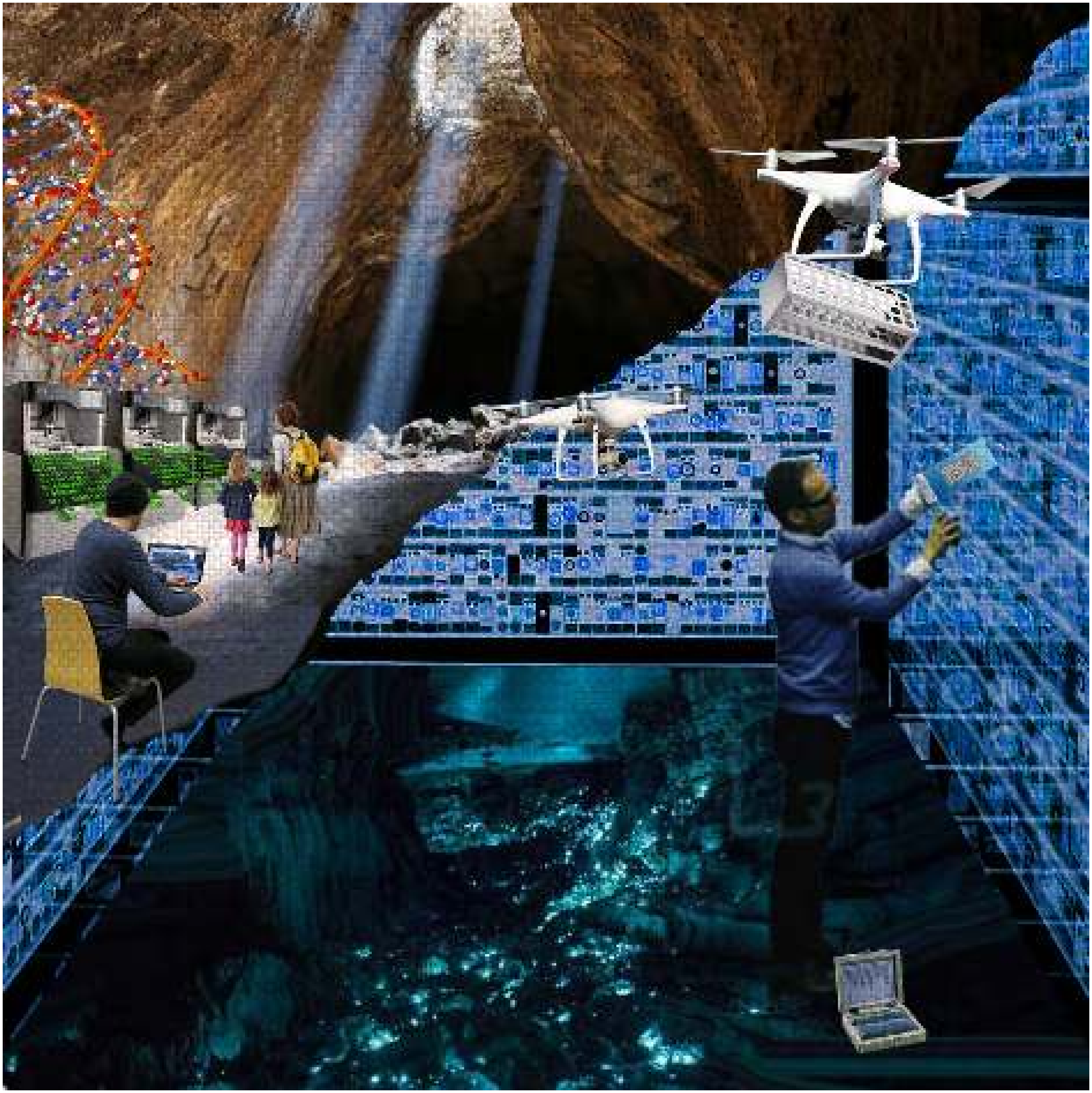
THE DNA ARCHIVES



Riccia Lim Yu Wen Singapore University of Technology and Design, Architecture, Core Studio 2

STUDIO BRIEF

The Deep Library

Google it. For most of us, that has become our immediate, almost subconscious, first step towards finding an answer to any question. As Eric Schimidt and Jared Cohen from Google1 state, we are beneficiaries of acollective, and relatively recent, endeavour to share human knowledge through virtual means. Every two days, we create more information than we did from the dawn of civilisation until 20032, and we are doing so at an ever-increasing rate. The emergence of the internet for public use3 in the 1990s was a catalyst for this explosive growth. "Everybook, magazine, newspaper, journal, song, film and play ever written... Every email in history ... search or product review ... text message ever sent, every chat ... every post ... every comment"4 is now stored in server farms and potentially retrievable. Moreover, in the last decade, tech firms began exploiting this information glut, developing AI that can learn from massive datasets to create new content5 alongside us.Considering how information is digitised, proliferates, and is readily accessed today, the library—commonly understood as a physical and finite repository of mostly printed content—appears antiquated, if not obsolete. Yet looking back at the history of this architectural typology,6 the concept of a library has proved to be surprisingly elastic, often evolving in response to technological and societal developments7. Contemporary interpretations of the library have become more expansive. Libraries now integrate digital

and physical media seamlessly in their collections and offer increasingly diverse programs catering to a wider community. Adopting the position that libraries serve an important role in our societies and will continue to be relevant8, this studio will investigate further ways in which the concept of a library may evolve and be manifested in future.The studio will begin with an exercise in world-building. Each student must author a fictional narrative thatsets up a context for their project. Students will subsequently develop an architectural proposal for an underground library specific to the fictional world established. The proposal should be informed by an understanding of issues relating to this typology and a speculative reading of opportunities offered by still-developing virtual technologies. Students should articulate a critical stance regarding the role of libraries and investigate novel ways of blending virtually and physically situated experiences through their proposals.The studio will be organised around several short exercises relating to narrative building, design of the physical and virtual library components, and their synthesis. Students are required to present their project through scripted VR experiences, supplemented by drawings, physical models and a booklet recording their entire design process throughout the term.

1 The name Google itself originated as a misspelling of the word googol—a quantity described by the number 1 followed by 100 zeroes.2 5 exabytes (1 exabyte is a billion gigabytes) of digital content is produced. Eric Schmidt and Jared Cohen, The New Digital Age (Great Britain: John Murray, 2013), 253.3 Wong, Liliane and Nolan Lushington, "The Library in its Social Context," in Libraries: A Design Manual, eds. Lushington, Nolan, Wolfgang, Rudorf and Liliane Wong (Basel: Birkhäuser, 2018), 11.4 Polson, Nick and James Scott, AIQ (New York: St. Martin's Griffin, 2018), 131.5 Today, some AI generated content is almost indistinguishable from our own. Leo Benedictus, "Man v machine: can computers cook, write and paint better than use", Guardian, accessed January 29th, 2020, https://www.theguardian.com/technology/2016/jun/04/man-v-machine-robots-artificial-intelligence-cook-write6 Kleefisch-Jobst, Ursula, "On the Typology of the Library," in Libraries: A Design Manual, eds. Lushington, Nolan, Wolfgang, Rudorf and Liliane Wong (Basel: Birkhäuser, 2018), 22-29.7 Wong and Lushington, "The Library in its Social Context,"10-15.

NARRATIVE

Funding and Affordability

As rare earth metals, chip-grade silicon and **energy deplete**, cloud and silica-based storage have become extremely expen sive and unsustainable. It is now monopolized by mega-corporations, like finance centers, who need speed and redundancy in accessing data and can afford it.

Hence, the world has made a shift to **archiving long-term data in compact chips of DNA**, freeing up the data centers for the transfer of quick and urgent information. **Libraries with their declining budgets** have not been exempted from this wave of change.

Data Decay

In the last decade, **library systems have been overwhelmed by the 175 zettabytes of digital data generated** by the world. File sizes have increased ten-fold with the incorporation of more digital features. Much of this new digital content is important for public access, including textbooks with educational VR maps and more. As technology advances to support this content, outdated but important files lose their accessibility.

Online digital platforms, from research publications to social media platforms, have also begun removing information created before 2030 from digital spaces and converting them into DNA chips to save operational costs. **With large, decaying digital archives from before the 2030's and no money to store them in the cloud, the DNA Library will be the public library's first investment into nascent, developing DNA technology.**

Democratizing Access to Knowledge

The average household now owns a DNA storage fridge and reader to archive their old photos and documents. Typical households pay for DNA writing services, akin to the photo printing shops of the past, to have their photos and documents written into chips, or to make copies of large files for work or school. **However, some families cannot afford these relatively new yet quintessential equipment and services**, rendering various forms of information inaccessible to them. The growing digital divide between the older generation (cloud storage users) and younger ones is also concerning.

The DNA Library will thus play a key role in creating equitable access to knowledge and providing DNA storage education to the community.

Delphine, 30 y/o
Academic Researcher

Since DNA storage became the primary mode of long-time archival, research journals have collated all papers from 10 years prior into DNA chips. The DNA Library has acquired copies of these research papers. Delphine is researching the evolution of COVID-19 in the 2020's, and needs to use the library to find and access relevant papers.

Searching Catalogues

Consults a librarian and searches the digital catalogue for labels and abstracts

Browsing

Grabs a basket. Lights guide her to her requested location

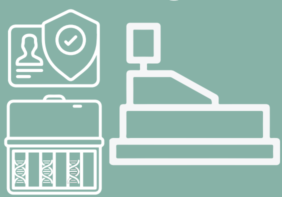
Loading

Loads the DNA to computer readable information. Delphine explores other things.

