

21st Century Library Concept and Design: A Case Study of Pridi Banomyong Library, Thammasat University, Tha Prachan Campus

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Abstract

The objective of our research is to study concepts and designs of 21st century libraries, which provide a new approach to supporting lifelong learning and diverse learning experiences and from this, develop design guidelines for transitioning interior spaces of a traditional university library into a 21st century library. The Pridi Banomyong Library, located at Thammasat University, Tha Phra Chan Campus, Thailand, was selected as the specific case study for this research in modernizing an outdated 20st century library. The Pridi Banomyong Library was built in 1994 on the occasion of Thammasat University's 60th anniversary and is nationally renowned in the field of Social Sciences.

The research process includes conducting surveys and collecting data on the project site, studying the ideas, theories, and evolution of library design, conducting interviews and seeking opinions from directors, staff, and library users, analyzing and summarizing the current library usage and future needs, proposing new interior concepts and layouts, and providing comparative data on design concepts to summarize a design guideline for modernizing the library. These design concepts incorporate the expression of the library's vision, mission, and identity within the context of learning in the 21st century and, in particular, support lifelong learning and diverse learning experiences through socially oriented learning spaces and various media. The design also proposes a new identity for the library with a focus on digital technology, positioning the library users as the central focus, and further enhancing the learning experience by highlighting the historical significance and value of the building and its location. In conclusion, this research and design revealed that the concept of 21st century skills has resulted in a major change in library design. By promoting new skills, such as interactive learning, social activities, lifelong learning, and diverse learning experiences, the Pridi Banomyong Library will serve as a center of Thammasat University for lifelong and social learning. The library is an exemplar design case for other libraries throughout Thailand that will help to develop Thai society into a more learning-centered society.

Keywords

Social learning space; User-centered design; 21st century library; University library

1. Introduction

The concept of “21st Century Skills” has emerged in global education reform in the first two decades of the 21st century. It emphasizes learning and developing new skills that differ from the traditional 20th century skills. It recognizes the need for improvement and development of these skills to adapt and survive in the face of significant changes caused by digital technology. These new skills include important life and work skills in three areas: learning and innovation skills; information, media, and technology skills; and life and career skills. For example, competencies that address challenging problems include critical thinking/problem-solving skills, creativity, communication skills, and collaboration skills (see more details at <https://www.imls.gov>). The promotion of these new skills extends to the general public and the elderly under new concepts such as lifelong learning and diverse learning. This role is not limited to educational institutions; museums and libraries also have a function in promoting these skills beyond the classroom. These institutions collaborate with the community to develop skills that meet the community’s needs.

Libraries have long been spaces that promote learning and have a long history of progressive development. They are one of the learning institutions that support and enhance knowledge and new learning skills. At the same time, society has changed to be more individualized, evolving from a traditional mass, rote learning approach, and requiring knowledge to be quickly and easily accessed through a diversity of interconnected sources. Libraries in many countries have started to improve the utilization of library spaces, including new library buildings and have begun to implement new management systems under the concept of the “21st century library”. Many new libraries in Thailand have been designed according to these new concepts, but there are still many old libraries that were built in previous centuries and have not been modernized. They still maintain the traditional concept of libraries as book storage spaces and lack space for promoting new learning skills and interactive learning. Additionally, there is a lack of research in the field of interior architectural design for transforming the old libraries into 21st century libraries in Thailand. Therefore, this research aims to fill that gap by offering a systematic research-design approach to study the concept and design of the 21st century library by selecting Pridi Banomyong Library, Thammasat University, Tha Phra Chan Campus, as a specific case study for transformation and modernization. This will serve as an exemplar design case for other existing libraries throughout Thailand.

2. Objectives

The objectives of this research are as follows:

- i. To study the evolution of library design from the past to the present, including changes in concepts, physical space utilization, and other factors that have an influence on library design.
- ii. To study the new concepts and designs of 21st century libraries which promote lifelong learning and diverse learning experiences.
- iii. To summarize a fundamental design guideline for transforming a traditional library into a 21st century library, by choosing Pridi Banomyong Library, Thammasat University, as a design case study.

3. Methodology

This study was conducted using the following methodology (as summarized in Figure 1):

- i. Study of the history of concepts and library design from the past to the 20th century by reviewing documents, print media, and online media.

ii. Study of the concepts and design of 21st century libraries, especially university libraries, which exhibit new concepts that support lifelong learning and diverse learning experiences, by reviewing documents, print media, and online media. Summarize and compare the differences between traditional university libraries and 21st century university libraries.

iii. Select Pridi Banomyong Library, Thammasat University, Tha Phra Chan Campus, as a specific case study for transforming a traditional university library into a 21st century library. The research steps include:

3.1 Survey and Data Collection

- Study of the project's site, including study of the history of the site and the building concepts.
- Survey and analysis of library current usage, such as circulations and floor plans of the building.
- Interview from executives, staff, and library users about future needs, through online formats.
- Analyze and summarize all data to create a design guideline.

3.2 Presentation of Concepts and Design with Floor Plans, Perspectives and Comparative Data on Past and Present Usage

- Summarization of the study results and proposal of recommendations.

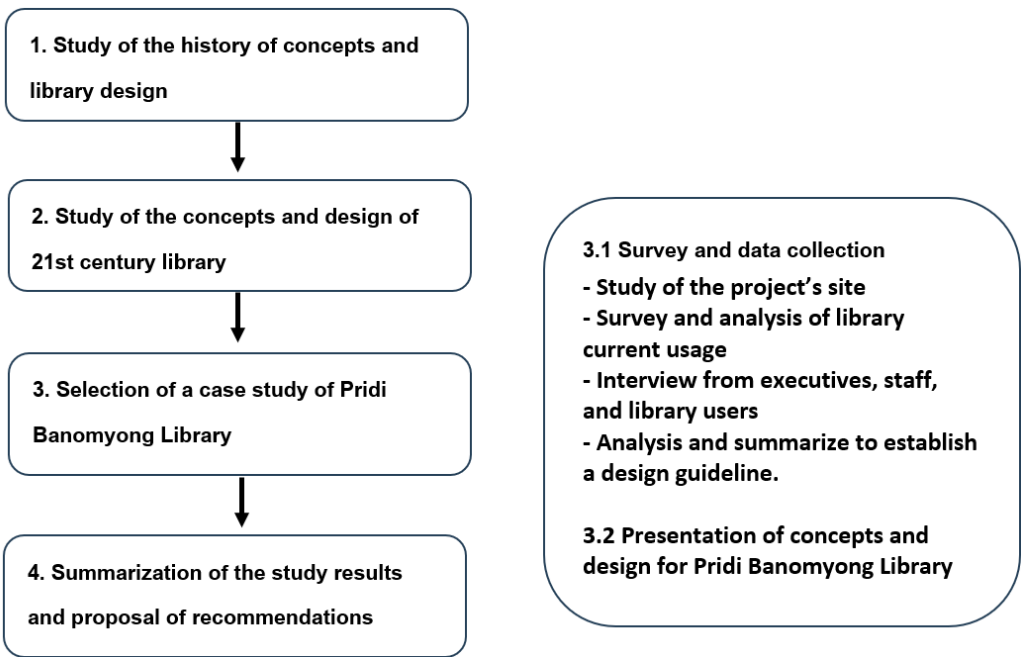


Figure 1. Diagram of research methodology.

4. History of Concepts and Design of Libraries from the Past to the 20th Century

Studying the history of concepts and design of libraries throughout different periods of time helps with the understanding of changes and development in physical spaces and various factors that influenced library design. This information provides a foundation for designing and transforming an old library into a new one by avoiding reverting back to outdated concepts and design that do not support present and future learning skills.

In the past, the term “library” was referred to by other words such as “bibliotheca,” “liberia,” “libraria,” “liberey,” etc. All of these words had meanings ranging from a cabinet or furniture for storing books, a room for storing books, to a building used for book storage. The history of library buildings began with the use of cabinets or furniture to store important books. Then, rooms or spaces within buildings were developed for storing particularly important books or documents. This gradually led to the design and construction of buildings specifically for storing and reading books (Kleefisch-Jobst, 2018).

Libraries first appeared in North Africa and Asia before Europe. The first-known library is assumed to be a library built during the Mesopotamian period by King Ashurbanipal of the Assyrian Empire, between 668 and 631 BCE. It was used as a place to store clay tablets with inscriptions in cuneiform script. In Asia, the first libraries appeared in China during the Confucius time, around the 5th century BCE. During the Greek period, around 300 BCE, a large library was built in Alexandria, Egypt, accumulating a vast number of documents for scholars and students. In the Roman period, starting from the 1st century CE, libraries began to appear in cities and spread rapidly, receiving support both from the state and private individuals (Feather, 2013, pp. 19-22).

In the Middle Ages, from the 5th to the 14th century, books were considered valuable treasures and held great significance and sanctity because they were still handwritten documents. Important books were copied and stored in cabinets in the vicinity of religious institutions and they were under the care and ownership of the clergy. The storage areas for books generally were rooms located near the religious ceremonial areas. During this time, there were no specific library buildings. However, when the first universities were established in Europe around the 12th century with financial support from kings or popes, libraries began to be developed. Initially, they functioned as places for book collection and lending, but there were no designated reading spaces yet.

