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The Need for an Inclusive Indoor Wayfinding, Signage and Navigation System for increasing Campus Accessibility

For many first-year university students, navigating through the academic buildings during the first couple of weeks can become an overwhelming experience especially for students with existing physical conditions that present them with many barriers on campus. Being a first-year international student myself, I found it difficult to navigate around buildings when I had back-to-back classes during the first couple of weeks in completely different buildings or on different parts of the campus. This made me wonder how difficult it might be to attend face-to-face classes for individuals with visual, cognitive and hearing impairment at the University of Victoria. Most of the faculty buildings at the University of Victoria were designed exclusively for individuals who do not present any physical barrier while attending classes. Despite several recent efforts for making the university barrier-free, navigating between classes is still a barrier for many students having hearing and audio-visual disabilities and students who are blind and wheelchair users. An indoor wayfinding application system can become an important tool in making the university accessible compared to the existing signage system by helping disabled students from all spectrums in getting tailored directions on following accessible routes inside academic buildings and also getting a more personal experience.

Figure 1: A traditional wayfinding and signage system designed for the University of North Carolina at Chapel Hill [1]

According to the World Health Organization, barriers are factors in an individuals' environment that, through their absence or presence, limit functioning and create disability [2]. Lack of assistive, adaptive, and rehabilitative devices and services or, lack of an accessible university system and policies can be regarded as barriers in the context of campus accessibility. Making a university accessible and universal for everyone does not have to only start with the removal of the architectural and physical barriers - it can also involve providing information about accessible routes on campus and inside faculty buildings [3]. There are many mapping services for helping users in navigating outdoors, though none of them are campus-specific tailored to help users get specific information about faculty buildings [4]. Though the university already has standardized interior wayfinding inside most buildings, existing wayfinding and signage guidelines do not meet the minimum accessibility requirements required for making faculty buildings accessible for everyone.