Reading

Sits at a computer workstation to read

Borrowing

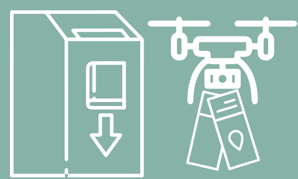


Borrows book with an authorized pass

Shopping

Purchases DNA storage equipment

Returning



Chips returned for sorting and shelving

The DNA Collection

DNA ARCHIVAL: Library of Congress Classification System (LCC)

By 2025,
175 ZB in the world

By 2050,
100,000 TB/computer

≈ **DNA Library:**
175,000 unique chips

Assuming
5 copies/unique chip

and space for expansion
and private storage

≈ **Total DNA Storage**
1000,000 DNA chips

Assuming
1000 chips/stack

Total Stacks
1000

≈ **Total Space**
500 stacks/160sqm

DNA READING MACHINES

Serviced Community
The Public

Majority Footfall
1000 academics, students, people archiving info, general readers/day

→ **Total Machines**
100 available

Academic Machines
15

Basic Machines
20

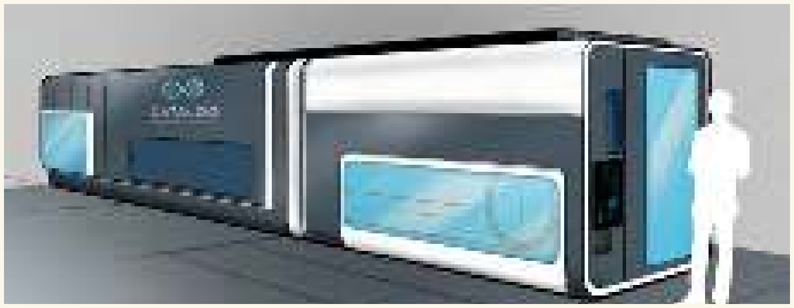
Portable Sequencers
65

DNA WRITING MACHINES

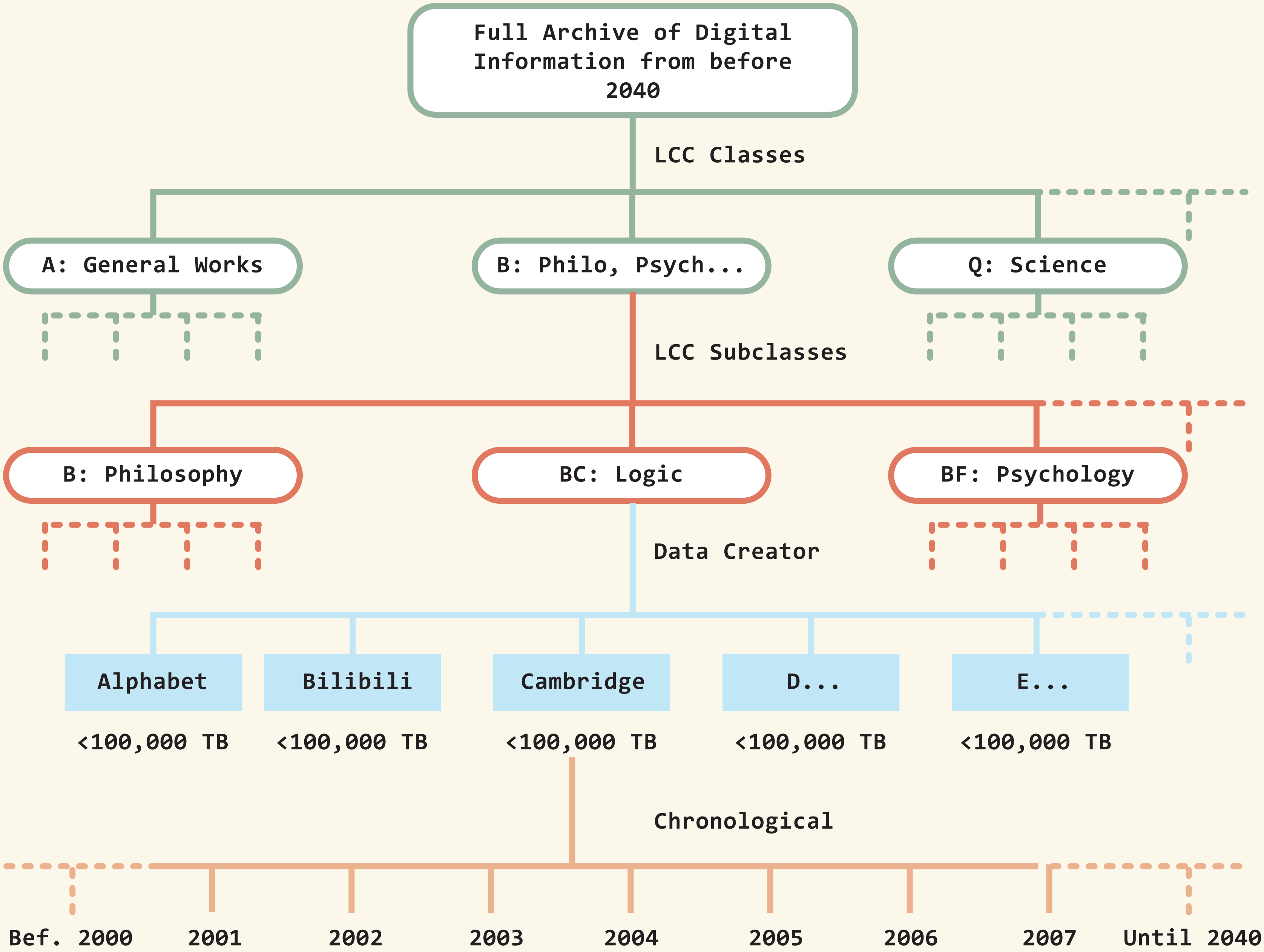
Serviced Community
Librarians, volunteers, paying civilians