During the Renaissance, from the 14th to the 17th century, the invention of the printing press revolutionized the production of books. This led to the duplication of books and their dissemination to the public, making them more accessible. A variety of new public buildings emerged, including library buildings. Printing changed the role of universities, elevating them to high-level learning institutions. In the early stages, university libraries stored both printed books and handwritten manuscripts without separate categorization. Books were chained and placed on shelves against the walls and there were tables for reading as part of the shelving system (Figure 2). Artists and architects were commissioned to design library buildings, particularly for private book collections. In the 16th century, seating areas for reading books specifically began to be established.

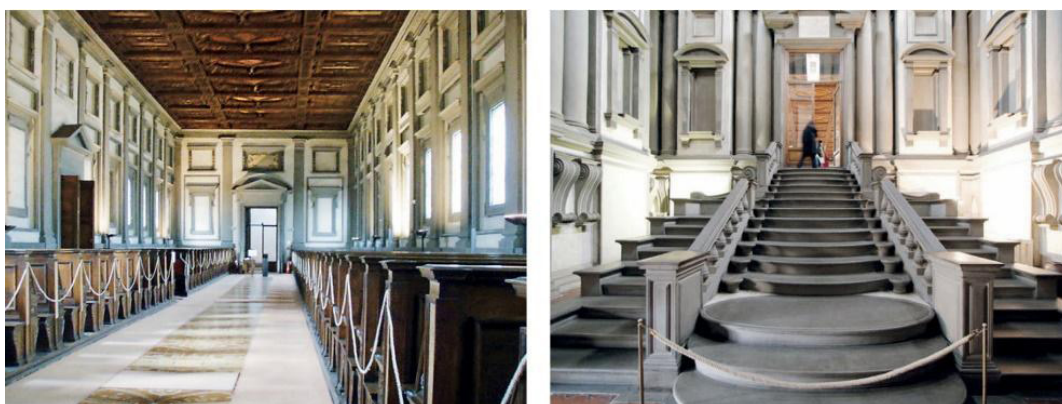


Figure 2. Laurentian Library in Florence, Italy, designed by Michelangelo in 1571 and owned by the Medici family (left) Library room (right) Main stairs at the entrance hall (source: Kleefisch-Jobst, 2018, p.25).

During the late Baroque period, from the 17th to the 18th centuries, there began to be a separation of printed books from handwritten books. The layout of library rooms started to develop into a rectangular shape without obstructive pillars. Bookshelves were placed against the walls and there were tables and chairs arranged for reading in the central area (Kleefisch-Jobst, 2018, p.25). From the 18th to the 19th centuries, during the Enlightenment Period, library buildings started to take on distinct architectural forms - a centralized floor plan, with the base of the building in the form of a box, cube, or cylinder, and a dome roof placed in the center of the building. This formal language became increasingly popular and evolved into a standard typology for general libraries (Figure 3). This corresponds with the change in libraries, which began to separate from religious and royal institutions and became more independent and public institutions. At the same time, books started to transition from being collectibles to objects of learning (Edwards, 2009, p.4).

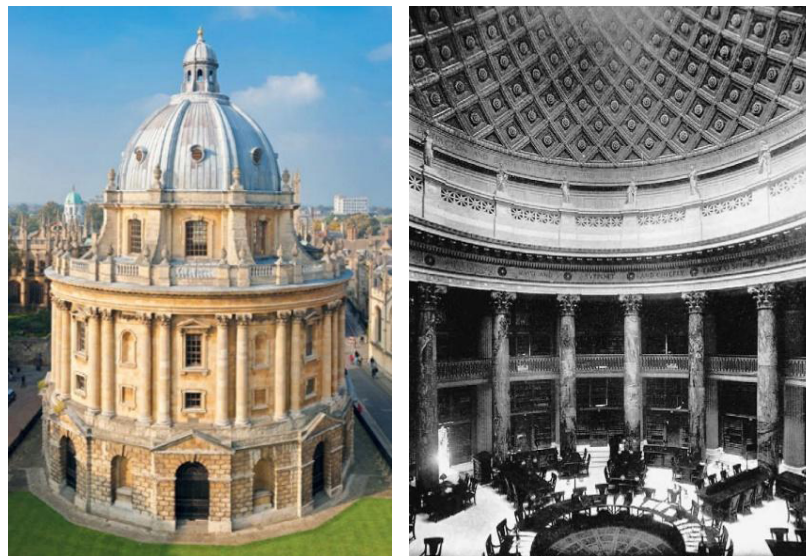


Figure 3. (left) Radcliffe Camera at the University of Oxford, England, designed by James Gibbs in 1747
 (right) Reading room at the New York University Library with a central dome, designed by McKim, Mead and White in 1895
 (source: (left) Kleefisch-Jobst, 2018, p.28, (right) Edwards, 2009, p.4).

In the 20th century, Modern architecture emerged as a significant development shifting from enclosed and solid buildings to open, volumetric, and spacious ones. This change was made possible by advancements in construction materials and the use of post and beam structures. The design of library buildings underwent significant changes during the 1920s and 1930s. Instead of placing bookshelves against the walls, they were now placed in the center of large open spaces, allowing the reading areas to flow seamlessly with the rest of the building. Additionally, windows transitioned from being vertical to horizontal, spanning along the walls. Libraries began incorporating amenities such as elevators and air conditioning systems (Edwards, 2009, pp.13-16). This architectural style became the standard for libraries, including those on university campuses.

From the 1960s until the end of the 20th century, Postmodern architecture became popular, incorporating elements, patterns, and forms from historical architecture into contemporary buildings, and placing greater importance on contextual surroundings. This resulted in the Postmodern style of library buildings, which resembled historical architectural styles of the Greek, Roman, and Baroque periods (Kleefisch-Jobst, 2018, p.35). The floor plans of libraries during this time reverted to enclosed spaces rather than open areas as previous modern libraries.

In the 1990s, the development of information technology systems, such as the internet and e-books, transformed society into a knowledge and information society. This had an important impact on the service model of libraries. Card catalogs, for example, were replaced with online databases, and physical books were substituted with e-books. The internet made accessing information and knowledge more convenient and faster compared to traditional book searching. Libraries began to serve as social learning spaces and started offering various types of amenities, such as shops and small cinemas. Additionally, libraries became multifunctional public spaces that fostered social learning and provided additional utilities beyond book-related services (Feather, 2013, pp.29-31) (Figure 4).

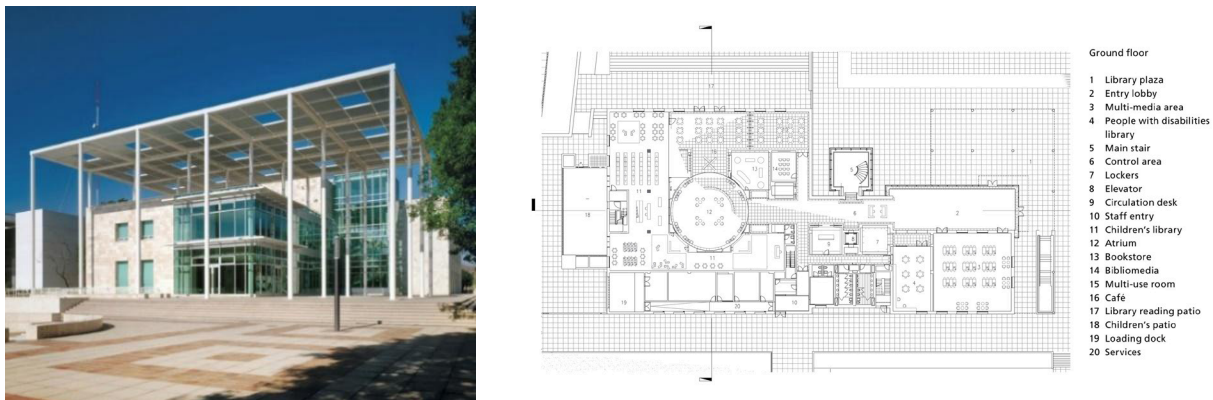


Figure 4. Central State Library of Guanajuato Wigberto Jimenez Moreno in Mexico, designed by Pei Partnership (source: Wong, 2018, pp.130,131).

With the global educational reform that has taken place in the first two decades of the century, a new concept of learning has emerged known as “21st century skills”. This concept focuses on learning and developing new skills that are different from the traditional skills of the 20th century. These skills are essential for life and work and include learning and innovation skills, information, media, and technology skills, and life and career skills (see more details at <https://www.ims.gov>). At the same time, society has changed to be more individualized, evolving from a traditional mass, rote learning approach, and requiring knowledge to be quickly and easily accessed, through a diversity of interconnected sources. The trend of environmental conservation is another important driving force. Many “green libraries” had been built in the 1990s in order to save energy and be environmentally friendly. The design and layout of the buildings have changed from a deep plan that lacks of natural light and relies on air conditioning to a shallow plan that allows more natural light into the interior space (Edwards, 2009). In addition, the uses of components such as new building systems, smart interior equipment, new supplementary energy sources such as solar energy, new water circulation systems, and environmentally friendly materials must be considered. The green library concept also includes green practices, services, information technology systems, as well as having green printed materials, in order to truly be a comprehensive green library.

