# Future of Libraries

ARUP

This report is a product of collaboration between Arup Foresight, Research and Innovation, and library expert and enthusiasts across the globe. We would like to thank all authors and experts for their contributions and dedication.

Foresight, Research and Innovation is Arup's internal think-tank and consultancy which focuses on the future of the built environment and society at large. We help organisations understand trends, explore new ideas, and radically rethink the future of their businesses. We developed the concept of 'foresight by design', which uses innovative design tools and techniques in order to bring new ideas to life, and to engage all stakeholders in meaningful conversations about change.

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"Without libraries what have we? We have no past and no future."

— Ray Bradbury

Photo: Dokk1 library, Aarhus, Denmark.

Foreword

Mahadev Raman
Director of the Arup
University

Many people see libraries as an endangered species, threatened by technological change, cultural shifts and – perhaps most critically – funding cuts. Yet if we evolve our understanding of what libraries are and what they can be, their value as strategic city assets will be fully recognised and their future more assured.

This timely report looks at the techniques and trends that are helping libraries to become active players in their communities, taking advantage of investment in city resilience and citizen wellbeing. It examines the relationship that libraries have with their urban context, successfully articulating that their impact extends far beyond their walls – both socially and economically.

It explores the idea that, as the original example of the sharing economy, libraries can support access to shared knowledge and services, and work to promote shared understanding. It makes the case for libraries as a place for people to learn, whatever their stage of life, a function that will become a vital component of our changing economies.

The recommendations found in this report are ideas that Arup itself is putting into practice, recognising their benefits to our own long-term prosperity. The renovation of the Arup Library in Sydney – part of our experiment there with workplace design – recently won the Special Libraries category at the inaugural ALIA Australian Library Design Awards.

Future of Libraries benefits greatly from the significant input of a number of independent experts, colleagues and library enthusiasts from across the globe. I'm grateful for their time and their insight. To me, this ability to assemble and draw on an extended, global network of peers is one of Arup's key strengths. One that benefits our clients, the company as a whole and our wider audiences.

While we mustn't be complacent about the threats to local libraries and the services they provide, I hope this report can help re-frame our thinking about their essential future role in our neighbourhoods and cities.

Left: 'Dipòsit de les Aigües' Library, Barcelona. The renovation project by architects Clotet and Paricio creates diverse reading areas and social spaces in a historical vaulted building by using prefabricated elements designed for disassembly.

Executive summary

Libraries are evolving to meet the changing needs of the cities they serve, in terms of the social infrastructure they provide and the services they offer. The increasing movement of people into urban areas has resulted in governments investing more resources in the construction of resilient cities. In this context, the role of libraries in helping to catalyse community cohesion and wellbeing is more vital than ever. Libraries are evolving into hubs for education, health, entertainment and work. They are becoming strategic city assets, designed to stimulate cultural exchange and economic prosperity, as well as nurture new community foundations and connections. The key function of libraries, to support lifetime learning and build stronger communities, aligns closely with Arup's own drive to deliver a social purpose in its building, planning and consulting work.

The findings contained in this report are the result of a global engagement with a network of experts and enthusiasts in the field, including library operators, policy makers, urban designers, planners, architects and members of NGOs involved in funding libraries. Insights were gathered through a series of workshops held in London, Milan, Melbourne, Sydney, Brisbane, Hong Kong, Singapore, New York and San Francisco.

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1 **Libraries are key assets for social resilience and economic prosperity**

Rapid population growth will strengthen the influence of libraries as key economic, social and cultural hubs. Library services can trigger positive change in underprivileged contexts and help stimulate the wider local economy.

2 **New labour markets drive interest in lifelong learning**

A future characterised by an extended working life and more fluid labour markets will transform libraries into places of lifelong learning and entrepreneurship.

3 **A new approach to curation and re-intermediation of information**

Technological advances in information management will put pressure on libraries to innovate their infrastructure and update operational skills, resulting in a new balance between digital tools, human assistance and social space.

4 **Libraries are powerful activators of public realm**

Walkable and green environments improve social interaction; designs that respond to the local history and context boost inclusivity; multi-use activities and services place libraries at the centre of economic and cultural life.

5 **Library buildings should embrace diversity and flexibility**

Offering activities tailored to various patron groups will require adaptable interior fittings to reconfigure spaces; automation and data gathered through sensors can facilitate asset optimisation and the sustainable use of resources.

6 **Services are most effective when designed through participation**

Libraries will rely increasingly on the active participation of communities to deliver relevant and economically-viable services; librarians will become facilitators, able to support, engage and guide bottom-up initiatives.

Photo: Cambridge Public Library, Massachusetts, USA.

The role of libraries in changing urban landscapes

## Activators for social resilience and economic prosperity

The global population has experienced unprecedented growth over the past century, reaching 7.3 billion in 2015.[1] By 2050, that number is predicted to expand to an unprecedented 9.7 billion people, 66% of whom will be living in urban areas, attracted by the promise of better education, jobs and healthcare.[2] This will strengthen the influence of these economic, social and cultural hubs. Today, more than 80% of global GDP is already produced in cities.[3] In the words of renowned architect Richard Rogers: "Cities are first and foremost the meeting of people – for friends and strangers, and for the exchange of goods and ideas. The concepts of citizenship, civil society and civil responsibility were all born in the city. Interesting things can happen when there is a mix of people and activities in flexible spaces."[4]

With more and more people reliant on urban systems to thrive, a city's social and economic prosperity will be largely defined by its capacity to be socially resilient.

According to the City Resilience Index, a tool developed by Arup to help cities assess their resilience, this will mean having the capacity to provide access to business opportunities and welfare, as well as create socio-economic systems that "enable urban populations to live peacefully, and act collectively".[5] Although simply stated, these objectives are ambitious and face growing challenges. An ageing global population will mean that, by 2050, 16% of people will be 65 or older (compared to 7% in 2000),[6] which has serious implications on welfare provision. In addition, rising economic inequality means that today just eight of the richest people in the world have a combined wealth equivalent to the 3.6 billion people in the poorest half of the world, according to the latest figures from Oxfam.[7] From a social standpoint, cities need to be places where collective identity and mutual engagement across communities can be preserved and cultivated. Alongside other cultural institutions, libraries have an important role to play.

Libraries are a longstanding symbol of the public realm and reflect the ambitions of a neighbourhood. They offer indiscriminate

Impact of libraries on key factors for cities' social resilience

Minimal human vulnerability
- Safe and affordable housing
- Adequate affordable energy supply
- Inclusive access to safe drinking water
- Effective sanitation
- Sufficient affordable food supply

Diverse livelihood & employment
- Inclusive labour policies
- Relevant skills and training
- Local business development and innovation
- Supportive financing mechanisms
- Diverse protection of livelihoods following a shock

Health & wellbeing

Effective safeguards to human health and life
- Robust public health systems
- Adequate access to quality healthcare
- Emergency medical care
- Effective emergency response services

Collective identity and mutual support
- Local community support
- Cohesive communities
- Strong city-wide identity and culture
- Actively engaged citizens

Economy & society

Comprehensive security and rule of law
- Effective systems to deter crime
- Proactive corruption prevention
- Competent policing
- Accessible criminal and civil justice
- Comprehensive business continuity planning
- Well-managed public finances

Sustainable economy
- Diverse economic base
- Attractive business environment
- Strong integration with regional and global economies

and egalitarian access to resources, knowledge and services, regardless of ethnicity, age, gender or sexuality. Libraries have historically been seen as non-judgmental places, where visitors can explore anonymously, privately and securely, away from the pressures of the world outside. Today, they also function as community hubs where people go to share ideas, form new relationships, or simply take shelter. As a resource that both reflects and benefits the public, the library can be seen as an important foundation for the community that helps unites the neighbourhood. Two-thirds of Americans say closing their local public library would have a major impact on their community. [8] A programme for homeless people, being promoted by San Francisco Public Library, provides one example of the positive change libraries can catalyse in communities. San Francisco has over 9,000 homeless people [9] and around 15% of the 5,000 daily visitors to the library have nowhere else to go. In 2009, it became the first central public library to employ a full-time social worker. Professionally-trained staff help homeless people navigate and understand information on their rights and legal resources. The programme has resulted in the permanent rehousing of over 150 homeless citizens and also ensured another 800 became entitled to social services. [10]

The rapid, and often uncontrolled, expansion of urban settlements, driven by contingent patterns of economic attractiveness, can often result in pockets of underused or

Library Parks

The brainchild of Mayor of Medellín Sergio Fajardo, the "library parks" initiative saw the construction of 10 public library and community hubs around the city's periphery between 2005 and 2011 in an attempt to provide safe neighbourhood spaces free from gang culture. The innovative building designs merge public green space with facilities for education, play areas, computing, social services and a traditional library, and follow the project's ethos to build the city's most inspiring buildings in its most deprived areas. The library parks have proved an enormous success, allowing safe social gathering space for local youth, as well as helping communities discover and access education and business opportunities. [11]

distressed properties, whose residents can live in alienation or isolation. This is particularly evident in developing countries, where the number of urban residents living in slums increased by 28% between 1990 and 2014. [12] Developed countries are not immune to the problem, for example, 16.7% of land area in large US cities was categorised as vacant in 2016. [13] Integrating library services into underprivileged contexts, often characterised by high crime rates, has great potential to trigger positive change. A hybrid laundromat, combining laundry, training and library services, was set up in a slum area of Cape Town in South Africa to improve early childhood education within poorer communities. The provision of affordable washing machines reduces the average nine hours a week parents spend hand-washing their clothes, freeing up their time to attend early childhood education classes. The classes focus on interactive book sharing,