Users
20 / day

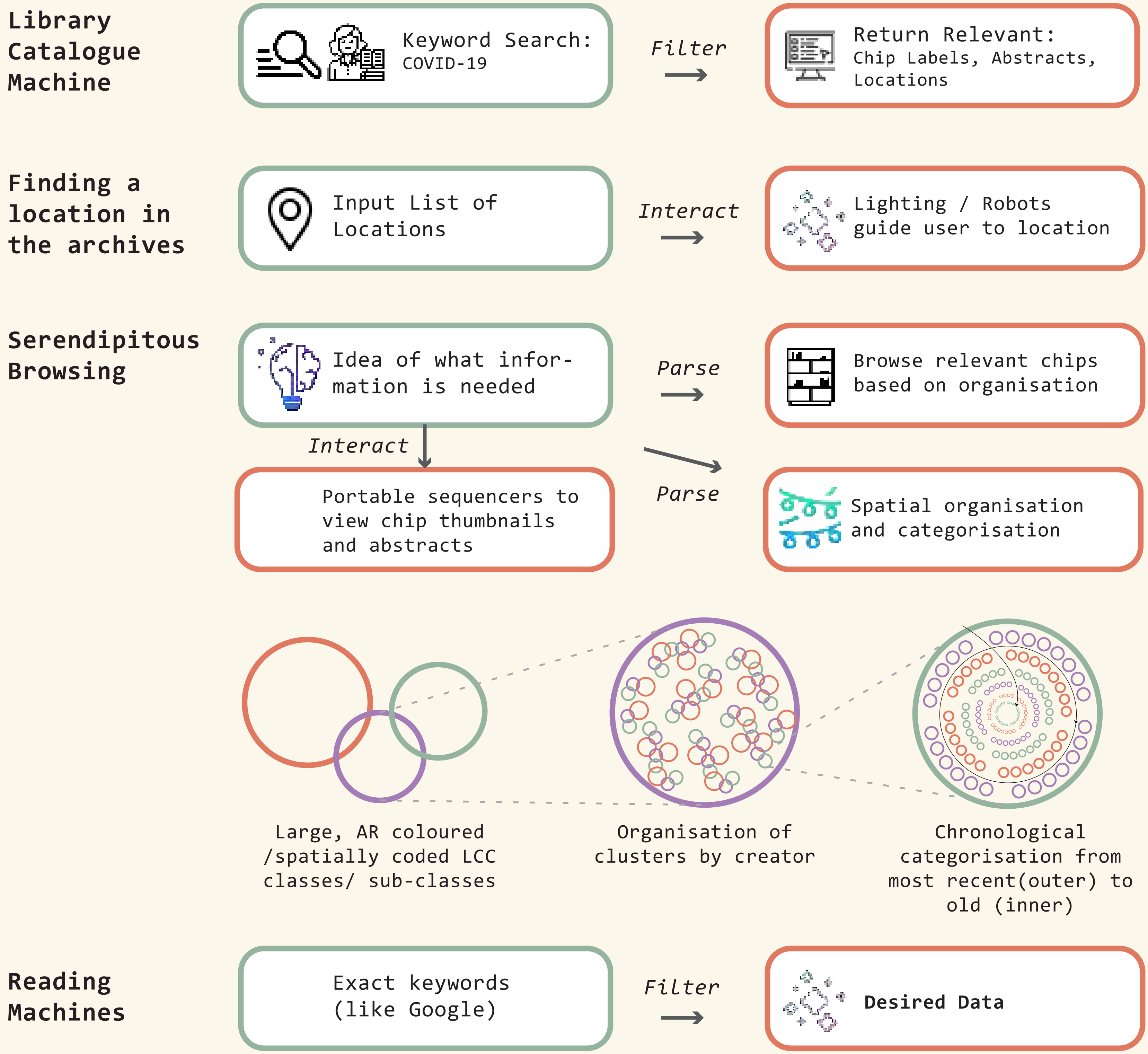
→ **Total Machines**
5



Collection Organisation



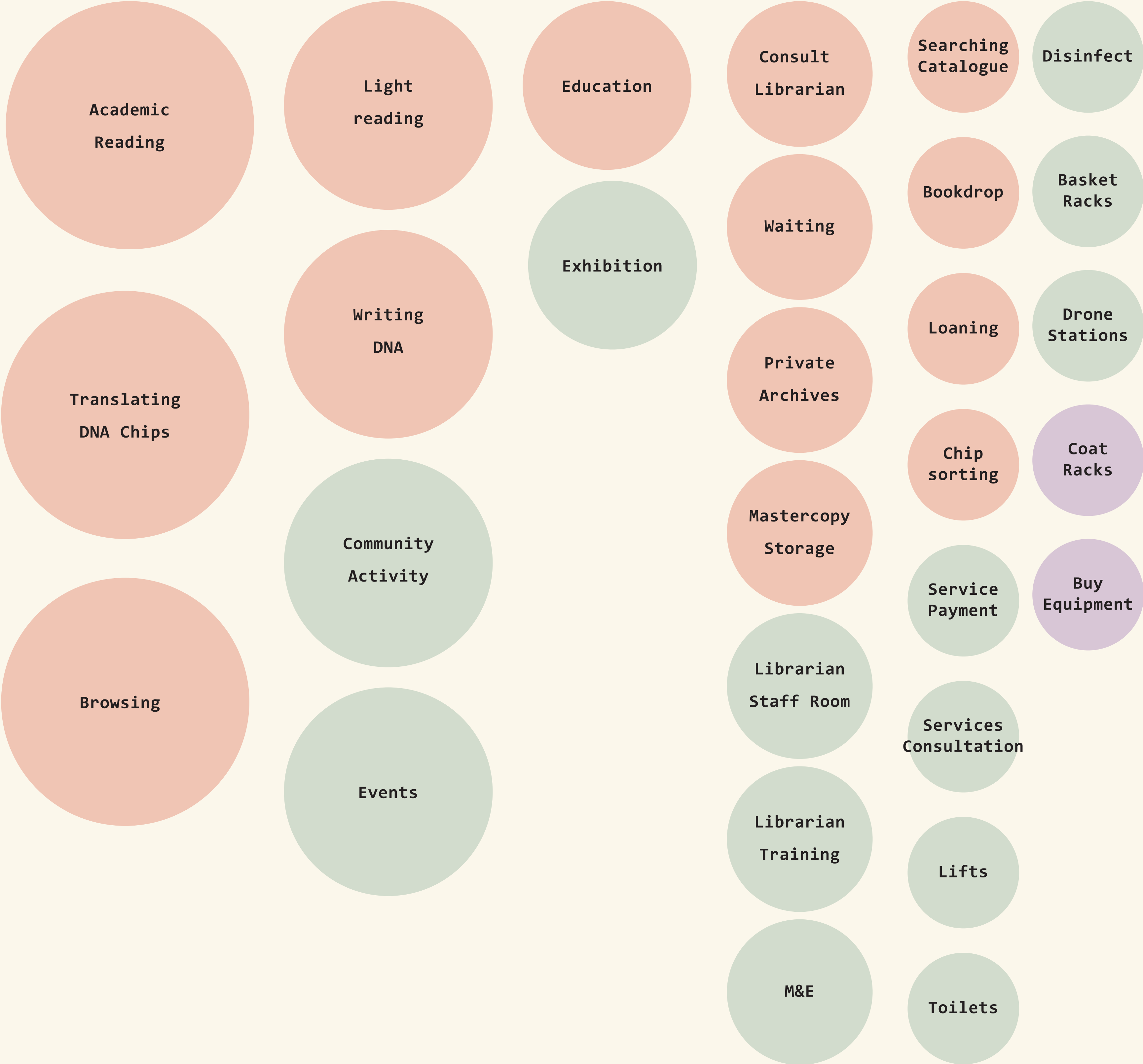
Interacting with the Collection



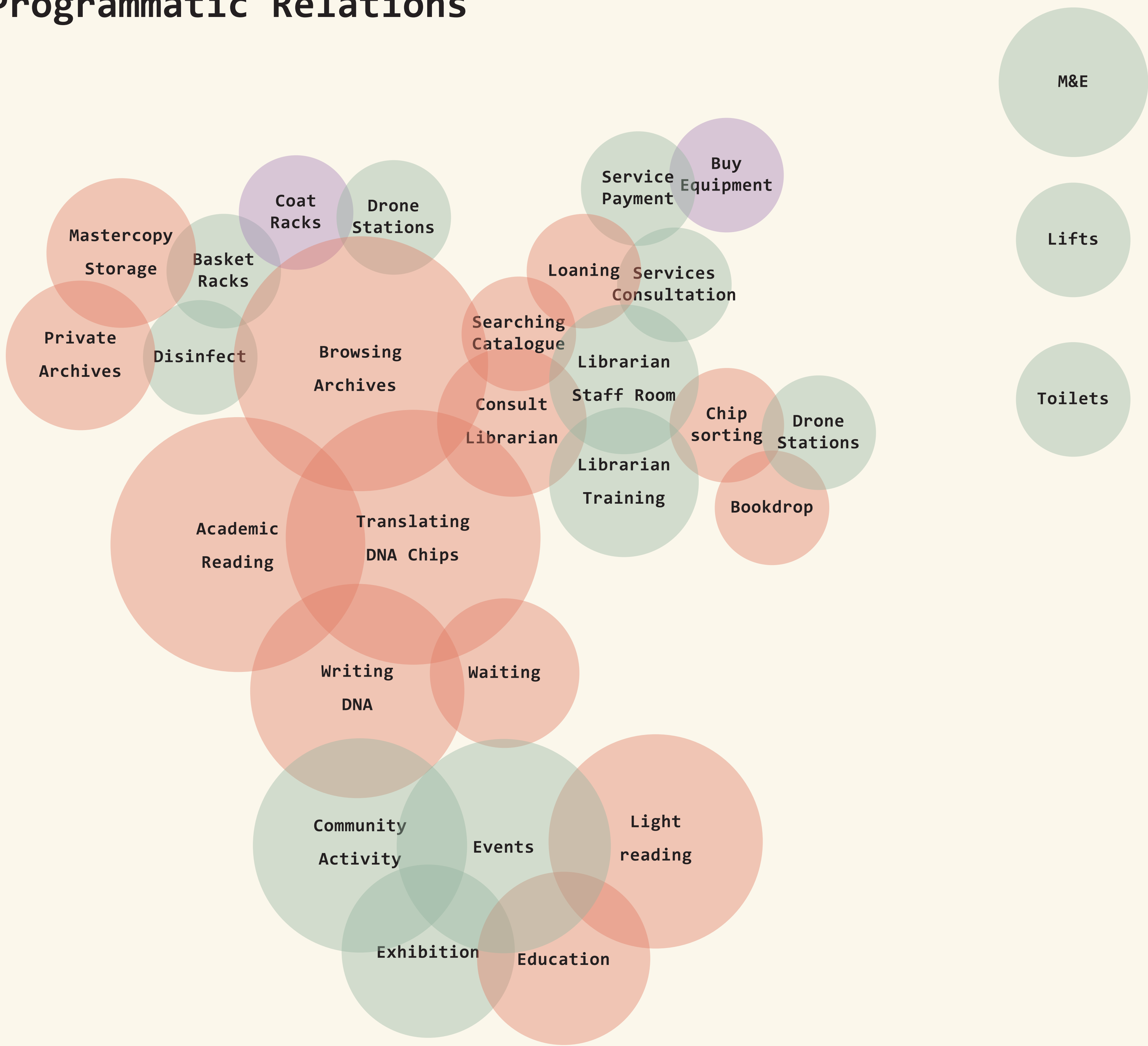
Programme Requirements

Hierarchy	Light (1-5)		Space		Authorization	
Primary Activities						
Light reading	5	Most Light	4	Most Space	5	
Education	5		3		4	
Consult librarian	5		2	Least Space	5	
Academic Reading	4		5		3	
Searching Catalogue	4		1		5	
Translating DNA	3		5		4	
Writing DNA	3		4		3	
Waiting	3		2		5	
Book Return	3		1		5	
Borrowing chips	3		1		4	
Browsing	2		5		4	
Chip return sorting	2		1		1	
Paid Archives	1	Least Light	2		2	
Store master copies	1		2		1	
Secondary Activities						
Community activity	5	Most Light	4		5	
Events	5		4		5	
Featured exhibition	5		3		5	
Librarian staff room	4		2		4	
Librarian training	4		2		4	
Payment for services	4		1		4	Most Public
Service consultation	4		1		4	
Lifts	3		1		3	
Toilets	3		1		3	
Disinfecting rooms	3		1		3	
Chip basket racks	3		1		3	Most Private
M&E	2	Least Light	2		2	
Drone/Robot stations	2		1		2	
Tertiary Activities						
Coat racks	3		1		3	
Buy DNA storage items	3		1		3	

Spatial Requirements



Programmatic Relations



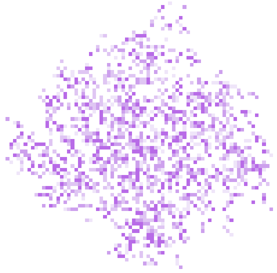
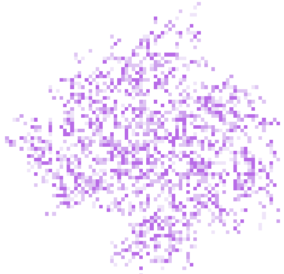
GENERATIVE DESIGN

Curve network Diffusion Limited Aggregation algorithm

Increasing DLA Density

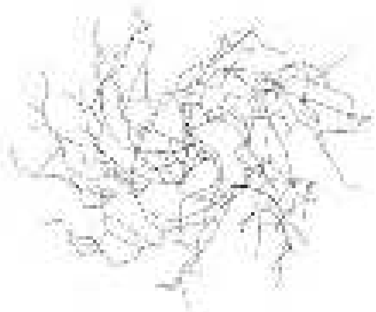
count = 30000 | count = 40000 | count = 50000 | count = 60000 | count = 70000



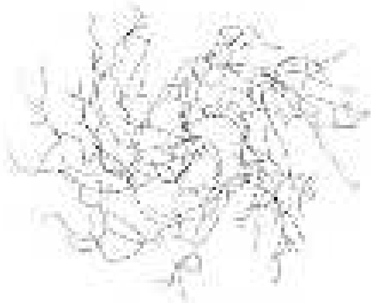




Curve Processing

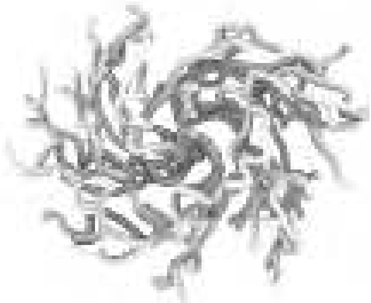
Initial Polylines



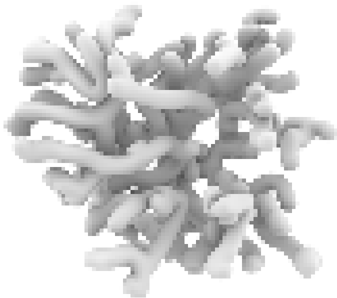
Transform to Curves



Multipipe, Uniform Radius



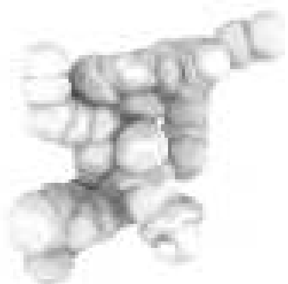
Pipe with Larger Radius



Modification Attempt 1

A few branches of the DLA was sliced off with rounded shapes arrayed along it to simulate natural cave formation.





SITE CREATION

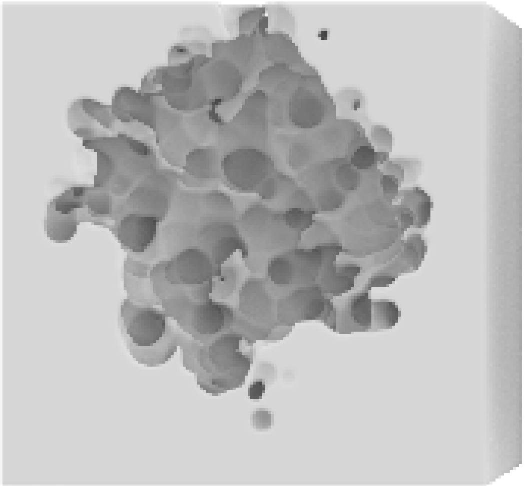
Merging Pipes

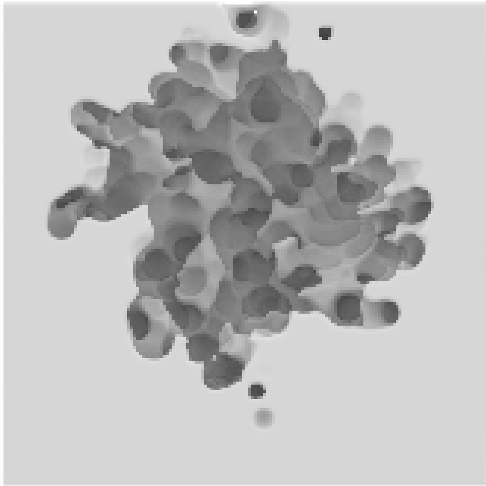
Rather than using a series of tunnels, this approach relies on the merging of pipes along the DLA generated curves to create a diversity of spaces.