5. Concepts and Design of 21st Century University Libraries

University libraries focus on serving students and university staff, while providing services to the external community as a secondary priority. Therefore, it is necessary for the university library to be adaptable and transformable in responding to the newly evolved social constructs for knowledge and information. This includes transforming from a “traditional library” space primarily for reading books to become a “learning resource

center” that encompasses both physical and virtual spaces, serving as a new gateway connecting knowledge to the outside world, which is not limited to knowledge solely from books in the library (Edwards, 2009, pp.190-191). This change responds to the need for a more socially-oriented learning space that supports new learning concepts such as self-directed learning, lifelong learning, broad and deep learning. The library thus could become a learning space that supports and enhances new knowledge and learning skills.

The factors that the university library must consider include (Childs et al., 2013):

- Learning and teaching methods: The library needs to be a socially-oriented space that accommodates new learning and teaching methods, rather than a quiet space following the ideas and design of traditional libraries.
- Student population change: The number of students is changing, with various age groups and studying both on and off-campus.
- Technology: Technology is the factor that has the most impact on library design because users can access information from multiple sources and there is a trend towards accessing digital information, reducing the need for physical space to store books.
- Alternative learning spaces and campus libraries: New physical spaces such as computer rooms or learning pods are emerging.
- Shared services: Spaces could be used for joint activities with other educational institutions, libraries, and public organizations to reduce budget and resource usage, as well as exchange and share expertise and supportive facilities.

One important concept is the shift towards a “user-centered/created” direction instead of determining services and use of various spaces by the librarians. The library space needs to be flexible, allowing users to exchange, design, and create different types of knowledge. Issues to be considered include the layout of collaborative workspaces, personal spaces, soundproofed areas, quiet zones, suitable furniture for different activities, as well as new spaces such as video recording rooms and creative makerspaces (Figure 5). The library also should provide digital information systems and exhibition spaces to disseminate knowledge, research, and creative works to both internal and external communities (Andrews et al., 2017). Furthermore, “cultural meaning communication” is another significant factor. The library must reflect and help to create a memorable identity for the university, as well as enhance the new symbol of the learning and cultural center, making it recognizable to the external society (Lushington et al., 2018).



Figure 5. New spaces in the 21st -century libraries (left) Makerspace with new 3D modeling tools (middle) music playing room (right) Private seating area for viewing movies (source: (left and middle) www.archdaily.com (2012), (right) www.archdaily.com (2019).

Table 1 summarizes and compares the concepts and design of traditional university libraries with 21st century university libraries.

Table 1. Comparing the Concepts and Design of Traditional University Libraries with 21st Century University Libraries.

Traditional University Libraries	21st Century University Libraries
1) Library with bookshelves	1) Learning resource center with diverse learning media
2) Physical spaces	2) Physical spaces + digital spaces
3) Reading areas	3) Social learning areas + lifelong learning areas + recreational spaces
4) Knowledge collecting spaces	4) Knowledge creation and innovation spaces
5) No green architecture	5) Green eco-friendly library
6) Layout of enclosed spaces	6) Layout of open spaces (a library without walls)
7) Librarian-centered/created knowledge	7) User-centered/created knowledge
8) Official and repetitive furniture	8) Relaxed and diverse furniture
9) Inaccessible spaces for the disabled	9) Accessibility for people with disabilities in various areas (Universal Design)
10) Providing a stand-alone service	10) Providing a networked service in collaboration with other educational institution libraries
11) Service provided by personnel (library staff)	11) Service using new technologies, such as digital applications for book borrowing, return, or reservation of group workspaces and meeting rooms
12) Utilizes regulations to control space acoustics	12) Allocates areas for sound-use/quiet areas

6. Case Study: Designing a 21st Century University Library: Pridi Banomyong Library, Thammasat University, Tha Phra Chan Campus

By studying the concepts and designs of 21st century libraries, which provide a new approach to supporting lifelong learning and diverse learning experiences, our research aims to create design guidelines for transitioning interior spaces of a traditional library into a 21st century library by focusing on a university library as a specific design case study. The Pridi Banomyong Library, located at Thammasat University, Tha Phra Chan Campus, was selected as the specific case study for showing the design transformation in modernizing an outdated 20th century library. The library is nationally renowned in the field of Social Sciences. It was built in 1994 on the occasion of Thammasat University's 60th anniversary and the site has a long history dating back to the early Rattanakosin period.

According to Table 1, the Pridi Banomyong Library was designed based on the traditional concept of a university library, where books are the primary source of knowledge. Therefore, the interior spaces were organized according to the traditional library layout, such as having numerous bookshelf and book storage spaces and quiet reading areas. However, there is no consideration for future sources of knowledge and learning skills, which resulted in a lack of interior spaces supporting new learning skills and interactive learning, according to the concept of a 21st century library. Such spaces would include opportunities for self-directed learning, innovation support, social activities, and lifelong learning. Finally, there is a lack of ideas for developing and managing the library towards a green library concept, which is another significant issue in the 21st century.

6.1 The History of Thammasat University, Tha Phra Chan Campus

The history of Thammasat University, Tha Phra Chan Campus, dates back to the early Rattanakosin period, when it was established as the capital city during the reign of King Rama I in 1782. In 1887, the area was designated as the “Wang Na” or the Front Palace, which served as the residence of the Prince until 1905 (Figure 6). Later, during the reign of King Rama V, the Front Palace position was abolished as part of the administrative reform to consolidate power under the monarchy or the “Grand Palace.” This was done to address the threats to Siam’s sovereignty from Western powers and the confusion caused by the decentralization of power within the Front Palace and various nobilities (The Association of Siamese Architects under Royal Patronage, 1997). After the Front Palace was closed in 1905, the area was repurposed to become the 11th Infantry Regiment’s military camp, which later transformed into the 4th Infantry Regiment during the reign of King Rama VI and also housed the Arsenal. This area eventually became the location of “University of Moral and Political Sciences” (former name of Thammasat University) in 1934 until present.

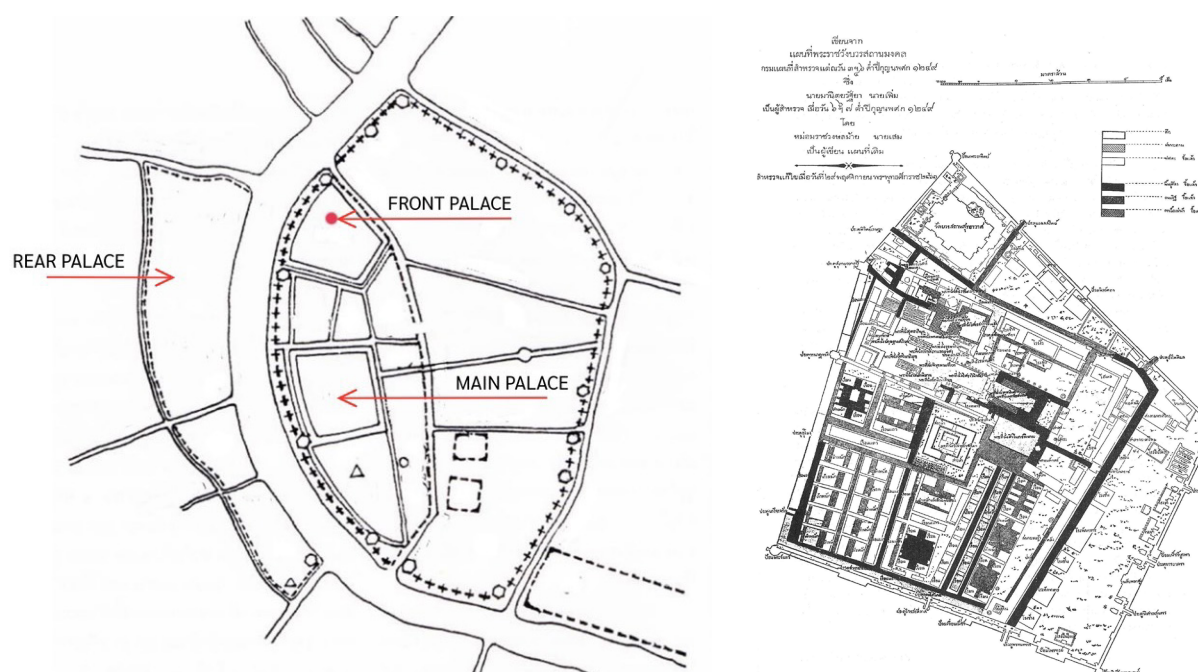


Figure 6. (left) Map showing the positions of the Front Palace, Main Palace, and Rear Palace during the reign of the King Rama I to King Rama V (right) Map of the Front Palace (source: Phrachai, 1994), Trakunwaranon, 1994).

