SPECIAL ISSUE ON TECHNOLOGY-ENHANCED LEARNING SPACES

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Trends and Issues in Library Technology

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TRENDS & ISSUES IN LIBRARY TECHNOLOGY

IFLA Information Technology Section Special Issue on Technology-Enhanced Learning Spaces

Departments

Special Section: Technology Enhanced Library Learning Spaces

Editor's Notes

Special Issue on Technology-Enhanced Library Learning Environments

A transformative journey is underway in the realm of libraries marked by the integration of Artificial Intelligence (AI), Virtual Reality (VR, XR) and new digital technologies. This evolution necessitates not only the integration of advanced digital infrastructures but also the conceptualisation of innovative spaces that nurture and accommodate these accompanying technological shifts. Considering these new developments, we are pleased to introduce a unique edition of the IFLA IT Section's "Trends and Issues in Library Technology," focused on exploring architectural innovation, learning technology spaces, and conceptual models for libraries as they transition into these sophisticated and dynamic new technology-rich environments.

In an era where technological advancements are no longer incremental but revolutionary and paradigm-shifting, libraries find themselves at a crossroads. We are embracing changes but also committed to fostering an environment of learning towards these new digital and algorithmic literacies. Recognising the global dimensions of our subject, we have curated a compelling set of library projects that reflect regional contributions and span the globe from Europe and North America to Africa and South Asia. This issue celebrates these diverse technological landscapes across these regions, highlighting unique methodologies employed and the chorus of voices within them. Our global libraries are committed to helping patrons and the public come up to speed and empowering them with these new-millennium learning and information technologies.

The genesis of this edition can be traced back to two insightful sessions in Rotterdam, Netherlands, during the past WLIC 2023. These discussions centered around VR, XR, Mixed Media Technologies and Technology Enhanced Learning Spaces for libraries. These laid the foundational groundwork for the rich and varied perspectives of this publication. Opening this issue, Traci Lesneski, architect and principal for MSR Design (US), offers an insightful introduction setting the stage for a journey through cross-disciplinary realms. Traci was one of the organisers of the Technology Enhanced Learning Spaces session, a joint effort between IFLA's IT Section and the Architecture, Buildings and Equipment Sections. Introducing perspectives, Sajeewanie Somaratna of the University of Colombo, Sri Lanka, presents the opening narrative of crafting a state-of-the-art academic library tailored for Generation Z in South Asia, anchored by the pioneering Information and Learning Centre. My article offers a retrospective analysis of the evolution of technologically enhanced learning spaces in US academic libraries, drawing on historical perspectives, pragmatic experiences, and current innovations. Introducing the next generation of projects, Vincent Cellucci, Alice Bodanzky, and Jeroen Boots from TU Delft Library discuss the transformative power of XR in reimagining non-traditional collections into vibrant halls of inspiration at TU Delft Library, Netherlands.

This issue also opens with a special message from our new IT Section chair, Cory Lampert of the University of Las Vegas, who shares an overview of our IT section's ongoing and future initiatives in 2024. Among these exciting endeavours is an upcoming global AI Satellite conference in Santiago, Chile for April 2024, with a call for contributions currently underway. Wouter Klapwijk of Stellenbosch University also provides a reflective synopsis of the IT Section's preceding 2023 AI Symposium in South Africa, underscoring the IT Section's commitment to a diverse and engaging calendar of global activities in 2024.

For this issue, I'd like to thank Francois-Xavier Boffy, Wouter Klapwijk, and Patrick Cher, and also new assistant editors Bohyun Kim and Satveer Singh Nehra for making this issue a success. As our IT group and IFLA collectively forge ahead into another year of discovery, technology, and innovation within library spaces, I also extend my heartfelt wishes for success in all your professional endeavours and look forward to meeting at one of our future gatherings in 2024.

Sincerely,

Ray

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IT Section Chair's Corner

Message from the Chair

I'd like to extend my greetings from the new slate of Officers (2023-2025) as we congratulate and warmly welcome the returning and newly elected IT Section Standing Committee. Many thanks to our previous Chair, Edmund Balnaves and our Section Mentor, May Chang for their support!

The past year has been a busy one, with the Section's expertise leading discussions and adding important context to some of the most critical issues facing libraries. Professional growth initially attracted me to service in IFLA, but I find it even more rewarding in the ways that IFLA has provided a chance to collaborate with others. The IT Section is uniquely situated to lead from the centre of many library technology conversations. This aspect of collaboration and innovation was strongly reflected in the sessions the Section contributed to the Congress in Rotterdam.

The theme of the WLIC 2023 was "Let's Library", and our Section took this theme to heart in the design of our satellite meeting, *"Agile Methodology in Libraries: Innovations in Library Projects and Management."* The satellite planning was led by Elena Sánchez Nogales of the IT Section in cooperation with the Continuing and Professional Development and Workplace Learning (CPDWL) and Subject Analysis and Access (SAA) Sections, and it was held at Erasmus University in Rotterdam. This satellite was an excellent showcase of how the IT field's agile project management techniques can be implemented and prove their value in a wide range of library environments. While initially planned as an in-person-only event, the team switched to hybrid, opening up a larger participation level with remote participants. The excellent slate of speakers represented Africa, Asia/Oceania, Europe, and North America, and Zoom attendees were similarly geographically diverse. Erasmus University's amazing event support team provided an event website, onsite lunch service, tea break, and a fascinating library tour.

The Section and the two Special Interest Groups (SIGs) – Big Data and Artificial Intelligence – sponsored by the IT Section held successful business meetings with their members on the first two days of the conference. The Big Data SIG, led by Patrick Cher, provided an engaging presentation at their business meeting. We learned about how the National Library Board in Singapore is using generative AI and machine learning in a variety of library use cases. The Artificial Intelligence Special Interest Group (AI SIG) also provided a venue for small group discussion and reflection on AI-related topics. Our Section's full roster is available on the Information Technology Section website, where we have links to join the Section listservs and get the latest news on our events and activities. The AI SIG website and Big Data SIG website are also great sources of information and provide links to get involved with our work.

The AI SIG convenor, Andrew Cox, led a showcase of sessions on this year's hot topic, collaborating with several other Sections, SIGs, and regional groups. While some sessions wrestled with questions of whether AI will be "friend or foe" and "partner or rival", several other speakers shared their practical experience with AI, noting that technologists recognise that AI has been with us for a while, certainly many years before the media jumped on the story of ChatGPT. Compelling sessions focused on the laws governing and regulating AI, case studies from national libraries, ways in which AI might evolve library roles, and approaches being taken to examine the ethics of development and implementation. A particular highlight of these sessions was the active and enthusiastic audience participation. Question and answer periods provided a rich source of continued learning and reflection.

WLIC 2023 also contained other fantastic sessions sponsored by the IT section. Edmund Balnaves and May Chang coordinated the Section's open session on "Digital Technologies and Sustainability: Say Your Piece in 7+3" showcased remarkable projects in libraries around the world. Edmund Balnaves chaired the session, "Artificial Reality/Virtual Reality, Meta-verse, Immersive Technologies – New Methods for Sustainable Communities in Libraries", in conjunction with the Audiovisual and Multimedia Section. Ray Uzwyshyn coordinated a session on Technology Enhanced Library Learning Environments, Architectural Spatial Design and New Information Technology Possibilities with the IFLA Building and Equipment Section. These events offered important insights into the way technology can support the UN Sustainable Development Goals (SDG) and also addressed the critical issues of technology-enhanced

library learning spaces for users of today and tomorrow.

Continuing with the way IT intersects with other functional areas of the library, the Section co-sponsored two sessions with the Subject Analysis and Access Section. These joint sessions were held in a massive room. Engaged audiences turned out curious to hear how machine learning applies to library data and cataloguing practice. Case study presenters spoke about harnessing the power of technology tools to improve descriptive workflows. Human insight is invaluable in these areas to create new efficiencies and the frameworks needed to do innovative work responsibly. And let's be honest, many of us who just wanted to hear the answer to the question, "Can AI catalogue?" The answer might surprise you!

As the Congress came to a close, issues of diversity, equity, and inclusion continued to remain an important focus. As the incoming chair, I see many opportunities for IFLA's engaged members to help guide the future strategic plan and the organisation's direction. IFLA is at a crossroads as it wrestles with the challenges of being a truly international organisation in an imperfect world. I commit to advocating for positive work that continues to allow librarians to cooperate and learn together, regardless of location or government. While we recently heard that there will not be a WLIC 2024, the Section is actively developing an Action Plan. Some topics we've already identified include AI literacy, accessibility, digital inclusion, and technology partnerships to improve preservation and access to information. I welcome you to reach out to our Section to work together in the coming years.

Regards
Cory

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IFLA's Internet Manifesto 2024 – Why Is It Relevant and Who Will Benefit from It?

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IFLA approved its first Internet Manifesto in 2002, providing early recognition of the vital role that the Internet plays in the library and information services field. In 2014, a second version of the manifesto was published, not only to reflect changes that the Internet had gone through, but also to reaffirm the crucial role of libraries in ensuring equitable access to the Internet and supporting freedom of access to information.

Today, a decade later, the world and Internet Governance landscape have changed drastically. Libraries, however, remain as key allies in Internet Governance conversations. They enable Internet and information access throughout the world. They also allow whole communities and individuals to make better use of their right of access to information for the development of more participative and democratic societies.

In July 2023, an expert group was set up to steer the manifesto's update and review process and to facilitate engagement from the wider library field. An informative session and open consultation process took place during WLIC 2023. One of the biggest concerns raised was to ensure the purpose and utility of the manifesto before its publication and to enable external contributors to provide their input before completion.

The Internet Manifesto principles paper was born from the desire to clarify the utility of the final document, which will be published in 2024, and to give it visibility and to mobilize as many relevant people as possible in our field. If you are curious about its purpose and possible ways for engagement, we invite IFLA IT members to review below.
The main manifesto is set out to be published in the first quarter of 2024, which will be followed by thematic months, online sessions, and open exchange among library and non-library stakeholders throughout the course of the year.

Internet Manifesto Revision Principles Paper
In 2024, IFLA is preparing a revised Internet Manifesto. This manifesto will be the fourth statement from IFLA in the area of Internet Governance, as libraries pivot to adapt to the changing nature of information delivery over the Internet.

View this resource on the IFLA repository

Introduction: Enhanced Library Technology Spaces

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Thriving in the 21st century requires the ability to communicate, collaborate, and problem-solve in a digital world. The ability to locate, make sense of, and apply information requires fluency in digital tools and platforms. Recognising this reality, libraries across the globe are investing in information, media, and learning technology-rich spaces that foster literacy in the use of technological tools and processes.

While technology-rich library environments are not new, the evolving landscape of learning technologies requires continual recalibration of how technology and the built environment come together. The technologies of today and tomorrow are mobile, personal, and simultaneously invisible and ubiquitous. The architecture and technology in successful learning environments need to support exploring, learning, and communicating. Achieving a seamless learning experience requires careful planning and integration while allowing flexibility. The exponential rate of change in technology creates an inherent tension between the built environment (largely permanent and slow to change) and technology (continually shifting and evolving). Since learning, play, and exploration happen indoors and outdoors, both settings require technology that advances 21st-century learning modes.

