

Engineering Strategies & Practice

University of Toronto
Faculty of Applied Science and Engineering
APS111
Conceptual Design Specifications (CDS)

Team #	149	Date	December 4 2023
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Project Title	Hart House Renewal Project - Wayfinding
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Please check off which components you are submitting for your assignment.

- CDS submitted as a PDF to Quercus with the following components:
- | | |
|--|--|
| <input checked="" type="checkbox"/> Cover Page | <input checked="" type="checkbox"/> Alternative Designs |
| <input checked="" type="checkbox"/> Executive Summary | <input checked="" type="checkbox"/> Proposed Conceptual Design |
| <input checked="" type="checkbox"/> Introduction | <input checked="" type="checkbox"/> Specification |
| <input checked="" type="checkbox"/> Problem Statement | <input checked="" type="checkbox"/> Measures of Success |
| <input checked="" type="checkbox"/> Service Environment | <input checked="" type="checkbox"/> Conclusion |
| <input checked="" type="checkbox"/> Stakeholders | <input checked="" type="checkbox"/> Reference list |
| <input checked="" type="checkbox"/> Detailed Requirements (FOCs) | <input checked="" type="checkbox"/> Appendices |
| | <input checked="" type="checkbox"/> Attribution Table |

If any required components are missing, your assignment is considered incomplete. It will accrue standard late penalties until completed.

1.0 Executive Summary

Hart House is one of the University of Toronto's well-known student event centers, but the old building style and design is unconventional by modern standards. The building's current wayfinding system is insufficient to direct users given the building's confusing layout.

Hart House's layout is complex, where the gap is the absence of a feasible navigation solution. The need is an intuitive, adaptable wayfinding system. The scope of this project includes all floors (Appendix A), as well as the staircases and accessibility ramps immediately outside of the Hart House entrances. The primary users of the facility will be university students.

Redesigning Hart House's wayfinding system involves the influence and impacts of many stakeholders. Some, like the student body at U of T, fund the project, while event hosts might expect increased attendance and participation. Hart House owes acknowledgment to the Huron-Wendat, the Seneca, and the Mississaugas of the Credit for its operation on treaty land.

The design's primary function is to direct users to their intended destinations, which is achieved by providing them with activity and navigational information. The objectives consist of a design that is most importantly reliable and adaptable, but also aesthetic and economic. The constraints include ensuring usability through the placement of wayfinding resources and textual specifications, as well as ensuring a complete and seamless design through scope and noise constraints.

The team's ideation process consisted of category-based idea generation, which was then narrowed down through multivoting and graphical objectives comparison. Three Alternative designs were selected:

- Building-wide projector system
- Digital kiosk and mobile app
- Wristband tap-activated guidance lights

The team selected the building-wide projector system as the proposed conceptual design, due to its instant display of information, exceptional adaptability, and recognizability. The USB-compatible projectors enable Hart House to match aesthetics, and acknowledge indigenous groups with the navigation system by instantly uploading the desired display graphics. These graphics can provide users with a diverse range of information, and provide further details through animation/video.

The evaluation of the design's reliability will allow optimization before implementation. This includes the development of an agent-based simulation of the system based on data collected from real-world interactions between users and individual projections.

2.0 Introduction

Hart House (Figure 1), located at the heart of The University of Toronto, is an institution for art, culture, and wellness where students, faculty, and visitors can participate in a variety of events. Hart House embodies the rich history and cultural significance of the university.

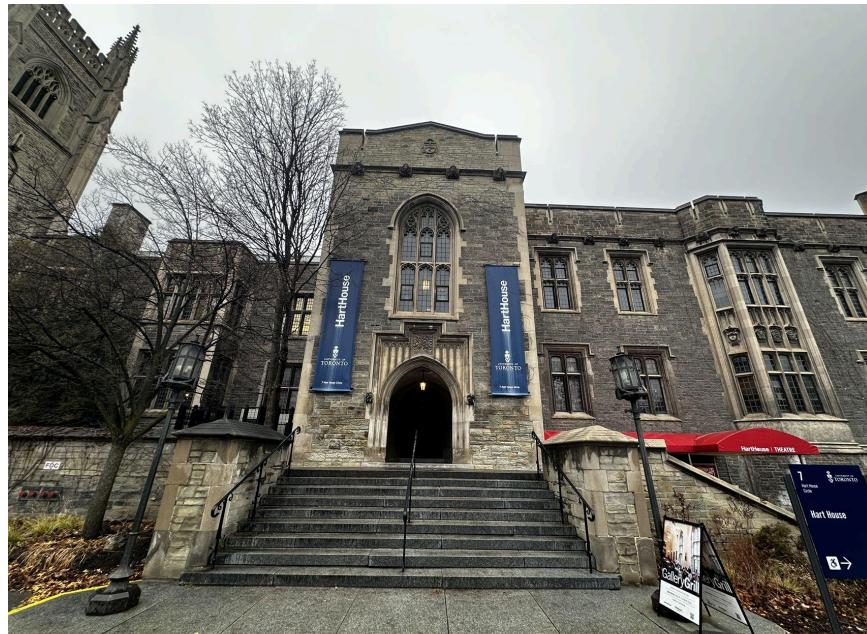


Figure 1: Hart House main entrance

Hart House's Director, David Kim, recognizes the challenge of navigating the building, which discourages its use. This document investigates the shortcomings of Hart House's current wayfinding system and develops design requirements accordingly.

3.0 Problem Statement

Wayfinding problems in public settings have been linked to psychological and physical distress, negatively impacting how users view the space [1]. Hart House's outdated layout discourages the use of its facilities, impeding the building's purpose as a community centre. To address this, the client would like to implement a flexible and intuitive wayfinding system [2]. Hart House facilities are constantly repurposed with new activities [3], but the only mode of wayfinding present is unalterable signage that gives little information about current events (Figure 2). The text size of common directional signage is 12mm tall, smaller than recommended 15mm accessibility guidelines [4, p. 12]. A well designed navigation system is necessary for signage to be effective [5].

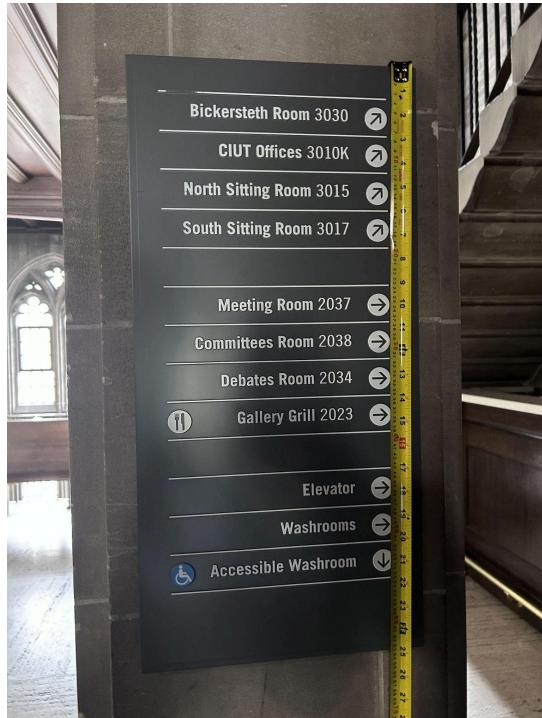


Figure. 2: Second Floor Stairwell Signage

In addition, Appendix B, Table 9 outlines a lack of wayfinding elements (e.g. signage, posters) throughout various intersections at Hart House. Figures 3 and 4 highlight areas without wayfinding elements.



Figure 3: North-facing View - SE Stairwell Intersection.



Figure 4: South-facing View - West Basement Corridor

These figures also highlight the lack of landmarks indicating user location, decreasing navigability [6, pp. 554-555]. The gap is the lack of an intuitive system which supports user navigation and provides event information. The need is an adaptive, accessible, and informative wayfinding system. The client has indicated the design should be deployable throughout the building; the scope of this project includes all floors, basements (Appendix A), and the bordering outdoor area (see Figure 5). Architectural or layout changes are out of scope.

4.0 Service environment

The team has identified three distinct aspects of the service environment through primary and secondary research.

4.1 Physical environment

The design's service environment is divided into 3 zones, separated by conditions and characteristics (Figure 5).

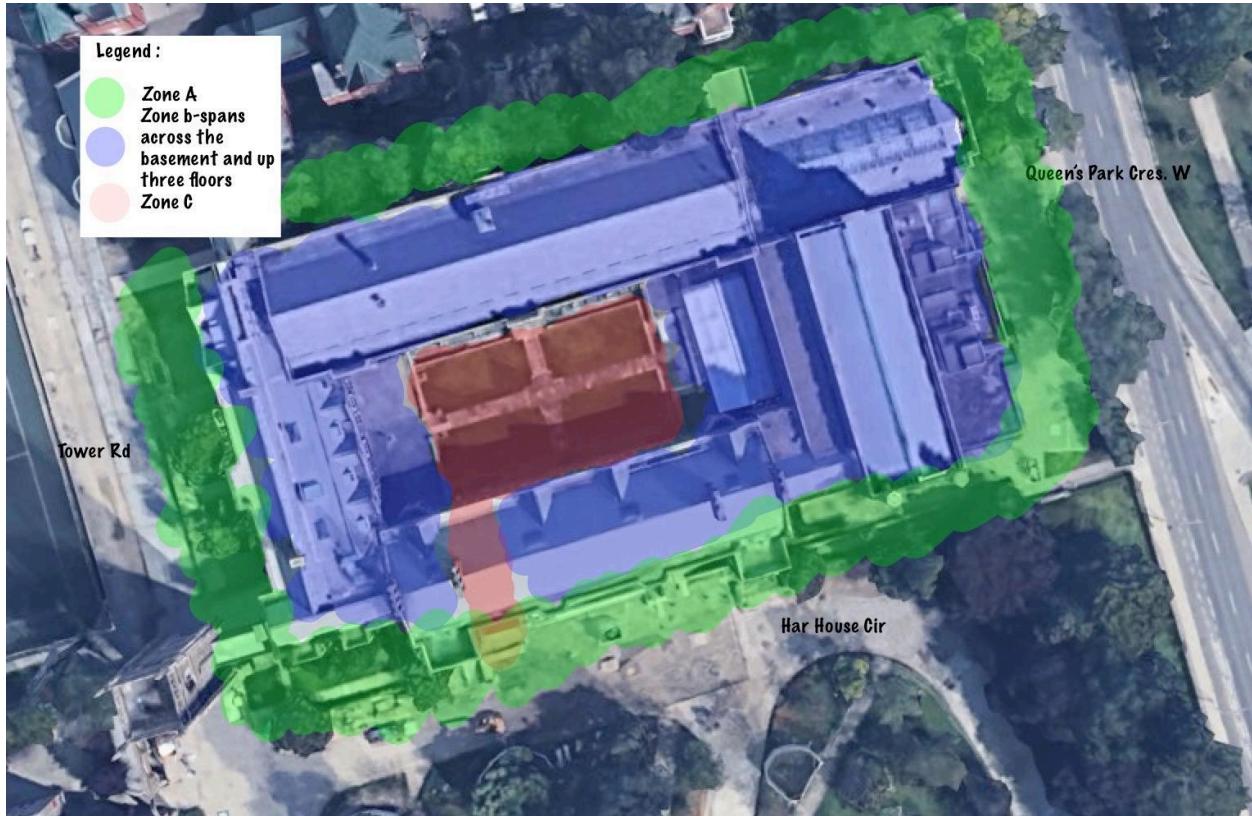


Figure 5: Satellite View of Hart House Highlighting Proposed Zones. Adapted from [7].

4.1.1 Zone A: Exterior environment

The scope of zone A is restricted to the building's immediate exterior (Figure 5). Relevant characteristics include:

- Temperature and weather conditions [8]:
 - November - March: minimum temperature -25°C, typical range ~ -5.5°C
 - June - August: maximum temperature 37°C, typical range ~ 26°C.
 - Toronto average annual precipitation : 830mm; ~55-85 mm/month
- Collegiate Gothic architectural style [3] (see Appendix B)

4.1.2 Zone B: Interior environment

Zone B encompasses all floors including basements. See Appendix B for additional measurement notes.

- Brightness: 60.0-80.0 lux
- Noise level: 60.0-65.0 dB
- Neutral colour palette (Figures 3-4)

4.1.3 Zone C: Hart House Theatre

Located on the sub-basement floor, the theatre's noise level and brightness do not fall within the range measured in Zone B. Lights are dimmed during performances and the noise levels likely exceed typical range.

- Pink walls in corridor descending to theatre
- Pink, brown carpeted floors

4.2 User environment

Interactions with diverse users and operators of Hart House are acknowledged. Figure 6 below shows a demographic of Hart House's most frequented groups by estimated age. Observations were made between 15:23 and 15:39, 14/10/2023.

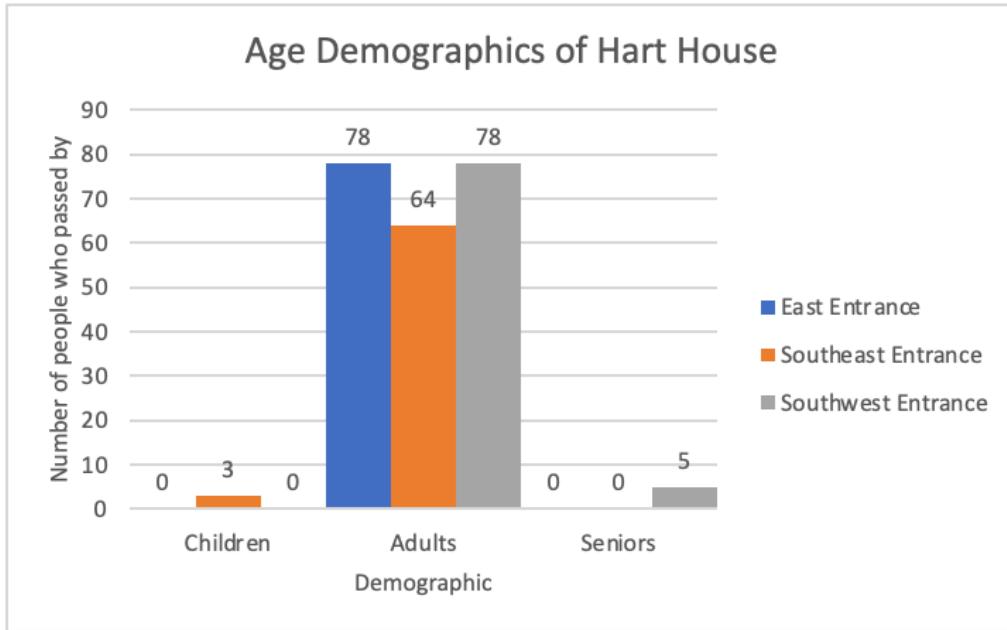


Figure 6: Hart House Age Demographics

The observations align with a 2020-2021 published distribution of Hart House users shown in Figure 7 below:

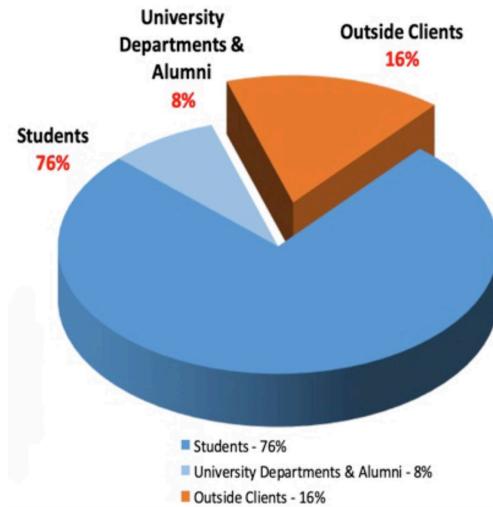


Figure 7: Percentage distribution of Hart House users from 2020-2021. Adapted from [9, p. 4]

The data implies students will be the primary users of the design.

4.3 Virtual environment

Virtual infrastructure will be available where the design is implemented.

- Internet speed: 14-17 Mb/s (Appendix B)
- The wireless network offered by the University of Toronto is accessible to students, staff, and registered guests.

5.0 Stakeholders

Proposed redesign of the Hart House wayfinding system impacts stakeholders outside of regular users and operators. Table 1 summarizes the influence of this project on stakeholders.

Table 1: Stakeholders and Corresponding Impact

Stakeholders	Impact on the Stakeholder
Event Holders ● Clubs ● Community Partners	<ul style="list-style-type: none"> ● Event holders use Hart House to build community [10, p. 13]. Better wayfinding and information service increases the impact of clubs by increasing awareness and participation [11, p. 121].
Students	<ul style="list-style-type: none"> ● Over 95% of Hart House revenue is funded by Student Fees. As a part of the Hart House renewal project, Hart House will receive funding from a certain portion of student-paid tuition [10, pp. 21-22].
Donors	<ul style="list-style-type: none"> ● Nearly \$100K of Hart House revenue comes from “Donations, grants, amortizations” [10, p. 53]; donors expect the funds to be reinvested in the Hart House community [12], through projects like wayfinding upgrades.
U of T Campaign Committee	<ul style="list-style-type: none"> ● “Hart House Renewal” is a featured initiative for the Defy Gravity campaign; U of T is willing to allocate resources towards improving Hart House [13]
Local Indigenous groups	<ul style="list-style-type: none"> ● Hart House operates on the traditional land of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit [14] - this fact and its history should be acknowledged.

6.0 Detailed requirements

The purpose of the design is to inform users of events and locations. The design must address the current inflexible wayfinding system that fails to cover the entire scope of the project.