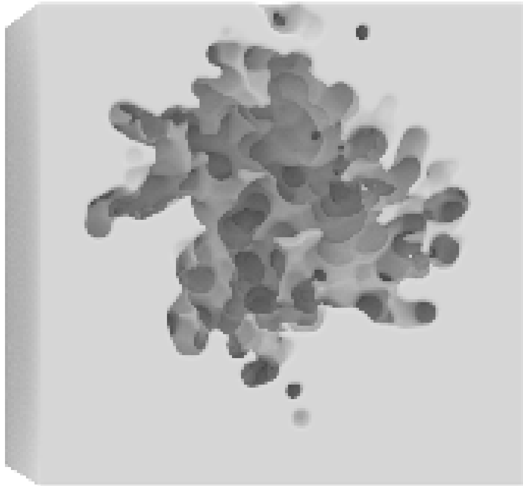
Pipe diameter decreases radially outward, creating a large void in the center, as well as small alcoves and overhangs at the edges

Larger pipe diameters

Thinner pipe diameters

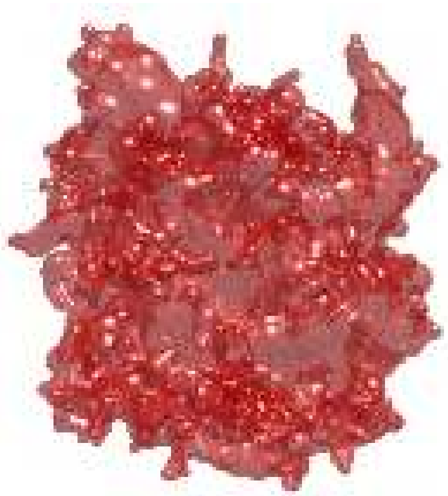






Increasing radius of outer curves creates a central rock shaft

Increasing radius of inner curves creates a central void



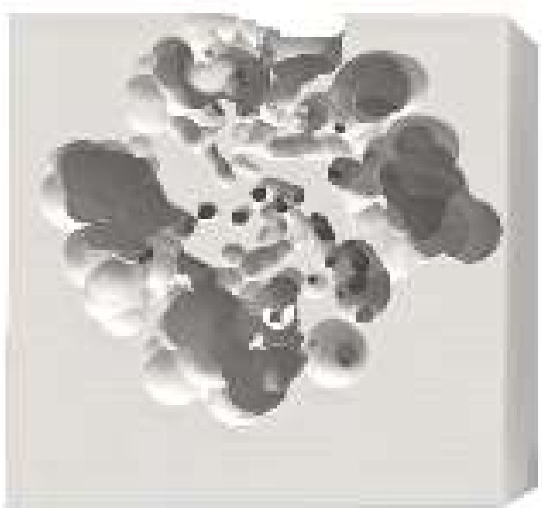
REFINING THE SITE

Pipe diameter was mathematically defined to increase exponentialy outward, then decrease again near the edge. This created a central column of rock that increased the area of overhangs and that circulation could center around.

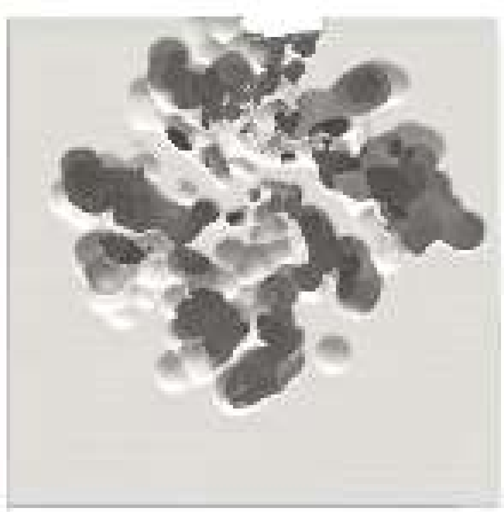
Special care was taken to manipulate the diameter of the pipes to create usable spaces in the small alcoves along the cave walls.

Through this, I achieved my three goals:
1) Creating a site with large amounts of overhangs
2) Creating a wide variety of spaces with a central area for circulation
3) Creating a site that simulates a natural rock formation

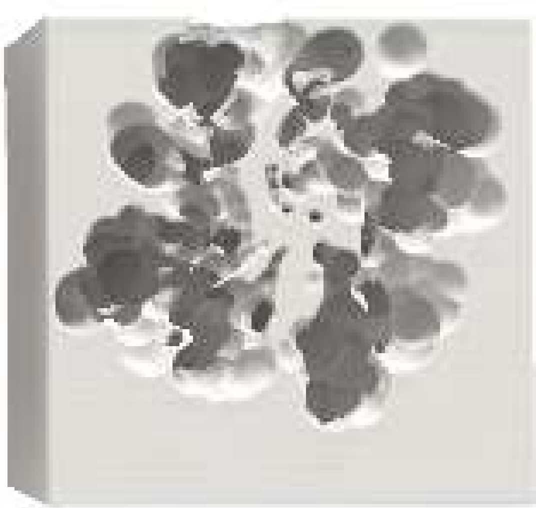
Central rock columm occupied too much space