A common assumption is that technology-rich equals expensive. Thoughts of extended-reality (XR) immersive environments, robust makerspaces, and sophisticated audiovisual editing suites may come to mind. Refuting this perception, the case studies in the January 2024 issue of Trends and Issues in Library Technology describe how to employ impactful methods of technology integration that can be replicated with relatively modest means. The ideas articulated in this issue span four continents and illustrate accessible methods of integrating information technology into buildings to create environments that enhance learning and digital literacy and build community—a necessary ingredient for libraries to thrive in the 21st century. These projects make exponential impact with modest investment, a hallmark of libraries

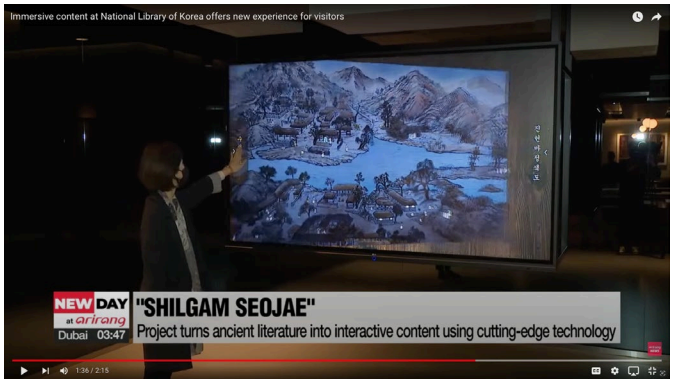
Projects, Technologies and Spaces

Sajeewanie D. Somaratna's article on the Information & Learning Centre (ILC) at the University of Colombo in Sri Lanka delves into the evolving needs of digital natives in place-centred activities. The project matches the desired learning experiences of Generation Z (e.g., learning by discovery and after-hours study) with learning spaces equipped with the right spatial and technological offerings. The integration of RFID-powered materials, self-checkout and return, a skills lab with e-boards, an open study area with a coffee shop, and a library studio with videoconferencing all support this goal. Careful attention to furnishings further supports learning styles and needs. Flexible furniture settings enable students to move the furniture to suit their learning needs and group size. Round tables facilitate collaboration. Key spaces in the ILC include an auditorium with an immersive multimedia experience and a flexible classroom where students can practice presentation skills and career development activities. Since opening in 2021, the use of the ILC has expanded beyond academic pursuits, actively contributing to the social cohesion and sense of community across the campus.

The expanded use of academic libraries beyond research and study is discussed in Raymond Uzwyshyn's article, "Developing Technologically Enhanced Learning Spaces for New Millennia Academic Libraries." Uzwyshyn describes the shift in academic libraries in the United States from quiet study spaces to places focused on creativity, technology, and interdisciplinarity. Providing space for collaboration informs personalised learning experiences with 24-7 access to information, new teaching roles and settings. For many libraries, this emphasis creates the need to consider spatial needs. Uzwyshyn asks, "How do we best make room for the new spaces needed for a technology and patron-centred learning commons?" The research outlines numerous solutions to this critical technology-related question. The article also overviews best practices and lessons learned over 20 years (2003–2023) through four university library design projects in Florida, Texas, and Mississippi. These projects constitute a variety of scales and complexities. Each embraces active and technologically-enhanced learning experiences that promote competencies required to succeed in our 21st-century digital world. Underpinning each project is a

crucial planning principle that technologies will change over time. Planning should reflect this reality by allocating space without establishing technology for each space. One can also better understand the quick rate of technology change in our libraries over the past two decades through Uzwyshyn's valuable historical mapping of space and technology changes in 21st-century library learning commons in various tables and diagrams.

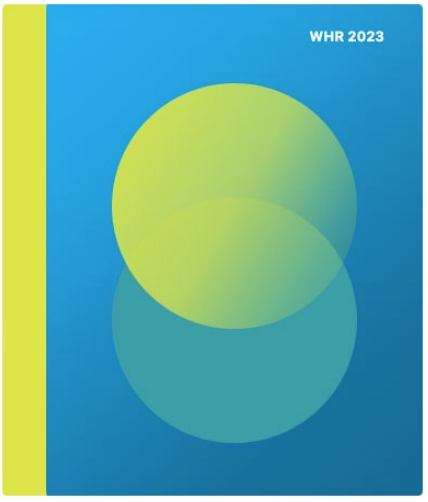
Few library images are as iconic as Delft University of Technology (TU Delft) Library's four-story suspended book wall and adjacent cone. Located in Delft, Netherlands, the building is referenced in numerous lists and articles, recommending it as a place people should visit in their lifetime. The library is embarking on an ambitious project to create an interactive XR browsing experience to better access its non-standard format collections, such as artefacts from campus exhibitions, 3D scans, and videos. The floors of the cone become virtual shelves for the collection. Vincent Cellucci, Alice Bodanzky, and Jeroen Boots of TU Delft Library delve into the prototype the library created for the XR Cone and share the headwinds and successes they experienced while developing and testing the prototype. Innovation and exploration are often sparked through play and delight. As the videos (https://youtu.be/-w-zg1AGW2w?si=liH082-65e2EDjE7) of users engaging with the National Library of Korea's immersive content illustrate, delight creates memorable experiences and fosters collaborative and social experiences. A measure of play is present in TU Delft Library's XR Cone prototypes and acknowledged in the article as one of the ways the XR Cone creates an association between educational content and enjoyable experiences.



Immersive content at National Library of Korea offers new experience for visitors

Conclusion

Technology is often discussed as a social isolator. Conversely, architecture is often addressed as a way to bring people together. The annual World Happiness Report (https://worldhappiness.report/), a Sustainable Development Solutions Network publication, consistently finds that happiness requires strong human relationships, robust social support, and evidence of trust—in other words, community. Libraries are a central hub for building community. Technology extends a library's ability to foster community inside and beyond its physical environment. The projects in this issue and special section demonstrate that when designed intentionally, technology and architecture can foster collaboration, exploration, scholarship, and community. Whether supporting a basic ability to get along in the digital-centric 21st-century world or igniting curiosity and interdisciplinary innovation, technology-rich environments are here to stay.



2023 World Happiness Report

Traci Lesneski is CEO and principal of MSR Design, an internationally recognised design firm headquartered in Minneapolis, MN, United States. Lesneski led the design of the Missoula Public Library and Culture House, which won the 2022 IFLA/Systematic Public Library of the Year Award.

Academic Libraries for GenZ: Information & Learning Centre at the University of Colombo, Sri Lanka

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Figure 1: Information & Learning Centre (ILC) at the Faculty of Science, University of Colombo

Introduction

Libraries have undergone significant changes over the past few decades, departing from their traditional models in various ways. First, there have been technological advancements driving these changes, and second, there has been a transformation in the architecture of learning spaces. Not only have libraries evolved, but so have the behaviours of patron groups. The introduction of Generation Z, often referred to as digital natives, into university settings, has led to substantial shifts in the entire library sector to meet their specific needs. Weise (2004) emphasised the responsibility of librarians in guiding the design of libraries and defining the role of 21st-century libraries. According to him, "the role of the library evolves beyond being just a 'storage facility' or even just an 'access facility,' shifting its focus towards the various place-centred activities and services that the library can support" (p. 12). As a result of these evolutionary changes, alternative names for academic libraries have emerged, moving away from the term 'library' itself. Terms like 'learning resource centre' better reflect the qualities of future academic libraries (Choy, 2011., Garoufali & Garoufallou, 2022).

Creating a modern library designed for GenZ users is relatively common in most developed countries, but it presents a significant challenge in developing countries. Nevertheless, with persistent requests and well-justified reasons for a library equipped with technological advantages and architecturally designed learning spaces, the Information & Learning Centre (ILC) at the Faculty of Science, University of Colombo, became a reality. The seven-story Information & Learning Centre at the Faculty of Science stands as a newly designed library building that incorporates the unique features of a modern library. (https://www.youtube.com/watch?v=Xj7I4zFepDA&t=1s) The various learning spaces within the ILC are tailored to accommodate the diverse learning styles of the GenZ library users. This departure from traditional library concepts encompasses a broad spectrum of

learning, from informal to formal.

Technological Advancements at ILC

The ILC is fully automated with RFID technology. It uses self-check-in/out machines with a return bin, empowering students to check out books themselves. This is the first and only academic library in Sri Lanka with a fully automated circulation system with self-check-in/out machines powered by RFID technology. Also, the entire library collection is secured by an RFID security system.

Figure 2: RFID self-check machine with the RFID security gate

The library provides access to a wide range of multimedia resources, including digital databases, e-books, online journals, and audiovisual materials, in addition to the physical collection. This allows students to explore diverse content and engage with different formats of information. With the introduction of Koha's open-source library management software, the entire library collection was computerised, providing library users with the ability to search the library collection through the Online Public Access Catalogue (OPAC). This feature is accessible onsite and remotely, significantly expanding the library's services.

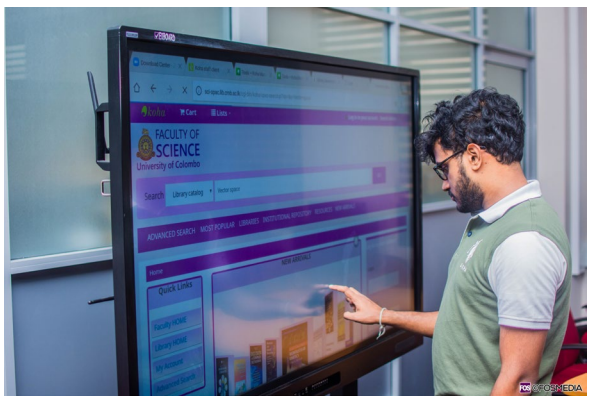

Figure 3: Searching books on Library OPAC

Integrating technology into library spaces enhanced student learning experiences

Also, the integration of various technological adaptations within each learning space is aimed at meeting the expectations of today's learners. Here are some technical facilities incorporated into the library: 24 x7 Wi-Fi access, State-of-the-art computer labs, E-boards and interactive boards, multimedia projectors, sophisticated sound systems, network ports and power outlets available at each study table, and video conferencing system are significant. This encourages GenZ to practice BYOD policies within the library premises.

Figure 4: E-resource Centre

ILC provides state-of-the-art computer labs, E-resource centres, makerspaces, Library studios or media production areas equipped with the necessary tools and software for digital projects and creative activities. The resource centres of the library consist of 110 computers, while the library studio consists of modern equipment which facilitates video conferencing and multimedia production.

Figure 5: Library Studio

GenZ expected learning activities

When designing the Information & Learning Centre, the

primary consideration was the students' informal learning activities, and specific learning spaces were created accordingly. This new library building includes five main study zones: a collaborative discussion zone, a quiet study zone, an interactive study zone, an open study zone, and a reference zone. Additionally, it features technology-enabled spaces such as state-of-the-art computer labs, e-resource centres, a library skill lab, a library studio, a librarian's classroom, a non-library classroom, and an auditorium, all reflecting the modern characteristics of a Gen Z library.

