STICKIE

by

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A thesis submitted in partial fulfillment of the
requirements for the degree of

MFA, Design & Technology

Parsons School of Design

2016

Faculty Advisors:
Dr. Scott Pobiner & Louisa Campbell, Thesis Studio, Spring 2015,
Dr. Anezka Sabek & Edward Jefferson, Thesis Studio, Fall 2016

PARSONS SCHOOL OF DESIGN

ABSTRACT

Stickie

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Stickie is a display and phone agnostic platform, which people can use to physically post content on multiple display surfaces. This thesis explores commercial technologies that aid in device-supported collaborations over the Internet. The phone acts as an interface between the tangible and the digital spaces. Space is a fundamental component of any analog brainstorming activity that stimulates the participants to create deep and meaningful collaborations in their work and life. Current digital sensor- rich technologies are well capable of utilizing physical interactions for expressive collaborations. This project constructs a novel methodology for collaborations across Internet, to incorporate cues of body language, expressions, and attitudes of the participants involved. The research is manifested as a demo workspace in which people can externalize their ideas by digitally annotating them in a physical space by using sensor-rich smartphones. User tests of the final prototype indicated that participants would prefer to use Stickie than ordinary sticky notes. They also expressed a host of features that could be added on top of Stickie's interaction model. Conclusively, it is important to rethink how we design our digital interfaces for creative content generation.

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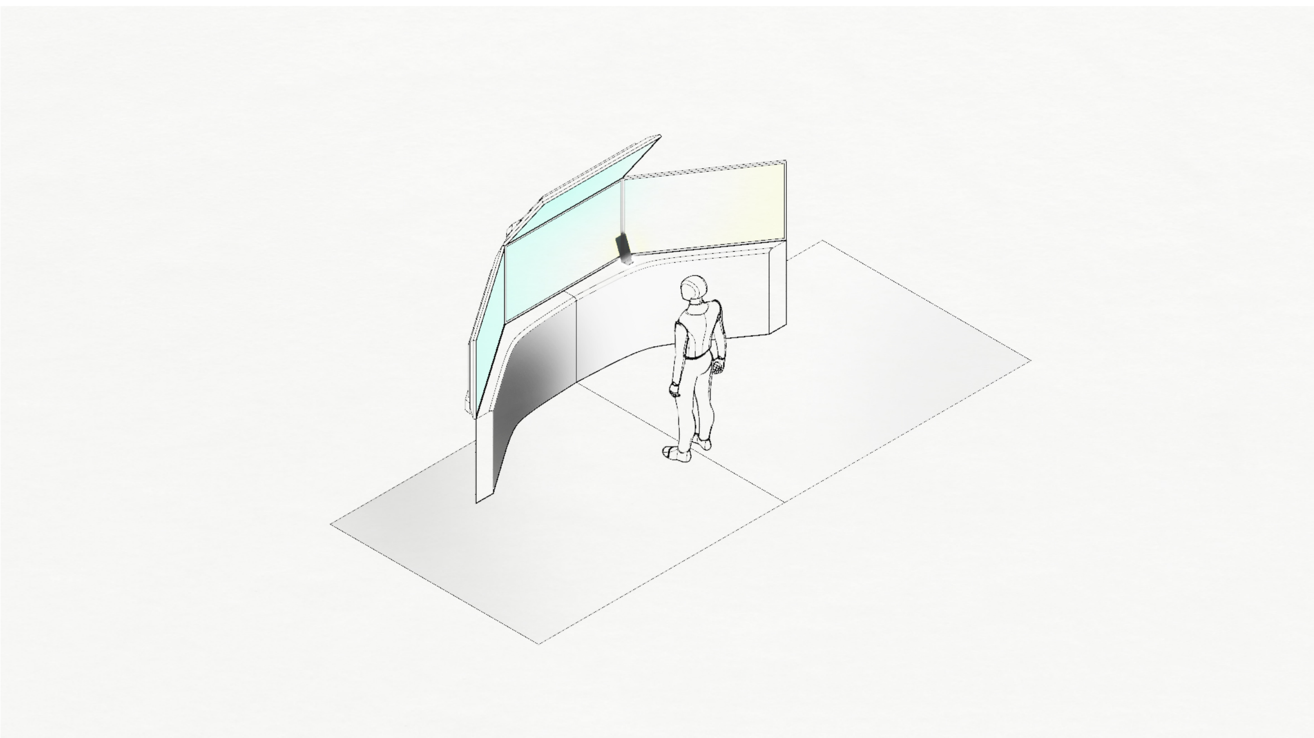
ACKNOWLEDGMENTS

The author wishes thank Professors Dr. Anezka Sabek and Dr. Scott Pobiner whose familiarity with the needs and ideas of the class was helpful during the undertaking of this thesis. In addition, special thanks to Professors Louisa Campbell and Edward Jefferson for their assistance in the preparation of this manuscript. Thanks also to the members of the Parsons Design & Technology Program for their invaluable input.



Chapter 1

DIGITAL COLLABORATIONS

Introduction

Digital data provides people an unprecedented access to data and shared information compared to any other form of media. It is phenomenal that over 90% of the information available today was generated in last two years![1] None of that would have been possible without computers, without Internet, without data constantly being transmitted as bits & bytes.

Technology has enabled people to converse over a variety of tools like Instant Messaging, VoIP, Screen Sharing, Web Conference, File Sharing, Note Taking etc. Each software leverages the undeniable utility and value of digitized media.

Space & Size

Access to volumes of information means that we constantly preserve, maintain, collect and archive digital assets[2]. Back in 80's this meant owning shelves of encyclopedias, printed photo albums and VHS Tapes. Digital assets have arguably trumped older practices of information sharing and management due to obvious advantages of saving space.

Not only the space for storing information has condensed, but also for the information generation. With every evolutionary step in transistor technology size reduction, Computers have shrunk from being room-sized behemoths to sleek pocket-sized devices[3]. Digitization of information has evidently transformed the way modern workspaces are designed. In an ordinary modern office, a display screen is the core source of human-computer interface. Naturally, a lot of emphasis is laid on constructing spaces comfortable to sit in for hours.