Rock column became too thin to realistically support weight

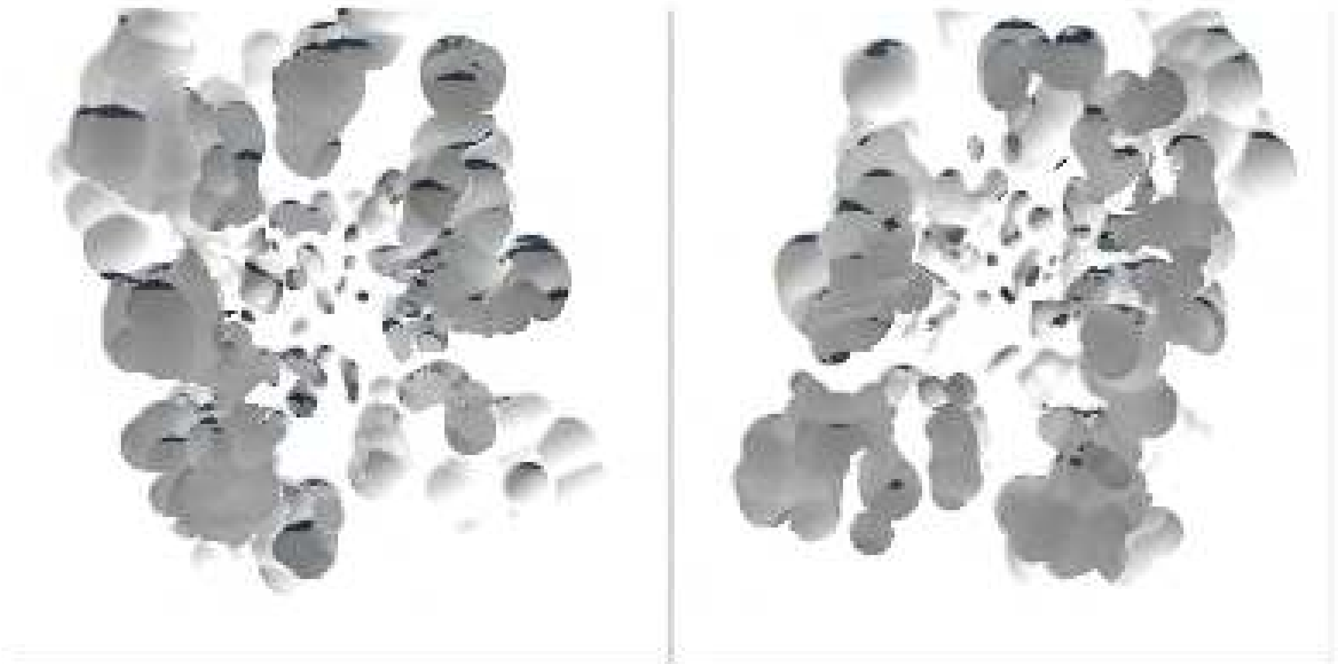


Final Result: Variety of spaces and rock column achieved

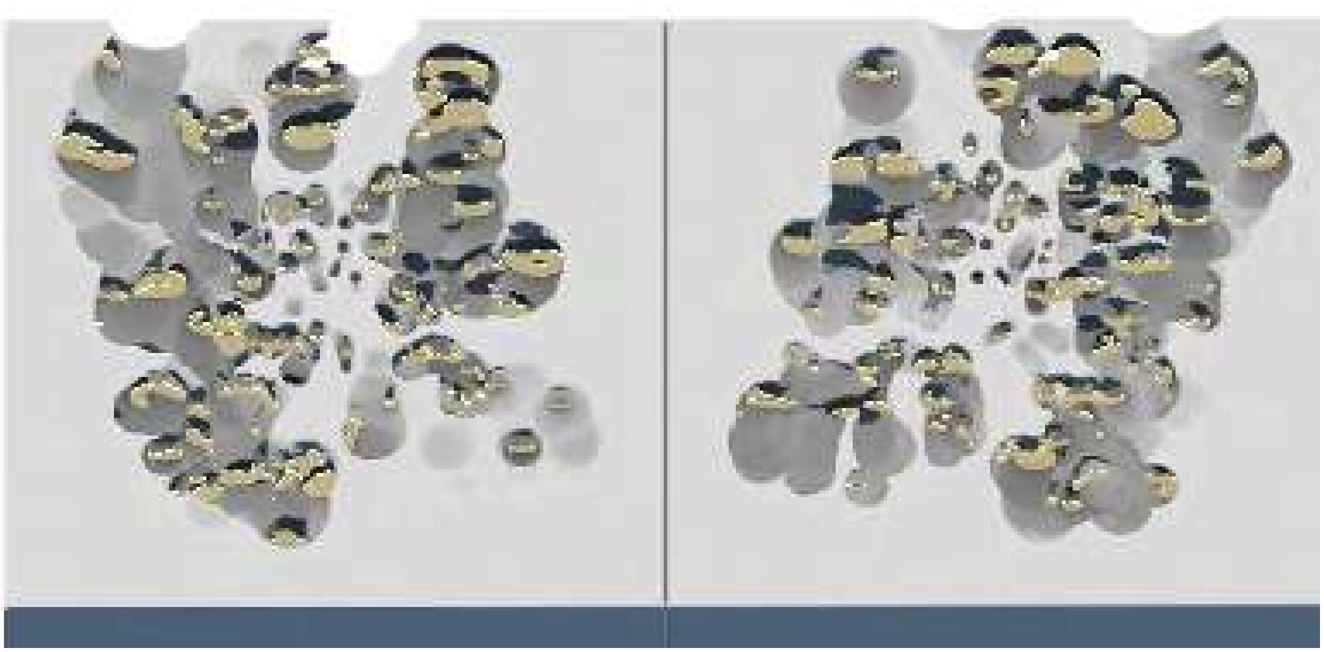


SITE ANALYSIS

OVERHANG ANALYSIS



Generate platforms beneath



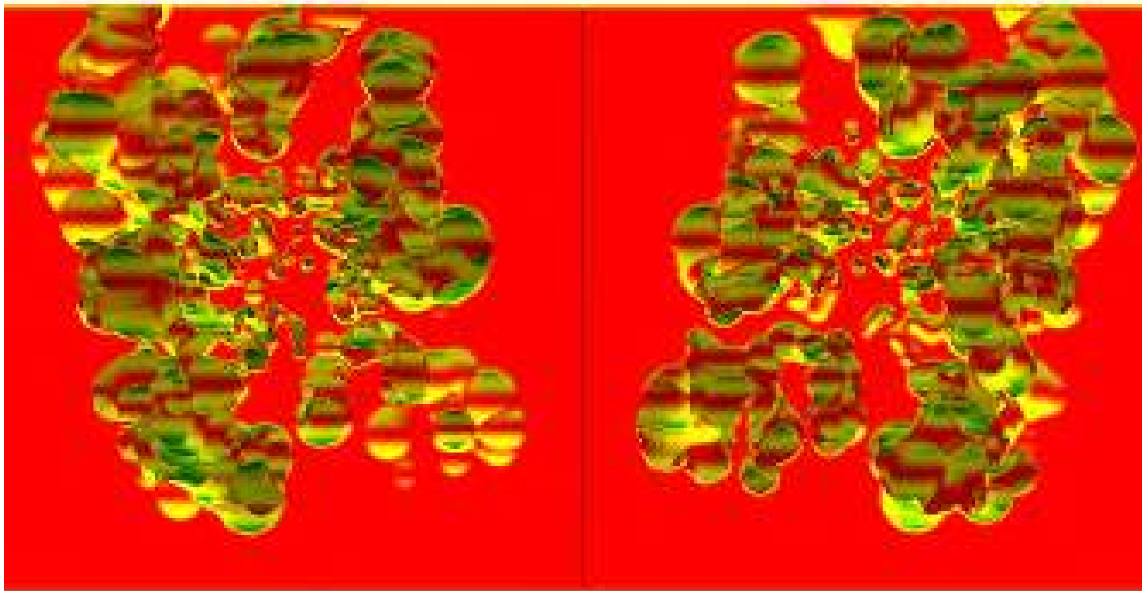
SITE ANALYSIS

CURVATURE ANALYSIS

Highest curvature

Slightly curved

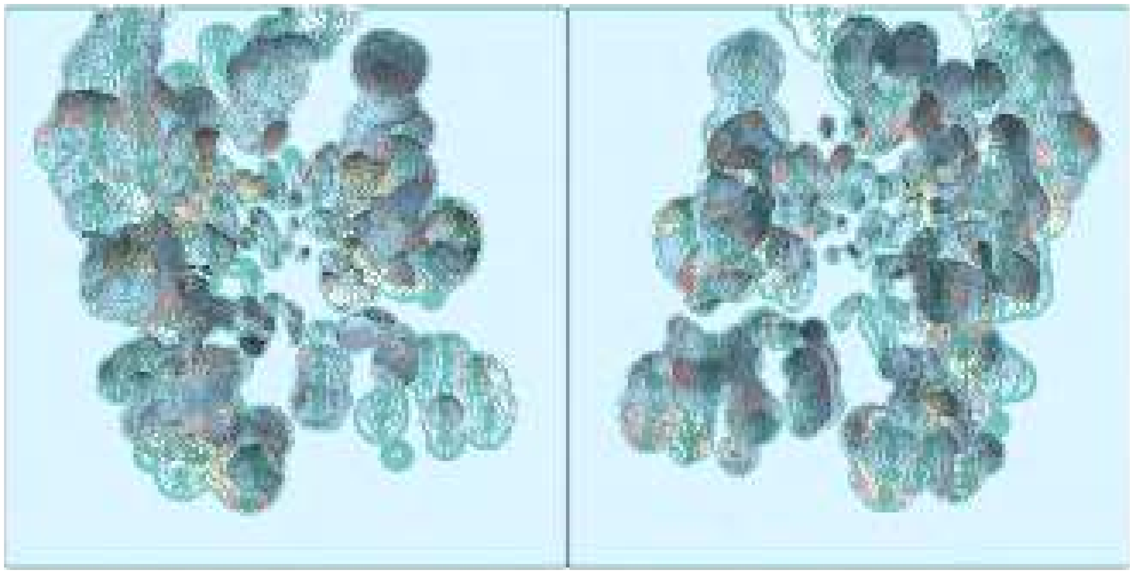
Lowest Curvature



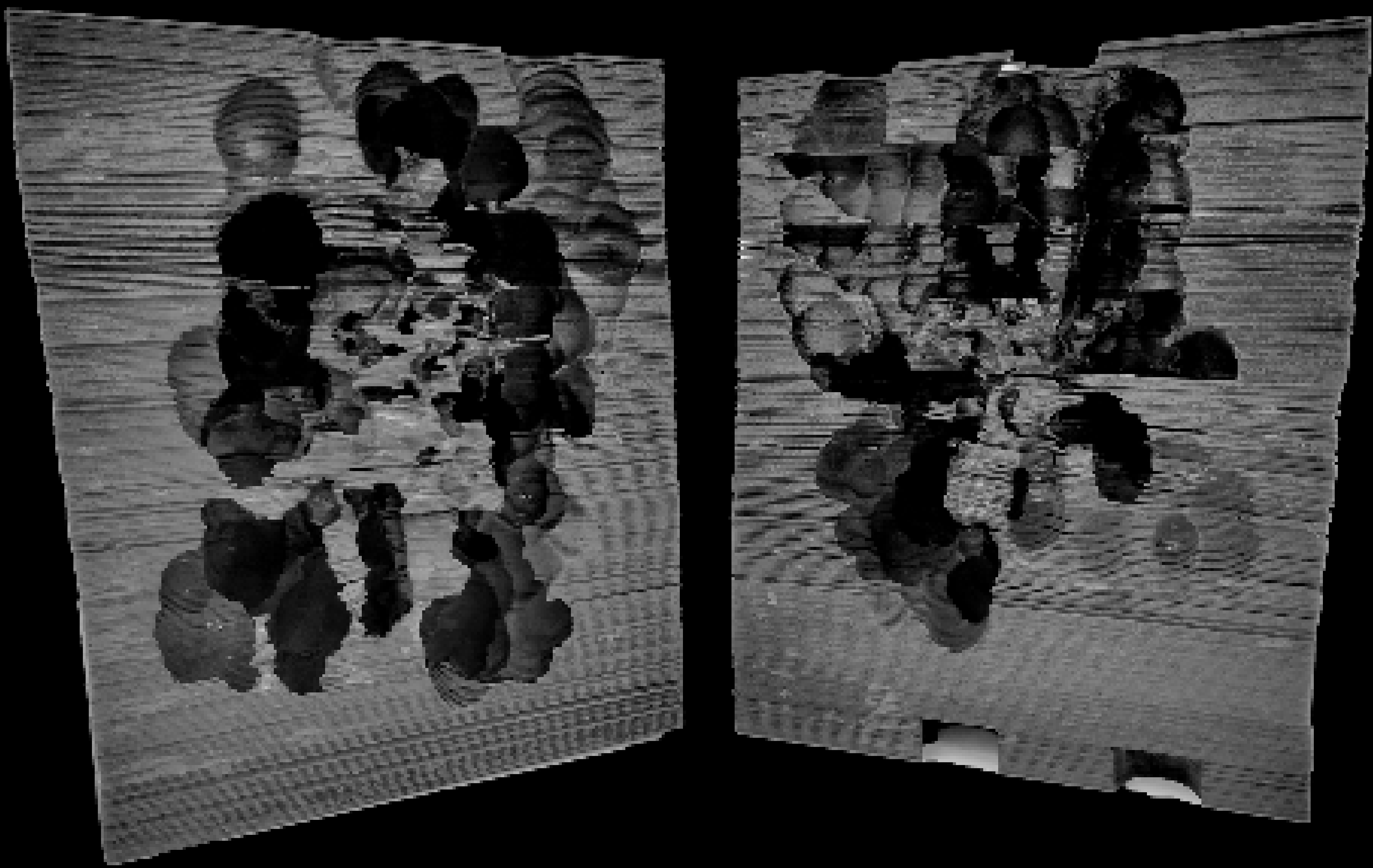
HEIGHT ANALYSIS

Greatest amount of vertical space

Moderate amount of vertical space

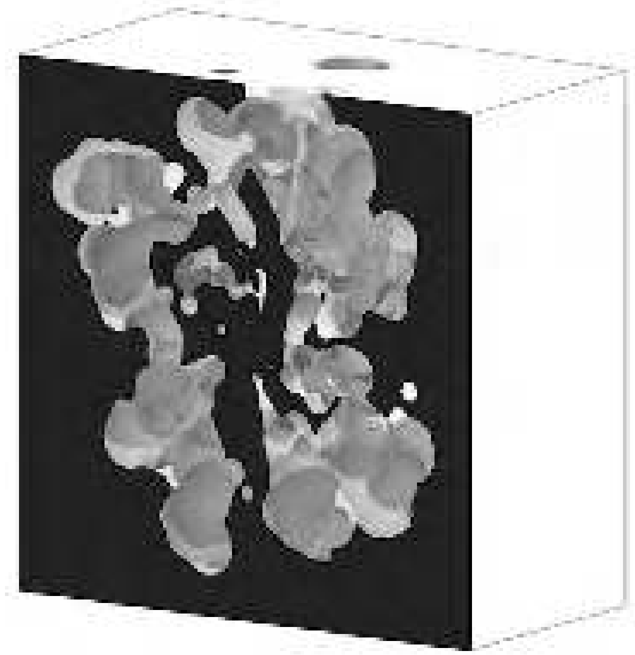


