Analyzing Micro-Local Communication Technologies to Support an On-Campus Agroecology Corridor

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Executive Summary

The College of Agriculture and Natural Resources seeks to to raise awareness of and stimulate conversations about sustainability, food security, and food supply within the University of Maryland and is pursuing the creation of an Agroecology Corridor. This project would connect the network of green spaces and sustainability projects on campus to maximize their use in teaching, demonstrations, community outreach, and research.

To support that connection and determine the best solutions, our team researched eight micro-communication technologies, and are propose the three most effective technologies we believe will assist the College achieve its goal. The research considered multiple criteria including affordability, accessibility, and durability.

The report's four sections follow each step of the project:
- an initial technology analysis introduces and describes the eight micro-communication technologies and examines their advantages, disadvantages and cost estimates
- case studies that consider the applications of each technology in different campus spaces for varied user demographics
- final recommendations for the top three technologies (beacons, push notifications, and nature signs) that our team believes would be the most effective
- next steps for groups that may continue this project.

Through research and analysis, this report aims to provide critical background information about beacons, push notifications, and nature signs as well as their potential for implementation on the University of Maryland campus. With proper integration, these technologies will help foster interest and important discussion about green spaces throughout campus. This report will also serve as the foundation for the project's future stages as it continues in coming semesters.

Initial Technology Analysis

We focused on the following eight micro-communication technologies in this project. They are described below with an examination of their advantages, disadvantages, and cost estimates.

Beacons

Beacons are Bluetooth radio transmitters. They constantly release signals to Bluetooth-enabled devices within range—typically about 50 meters/160 feet. Users download a corresponding app and enable their Bluetooth service to receive beacon notifications. Beacons are typically used for marketing purposes but can be used to convey any type of information.

Pros:
- Can be accessed by anyone with a device that has Bluetooth capabilities
- Varied levels of user interaction
    - Initial beacon notification can include small pieces of information
    - Can lead user to app with more information
- Notifications are automatically sent to users as long as the beacon is on and the user is in range
- Multiple power options for long-term installations
- Relatively low cost per unit

Cons:
- Requires downloading a supplementary app
- Character limit on beacon notifications (107 characters)
- Can't limit notification to one per user, per location
    - Beacons constantly send out signals and have can't recognize specific devices

Estimated cost: $25 per unit

Beacons provide a low-maintenance and cost-efficient method for encouraging user interaction and providing varied levels of information. Beacon notifications can be especially effective in creating

interest among users with limited knowledge about green spaces. Providing small pieces of information helps prevent users from feeling overwhelmed. However, beacons can also be useful for users more interested in learning about green spaces. The different levels of interaction can appeal to users at any level of interest, and beacon notifications can serve as a starting point that leads to further information on the app.

This method requires investment in the development of an app that users download before receiving beacon notifications. It's also important to consider the limitations that Bluetooth-enabled devices place on certain demographics of users. Another limitation of this type of location-based technology is that it can't reach users who don't pass certain spaces. Beacons would be most effective in high traffic areas around campus where most students and visitors pass, while considering that the amount of notifications sent can't be limited.

QR Codes

QR Codes, or Quick Response Codes, are scannable codes that store and present digital data, such as URL links, text, and applications. Information is accessed via QR Code scanning apps, or most often via the code scanning capabilities built into smartphone cameras. QR Codes can convey any type of information and are used frequently by a wide variety of organizations.

Pros:
- Requires no maintenance
- No need to worry about user privacy concerns
  - Personal information is not collected when code is scanned
- QR Codes can be easily generated
- Metrics can be gathered to analyze user interaction

Cons:
- Optimal locations for QR Codes may be difficult
  - Especially if placed in green spaces
- Difficult to encourage users to scan
  - QR Codes are not as effective in initializing user interaction

Estimated cost: $15 - $20 per month

QR Codes are an affordable and simple option that many users are already familiar with. Because they are used frequently in various situations, they are a well-known option. Familiarity makes user interaction easier; most users know how to access the information, and for those not familiar with QR Codes, brief instructions can inform users of their purpose. Especially paired with other technologies like nature signs or Soofa signs, QR Codes can provide additional user information, and can provide an extra level of interaction.

The simplicity of QR Codes could also be a disadvantage; it may be difficult to encourage users to scan the code. Placement and presentation of the codes should be considered to encourage users to interact. Unlike an automatic notification, QR Codes require effort on the users' end to access the information. Users must be compelled to learn more. QR Codes will likely need to be paired with another technology to ensure that they stand out in green spaces.