6.1 Functions

Functions were developed using the Black Box method (Appendix C, Figure 27). The following flowchart (Figure 8) describes the primary and secondary functions:

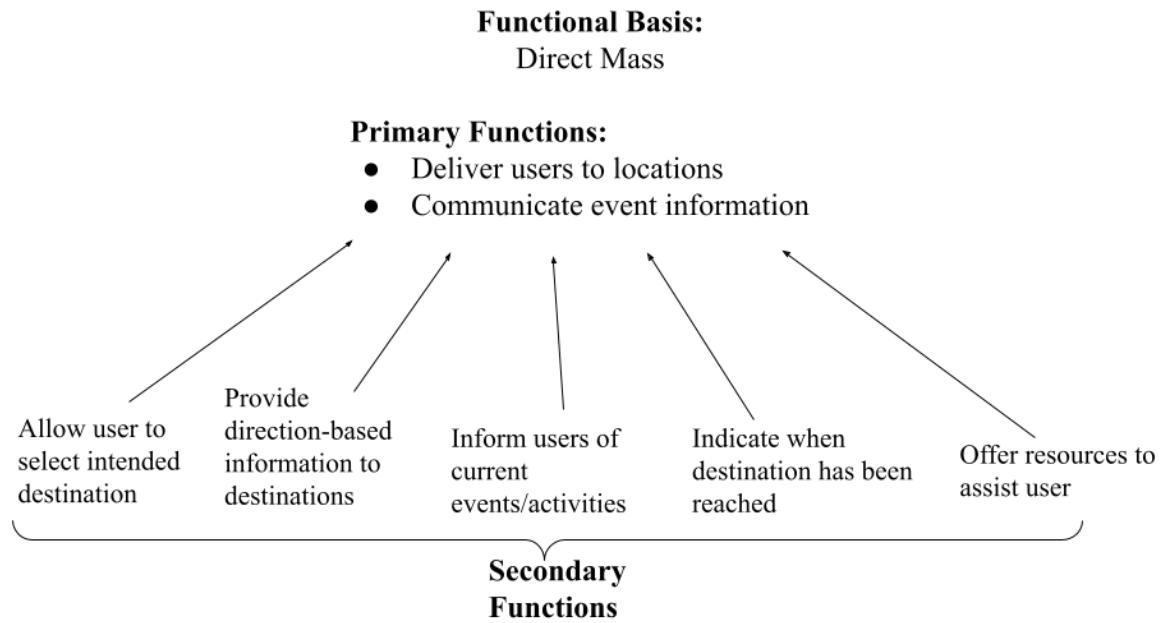


Figure 8: Functions of Hart House navigational system design

6.2 Objectives

Objectives were developed using a How-Why Tree (Appendix C, Figure 28) and ranked using Pairwise Comparison (Appendix C, Table 9). The following table describes and quantifies what the design should be.

Table 2: Objectives, with corresponding Goals and Metrics

Objective	Goal and Metric Design should (have):
<u>Reliability</u>	
Effectiveness	<ul style="list-style-type: none"> • <5 mins to reach target destination • <1 hesitations during navigation
Clear delivery of information to user	<ul style="list-style-type: none"> • Communicate information in >3 of the most spoken languages in Canada [15] • Use standardized graphical symbols from ISO 28564-1 [15]
Consistent presentation of information throughout design	<ul style="list-style-type: none"> • Consistent location placement of wayfinding elements on each floor, promoting “user familiarity and comprehension” [16] • Elements placed at optimal reading height for standing and wheelchair users of ~1500mm above floor [4, p. 5] • >1 wayfinding resource placed at all intersections, stairwells, entrances and exits.
Universal in design, satisfying the needs for the broadest possible population	<ul style="list-style-type: none"> • Align with >4 /7 Universal Design Principles [17]
<u>Adaptability</u>	
Provides options to alter and update information	<ul style="list-style-type: none"> • Able to be updated daily with new events [18] • Wayfinding elements updated within <1 min
<u>Aesthetics</u>	
Coherent with Hart House’s collegiate gothic style [3] (Appendix B)	<ul style="list-style-type: none"> • Not conflict with high arches, ceilings and intersections.

6.3 Constraints

Constraints were developed by cross-referencing the client statement and legal liabilities restricting the design. The constraints are set boundaries that must not be violated, and are listed in the table below.

Table 3: Metric-based constraints with justification

	Constraints Design must (be):	Justification
Client-based constraints	Usable without digital elements.	Solutions must fully accommodate users without cell phones and must not be “simply a set of screens” [2].
	Employed throughout the entire building.	The client requests a design that scopes the entirety of Hart House [2].
	Have >1 element acknowledging the land that Hart House was built upon.	Honouring the first peoples is a responsibility for the city of Toronto residing on traditional lands [14].
<hr/>		
Team-developed Constraints	Elements intended to be read at eye-level must be 1150mm - 1800mm above the floor.	Eye height of 95% of people is less than 1800mm and the minimum eye height for wheelchair users is 1150mm [19].
	Noise levels must not exceed 85 dB.	By provincial law, any form of audible communication should be kept below 85 dB to not be harmful [20].
	Text must be presented with a minimum contrast ratio of 3:1.	A minimum contrast ratio of 3:1 is required by ISO-9241-3 for text to be readable by those having colour deficiencies [21].
	Font size must be a minimum of 18 point text or a minimum of 14 point bold text for typical roman fonts.	This minimum is sufficient for those who have colour deficiencies [21].
	Have a form of communication for individuals having visual impairments and/or hearing disabilities	The Accessibility for Ontarians Disability Act requires public spaces make delivery of information accessible universally [22].

7.0 Idea generation process

Our idea generation process aimed to maximise creativity to create a diverse initial design space and avoid confirmation bias. Figure 9 below describes the process:

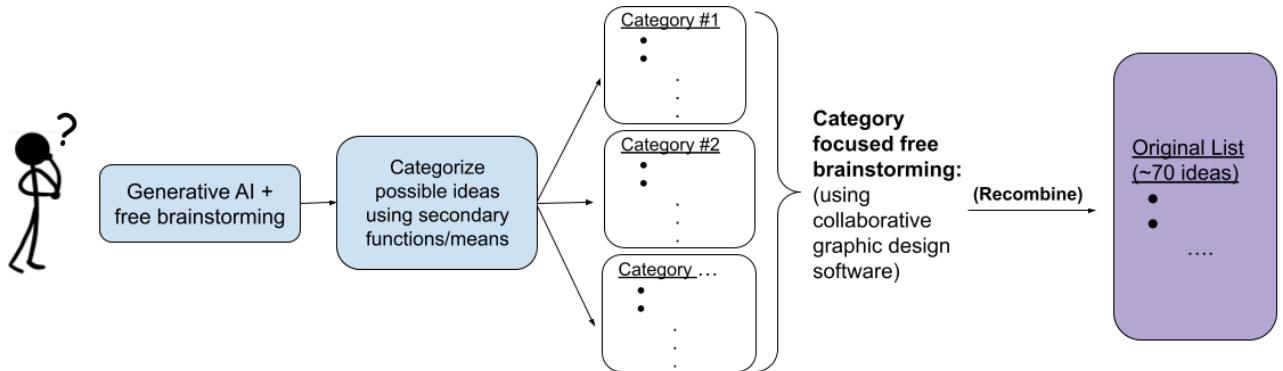


Figure 9: Summary of Idea Generation process.

Design generation began with free independent brainstorming, leveraging the strength of individual thinking's strength over collaborative work to create the most diverse basis of ideas [23]. Individual team members made use of generative AI to aid their creative thinking [24] (Appendix D). Brainstormed ideas were compiled into a collective list (Appendix E). Ideas often shared a common means to complete the primary function, so ideas were grouped by functional means. Further brainstorming aimed to span the entirety of functionally possible ideas, using the secondary functions as stimuli. The group split to focus on separate categories to make the most of the team's collective thinking ability by expanding the design space over various sub-functions and themes.

A collaborative digital graphic design software shown in Figure 10 below, was used to increase productivity by enabling collaborative editing and reducing social inhibitions (Appendix F). Furthermore, the software enabled effortless documentation using screenshots. The original list of ideas is included in Appendix E.

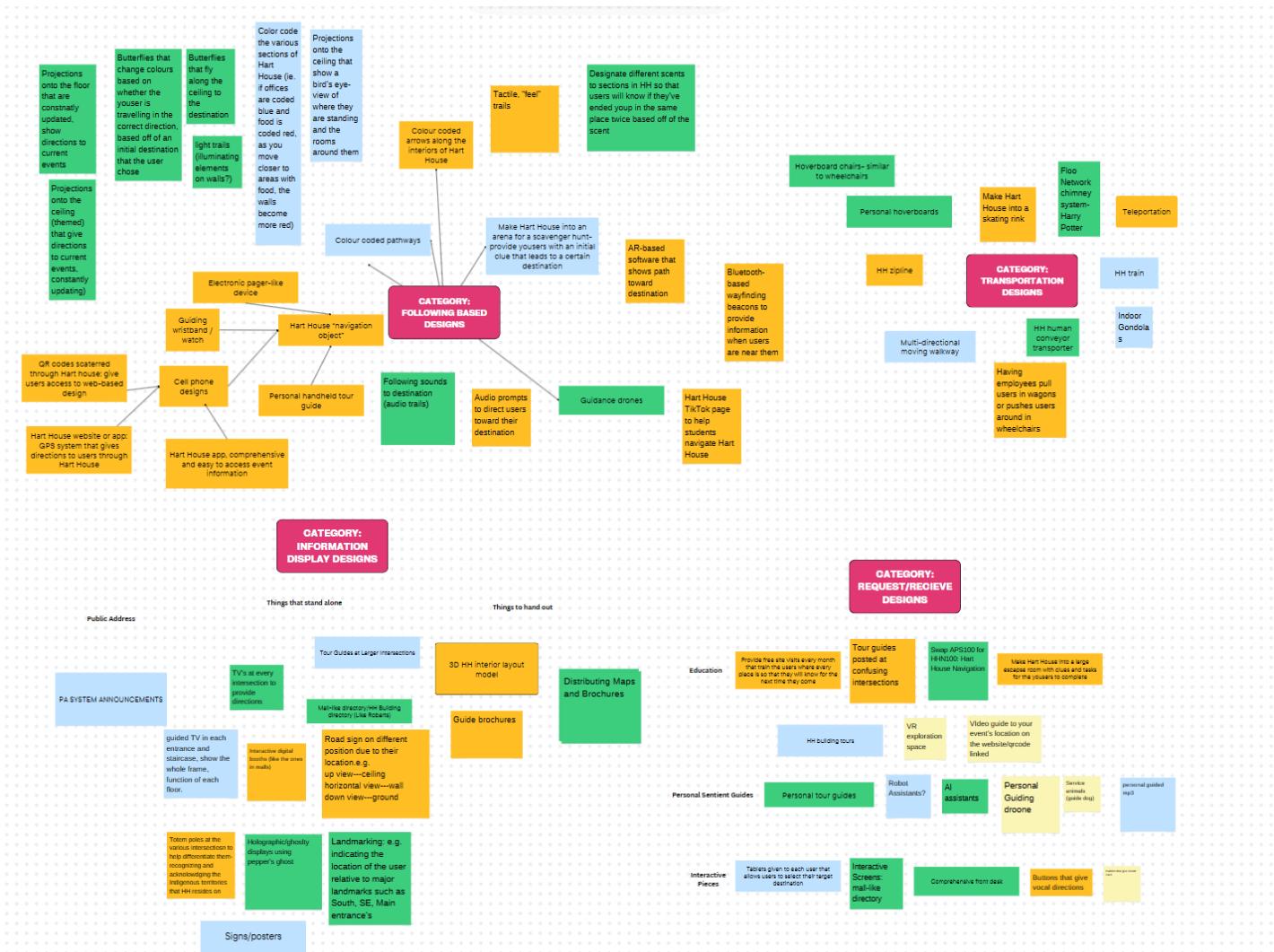


Figure 10: Collaborative Mind Maps

8.0 Alternative Design Selection Process

Selection of alternative designs was formulated to incorporate reiteration and appending processes to create more effective, multi-faceted solutions [5]. Figure 11 below describes the alternative design selection process:

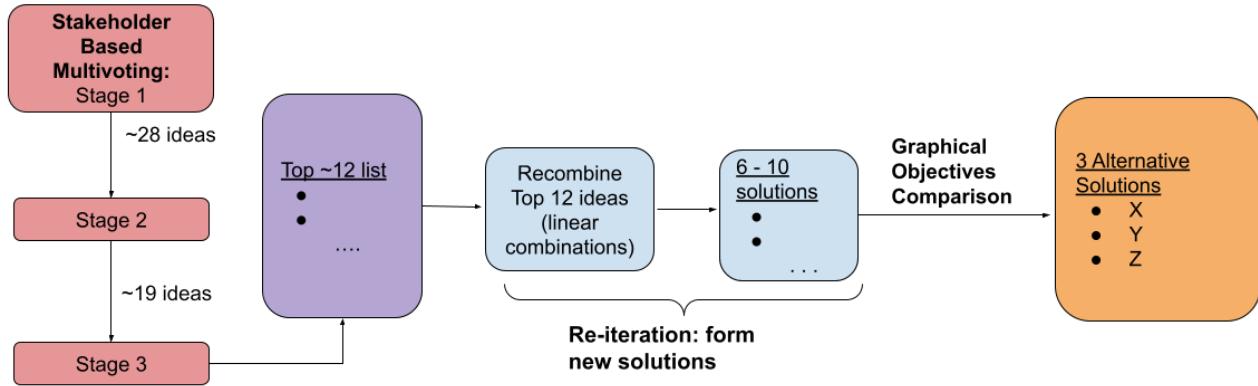


Figure 11: Summary of Idea Selection process and convergence onto 3 Alternative Solutions.

After removing duplicates, unfeasible options were eliminated upon comparison to functions and constraints. Ideas that could be modified to be feasible were preserved since they could later be combined into more ideas, considering the composite nature of wayfinding systems [5]. Three rounds of multivoting followed, where team members adopted the priorities of different stakeholders during the voting process to ensure Hart House's wide variety of user and stakeholder interests were maintained. Two team members voted on behalf of students because they are the largest stakeholder group. Using a spreadsheet (Appendix G) we streamlined the voting process (Figure 12).

	Idea Name	Unfeasible?	Isaac (Donors)	Grace (Indigenous groups)	Naisha (UoT Campaign)	Yimin (students)	Michael - Event Holders	Andrew (Students)	Total Votes
1	Interactive digital booths (like the ones in malls)			1	1	1	1	1	5
2	AI assistants		1		1	1		1	4
3	Robot Assistants		1	1	1				3
4	AR-based software that shows path toward destination		1			1			2
5	Mall-like directory/HH Building directory (Like Robarts)					1		1	2
6	Butterflies that fly along the ceiling to the destination		1	1					2
7	Comprehensive front desk					1		1	2
8	Guiding wristband / watch				1		1		2
9	Hart House website or app: GPS system that gives directions to users through Hart House						1	1	2
10	light trails (illuminating elements on walls?)				1		1		2
11	Projections onto the ceiling (themed) that give directions to current events, constantly updating)		1		1				2
12	TV's at every intersection to provide directions					1		1	2

Figure 12: Extract from Multivoting

Noticing that stronger ideas could be constructed through the combination of the 12 remaining ideas after multivoting, the SCAMPER process was applied, adding 6 combination ideas to the design space. By

eliminating ineffective ideas before idea expansion processes, we avoided creating an excessive amount of unfeasible ideas (Appendix H).

A graphical decision chart was then applied to compare the efficacy of the remaining design ideas, and to highlight the difference in the strengths of the individual ideas compared to the combination ideas. The chart was initially completed collaboratively on a blackboard Appendix I to aid in the visualisation of the relative positions of the ideas toward each objective. Table 4 and Figure 13 summarise the process and results.

Table 4: Terms in graphical decision chart

Objective	Definitions generated by team (see Table 2 for metrics)
“Reliability”	<ul style="list-style-type: none"> - Effective results - Easy to understand (visitors) - Easy to maintain (staff) - Considers universal design
“Adaptability”	<ul style="list-style-type: none"> - Easy to update - Thematically adaptable to events - Back-end customizable

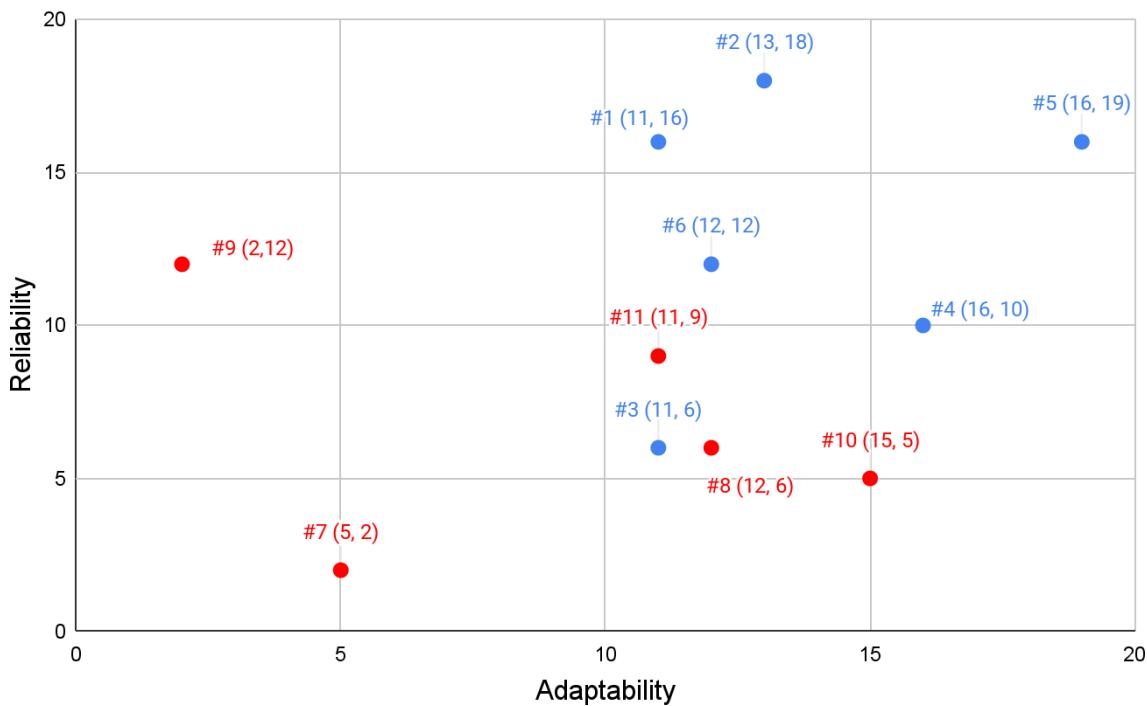


Figure 13: Graphical Objective Comparison for six design solutions, ranked against top two objectives, see Appendix J for rationale.