SITE MODEL

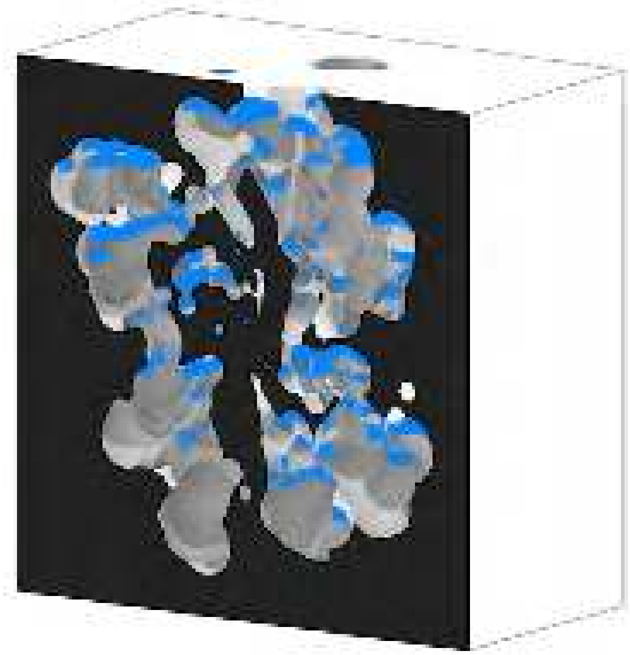


DESIGN SYSTEM

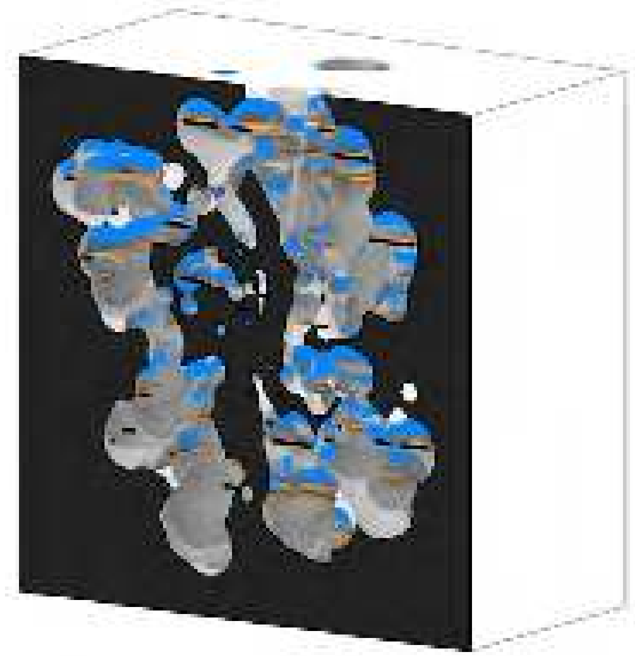
Mesh analysis locates over-
hangs



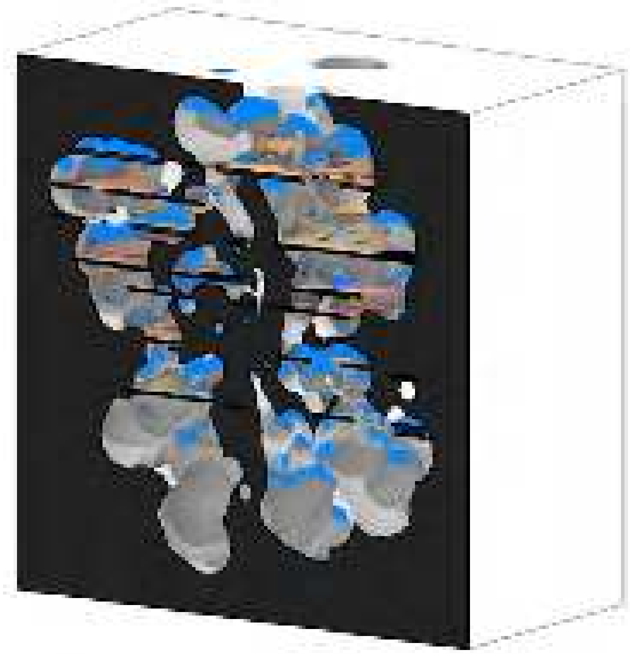
Hanging stacks are arrayed on
the overhangs



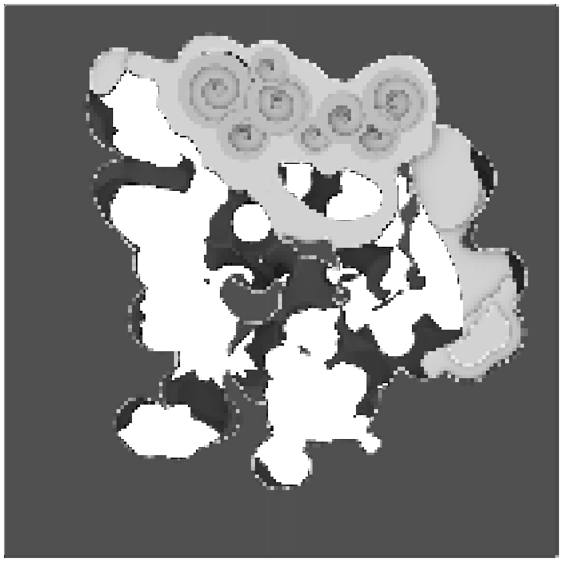
Shape of stack clusters are extracted
and extruded to create platforms



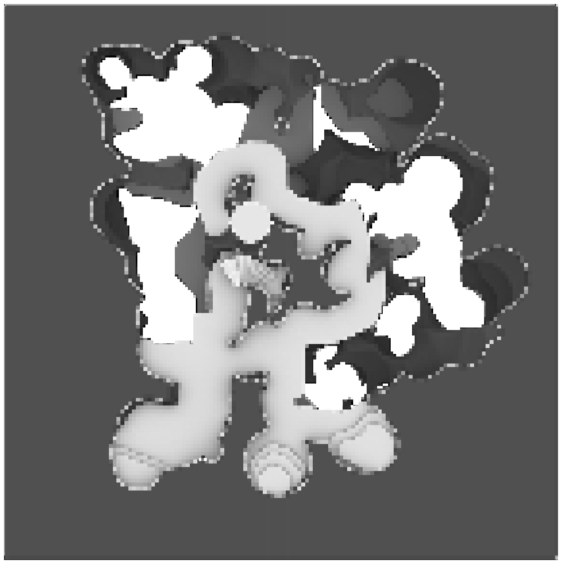
Platforms within a meter of each
other are clumped together



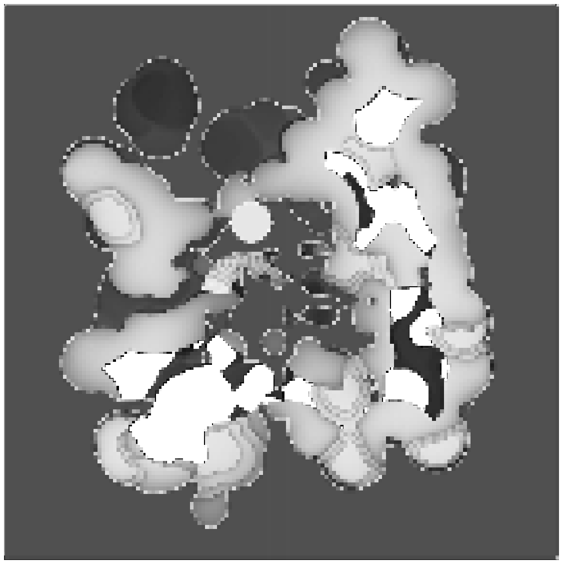
PLATFORM AND LINKWAY TYPES



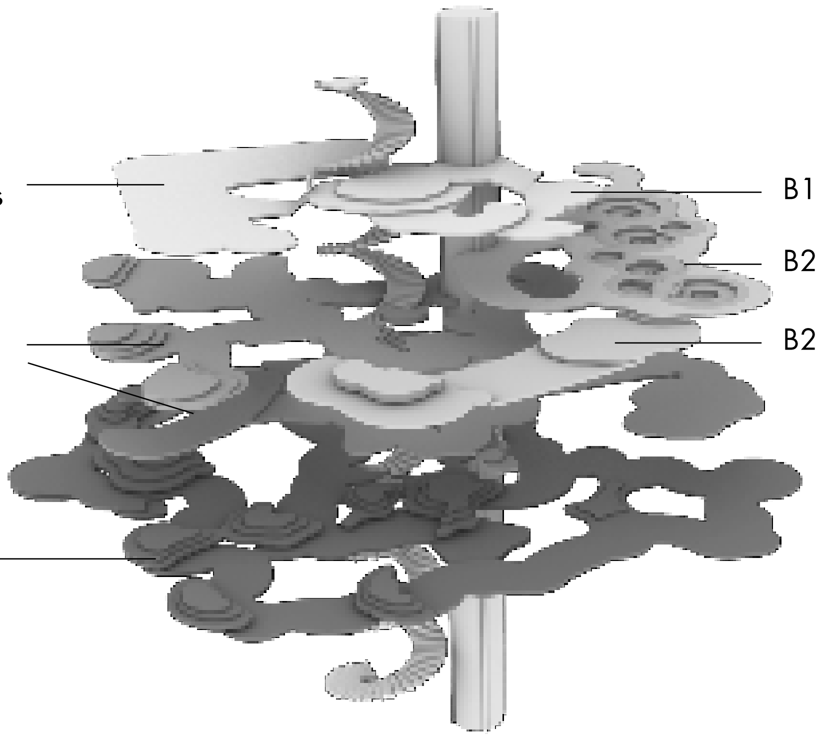
One-sided slab in areas with high stack density