Expected Learning Activity	Learning Space
Collaborative learning	Collaborative discussion zone
Student individual learning	Quiet/self-study zone
Learning by discovery	Interactive study zone/ reference zone
Focused learning – research studies	Library skill lab
Library classroom learning – information literacy	Librarian's classroom
After hour studying	Open study zone / Information learning space
Auditorium facilities – public / campus events	Library auditorium
Learning by video conferencing	Library studio
Faculty learning	Faculty reading space
Students' skill development	Non-library classroom

Figure 6: GenZ's learning preferences and learning spaces

Architecture of Learning Spaces

Collaborative Discussion Zone: The ILC is designed to provide designated areas that encourage student discussion through group work discussions and collaboration. These spaces include group study areas equipped with technology and interactive tools to facilitate teamwork and brainstorming sessions. Round study tables with comfortable cushioned chairs are chosen to facilitate collaboration among students. The furniture arrangement can be adjusted based on the size of the learning group.

Figure 7: Collaborative Discussion Zone

Quiet Study Zone: Quiet study zones are available at ILC, where students can focus and study individually without distractions. These areas have a calm and peaceful atmosphere favourable to concentration and deep learning. Individual study tables with comfortable cushioned armchairs are provided to create a favourable environment for focused individual learning.

Figure 8: Interactive study zone

Interactive study zone: This study zone is also popular among students; comfortable sofas and beanbags are used to create a comfortable and relaxed learning experience that promotes interaction and engagement.

Figure 9: Library Skill Lab

Library skill lab: This is designed with flexible learning spaces that can be easily reconfigured to accommodate different learning activities. Furniture on wheels, movable partitions, and adaptable seating arrangements allow students to customise the space

according to their needs, whether it's for group discussions, individual research, or presentations. The library skill lab of the ILC provides this learning experience to learners with flexible study tables that can be arranged as round tables or long rows to accommodate different learning activities.

Informal Gathering Areas: Also, ILC has incorporated comfortable seating areas and lounge spaces where students can relax, engage in informal discussions, and exchange ideas. These areas foster social interactions and unexpected learning moments. The Open/after-hour study zone of the Science Library is used for this purpose. Light-weight chairs are used at outdoor study tables, providing a suitable seating option for students studying there. As this is an open area on the ground floor, students can comfortably use this space to experience the natural wind breeze. The coffee shop is located alongside this open study zone, allowing students to enjoy hot coffee while studying and providing a cozy, homelike environment for learning.

Library auditorium: A state-of-the-art arena is furnished with 300 modern auditorium chairs, and this space is exclusively used for professional or academic gatherings of faculty and students. They use this for conferences, talks, faculty and student events.

Faculty reading space: Academics actively engage in Continuous Professional Development (CPD) programs throughout their careers. To promote faculty learning, a dedicated space has been established in ILC—academics who had never visited the library before are now utilising this space effectively for learning and research purposes.

Figure 10: Librarian's classroom

Librarian's Classroom: Besides physical spaces, ILC offers academic support services, such as tutoring centres, writing assistance, research consultations, and access to specialised librarians who can guide students in their information-seeking process. Librarian's classroom is specifically designed for this purpose.

Figure 11: Non-library classroom

Non-library classroom: This space encourages formal and informal learning practices among students. The classroom has 300 comfortable lecture chairs with integrated writing pads, creating a suitable learning environment for classroom-based teaching. In addition, this space is designed as an adjustable space ideal for workshops, activities of student societies and other functions. Students actively use this space to develop their speaking skills, leadership skills, career development activities, etc. Student societies such as the Career Guidance Unit, Rotaract Club, Gavels Club, AISAC, Music Society and FOS media use this space exclusively.

Likewise, creating diverse learning spaces within the library can promote independent learning, collaboration, and innovation. These learning centres/libraries serve as dynamic environments that cater to students' evolving learning needs and empower them to cultivate effective learning habits outside the traditional classroom setting.

ILC: the most popular learning space in the University of Colombo

The existence of dedicated learning spaces, where technology and architectural design converge within the Information & Learning Centre (ILC), ensures that students have suitable environments tailored to their specific learning needs. These spaces facilitate various activities and enable students to use their preferred learning methods. The ILC actively promotes

collaborative and interactive learning, fostering a culture of group work and knowledge sharing among its students.

A notable feature of the ILC is the emergence of student-educators within its community. This highlights that students are not just passive recipients of knowledge but also actively engage in sharing their expertise with their peers, contributing to the creation of a collaborative and dynamic learning environment.

Moreover, the library spaces within the ILC extend beyond academic pursuits. Student societies make use of the library for organising collaborative activities, encouraging interdisciplinary interactions, and cultivating a strong sense of community among the student body.

Also, the library effectively implements Bring Your Own Device (BYOD) policies, allowing students to use their personal devices to access digital resources and engage in online learning activities. According to students, this concept has encouraged their learning process as they can use the same device all the time when learning.

Blended learning procedures are actively practiced within the library, combining face-to-face instruction with online resources and activities. This allows students to benefit from various learning methods and adapt to different learning styles.

The library facilitates continuous transitions between formal and informal learning methods, providing students with flexibility in their learning approaches. Students can easily switch between structured classroom learning and self-directed, informal learning within the library environment.

Overall, the Science Faculty Library stands out as the most popular and fully engaged learning space within the university. Its implementation of knowledge-based procedures, collaboration with students, and provision of diverse learning spaces contribute to a vibrant and enriching learning experience for the entire university community. By addressing these factors and providing a well-equipped, comfortable, and engaging learning environment, the Science Faculty Library of the University of Colombo aims to meet the expectations of GenZ students.

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Developing Technologically Enhanced Learning Spaces for New Millennia Academic Libraries

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Introduction

The need for enhanced information technology spaces and library architectural redesign presents opportunities for academic libraries in the new millennia. Through the technological reimagining of library spaces, new digital and algorithmic literacy infrastructures for the 21st century are enabled. This ranges from possibilities with AI, data, and immersive technologies to algorithmic and digital literacy labs requiring better learning-enabled architectures.

This research pragmatically focuses on four US academic research and teaching university libraries which highlight possibilities for building these new types of spaces: University of West Florida, John C Pace Library, Texas State University, Albert Alkek Library, University of Miami, Otto Richter Library, and Mississippi State University, Mitchell Memorial Library. This article highlights best practices and lessons learned from work and reflections over a twenty-year period on small, medium, large and x-large, leading-edge, technologically enhanced library architectural projects (See Uzwyshyn, References 2003-2023). This ranges from large multi-year projects (Texas State Learning Commons, 2014-2021) to medium-sized technology-enhanced floor redesigns (University of West Florida Skylab, 2006-2010) to new projects currently in early developmental phases (Mississippi State Library
Transformation, 2023). The work also glances at early information commons (University of Miami Information Commons, 2003) and consistent threads to help future brainstorming and digital literacy. It emphasises the need for imagination and imagineering technologically enhanced projects and spaces. This work, in this way, reflects on technology's path forward through a look back and forward view to the future of academic libraries to suggest pragmatic approaches and visionary possibilities in creating new architectural spaces with new technologies for libraries.

Figure 1: University of Miami Library Information Commons (2003), Architectural Rendering

Figure 2: Texas State University Learning Commons (2023), Photograph

The University of West Florida Skylab (2006-2010)

Perhaps it is best to introduce the topic of 'technology-enhanced spaces in libraries' as '*In Media Res*' or the historical middle of a narrative through the unifying theme of libraries and literacy. What does it mean for a person to be literate in the 21st century? Simply put, it means that an educated, literate person in our new millennia must be digitally literate. They must be able to use the necessary tools to write, read, and communicate globally on the web through various media formats and tools. The University of West Florida Skylab (envisioned in 2006, completed in 2010) conceptualises this project. Skylab was an approximately 1M dollar USD project to take back the John C. Pace's library's fifth floor from university administration. The space rearticulates an outdated 20th-century classroom and library structure to reclaim a new digital literacy definition as a technology-enhanced library learning centre and information literacy lab. The Skylab envisioned a tripartite technologically enhanced redesign of the library's fifth floor (Uzwyshyn, Envisioning, 2010). This consisted of an information literacy classroom lab, multimedia digital literacy studio and digital literacy and media conversion centre for students and faculty. While the old classroom consisted of a Cartesian grid-like structure, more suitable to the 19th and early 20th-century industrial revolution, the new space focused on commingling group study, technology-rich areas and re-articulating the classroom through technological possibility. Key differences in this type of space sought to spatially rearticulate new areas regarding learning and literacy needs. This included new teaching methodologies, classroom settings, teaching roles, resources, and technology possibilities. It also had extraordinary ideas regarding collaboration, engagement, technological skills, and new learning space requirements. These new spaces sought to efface 19th-century Industrial Revolution parallels. This included a larger paradigm shift from rote learning and a lectern at the front to active learning. Spatially, there was a replacement of the previous uniform grid-like Cartesian rows of desk classrooms, with more flexible and varied layouts to promote collaboration, adaptability, and integration of an abundance of advanced technologies. This shift also involved new conceptual ideas of student engagement. Student roles have changed from passive receptacles of information to active student engagement via participatory learning technologies. The teacher no longer stood at the front as a primary source of authority but was now a more decentered but essential assistive guide and facilitator. Necessary skill levels also shifted and increased from basic reading, writing and research to digital, algorithmic and database search literacy and suitable associated modalities. (See Table One below for further detailed comparison).

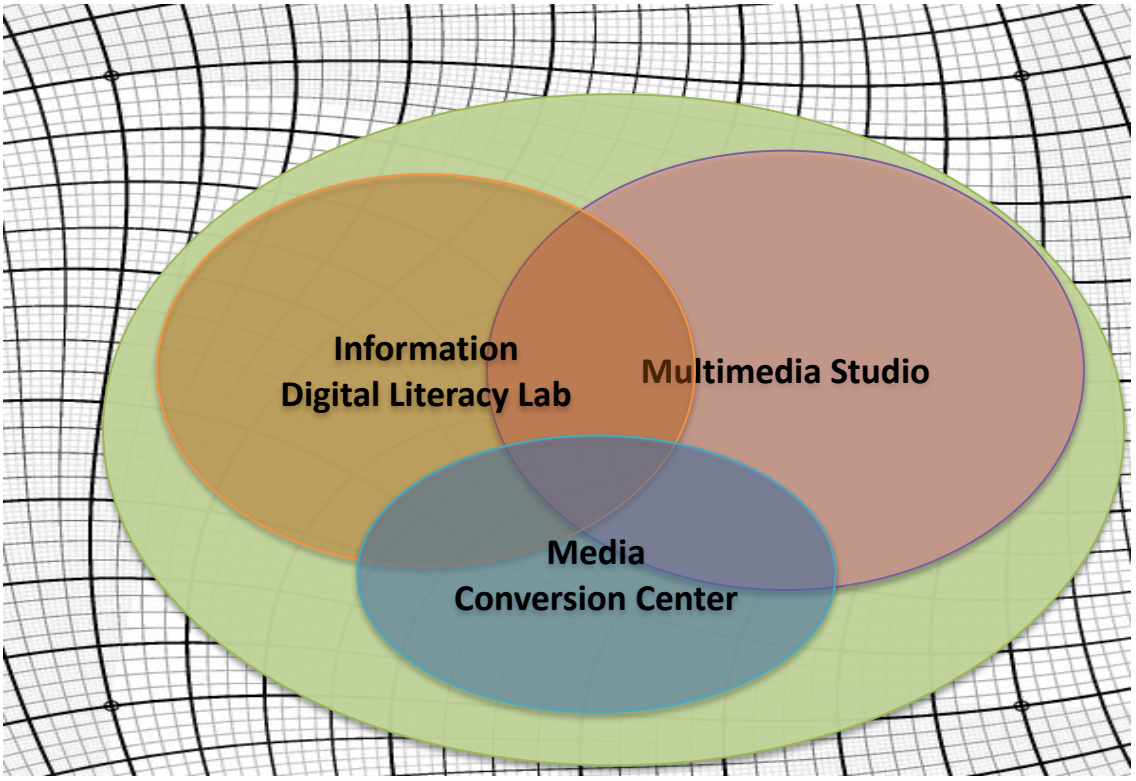
Figure 3: University of West Florida 20th Century Library Classroom