"The city is a human construct; a socially constructed human artifact"

— United Nations Human Settlements Programme [14]

for example how to read and explore picture books with children, considered particularly important for parents that struggle with literacy. The result is a significant improvement to the literacy, attention span and quality of life of local children, with obvious long-term benefits for the future of the community. [15]

Beyond their social role, libraries can be agents for positive economic stimulation in the wider community. The British Library, in London, has been calculated to generate a return on investment of US$4.40 per US$1 invested each year, [16] whilst libraries in Florida have been estimated to generate an average return of US$6.40 per US$1 invested. [17] Libraries increase footfall and generate more income for local businesses, particularly when they are the main catalyst for the regeneration of a neighbourhood. This was the case at the Old Market Library, constructed at the centre of a 100-year old market in Min Buri, Bangkok. The market was once a flourishing commercial centre, but had fallen into decline in the late 1990s after it was abandoned following a fire. The local community was closely involved in the design process for the new library, and local materials and skills were used during its construction. This process helped re-establish the community's confidence and a sense of pride, which translated into greater agency and ownership of local private and public spaces. This positive development of the neighbourhood is embodied in the library itself, a structure that provides education and resources to all. [18]

Participation in lifelong learning [19]

% of total EU population between 25 and 64 (y-axis)

Years on x-axis: 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 — **year**

Legend: Women — Total — Men

Data labels on Total line: **7.1** (2002), **10.7** (2015)
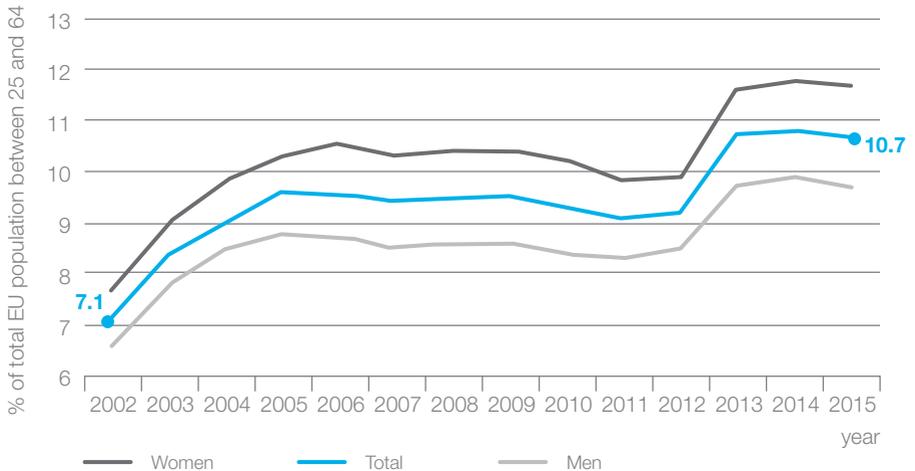
Lifelong learning in changing labour markets

Average global life expectancy has experienced its fastest growth since the 1960s, and in the last 15 years alone has increased by an average five years. [20] Today, the emergence of artificial intelligence and machine learning techniques is expected to significantly disrupt traditional working practices and eradicate low skilled jobs. A German study has estimated that up to 80% of jobs traditionally carried out by poorly educated people are at risk, compared to just 18% for jobs done by people with a doctorate degree. [21] The likelihood of a near future characterised by an extended working life and a fluid global labour market will require people to be more flexible regarding their career paths. Citizens of all ages will need to be more agile and continue to learn and retrain throughout their lives. The theme of lifelong learning is gaining global strategic importance: the EU wants to increase the number of citizens engaged in lifelong learning by a minimum of around 5% between 2010 and 2020, with an upper level target of 15%. [22] The ability to instil confidence and promote entrepreneurial skills among citizens will

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New Americans Corner

Newcomers to migrant communities in New York are largely reliant on informal word of mouth to get information on how to set up a business. Spotting this gap in training and development provision, the New York City Department of Small Business Services teamed up with Brooklyn Public Library, New York Public Library and Queens Public Library, to provide free multi-lingual business courses where trained staff help immigrants make their first steps in business. Libraries were considered the ideal location for the courses, due to their perception, among the local immigrant population, as safe and reliable institutions, compared to other government services. [23]

be a major factor as job security diminishes. For this reason, academic courses that address holistic development, and spark creative thinking, ambition and the ability to drive visions through to realisation, are gaining momentum.

These trends are reflected in the ongoing transformation of library services and interior spaces. Many libraries now integrate maker spaces, innovation hubs, residency programmes and dedicated business centres to create an ecosystem where mutual support, networking and the cross-pollination of ideas can take place. For example, The Edge, a dedicated space at the State Library of Queensland, includes flexible working areas and mentorship programmes designed to help users with various projects. It hosts regular residencies where selected professionals are invited to share their knowledge and ideas with patrons in exchange for access to facilities and resources for their own work. [24]

This form of asset is particularly useful to small and medium-sized enterprises (SMEs), a vital ingredient in future urban centres, due to their ability to quickly adapt to changing market conditions as well as retain innovation and growth inside communities. [25] Although SMEs generate less revenue than larger corporations, they are often the main building blocks behind local economies. In the UK, the number of SMEs in urban areas has grown at a rate of 37% since 2005, compared to a growth rate of 14% among

large-scale businesses. Almost 50% of all private sector jobs available in cities are SME-based. [26] Entrepreneurs, especially start-ups trying to keep their overheads down, often take advantage of library facilities and tools, such as free wi-fi access, spaces to work or hold informal meetings, business knowledge, support and advice. Libraries are therefore reformulating their profiles as places where knowledge exchange can flow through education and entrepreneurship, adding mutual value to both. This development is highlighted in the '50 Schools, 50 SMEs' initiative, promoted by the Singapore National Library Board, in partnership with SPRING Singapore (Standards, Productivity and Innovation Board Singapore) to catalogue and display the experiences of local businesses shaping the economic history of Singapore. Students in the city reached out to local businesses to hear their stories and document them using library resources. The project provided a unique opportunity for students to make authentic connections with businesses, and many were able to translate their learning in concrete initiatives or were inspired to start their own companies. [27]

Re-intermediation and participation

The traditional role of libraries as repositories of public knowledge has come under threat in recent years, due to the fast pace of technological advancement and shrinking economic resources, among other factors.

The exponential proliferation of digital media, that characterises the post-Gutenberg information era, has created barriers to the acquisition and curation of material considered trustworthy, relevant and suitable for public consumption. The number of internet users worldwide increased tenfold between 1999 and 2013, reaching 3.5 billion. [28] To date there are over a billion websites and users are uploading around 1.8 billion images every day. [29] New intermediators are being offered to the public to help them manage the vast amount of data available. Artificial intelligence is able to exploit personal data to tailor content and provide more accurate and relevant responses to search queries. But running counter to this, the post-truth agenda and the advent of 'fake news' media has resulted in greater value being placed on human assistance, dialogue and support. This represents an opportunity to expand the roles of librarians and curators to make information more user friendly and quality data more digestible.

Hardware and software can quickly become obsolete and data can get lost if not appropriately archived. This phenomenon, known as Data Decay or Bit Rot, prevents information from being passed onto new generations. Vinton Cerf, one of the fathers of the internet, has identified this as a serious problem that needs a solution. [30] This has significant implications when planning library infrastructure and the skills required for its operation. A

Crowdfunding total volume [32, 33]

2012
$2.7bn

2013
$6.1bn

2014
$16.2bn

2015
$34.4bn
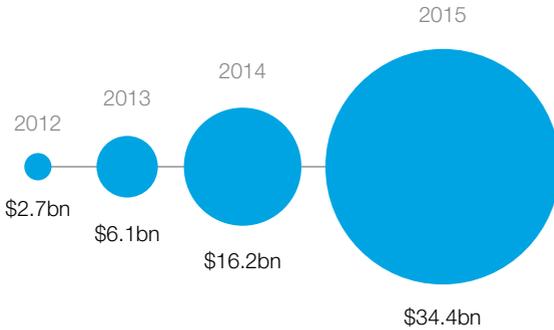
1,250

Number of crowdfunding platforms worldwide

270,000

Number of jobs crowdfunding created in 2014

significant number of libraries are striving to identify the resources necessary for successful change whilst dealing with policies of austerity that have eroded funds for library operation in many countries. In the UK, for example, 324 libraries have been closed since 2011 due to government cuts. [31] There are notable exceptions, however, such as South Korea which invested ₩552 billion (US$493 million) between 2009 and 2013 to open new libraries. [34] The networking infrastructure available via the internet provides a cheaper means of increasing transparency and engagement with local and global communities, enabling a transition to financial and operational support.

The use of social media to engage with library patrons is now widespread (the number of social media users worldwide is projected to reach 2.95 billion by 2020). [35] In many cases, this is seen as the most effective method of keeping patrons informed of available services and upcoming events. More and more librarians are exploiting social media's potential to bring previously inaccessible archives to public attention or crowdsource information related to digitised items. This phenomenon is shifting the debate away from the struggle to digitise information, towards opportunities for collaborative curation and the creative reuse of resources. The website Flickr was a key platform used by

The Internet Archive

A key actor working to preserve the rapidly growing mass of ephemeral information constantly uploaded online is the Internet Archive, a non-profit organisation based in San Francisco. The Archive provides free public access to its digital library, which includes 11 million books, over 155,000 historical software-related materials – the largest collection in the world – and more that 279 billion pages from the public web, collected by its web crawlers or uploaded by users. [36]

librarians to catalyse the process. A pilot Flickr project known as The Commons was launched in 2008 in partnership with The Library of Congress in Washington D.C., to enable widespread access to previously hidden archives. Volunteer Flickr users tagged and added information to photos uploaded by librarians, making them more data rich and discoverable by other online users. This proliferation of information would have been impossible using the traditional practice of librarians managing vast archives of physical photos. [37]

The internet has underpinned the growth of crowdfunding, a market that expanded in size from US$2.7bn in 2012 to US$34bn in 2015. [38] This new method of accessing finance is very effective at leveraging the support of local and global communities that share a passion for a cause or project. The crowdsourcing platform Kickstarter exceeded US$1bn in pledges in March 2014 (from a total 5.7 million backers from 224 countries). Over 300 library-related projects were successfully funded on Kickstarter between 2013 and 2017. [39] Successful Kickstarter projects have used funds to extend library collections, buy new equipment, or give patrons access to 3D printers. Others have set up free mobile libraries and podcasts to share ideas and help innovate the profession. When this funding model is combined with increased engagement in public-private partnerships and volunteers, it has great potential to improve the financial resilience of libraries, especially those in contexts with limited public funding.