6.2 The History and Design of Pridi Banomyong Library

On the occasion of Thammasat University’s 60th anniversary in 1994, the university had plans to construct the Pridi Banomyong Library (Figure 7) and the 60th Anniversary of Thammasat University Building in the area along the Chao Phraya River. Both buildings were designed in the Postmodern architecture style, which was popular at the time. However, Sumet Jumsai na Ayudhaya, the architect, believed that the university buildings as viewed from the Chao Phraya River were too diverse and confusing. Therefore, he incorporated Thai architectural styles from the King Rama V reign and the design of ancient city walls from the early Rattanakosin period to create a new, more unified university frontage that integrated better with the history of the site. These design considerations are evident in the form of arched windows and openings of the buildings that have a repetition similar to the pattern of the old, demolished city walls. The use of hipped roof, which was a popular roof type in the King Rama V period, as ornaments on building facades and the recreation of a new

city wall all are parts of creating an “architectural back drop” along the Chao Phraya River (Figure 8). The purpose was to create a new perspective of the university’s buildings from the river, so that the overall architectural ensemble of the university would have a more harmonious appearance with the atmosphere of Bangkok (The Association of Siamese Architects under Royal Patronage, 1997).



Figure 7. (left) Pridi Banomyong Library (right) Map of Thammasat University, Tha Phra Chan Campus.

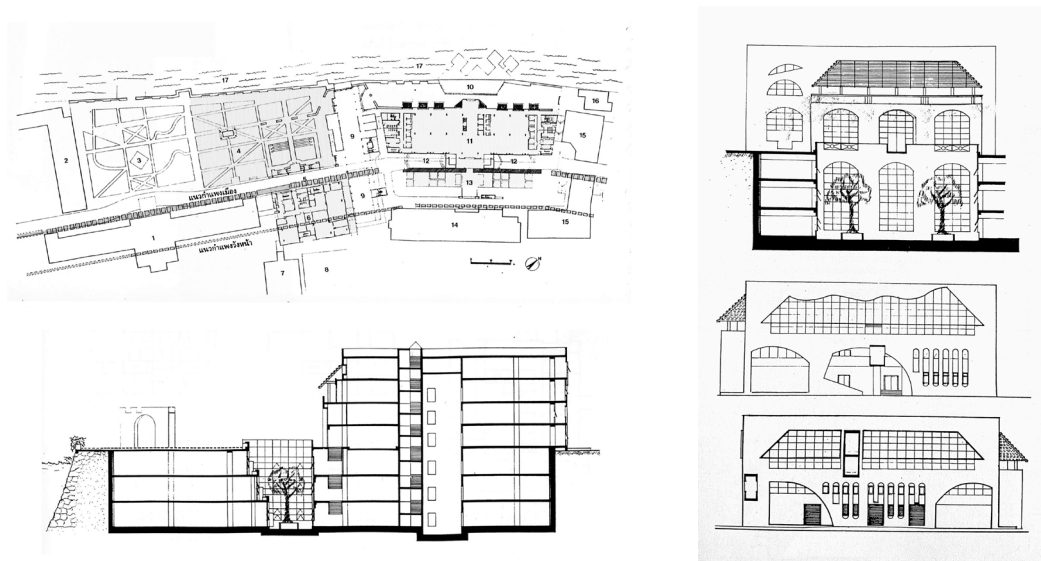


Figure 8. (top left) Site plan showing the original city wall and the Front Palace wall (bottom left) Building sections (right) Elevations of the buildings (source: The Association of Siamese Architects under Royal Patronage (1997).

The Pridi Banomyong Library was designed as a large public building, consisting of four above-ground floors and three underground floors (U1-U3 floors). The building features a central garden that extends to the lowest underground floor, allowing natural light to penetrate the underground area and serving as a ventilation space. This garden also provides a pleasant visual experience for users of the lowest floor. The underground walls are designed as double walls to prevent moisture seepage from the river (The Association of Siamese Architects under Royal Patronage, 1997). During the construction of the underground floors, ancient walls, such as the city wall, the Front Palace wall, and numerous ancient artifacts were discovered through excavation. This required some design adjustments to preserve and establish a connection with the area’s historical significance. The sections of the ancient city wall and front palace wall, thus, are symbolically reconstructed to signify the ancient walls as represented by the brickwork embedded in the underground walkway of the library (Figure 9).



Figure 9. (left) Recreation of the old city wall in front of the library (right) Symbolic preservation of the Front Palace wall incorporated into the U1 floor.

Since its construction was completed in 1997, the library continuously has been in service, although parts of the interior space have been renovated, resulting in a diverse and confusing arrangement. However, the library does not reflect the new concept of a 21st century library, which supports various new learning skills. In addition, the location of the library building holds historical significance, of which, unfortunately, the majority of users are unaware. The library space could be a specific design case to show how to develop an old university library into a library that provides historical knowledge paralleled with its main and new functions to serve 21st century skills.

7. Survey and Analysis of the Current Usage of the Library

7.1 Analysis of the Current Layouts of the Library

The Pridi Phanomyong Library building has two entrances: one is the staircase on the G floor for general library users while the other entrance is for staff and users with disabilities, located within the office building on the opposite side (Figure 10).

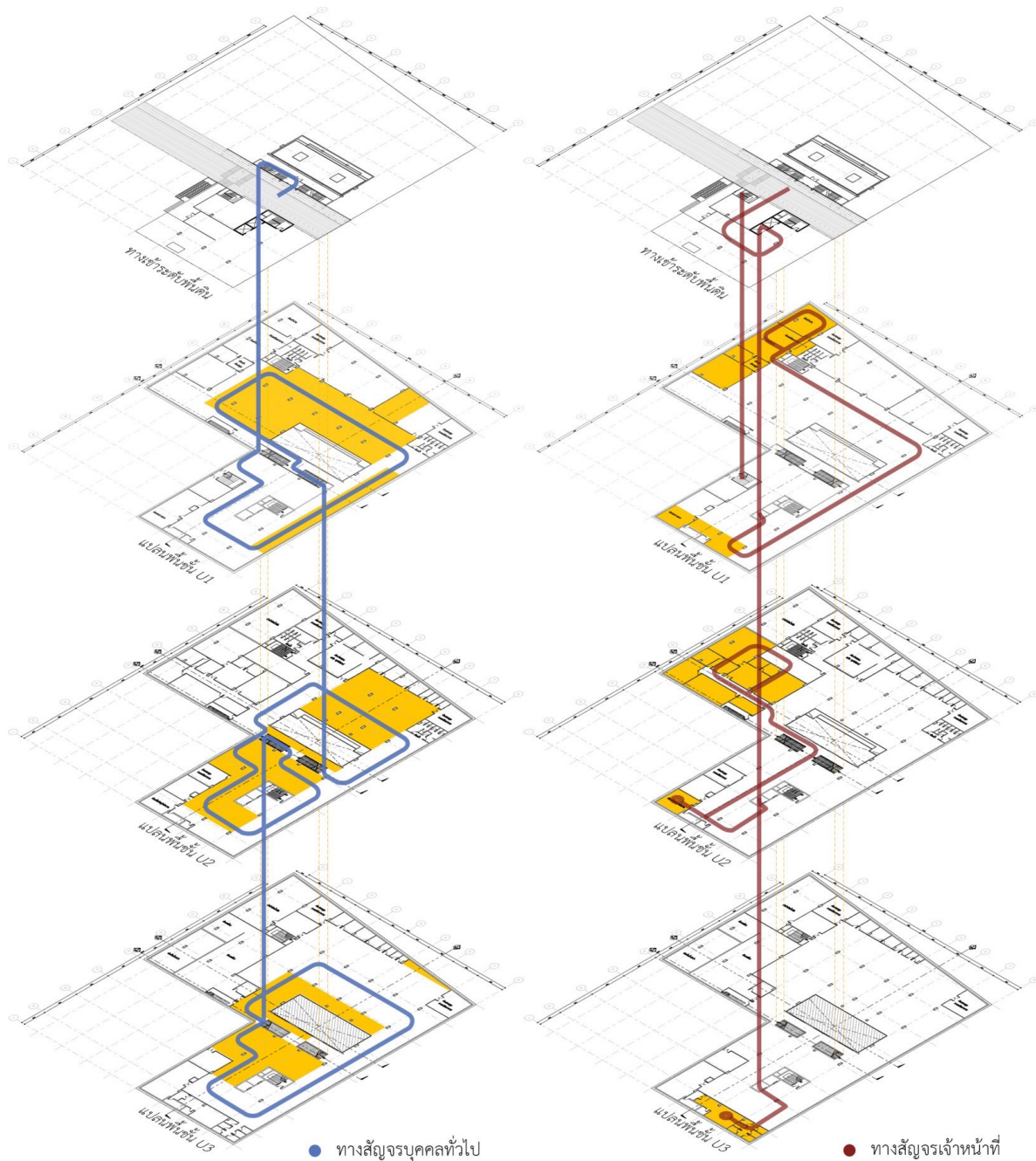


Figure 10. Floor plans showing circulation in the library classified by users (left) General user's circulation (right) Staff's circulation.

The library consists of 11 types of areas, ranked from the largest to the smallest area: reading area, bookshelf area, circulation, building system area, staff area, special area, library service area, garden, group work area, learning area, and waiting area (Figure 11 and Table 2).