Our minds haven't evolved to be like this. Human bodies are nimble, dexterous, evolved to walk, sit, stand, lean, jump – **move**. A human hand itself has 27 degrees of freedom. Our bodies are instinctively good at understanding and solving problems through spatial relationships.

Space and Human Computer Interactions

On the other hand, Human Computer Interaction is a study that encompasses how we interact with digital information tangibly. Undoubtedly, it has a psychological branch of human behavior, which cannot be studied in isolation with body left out of context. Yet, current devices do not fully take advantage of our biological agility beyond UI/UX industry standard practices.

Figure 1. Myron Krueger demonstrating real-time sketching application.

Myron Krueger was one of the pioneers to research human body interaction with computers. As a graduate student in University of Wisconsin he was disappointed by the fact the he had to sit down to operate a keyboard. "I resented it (computer) was denying I had a body of any kind."-Myron[4] He also understood that artists have the best relationships with their tools, so why can't users have that with computers. So he performed an experiment in which he was a "computer" and he used a data tablet to draw on a computer screen. The live sketch was telecasted in real-time in a gallery where it was being projected onto an image of people in the gallery. Although it was regarded as an computer science experiment, he succeeded demonstrating new kind of interactions on two fronts, **collaborative artistic medium** and **full body**

immersion in HCI. The experiment set a prelude to developing sophisticated micro sensors used in today's garden-variety of consumer electronics from touchless hand-dryers to phones and laptops.

Mark D. Weiser, Chief Scientist from Xerox Parc, father of ubiquitous computing, who coined the term in 1988[5] stated that every computer system should be built on 5 following principles:

- **SEE** - Improved reporting and seeing of complex systems
- **KNOW** - Better models of interaction with the larger world
- **BUILD** – Better abstractions
- **TIE** – Better ties to cyberspace
- **FIT** – More useful to people

Figure 2: Siftables by David Merrill demonstrating tangible interactions with spatially aware displays.

A physical space provides the necessary allowance for ubiquitous computing in that environment. We eat, sleep, and work in dedicated spaces. Those spaces are designed and engineered to help us achieve our necessary goals and tasks. The tools that we use in those spaces to communicate with the ubiquitous computing environment are essentially – *Spime* – short for "Objects of Space and Time". Any artifact that is 'aware' of its presence in the environment is considered as Spime[6]. This device awareness is possible through on-board processing done by microcontrollers and sensors.

Purpose of research

The purpose of this study is to utilize device awareness for tangible interactions with digital information. The outcome is manifested as a web based collaborative system called *Stickie* that digitally replicates the physical interactions of sticky notes. Stickie incorporates smartphones as an extension of the human body to spatially interact with shared visual content displayed on large screens.

In other words, it transforms a regular display screen into an editable whiteboard, smartphones into sticky notes and styluses into marker pens, creating a digital layer over the certain tangible aspects of sticky note brainstorming.

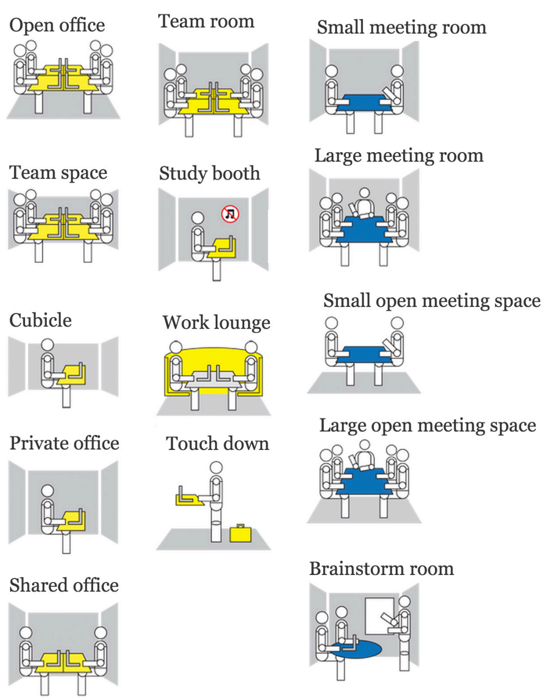


Figure 3 : Types of workspaces
(www.planning-office-spaces.com/workspaces.html)

"Most digital communication across the Internet lacks the verbal, facial and body language cues of a face-to-face conversation, but the reach of our messages and the media at our disposal (photos, videos, memes, gifs, articles, etc.) has made it a medium of undeniable allure and value."[7]

Users

The research investigated multitudes of professions and scales of organizations to understand the nature of tangible collaborations in ordinary workspaces. A common activity amongst the observed demographic was the management of large volumes of raw unstructured written and audio-visual information and ideas. Many people who were interviewed were Project Managers, Visual Artists, Industrial Designers, and Architects. This study, Project Managers and Scrum Masters were identified as the core user group of Stickie. In their day-to-day work, the breadth of kinds information ranged from task assignments and process maps to content structuring and game design maps.

The challenge for this research was to create a solution based on technologies found in ordinary workspaces. It had to be flexible enough to adapt to variety of workspaces like cubicles, meeting rooms, private and open offices[8]. The solution had to tangibly facilitate the externalization of ideas.

One noteworthy firm Rasmussen Consulting is helping other organizations and institutions to solve management related problems, tangibly with Lego Blocks[9]. These are some problems like strategic planning, communication and creative thinking that are non-tangible aspects of an organization, which do not exist spatially. Rasmussen believes that their approach has considerably helped employees to unlock their hidden talent.

Concurrently, the aim of this thesis is to facilitate the above-mentioned processes by creating a digital platform inspired by sticky notes, which allows multiple users to remotely brainstorm in real-time. A good brainstorming session is expected to end with a reflection of summary of the session.