Push Notifications
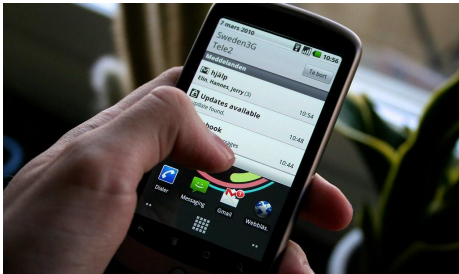
Push notifications are messages sent directly to a user's phone, either through SMS or a corresponding app. Users can opt in and out of push notifications in the app's settings. Push notifications can be sent when users enter a specific area marked through geofencing (location based) or at certain intervals (time based). Location-based push notifications can be sent either when a user enters a space, exits a space, or spends a certain period of time in a space. They are most frequently used for marketing purposes to increase user engagement.

Pros:
- Opt in and permission based
  - Users provide informed consent to receive notifications
- Time or location sensitive
- Ensured delivery
- Little to no maintenance
- Varied levels of user interaction

Cons:
- Requires users to download a corresponding app
- Potential for information overload

○ Need to consider how often notifications are sent
- Character limit for push notifications (178 characters)
- Location-based notifications can't be limited to one per user, per location

Estimated cost: $100 per month

Anyone with a smartphone is familiar with push notifications. They provide reminders, useful information, and prompt consistent user interaction. Using push notifications, can provide varied levels of interaction for users. Short and simple notifications grab the user's attention and encourage them to explore the app for more information. It is a familiar technology, which can help draw in users. Its application should make distinctions between location-based and time-based notifications to decide which would be more effective in conveying information.

Location-based push notifications are sent to users when they enter a space that has been marked through geofencing. The area can vary in size and the notification is customized to fit the space. When a user enters, exits, or stays in the designated area for a certain period of time, they receive a notification. Location-based push notifications are ideal for encouraging users to interact with the green space that they are in. If they receive information about a certain aspect of that green space, they are more likely to continue exploring the space. However, if users don't pass through certain green spaces, they may never be made aware of them, reducing the amount of exposure to green spaces they receive.

Time-based push notifications are sent to users at determined intervals, regardless of location. They can be customized for a certain amount per day or week. This is ideal for increasing exposure to different green spaces, especially spaces in low traffic areas. If users can be made aware of less popular spaces, it might encourage them to explore different parts of campus and draw attention to different green spaces around campus. Time-based notifications are convenient, but their frequency should be considered to avoid being too persistent, which can lead to decreased use.

Soofa Signs

Soofa signs are sustainable, solar-powered digital signs. They are 7.5 feet tall and contain a 42-inch electronic ink display. The screen is in two sections; the top 75 percent can update every two minutes,

while the bottom 25 percent can update in real time. Soofa signs are most often used in cities to display content such as local events, advertisements, and transit information.

Pros:
- Solar powered
- Can collect data about user interaction
  - Helpful in gauging public response
  - Collects data about activity, not personal data
- Information can be updated regularly

Cons:
- Large size may take away from the aesthetic of green spaces
- Require maintenance over time
  - weather-related damage or vandalism
- Limited user interaction
  - users only see information displayed on the screen at any given time

Estimated cost: $4,300 per unit

Soofa signs are a less familiar technology, but their simplicity and sustainable design make them an attractive option. Digital signs with high customization ability are ideal for providing a lot of information without information overload. Information displayed on the screen can easily be changed as green spaces change over time, over the course of a day or with the seasons. Since the Soofa sign can be updated in real time, it is also possible to draw user interest through customized greetings based on specific groups passing through the space (such as orientation groups or campus tours for prospective students).

Green spaces are often delicate and aesthetically pleasing, so a 7.5-foot-tall sign may draw attention away from the space's natural beauty. Sign placement should not take away from the green space. Digital signs also provide limited user interaction; users can only see the information displayed at the time that they are looking at the sign. This may deter users from learning more about the space, unsure it's worth the extra effort.

Geocaching

Geocaching is an outdoor treasure hunt using GPS devices. Via GPS receivers or mobile devices users locate geocaches, physical containers at given coordinates. In this case, each container will include information and visuals about the green space. This technology is a fun and engaging way for people of all ages to learn about the green spaces.

Pros:
- Engages users
- Promotes physical exercise
- Brings people to UMD campus
- Educational
- Offline
- Free geocaching apps are available

Cons:
- Stationary
- GPS based
- Users may experience a learning curve
- Requires maintenance
- Garbage left behind

Estimated cost: Varies based on what's included in the containers

Geocaching is a hands-on activity that requires active participation from users. It is inexpensive, simple to set up, and is a good option for low-traffic locations on or around the edge of campus, such as trails. Users can learn about the space they're in and contribute to the geocaches, providing multiple levels of user interaction. Geocaching activities can be incorporated into campus-wide events like Maryland Day to draw interest from students and visitors.