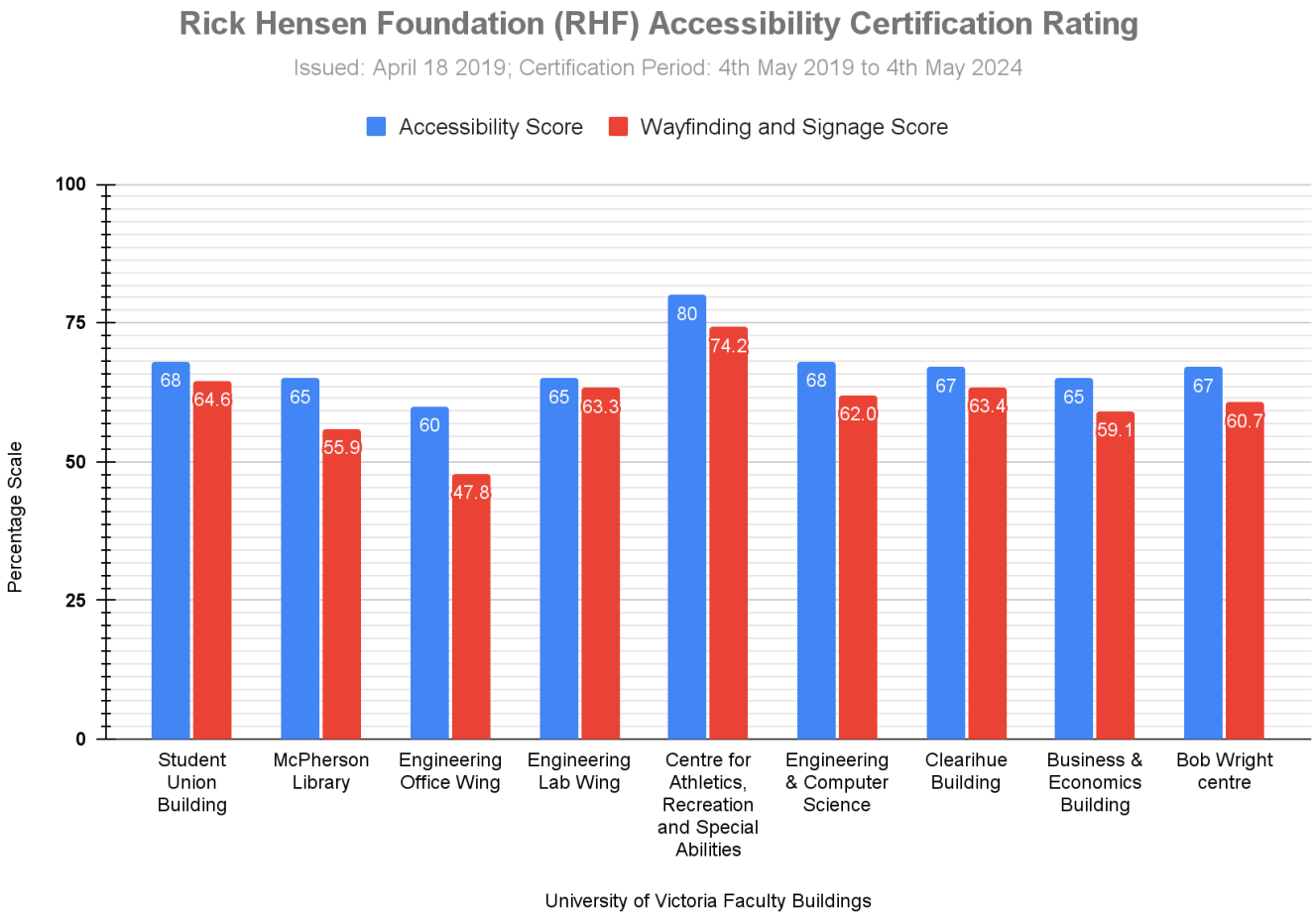

Figure 2: The chart shows the overall accessibility score of some of the well-known faculty buildings on the University of Victoria Campus, compared to the Wayfinding, Signage and Information Ratings of each building [13-20].

Rick Hansen Foundation Accessibility CertificationTM (RHFAC) is a national rating system that measures and certifies the level of meaningful access of buildings based on the environmental and architectural factors that present barriers [5]. Factors like Vehicular Access (VA), Interior Circulation (IC), Interior Services and Environment (ICE), Sanitary Facilities (SF), Wayfinding and Mapping System (WMS), Signage Designs (SD), Emergency Systems (ES) placed inside a building are being taken into account before giving a comprehensive analysis and a final accessibility score. A minimum score of 60% is required for getting **RHF Accessibility Certified**. Most faculty buildings inside the University of Victoria barely meet the minimum requirement (60%) for existing signage and wayfinding systems on each building, but some buildings (McPherson Library, Engineering Office Building, Business and Economic Building) do not even meet the bare minimum [14, 17, 19]. A score of 80% (or more) means a building meets the most mandatory requirements for being accessible to everyone [5]. Only one building has fully complied with the accessibility guidelines required by the RHFAC - Centre for Athletics, Recreation and Special Abilities (CARSA) [20].

Figure 3: (Left to Right) Wayfinding and Navigational Signage Systems placed on the campus of University of British Columbia (UBC), University of North Carolina (UNC) at Chapel Hill and University Clinic Greifswald (UGC).

Indoor Signage and Wayfinding Systems are designed around urban university campuses to meet the specific needs of users with disabilities who need to use tailored paths within a building to avoid barriers such as stairs and steps; and also provide disabled users with the necessary tools to help them navigate inside university buildings, labs and classrooms [3, 5]. Wayfinding Systems can be of many forms - it can be a turn by turn instructional wearable smart device or it can be a web application that gives verbose descriptions of the surrounding environment of the faculty buildings and classrooms [Figure 6]. In both cases, the navigational wayfinding application system has to be equally accessible to everyone and must have an

accessible user interface and interaction mechanisms that help students, faculty members and staff to get navigational directions from one building to another easily.