Based on Mark Weiser's principles Stickie can be evaluated as following:

- **SEE** - *Improved reporting and seeing of complex systems*
    - Provides analytics of the session, otherwise not possible to monitor with physical paper.
    - Has the potential to query data.
- **KNOW** - *Better models of interaction with the larger world*

- Acknowledges the how users spatially manage information

- **BUILD** – *Better abstractions*
    - Builds better workflow to add visual content like images with disrupting the flow of conversations

- **TIE** – *Better ties to cyberspace*
    - Facilitates the use of digital multimedia content
    - Allows saving sessions and editing

- **FIT** – *More useful to people*
    - Encourages involvement of more people by reducing the need to convene at one place.

Chapter 2

CONCEPTUAL FRAMEWORK

The framework for the development was based initial research that looked into the nature of problems associated with sticky note brainstorming.

Components of Problem

The problem can be broken down into two major components:

- Limitations of physical space
- Current Digital Interfaces

"It is cumbersome to switch between teaching code on screens and whiteboards for sketching, where I often run out of space."- Ramsey Nasser

Ramsey is computer scientist and a game developer based in New York. He is well versed with limitations that work environments pose, especially when most of his work is resides as code. To his own aid, Ramsey developed a web application *Boards*, as medium to digitize his sketches on a web platform[10]. He uses a pen tablet to draw on an infinite digital canvas. For Ramsey that feature is the single biggest utility that allows him to transcend the limiting finite nature of physical space in digital realm.

Arguably similar limitations are confronted in sticky note brainstorming, more notable in sessions with large number of participants or lengthy timelines.

Lena Greenberg is a Civic Liberal Arts Student Fellow at The New School, New York. One of her recent research-intensive projects is a game under development to dissect decision-making behavior in certain socio-cultural issues in modern society. The project has large number of participants and during each game session Lena 'codes' (take structured notes) all the information being generated by each participant. This game is not a digital but it is narrative based on verbal decisions and engagements amongst the participants. During an interview, she expressed her confinement to work few select places to take notes, because some of them were massive complicated process-maps. The one for the game, spanned over several feet of wall. It not only consumed copious amount of public space but also remained there for weeks depriving other colleagues of a prime space to work. It resided there for a long time because Lena didn't want to lose the opportunity to make changes to her process map as her research advanced and also because other people were cautious of tampering with someone else's work, even though they had all the right to do so, since it's a public space.

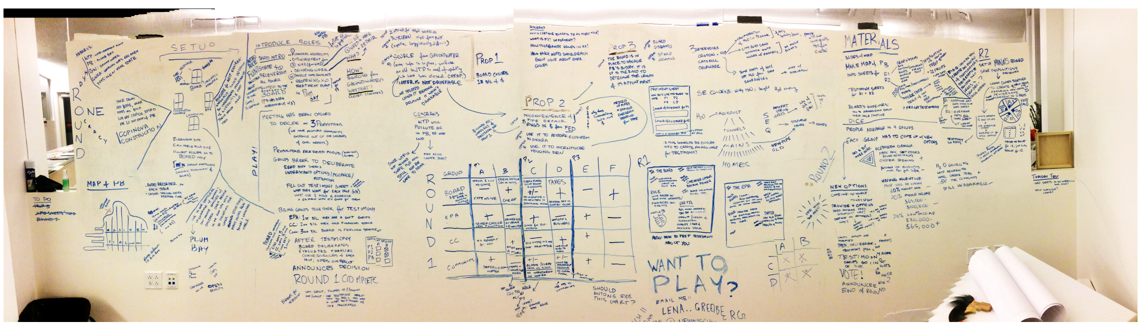


Figure 4: Lena's Game Process Map

Therefore, the problem with personal and collective brainstorming goes beyond space limitations and is more complex than solely addressing that. There is a time, archiving, transformation and social engagement attached to it.

At a point during this research, a question was posed to an audience of 30 people who were attending presentations – "How many people have a record of their last sticky note session?" Only a few raised their hands. A quick Q/A revealed that the current preferred way to store their sticky notes session was taking a photo of all the notes with a personal smartphone. Why? Convenience is the biggest factor that leads up to that choice. Taking a photo from a smartphone is a quick and easy way to archive visual messages; but not the best. Upon further investigation, it verified that people rarely updated their archives, not because it is not of any benefit but because they had no way to restart that session and continue working from a point where they left off. Hence, people had to initiate another sticky note exercise, to culminate the summary of last session and continue from that checkpoint.

It does not necessarily imply that digitizing information would be a perfect substitute for pen and paper. This research recognizes the tangible experience associated with those traditional tools is very dexterous. The research does not mediate the solution to completely replace or abolish the traditional ways of using sticky notes. The goal is to simply augment those activities digitally.

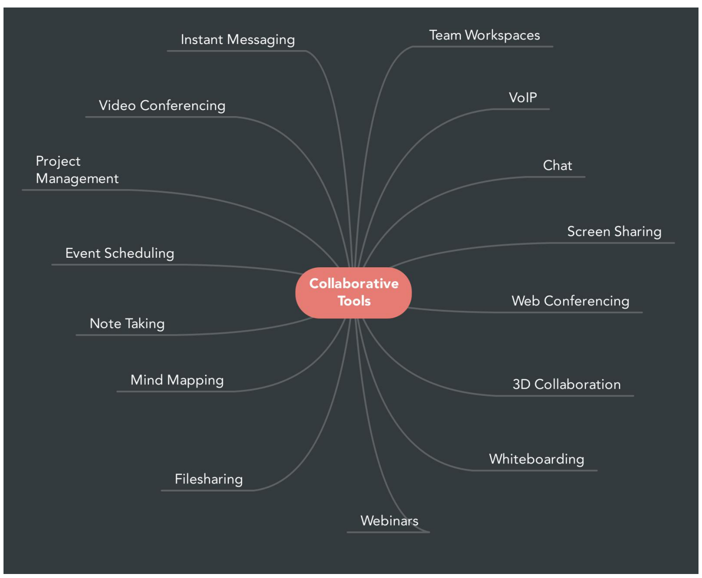


Figure 5 : Segmentation of collaborative tools

Existing tools

There are hundreds of digital collaborative tools available on the consumer market today[11]. The vast segmentation of such tools address very specific needs like video conferencing, event scheduling, mind mapping, white boarding, collaborative CAD, file sharing and instant messaging. Each application facilitates a certain degree of collaborative environment. Still, there are only a very few quality tools that resonate with the experience of sticky notes to display screens. None seem to have quite reached a point where it feels comfortable to switch over from using physical tools.