Platforms that enhance participation and optimise operation

Libraries are focal points for cultural and social life within communities. Designing spaces and activities that respond to the needs and interests of local communities can maximise the benefits libraries bring to cities' social infrastructure and cultural vibrancy.

Libraries are rarely standalone buildings: they form a cultural network in cities comprising facilities of varying scale, vocation and times of use. Several emerging and consistent trends demonstrate how libraries are changing to accommodate the new methods of learning, work and engagement in cultural or civic activities. The way libraries manifest themselves in the urban environment is changing in response to evolving lifestyles and technology, from iconic new buildings to free e-books accessed via QR codes posted in train carriages.

The following pages highlight best practice and key signals of change in three main areas: integration with public realm, building design and service offering.

1
Activating the public realm

2
Buildings that enable diversity

3
Services shaped through participation

Left: Geelong Library and Heritage Centre, Australia. The building designed by ARM Architecture includes areas for social engagement, as well as a heritage repository holding 120,000 print and digital items.

Best practice and signals of change shaping future libraries

24/7 opening **3**c

Intelligent building systems **2**d

Experimentation for all **3**b

Informal interaction with staff **2**f

Community-led programmes **3**a

Co-location of services **1**c

1e

1a

Civic landmarks **1**b

Gathering Spaces **2**e

Walkable and green environments

Robotics and automation **2**b

1 Activating public realm

2 Buildings that enable diversity

3 Services shaped through participation

2c Digital infrastructure

1e

Mobile and temporary facilities

1d

Citizen labs

3d

Permeable thresholds

1f

1f

2a Flexible and informal interiors

1e

1e

1e

Urban stations

©Arup | Steven Scicluna

(1)
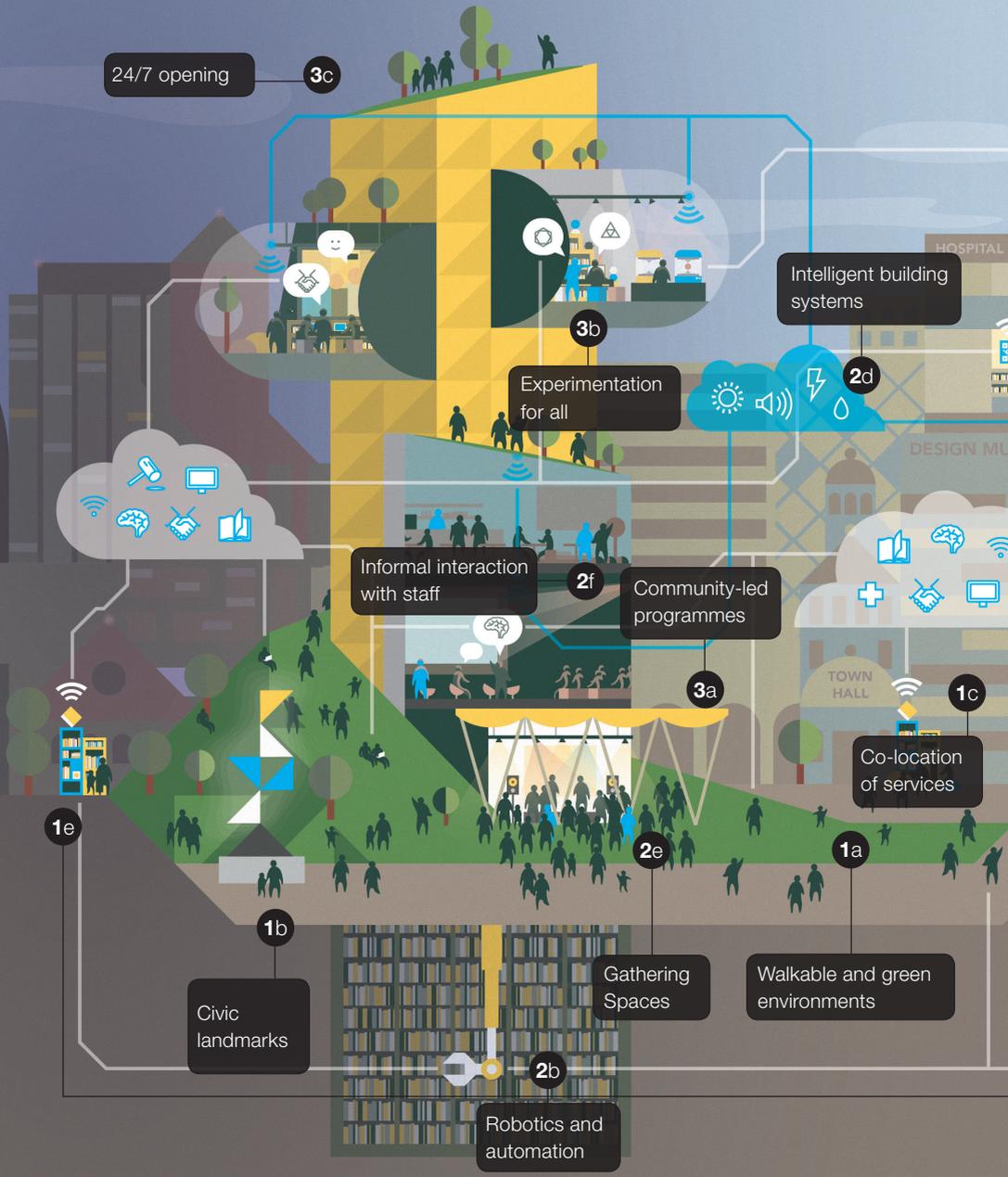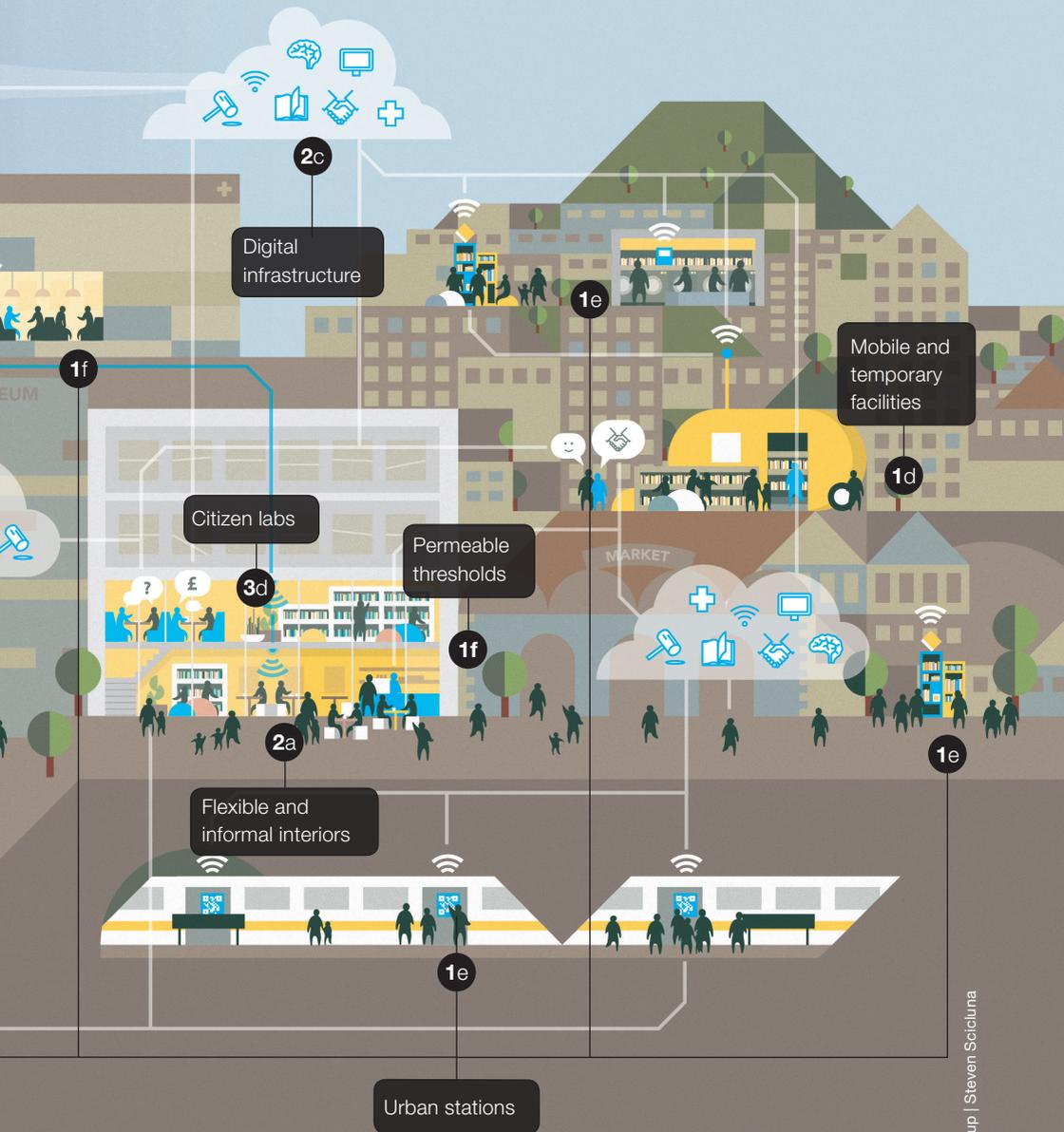
**Activating
public realm**

Libraries can activate urban
spaces to increase economic
activity in the surrounding
area and ensure inclusive
participation for members of
different communities.