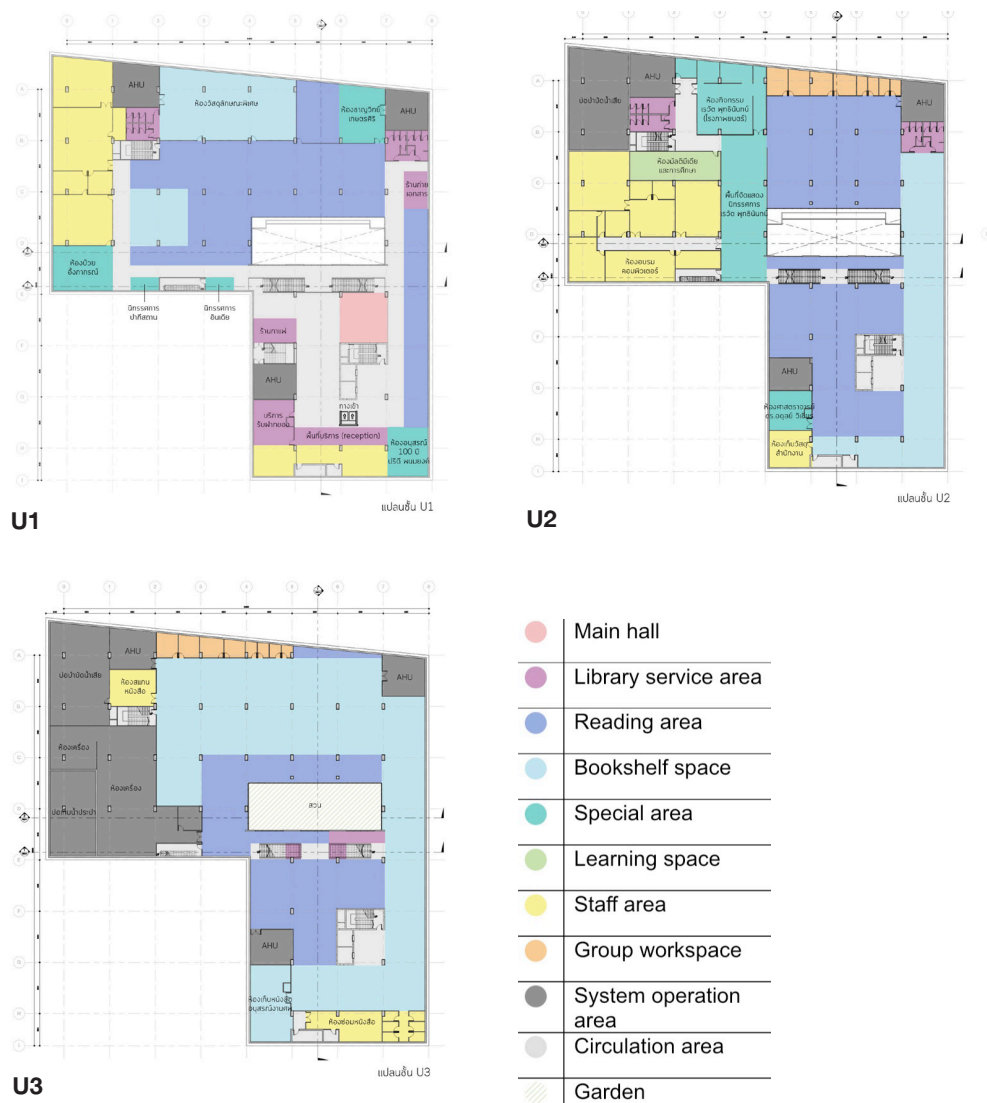


Figure 11. Floor plans showing current usage areas (top left) U1 floor plan (top right) U2 floor plan (bottom) U3 floor plan.

Table 2 Area Size of Pridi Banomyong Library.

List	U1 Fl. (Sq.m.)	U2 Fl. (Sq.m.)	U3 Fl. (Sq.m.)	Total (Sq.m.)	Percentage of use area
Main hall	82	-	-	82	0.72
Library service area	270	100	40	408	3.56
Reading area	975	1,060	693	2,728	23.80
Bookshelf space	434	537	1,542	2,513	21.93
Special area	285	480	-	765	6.67
Learning space	-	92	-	92	0.80
Staff area	535	579	176	1,290	11.26
Group workspace	-	109	95	205	1.79
Building system area	188	396	939	1,523	13.29
Circulation	947	363	232	1,634	14.26
Garden	-	-	220	220	1.92
Total area	3,716	3,716	3,936	11,460	100

When compared to the international standards of library areas, it was found that the Pridi Banomyong Library (between 2017-2018) had the following areas and ratios:

- Total area of the library: 11,460 square meters, which accounts for 11% of the total study area of the Tha Prachan campus (international standard is 8-10%).
- Space utilization ratio: 0.77 square meters per student (international standard is 1 square meter per student).
- Number of reading seats: 10.9% of the total number of students (international standard is 20%).
- Area per reading seat: 2.74 square meters (international standard is 2.70 square meters).
- Staff area: 13% of the total building area (international standard is 12%).

Based on these comparative data, it can be concluded that the Pridi Banomyong Library meets or is close to the international standards in some aspects, but falls below in some others (mainly, the space utilization ratio).

7.2 Interview of Executives and Staff

For this research, an in-depth interview method was employed to obtain detailed insights from the interviewees. The interviews were conducted between July and August 2023, divided into three sessions, each lasting approximately 60 minutes. The interviews were conducted online via Zoom, involving participants from executives and staff related to the administration of the library. The aim of the interviews was to explore the library's vision, policies, and development strategies, as well as to identify challenges and future opportunities.

A total of 11 interviewees participated, consisting of 7 males and 4 females. The selection of interviewees was intended to encompass a diverse range of perspectives in terms of gender and work experience (Individuals with over 5 years of experience in key positions to ensure that the data collected were credible and comprehensive). Questions were composed of future visions, strengths and weaknesses, role in supporting learning, internal management, current technology utilization, future needs of library space development, and social services and social responsibility. The information obtained from interviews with library personnel is managed confidentially, without revealing names or any identifiable information. All interviewees gave their consent to participate and could withdraw at any time. The information will be used solely for policy analysis and the development of library management. The ideas and suggestions for developing library spaces in the future can be summarized as follows:

- In the future, the library will be changed into an active learning space rather than just a passive space for reading. Various activities will be offered in the library that support different learning needs, and there are plans to provide 24-hour service in certain areas, such as the U1 floor.
- The library has a goal to reduce the number of books in the future and will focus more on digital media services.
- The library has a plan to develop digital technologies, both currently and in the future, such as smart lockers, Internet of Things (IoT) devices, and immersive technologies.
- The library has a plan to develop spaces that support learning in other areas for university staff, such as co-kitchens, art exhibition, and exchange spaces for groups with similar interests.

- Suggestions for future usages:
 - **U1 floor:** This would be a space that does not require library staff and can operate 24 hours a day. It would be a general multi-purpose area for students, such as co-working spaces, coffee shops, art exhibition spaces, etc. There also would be areas where users can have active, unhindered discussions to facilitate exchange of ideas.
 - **U2 floor:** This would be a reading area, with separate spaces for quiet reading and for borrowing and returning digital technology devices.
 - **U3 floor:** This would be a book storage area with reading spaces. It would require the temperature and humidity to be controlled by specific air conditioning units.

7.3 Survey of Library Users

The data from library users were collected by the library's staff between June to July 2021. The users were asked to express their opinions and recommendations on the use of library spaces, current activities, and future needs via an online platform – Google Forms. The questionnaire form was posted on the library's website and also was directly emailed to the library's users who frequently use the services. The survey had a total of 173 respondents, including 79% students, 15% professors, 1% researchers, 1% staff members, 3% alumni, and 1% adjunct professors (Figure 12).

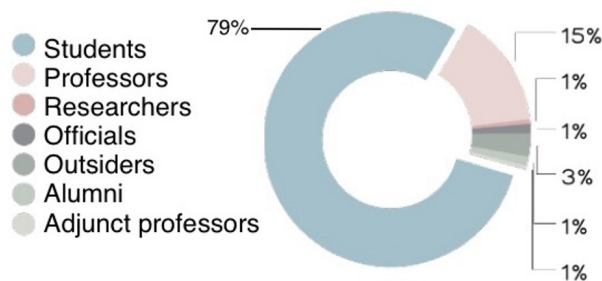


Figure 12. Respondent demographics as of July 2021.

The survey results from the users are as follows:

- Current activities in the library are ranked from least to most frequent on a scale from 0-4 (0 = never used, 4 = the most frequently used): “reading books” is the most common activity, followed by “individually working,” and “group working,” while “resting,” “using computers,” and “watching movies/listening to music” are the least common activities (Figure 13).

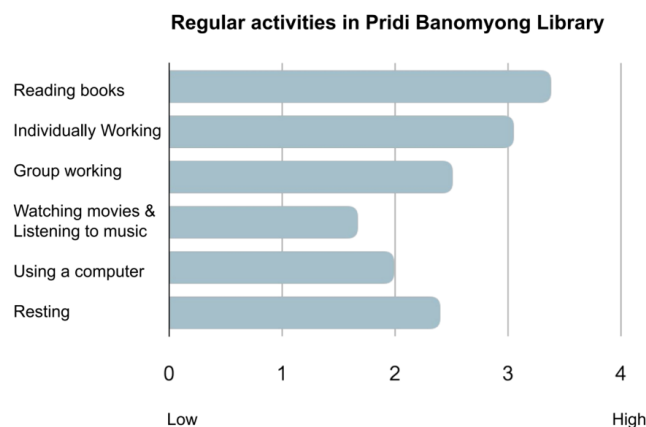


Figure 13. Rating of current activities in the library.