The team noted that the combination ideas were strong in both objectives, while individual ideas were aligned closer to one objective only due to the composite nature of wayfinding systems.

9.0 Alternative Design Descriptions

The top three ideas of the Graphical Objectives Comparison (Figure 13) were selected as alternative designs. Each idea approaches the required primary functions in a unique way, detailed in the following subsections.

9.1 Alternative Design A: Building-wide projection signage

Design A uses projectors to display information and directions onto walls, floors, and ceilings of Hart House corridors. Being a digital display, the projected images are adaptable to display anything desired. Projectors can be controlled by a central computer and display creative or animated graphics. The design is evaluated in Table 5.

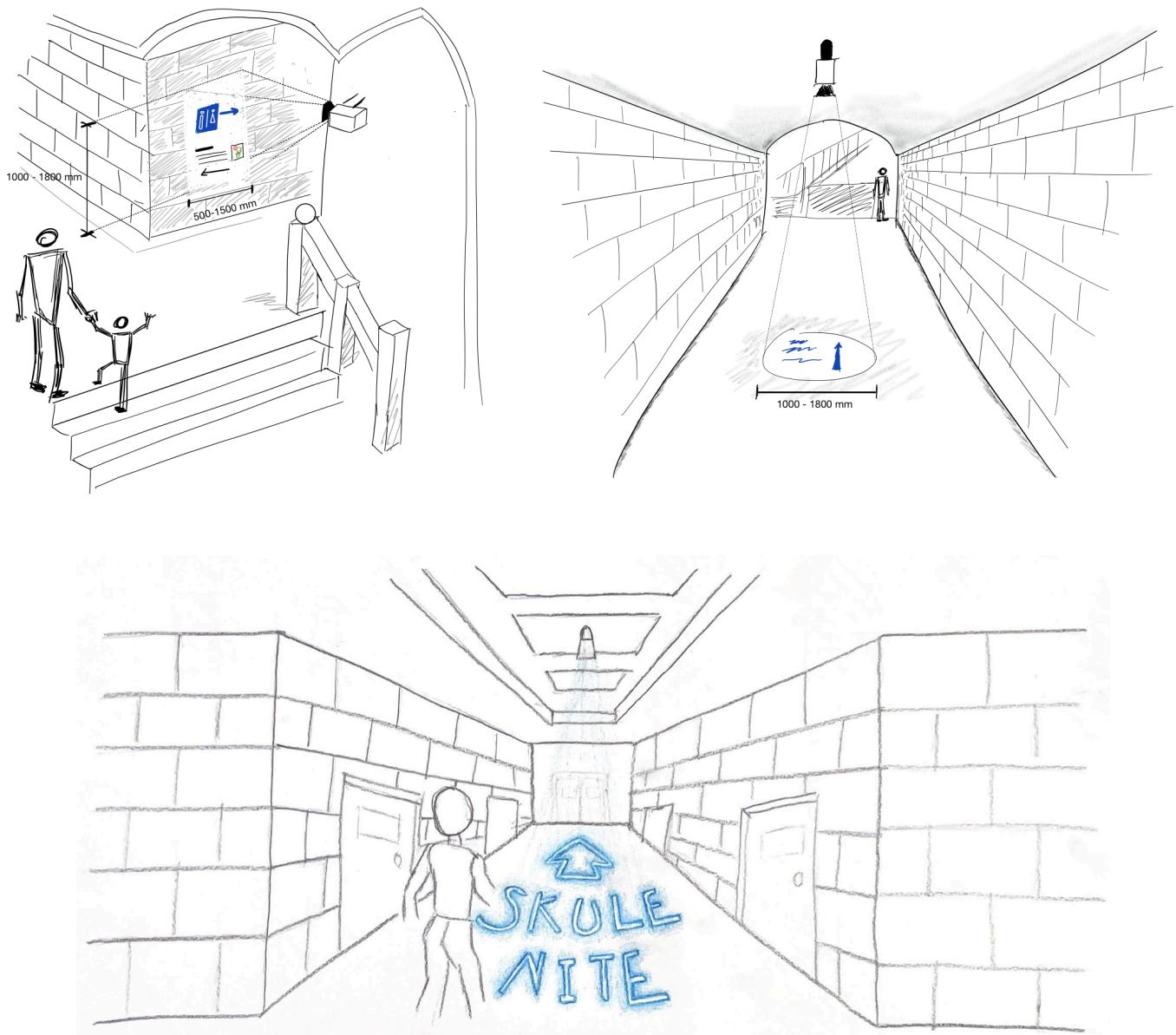


Figure 14: Visuals of building-wide projection signage

Table 5: Evaluation of Alternative A

Function	Means
Deliver users to locations	Projections of guiding visuals
Communicate event information	Projection of event information
Objective	Method/degree of Achievement
<u>Reliability</u>	
Clear delivery of information to user	<ul style="list-style-type: none"> ● Large, clear, visuals ● Multilingual ● Use standardised symbols
Consistent presentation of information throughout design	<ul style="list-style-type: none"> ● Employable everywhere ● Elements placed at optimal reading height
Universal in design, satisfying the needs for the broadest possible population	<ul style="list-style-type: none"> ● Delivers information to many people simultaneously ● Does not immediately account for the visually impaired ● Low physical effort for usage
<u>Adaptability</u>	
Provides options to alter and update information	<ul style="list-style-type: none"> ● Highly adaptable, via digital graphic design
<u>Aesthetics</u>	
Coherent with Hart House's collegiate gothic style [2] (Appendix B)	<ul style="list-style-type: none"> ● Does not disrupt aesthetic, taking up no floor space ● Projections can be designed to match the style

Alternative A's strengths are its customizability and aesthetics. Its non-interactive nature is well-suited towards guiding people through a high traffic area.

9.2 Alternative Design B: Digital-kiosk supplemented with mobile app and GPS

Interactive touch-screen digital kiosks giving detailed navigational instructions and event information installed in high traffic areas and main entrances. Kiosks would be compatible with a mobile app to transfer navigational and event-related information to a personal device with detailed directions, shown in Figure 15 below. The design is evaluated in Table 6.

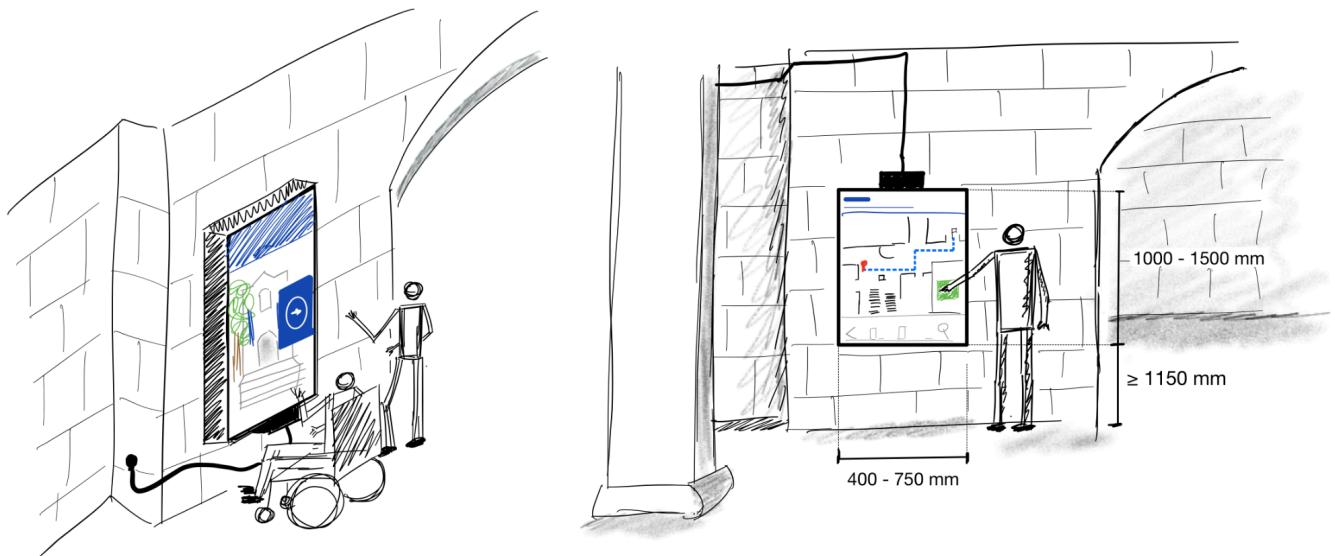


Figure 15: Digital Kiosk User Experience

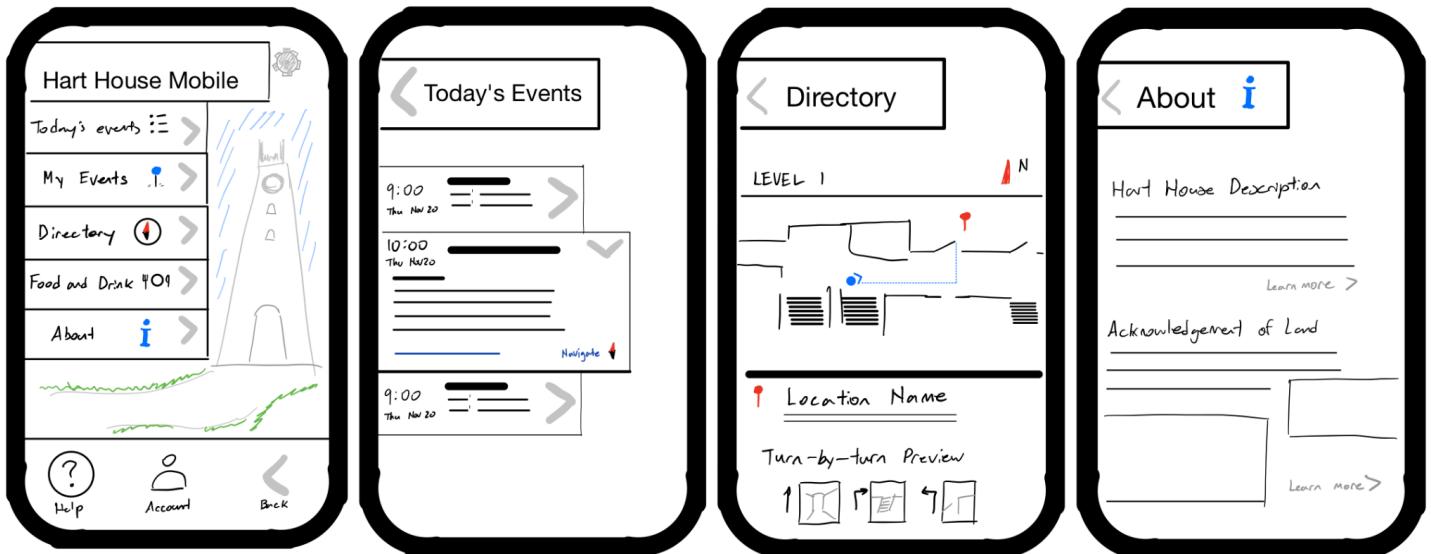


Figure 16: Hart House App Design

Table 6: Evaluation of Alternative B

Function	Means
Deliver users to locations	Interactive kiosk
Communicate event information	Interactive kiosk
Objective	Method/degree of Achievement
<u>Reliability</u>	
Clear delivery of information to user	<ul style="list-style-type: none"> ● Clear visuals ● Multilingual ● Use standardised symbols
Consistent presentation of information throughout design	<ul style="list-style-type: none"> ● Placing kiosks throughout building ● Employable everywhere
Universal in design, satisfying the needs for the broadest possible population	<ul style="list-style-type: none"> ● Does not immediately account for the visually impaired ● Giving audio directions
<u>Adaptability</u>	
Provides options to alter and update information	<ul style="list-style-type: none"> ● Remotely updatable at any given time ● Large-scale updates may not be within <1 min
<u>Aesthetics</u>	
Coherent with Hart House's collegiate gothic style	<ul style="list-style-type: none"> ● Neo-gothic frame design ● Screen may conflict with architecture

The kiosk design benefits from user familiarity as kiosks are commonly used in the wayfinding industry [25]. The kiosks and mobile app would be maintained through a centralised software system for remote and widespread updates, allowing for an adaptable design.

9.3 Alternative Design C: Near field-communication (NFC) tap-activated guiding lights and wristbands

This design includes a digital booth dispensing wristbands containing a location-specific NFC identifier. Theatrical audiovisual cues throughout the building, such as LED lights or speakers, activate upon proximity with the beacon (tap-activation unit), guiding the user towards their destination. The design is evaluated in Table 7.

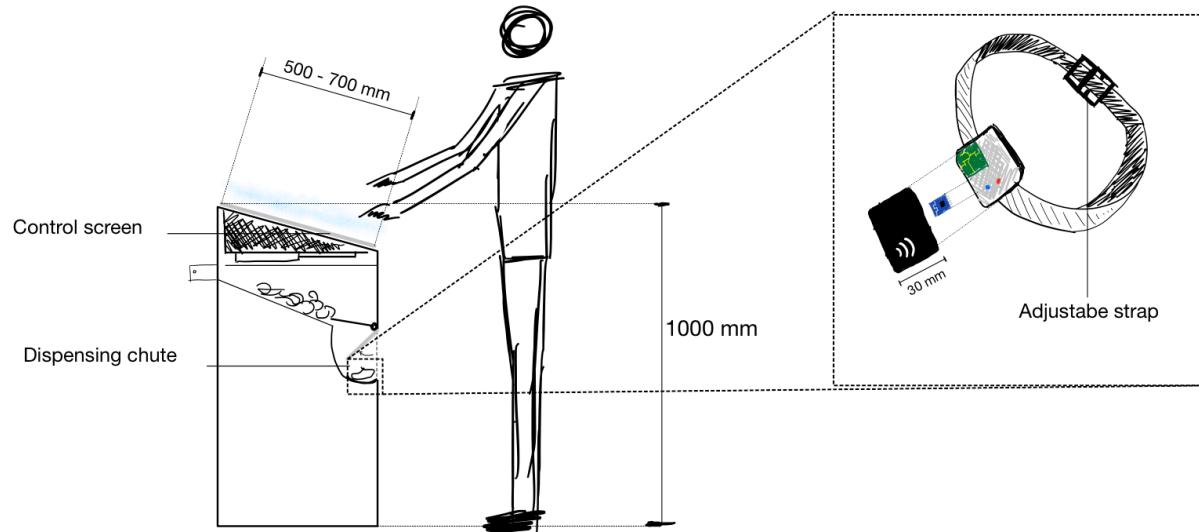


Figure 17: Bluetooth Wristband and Dispensing Kiosk

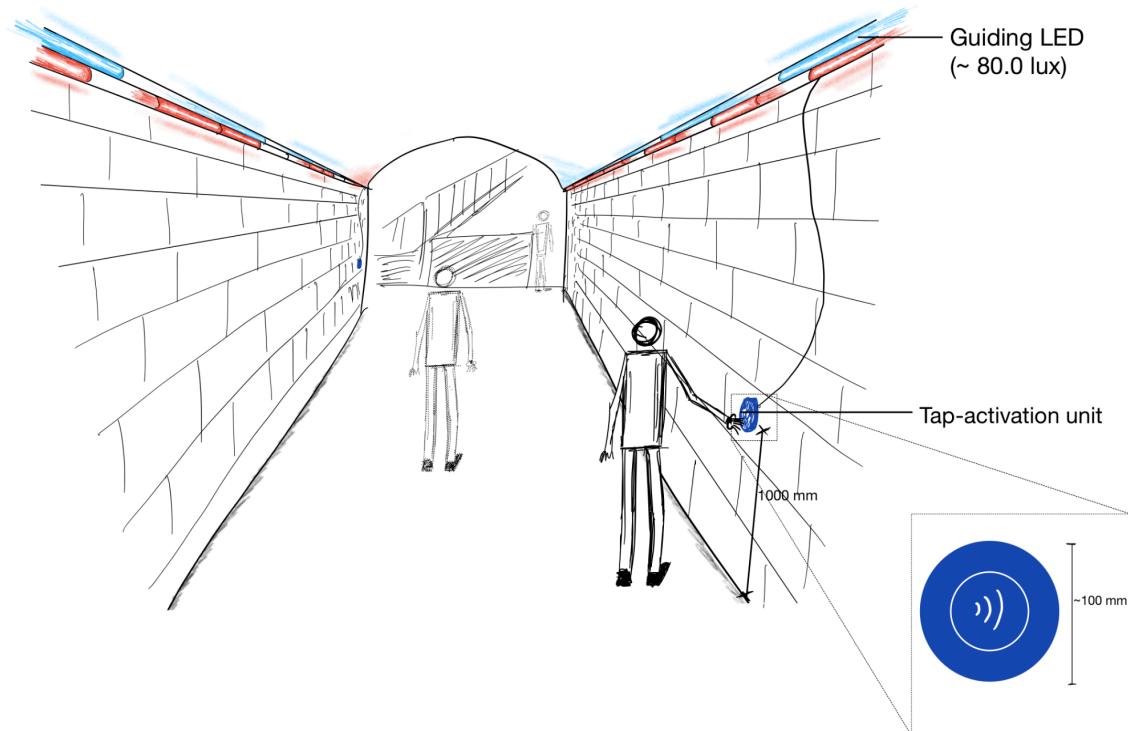


Figure 18: Bluetooth Audiovisual Guiding Beacons

Table 7: Evaluation of Alternative C

Function	Means
Deliver users to locations	Audiovisual cues
Communicate event information	Booth digital display
Objective	Method/degree of Achievement
<u>Reliability</u>	
Clear delivery of information to user	<ul style="list-style-type: none"> • Users' audiovisual cues may clash with others under high traffic • Multilingual
Consistent presentation of information throughout design	<ul style="list-style-type: none"> • Elements placed at optimal reading height • Elements employable everywhere
Universal in design, satisfying the needs for the broadest possible population	<ul style="list-style-type: none"> • Audiovisual cues involving standardised symbols (ie. arrows) • Low physical effort for usage
<u>Adaptability</u>	
Provides options to alter and update information	<ul style="list-style-type: none"> • Digital kiosks manually updated as needed, but having few kiosks limits user interaction • Self-activating within <1 min of user proximity
<u>Aesthetics</u>	
Coherent with Hart House's collegiate gothic style	<ul style="list-style-type: none"> • Visual lighting can be designed to align with overall or event-specific aesthetic • Occupies minimal floor space and doesn't obstruct corridors • Kiosk screens may conflict with building style

Design C offers an immersive navigational experience by giving user-specific directions through an engaging visual display. The tap-activated beacons throughout the building present the user with navigational assistance as required.