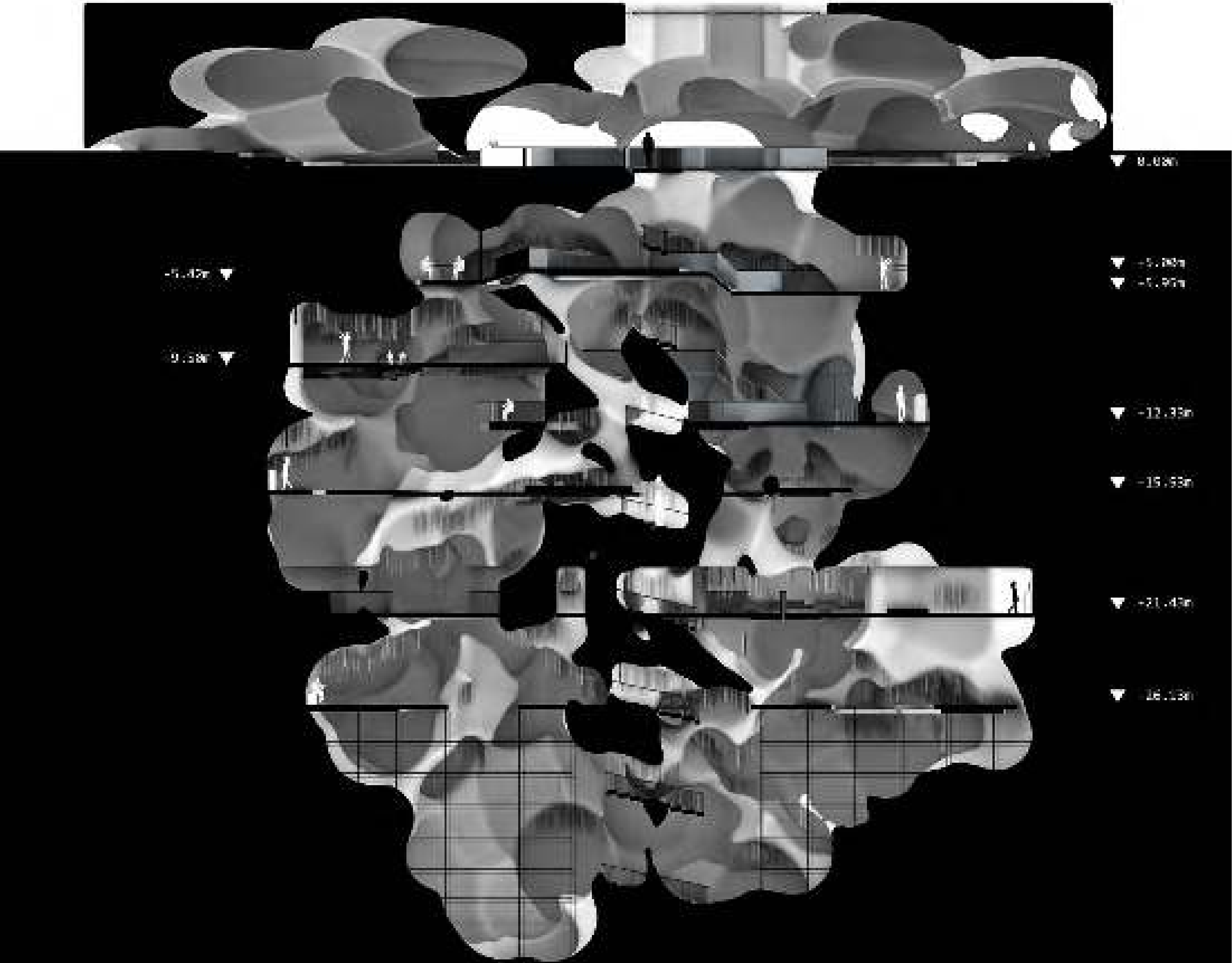
Offset from the central shaft and linked to dense stacks