- Additional spaces: asked users to choose five areas from a provided list of areas. It was found that users have a high demand for a coffee shop and temporary accommodation (napping area), with the next preference being a makerspace, a mini theater, a temporary exhibition area, a karaoke room, a game room, a video production room, a fitness room, and a permanent exhibition area. (Figure 14).

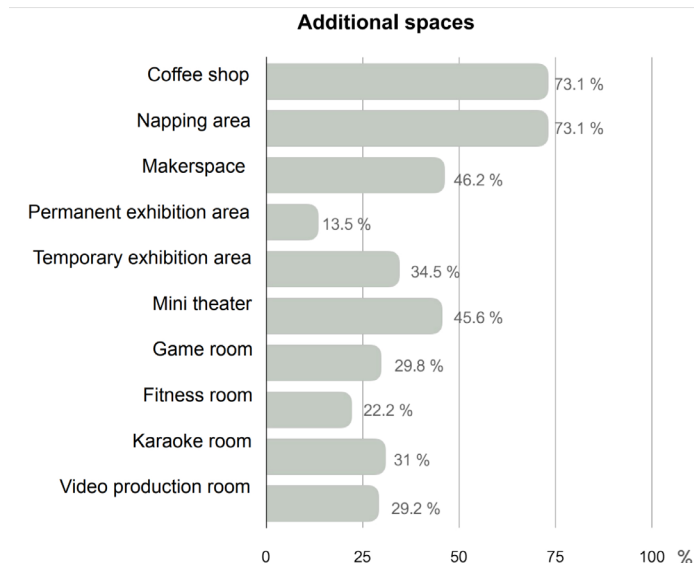


Figure 14. Desirability of additional spaces.

8. Design Guideline for 21st Century Library

After collecting all data, a proposed design guideline for 21st century university library design is summarized as follows:

- i) The library will be a learning resource center with diverse learning media instead of being a traditional library with books.
- ii) The library should emphasize both physical spaces and digital spaces.
- iii) The library should provide new social learning areas, lifelong learning areas, and recreational spaces to support 21st century skills.
- iv) The library will focus more on knowledge and innovation creation and provide makerspaces or other facilities for support.
- v) The library should be designed and managed following eco-friendly principles.
- vi) The library should have a layout of open, flexible spaces instead of enclosed spaces for both academic and leisure activities.
- vii) The library should support user-centered/created knowledge rather than providing librarian-centered content.
- viii) The library should have relaxed and diverse furniture to support individual and group work and to facilitate discussions and exchange of ideas.
- ix) The library must be easily accessible for people with disabilities in all areas.
- x) The library should provide a networked service in collaboration with other educational institution libraries.

- xi) The library should include new digital technologies such as smart lockers, Internet of Things (IoT) devices, and immersive technologies. The library also should provide “a library of things” that has digital appliances such as tablets, notebooks, etc. for users to check out of the library.
- xii) The library should allocate areas for sound-use/quiet areas for different kinds of users and activities
- xiii) The library should provide 24-hour service in some areas, if possible, for all-times learning.
- xiv) The library should express vision, mission, and identities of the library and its place/location.

7.1 Proposed Concepts and Design for Developing the Interior Spaces of Pridi Banomyong Library into a 21st Century University Library

- To express the vision, mission, and identity of the library within the context of learning in the 21st century.
- To promote the learning of the site’s history, the history of the library building, and biography of some important figures of the university in the library’s interior.
- To support lifelong learning and diverse social activities, according to the 21st century skills, by providing new spaces that focus on digital technology, with user-centered design and smart building systems, and also provide spaces available for 24-hour use.
- To rearrange and design the entire library building to support 21st century skills:

Our proposed plans focus on the analysis, the survey of future requirements, and the concepts and design of a 21st century library as follows:

G floor: G floor serves as the entrance to the library, with a main entrance for general users and a secondary entrance for people with disabilities. Additionally, there are elevators for staff and disabled users (Figure 15). The glass walls of the main entrance hall bring in more natural light to the central stair. On the surfaces of both glass walls are QR-code patterns so that users can use smartphones to connect to other university libraries’ websites (Figure 16).

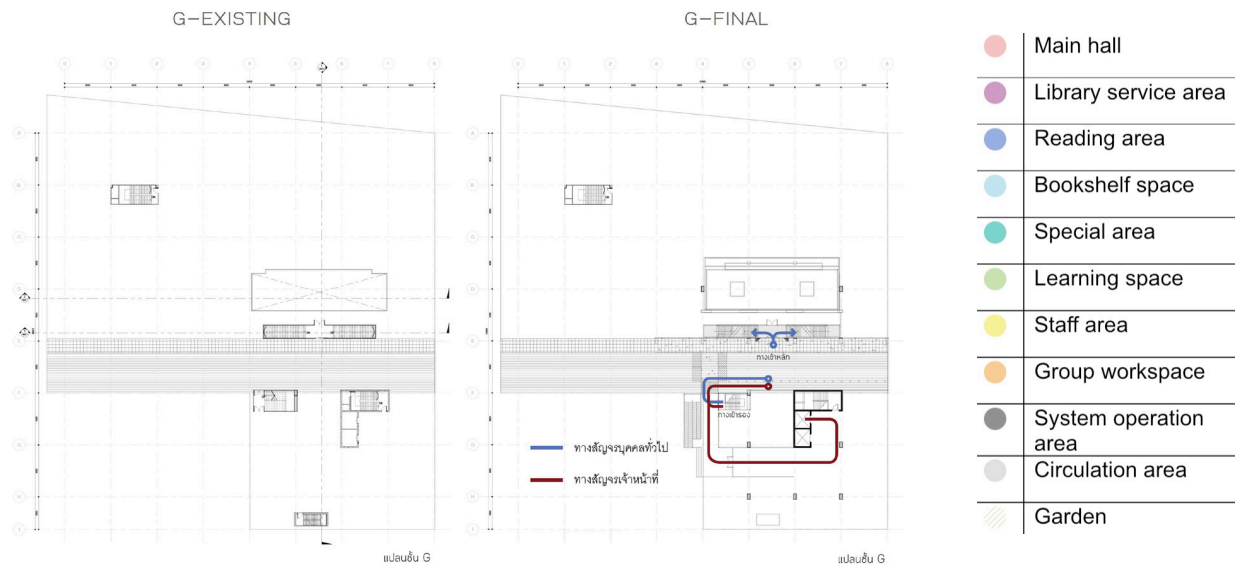


Figure 15. Comparison of the G floor spaces (left) Current plan and (right) New plan.



Figure 16. New design main entrance on G floor (left) Library entrance and (right) Central staircase to U1 floor.

U1Floor: U1 floor is a public space with a main concept of conveying symbolic meanings and promoting the learning of the area's history. A long digital wall would be placed on the old city wall's line as a new wall to provide historical knowledge of the area. This floor would consist of an entrance hall, staff offices, general reading areas, a coffee shop, permanent exhibition rooms, multipurpose rooms, temporary sleeping areas, and group workspaces. Certain areas would be open 24 hours to support knowledge exchange and various activities. The left part of the floor plan would contain a group work area with 6-10 seats and a permanent exhibition room that exhibits the history and concept of the library building. The upper part of the floor plan would contain a large multipurpose room for academic conferences and film screenings (Figures 17 and 18).

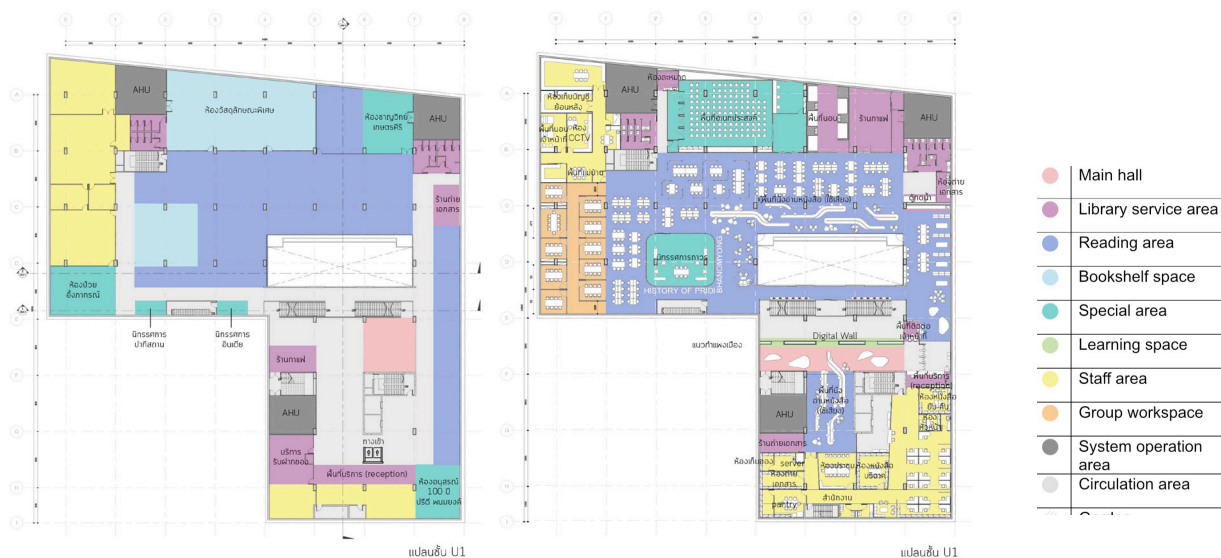


Figure 17. Comparison of U1 floor plan (left) Current plan and (right) New plan.