For an outdoor environment, Global Positioning System (GPS) is being used as a standard by almost every wayfinding system as there is no need to use any additional technologies like Beacons and Wi-Fi Signals [9]. Users are located by calculating their distance from Ground Stations and Satellites through sending and receiving signals from their electronic devices (like a mobile phone or a laptop). GPS has been the most effective solution in terms of locating a targeted user, but it presents various accuracy challenges when locating users inside any large and busy indoor environments like airports, urban campuses and sometimes underground tunnels as there is a lot of interference with the signals while sending them [9]. indoor wayfinding research and related experiments have been done in recent years on various urban campuses to find a standard solution to the open challenge.

Figure 4: iBeacon - A Bluetooth Low Energy (BLE) Beacon System implemented for Indoor Wayfinding [11]

One of the proposed indoor wayfinding system designs was mainly based on the use of BLE (Bluetooth Low Energy) beacons around specific access points inside a building or an indoor environment (like a classroom section inside an academic building) to accurately locate the target users or devices within a radius of 100 meters [10]. Bluetooth beacons are small battery-powered, always-on devices that use low-energy signal packets to send data at a fixed time interval to all the receivers within a close radius [11]. Bluetooth Low Energy (BLE) on the other hand, is a wireless personal area network that has been used as a standard solution for

transmitting data over short distances and has been designed for low energy consumption and cost. The idea is to use several access points (Bluetooth beacons) at specific locations, through Received Signal Strength Indicator (RSSI) values of a targeted user in the system [3]. A higher RSSI value generally indicates an accurate location of the targeted user, which is highly dependent on the increased number of access points around the range of the receiver.

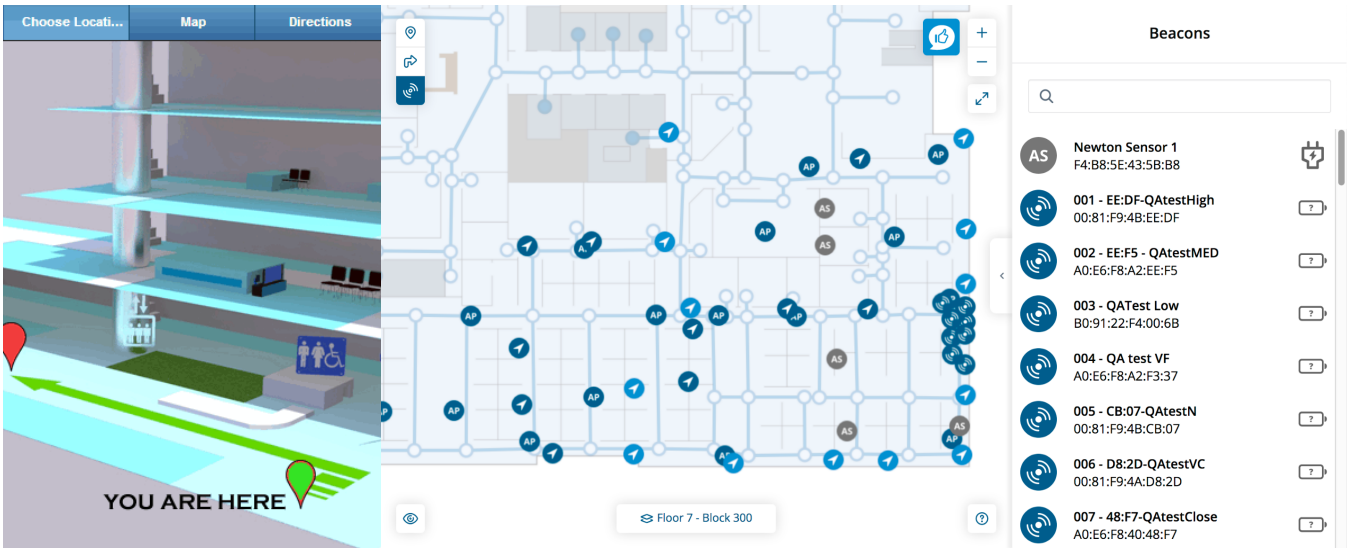

Figure 5: A Wayfinding and Navigation System designed with the help of Bluetooth Low-Energy (BLE) Beacon System in Gove County Medical Center (Quinter, Kansas) [21]