Murally

Lino

Stormboard

Figure 6 Example of web-based applications for sticky note collaborations.

A fundamental problem with these tools is that they attempt to faithfully replicate the experience of sticky note exercises and unfortunately it occurs only visually at a superficial level. The glossy UI is ridden with features that are either too complex to navigate or simply too limiting to be of any practical use. In either case, the only means to interact with the canvas of notes is through a keyboard and a mouse; none of which are designed with a focus to replicate the physical act of working with notes on a wall. Hence, every participant has a canvas that mimics a blank wall of canvas but the only means to interact with that is through a proxy of devices that are unfit to do so.

Figure 7 Make Space by Scott Doorley & Scott Witthoft

Make Space written by Scott Doorley and Scott Witthoft explains how space affects people's mood and behavior in the context of creative collaborations.

"The last 100 years of technological innovation in workplace have focused on the big brain part. Book, computers, desks, offices are all focused on helping us get most out of our brains. Remove the desk from the equation, give people permission to assume alternative postures, and watch what happens. Students lie on the floor, perch on the backs of couches, bounce on their toes, pace around the room and do chin ups on exposed beams - all during "work" sessions." -Make Space[12]

Computer based collaborative tools miss out on integrating or mistranslating a lot of physical spatial cues of organization and interactions.

Technical scope of development

The scope of this research was to develop a novel digital interface that facilitated collaboration by replicating the experience of sticky notes in a way that utilizes the spatial interactions with the information. The prototypes were developed with a goal to digitize the physical information generated by the participants, while keeping in mind to not to disrupt the actual interactions with sticky notes.

Chapter 3

PRODUCTION METHODOLOGY

The research used a 5D methodology - **Discover Define Design Develop Deploy**[13]**.** This process helped structure a user focused solutions by avoiding assumptions. The first two chapters touched upon *Discover* and *Define* stages. The majority of the production focused on iterative development, where valuable feedback from users was constantly integrated to improve the overall functionality of Stickie.

The journey for production of the final prototype can be broken down into 3 overarching phases.

Figure 8: 5D methodology

Phase I: Technological investigation

During phase I, the problem was loosely defined as a lack of tangible interactions in the digital environment. The goal during this phase was to produce rapid and economic prototypes in order to test hypothesis related to digital interactions. The insights shaped the following iterations of the prototypes.

Prototype I, a paper prototype, was an experiment with the tangible characteristics of an object, such as weight, shape, size and degrees of freedom. The image below depicts how the interaction might take place. The user would use tangible items to brainstorm with a digital model. That model could be viewed in mixed reality. In fig. 9 the orange space represents the digital simulation.

The physical nature of the prototype laid out the forthcoming challenges at intersection of digital and tangible properties of the objects.

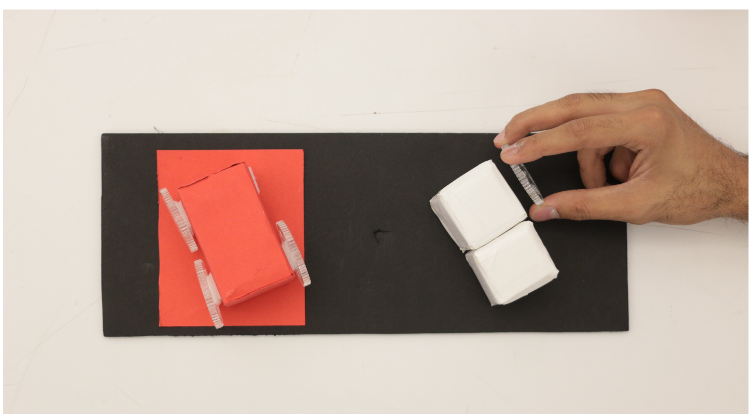


Figure 9: Prototype I

User testing this prototype revealed several complex issues. Users found it difficult to track individual objects in the workspace. Mixed reality representation seemed to confuse them, as in what was real and what wasn't. Distinguishing between that is highly crucial in serious collaborations in order to avoid errors and misunderstanding.

Unlike Prototype I, Prototype II focused on the human body instead of the objects. More specifically, it aimed at tracking human hands and how they could interact with virtual objects.

A simulation environment was constructed in Unreal Engine that used a Leap Motion device to capture the movements of hands. The skeleton of hands could interact with basic geometries in the simulation and the physics was defined to scale with natural world.

The goal of this prototype was to interact with virtual objects as elements of an abstract form of brainstorming activity. The Leap Motion tracking became noisy as the distance of the hands increased from the device itself. The motion tracking was limited to hands only because Leap Motion cannot detect objects. That essentially left the users interacting with space without any tangible feedback.

Figure 10: Prototype II

Phase II: Artifact augmentation

The second phase of research focused on defining constraints for feasible applications within the domain of creative brainstorming. The scope of research was narrowed down to sticky note exercises.

At the core of these exercises, the notes embody the metaphor of collaboration. The following prototypes aimed at non-invasive augmentation of the notes with hardware and software technologies.

Prototype III was developed after observing groups of people brainstorming with sticky notes. It took a different technical approach than the previous prototypes to track objects. This prototype used Open Computer Vision (Open CV) to individually track the sticky notes.

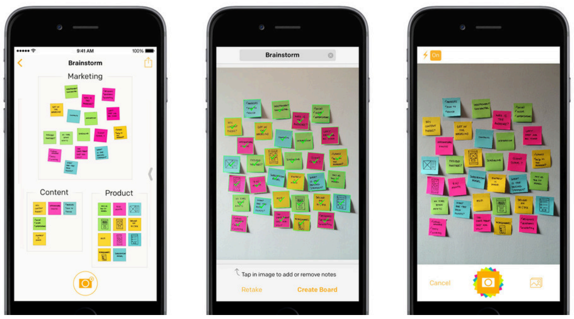


Figure 11 : Post-it App for iOS

The Post-it App for Apple iOS available in online store also uses computer vision to identify notes. The app can save sessions in an interactive and sharable format[14].