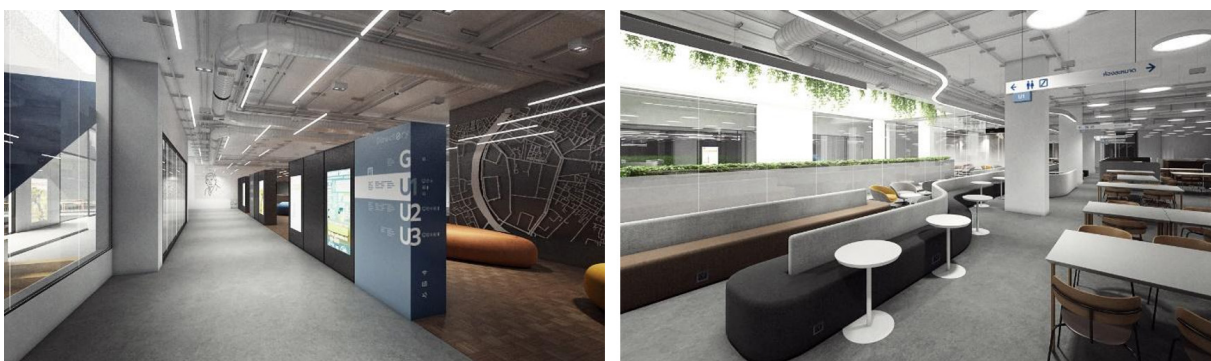


Figure 18. U1 new design floor (left) Library entrance hall and a digital wall (right) Reading areas.

U2 Floor: U2 floor is a large learning space that would consist of a quiet reading area and a semi-quiet reading area. The concept is to symbolically communicate a global community, where users are wirelessly connected to different areas around world. The gridded-city pattern would use a furniture layout for the quiet reading area located on the upper part in the plan, while the semi-quiet reading area would represent local communities with diverse physical characteristics in the lower part. A library of things, which symbolizes a landmark of the city, would be placed between both reading areas. In addition, there would be a rare book room and recreational spaces such as a mini theater, a karaoke room, a board game room, online media production rooms, and a computer lab placed throughout the floor space (Figures 19 and 20).

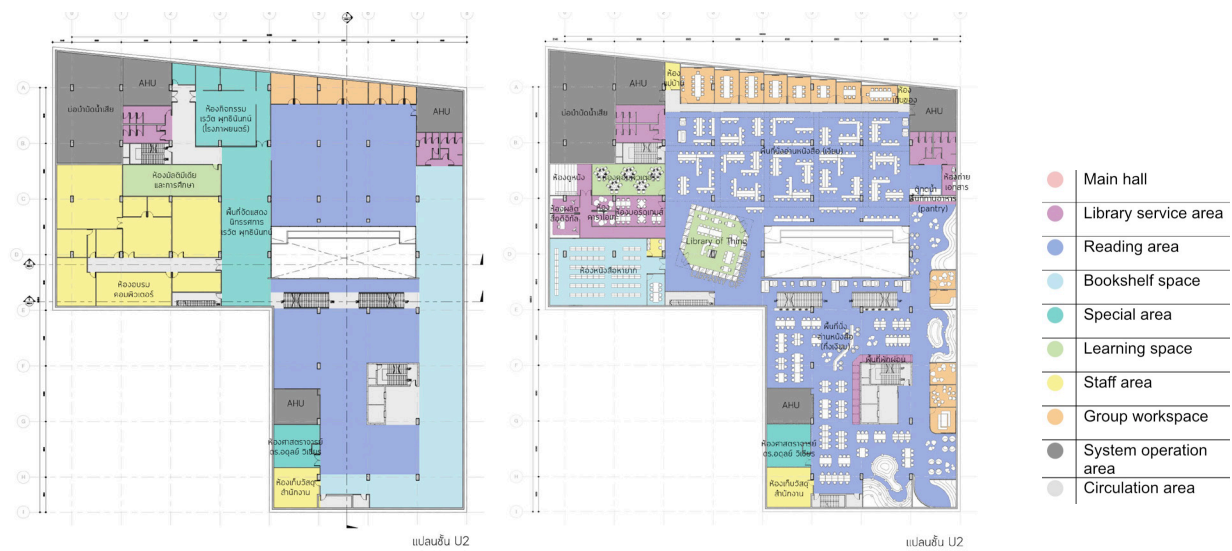


Figure 19. Comparison of U2 floor plans (left) Current plan and (right) New plan.

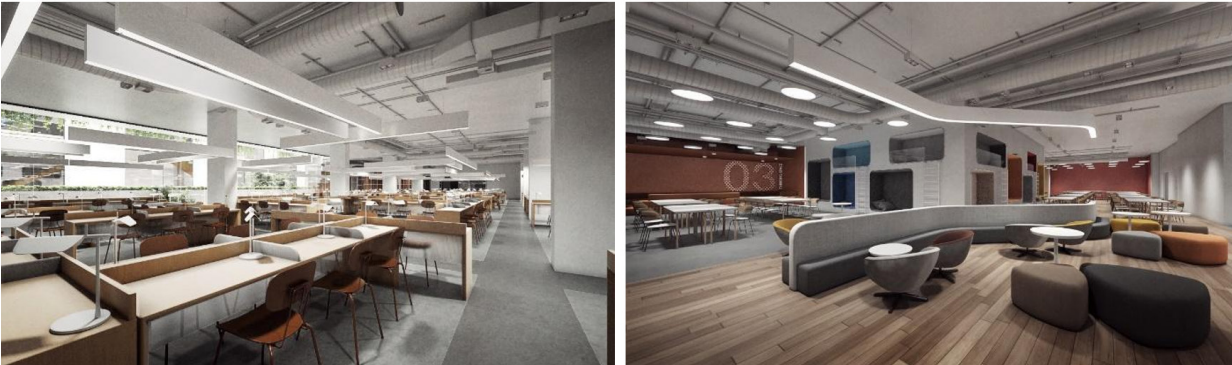


Figure 20. U2 new design floor (left) Quiet reading area symbolizing gridded-city pattern and (right) Semi-quiet reading area symbolizing local communities.

U3 Floor: Would receive natural light and views, with a large quiet reading area surrounding the central garden. This would reduce user fatigue from a long period reading. Bookshelves would be separated from the reading area by glass walls to control temperature and humidity. A motion detection system would be installed to turn on the luminaire for energy savings (Figures 21 and 22).

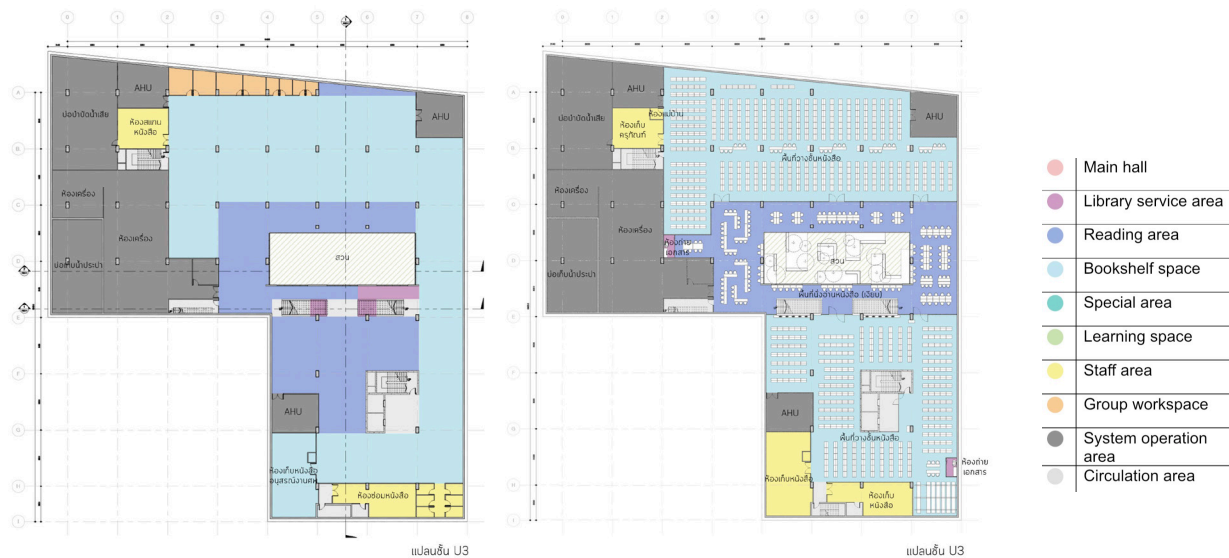


Figure 21. Comparison of U3 floor (left) Current plan and (right) New plan.