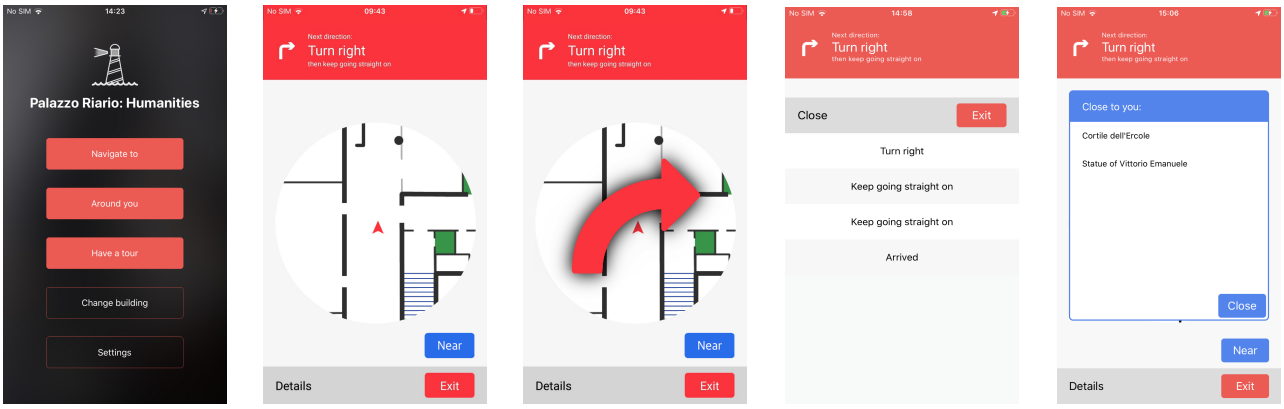

Figure 6: An Inclusively Designed Navigational User-Interface (UI) implemented for the Indoor Wayfinding System developed by the facility of the University of Bologna, Italy. [3]

It is generally accepted that first impressions of a distinctive campus are formed through the initial experiences of a prospective student navigating the roadways, paths and academic buildings. Wayfinding signage is a key component for making a good first impression on any first-time student as well as any new visitors on campus. It will also help them to find their way around campus through the help of a properly implemented navigational and wayfinding

signage system on campus. A wayfinding application will function in the same way but it will give users a more personal experience to their visit on campus. Here are some points on how wayfinding, signage and navigational mapping system implemented on campus can help the student body, as well as disabled students from all spectrums:

- **Guiding students to the right buildings:** A wayfinding application can direct students to specific buildings on campus through a mapping navigational User Interface (UI) to help them know which way to turn as they navigate their way on campus. It can also provide more details such as how far away a particular building is in feet, meters or minutes.
- **Identifying classrooms, labs and floors:** Students can find the right classroom on the first day of the semester easily with the help of a wayfinding application. Students with disabilities can also use this system daily for getting from one place on campus to another.
- **Helping students find their way:** The wayfinding application can also include navigational maps that will help students once they are on campus. The maps can show students where they are and how far they need to walk to reach their destination, which can be a classroom, a building, or any specific spot on campus.
- **Share rules, updates and information:** Currently, students can get any updated news and pieces of information from the official university website. The wayfinding application can also help to share any news and information to everyone using the application. As students will tend to use this application more compared to visiting the university website, they will more likely get across any emergency updates, news and information.

In comparison to the traditional wayfinding and signage system, a wayfinding navigational application system can work tailoring to the needs of every student, faculty member, especially students with disabilities from all spectrums [3]. This system can also provide necessary tools to assist blind and wheelchair-bound students and students with hearing, audio-visual impairment on campus by guiding them in a way suited to their needs [7].