Similar to that app, the goal of this prototype was to attempt content recognition of the notes. On a physical level, it captured the spatial quality of placing sticky notes on a plane. The individual notes that were digitally detected could then be projected on the collaborator's workspace. Thus, everyone could share common spatial reference of the brainstorming session regardless of where they were.

The assessment from the observations concluded that activities such as placing the notes on a wall that have spatial characteristics are essential to creative solution development. Users related more strongly to physical organization of content than digital archiving in form files and folder. They were willing to adapt to a tool that had the conventional experience of using sticky notes and archived the sessions digitally without weighing it down with UI elements.

Figure 12 User Observations

Phase III: Application development

Phase III focused on developing software applications that would validate the hypothesis generated in phases I and II of this research.

Earlier prototypes extensively relied on hardware like cameras and projectors in addition to a computer laptop. They required time-consuming precise calibration for each different space setup. The following prototypes attempted to reduce the setup time, management and maintenance of the system. The research looked in various sensor rich devices and smartphones were the most massively available consumer grade technology.

"People are comfortable with their smartphones, laptops & tablets - they serve as capture devices, Web browsers, communication devices & everything else. These tools have the advantage of familiarity, ubiquity and strong communities of tech support." – Make Space[15]

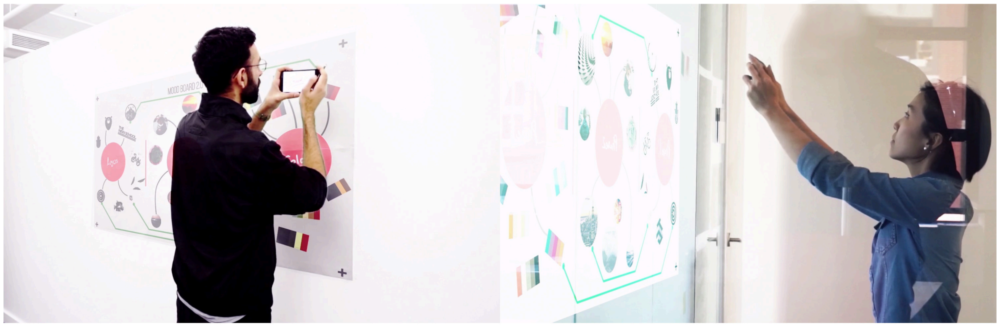


Figure 13: Stickie Mock Video

A mock-up video was created to visualize the interactions of brainstorming session mediated by two devices - a smartphone and a large display screen[16]. It highlighted two key benefits.

1. Non-invasive indoor positioning
2. Device supported collaborations

Taking cues from the mock video, Prototype IV demonstrated the use of smartphones as an extension of our bodies[17]. The user could write notes on the smartphone and position it in front of the display monitor in order to post it on the canvas.

The setup required constant tracking of the phone in relation to the display screen. A Microsoft Kinect sensor detected the positional coordinates of the user's skeleton and the smartphone provided the orientation data of the hand it was held in. By binding both sensor data streams, the system calculated the position and orientation of the phone in the workspace.

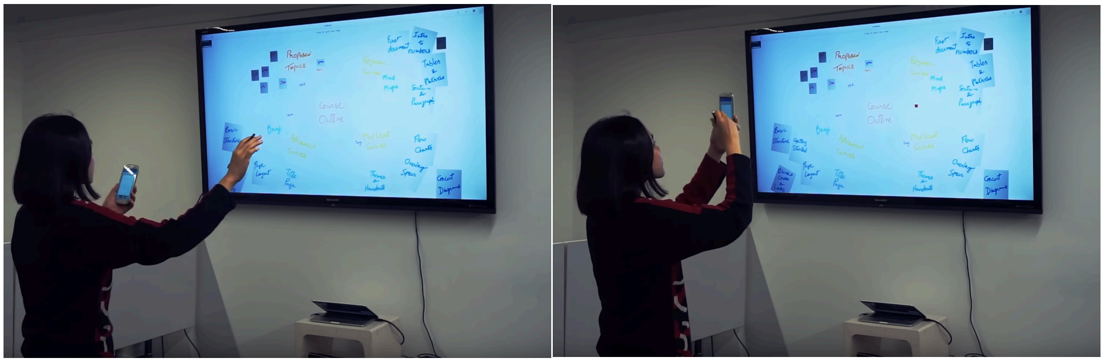


Figure 14: Prototype III

The interface displayed on collaboration canvas was completely web browser based. "The great thing about a modern web browser is that it can render all languages and you don't need additional language packs. That way you encourage more people to be a part of the conversation regardless of what language they prefer. On top of that, there are established protocols to serve variety of content on the web. The modules are baked in the browser to link and render image and videos making them easily sharable.", Ramsey Nasser.

The indoor positioning system still required some calibration from another device (Microsoft Kinect) to correct the values. For practical use, the Kinect contributed to a lot of inaccuracies and noise during the interactions. Overcoming indoor positioning inaccuracies was addressed in later prototypes.

It was concluded from the observations that people have very strong relationships with their smartphones and how they hold them. There were bold body language cues associated with certain interactions with these devices. For general use, people held phones horizontally in the palm of their hands, parallel to the floor. They pointed it upwards only in events like taking a picture from the camera.

Figure 15: Common phone holding position

The prototype required people to post a note on the canvas by positioning the phone in mid air. It was not the most convenient position to keep a check on the phone screen. During user tests, it was unnatural for users to shake off the connotation of holding phones parallel to ground. Therefore, it suffered from poor hand and eye coordination on user's end. Moreover, it took some practice to get a hang of appropriately positioning the phone in order to post content on the screen.

Otherwise, the users were comfortable with on-screen experience with the hardware. It was easy for them to understand the UI and UX of mobile dashboard, buttons, menus and the associated interactions.

The next Prototype V, addressed the phone positioning pitfalls of prototype IV. A novel phone-positioning method was devised that improved the overall user experience.