© Christopher Frederick Jones
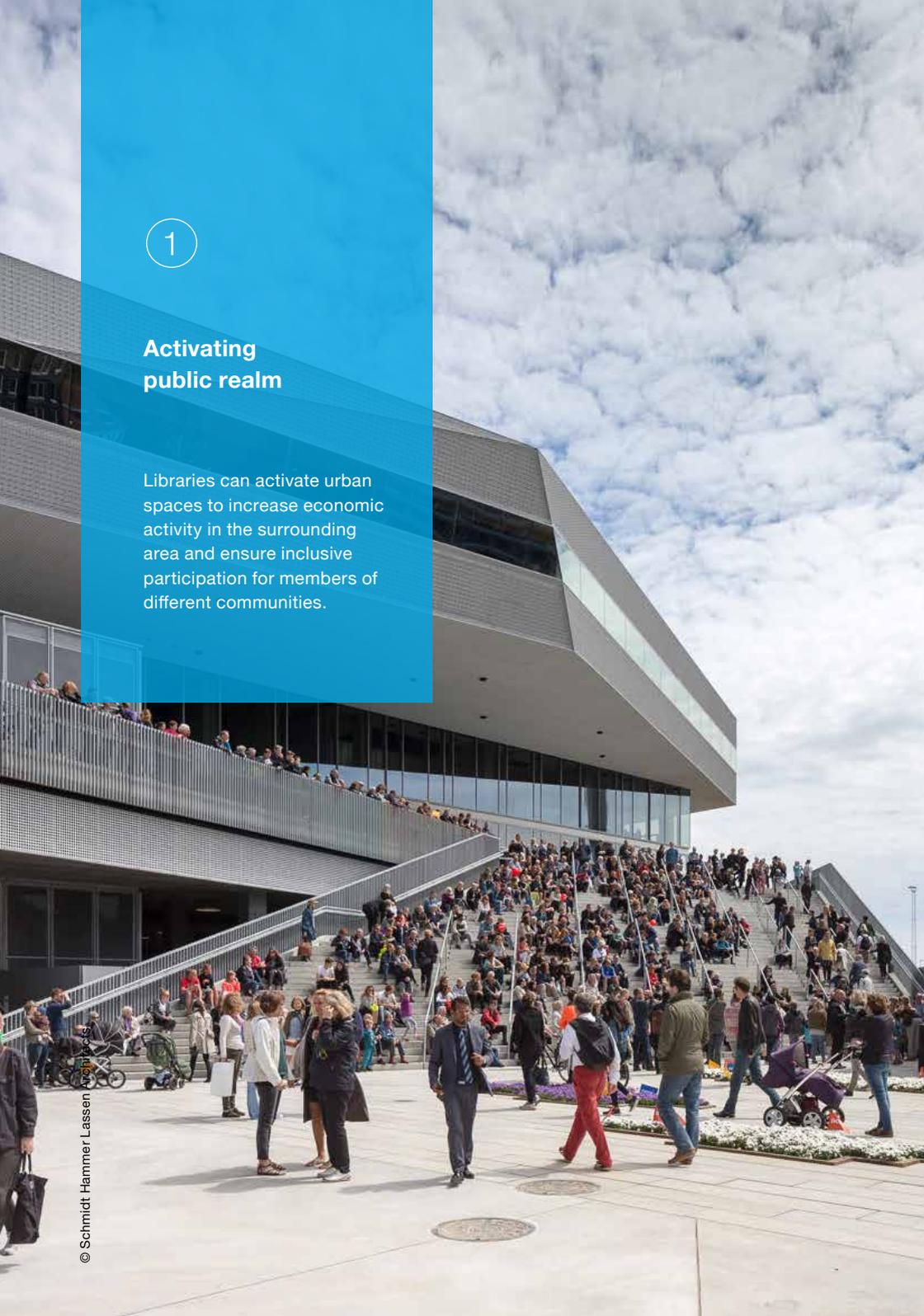
© Christian Richters

Inclusive access is the most important characteristic to help reinforce the social impact of libraries. The provision of walkable environments, inside and outside buildings, can facilitate social interaction, bring health benefits to patrons and foster economic development in the surrounding area. Strategic connections to public transport further enhance the inclusivity of sites. Green space and large trees create attractive and healthy environments that encourage patrons to spend more time around a library.

The rainforest garden at USQ Ipswich Library optimises the quality of learning environments, and separates social spaces and quiet study areas. It also significantly improves air quality throughout the library.

Libraries must stand out as exemplars of local identity to become cornerstones of community resilience. Building designs that reinterpret local landscape or heritage, informed by effective community consultation, can foster a strong sense of belonging. This can be achieved at different scales and budgets, from entire buildings to smaller public art installations in or around a library.

The structural steel and glass skin of the Seattle Public Library unifies the five platforms that shape its interior, and defines the interstitial public spaces. The resulting iconic shape makes the library one of the most recognisable buildings in the city, able to attract 2.3 million people in its first year of operation.

Left: Dokk1 library, Aarhus, Denmark. The building by Schmidt Hammer Lassen architects aims to be an iconic representation of the knowledge society. The staircase, doubling as a seating area, gives an outstanding display of public life.

Stavros Niarchos Centre

A major new park, library and theatre complex in Athens, completed in 2016, transforms a former car park lot and stadium, abandoned after the 2004 Olympic Games. The design, by Italian architect Renzo Piano, includes a ground level opera and library, organised around a public plaza and partially hidden below a 170,000 sq m artificial hill that rises towards the south end of the site. The slope of the hill forms a new public park, planted with indigenous Greek plants and trees and at the top provides an inspiring view of the sea. The mix of facilities in the building includes a business incubator, dedicated to entrepreneurship, a music recording studio, and areas for children and teenagers. [40]

1c. Co-location of services

© Frances Andrijich, courtesy of the City of Perth

1d. Mobile and temporary facilities

© Storefront Library

Libraries are becoming multi-use destinations that offer activities and services tailored to the needs of the communities they serve, bringing people together in the process. Libraries that are placed at the centre of economic and cultural life in neighbourhoods are best positioned to work in synergy with other retail and leisure amenities, such as leisure centres, theatres, museums and public markets, to create positive feedback loops of revenue.

Built as a social anchor for a newly regenerated neighbourhood, the Perth City Library is open to the public space and complements the nearby curated retail spaces to add vibrancy across the precinct.

Mobile or temporary libraries can help re-activate engagement across communities by acting as social anchors. Neglected neighbourhoods can benefit from temporary libraries placed strategically at ground level and fitted with vibrant display spaces. Libraries placed in these contexts can help unlock social regeneration.

The Storefront Library operated in 2009 for a year in a vacant retail space in Boston's Chinatown. Located at street level, the library was an attractive hub for the local community. In 2017 public funds were granted to create a permanent library, in response to the community's campaign to extend the lifetime of the project.

1e. Urban stations

1f. Permeable thresholds

Small-scale library outposts, distributed across a city, can significantly improve the quality of the public realm. Library stations, curated by local communities, can strengthen local identity and create a sense of place. Digital connections to library services, placed in strategic locations like public transport, medical facilities, or post offices, can transform the process of waiting for services into a learning experience.

Inspired by the Little Free Library project, which promotes community managed micro-libraries across the world, the city of New York commissioned a group of designers to create a series of engaging public library installations across the city.

Library spaces should be designed to reflect their function as places for unhindered public access to information. Visual and physical connections, between interior and exterior spaces, can increase transparency and help draw visitors into the building. Sophisticated security systems can enable gateless access for all patrons, helping create a sense of welcome, rather than one of control.