10.0 Proposed Conceptual Design

The balance of objectives is crucial in the selection of design for a wayfinding solution since compromises must be made between the function and aesthetics of the design.

Table 8: Pugh Matrix

	Traditional signage (Datum)	Building-wide projection signage	Digital kiosk, mobile app, and GPS	NFC guiding lights and wristbands
Reliability	S	+1	+2	+1
Adaptability	S	+2	+1	+1
Aesthetics	S	+1	0	+1
Sum	0	+4	+3	+3

Alternative design A, the building-wide projection system was determined to be the strongest option, having the highest overall score.

The projection system will encourage more use of the Hart House space by both event holders, students, and visitors with its unique and effective method of displaying information. Easy navigation of the building attracts both event holders and guests [1], and the visual impressiveness can generate additional interest in the building.

Digital visual input is fully customizable and can be easily modified to showcase current event information, complimenting the constantly changing events and ever-evolving nature of Hart House. The customizability also accommodates the feature of displaying local indigenous artwork, giving them more representation in the space. Furthermore, the projection system has aesthetic appeal: it does not create any additional visual obstruction in the space, yet remains easily recognizable.

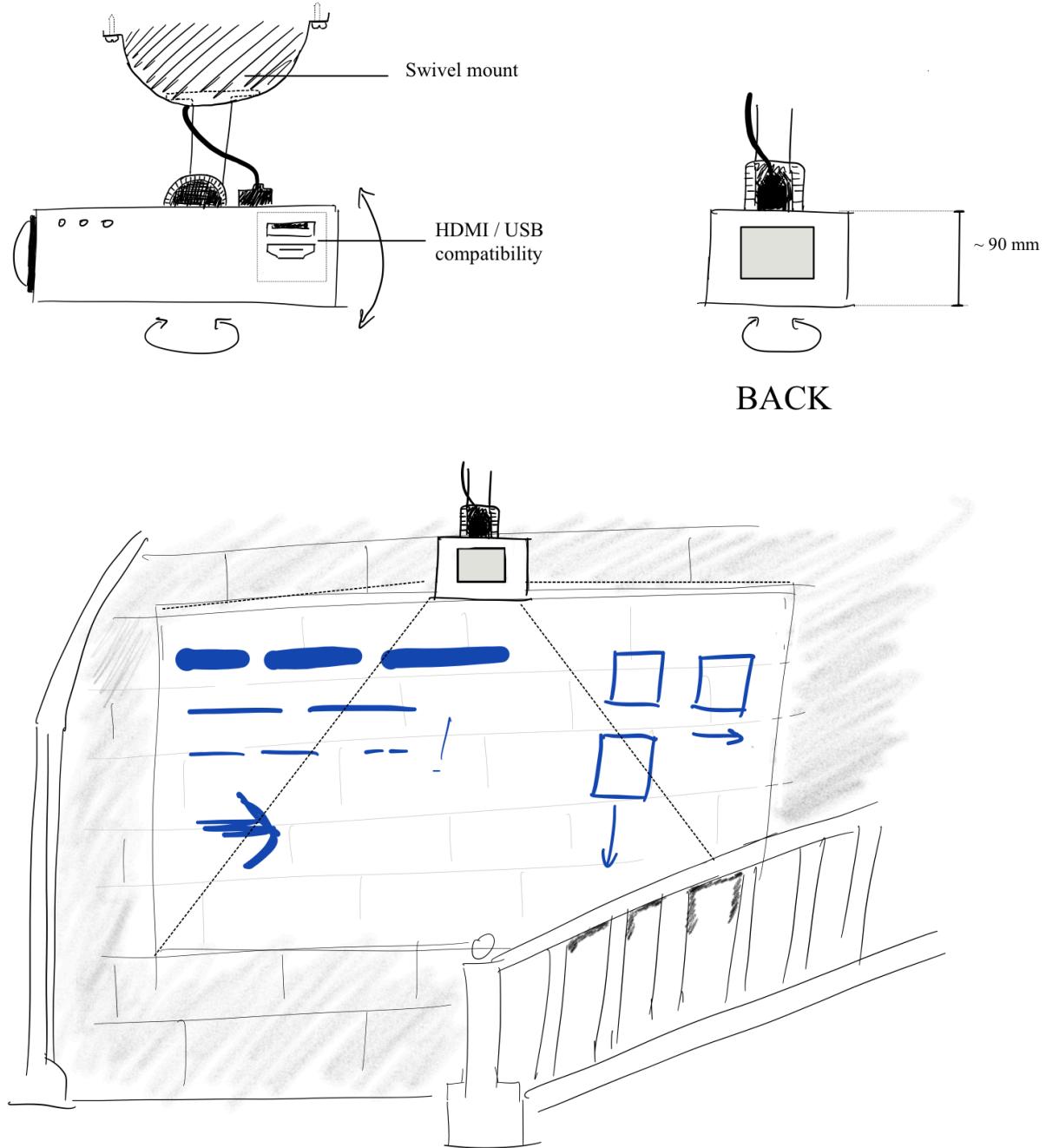


Figure 19: System Projection Unit (top) and Multimodal Functionality.

11.0 Measures of Success

To test the reliability of the proposed solution, the team will use an agent-based model since they accurately simulate the flow of people [26]. Agents in the simulation represent visitors, and their decisions are based on probabilities calculated from their interactions with elements in the environment and with other agents [26]. The model will allow us to observe and measure behavioural metrics including time to reach destination and number of hesitations. By relocating wayfinding elements within the model, the simulation will predict the outcome in user behaviour, allowing us to complete multiple iterations of layouts within the allocated time span. Using a temporary instalment of projected visuals in Hart House (Fig. 20, linked video), real-world observations will be analysed to create the probabilities for interactions and decision-making within the agent-based simulation.

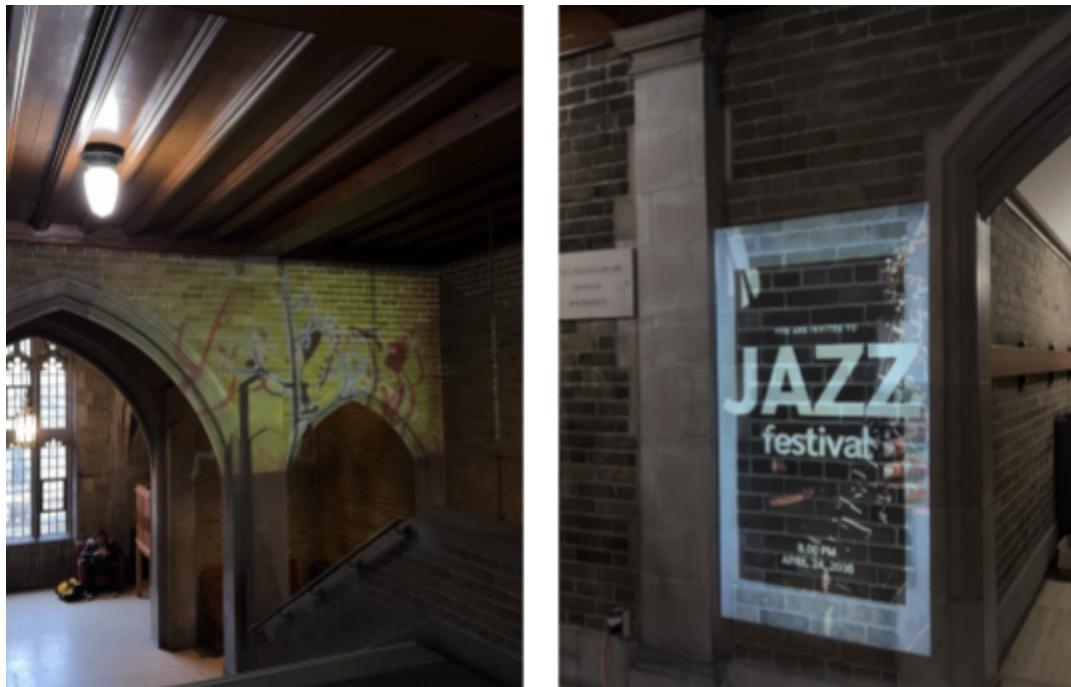


Figure 20: Projected visuals in Hart House. Adapted from [27-28].

[Figure 21: Linked video of temporary projected visual setup](#)

The simulation tests for communication clarity and user comprehension as the broadest population range can be simulated. A successful universal design will aid agents of all cultures and demographics, reducing their navigation times.

12.0 Conclusion

Hart House's historical relevance to the University of Toronto and its usage as a community centre and event venue makes effective navigation an important consideration. The current navigation system fails to address its complex layout, with nonadaptive signage scattered throughout the building yet missing in certain intersections. The proposed design had to reliably direct users through Hart House in a flexible and attractive manner, while also adhering to signage standards, maintaining accessibility, and acknowledging the land. This led to an iterative ideation process where three alternative designs were chosen through multivoting and graphical objective comparison. The proposed design, a building-wide projector system, was chosen for its immediate display of information and outstanding adaptability. This enables Hart House to match overall or event-specific aesthetics with the navigation system, and acknowledge indigenous groups through the projections. Next steps include evaluation of the design's reliability through agent-based simulation of interactions between the system and Hart House users. Based on data from real-world interactions with the design, this will allow the design to be optimised before implementation.

13.0 Reference List

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14.0 Appendices

Appendix A: Hart House Floor Plans

The client has provided the team with the floor plans of each individual floor of Hart House to aid in the understanding of the layout of the building, shown in Figures 22-26.

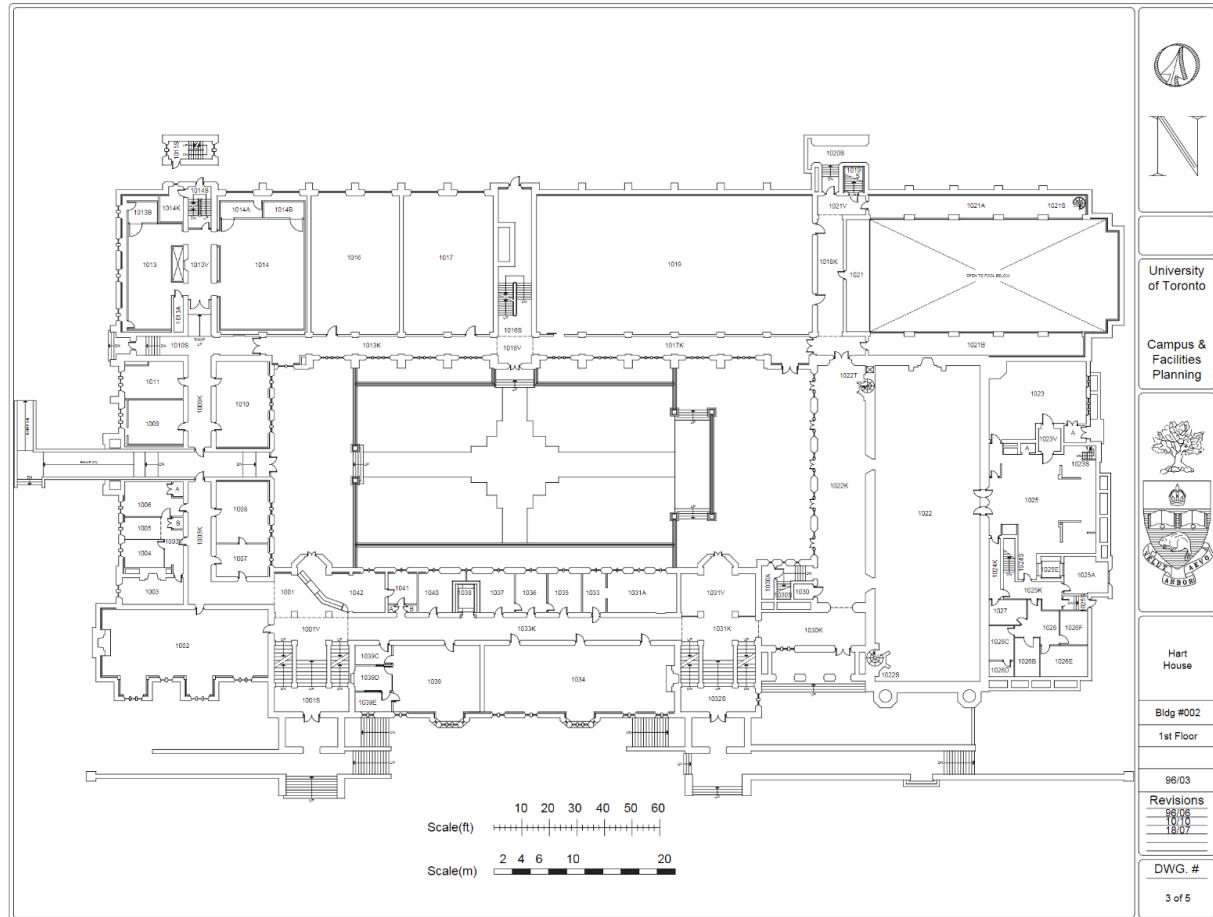


Figure 22: Floorplan of 1st Floor in Hart House [29]

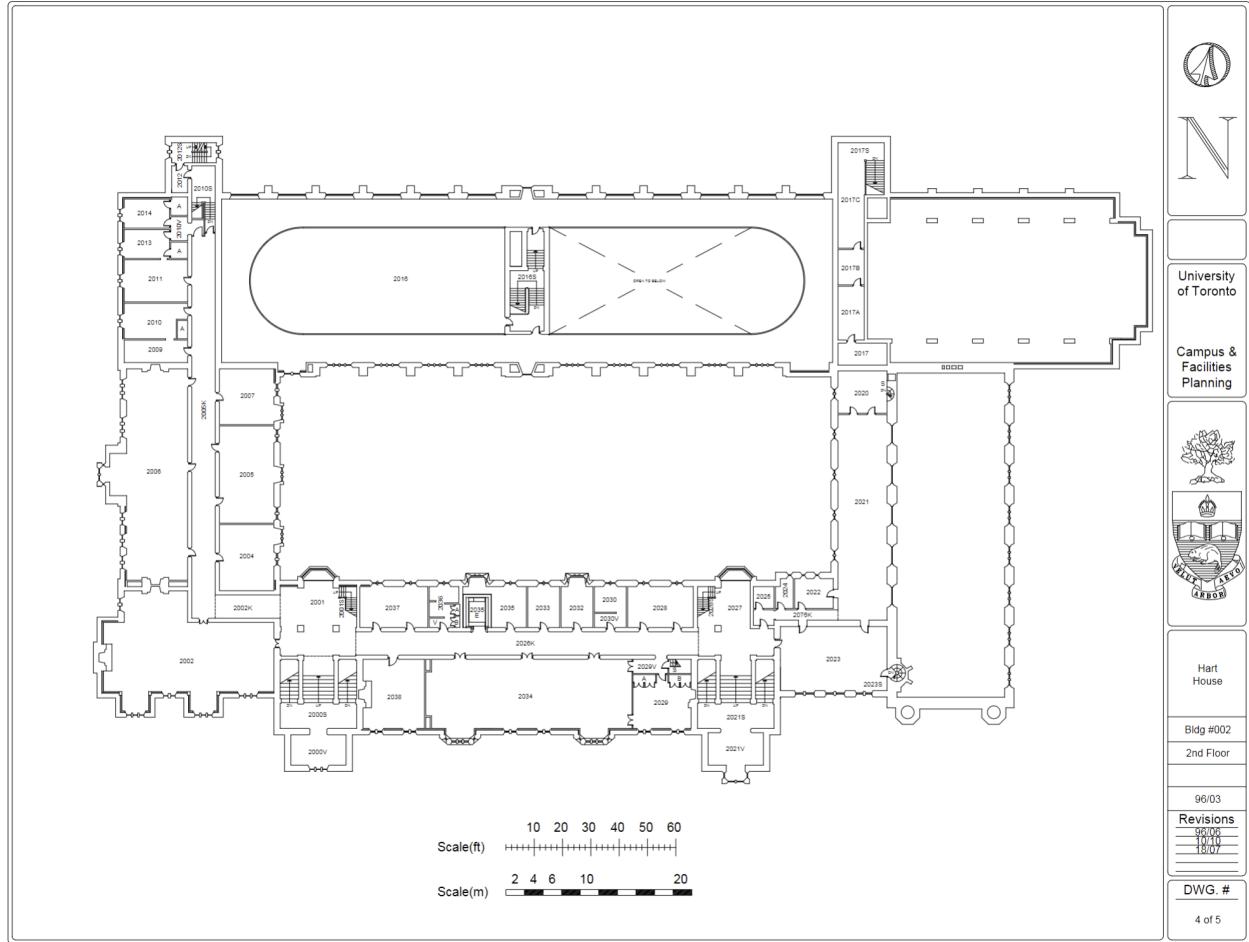


Figure 23: Floorplan of 2nd Floor in Hart House [29]