Figure 4: University of West Florida 21st Information Literacy Lab / Classroom

Characteristics of Learning Spaces	19th Century Classroom (1st Industrial Revolution)	21st Century Classroom (4th Industrial Revolution)
Learning Methodology	Rote learning focused on memorisation and repetition.	Active learning, emphasising creativity and critical thinking skills.
Classroom Setting	Uniform grid-like Cartesian rows of desks, with a teacher at the front; "one-size-fits-all" approach.	Flexible and varied layouts that promote collaboration, adaptability and personalised learning environments.
Teaching Role	Teacher-centred instruction, with teachers as the primary information source.	Student-centred instruction, with teachers as assistive guides and facilitators.
Resource Availability	Limited resources - primarily textbooks and physical materials.	Abundance of resources - digital e-textbooks, online materials, multimedia, OER and Open Access resources.
Technology Usage	Little to no technology in classrooms.	Integration of advanced technologies (laptops/tablets, phones, LMS systems, online libraries, digital whiteboards, multimedia, interactive technologies
Collaboration	Individual-focused tasks and desks, limited group work.	Emphasis on teamwork, collaborative projects, and online global classroom collaborations.
Student Engagement	Passive receipt of information, limited student engagement.	Active student engagement via interactive, participatory and personalised and data-informed learning technologies.
Access to Information	Limited access to information, confined to school hours and physical materials.	Anytime, anywhere, access to information, large bandwidth digital connectivity.
Skills Emphasis	Focus on basic literacy and numerical skills.	Emphasis on 21st-century digital and algorithmic literacy, creativity, critical thinking, problem-solving, communication, and collaboration.
Learning Pace	Uniform pace of instruction for all students.	Personalised learning pace, enabled by adaptive learning technologies.

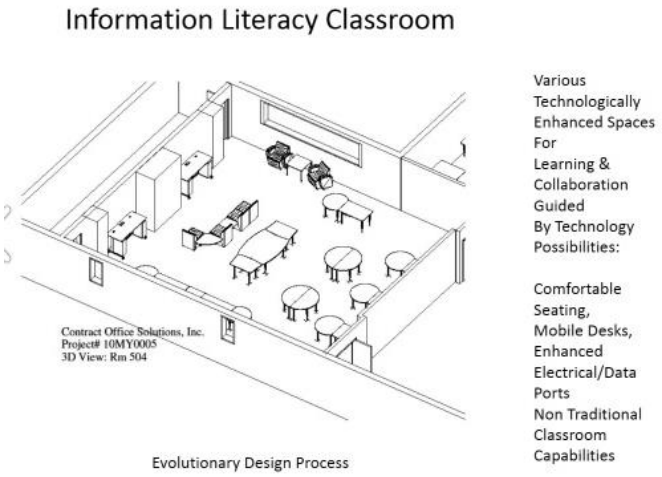
Table 1: Factor and Characteristics Comparison and Contrast of 19th and 21st Century Classroom and Academic Library Learning Spaces

Intersectional Spaces, Innovative Technology, Interdisciplinary Learning & Research



Rearticulating the 20th Century Cartesian Library Classroom Grid with Faculty and Student Interdisciplinarity and Enhanced Technological Intersections

The University of West Florida Skylab reimagined the 19th-century space of learning in terms of enhanced technology possibilities for the classroom. It also rearticulated the libraries as the 'third social space' in terms of digital literacy. This reclaims a Gutenberg-type role for the library and renaissance set of possibilities for digital literacy as the intersections of a broad cross-fertilisation of projects, people, tools and skillsets. This was also the first move towards 4th Industrial Revolution ideas. It reflected our new millennia era's rapid technological changes in societal patterns, social processes, and new possibilities for areas, ranging from interconnectivity and learning to technology, and putting forward the academic library in its best light. The Skylab included a multimedia studio, digital literacy classroom, media conversion centre, and associated services.



University of West Florida Skylab, Technology, New Services and Space

MEDIA CONVERSION CENTER
TWO TIERS OF SERVICES ENABLED

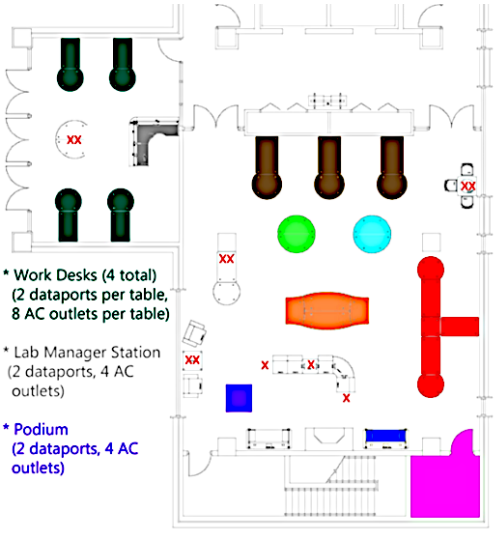
Format Conversion
Audio/Video Analog to Digital
Oral History Projects
Video History Projects
Public History
Special Collections Projects
Online Digital Archives

MEDIA CONVERSION CENTER

Hardware & Software Main Components

Cassette to MP3 Conversion Hardware
VHS to DVD Conversion Hardware
Multimedia port enhanced PC
TB Hard drives for Storage
Large Format (11x17) Scanner with Slide/Negative Capabilities
Headphones &
Audio Conversion Software (Audition)
Video Conversion/Editing Software (Vegas)

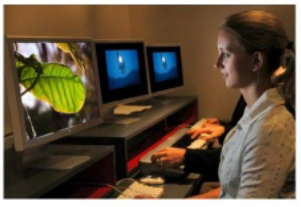
School of Athens, Raphael, Data and Renaissance Models of Interdisciplinary Learning



Skylab, Enhanced Classroom Electrical Needs.

MULTIMEDIA STUDIO SERVICES ENABLED

Image Editing
Scanning Assistance
CD/DVD Creation
Digital Audio/Video Capacity
Podcasting
Website Creation and Design
Multimedia Website
Specialized Student Digital Literacy Projects



Keyword for 21st Century Libraries: **Digital Literacy**

MULTIMEDIA STUDIO

Main Equipment Components (Hardware & Software)

2 Multimedia Macs with Dual Monitors
Digital Camcorders
Digital Cameras
Flatbed Slide Scanners
Adobe Creative Suite 5 (Suite of Software)
Apple Final Cut Pro (Digital Video)

Total $32,18.00

Texas State University Learning Commons and Alkek One (2014-2021)

Albert Alkek Library, Texas State University

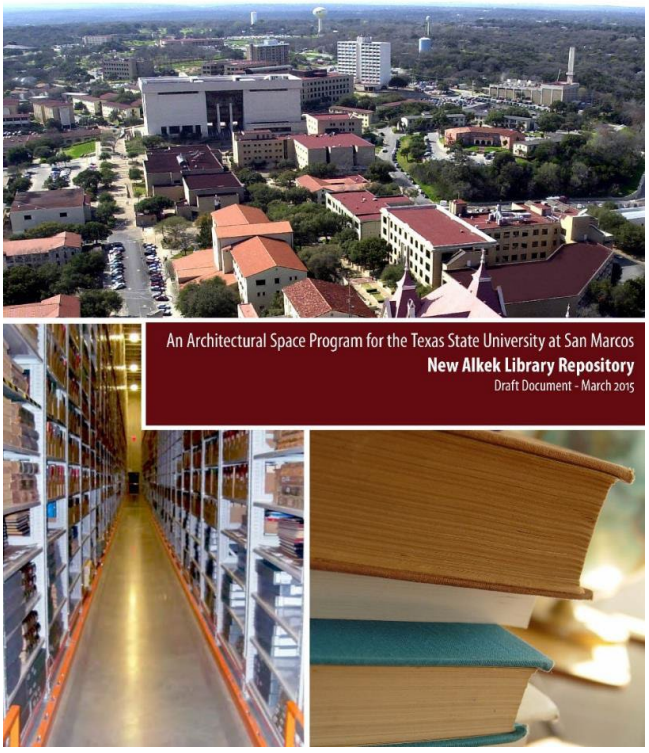
The Texas State University Learning Commons and Enhanced Technology Transformation expanded and continued these ideas. This very large project occurred over a seven-year period (2014-2021), transforming TXU's Alkek Library from a 20th-century hieroglyph (a vast book warehouse academic library model) to a 21st-century multi-tiered Learning Commons refocused on new millennia student success and new faculty research and teaching possibilities. Texas State University is a Carnegie Class R2 Doctoral University of approximately 40,000 students and faculty focused on higher research activity. This multi-year and multi-stakeholder project involved building on previous University of West Florida ideas. A decade later, with more mature technologies, there was wider acceptance of a broad spectrum of enhanced multimodal technologies with more possibilities for interdisciplinarity (Video Tour, 2020). The eventual 40M dollar USD project consisted of 3-5 multi-year planning and build phases. These involved architectural programming, design, technological implementation, and many voices. This project may be divided into three larger phases for brevity.

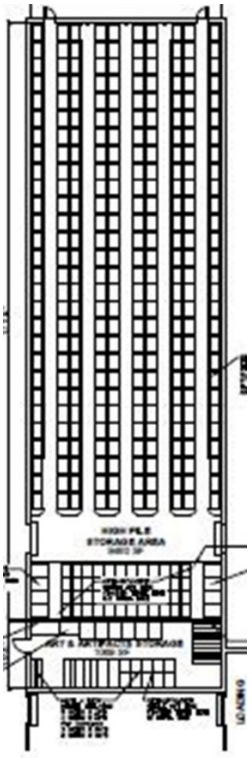
- **Phase I:** Infrastructure Upgrade: Electrical/Data, 2014-2017. 5M
- **Phase II:** Mid-Term Learning Commons, Library Transformation of Spaces/Floors: Furniture/Special Collections, Offsite-Repository (ARC)/1M Books Moved, 2016-2019. 10M
- **Phase III**: Alkek I, Future Learning Spaces/Themed Centers, 1st Floor Technology, Immersion Studio (VR), GIS Lab, Makerspace, Smart Classrooms/Digital Media Labs/Studios (2018-2020). 25M

A few caveats and generalisations are in order. These involve design parameters/constraints for this type of larger project. Before going into any project of this size, more significant project management facets should be closely examined. Primary considerations include budgetary allowances, university administrative directions, donor possibilities and human resource requirements. Staff, stakeholder/university interests, library and university work culture, social factors and current and future library needs should all be reflected upon more carefully. Planning principles regarding technology-enhanced learning spaces should be adhered to in larger aspects. In the author's 20-year experience, the most important is that '*technologies deployed in academic libraries in the 21st century will change over time*. *Planning should reflect this by allocating appropriate space without necessarily establishing a specific technology for each space'*. In this regard, it's wise to glance back retrospectively at conceptual changes for library learning spaces and technology in the past twenty-five years and new millennia, roughly 2000-2024 moving forward.