The glass facade of the Public Library in Cambridge, Massachusetts creates a continuous dialogue between internal and external activities, creating an inviting public display of cultural life inside the building.
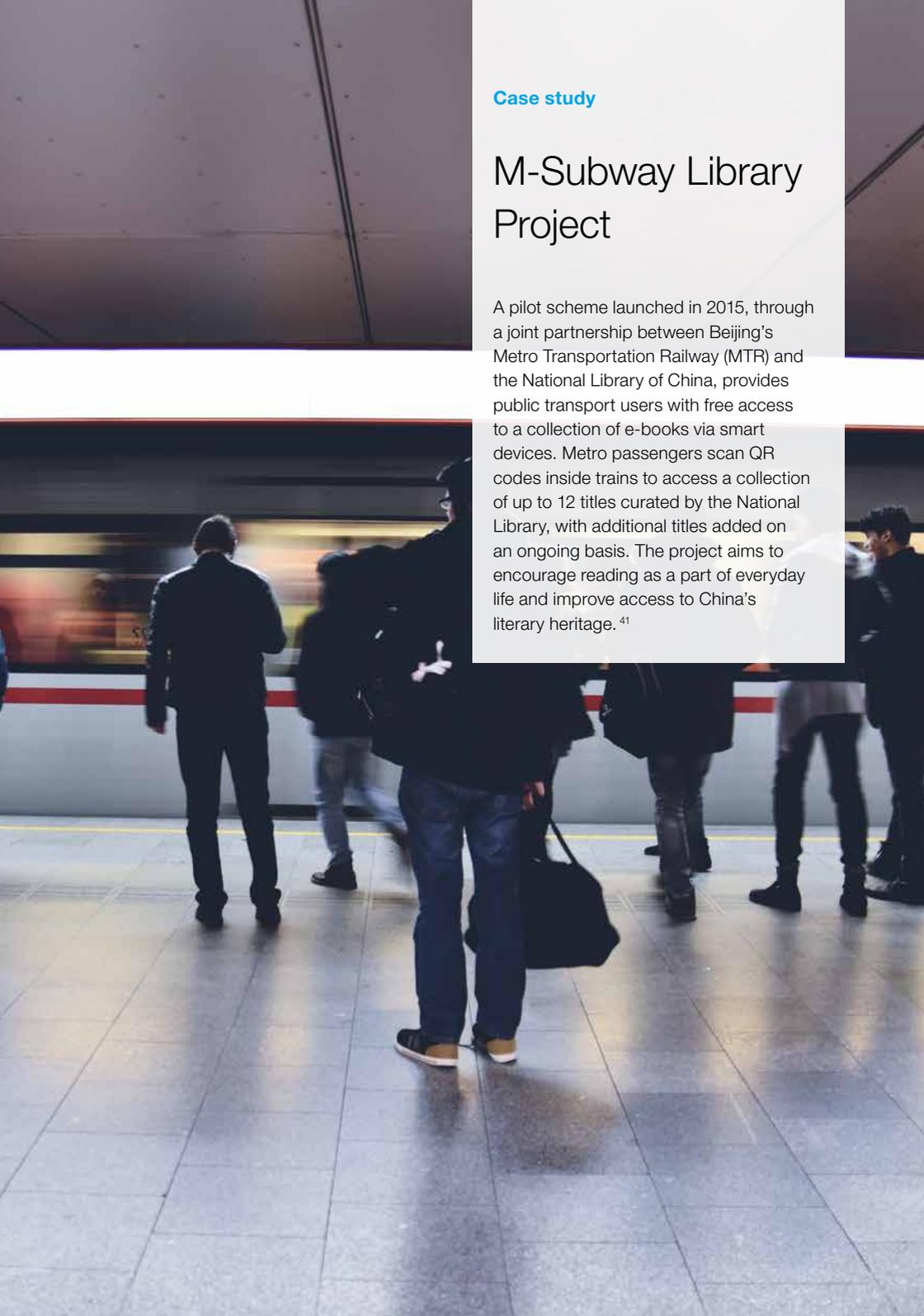
M-Subway Library Project

A pilot scheme launched in 2015, through a joint partnership between Beijing's Metro Transportation Railway (MTR) and the National Library of China, provides public transport users with free access to a collection of e-books via smart devices. Metro passengers scan QR codes inside trains to access a collection of up to 12 titles curated by the National Library, with additional titles added on an ongoing basis. The project aims to encourage reading as a part of everyday life and improve access to China's literary heritage. [41]

（2）

Buildings that
enable diversity

Libraries can encourage
engagement in different forms
of learning, cultural exchange
and participation in the civic
life of a community.
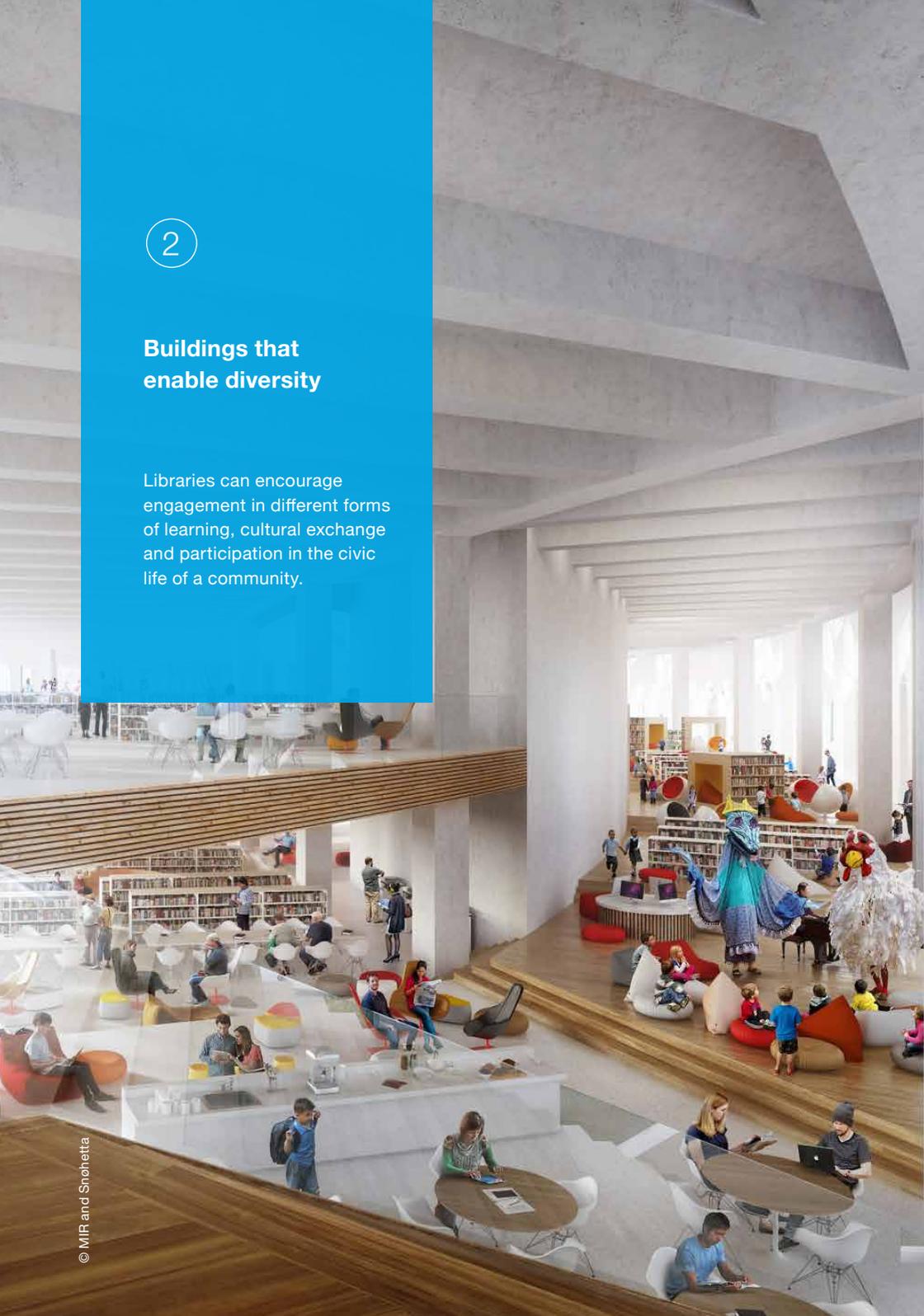
2a. Flexible and informal interiors

2b. Robotics and automation

In the future, libraries will host increasingly diverse activities for different patron groups across days, months and years. Makers and fixers courses, quiet study, co-working, classes and performances are just a few activities that already coexist in many libraries. Adaptable interior fittings and light, informal furniture are ideal to reconfigure spaces in response to different conditions of attendance, energy use and lighting, and acoustic requirements.

The interior of Ørestaden's Public Library is designed to shift from serving as a school library in the morning, towards public learning use in the afternoon, and then other community activities in the evening

Programmable machines can optimise the performance of retrieval systems as the volume of items that need to be stored escalates, and the availability of space shrinks. These systems allow libraries to move archives to dense underground or off-site storage, but which are still available on demand. With the design of libraries no longer constrained by conservation requirements, a greater proportion of space can be devoted to social activities.

The five storey underground archive of the Joe and Rika Mansueto Library at the University of Chicago can only be accessed by robot cranes. Retrieved books can be enjoyed in a fully day-lit environment enclosed in a glass and steel dome above ground.

Left: the new Calgary Public Library. Snøhetta and DIALOG's design creates a vibrant new public space by welcoming visitors with a day-lit atrium where public events are held. In the upper levels, patrons find space for quiet activities.

Case study

Measure the Future Dashboard

Conceived by Jason Griffey, Head of Library Information Technology at the University of Tennessee, the 'Measure the Future' dashboard helps library operators understand visitor movements and identify the areas they browse most. Real-time movement data, collected from sensors, is used to develop more efficient and effective spatial layouts and as the basis for smart environmental control. The latter helps improve sustainability by enabling library operators to adjust lighting and heating based on levels of occupancy in different areas. [42]

2c. Digital infrastructure

2d. Intelligent building systems

Libraries will have to integrate digital infrastructure, such as digital interfaces and cloud computing, to meet growing expectations from users to access digital services in the library and on the go. This will require considerations in terms of technology obsolescence, privacy, censorship and accessibility. Staff will need to be digital information mentors, assisting users in their research, and helping to bridge the digital divide in the community.

As part of the Culture in Transit project, the New York branch libraries developed a mobile kit to digitise historical material from local communities and share it online, thus facilitating the sharing of local heritage.

Embedded sensors gather data related to building performance, usage and environmental quality. The use of this information can ease security and maintenance, whilst enabling a more sustainable use of resources. Usage data can inform the design of services, both within a single library and in the wider network of branches. Open hardware and software can ensure an inclusive and collaborative approach.