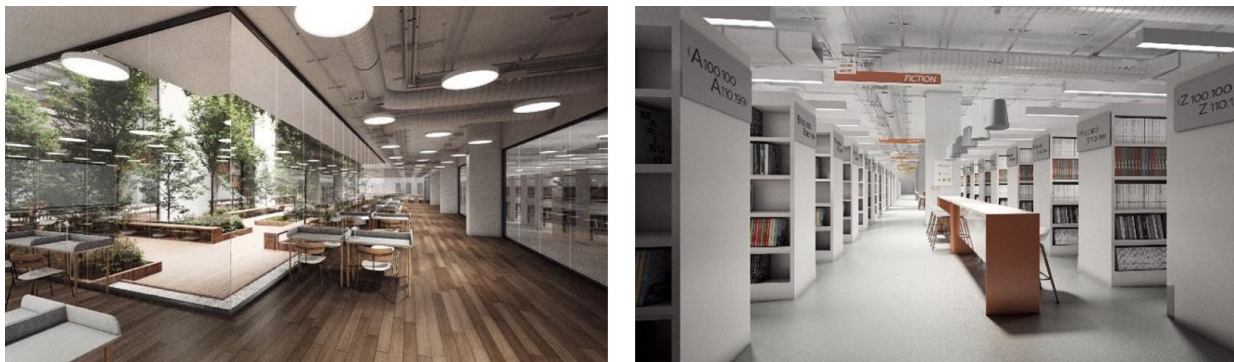




















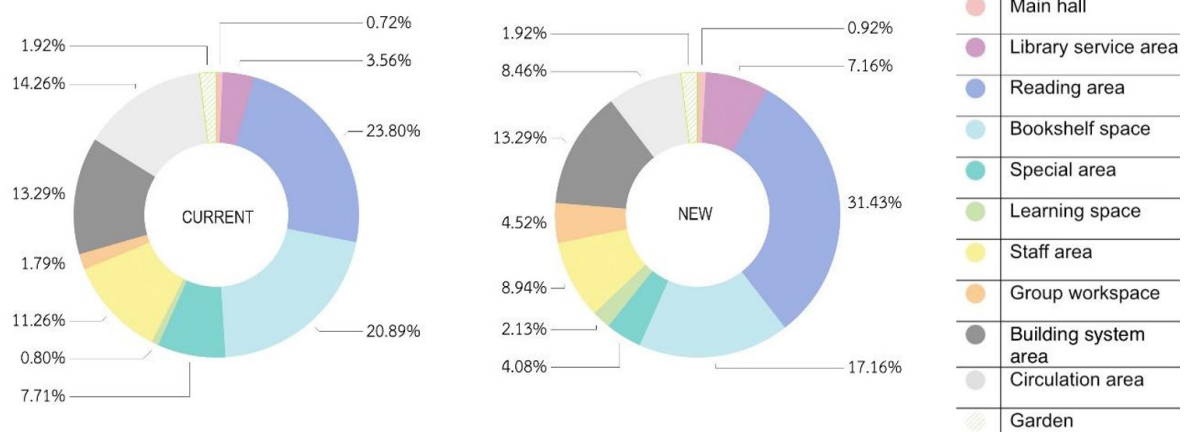


Figure 22. U3 new design floor (left) Reading area surrounding the central garden and (right) Bookshelf area.

Compared to the current plans of the library, the proposed plans show significant changes in areas and percentage of change in each area. The increased areas, in descending order (percentage of change), consist of learning spaces, group work rooms, library service areas, reading areas, and reception halls. The decreased areas, in descending order (percentage of change), consist of special areas, traffic areas, staff areas, and bookshelves. It should be noted that the largest area in the library is the reading area, followed by the bookshelf area (Table 3 and Figure 23).

Table 3 Comparing the Area Size and Space Utilization Ratio of Pridi Banomyong Library for Current and Proposed (New) Plan

List		Current spaces		New spaces		Percentage of change
		Area (Sq. m.)	Percentage	Area (Sq. m.)	Percentage	
	Main hall	82	0.72	105	0.92	 21.9
	Library service area	408	3.56	821	7.16	 50.3
	Reading area	2,728	23.80	3,602	31.43	 24.3
	Bookshelf space	2,394	20.89	1,966	17.16	 17.9
	Special area	884	7.71	468	4.08	 47.1
	Learning space	92	0.80	244	2.13	 62.3
	Staff area	1,290	11.26	1,024	8.94	 20.6
	Group workspace	205	1.79	518	4.52	 60.4
	System operation area	1,523	13.29	1,523	13.29	-
	Circulation area	1,634	14.26	969	8.46	 40.7
	Garden	220	1.92	220	1.92	-
Total area		11,460	100	11,460	100	-

**Figure 23.** Summary of current (left) and new (right) areas of the Pridi Banomyong Library.

When compared to the previous area, the number of reading seats has a large increase. Previously, the library had 966 seats, accounting for 10.9% of the total number of students. In the new plan, it will be increased to 1,662 seats, accounting for 18.76% (the international standard is 20% of the total number of students).

9. Conclusions and Recommendations

The study on the concept and design of the 21st century library revealed the development of libraries from the past to the 20th century, where libraries evolved from personal book storage spaces to public buildings accessible by the community. The significant changes began in the late 20th century when information technology had an impact on society, leading libraries to adopt digital technology in their services. The concept of the 21st century skills introduced in the early 21st century has resulted in a major transformation in learning,

prompting educational institutions, museums, and libraries to adapt and promote new skills different from those of the 20th century, such as interactive learning, social activities, and lifelong learning. This process includes the transformation of university libraries to provide new learning and social spaces for university students and staff.

The Pridi Banomyong Library, Thammasat University, Tha Phra Chan Campus, was selected as a specific case study to present a design guideline for transforming the old library building into a 21st century university library. It presents a research method and a design process on how an old library can be systematically transformed into an efficient and practical 21st century library. The methodology of the research included the study of evolution of library concepts and design, survey and data collection of the area, interviews from executives, staff, and library users, analysis of current library plans and usages. The proposed design consists of floor plans showing the utilization of space on G, U1, U2, and U3 levels, and comparing them with the current library plans to clearly show changes in areas and percentage of each area, and a series of 3d-computer-generated perspective views to show the new interior spaces that promote the 21st century skills. By positioning the library users as the central focus, the library will support lifelong learning, providing a diverse learning environment, highlighting the historical significance and value of the building and its location, as well as a creating a new identity for the library with a focus on digital technology.

The research shows that a design guideline for a 21st century university library consists of: i) being a learning resource center with diverse learning media instead of a traditional library with books; ii) emphasizing both physical spaces and digital spaces; iii) providing social learning areas, lifelong learning areas and recreational spaces; iv) focusing more on knowledge and innovation creation; v) being eco-friendly; vi) having a layout of open, flexible spaces instead of enclosed spaces; vii) supporting user-centered/created knowledge; viii) having relaxed and diverse furniture; ix) being accessible for people with disabilities; x) providing a networked service in collaboration with other educational institution libraries; xi) offering access to new digital technologies; xii) allocating areas for sound-use/quiet areas; xiii) open 24 hours to facilitate learning access; xiv) expressing vision, mission, and identities of place and library.

According to the Pridi Banomyong Library, the new plans proposed that G floor will be the library entrance, with a main entrance for the general users and a secondary entrance for staff and the disabled. U1 Floor will be the public space, accommodating various learning and social activities. U2 floor will be the main learning space, with areas for different reading activities. U3 floor will be the quiet reading space, with separate areas for reading and bookshelves. In comparison to the concepts and design of 21st century libraries, it was found that the plans proposed by the authors follow these new concepts. For example, there is an increase in reading spaces compared to the current plan, which help support social learning and enhance new learning skills. There are areas that would decrease in size, such as special areas, circulation, staff areas, and bookshelves, as digital media and smart technologies have replaced books and the increasing use of automated services instead of staff assistance.

In conclusion, this research proposes a design guideline and a specific case study of transforming an existing traditional university library into a 21st century university library. By promoting new skills, such as interactive learning, social activities, lifelong learning, and diverse learning experiences, the Pridi Banomyong Library will serve as a center of Thammasat University for lifelong and social learning. The library would be an exemplar design case for other libraries throughout Thailand that will help to develop Thai society into a more learning-centered society. However, since most of the library's usable spaces are located underground, this creates some limitations in design transformation, such as exiting entrances and exits that are not convenient

for people with disabilities and the reliance on natural light coming from above, as the walls of the building are earth-retaining. Therefore, the conclusions drawn from this research cannot be directly applied to the renovation of other libraries, such as those situated above ground or smaller libraries with limited space. Consequently, further research is needed for each case to ensure the designs are appropriate for different contexts. This study, moreover, excludes some design details such as lighting equipment and building systems. Further studies, such as smart technologies, will help to improve many existing old libraries throughout Thailand, whether they are public libraries operated by the government, private libraries, community libraries, or educational institution libraries. This will help to develop Thai society into a more learning-centered society, similar to the approaches that Singapore has taken with respect to improving and developing their old libraries nationwide over the past decades.

Author Contributions

Conceptualization, P.J and S.P.; methodology, P.J and S.P.; formal analysis, P.J and S.P.; writing-original draft preparation, P.J and S.P.; writing-review and editing, P.J and S.P.; visualization, P.J and S.P.; project administration, S.P. All authors have read and agreed to the published version of the manuscript.

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