Geocaching is time consuming, especially for first time users. It is likely be an effective technology for those with a high level of interest in green spaces. Teaching first time users about geocaching may

be more difficult than a more straightforward technology. In addition, because students and faculty are typically busy navigating hectic schedules during the school year, it may be difficult for them to commit the time to participate in geocaching.

Nature Signs

Nature signs are the typical trailhead and informational signs seen in parks and natural areas and they would be placed at the outskirts of green spaces. Nature signs provide a great way for people to receive information about the green spaces, including a description, defined terms, and websites and QR codes that lead to more information and ensure that the reader's learning experience is lasting.

Pros
- Easily visible
- Contain varying amounts of information
- Offline learning experience
- Lasting effect

Cons
- Require maintenance and cleaning
- Signs may be damaged or vandalized; require repair
- Expensive

Estimated cost: $3000 - $5000 per unit

Anyone who's visited a park or hiked a trail has likely come across nature signs. They are probably the most well-known micro-communication technology and are the most direct method for conveying information. Nature signs would be most effective at the entrances of green spaces, informing users of what to expect and providing basic information. They can be paired with other technologies like QR Codes to provide different levels of interaction. Because nature signs provide basic and succinct information, they would be most beneficial for users with limited knowledge.

Encouraging users to actually stop and read the signs may be difficult, especially if they are in high traffic areas that most people pass through quickly. If not used in conjunction with another technology, their simplicity might not achieve the desired level of interaction. As with any other physical technology, they can be vandalized or damaged by weather, so their placement should be carefully considered.

Digital Signs

Digital signs use LCD, LED, and/or projection displays. Like the Soofa and nature signs, they're used to display information and facts about an area. They can feature text, videos, and audio and with touchscreens, can be highly interactive. They are typically found in high traffic public spaces such as malls, museums, and transportation nodes. Digital signs must be connected to electricity to operate.

Pros
- Visually appealing
- Interactive
- Offer significant screen space as user flips through tabs

Cons
- Most expensive investment of the technologies reviewed
- Requires content maintenance and updates
- Requires placement near electrical circuit

Estimated cost: $3,000 - $10,000 per unit

Although similar to regular nature signs, digital signs add the element of user interaction. With a touchscreen, users can navigate tabs to learn more about a specific green space. Digital nature signs will likely be most effective in low traffic green spaces, where users are more likely to take the time to browse the information provided. Because digital signs can offer more information, they can provide specific information about each aspect of a green space. They also work well with other technologies like QR Codes, so interested users can easily access more information.

Digital signs are electrically powered, so need to be placed near an outlet. This limits where they can be used, especially areas farther away from buildings. While digital signs can offer more information than nature signs, there is a limit to how much information can be included without overwhelming the user. Too much information can deter users from reading it. Since they are a big investment, it is important to consider the spaces where they would be the most effective to prevent wasting the technology.

Chatbots
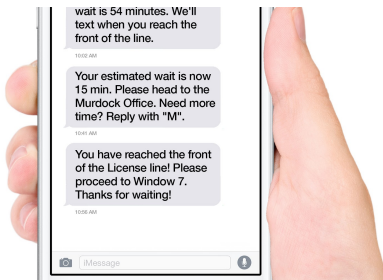
Chatbots are conversational computer programs that simulate human interaction. Chatbots communicate with text messages or voice commands using artificial intelligence to answer questions about relevant topics. Chatbots can communicate in single words or phrases or in more complex conversations, depending on the time and money invested in programming.

Pros
- Quick and responsive
- Interactive
- Reduced labor costs
- Easily accessible

Cons
- Limited responses
- Complex chatbots are expensive
- Initial setup, development, and ongoing maintenance can be time consuming and costly

Estimated cost: $15,000-$30,000 per custom bot

As computer programs, chatbots are not physically present; they need to be combined with another technology for users to access them. The benefit is that users can seek out the specific information they're interested in, rather than browsing various spaces to find what they want. Chatbots are highly interactive and can help to encourage users to seek out different green spaces around campus.

Since chatbot responses are triggered by key words, users must have basic knowledge about the topic. Chatbots would not be effective for users seeking basic, general information about green spaces. Since chatbots are not physically present, it may be difficult to inform users about them and encourage them to use the chatbot for information. The extra effort on the user's end may actually end up decreasing the amount of user interaction.

Technology Applications

Community Learning Garden

Near the Eppley Recreation Center, the UMD Community Learning Garden is an ideal place for students to learn about UMD's sustainable practices using nature signs. Nature signs should be aesthetically pleasing and could include QR codes that visitors can scan for more information. Signs can vary in size, and can share information on the garden's plants and how visitors can use them in their own gardens.