BluuBeam uses iBeacon technology to send location-triggered information to patrons. This way visitors can be better informed about events, activities or further reading related to their preferences.

© Stewart Hollenstein

© MIR and Snøhetta

Spaces inside and outside libraries are the perfect setting for talks, workshops, festivals and exhibitions. These events bring library spaces to life and truly display their presence in the community. Libraries need atria, plazas, parks and streets that can choreograph changing flows of people at different times of the day. Smart weather coverings can extend the use of outside space, whilst flexible public lighting can provide appropriate ambiance for different occasions.

Due for completion in early 2018, Sydney's Green Library will be constructed partially below ground level, giving space to a public plaza above and creating new opportunities for events and activities.

As libraries become containers for collaboration and the spread of peer to peer knowledge, librarians' ways of working will change substantially. Reception desks are likely to disappear, replaced by more seamless interaction with information stations and roaming staff providing informal assistance to patrons. Strategic wayfinding, aided by technology such as augmented reality, will facilitate this transformation.

The interior design of Calgary's new Central Library is strongly informed by these principles. Digital stations spread across the building and wandering staff provide visitors with an experience that is free from security constraints and forced paths for assistance.

Case study
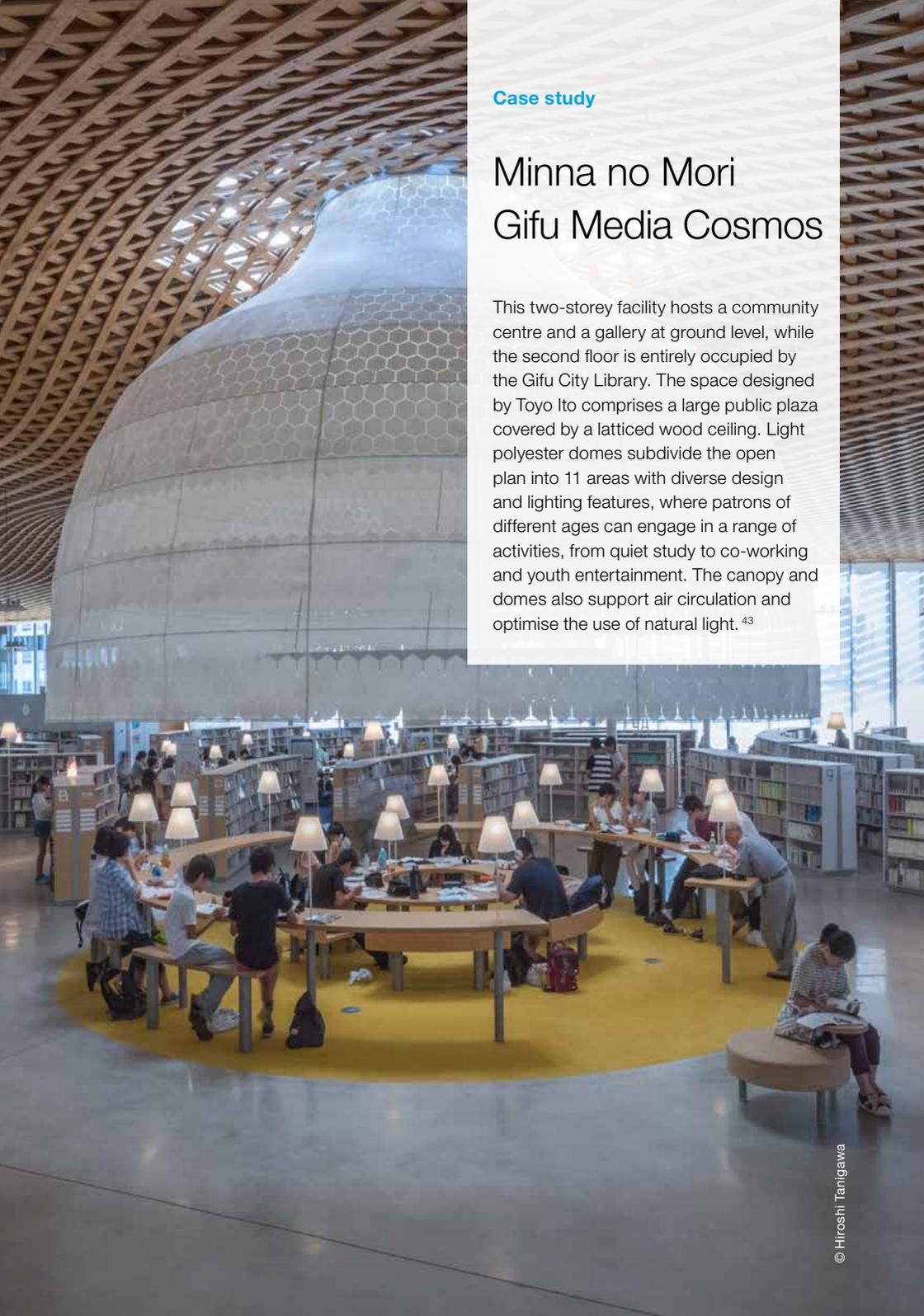
Minna no Mori
Gifu Media Cosmos

This two-storey facility hosts a community centre and a gallery at ground level, while the second floor is entirely occupied by the Gifu City Library. The space designed by Toyo Ito comprises a large public plaza covered by a latticed wood ceiling. Light polyester domes subdivide the open plan into 11 areas with diverse design and lighting features, where patrons of different ages can engage in a range of activities, from quiet study to co-working and youth entertainment. The canopy and domes also support air circulation and optimise the use of natural light. [43]
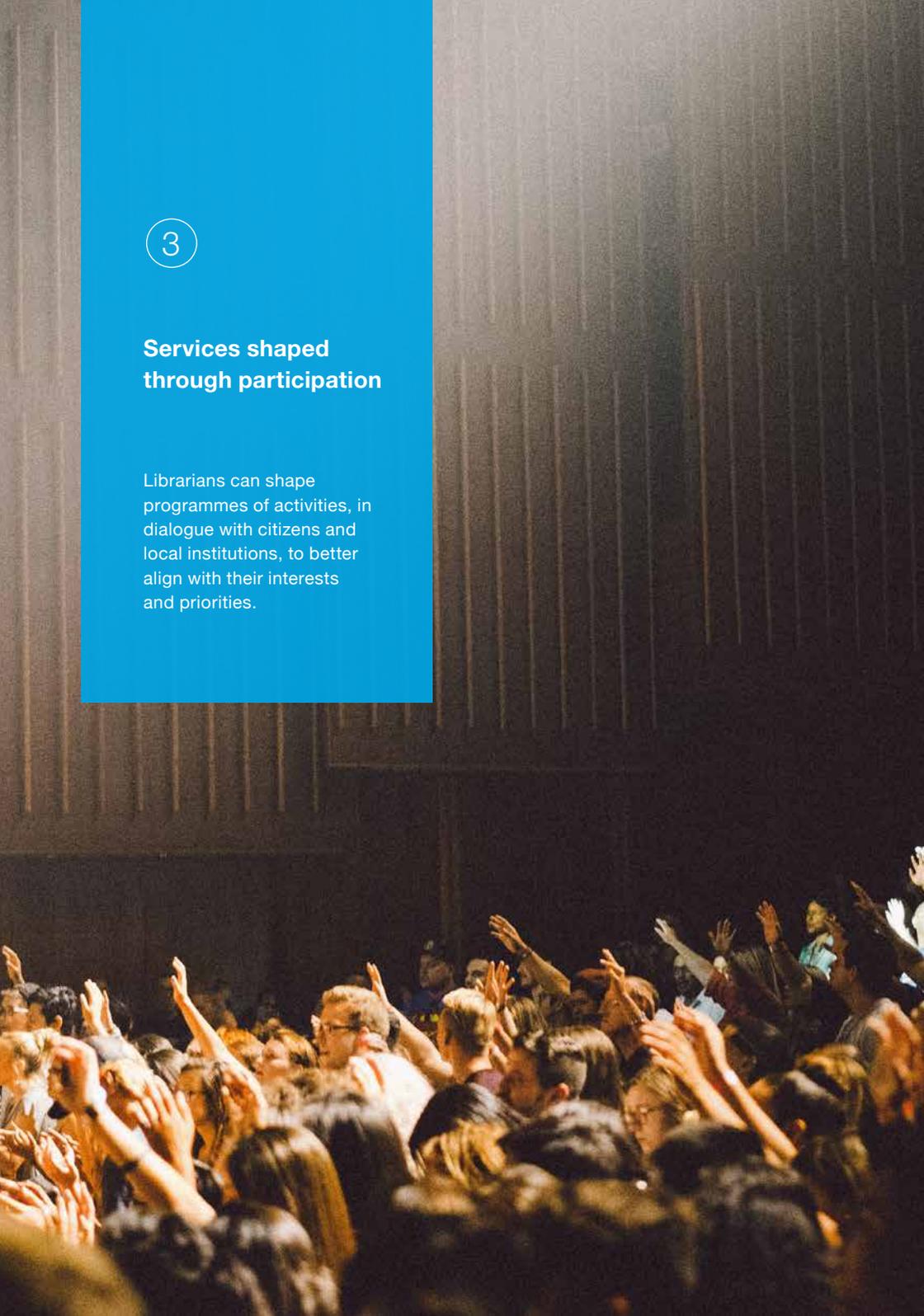
(3)

**Services shaped
through participation**

Librarians can shape
programmes of activities, in
dialogue with citizens and
local institutions, to better
align with their interests
and priorities.