The solution was to allow users to write content on a phone in howsoever manner they felt comfortable in, without worrying about indoor tracking and positioning. After that they should be able to position their phone on the screen in order to transfer the content from phone to the display screen.

To technically achieve the interaction, the prototype was created using Ketai Library for Processing. Ketai Library was useful to quickly prepare a mini Android application that communicated with a processing sketch running on a laptop. The Android application had the functionality to read colors from the phone's back-facing camera. That data was communicated to the laptop using OSC over a local Wi-Fi network. The laptop accordingly generated patterns on the display screen.

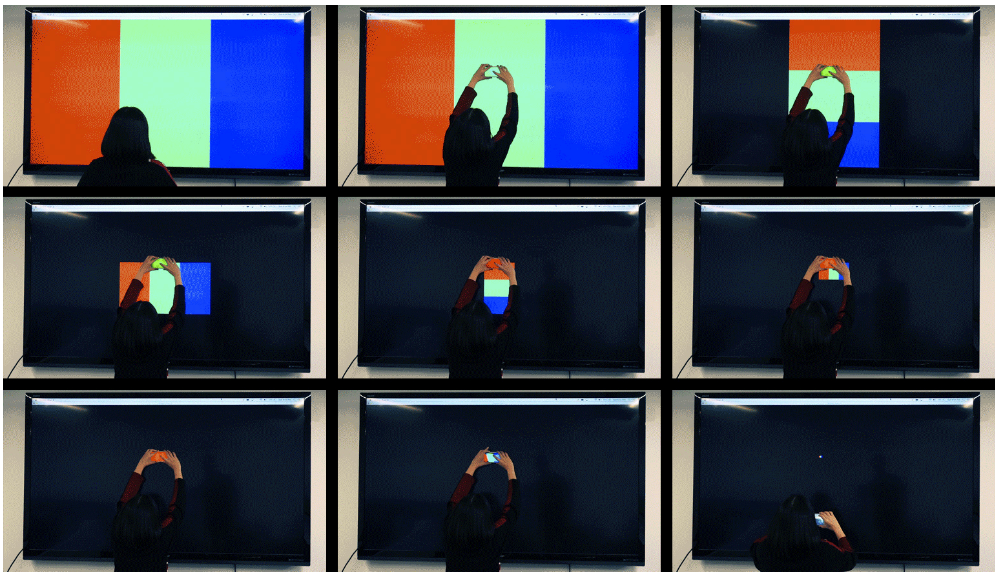


Figure 16: Prototype V showing on screen phone locating

When the phone was placed on the screen surface, a sequence of colors was displayed on the screen. The back facing phone camera read the color directly underneath it and accordingly the next iteration of color pattern was produced on the display screen. The system zeroed in on the position of the phone with subsequent iterations and the accuracy could be achieved within 4-pixel width on a Full-HD screen.

The Ketai Library was written by Jesus Duran and Daniel Sauter[18]. Daniel is currently an Associate Professor of Data Visualization at Parsons. "There are numerous ways to approach indoor positioning. Some solutions vary from expensive IR camera tracking setup. Phones have numerous on-board sensors that you can take advantage of in specific cases. One can monitor Wi-Fi signals strength to triangulate the position of phone in a given space. Ultimately, using the camera is more universally applicable."- Daniel Sauter

This prototype trimmed down the hardware setup to a phone and a display screen only. Virtually no spatial calibration was required to setup the hardware. The improved interaction model, allowed users to place the phone on the spot where they wish to leave the note, similar to using actual sticky notes.

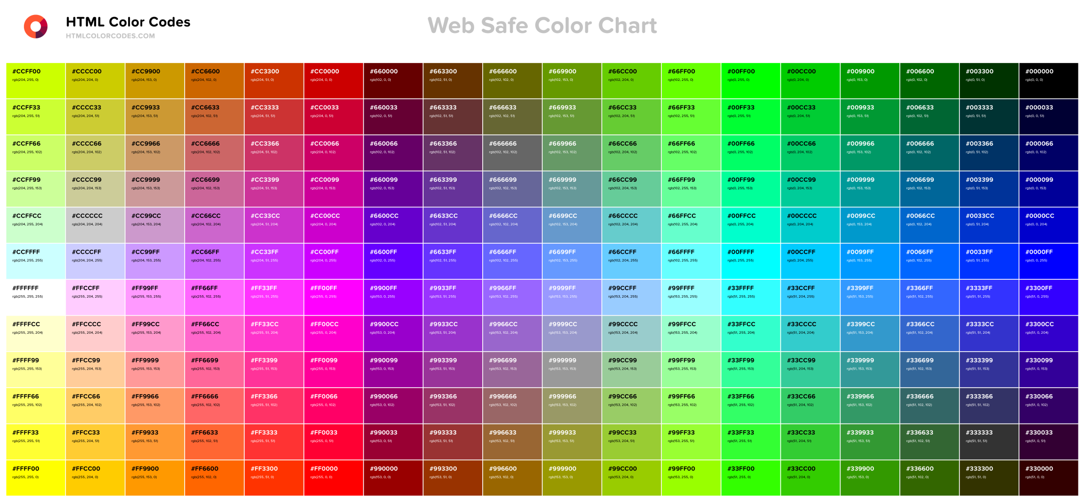


Figure 17 : Web Safe Colors

History of Phone-Screen Interaction

Stickie is one of its kind application that applies phone and screen interaction to sticky note brainstorming process.

There are two notable projects in the past that have demonstrated the similar interactions with different technical approach.

1. **Google Open Project**[19] – It uses QR code display on larger screen, which is tracked by phone's back facing camera. The positioning of the code on screen indicates the relative position of phone with respect to the screen. The interactions are limited to distances more than the minimum range of focus for the phone's back facing camera. If the phone is held too close to the screen, it won't be able to focus on the QR code.

Figure 18: Google Open Project

2. **THAW by Fluid Interfaces Lab[20]** – It demonstrates the recognition of drag gesture of the phone across the screen by tracking a masked circle on screen under the phone's camera. The circle is filled with a gradient of color. When the phone rests on screen, the movement of the phone registers a shift in change in color from the gradient and the circle is appropriately re-centered at the location of the phone's camera. However, to point to a certain location on screen using the phone, one might always have to drag the circle from an arbitrary point to the desired location.

