buildings*. Encyclopedia of China Publishing House.
- [16] Jun L. (2015) *The New China's Higher Education Policy in the Past 65 Years: Evolution and Analysis*. University Education Science, 79–87.
- [17] Xinyuan L. (2021) *Retrospect, Status Quo and Prospect of Higher Education in China*. *Journal of Xi'an University (Social Sciences Edition)*, 69–75.
- [18] Gang F. (2005) *The Analysis of Contemporary Campus Planning in China and Discussion on Functional Units of Campus Planning*. Tianjin University.
- [19] Yifan H., Wenqin SH. (2023) *The Scale Expansion and Type Differentiation of Chinese Higher Education System: 1895-2019*. *Journal of Higher Education Management*, 114-124.
- [20] Zhu J. (2013) *Architecture of modern China: a historical critique*. Routledge.
- [21] Zijian CH. (2018) *The Library of Fuzhou University*. *Architectural Practice*, 16–21.
- [22] Yingzi T., Peigen CH. (2015) *A Review on the Design of Technology Library of Shandong University*. *Architecture Technique*, 69–75.
- [23] Hua T. , Zheng H. , Haibing H. , Wei S. , Weiguo Sun. , Qiong D. , Xing F. , Zhenhuan H. (2017)

- Library of Huxi Campus, Sichuan Fine Arts Institute. Urban Environment Design, 46–55.*
- [24] Hanhua W., Bo W. (2022) *An Analysis of Basic Statistical Data of Chinese Academic Libraries in 2021. Journal of Academic Libraries, 42–49.*
- [25] Center for School Planning and Construction Development, Ministry of Education. (2018) *Exemplary Library Design Compilation of Universities in New Era. Southeast University Press.*
- [26] Li Y., Kai ZH. (2021) *Library on the New Campus of Tianjin University. Urban Environment Design, 252–265.*