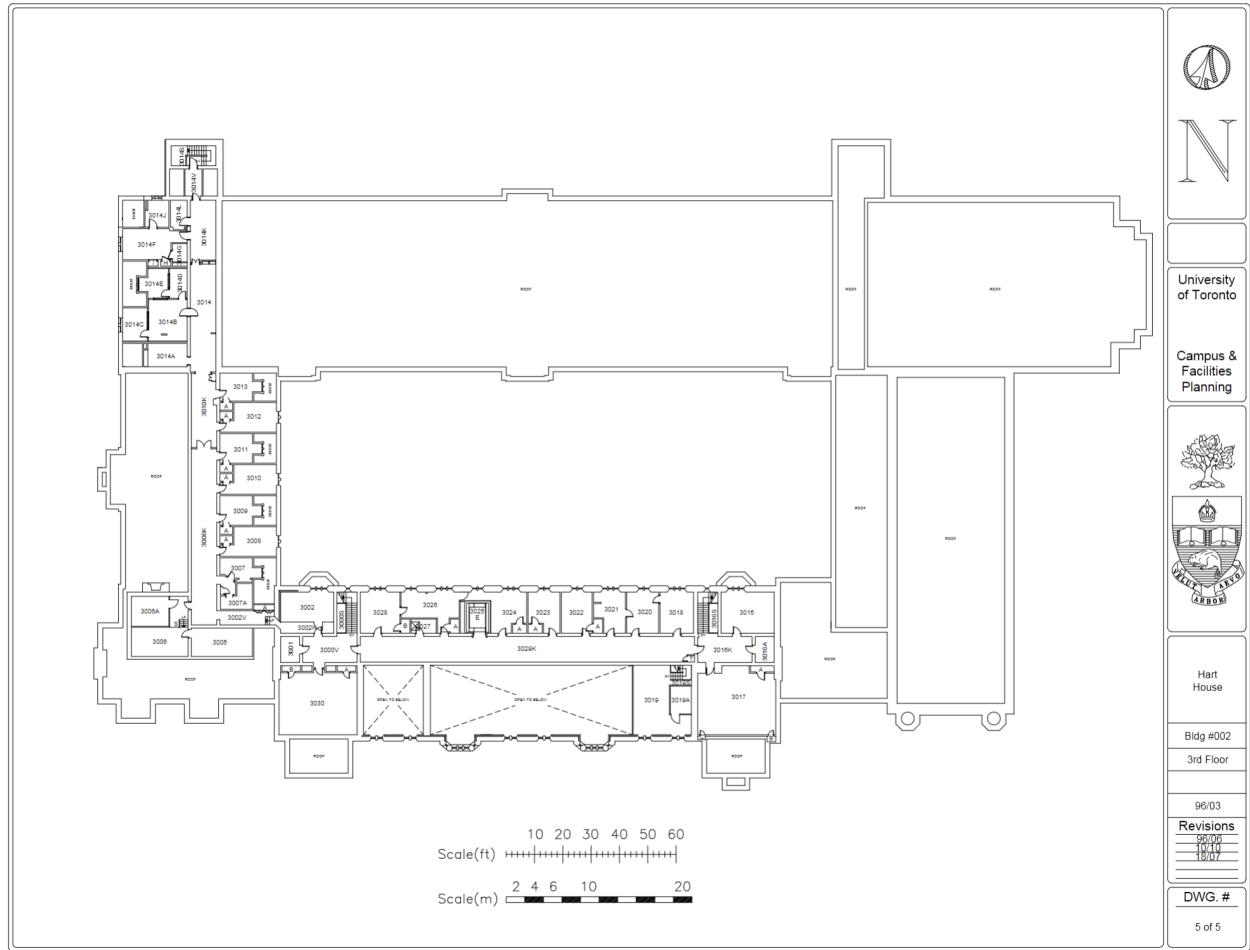


Figure 24: Floorplan of 3rd Floor in Hart House [29]

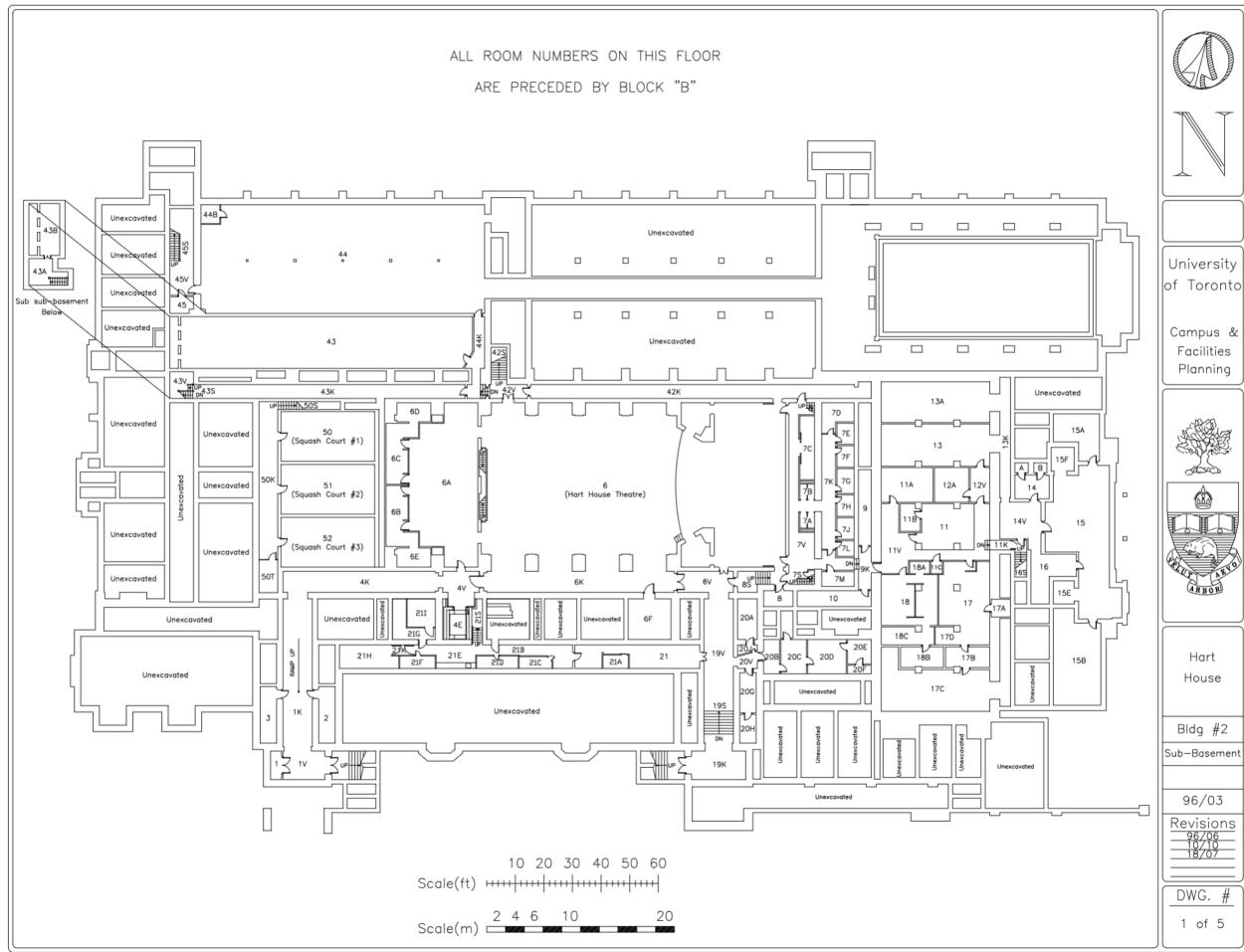


Figure 25: Floorplan of Sub-Basement in Hart House [29]

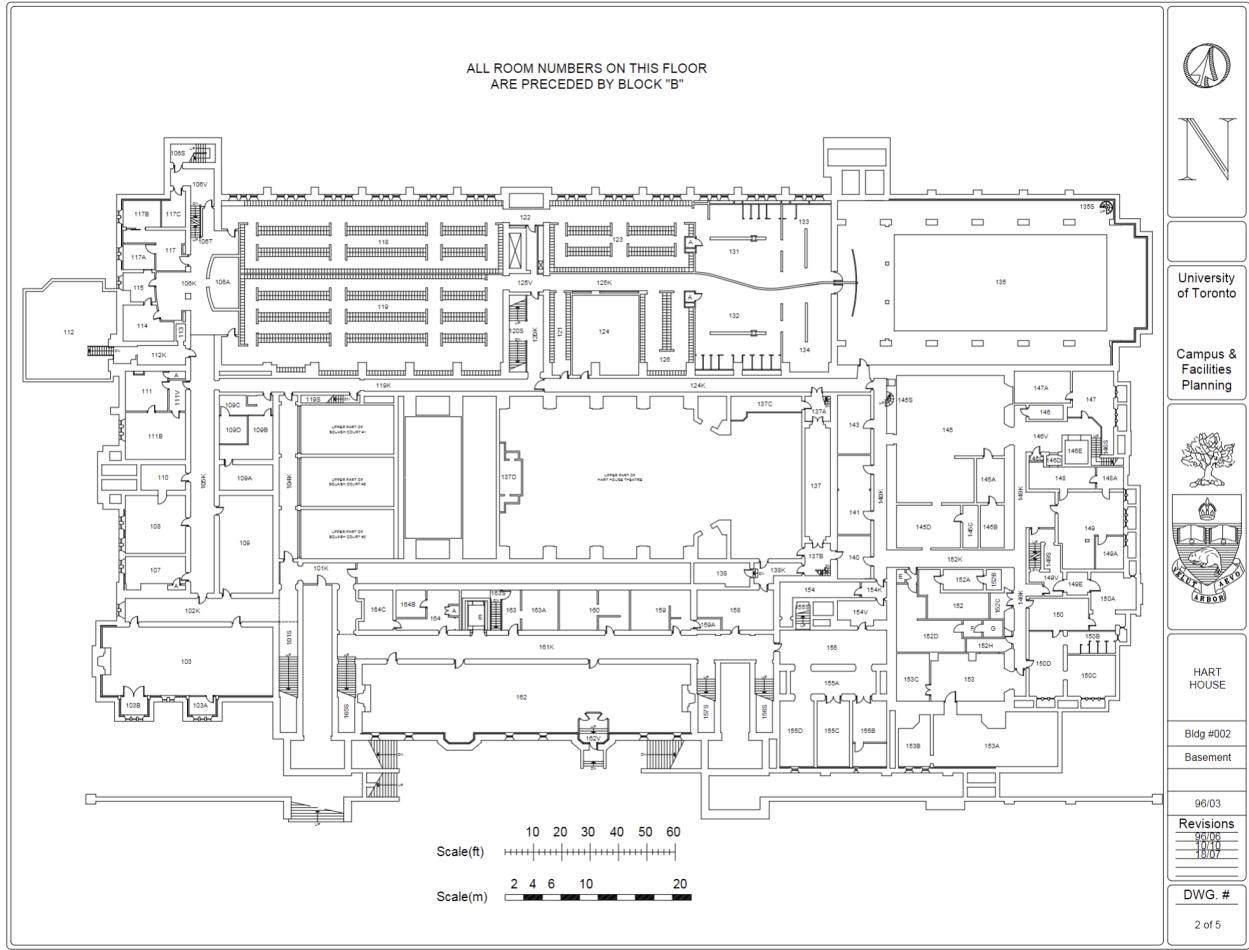


Figure 26: Floorplan of Basement in Hart House [29]

Appendix B : Notable Observations

Table 9: Number of wayfinding elements in various Hart House locations

Location	Floor #	Number of Wayfinding Elements
Southeast Stairwell	1st to 2nd	0
Southwest Stairwell	1st to 2nd	0
Main Entrance Interior Stairwell	1st	2 textual signs + floor map
Southeast Stairwell	Basement to 1st	2 textual signs
West Basement corridor	Basement	1 exit sign, not illuminated 0 signs

Architecture of Hart House: Collegiate Gothic Style

The Hart House building, designed in the late 1800s, adopts the Collegiate Gothic Style. This style is renowned across Canada for its medieval architecture and Romanesque that is unconventional by today's standards [30]. The following list summarizes elements of Hart House, unique to the Collegiate Gothic style:

- Castle-like imitation of ivy-clad walls of red brick, stone, and slate
 - Often chiselled and hand-hewn walls
- Pink sandstone and red brick made up the neutral colour palette for the collegiate gothic-style buildings of the University of Washington
 - The colour palette of Hart House is similar, with brick walls and tile (Figure 3), as well as grey stone walls (Figure 4)
- Often nicknamed the “college of memory”, memorial stone carvings and artworks are important to the style’s aesthetic [31, p. 216]
- High arches, high ceilings and wide intersections in its interior

Zone B, Interior Environment Observations:

- Brightness (measured with digital illuminance meter): 60.0-80.0 lux
 - Measured along interior hallways
- Noise level: 60.0-65.0 dB.
 - Measured using online decibel sound meter [32]
 - Measured along the first floor, south facing hallways, at 17:30, 19/10/2023

Virtual Environment:

- Internet Speed: 14-17 Mb/s
- Measured using an online internet speed tester found in [33] across the three floors of the building

Appendix C: Tools Utilized for Detailed Requirements

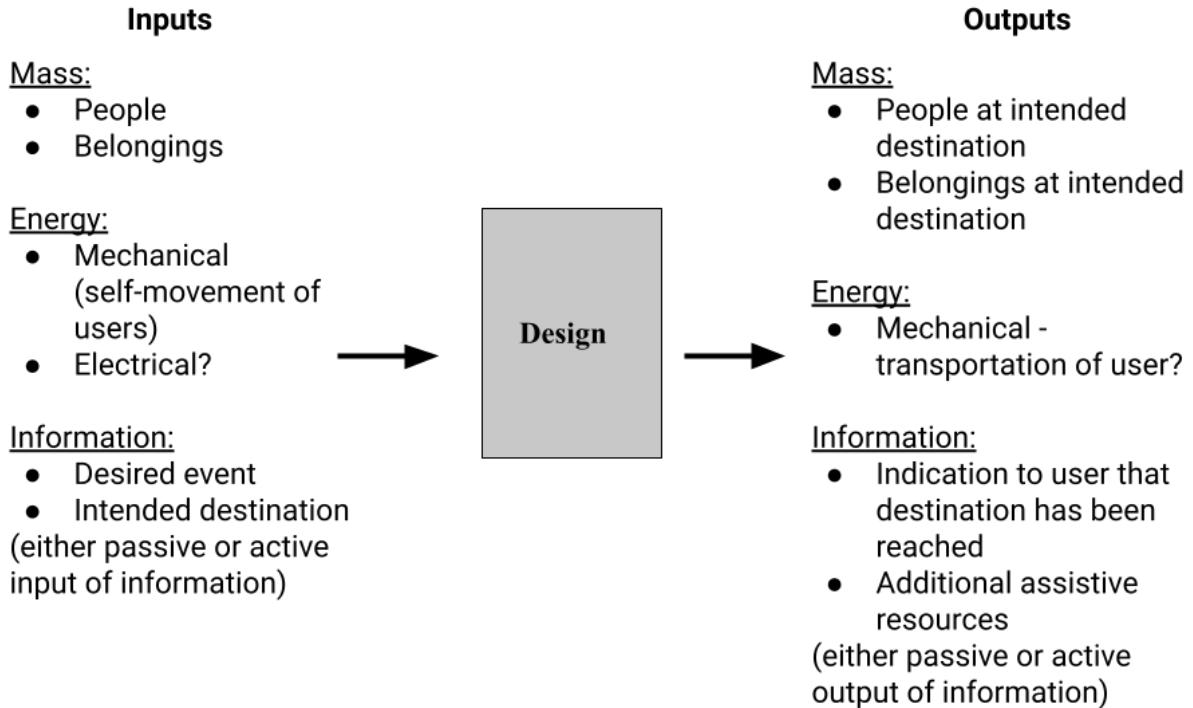


Figure 27: Black Box method of function generation

To help break down what the design should be, the team used a How-Why Objective Tree to help brainstorm a list of possible objectives (Figure 28)

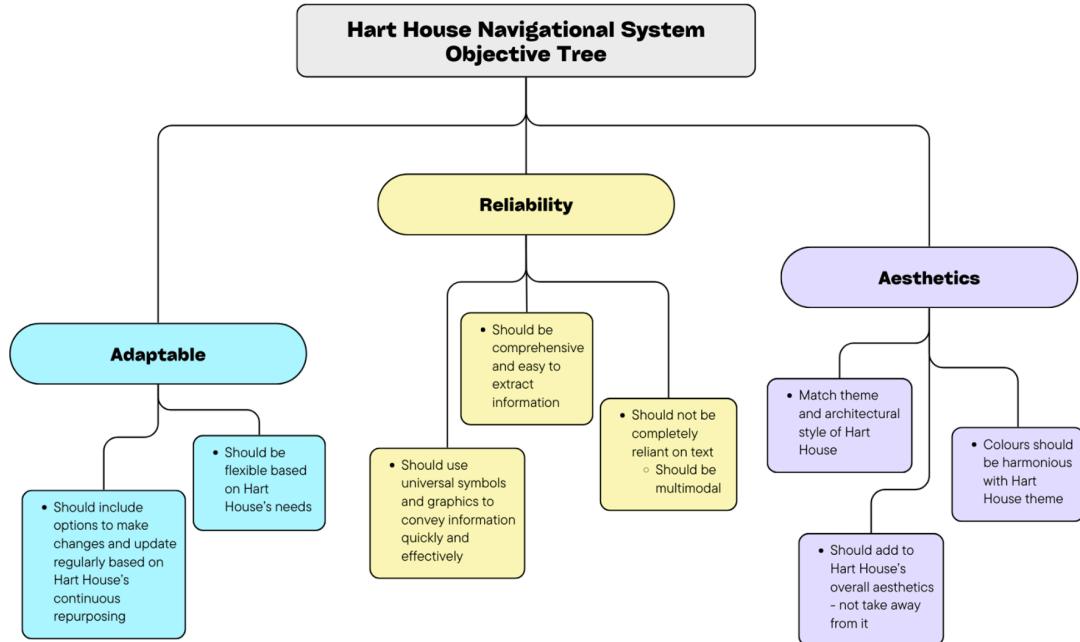


Figure 28: How-Why Objective Tree for navigational system design

To help rank which objectives hold more priority over others, the team used a Pairwise Comparison Chart (Table 9)

Table 9: Pairwise comparison chart of design objectives

	Reliable	Aesthetics	Adaptability	Economic	Total
Reliable	-	1	1	1	3
Aesthetics	0	-	0	1	1
Adaptability	0	1	-	1	2

The reliable objective was prioritized first because the primary function of a wayfinding system is to provide a user with convenient guidance to their intended destination - if the user feels that the system is unclear and confusing, visitors will not use the design and render it obsolete. Adaptability was ranked over aesthetics specifically because of Hart House's multifunctional use and hosting of a wide range of events. However, designing a solution that is aesthetic will also give a cohesive feel to the building and improve navigability. Aesthetics also encompasses the design's consistency throughout the building, which makes it easy for users to recognize wayfinding resources. If these three objectives cannot be achieved, the design would be incomplete no matter how economic the solution may be.