Wall of Wellness (STAMP)

The STAMP BioWall is a beautiful display and a perfect place to pique the interest of passersby. STAMP is at the heart of campus and is often the first place visitors go; a digital sign here could be easily updated and would complement this green space. This is a high-traffic area so push notifications would be an effective complement to a digital sign. Users would receive push notifications that share "fun facts" about the green wall and direct them to the digital sign. The digital sign can be updated and share large amounts of information with visitors.

Garden of Reflection and Remembrance

Students, alumni, and visitors looking for a peaceful spot often come to this garden near South Campus. A nature sign would be more appropriate here than digital outreach. While visitors would not want to be bothered by push notifications, they may be intrigued by aesthetically pleasing nature signs that shares information about the garden's design and its trees and flowers. Nature signs would fit in along the walking path through the garden and at plants near benches. Nature signs could provide interesting details about the flowers chosen for the garden and why they are meaningful. Users would be encouraged to learn more, and they could easily use their smartphones to scan QR codes for more information.

McKeldin Mall

McKeldin Mall is a high-traffic area. Thousands of students walk across the Mall every day, usually rushing to class. This would be the perfect location for push notifications or beacons because visitors who don't have time to stop and look at a sign will have time to read push notifications on their phone five minutes later. Users anywhere on the Mall can get push notifications and notifications from beacons if they are near certain areas.

Tawes Plaza Garden

This is another high-traffic location, the center of three academic buildings and an outdoor venue for students to lounge, making it an ideal location for push notifications. There's a weekly farmer's market in Tawes Plaza, ideal as well for push notifications but also for a digital sign or a Soofa sign. Push notifications could reach passersby and digital signs or soofa signs could reach those spending more time in the plaza. Push notifications can alert users to a nearby soofa sign. Soofa signs can automatically update with new information, and they can collect data on visitor impressions.

Final Recommendations

We believe the most effective technologies to implement on campus are beacons, push notifications, and nature signs. These technologies would be the best at educating users, offering a quick initial informative interaction with the opportunity to learn more.

Beacons are small, wireless transmitters that make it easy to interact with users in a physical location. They would be used to send messages about the surrounding environment. They improve the user's experience by helping them navigate a specified environment. Beacons should be implemented in higher traffic areas, so users can either stop to browse the green space they're in or can view the notification afterwards and visit the space another time. Including suggestions about caring for the environment, such as picking up trash or recycling, we can inform visitors about how their actions contribute to the difference UMD is trying to make.

Push notifications can be used in the AgroEcology Corridor to send users notifications about the spaces around them. Users can opt in or opt out. The notifications would encourage interaction with the complementary technologies implemented. For example, time-based push notifications could draw users to certain spaces, while beacon notifications can inform users about the space. By using

push notifications that aren't location based, more users can be made aware of campus green spaces—especially those that are low traffic or less well known.

The third technology recommendation is the implementation of nature signs, a good way to reach users who have time to interact. They can learn about a space's specific characteristics, as well as more basic information. Nature signs are ideally implemented in low traffic areas or at the entrance of a larger green space. Since including too much text can deter users from reading the sign, they should rely on pictures and basic information. Beacons can then provide further information if the user chooses to learn more about a space.

These technologies also were chosen because they work well together. If a user walks by a green space that contains a beacon, they'll receive a location-based beacon notification. However, if they're not nearby, they would receive a time-based push notification that encourages them to visit a particular green space. Once they visit, they would receive a beacon notification. The nature signs can be placed in any green space and can provide basic information for users who haven't downloaded the app for beacon and push notifications. By combining these technologies, we hope to reach the widest audience possible while providing varied levels of user interaction.

Next Steps

To implement this project, the top three technologies should be presented to leadership personnel in the College of Agriculture and Natural Resources (AGNR). Since AGNR is the lead department and the most familiar with campus green space, their input is vital. A collaboration should examine whether the technologies would work well in the green spaces and if the proposed implementation strategies make sense.

The next team might consider another survey to the campus community, asking their opinions on the proposed technologies. This would help in planning the user experience by better understanding the community's needs and wants. The experiences of people interacting with these technologies are important; a good experience determines if they are able to learn and interact with the spaces. Planning the user experience should include developing user flows, prototypes, tests, and evaluation.

After the technologies and implementation strategies are approved and finalized, funding must be secured. The next team should research the project costs, funding sources and maintenance responsibilities. Will the College of Agriculture and Natural Resources fundraise, will they take out a loan, or ask alumni to donate? This project makes cost estimates, but the next team should research specific contractors' technologies, services, and rates. After establishing funding, stakeholders should develop goals for the user experience to guide AGNR's contractors in constructing, developing the app and implementing the project technologies on campus.

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