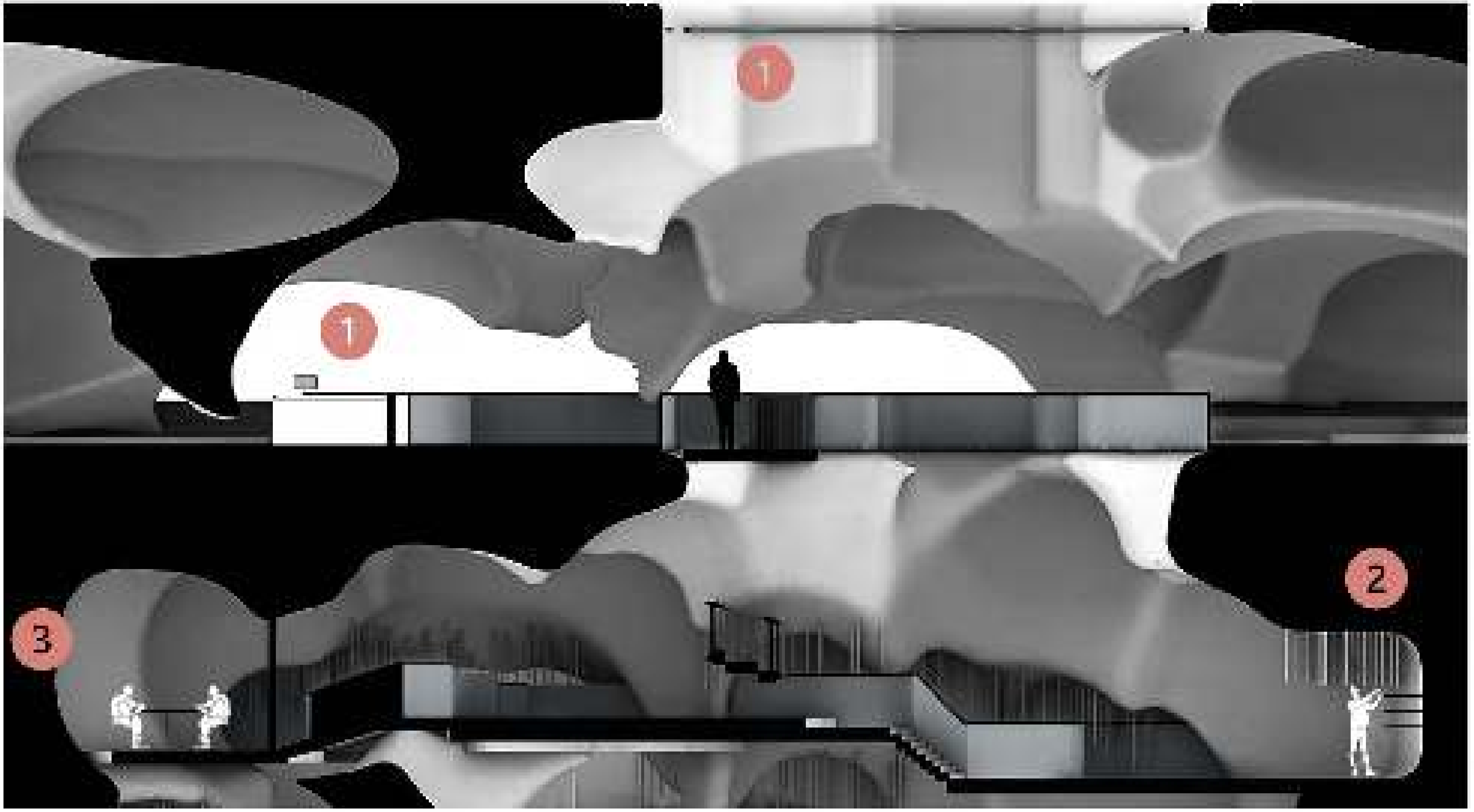
Offset from outer ring of rock



SECTION



SECTION

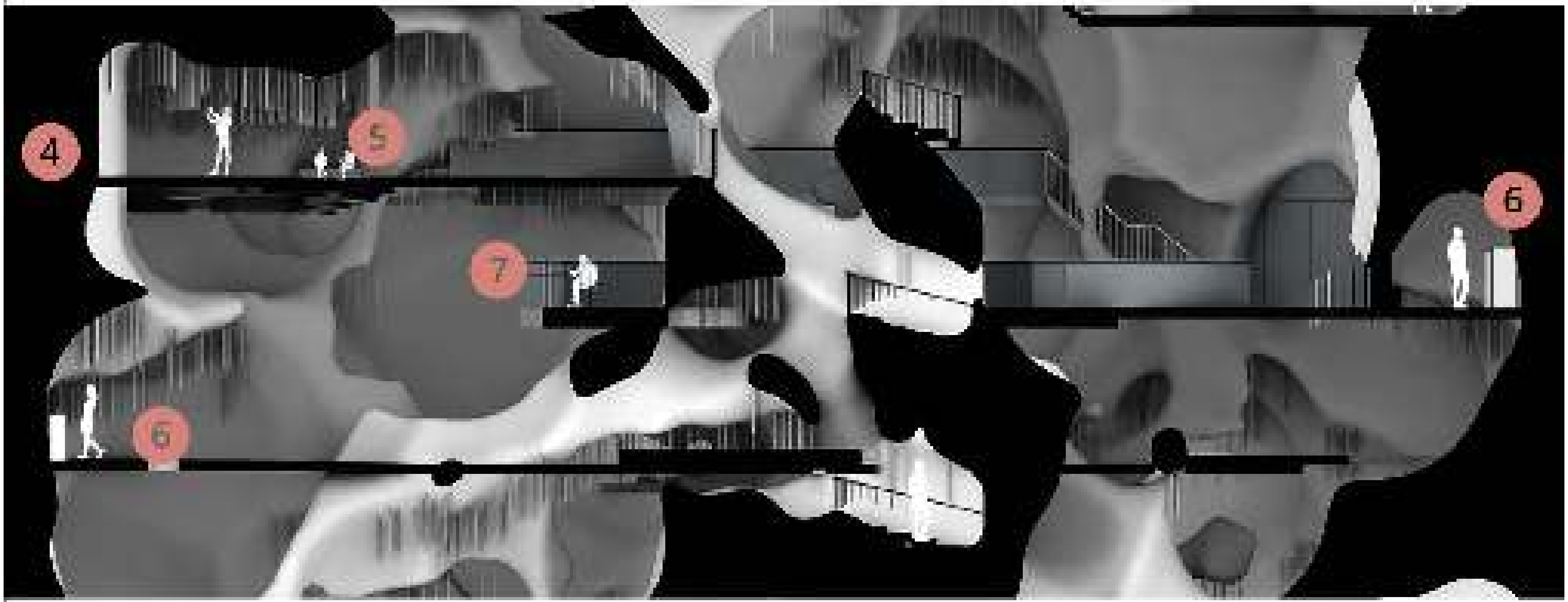


1 Chip return and drone racks

2 Lobby, directories, VR glasses and Cool Box borrowing shelves

3 Meeting / Activity room

SECTION



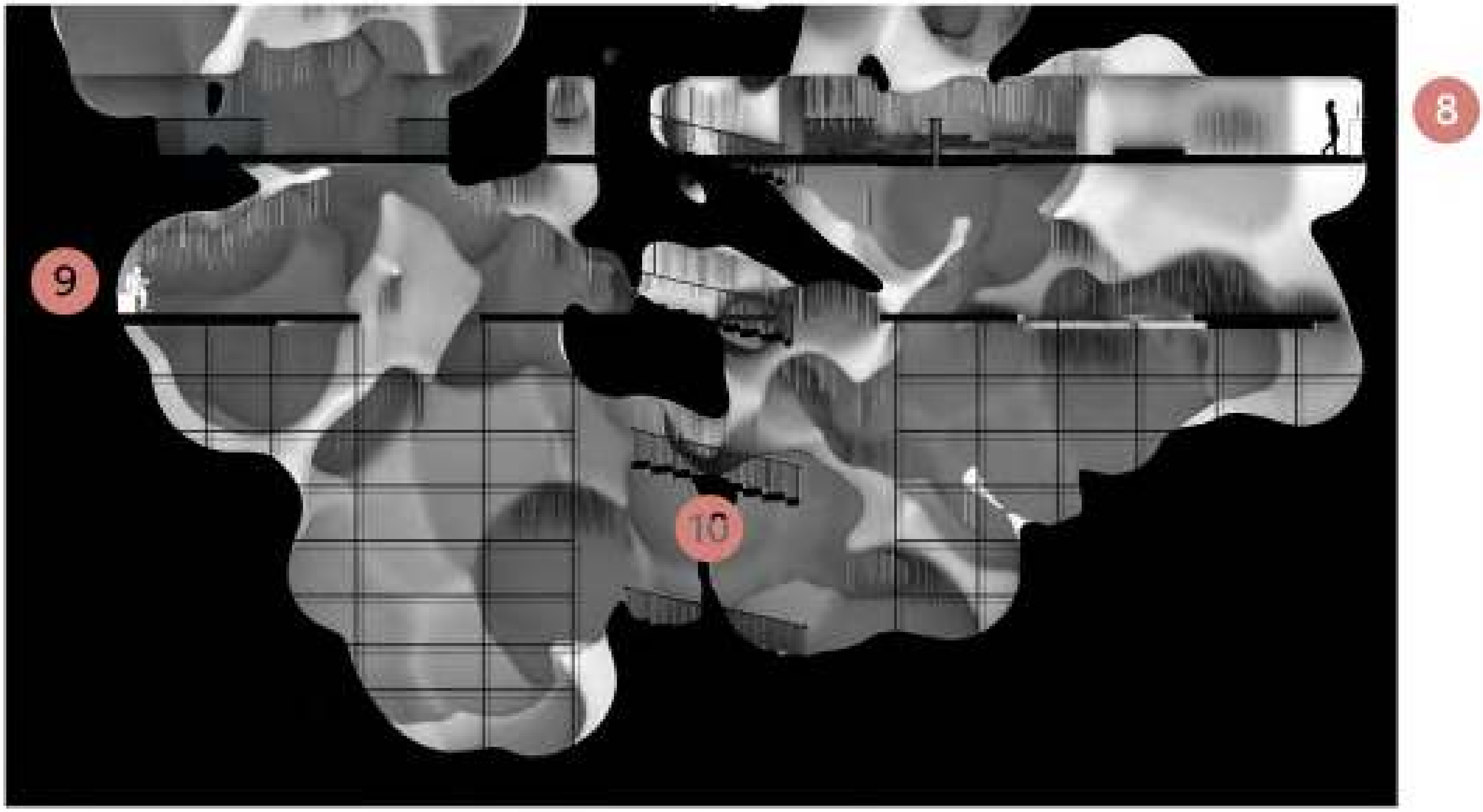
4 Large spiral stack collection on B2

5 Light reading, small reading machine alcoves

6 Heavy-duty, large DNA readers on B3

7 Desks for reading

SECTION

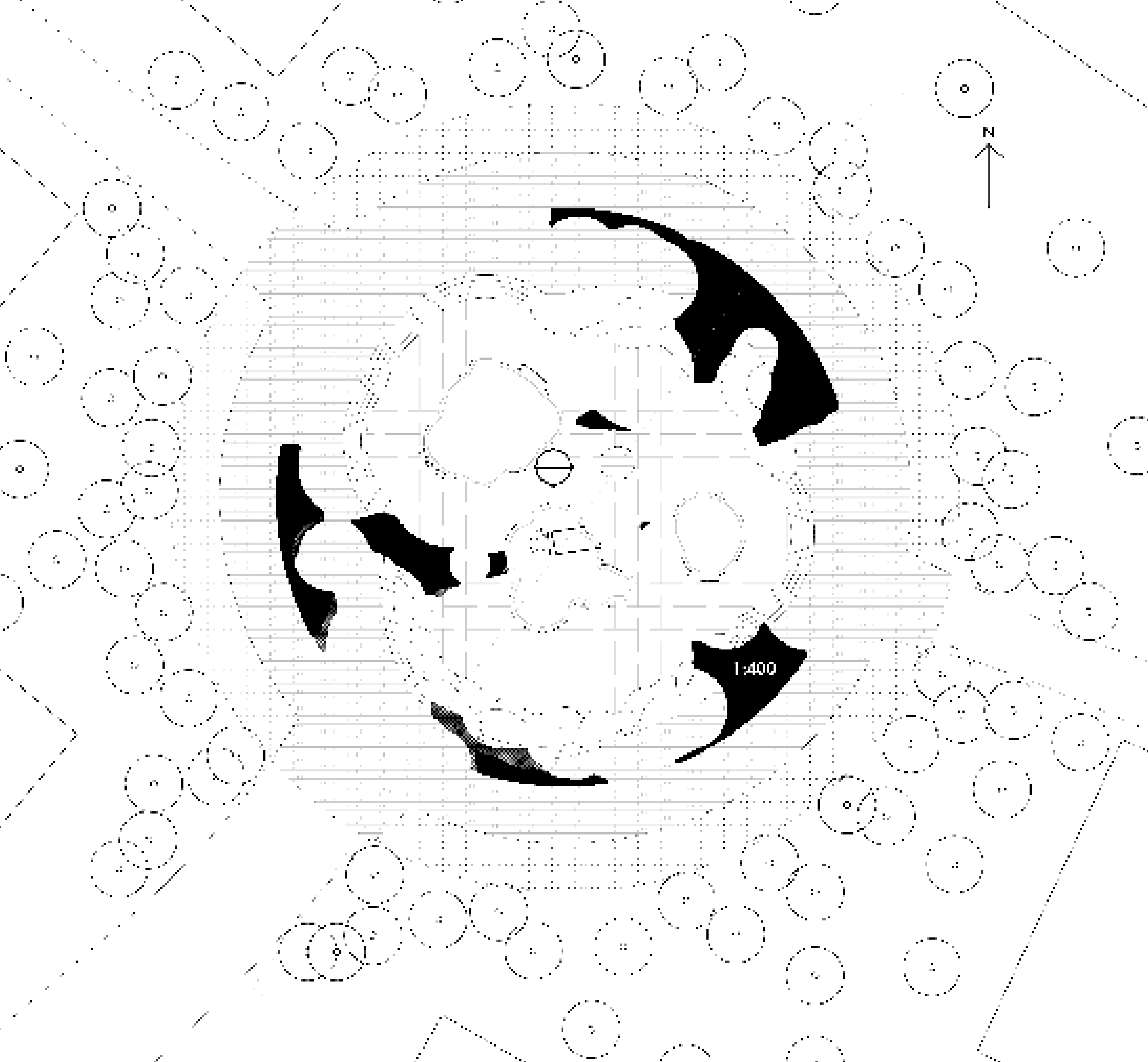


8 Workstation and small DNA readers. Main browsing floor (B5).

9 Reading alcoves. Main browsing floor (B6).

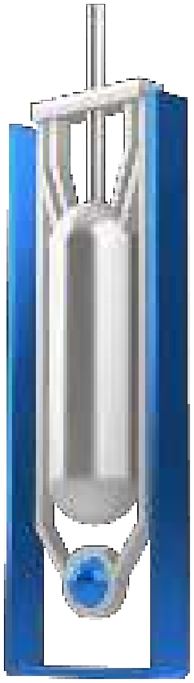
10 Master-copies and private archival racks (Librarian access only

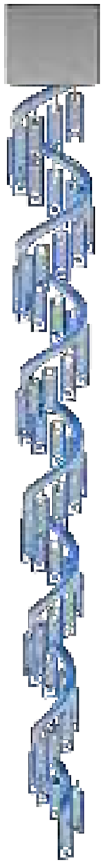
1:400 ROOF PLAN

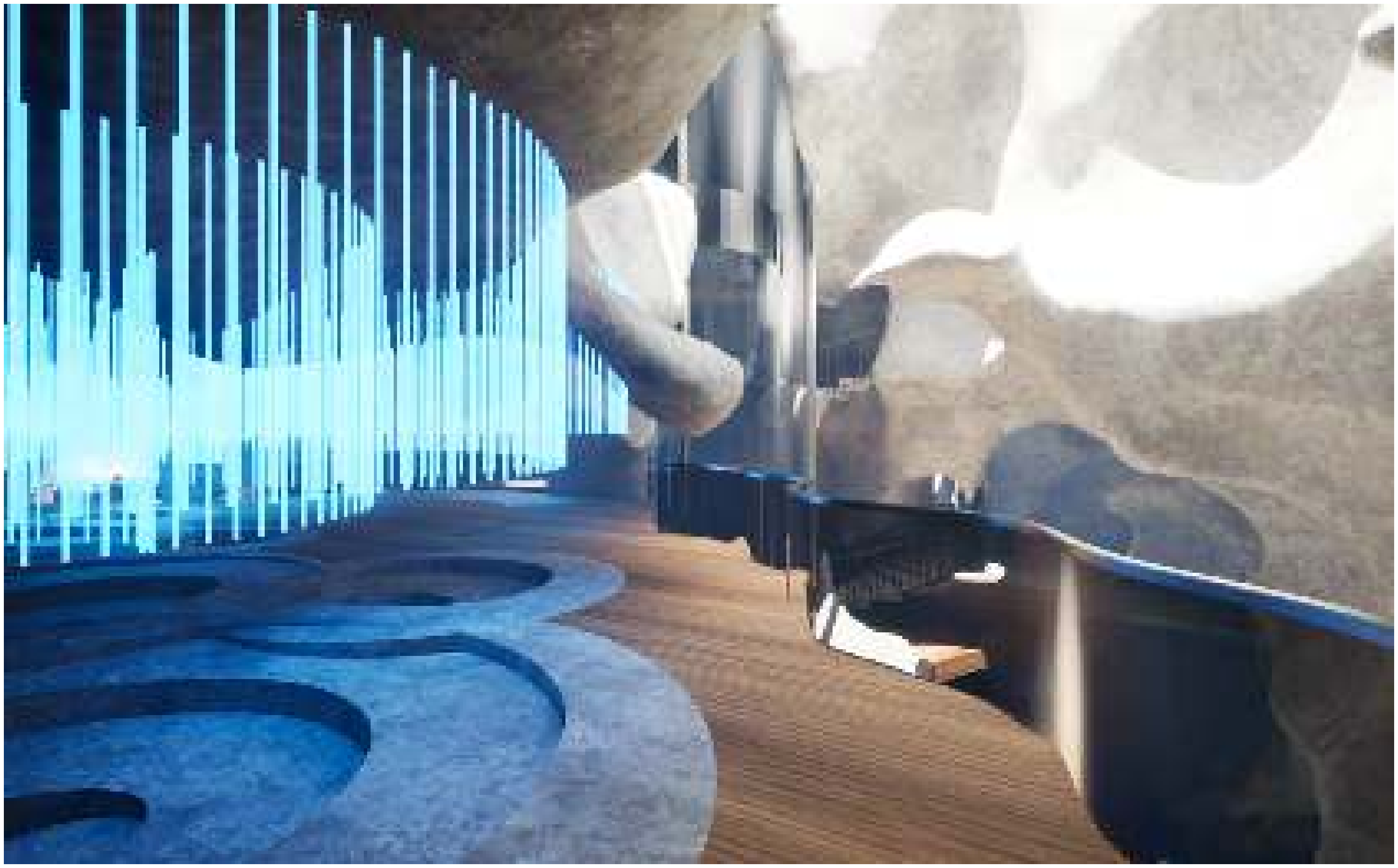


1:200 B1 FLOOR PLAN

THE STACK








Medicine
RA
Public aspects
RB
Pathology
ITP


POD2