Library Commons General Developmental Periods	Historical Space/Technology Conceptual Changes in 21st Century Library Learning Commons
2000-2000, Early PC Phase Information Commons 	**Initial Information Commons Adoption Phase** • Libraries are still primarily viewed as physical repositories of books and materials (Book Warehouse Phase). • Initial integration of technology: PCs and online databases begin to complement and displace traditional print resources. • Onset of information commons, higher speed network throughput, Wi-Fi enabled spaces allow users to use their own devices. • Early adoption of online e-books and digital media database content occurs. • Innovative libraries start experimenting with makerspaces.
2010-2020, Digital and Cloud Integration Phase 	**Transition to Learning Commons, Digital Integration Phase, Ver 1.0** • Rapid proliferation of mobile technologies, increased demand for digital content, and Wi-Fi bandwidth continues to increase. • Libraries adopt more technology, self-service kiosks, digital repositories, and 3D printing labs. The library becomes the university's largest computing lab. • E-books, online journals, and digital databases become dominant. Books and bound journals begin to be moved out. • Libraries transform into collaborative student/faculty digitally-enabled learning spaces. Areas for group study, digital collaboration, research and learning. • Introduction of widespread digital and data literacy programs, data research repositories, technology training workshops, and micro-credentialing.
2019-2024+ 	**Digital Transformation Expansion Phase – Learning Spaces** • Mobile, digital, media and communications technologies have become ubiquitous reshaping libraries into multidimensional learning commons. • Complete acceptance of BYOD (Bring Your Own Device) culture. Libraries provide charging stations, digital resources, and robust Wi-Fi. • A complete shift is seen towards cloud-based resources and media for storage and access to cloud-based digital materials. • New integration with emerging technology begins: AI, AR/VR/XR labs, IoT, data research repositories and associated library 'help' services. • Libraries increasingly integrate makerspaces, digital media labs, data, digital and algorithmic literacy learning and innovation centres for faculty and students.

From Book Warehouse to Learning Commons



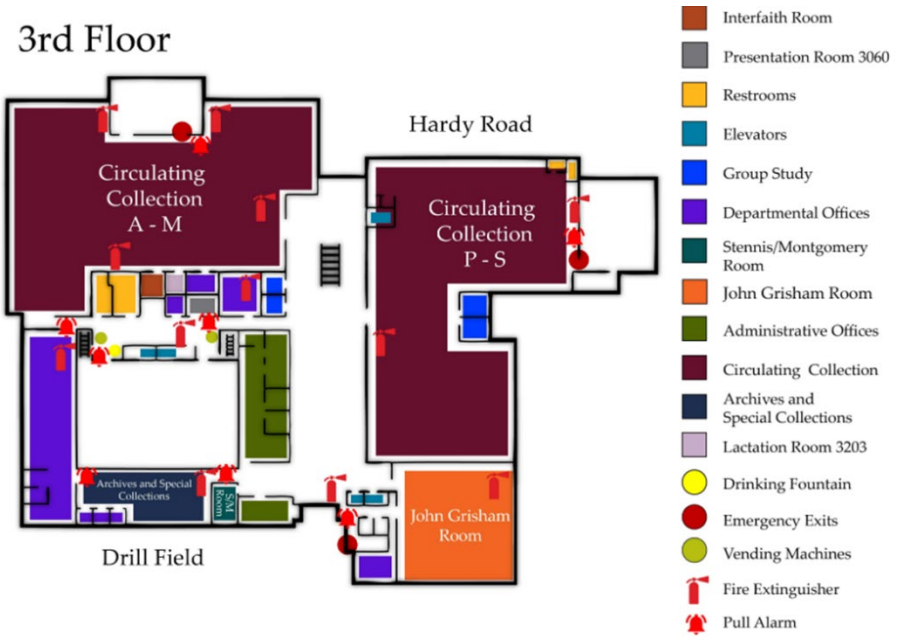


Texas State Offsite Repository Preliminary Planning Documents, 2015

Big questions arise in transforming any library book warehouse into a technologically enabled 21st-century learning commons. First among them is what is to be done with the books and material holdings (i.e., bound journals, media, special collections archives). How do we make the best room for new spaces needed for a technology and patron-centred learning commons? These more considerable challenges may be handled in many innovative ways. For Texas State University, in 2015, the solution was to build an offsite repository (10M dollar USD) or, as it was later named, the ARC (Archival Research Center). This involved moving approximately one million of the four million monographs and bound journal collections. Space will be needed for the makerspaces, digital studios, technology-enabled study spaces and digital literacy labs. This will also require moving previously filled library stacks and, simultaneously, installing efficient information control structures regarding offsite inventory for these operational workflows and patrons who need these materials.

Texas State Offsite Archival Research Center, 2017

Other Space Enabling Possibilities – Digital Resources and Backfiles



Third Floor, Mississippi State University Library, Circulating Collections, A-S

If building an offsite repository is not currently feasible in making room for new technologically enhanced spaces, other possibilities exist. Monographic collections may be moved to other areas of the library while simultaneously converting unused larger bound journal collections to digital media to reside in the cloud. In early learning commons planning at Mitchell Library Mississippi State University (Keith et al., 2023), digital backfiles were purchased from the large historical research backfiles such as those from the Institute of Electrical and Electronics Engineering (IEEE) and JSTOR. Other very large historical journal storage digital archives covering large swathes of leading academic journals from STEM disciplines to the social sciences and humanities are increasingly available. HathiTrust memberships may also be obtained for electronic borrowing as largely unused bound journal stacks are repurposed. Search preference modalities for academics working in the 21st century on article-based research weigh towards the database and instant search rather than muddling through stacks. These subscription cloud-based possibilities may also be combined with space planning to affect larger innovative possibility.

Mitchell Memorial Library, Five Floors, 70,000 sq. ft.

Final Notes: Funding, Donors, New Models and Vision

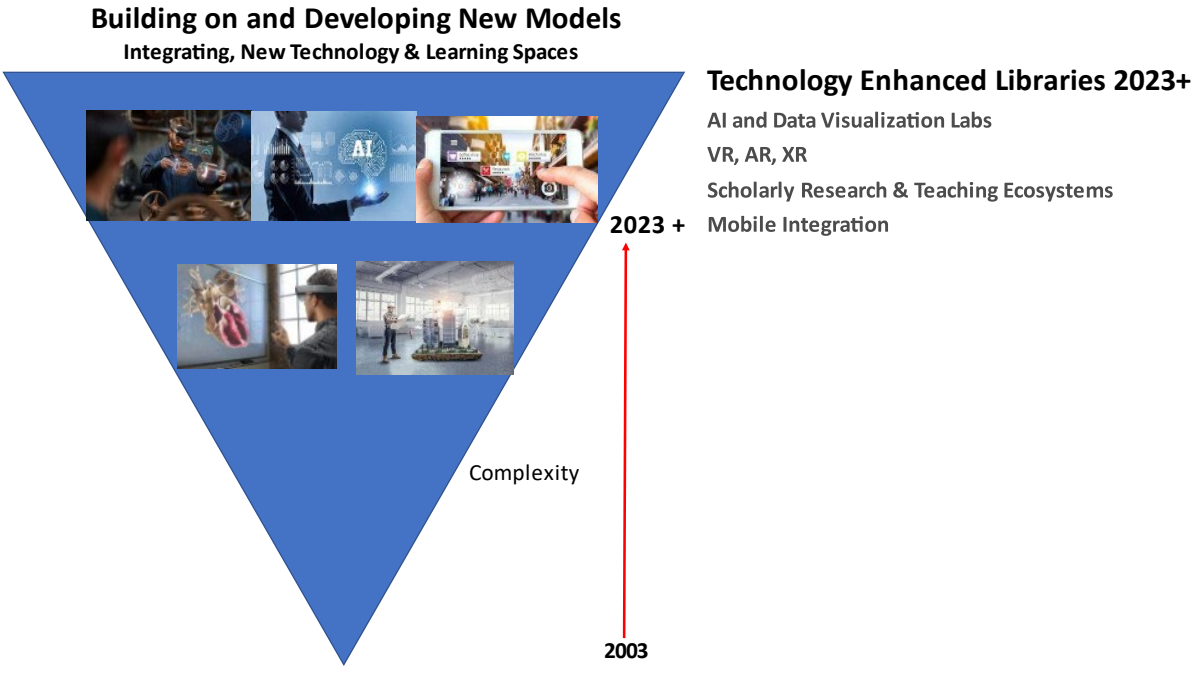
U Miami Commons 2003 Donor Architectural Renderings

Mississippi State University Donor Adobe Firefly 2023 Generative AI Photographic Digitization Lab Visualizations

Funding and donors will be needed to build any new technologically enhanced library space. Whether this comes from university, state, or national appropriations, or an interested donor or set of donors, a vision of the future and possibilities should be set. As much as possible, spaces should be more precisely described to gain funding. This new space planning begins with the ability to imagine, reimagine, and set a vision for these new spaces through images and text. These aspirational and inspirational plans are then circulated widely through documents to prospective funders and stakeholders. Twenty years ago, this was done with architectural renderings and documents. Today, we have various generative AI multimedia tools that can help us envision the future (See Reference List).

So, libraries can better first interest donors and then begin to partner with architects and engineers to reify projects and realise dreams.

In 2023, technology-enhanced academic libraries consist of new possibilities for scholarly research, teaching ecosystems, and mobile integration. We are building the future. We are also extending and integrating new technology and learning spaces with historical ideas of literacy. This now includes information, digital and algorithmic literacy. This core thematic literacy function has always been the library's unique role through many historical variations. The focus should continue to remain for learning, research, and the forward progress for knowledge in libraries.



Acknowledgements

Developing these types of technology-enhanced learning spaces is always a larger group effort, often occurring over many years. The author gratefully acknowledges the multitude of library, university staff, faculty architects, engineers, and university IT with whom he has worked with over the years on all these projects. This includes the various library faculties and professional staff at the University of Miami Libraries, Otto Richter Library, University of West Florida John C. Pace Library for the Skylab, Texas State University Libraries, and Mississippi State University Libraries.

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- Adobe Inc. Firefly (Photoshop). Generative AI for Creators.
- Dalle-3. Open AI
- Runway and Stability AI. Stable Diffusion: Text to Image AI Photorealistic Modelling Software
- Midjourney Inc. Midjourney: AI Images from Natural Language Processing

XR Cone: Turning Non-standard Collections into a Hall of Inspiration

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Figure 1: TU Delft Library book wall and main hall. Photo credit: Mecanoo.

Introduction

Libraries may be associated with their general and special collections but are increasingly becoming acknowledged for their role in cultural programming and content production. This leads to a situation where there are non-standard collections beyond mainstay collections. As these projects and initiatives arise, especially in a booming digital landscape, this creates a situation where websites full of content exist untethered to online public access catalogues. These collections-affiliated sites may be neglected or actively updated with fresh, regular content, but they usually lack audiences and reach beyond, and even within, their communities. Library visitors and traffic are an obvious audience to target in the physical space of the library, where online collections often have little presence.