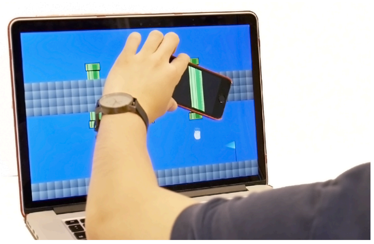


Figure 19: THAW by Fluid Interfaces Lab

In comparison to these projects, Stickie uses quantified values of set number of colors that generate a grid pattern on screen. Once the phone is placed on the screen, the grid resizes from full-screen to a few pixels at the phone's resting location that indicates the position of the phone. The speed of locating the position is proportional to the number of colors generated on screen distinguishable by the phone and latency of the network.

Chapter 4

TECHNICAL DEVELOPMENT

The development of on-screen phone-positioning system essentially kick started the development of Stickie as a packaged application. The interaction between two devices, phone and display screen, represented the act of pasting a sticky note on a wall surface.

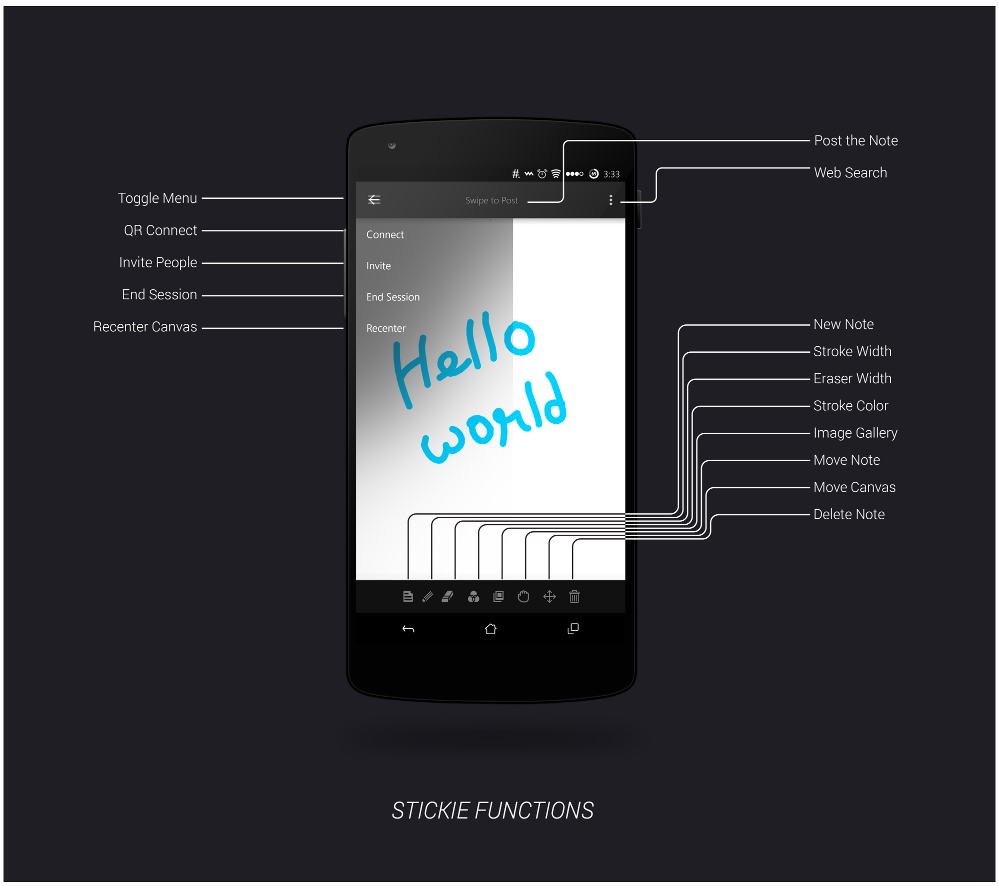


Figure 20 : Stickie Android App Features

Operating system

The subsequent versions were developed in Android SDK for minimum version of Apk-23 (Marshmallow). Android was preferred over iOS due to a personal familiarity and experience with Android's interface. The mobile app communicated with a local Nodejs web server that managed the communications between all the devices. It had the features to let people draw on a blank canvas on phone like an ordinary drawing app. They could add images from phone's default gallery or other applications like an email or a browser.

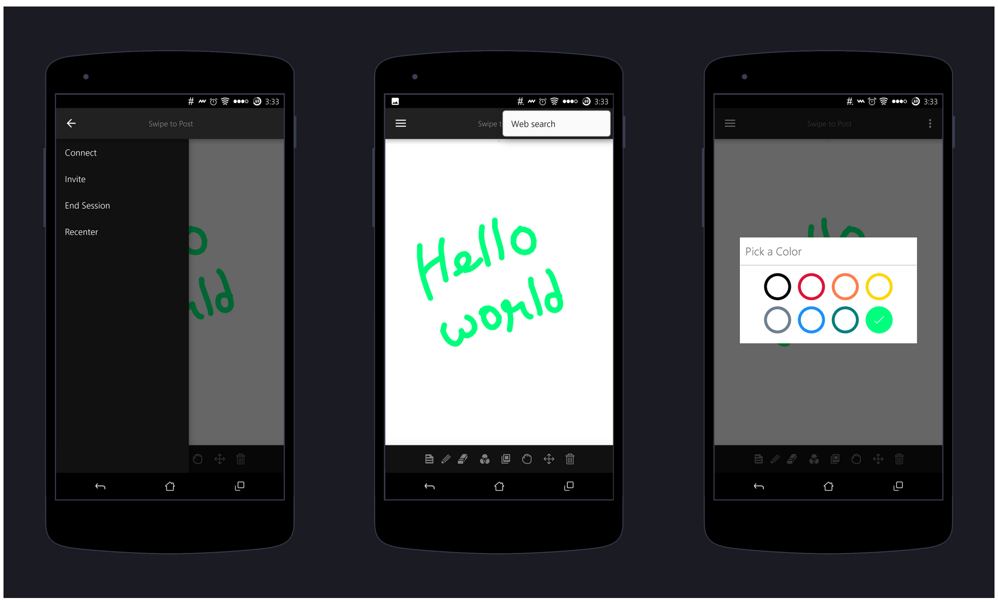


Figure 21 : Stickie App screens

Display Setup

Furthermore, the possibilities were not limited to only a single display surface; the workspace canvas could span across multiple display screens at different orientations. While posting a note on a display, the orientation of the phone parallel to the plane of the display could indicate what display it was.