Appendix D: Generative AI usage

The following table includes the prompt-and-response interaction with the generative AI tool “ChatGPT”, used to aid in idea generation [34].

Table 10: Generative AI Prompts and Responses

Prompt: Pretend you are an engineering student in a design course. Use SCAMPER to generate ideas for wayfinding within a historical building used for recreational activities like music, arts, and wellness.
Response: Sure, let's use SCAMPER to generate ideas for improving wayfinding within a historical building used for recreational activities like music, arts, and wellness. Substitute: Substitute traditional signage with interactive digital screens that provide dynamic maps and event information. Replace static signs with augmented reality (AR) applications on smartphones for a more engaging and personalized navigation experience. Combine: Integrate musical cues or subtle background sounds associated with each area to help visitors identify different recreational zones. Combine traditional signage with QR codes that, when scanned, provide additional information about the historical significance of the building. Adapt: Adapt the use of color-coded pathways to represent different recreational activities, making it visually intuitive for visitors. Use tactile floor markers or textures to assist those with visual impairments in navigating through the building. Modify: Modify existing signage to include not only directional information but also upcoming events, workshops, or performances. Implement modular signage that can be easily rearranged to accommodate changes in room usage or event locations. Put to Another Use: Use the historical aspects of the building as thematic wayfinding points, incorporating interesting facts or stories along the routes. Utilize existing architectural features, like windows or pillars, as natural points of reference for navigation.

Eliminate:

Eliminate confusion by simplifying signage language and using universally recognized symbols for various recreational activities.

Remove unnecessary physical barriers to create more open and accessible pathways.

Reverse:

Reverse the conventional approach by starting the wayfinding experience from the recreational destination backward to the entrance.

Create a guided tour system that leads visitors through the building's historical journey before reaching the recreational areas.

Using SCAMPER in this way can help generate innovative ideas to enhance wayfinding within the historical building, making it more enjoyable and efficient for visitors exploring the music, arts, and wellness spaces.

Prompt:

this isn't really what I wanted. Lets try this again, take a deep breath. First brainstorm for me 20 ideas that are very unique from one another.

Response:

Certainly! Here are 20 unique wayfinding ideas for a historical building used for recreational activities like music, arts, and wellness:

Musical Pathways:

Embed musical notes in the flooring that lead to different recreational zones, creating a sensory navigation experience.

Artistic Beacon Stations:

Install interactive art installations at key points, serving as both wayfinding markers and artistic elements.

Historical Holograms:

Use holographic projections to display historical figures or events at specific locations within the building, guiding visitors through time.

Scented Trails:

Infuse scents related to different recreational activities along designated pathways to help visitors follow their noses.

Interactive Mirrors:

Place interactive mirrors that provide directions when approached, integrating technology with wayfinding.

Storytelling Walls:

Design walls that tell stories about the building's history and guide visitors through narratives as they walk.

Glow-in-the-Dark Floor Markings:

Implement glow-in-the-dark floor markings to guide visitors during evening events, creating a visually appealing effect.

Living Plant Navigation:

Use potted plants or living walls arranged in specific patterns to guide visitors through the building.

Architectural Soundscape:

Designate unique sounds or melodies to different architectural features, helping visitors identify various areas by ear.

Customizable AR Wayfinding App:

Develop an augmented reality app that allows visitors to customize their navigation experience based on personal preferences and interests.

Historical Puzzles:

Create floor puzzles with historical images that visitors must navigate to complete, adding an interactive and educational element.

360-Degree Viewing Stations:

Install rotating viewing stations at strategic points, allowing visitors to orient themselves by viewing the entire building layout.

Whispering Walls:

Incorporate directional whispers through directional speakers, guiding visitors without the need for visible signage.

Kinetic Sculptures:

Install kinetic sculptures that move or change shape based on the direction visitors need to go.

Sensory Beacon Boxes:

Place sensory boxes at intersections, each emitting a unique texture, scent, or sound to signify different recreational zones.

Magnetic Poetry Signage:

Create magnetic poetry boards at crossroads, allowing visitors to rearrange words to form directions or clues.

Graffiti Navigation:

Commission local artists to create wayfinding graffiti art that blends seamlessly with the historical aesthetics.

Wind Chime Arrows:

Hang wind chimes in arrow formations, with each direction producing a distinctive sound, aiding in wayfinding.

Time Capsule Navigation:

Bury time capsules at various points, each containing clues or information about the building's history and its current use.

Historical Beacon Lanterns:

Install lanterns with historical information that automatically light up as visitors approach, creating a visual path of enlightenment.

These ideas range from incorporating technology to engaging the senses and combining historical elements with modern design, providing a diverse set of concepts for unique wayfinding within the historical building.

Prompt:

Generate 20 more, considering that the building has a neo-gothic collegiate style

Response:

Certainly! Taking into account the neo-gothic collegiate style of the building, here are 20 more unique wayfinding ideas:

Gothic Architecture Illumination:

Illuminate key neo-gothic architectural elements such as arches, spires, and gargoyles to serve as natural wayfinding markers.

Stained Glass Pathways:

Design floor patterns inspired by stained glass windows, leading visitors to different recreational areas.

Collegiate Shield Signage:

Use the collegiate's coat of arms or shield as directional signage at intersections, incorporating historical symbolism.

Gothic Rose Compass:

Create a central rose compass on the floor, with directional petal paths leading to different wings or sections.

Quill Pen Trail:

Paint quill pen illustrations on the floor to guide visitors, tying in with the collegiate theme and history of the building.

Medieval Banner Markers:

Hang medieval-style banners at crossroads, each depicting symbols associated with music, arts, and wellness.

Gothic Window Light Projections:

Project directional information onto the walls using light projections through neo-gothic window patterns.

Stone Carving Path Markers:

Engrave directional markers into the stone walls or floor using neo-gothic-inspired typography and carvings.

Gargoyle Wayfinders:

Place gargoyle sculptures at key points, with each gargoyle facing the direction of a different recreational area.

Parchment Map Displays:

Install digital displays framed with neo-gothic parchment-like borders, showing interactive maps and event information.

Cathedral Organ Sound Navigation:

Use recorded sounds of a cathedral organ to guide visitors, creating a dramatic and immersive auditory experience.

Gothic Arch Door Frames:

Frame doorways with intricate gothic arches, using them as natural entry points to different recreational zones.

Stone Rune Markings:

Incorporate runic symbols associated with music, arts, and wellness into the floor as wayfinding markers.

Gothic Lantern Pathways:

Line pathways with neo-gothic lanterns, each casting unique shadows and providing subtle illumination.

Bookshelf Directory:

Design interactive bookshelf displays with digital screens that serve as directional guides, integrating with the collegiate theme.

Gothic Alphabet Floor Tiles:

Create a floor mosaic using gothic-style letters to spell out directional messages leading to various activities.

Heraldic Shield Beacons:

Install illuminated heraldic shields at intersections, each representing a different recreational area.

Gothic Quad Map:

Develop a courtyard map in the style of a collegiate quad, with paths leading to different parts of the

building.

Gothic Tower Beacons:

Use the building's towers as focal points, with illuminated beacons signaling the way to specific recreational destinations.

Stone Paver Labyrinth:

Design a labyrinth on the ground using stone pavers, with each pathway leading to a different recreational space.

These ideas blend the neo-gothic collegiate style with practical wayfinding solutions, creating a unique and cohesive experience for visitors exploring the building's recreational areas.

Prompt:

now , on each of these 20 ideas, use scamper to generate more ideas out of each one

Response:

Certainly! Let's apply the SCAMPER technique to each of the 20 wayfinding ideas:

Gothic Architecture Illumination:

Substitute: Experiment with different lighting colors to evoke specific moods for different recreational areas.

Combine: Combine the illuminated architecture with subtle background music to enhance the overall ambiance.

Adapt: Adapt the lighting system to change dynamically based on the time of day or specific events.

Modify: Modify the intensity of the illumination to guide visitors subtly without overpowering the neo-gothic aesthetics.

Put to Another Use: Use the illuminated architecture as a backdrop for guided nighttime tours, emphasizing historical narratives.

Stained Glass Pathways:

Substitute: Substitute traditional floor materials with translucent materials to mimic the effect of stained glass.

Combine: Combine the stained glass pathways with interactive floor projections that tell stories related to the building's history.

Adapt: Adapt the color palette of the stained glass patterns to correspond with the color-coded recreational areas.

Modify: Modify the layout of the stained glass pathways to form intricate patterns inspired by neo-gothic motifs.

Put to Another Use: Use the stained glass pathways as platforms for small impromptu performances or art installations.

Collegiate Shield Signage:

Substitute: Substitute traditional signage with holographic projections of the collegiate shield that

appear at specific intersections.

Combine: Combine the shield signage with interactive touchscreens displaying historical information about the collegiate.

Adapt: Adapt the shield signage to include directional arrows, making it more explicit in guiding visitors.

Modify: Modify the collegiate shield to incorporate symbols representing each recreational area within the building.

Put to Another Use: Use miniaturized collegiate shield replicas as handheld guides for visitors during events.

Gothic Rose Compass:

Substitute: Substitute the traditional rose compass with a dynamic interactive display that changes in response to visitor input.

Combine: Combine the rose compass with aromatic diffusers at each directional point, engaging multiple senses.

Adapt: Adapt the rose compass to include information about ongoing events or exhibitions in each direction.

Modify: Modify the size of the rose compass, creating smaller versions as tabletop displays for informational hubs.

Put to Another Use: Use a virtual version of the rose compass in an app, allowing visitors to navigate the building from their smartphones.

Quill Pen Trail:

Substitute: Substitute traditional floor markings with 3D quill pen sculptures embedded in the ground.

Combine: Combine the quill pen trail with audio recordings of historical letters or writings played at specific locations.

Adapt: Adapt the quill pen trail to lead visitors to hidden corners where historical artifacts or artworks are displayed.

Modify: Modify the quill pen trail to include QR codes that, when scanned, provide additional historical information.

Put to Another Use: Use quill pens as physical wayfinding tokens, given to visitors at the entrance to enhance their interactive experience.

These adaptations build upon the initial ideas, offering additional layers of creativity and functionality to the wayfinding concepts in the neo-gothic collegiate building. If you'd like more ideas for the remaining concepts, feel free to let me know!

Prompt:

yes do the rest

Response:

Medieval Banner Markers:

Substitute: Substitute traditional banners with digital banners that display dynamic information and directional cues.

Combine: Combine the medieval banners with wind sensors, making them ripple subtly and draw attention to directional changes.

Adapt: Adapt the banners to include embedded LEDs that change color to signify different recreational areas.

Modify: Modify the banners to include pockets for brochures or maps, serving a dual purpose as informational hubs.

Put to Another Use: Use miniaturized versions of the banners as interactive tabletop displays at resting points, providing information about the building's history.

Gothic Window Light Projections:

Substitute: Substitute traditional projections with interactive projections that respond to visitor movements or gestures.

Combine: Combine window projections with audio elements, such as whispers or medieval music, enhancing the atmosphere.

Adapt: Adapt the window projections to showcase historical scenes or events related to the recreational areas.

Modify: Modify the projection angles to create illusions of moving shadows or characters within the building.

Put to Another Use: Use the window projections as a storytelling tool during guided tours, bringing history to life through light.

Stone Carving Path Markers:

Substitute: Substitute traditional stone carvings with 3D-printed replicas that are more tactile for touch-sensitive wayfinding.

Combine: Combine stone carvings with small embedded speakers that share historical anecdotes when touched.

Adapt: Adapt the stone carvings to include small built-in screens displaying real-time information about the building's usage.

Modify: Modify the stone carving patterns to include QR codes, linking to online resources for deeper historical dives.

Put to Another Use: Use miniaturized stone carving replicas as tactile souvenirs for visitors, providing a tangible connection to the building.

Gargoyle Wayfinders:

Substitute: Substitute traditional gargoyles with animated digital projections that change expressions or gestures.

Combine: Combine the gargoyles with motion sensors to trigger subtle movements or sounds as visitors approach.

Adapt: Adapt the gargoyles to emit soft lighting to guide visitors in low-lit areas.

Modify: Modify the gargoyles to include QR codes that, when scanned, provide information about nearby recreational zones.

Put to Another Use: Use smaller gargoyle replicas as interactive table centerpieces in event spaces, doubling as conversation starters.

Parchment Map Displays:

Substitute: Substitute traditional parchment maps with e-ink displays that can be updated in real-time for event changes.

Combine: Combine the parchment maps with interactive touchscreens to allow visitors to customize

their routes.

Adapt: Adapt the parchment map displays to include augmented reality features, overlaying historical images onto the real-time view.

Modify: Modify the parchment map layouts to include hidden compartments revealing artifacts or historical documents.

Put to Another Use: Use smaller versions of the parchment map displays as digital brochures for visitors to take with them.

Cathedral Organ Sound Navigation:

Substitute: Substitute traditional organ sounds with electronic remixes that reflect the building's fusion of history and modernity.

Combine: Combine the organ sounds with directional echoes that guide visitors through acoustics.

Adapt: Adapt the organ sounds to change dynamically based on the density of visitors in different areas, creating a unique auditory experience.

Modify: Modify the organ sounds to include subtle hints or melodies indicating proximity to recreational spaces.

Put to Another Use: Use the organ sounds as ambient music for wellness spaces, creating a calming and immersive atmosphere.

Gothic Arch Door Frames:

Substitute: Substitute traditional door frames with augmented reality portals that display information or scenes related to the upcoming recreational area.

Combine: Combine the gothic arch door frames with RFID technology, allowing personalized greetings or information when visitors approach.

Adapt: Adapt the door frames to include embedded LEDs that change colors to signify different types of activities.

Modify: Modify the arch shapes to create optical illusions that visually guide visitors through the space.

Put to Another Use: Use smaller versions of the gothic arch door frames as decorative elements in event invitations or promotional materials.

Stone Rune Markings:

Substitute: Substitute traditional stone runes with bioluminescent materials that glow softly in low-light conditions.

Combine: Combine the stone runes with tactile elements, allowing visitors to feel the engraved symbols.

Adapt: Adapt the stone runes to include heat-sensitive materials, changing texture when touched.

Modify: Modify the stone runes to incorporate NFC technology, triggering historical audio narratives when touched with a smartphone.

Put to Another Use: Use miniaturized stone rune replicas as decorative elements in merchandise, each symbol representing a specific recreational area.

Gothic Lantern Pathways:

Substitute: Substitute traditional lanterns with lanterns that emit different scents associated with each recreational area.

Combine: Combine the lanterns with wind chimes that tinkle softly, creating a multisensory

experience.

Adapt: Adapt the lanterns to include small screens that display directional information or historical trivia.

Modify: Modify the lanterns to include solar-powered LEDs, creating an eco-friendly and energy-efficient pathway.

Put to Another Use: Use smaller versions of the gothic lanterns as interactive centerpieces for events, providing a touch of historical elegance.

Bookshelf Directory:

Substitute: Substitute traditional bookshelf displays with holographic bookshelf projections that change dynamically.

Combine: Combine the bookshelf displays with augmented reality apps that provide virtual book recommendations guiding visitors through the building.

Adapt: Adapt the bookshelf displays to include QR codes linking to online resources related to the building's history.

Modify: Modify the bookshelf layout to create hidden compartments that reveal artifacts or historical documents.

Put to Another Use: Use miniaturized bookshelf replicas as unique event invitations or promotional items.

Gothic Alphabet Floor Tiles:

Substitute: Substitute traditional alphabet tiles with dynamic LED floor tiles that spell out directional messages.

Combine: Combine the alphabet tiles with pressure-sensitive technology, triggering additional information when stepped on.

Adapt: Adapt the alphabet floor tiles to include embedded screens displaying real-time event schedules or announcements.

Appendix E: Initial list of ideas

The following list compiles all ideas generated before feasibility checking.