At the TU Delft Library, we are embarking on an ambitious project, turning our four-story suspended book wall (Figure 1) into a collections wall to visualise and activate collections and address some of the issues raised. This short article details the second of a series of prototypes in the collection wall project, XR Cone (Figures 2-3), which is a proof-of-concept station that enables the visualisation and interactive browse of our non-standard format collections (e.g., videos, maps, 3D assets, and more) in extended reality (XR). Like other XR projects in education, XR Cone "does not aim to provide significant knowledge transfer, but instead to create an association between education content and enjoyable experiences, utilising a new medium" (Boletsis, 2013). XR Cone also accounted for "private (alone or two)...interactions…design[ed] for quiet reflection] that can enhance learning"(Raybourn et al., 2019).

One of the main experience goals of our prototypes, especially XR Cone, is to offer something attractive in the physical space for patrons that could not be replicated online. Extended or augmented reality is especially promising in this regard. XR and augmented reality incorporate virtual elements in combination with the physical location. Our Library's iconic architecture—designed by Mecanoo, the first of many library projects led by Francine M.J. Houben—suggested an ideal site for an XR intervention: underneath the central cone, looking up into the four floors above (Figures 2-6). This is a space that many visitors come to admire for its own sake. We wanted to see how extended reality could heighten the experience by turning the cone floor into a hall of inspiration for collections content and architecture.

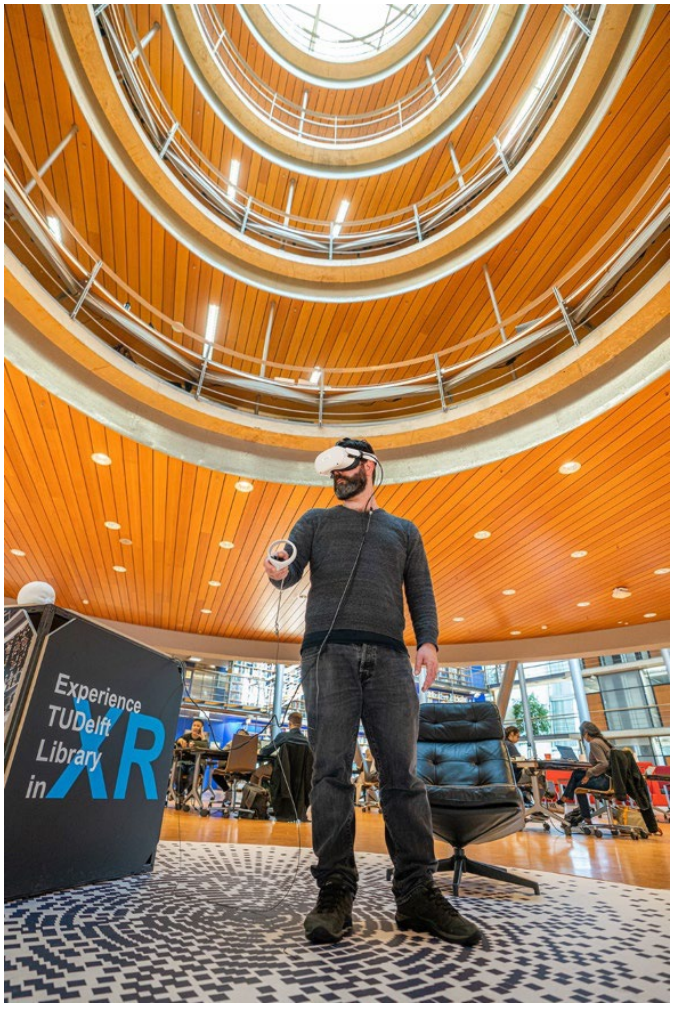


Figure 2: XR Cone physical setup with HMD tracking rug (standing). Photo credit: Mischa Mannot.

Figure 3: XR Cone physical setup with HMD tracking rug (sitting). Photo credit: Mischa Mannot.

Figure 4: XR Cone data visualisation concept sketch. Credit: Alice Bodanzky.

Figure 5: User experience video of an early version of XR Cone (https://www.youtube.com/watch?v=j-GwQmMN66Q). Credit: Jeroen Boots.

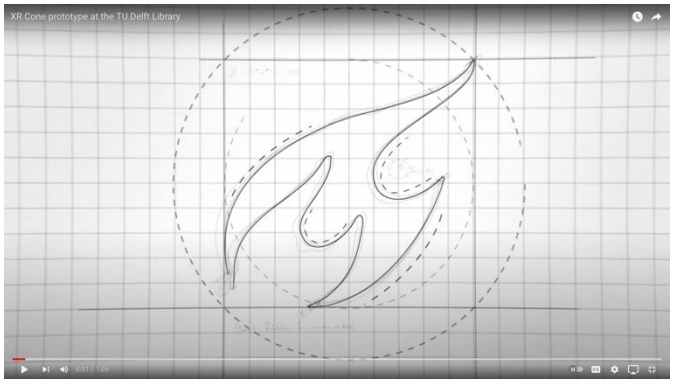


Figure 6: Documentation trailer of XR Cone (https://www.youtube.com/watch?v=uHd3jb_pn3k). Credit: TU Delft NewMedia Centre.

XR Cone Prototype Development and Documentation

The objective for XR Cone was simple: an interactive browsing experience, proof-of-concept, which enabled us to work in as many non-standard format collections as possible. Library staff co-designed the concept, which essentially turns the floors of the cone into shelves for collection items, which would be presented as a vast data visualisation above (Figure 4). This data could be collected, curated, and animated to be more visually appealing and dynamic for modern audiences. Two pop cultural influences for the concept consisted of Ariel's secret grotto from Disney's *The Little Mermaid* (1989) and the Hall of Faces scene from the fifth season of HBO's *Game of Thrones* (2015). Both memorable scenes present a hall of potential knowledge to inquisitive minds yearning for exploration beyond their experience.

While conducting the concept and technical meetings with our developer to conceive what was feasible for a prototype, we discussed the desired file types and contextual information we wished to incorporate. We agreed to use a selection of 1) historical maps, 2) lecture videos from classes and cultural programming, 3) artefacts from recent exhibitions, 4) images, and 5) 3D scans.

Because reading even small amounts of text in pixel-noticeable XR is undesirable, we limited context to providing a title and one-sentence accompanying text (and if the process allowed, we wanted to explore adding audio to the context information in an update). These were achievable from our developer's perspective, so the next step was streamlining. All information was compiled using a simple collaborative spreadsheet where we specified the name, sublocation, file type, and description for each file. For videos, we added the year and speaker name. We had a team of three people, including the developer, to collect, curate, and edit the data that would be housed in this application. For aesthetics, we tried to be minimal and conform to the university's house styles for communications, instead focusing on functionality and trying to get the data populating and animated on the shelves. Regarding interactivity, we hoped to have the data selectable and 3D assets scalable and movable around the virtual space.

XR Cone was developed using the Unity game engine for the Meta Quest 2 headset. This offered the best extended reality potential for the price point and the ability to use the headset without cables. A notable feature of the Meta Quest 2 is the passthrough capability. At the start of the project, the Quest headset was one of the few head-mounted displays (HMDs) that allowed the developer to use the cameras on the Quest and show a video feed. Now, other HMDs allow this.

Initially, the idea was to use the passthrough feed for object tracking or QR code-based tracking, but the feed proved inaccessible to the developer. It can only be used as a window into the environment, not modified or used by the developer for image processing. This limitation is done for privacy reasons, as this is a consumer-grade headset, but unfortunately, this made some of our ideas impossible and others difficult.

We also originally intended to use hand tracking as this sounded like the viable choice for a standalone headset without someone helping every user. Using hands as input with gestures would mean no controller (which eliminates problems with power and teaching controls/buttons). However, during testing, we found out that not everyone is as comfortable with hand tracking yet. Plus, sometimes, the hands would not be tracked at all. These reasons made us opt for controller-based input for the prototype.

This prototype was made as modular and extendable as possible within the time. The collection was divided into themes that give user guidance and allow the developer to add in a combined effort. Further, our collection spreadsheet could be imported as a .csv. This allowed us to achieve a prototype that could be adapted to new needs and ideas. The spreadsheet could then be loaded into the headset and update the titles, summaries, video locations, etc. This method allowed for faster development time and made it easier to update with more themes (and collections items). The videos were added to the headset into their respective folders corresponding to the location of the .csv. The application then loaded them locally. This allowed us to upload a large amount of content into the app, circumventing the restrictions on Android app sizes.

Later in development, we made further determinations to prioritise functionality and variety of data in the prototype over some of our initial intents. The causes were technical challenges that were unrealistic to solve with a single developer. We employed a menu structure for navigation. While not ideal in XR, this proved to be a much more efficient way for us to develop this proof of concept. One of the difficult features was aligning the menu to the physical floor. Ultimately, we solved the alignment by using a setup process every time the headset was on. This process aligns the virtual world with the actual world, but it also creates an additional threshold for users not experienced with XR. Some of the interactivity with the 3D models was dropped as well. For example, scaling and placing the 3D model in space was not an important enough factor of the experience goals to justify the development time needed. Related to this, limitations on the Meta Quest 2's boundary and location tracking methods prevented as much free range as we imagined.

We had other unexpected problems in the physical space. The Meta Quest 2 headset uses infrared cameras as its eyes to see where it is in physical space—tracking elements to see where it is relative to that object as you move. In our case, the experience was placed right underneath a window and on a highly reflective floor with little to no distinguishing features. The windows let in an abundance of light (also infrared) in such a way that tracking becomes difficult as cameras cannot see enough contrast in the environment. To solve this problem, we designed a "rug" with a distinguishable pattern (Figures 2 & 3) made from a non-reflective material.

We incorporated initial user testing during development, which revealed opportunities to improve how selected items were spawned and delivered (e.g., location and speed), maximising and minimising windows and their locations (to prevent overlapping) and limiting it to a one-button, one-controller experience. We discovered an apparent oversight: that there needed to be a "clear" button to remove all the explored content from a user's field of view. Testing also revealed that it was not feasible to show more than one 3D asset in the space at a time. Even optimised assets as small as 2MB were too heavy to show two at a time.

One fundamental question was whether this was a sitting or standing experience. The variety of media was the root cause of this ambivalence. We knew no one was going to watch hour-long videos on our prototype, but we also knew people might be more inclined to check out videos longer if they were comfortable. At the same time, the 3D assets promised a fuller experience standing as one could walk around them. The physical site and concept requiring users to look up also seemed to favour seating. Eventually, we decided to provide for both experience options. We also focused a question on our feedback survey to further inform this decision for a future iteration. We then integrated a 360-rotation player on the 3D assets to ensure seated users will have a 3D experience with the assets without having to stand.

In new media projects and prototypes, deadlines offer us a crucial moment to stop endless development and focus on presentation, use, documentation, and feedback. The authors are grateful to IFLA for providing a venue in which we can document our prototype. So, here is what we managed to execute in this XR Cone prototype:

1. **Accumulate all intended varieties of data** (e.g., images, text, video, 3D scans/models) **into a single physical location, presenting a digital container for interactive browsing.** Having one location, front and the centre of the library, that effectively highlights collections content currently distributed over no less than four websites cannot be underestimated from a patron point of view. We think a similar application would be valuable for other libraries dealing with the realities of diffused and informal non-standard format collections, especially because of the possibility of incorporating standard collection items.