3a. Community-led programmes

© Arup

3b. Experimentation for all

Faced with uncertain funding prospects, libraries will need to rely more on the support of their communities to deliver services. This will require a shift in the role of librarians, who will need to become facilitators, able to support, engage and guide bottom-up initiatives and contributions from volunteers. This approach will not only bring economic viability for library services, but will also ensure that they truly reflect local interests of all user groups.

In 2016, IDEO developed a toolkit for librarians to help them face their everyday challenges by adopting a design thinking approach and shape new initiatives that embrace the interests and needs of patrons.
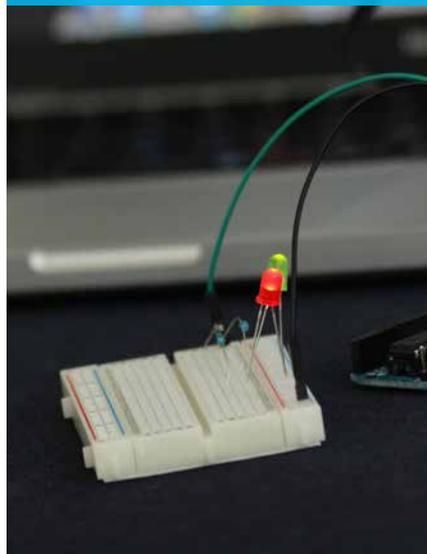
Increasingly, libraries act as incubators for ideas that give life to small businesses. Public access to technology, combined with expert advice, is key to providing equal access to learning opportunities. Tool lending also encourages experimentation and sustainable behaviours. By hosting these activities, libraries can equip people with the skills demanded by a fast-changing work environment.

In 2010 the Fayetteville Free Library, New York was the first public institution to host a maker space. Since then, similar initiatives have been introduced in libraries across the world, where patrons can test emerging technologies such as digital fabrication.

© Tal Rogovski, Yoav Meiri Architects
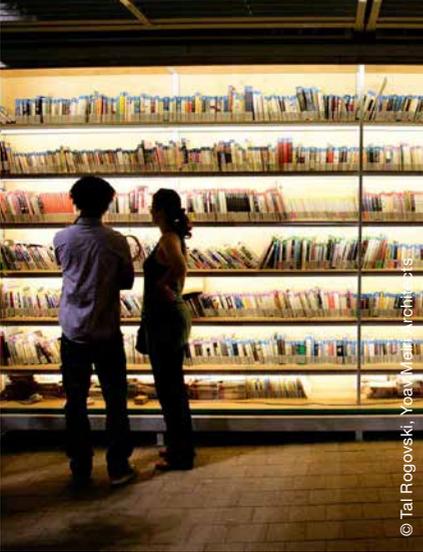
With the global rise of the 24 hour city, libraries are faced with increasing demand for services at all hours of the day and night. New working and learning patterns, characterised by international collaboration, require video conferencing with different time-zones. Providing these services at extended times will involve investment in security, digital infrastructure and staff, but will allow libraries to meet the demands of a broader range of patrons.

The Levinski Pop-up Library, located in Tel Aviv's Levinski Park, is designed to be an approachable hub for illegal immigrants at any time.
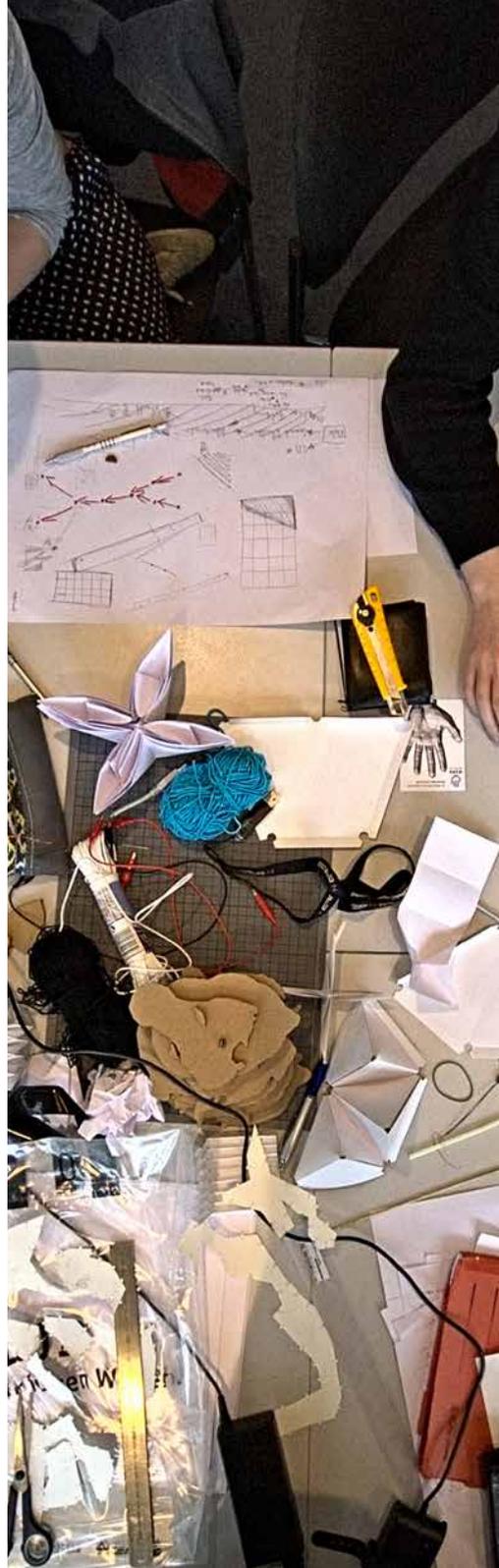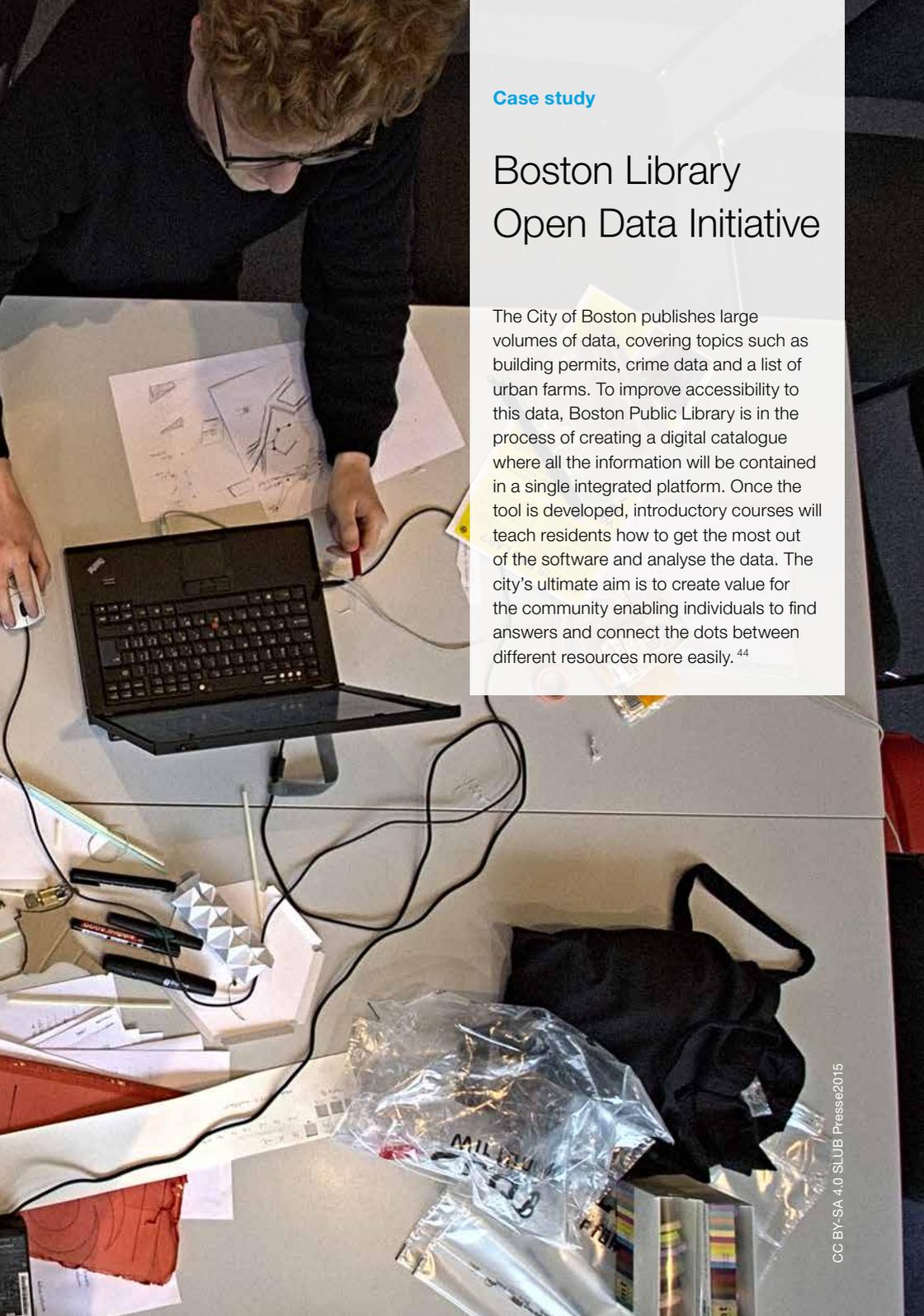
Boston Library Open Data Initiative

The City of Boston publishes large volumes of data, covering topics such as building permits, crime data and a list of urban farms. To improve accessibility to this data, Boston Public Library is in the process of creating a digital catalogue where all the information will be contained in a single integrated platform. Once the tool is developed, introductory courses will teach residents how to get the most out of the software and analyse the data. The city's ultimate aim is to create value for the community enabling individuals to find answers and connect the dots between different resources more easily. [44]

Conclusions

The role of libraries will significantly change over the coming years, driven by demographic changes, rising urban migration and technological advances. Libraries of the future will have to serve more culturally diverse and physically dense communities, under the pressure of limited resources. Libraries can remain vital and relevant to their communities, especially in more isolated contexts, if they integrate a wider range of public and commercial services. Physical interaction will remain a key demand of users, despite the opportunity for ubiquitous and constant access to information enabled by technology. Community engagement will help develop services specifically targeted to users' demands and aspirations.