1. Butterflies that change colours based on whether the user is travelling in the correct direction, based off of an initial destination that the user chose
2. Projections onto the floor that are constantly updated, show directions to current events
3. Butterflies that fly along the ceiling to the destination
4. Color code the various sections of Hart House (ie. if offices are coded blue and food is coded red, as you move closer to areas with food, the walls become more red)
5. Projections onto the ceiling (themed) that give directions to current events, constantly updating)
6. light trails (illuminating elements on walls?)
7. Projections onto the ceiling that show a bird's eye-view of where they are standing and the rooms around them
8. Colour coded pathways
9. Colour coded arrows along the interiors of Hart House
10. Electronic pager-like device
11. Guiding wristband / watch
12. QR codes scattered through Hart house: give users access to web-based design
13. Hart House website or app: GPS system that gives directions to users through Hart House
14. Hart House app, comprehensive and easy to access event information
15. Personal handheld tour guide
16. Following sounds to destination (audio trails)
17. Make Hart House into an arena for a scavenger hunt- provide yousers with an initial clue that leads to a certain destination
18. Audio prompts to direct users toward their destination
19. Guidance drones
20. AR-based software that shows path toward destination
21. Bluetooth-based wayfinding beacons to provide information when users are near them
22. Hart House TikTok page to help students navigate Hart House
23. Designate different scents to sections in HH so that users will know if they've ended youp in the same place twice based off of the scent
24. PA system announcements
25. TV's at every intersection to provide directions
26. guided TV in each entrance and staircase, show the whole frame, function of each floor.
27. Interactive digital booths (like the ones in malls)
28. Holographic/ghosly displays using pepper's ghost
29. Tour Guides at Larger Intersections
30. Mall-like direcotry/HH Building direcotry (Like Robarts)
31. Road sign on different position due to their location.e.g.
32. up view---ceiling
33. horizontal view---wall
34. down view---ground
35. Landmarking: e.g. indicating the location of the user relative to major landmarks such as South, SE, Main entrance

36. Totem poles at the various intersections to help differentiate them- recognizing and acknowledging the Indigenous territories that HH resides on
37. 3D HH interior layout model
38. Distributing Maps and Brochures
39. Guide brochures
40. Hoverboard chairs- similar to wheelchairs
41. Personal hoverboards
42. HH zipline
43. Multi-directional moving walkway
44. Make Hart House into a skating rink
45. HH human conveyor transporter
46. Having employees pull users in wagons or pushes users around in wheelchairs
47. Floo Network chimney system- Harry Potter
48. Teleportation
49. HH train
50. Indoor Gondolas
51. Provide free site visits every month that train the users where every place is so that they will know for the next time they come
52. Swap APS100 for HHN100: Hart House Navigation
53. Make Hart House into a large escape room with clues and tasks for the yousers to complete
54. HH building tours
55. VR exploration space
56. Vldeo guide to your event's location on the website/qrcode linked
57. Tablets given to each user that allows users to select their target destination
58. Interactive Screens: mall-like directory
59. Comprehensive front desk
60. Buttons that give vocal directions
61. Buttons that give sound cues
62. Personal tour guides
63. Robot Assistants?
64. AI assistants
65. Personal Guiding drone
66. Service animals (guide dog)

Appendix F: Collaborative Graphic Design Tool used in Idea Generation

The following figures show the collaborative Graphic Design Tool used in Idea Generation. Each figure separates a category of ideas, used as stimulation for further ideation.

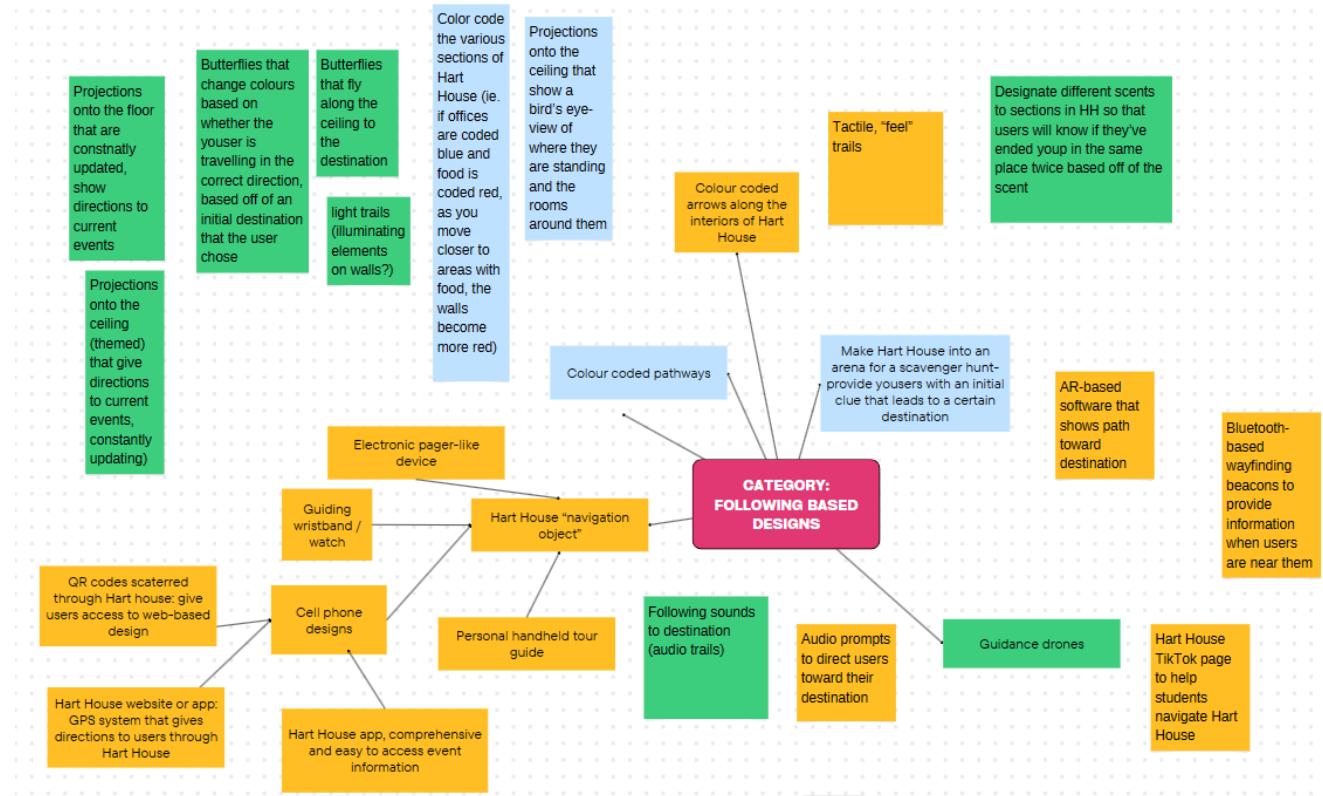


Figure 29: Idea generation collaborative mind map: following based designs

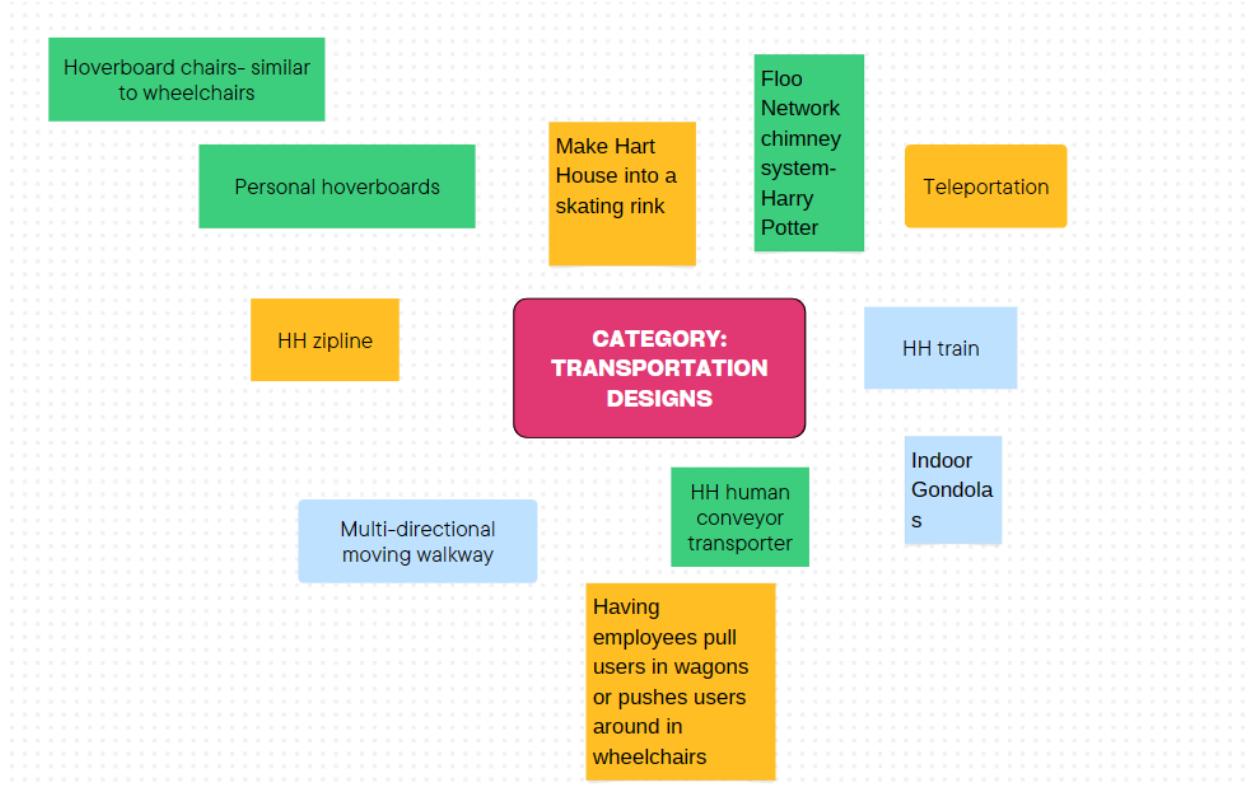


Figure 30: Idea generation collaborative mind map: Transportation Designs

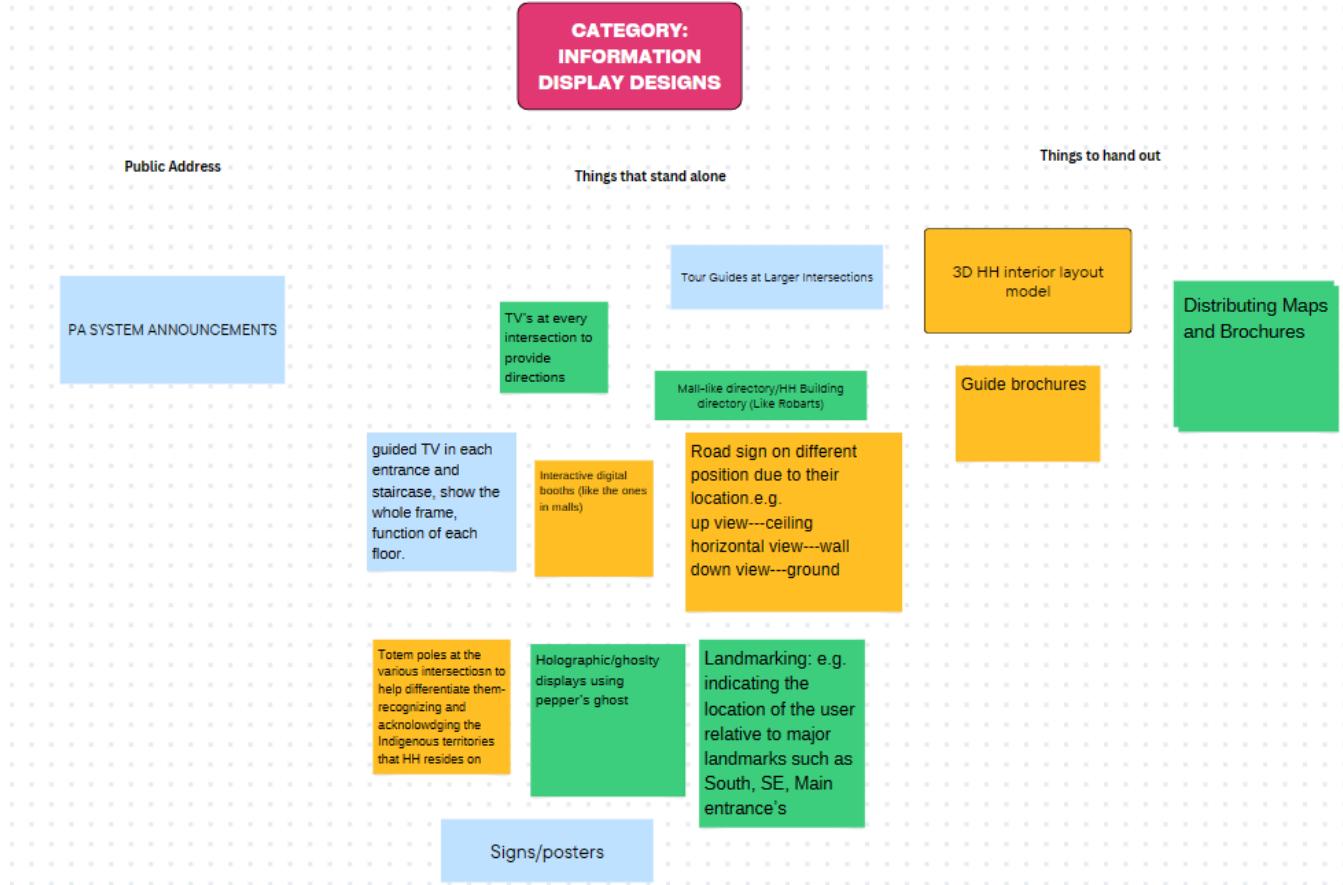


Figure 31: Idea generation collaborative mind map: Information display designs

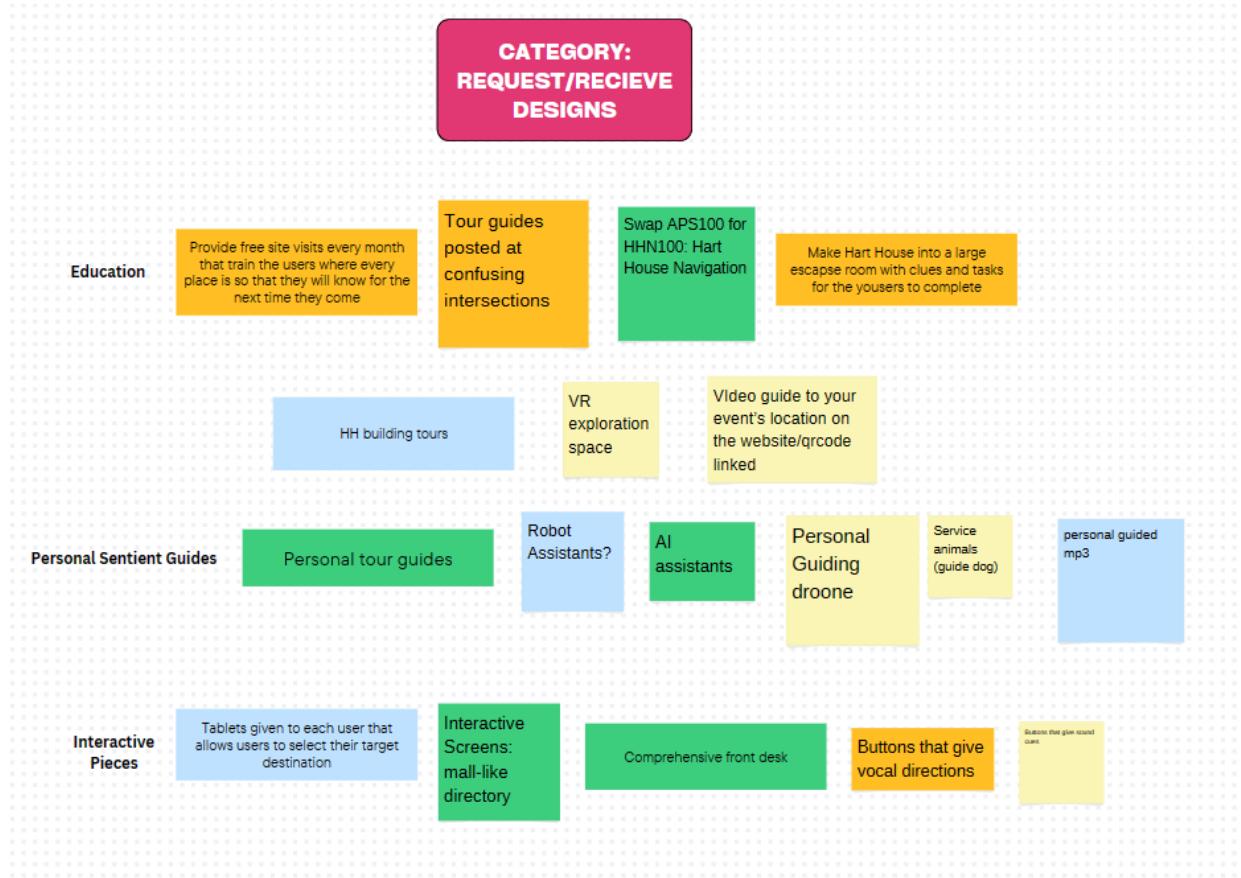


Figure 32: Idea generation collaborative mind map: Request/receive designs

Appendix G: Multivoting Spreadsheet

The following spreadsheet was used in Multivoting Round 1:

Idea Name	Unfeasible?	Isaac (Donders)	Grace (Indigenous groups)	Naisha (UofT Campus)	Yimin (students)	Michael - Event Holders	Andre w	Total Votes
Hart House website or app: GPS system that gives directions to users through Hart House		1	1	1	1	1	1	6
Interactive digital booths (like the ones in malls)		1	1	1	1	1	1	6
Distributing Maps and Brochures		1	1	1	1	1	1	6
Butterflies that fly along the ceiling to the destination		1	1	1		1	1	5
Guiding wristband / watch		1	1	1	1	1		5
Hart House app, comprehensive and easy to access event information				1	1	1	1	5
AR-based software that shows path toward destination		1		1	1	1	1	5
3D HH interior layout model		1	1		1	1	1	5
AI assistants		1		1	1	1	1	5
light trails (illuminating elements on walls?)		1		1		1	1	4
QR codes scattered through Hart house: give users access to web-based design				1	1	1	1	4
Hart House TikTok page to help students navigate Hart House		1	1	1	1			4
Tour Guides at Larger Intersections		1	1	1			1	4
Mall-like directory/HH Building directory (Like Robarts)				1	1	1	1	4
VR exploration space		1		1	1	1		4
Comprehensive front desk		1			1	1	1	4