2. **Use extended reality to successfully map our libraries data in the physical environment.**

Relying on XR technologies, the library can present interactive multimedia while keeping the space visually "quiet" for studying. While reducing the replication potential (certainly a tradeoff to be aware of), being site-specific makes the application more meaningful and inspiring for users because it reinterprets the quotidian, living up to the name of the technology by extending our lived reality of the place. Current technology met our expectations in this aspect, and we were delighted with the results.

3. **Provide aesthetic animations and the feeling of vast amounts of data (**Figure 5-6). Using the digital language of RGB colour for rectilinear, spine-like data visualisation forms and integrating it with library collections data provided a visually pleasing experience. To make the shelf space even more visually interesting with a limited prototype dataset, we duplicated the data to fill the shelves more and innovated a "wink" animation that consisted of images getting larger and smaller, almost disappearing as they moved. This addition helps maintain interest for longer. Items drop down from the centre of the cone above and beam out of the portal area at the top of the cone. This speed took adjustments. We did decide to put a brief, timed message triggered after clicking the menu bar to "look up" to help orient users, as it takes a few seconds for items to arrive and be displayed in the eye-level panorama, where content items rotate around to fill the space. Lastly, fitting maximised items to take up the scale of a whole floor at eye level allowed a much closer examination of maps and a cinema-like experience for video.

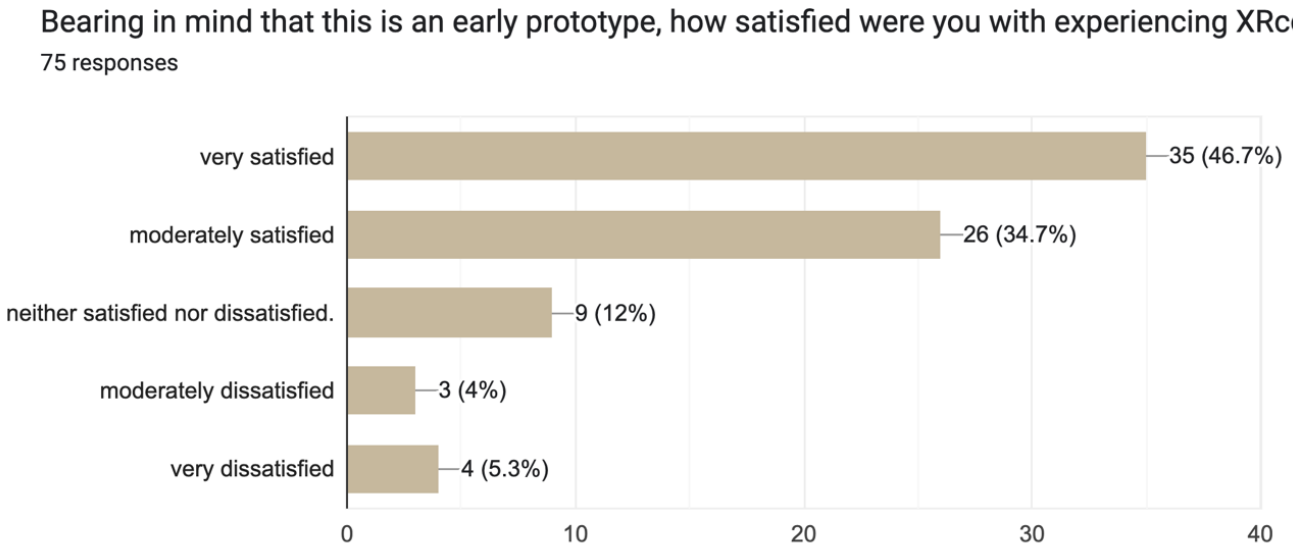
4. **Hone down the primary interaction to interactive browsing.** It is natural to want to have new media as interactive as possible. However, after being critical of the meaningfulness of these interactions, we realised the inspiring part of the experience was navigating the information, not rescaling 3D items. In the future perhaps applications can be developed that allow patrons to curate, save, and share their own XR exhibitions using library collections items.

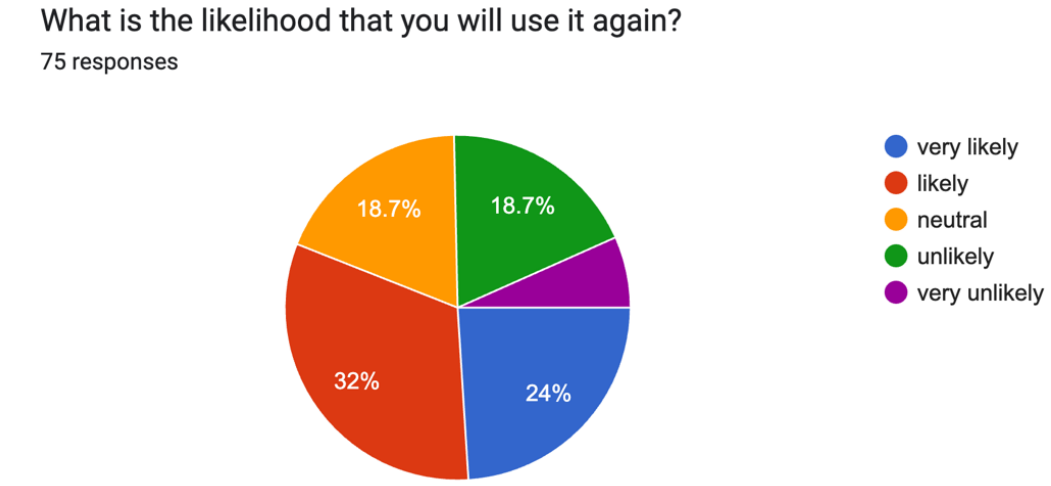
5. **Explore alternative technology and format for curation of content.** XR Cone curates lectures organised by each of the eight university faculties (e.g., Aerospace Engineering, Architecture, etc.) and houses artefacts from past and current exhibitions [e.g., a curated sample of chairs that related to the *Redesign Rietveld* exhibition the library presented at the same time https://www.tudelft.nl/en/events/2023/library/redesign-rietveld-exhibition). We 3D scanned original Rietveld chairs from our Academic Heritage collection (https://collecties.bk.tudelft.nl/chairs) and included them as 3D assets in XR Cone. Content-wise, the 3D scans and models make the most of XR. The TUD New Media Center was also keen on how to repackaged videos from its classroom lecture capture service (https://collegeramavideoportal.tudelft.nl/catalogue). Video content from cultural programming was also repackaged and repurposed for library visitors to discover. Lastly, to include more contemporary 3D assets in addition to historical collections, we ran a student design competition for students to create virtual model homages to Rietveld's designs, and we presented the winners in the XR Cone application (https://newmediacentre.tudelft.nl/rietveld/).

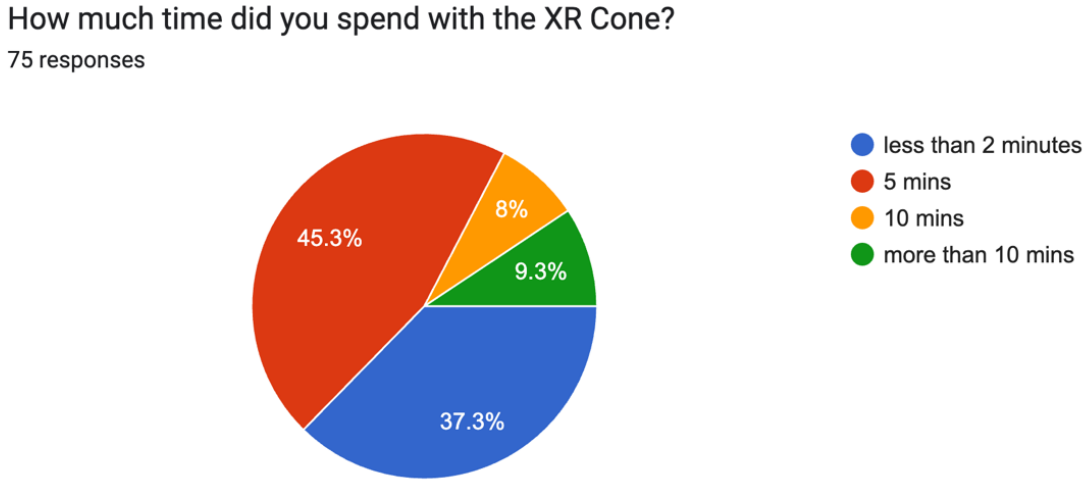
Assessment and Reflection

Given the ongoing nature of this work, we would like to offer some preliminary assessment and reflections instead of "conclusions."

The XR Cone prototype was installed for user testing for six months, which extended over the summer break into the start of the new academic year (February 23 – September 11, 2022). For feedback, we created a short online survey form consisting of eight content-related questions and three user demographic questions. We relied heavily on connections with education and held structured user testing sessions with related courses and student groups. Formal learnings, insights, and new ideas from these sessions are still being tabulated for the context of the collection wall project. We also ran coffee voucher giveaways to encourage more of the library's general student population to respond to the survey; participation was not a problem as the XR Cone was quite popular. We also incorporated XR Cone into an XR festival the library co-facilitates, thereby extending our connection and reach to the greater XR community.







Figures 7-9: Survey results.

The survey results were encouraging. Reponses overwhelmingly indicated that people saw XR Cone as an essential means to browse extensive overviews of data, watch videos of lectures/programming, and for thematic storytelling. Out of approximately 75 responses, 80% were students under 30, with over 80% of users being very or moderately satisfied and 60% saying they were likely or very likely to return to using XR Cone again. 63% preferred seated. Over 50% of users were attracted to it to relax during their study break; 32% visited the library for the first time; and almost 15% were guided by staff, which reveals that extended reality may need some human encouragement and support. However, ultimately, it provides another avenue for interaction between library staff and library patrons. Another statistic worth reporting is that 83% of people using the prototype interacted with it for less than 5 minutes. This could be due to the limited dataset, but we feel this number reflects the current attention span people are willing to offer for these types of experiences, which is a highly relevant consideration for designers and developers to bear in mind. The most recurring theme in the suggestions for improvement was making XR Cone a more social experience, using multiple headsets and allowing a virtual interaction with other viewers.

Data preparation and the development workflow for XR Cone were a bit underestimated by the team. This is an important factor for those interested in custom developing XR applications. One leading developer worked on the project for 130 hours, and the demands for edits, updates, and maintenance (especially considering the student design contest addition) have continued past the allocated time. We expect the effort commitment for a full-scale project more towards a product than a quick prototype to multiply. Bringing in outside developers would again multiply the budget, translating into an exponential increase in overall effort and expense for such a project and keeping it updated.

There were multiple other suggestions and improvements we consider worthy of exploration. One fun idea would be to orient maps on the ground floor, so that users could walk around the territory. However, the most fundamental improvement known to the developers would be to allow users the ability to select items from animated shelves instead of solely relying on the menu navigation.

Another implementation we think would improve the user experience would be incorporating audio instead of text descriptions. Audio was planned for a second stage intervention to amplify data curation and context without relying on text. The reason for this postponement was that audio entails an additional production process, writing, recording, and editing new files. We believe this is easily achievable, technically, although it would be nice to test the user experience of supplemental audio within this application as there may be surprises lurking there (like with multiple renderings of 3D assets). We also envisioned this container as a gateway to other XR apps created by the XR Zone. Such an addition would further utilise the hardware format and broaden interactive browsing to a curated range of interactive experiences or training more reflective of the "3D/VR[/XR] research ecosystem that supports the full research lifecycle of 3D creation, analysis, publication, and curation" (Lischer-Katz, 2022), which is particularly relevant given the educational context of university labs in STEM disciplines.