Library spaces will need to be flexible and adaptable to stimulate collaboration and social interaction, yet still enable quiet reflection and serendipitous discovery. The deployment of robotics and automation can help libraries cope with a lack of space for archives and conservation requirements, resulting in cost-effective storage.

The mentoring expertise of librarians, in support of education, research and well-informed decision making, will become more crucial as access to technology spreads and the volume of information grows exponentially. While some would argue that sophisticated algorithms could enable digital curation to replace librarians, there will always be a need for skilled professionals, with knowledge of when and how resources and tools are best deployed for more complete and effective outcomes. The fast pace of technological change is challenging librarians' traditional training and skills. A more open disposition to collaboration and a multi-disciplinary thinking will be key to stimulating urgently-needed innovation.

Planners and developers

Combine the use of public data with engagement with communities and local associations to prioritise and distribute library facilities, to assess potential relocations or new building sites.

Prioritise buildings that allow for adaptability and flexibility, include gathering spaces, allow public access, encourage engagement, especially at street level, and ensure visual and physical connection with the rest of the city.

Consider the inclusion of complementary public or commercial services to maximise the attractiveness of the site, create positive synergies and generate revenue.

Acknowledge the value of the identity of the site and favour physical solutions that reflect the values or heritage of local communities.

Operators

Recognise the emerging need of digital mentorship and curation and invest in training and integration of new skills.

Consult key stakeholders in local communities and adopt an agile iterative approach to test new services that adapt to changing needs, aspirations of patrons and provide opportunities to experiment with new tools or technologies.

Assess and balance the proportion of physical and digital access to collections, including opportunities for research and creative reuse.

Take advantage of sensors and data to monitor the performance of buildings and assess visitors' engagement with the space and services.

Integrate data-based evidence with value stories to demonstrate the value of libraries and make the case for financial and operational support.
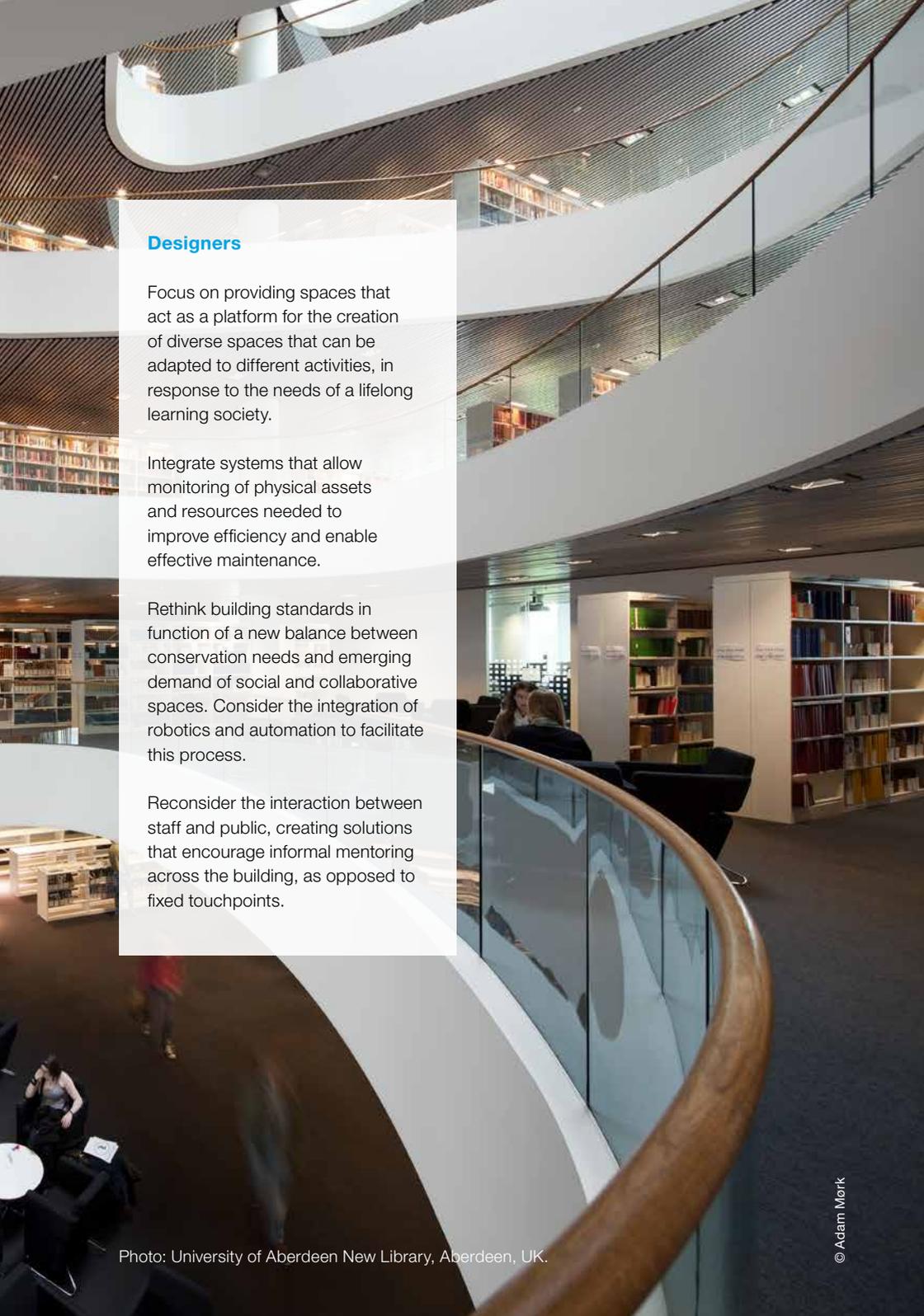
Designers

Focus on providing spaces that act as a platform for the creation of diverse spaces that can be adapted to different activities, in response to the needs of a lifelong learning society.

Integrate systems that allow monitoring of physical assets and resources needed to improve efficiency and enable effective maintenance.

Rethink building standards in function of a new balance between conservation needs and emerging demand of social and collaborative spaces. Consider the integration of robotics and automation to facilitate this process.

Reconsider the interaction between staff and public, creating solutions that encourage informal mentoring across the building, as opposed to fixed touchpoints.

Photo: University of Aberdeen New Library, Aberdeen, UK.

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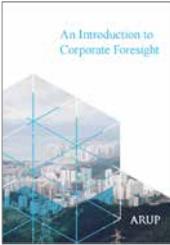
Foresight can be applied to a broad range of business contexts. These include strategy, risk and innovation processes as well as the delivery of marketing, design and engineering projects. All of these benefit from a critical exploration of the future. The aim is to ensure that future opportunities are maximised and that risks are minimised.

An introduction to corporate foresight provides an introduction to the practice of foresight, including key principles and methodologies, and examples of application within the context of the built environment.

Reimagining property in a digital world highlights that the property sector has not yet fully committed to operating digital property portfolios. Individual initiatives are often isolated, and as a result the full benefits are not realised. The message for developers and corporate real estate executives is that every business will need its own digital strategy if it wants to achieve improved operational performance, a better end user experience and consequently higher long term valuations.

The circular economy in the built environment identifies how the circular economy can benefit Arup, our clients, and the built environment sector. We reflect on the economic, social and environmental advantages of employing circular principles. We propose strategies to progress our offering, deliver new services, engage a wider network of stakeholders and unlock opportunities for all parties in the value chain.

Green building envelopes can help to reduce the urban up-heating (heat island effects), filter fine dust on the streets and reduce noise levels. Within this edition of *Cities Alive* report, experts from eight Arup skill networks across the globe cross-examine these questions with a view to shape better cities. The comprehensive research considers whether green building envelopes can have a special role to play in improving our cities for their inhabitants.

About Arup

Arup is the creative force at the heart of many of the world's most prominent projects in the built environment and across industry. We offer a broad range of professional services that combine to make a real difference to our clients and the communities in which we work.

We are truly global. From 100 offices in 38 countries our 11,000 planners, designers, engineers and consultants deliver innovative projects across the world with creativity and passion.

Founded in 1946 with an enduring set of values, our unique trust ownership fosters a distinctive culture and an intellectual independence that encourages collaborative working. This is reflected in everything we do, allowing us to develop meaningful ideas, help shape agendas and deliver results that frequently surpass the expectations of our clients.

The people at Arup are driven to find a better way and to deliver better solutions for our clients.

We shape a better world.

Libraries are undergoing a renaissance, in terms of the social infrastructure they provide and the services they offer. Increasingly functioning as a catalyst for community cohesion and wellbeing, libraries are evolving from their traditional function into hubs for education, health, entertainment and work.

Future of Libraries examines this shift, engaging with a network of experts and enthusiasts in the field, including library operators, policy makers, urban designers, planners, architects and library-funding NGOs and informed by a series of workshops held in London, Milan, Melbourne, Sydney, Brisbane, Hong Kong, Singapore, New York and San Francisco.

The key function of libraries, to support lifetime learning and building stronger communities, aligns closely with Arup's own drive to deliver a social purpose in its building, planning and consulting work.

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