Projections onto the ceiling that show a bird's eye-view of where they are standing and the rooms around them			1	1		1		3
Projections onto the floor that are constantly updated, show directions to current events				1	1		1	3
Projections onto the ceiling (themed) that give directions to current events, constantly updating)		1	1			1		3
Bluetooth-based wayfinding beacons to provide information when users are near them					1	1	1	3
Landmarking: e.g. indicating the location of the user relative to major landmarks such as South, SE, Main entrance's			1		1	1		3
Provide free site visits every month that train the users where every place is so that they will know for the next time they come		1	1		1			3
Robot Assistants		1	1	1				3
Make Hart House into an arena for a scavenger hunt- provide users with an initial clue that leads to a certain destination				1		1		2
Color code the various sections of Hart House (ie. if offices are coded blue and food is coded red, as you move closer to areas with food, the walls become more red)					1		1	2
Colour coded pathways				1			1	2
TV's at every intersection to provide directions			1				1	2
HH building tours			1				1	2

Video guide to your event's location on the website/qrcode linked	1				1	2
Interactive Screens: mall-like directory	1				1	2
Colour coded arrows along the interiors of Hart House					1	1
Personal handheld tour guide (device)				1		1
Guidance drones	1					1
Designate different scents to sections in HH so that users will know if they've ended youp in the same place twice based off of the scent	1					1
guided TV in each entrance and staircase, show the whole frame, function of each floor.					1	1
Totem poles at the various intersections to help differentiate them- recognizing and acknowledging the Indigenous territories that HH resides on			1			1
Multi-directional moving walkway			1			1
Make Hart House into a skating rink	1					1
Floo Network chimney system- Harry Potter	1					1
Teleportation	1					1
Indoor Gondolas	1					1
Tablets given to each user that allows users to select their target destination			1			1
Buttons that give vocal directions	1					1
Personal Guiding drone			1			1

Holographic/ghostly displays using pepper's ghost								0
Electronic pager-like device								0
Following sounds to destination (audio trails)								0
Audio prompts to direct users toward their destination								0
PA system announcements								0
Road sign on different position due to their location.e.g.								0
Hoverboard chairs- similar to wheelchairs								0
HH zipline								0
HH human conveyor transporter								0
Having employees pull users in wagons or pushes users around in wheelchairs								0
HH train								0
Swap APS100 for HHN100: Hart House Navigation								0
Make Hart House into a large escape room with clues and tasks for the yousers to complete								0
Buttons that give sound cues								0
Personal tour guides								0
Service animals (guide dog)								0
Votes used	20	20	20	20	20	20	20	20

Table 11: Multivoting Round One Spreadsheet

The following spreadsheet was used in Multivoting Round 2:

Idea Name	Unfeasible?	Isaac (Donors)	Grace (Indigenous groups)	Naisha (UofT Campaign)	Yimin (students)	Michael - Event Holders	Andre w	Total Votes
Interactive digital booths (like the ones in malls)			1	1	1	1	1	5
Hart House website or app: GPS system that gives directions to users through Hart House				1	1	1	1	5
Butterflies that fly along the ceiling to the destination			1	1	1	1	1	5
Robot Assistants		1	1	1	1			4
TV's at every intersection to provide directions				1		1	1	3
Projections onto the floor that are constantly updated, show directions to current events					1	1	1	3
Mall-like directory/HH Building directory (Like Robarts)				1		1	1	3
Hart House TikTok page to help students navigate Hart House		1		1			1	3
AI assistants		1		1	1			3
VR exploration space		1		1				2
QR codes scattered through Hart house: give users access to web-based design						1	1	2
Projections onto the ceiling that show a bird's eye-view of where they are standing and the rooms around them				1		1		2
Projections onto the ceiling (themed) that give directions to current events, constantly updating)			1	1				2
light trails (illuminating elements on walls?)			1			1		2

Interactive Screens: mall-like directory					1	1		2
Guiding wristband / watch		1		1				2
Distributing Maps and Brochures			1				1	2
Comprehensive front desk					1	1		2
AR-based software that shows path toward destination		1		1				2
3D HH interior layout model						1	1	2
Video guide to your event's location on the website/qrcode linked							1	1
Landmarking: e.g. indicating the location of the user relative to major landmarks such as South, SE, Main entrance's						1		1
HH building tours			1					1
Bluetooth-based wayfinding beacons to provide information when users are near them						1		1
Tour Guides at Larger Intersections								0
Make Hart House into an arena for a scavenger hunt- provide users with an initial clue that leads to a certain destination								0
Colour coded pathways								0
Color code the various sections of Hart House (ie. if offices are coded blue and food is coded red, as you move closer to areas with food, the walls become more red)								0
Votes used		10	10	10	10	10	10	

Table 12: Multivoting Round Two Spreadsheet

The following table was used in Multivoting Round 3:

Idea Name	Unfeasible?	Isaac (Donors)	Grace (Indigenous groups)	Naisha (UofT Campaign)	Yimin (students)	Michael - Event Holders	Andrew (Students)	Total Votes
Interactive digital booths (like the ones in malls)			1	1	1	1	1	5
AI assistants		1		1	1		1	4
Robot Assistants		1	1	1				3
AR-based software that shows path toward destination			1		1			2
Mall-like directory/HH Building directory (Like Robarts)					1		1	2
Butterflies that fly along the ceiling to the destination			1	1				2
Comprehensive front desk					1		1	2
Guiding wristband / watch					1		1	2
Hart House website or app: GPS system that gives directions to users through Hart House						1	1	2
light trails (illuminating elements on walls?)					1		1	2
Projections onto the ceiling (themed) that give directions to current events, constantly updating)			1	1				2
TV's at every intersection to provide directions					1		1	2
3D HH interior layout model				1				1
Distributing Maps and Brochures				1				1

Projections onto the ceiling that show a bird's eye-view of where they are standing and the rooms around them					1					1
Projections onto the floor that are constantly updated, show directions to current events							1			1
QR codes scattered through Hart house: give users access to web-based design							1			1
VR exploration space			1							1
Hart House TikTok page to help students navigate Hart House									0	
Sum		6	6	6	6	6	6	6	6	

Table 13: Multivoting Round Three Spreadsheet

Appendix H: List of designs to be evaluated

The following list summarises the list of ideas after the final generative phase and entering the selection phase.

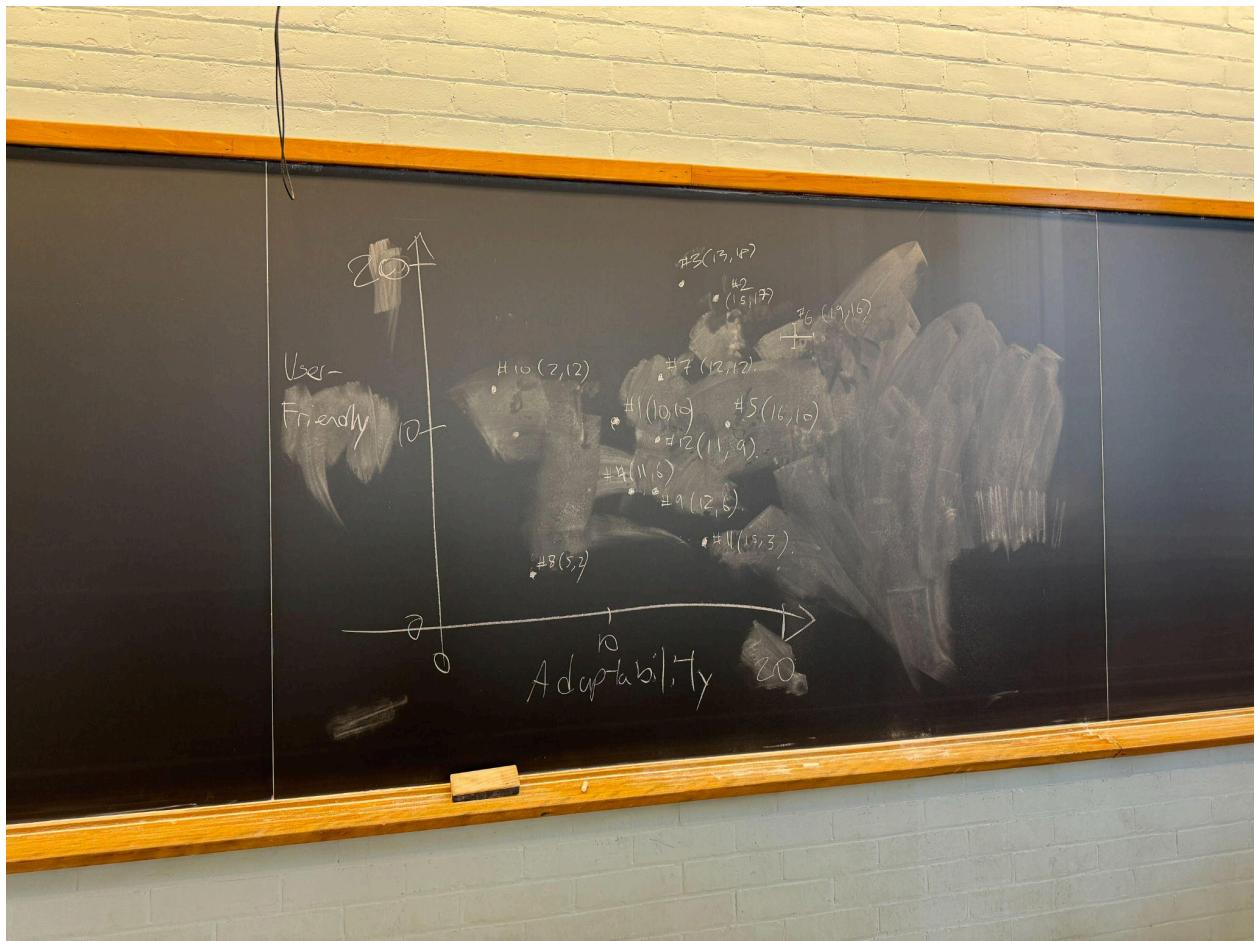
Combination ideas

1. Portable navigation device - easily accessible and always available
 - A hand-held device can play the role of a dynamic menu, it can display all the events are holding or will happen.
 - Can make an appointment for usage of certain function rooms, like the piano room.
 - Able to incorporate multiple subfunctions, especially information display in a miniaturized digital element.
2. Digital Kiosk + Light Trails + AI Assistant
 - A digital kiosk that is available at large/confusing intersections in HH
 - Has an AI Assistant that can help user
 - Uses light trail projections from the kiosk to prompt to guide users towards their destination.
3. Hart House app/website/GPS system + AR based software + mall directory
 - Mobile application that can provide users with a 360deg view, modelled off of google maps and first-person navigation.
 - Gives individuals an in-person view of the HH interior so that they are familiar with the interior view before making navigation decisions.

- If the user does not want to use a mobile device, the in-building H.H. directory can also display first person /interior POV's of different Hart House locations for in-person use.
4. Robot + AI Assistant + Kiosk on the Robot
 - Personal Robot that has AI software to assist and guide user around HH
 - Robot has an interactive touch screen that serves as a personal kiosk
 - Has 3D view and layout of HH
 5. Comprehensive Front Desk + AI Assistants
 - Various AI assisted digital booth located at front desk or throughout the building:
 - Utilising lip reading and voice recognition.
 - Allows users to give input requests (wayfinding questions, event information requests), and help formulate directions or next steps for the user to address their request.
 6. Light Trails + projections + butterflies:
 - Building-wide projection system
 - Informs users with events through projections onto wall / ceiling
 - Projections on ceilings, wall of floor are flexible as they can be used for event information or navigation elements (light trails, arrows,)

Individual Ideas

7. Interactive digital booths
8. Robot assistants
9. AR based software that shows path toward destination
10. Mall-like directory robarts
11. Hart House website or app
12. TV's at every intersection

Appendix I: Blackboard work (objectives comparison)

Appendix J: Tabulated objective comparison graph and justifications

The following table summarises the objective comparison graph and the justifications behind each idea's placement in the space.

Table 14: Objective comparison justifications

Idea #	Idea	Rating	Justification
1	Personal navigation device and assistive software	Ease of use: 11 Adaptable: 16	<ul style="list-style-type: none"> ● Unfamiliar interface ● Adaptable changes can be made on the screen ● Limited to screen display
2	Hart House app/website/GPS system + AR based software + mall directory	Ease of use:18 Adaptable:13	<ul style="list-style-type: none"> ● Helpful first person view ● No creative element
3	Robots	Ease of use:6 Adaptable:11	<ul style="list-style-type: none"> ● Difficulty interacting with robot ● Not multi-user accommodating ● Easily adaptable and modifiable
4	Front desk	Ease of use: 10 Adaptable: 16	<ul style="list-style-type: none"> ● Only found on the first floor ● Centralised system- easier to maintain
5	Light Trails + building-wide projections	Ease of use:16 Adaptable:19	<ul style="list-style-type: none"> ● Easy to follow ● Does not require interaction ● Displayable on walls and easily modifiable
6	Interactive digital booths	Ease of use:12 Adaptable:12	<ul style="list-style-type: none"> ● Familiar interface ● Adaptable as it is digital
7	Robot assistants	Ease of use:2 Adaptable:5	<ul style="list-style-type: none"> ● Unfamiliar- difficult to interact with ● Difficult to find ways for information display
8	AR based software that shows path toward destination	Ease of use:6 Adaptable:12	<ul style="list-style-type: none"> ● Software-based- easily updatable ● Unfamiliar and unconventional
9	Mall-like directory robarts	Ease of use: 10 Adaptable:2	<ul style="list-style-type: none"> ● Comprehensible, and familiar information display ● Can lack clarity ● Difficult to update
10	Hart House website or app	Ease of use:5 Adaptable:15	<ul style="list-style-type: none"> ● Limited to mobile devices ● Website can constantly be updated
11	TV's at every intersection	Ease of use:9 Adaptable:11	<ul style="list-style-type: none"> ● Familiar interface

Appendix K: Attribution Table

Tutorial #:	0122	Team #:	149
Assignment:	Conceptual Design Specifications	Date:	4 December 2023

The Attribution Table is a major resource used by your TA in determining whether there was equal contribution to the team assignment. If your TA determines that there was significant under contribution, then they may apply an individual penalty to the under contributing team members' grade. As a future professional engineer you should NOT sign any document you have not read and do not agree with.

The Attribution Table must be completed, signed by all team members, and included as an appendix of your assignment AND uploaded to your MS Teams team channel. Teams who do not submit a completed form, including those that submit an incomplete form, such as one missing a team member's signature, will receive zero on the assignment. The team may submit a petition to the ESP Office if they feel the lack of signature is through no fault of the team.

The Attribution Table should accurately reflect each team members' contribution to the document. Be sure to keep a copy of this form for the team's records.

If there are irreconcilable differences that are preventing all team members from signing the attribution table then each team member must write a letter (<one page) explaining their position on the difference and suggest a solution. These letters must be submitted to the TA.

As with any engineering statement this attribution table must be backed by credible evidence. In most cases this will be found either in the Google Docs document revision history, or your engineering notebook. Making fraudulent claims in an Attribution Table displays intent to deceive and is a serious academic offence.

Section	Student Names					
	Naisha	Grace	Michael	Andrew	Isaac	Yimin
Executive Summary	MR,ET,FP		WD, MR, FP	ET TP	FP	FP
Introduction (revision)	ET,FP	RS1 MR ET FP	FP	ET FP	FP	ET,MR,FP
Problem Statement (revision)	MR,ET,FP	RS1 MR ET FP	FP	ET FP	FP	FP
Service Environment (revision)	ET,FP	MR ET FP	FP	MR ET FP	FP	FP

Stakeholders (revision)	FP		FP	MR ET FP	WD FP	FP,ET
Detailed Requirements (revision)	ET	RS1 MR ET FP	ET, FP	ET FP	ET FP	FP
Idea Generation Process	OR2,ET, FP	FP	OR2, FP	MR ET FP	WD FP	MR,OR2,FP,ET
Alternative Design Selection	ET,FP	FP	OR2	FP	WD FP	ET,FP
Alternative Design Description	FP	WD FP	OR2, WD, ET, FP	ET FP	ET FP	FP
Proposed Conceptual Design	FP	OR2 FP	OR2,, FP	ET FP	WD FP	FP
Measures of Success	FP	OR1 WD	RS1, WD, FP	ET FP	WD OR1 RS2 MR FP	OR1,FP
Conclusion	FP		WD, ET, FP	ET FP	ET FP	FP
Reference List		WD FP		ET FP		FP
Appendices		FP	FP		WD MR FP	FP

Fill in abbreviations for roles for each of the required content elements using the abbreviations found on the next page. You do not have to fill in every cell.

RS – Research (give details below)

WD – Wrote Draft

MR – Major Revision

ET – Edited

FP – Final Proofread of COMPLETE DOCUMENT

verifying for flow and consistency

OR – Other (give details below)

If you put RS (research) please add a number identifier such as RS1, RS2, etc. Give the research question / topic:

RS1: Researched for PR revision

RS2: Researched agent-based simulation for measures of success

RS3:

If you put OR (other) please add a number identifier such as OR1, OR2, etc. Explain the role below:

OR1: Took photos of the prototype at Hart House

OR2: Created graphics, such as flow charts, mind maps, or drawings.

By typing your name below to sign, you verify that you have:

- Read the attribution table and agree that it accurately reflects your contribution to the associated document.
- Written the sections of the document attributed to you and that they are entirely original.
- Accurately cited and referenced any ideas or expressions of ideas taken from other sources according to the standard specified by this course.
- Read the University of Toronto Code of Behaviour on Academic Matters and understand the definition of academic offense includes (but is not limited to) all forms of plagiarism. Additionally, you understand that if you provide another student with any part of your own or your team's work, for whatever reason, and the student having received the work uses it for the purposes of committing an academic offence, then you are considered an equal party in the offence and will be subject to academic sanctions.

Grace Lin

Student #1 Name

Andrew Xu

Student #5 Name

Yimin Chu

Student #2 Name

Isaac Ali

Student #6 Name

Naisha Shah

Student #3 Name

Student #7 Name

Michael Feng

Student #4 Name