In terms of the presentation of XR Cone, a few things could be improved. Relying on security and power cables was regrettable for the experience. If the situation and budget allow, it would be preferable to have a monitored station or checkout system that would enable a completely cordless experience. XR is far from accessible, especially for the seeing-impaired, to the point of excluding some users with eyeglasses, reminding us of the importance of our colleagues' charge for "librarians...to take an active role in ensuring that VR[/XR] can fully support users with different abilities" (Lischer-Katz & Cook, 2022).

That said, we still hope to see XR technology grow the extension of reality to larger spaces, offering more extensive boundary conditions and the processing power to view many 3D assets simultaneously. Our XR Cone was a "simple" prototype to test a promising concept and associated technology for application to a more prominent location. This paper shares development decisions and some of the preliminary ideas for improvement when facing the many challenges of 3D/VR that "can only be solved through a systematic and concerted effort across multiple stakeholder groups and existing subfields of preservation research and practice" (Lischer-Katz et al., 2018). May it help colleagues interested in pursuing XR "digital interventions...to transform, improve, correct, enliven; … emerging from a deep engagement with the collections and their history" in site-specific interventions in the ever-expanding program of the buildings we refer to as libraries (Geismar, 2018).

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2023 IFLA South Africa AI Symposium Review

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Introduction

The International Federation of Library Associations (IFLA), in collaboration with the North-West University (NWU) library and information service, hosted the 3rd IFLA Symposium on Artificial Intelligence (AI) in libraries on 5 – 7 September in Potchefstroom, South Africa. Together with the IFLA regional office for Africa and the South Africa National Convention Bureau (SANCB), the NWU library and information service organised and hosted a symposium that brought together specialists from the information science industry in South Africa to discuss current developments for adopting AI in all types of libraries.

IFLA regards the influence of AI on libraries across the different world regions to (a) help improve access to information, (b) help create greater language and cultural diversity, (c) preserve indigenous knowledge, (d) enhance community engagement and outreach, (e) enable better data analysis to respond to community needs, and (f) better collaborate and share knowledge. To accomplish these objectives, the IFLA community will have to rely on all three models of AI, namely symbolic AI (e.g., linked data applications based on knowledge representation), connectionist AI (i.e., machine learning applications built on statistical probabilistic analysis), and generative AI (i.e., large language models' applications based on word prediction algorithms).

A core theme that arose during the symposium was the potential of generative AI (GenAI) to enhance existing library services, especially given the launch of the ChatGPT GenAI service in late 2023 and the impact it has had on all industries worldwide. There is often a sense that *ChatGPT has become AI*, something that is a misinterpretation because AI isn't just about GenAI but spans multiple domains and is specifically about moving work into machines. Another trend from the symposium is how South African academic institutions are rolling out AI-enhanced services within the bedrock of existing Digital Transformation (Dx) strategies.

Digital Transformation (Dx) Strategies and The Pace of Change

As more and more South African Higher Education Institutions (HEIs) are getting to grips with the growing impact of AI on their business model and pedagogy, they are implementing Dx strategies to align their systems and processes with the demands of the Fourth Industrial Revolution (4IR). To assist in identifying new areas of AI application, NWU has developed a matrix which is divided across Administration and support, Teaching, Learning, Research, and the institutional Business Model. From this matrix, they can identify whether a particular area can be optimised, automated, or transformed by AI. In turn, as a strategic partner and key enabler of digital transformation, the NWU institutional IT Department stated that they use AI-enabled virtual assistants to provide automated 24/7 client support at a reduced headcount. They also use GenAI as part of coding practice to accelerate systems delivery, implement LowCode / NoCode technologies to empower users and reduce the load on IT resources. They have also adopted Zero Trust architecture with

GenAI to improve threat detection and implement AI for IT Operations (AI Ops) to monitor system operations.

Common Assumptions and Trends
Common faulty assumptions raised by other institutions about Dx in HE can be grouped as:

1. **Pace**: believing that everyone else is ahead of you.

2. **Change**: believing that as brick-and-mortar institutions, digitisation only marginally affects HE institutions.

3. **Technology as a priority**: believing that the institutional IT department is primarily responsible for affecting Dx at HE institutions.

4. **Competencies**: believing that there is an insurmountable gap between digitally competent students and inexperienced lecturers.

5. **Finance**: believing that the cost of digitisation consistently exceeds institutional budgets.

Heeding these faulty assumptions is an important precursor for adopting AI technologies at HE institutions since such faulty assumptions can easily be amplified within the ever-changing domain of AI. In turn, identifying a relevant AI project can be done based on identifying initiatives that can (a) decrease operational costs, (b) lower risk exposure, and (c) improve customer experience. Across industries, the experts tend to advocate firstly improving the customer experience, although this should not necessarily be the first and foremost choice.

A common trend from most papers covering Dx, strategy, and creating frameworks for implementing AI, is that behind every AI strategy, there must also be a data strategy. AI is data driven. Whereas symbolic AI relies on encoding semantics into structured data, both connectionist AI and GenAI depend on mostly unstructured data that should be trusted. It is not subject to copyright restrictions, is not biased, and adheres to POPIA (or GDPR) guidelines, to mention only a few considerations. These considerations should be outlined in a data strategy to create awareness of restrictions in using data for AI applications – i.e., the practice of so-called "responsible AI".

Use Cases of AI in HE Libraries
Most use cases of AI in libraries discussed developing an automated chatbot and leveraging existing GenAI applications.

AI in software vendor applications
From a systems perspective, Clarivate, a symposium sponsor, indicated that they are upgrading the DARA bot in Alma from a rules-based (symbolic AI) to a machine-learning bot (connectionist AI). This would imply that they have collected sufficient data through their Alma cloud service to do probabilistic statistical analysis to generate recommendations and no longer have to knowledge engineer the bot as one would do with an expert system. Clarivate is also working on a new discovery system experience that will be based on GenAI and has developed GenAI capabilities to generate metadata in MARC format for backwards compatibility where systems are not yet "linked data" compatible.

AI for literature review and scientific writing
Several presentations described the advantages and pitfalls of using GenAI in the literature search process as well as the different stages of scientific writing. A few of the most common AI applications mentioned are summarised below, and they underscore the importance of remaining up-to-date with the latest AI tools for contemporary digital literacy skills.

AI for Literature Search and Systematic Review	AI for Writing and Editing	AI for References and Citations	AI for Review Workflows	AI for Plagiarism Verification
• Scite • Semantic Scholar • Yewno • Scholarcy	• Grammarly • SciNote • AI Writer • Trinka	• scite.ai	• AuthorONE • ScholarONE • Pentelope.ai • UNSILO (Evaluate, Classify, Recommend)	• iThenticate • Copyleaks • Grammarly • Plagiarized.ai

From the papers presented, utilising AI tools during the four stages of writing can be summarised as follows:

1. **Generative writing:** The informal writing and brainstorming stage in which writers write for themselves as a form of thinking and in many different forms to generate ideas deductively. GenAI needs more applications at this stage.

2. **Drafting:** The stage in which the writer starts constructing a conversation and argument. GenAI has no application in this writing stage because it needs the ability to theorise.

3. **Editing:** The stage in which the writer does the editing and focuses on presentation, such as having concern for spelling, grammar, vocabulary, and layout. GenAI can assist in conforming to these editing expectations of the genre or community the writer is writing for. During this stage, the writer also ensures alignment with other aspects of the research and revisits the generative writing stage, for which GenAI is of no use.

4. **Scientific peer-review:** In this stage, engagement with and validation by the scientific community in the form of reviewers, examiners, and editors is done. GenAI is of no use when doing this.

Overall Conclusions

Overall, GenAI is viewed as helpful with author-driven writing – which leans on an existing corpus of codified knowledge using word prediction algorithms – as opposed to claims-driven writing, which is dependent on conjectural theorising (in the literature referred to as "inference to the better explanation"). GenAI cannot assist when moving from the known to the unknown while making an argument (i.e., particularising). However, summarising and making conclusions to an argument already made is an aspect of scientific writing GenAI can be helpful with.

Another limitation of GenAI in scientific writing is its inability to apply proper hedging techniques to limit a writer's commitment to a claim. Hedging acknowledges a gap in a writer's claim, and because GenAI has no sense or understanding of what it is generating through a process of mere word prediction, it cannot apply conceptual blending to the writing technique. If it were relied on to do this, it would be prone to producing plausible untruths or, as they are often known, hallucinations.

Generally, GenAI was viewed as good at generating broad ideas, writing introductions and summaries, and proofreading – keeping in mind that summaries are not original contributions. Conversely, GenAI fails at contextualising, generating new arguments, particularising, and referencing.

GenAI was also viewed as very close to plagiarism. A related problem area that was highlighted was that there are now more people developing AI programs than developing anti-plagiarism programs. This can mean that false positives in plagiarism detection can occur for honest students. Even a false positive return rate of 1% on all anti-plagiarism submissions is considered too high.

Summary

The symposium was a mix of theory and use cases mainly underpinned by GenAI methods. Overall, it did drive home the point that we should be careful not to become victims of the overwhelming amount of AI tools, especially because AI is constantly a moving target. We should use and experiment with tools to determine hands-on their strengths and weaknesses; otherwise, we risk falling behind entirely.

Similarly, libraries should continue their symbolic AI work through knowledge representation projects and proactively and decisively work on upskilling their competencies to tackle connectionist AI projects. The information science industry should be careful in jumping from strategy to generative AI applications and straight across applications of symbolic and connectionist AI due to the complexities in dealing with them. The challenge as we advance is to identify the relevant use cases and effecting skills building to leverage all AI models appropriately.

We look forward to the 4th IFLA Symposium on Artificial Intelligence (AI) in libraries that will be hosted by the University of Chile and the Library of the National Congress of Chile in conjunction with the 10th Congress of University and Specialized Libraries in April 2024.

IFLA IT Section

The Information Technology (IT) Section promotes and advances the application of information and computing technologies to library and information services in all societies, through activities related to best practices and standards, education and training, research, and the marketplace. The scope covers IT for creation, organization, storage, maintenance, access, retrieval, and transfer of information and documents for all types of libraries and information centers; IT for the operation of libraries and information centers; and related management and policy issues. Of primary importance are applications of IT for supporting access to and delivery of information. In recent years, the uses of use of technology in libraries have expanded to cover improved machine learning and AI techniques, digital humanities, and data analytics.

The section meets annually at the IFLA Congress; in between congresses, members collaborate with other Sections on programs and workshops. There are election ballots every two years as members complete their 4-year term. The IT Section is one of the largest in IFLA with over 300 members from nearly 80 countries, all types of libraries, and a range of disciplines. We welcome all members (http://www.ifla.org/membership).

The IT Section's website at http://www.ifla.org/it has news and resources regarding activities of the Section, session minutes, publications, and membership details.

The IFLA-IT email list provides a forum for members to exchange ideas and experience in the use of information and communication technologies in libraries. The list address is ifla-it@iflalists.org, and subscription is at https://mail.iflalists.org/wws/info/ifla-it.

The Trends & Issues in Library Technology (TILT) newsletter is published twice a year in June/July and January.

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