To make a software application that can be equally accessible to everyone, a design system can be implemented based on the design principles ‘Design for Special Needs’ and ‘Universal Design’ (UD) to help disabled groups of individuals from all walks of life who need the use of tailored wayfinding, to use this navigational system without hesitation. As stated in one of

the first research papers published by the *National Institute on Disability and Rehabilitation Research* on implementing the accessible design on campus:

> Universal design can be defined as the design of products and environments to be usable to the greatest extent possible by people of all ages and abilities. The universal design respects human diversity and promotes the inclusion of all people in all activities of life. [12]

Implementing inclusive wayfinding, signage and navigational application system on the university campus is generally inexpensive and highly efficient in helping students with motor, hearing and audio-visual impairment compared to using a traditional system for accommodating the needs of disabled students. Recent developments on various projects relating to implementing various wayfinding systems on university campuses show that the system is highly effective in meeting the needs of targeted students and disability groups [8]. Therefore, it is safe to say that implementing a wayfinding system will not only help the University of Victoria in accomodating the needs of prospective students and faculty members, but it will also help to make the campus more accessible and barrier-free for every student.

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Fogli is a full-time professor in the Department of Information Engineering of the University of Brescia and has a Ph.D. degree in Information Engineering from the same university. This journal article investigates the problem of accessibility around university campuses as well as urban areas around the university and proposes a navigational system inclusive of universal design for all minority groups, individuals, with visual, motor and mobility impairment. The article evaluates the usability and accessibility of the developed navigational system in the university campus through the help of twenty-five participants inclusive of visually impaired individuals as well as individuals with motor disabilities.

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Prandi is a senior assistant professor in the Department of Computer Science and Engineering of the University of Bologna and she has a Ph.D. degree in Computer Science from the same university. In this research paper, the authors investigate the effect of indoor mobility, localization and wayfinding on people with disabilities and also individuals who are moving to an unknown place (i.e visitors and tourists). Through developing an inclusive navigational system that provided wayfinding functions in indoor environments in campus buildings through an accessible mobile application, the authors investigated how the existing system can be improved in the established university context, and which indoor localization strategy provided a good wayfinding experience to the participants of the research.

[3] C. Prandi, B. R. Barricelli, S. Mirri, and D. Fogli, “Accessible wayfinding and navigation: a systematic mapping study,” *Universal Access in the Information Society*, Sep. 2021, DOI: 10.1007/s10209-021-00843-x.

Prandi is a senior assistant professor in the Department of Computer Science and Engineering of the University of Bologna and Fogli is a full-time professor in the Department of Information Engineering of the University of Brescia, both of whom have a Ph.D. in Computer Science and Informational Engineering from the university they teach. In this research paper, the authors surveyed and investigated the various navigational tools and software applications developed for preventing architectural physical barriers in various indoor and outdoor environments around the university campuses as well as public and private buildings inside the campus. This article addresses several persisting problems in the navigational systems, reflects on challenges and issues that must be taken into consideration for the design of accessible places in the future, and proposes solutions to some of the issues presented in the given context.

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Mike Prescott is a Ph.D. candidate and a Research Assistant in the Department of Rehabilitation Sciences at the University of British Columbia, who has a Master’s in Urban Planning from the University of Waterloo. The author is examining the Spatio-temporal dynamics of accessibility and navigation as it relates to the mobility of people with disabilities. In this research paper, the authors explore the various challenges faced by individuals who use wheeled mobility devices while navigating in an unfamiliar pedestrian environment. The research finds that experiences among the participants in the research differed on the type of navigational system/tool used by the participants. The authors concluded that the navigational tools should be designed inclusive and accessible to universal needs, to meet the needs of all wheeled mobility device users.

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The Rick Hansen Foundation Accessibility Certification Registry is a public listing of existing sites that have completed the RHFAC rating process. A list of all the sites that have been rated and certified based on the accessibility score, can be found on this webpage. I compiled all the scores from each section for each building (35+) and chose the ones that reflected the most ideal for my research purpose (buildings that are most commonly used for first-year courses, lab and tutorial sections). I compiled all the data in an excel format, which can be accessed here (Building Wayfinding and Accessibility Score), and compiled the chosen buildings/sites on campus on a different sheet inside the document. A comprehensive analysis of each building is included in the research paper for the sole purpose of understanding the wayfinding situation of individual buildings (specific situations like, *what exit strategies can a disabled individual take in case of an emergency?*) was also taken into account.