"Users can have multiple display surfaces and it is the same zeroing algorithm that is scalable to *n* displays. Imagine a display and perpendicular to another in an L-shape configuration. In a spatial problem it could show plan and top view on separate displays. The benefit is of this (Stickie) is generalizable to several setups." Scott Pobiner, Vice President at Motivate Design, New York.

Scott also highlighted that Stickie leveraged the utility of two most prominent consumer technologies out there, TV screens and smartphones. "Anyone can walk up to any screen and swipe on their phone to *paste and leave* stick the note on the screen." – Scott

Networking

Initially, the mobile app and node server were hardcoded to communicate with specific devices, limited to two users per session. The next challenge was to build a scalable prototype to test with audience outside local Wi-Fi network.

"Online collaboration is one of the hardest things to tackle. I write code for games and in multiplayer games, there are so many protocols that maintain the consistency of data on each client." - Ramsey

Ramsey shared his experience in handling and maintaining large amounts of dynamic data sets and certain practices to build a scalable backend. The data generated by each device needed to be properly labeled with specific parameters such that it ended up reaching the correct destination - a server, a corresponding client screen or other members in the session. Information had to be efficiently managed not only means speed of communication but also robustness of the network.

"There are only two hard things in Computer Science: cache invalidation and naming things."- Phil Karlton[21]. Naming 'things' was the one of the most arduous tasks that Ramsey shared his insights about good coding practices.

User Interface

On a surface level, an application is as functional as it user interface. After multiple user tests, several iterations were made to the overall UI of the mobile app and its associated halve of web interface. The current interface prioritizes the flow and momentum of users ideating. Hence the most used operations reside on the parent screen of the application. Some of the supporting features were later added to navigation bar. Pontus Axelsson, CTO and founder of Bontouch, a company that developed the Post-it App explained their methodology for prototyping and developing the final application.

"We tried a lot of things and the challenge was to keep the momentum going during the brainstorming sessions while or after you augment the information using digital tools. The key thing to remember is that any digital tool is never finished. At any given point it should be able to solve some key issues for majority of users. The underlying technology of digitization and segmentation of information is a great starting point to bring a lot of value to the users."- Pontus Axelsson

Features

While posting things on screen seemed the most useful aspect of Stickie, the users wanted to be able to edit and move their notes on the shared canvas.

"Putting things on screen seems final. Big screens usually are used for presentations in workspaces. White boards are used for editing thought process and hence represent progress. Stickie breaks down this connotation which surprises the user." - Winnie Chang, Design Strategist at Verge NYC

After the discussion with Winnie, "Grab-hold-release" feature was introduced in Stickie for moving notes present on the canvas. When the button to move notes is pressed in the Android app, the note on the workspace, closest to the phone gets selected. The user can move the phone freely while holding onto the move button. Once the button is released, the note is repositioned on the workspace at the location where phone is held.

Subsequently, another feature was added to pan across the canvas by simply tilting the phone in the direction of travel required. Navigation and placement contributed to a major organization and managing privilege for the user.

"I'm writing a book. Looking at digital tools, my options outside word processors are quite limited. It is tremendously difficult to organize content digitally in a non-linear format. I love that here I can interact and modify contents even on non-touch screen display." - Brad McDonald.

Brad McDonald is visual and game designer based in New York. He shared his technical habits of maintaining notes. Currently, he is writing a book and there are challenges specifically in initial stages of writing that require a non-linear layout of the composition of contents, in other words, mesh network book indices.

The reactions from Lena and Brad were positively mutual about the added features. "Rearrangement is the most appealing part of it and navigation around the board is crucial." – Lena Greenberg

In future screen-sharing features can be integrated to provide flexibility in meeting rooms. In large meeting rooms the distance of participants is non-uniform from the screen that hosts video-conferences. Screen-sharing from anywhere in the room can be more practical than everyone clustering around the screen. This can provide flexibility to operate Stickie.

For example, at Shop an architecture firm, the design and engineering teams often hold video conferencing calls in a large meeting room with one giant screen on one end of the room. "We absolutely need a screen-sharing feature where I can use my phone or tablet to manipulate the content on screens using touch, whenever appropriate." - John Cerone Director of Virtual Design & Construction at Shop.

Analytics

The last phase of the development introduced analytics to Stickie. It let's the users self-quantify their activity at the end of the session. The instant benefit of it is that before this people never had a chance to quantify and visualize their participation in a group activity. Once the user ends the session to exit, they are presented with *"notes posted vs. time"* scatter plot of their participation in the session.

Deployment

The latest version of Stickie has been deployed on Heroku. The database is maintained on Mongolab, a Heroku add-on resource. The repositories for the webservice and the app are hosted on Github.


Stickie
Now Available
Connect
Invite
End Session
Recenter
Swipe to Post
Tanga Trophy

Chapter 5

FUTURE SCOPE

Stickie is a base level interaction model between mobile phones and backlit displays, on top of which a host of features can be tailored for specific user segment, example vector shapes for drawing, text keyboard for those who prefer typing over writing, resource management and so on. During user tests the deployment of the application resonated with many different occupations ranging from design and architecture to education and teaching.

Stickie is a paperless process that cuts down the organization and clutter in work places. "Our team has to print out a ton of images for a meeting and paper is so expensive. In the end, we take a photo of the whole session and CC everyone on an email thread to follow up on the discussion."- John Cerone. He acknowledged the fact that Stickie would make it easier for the team to add images on canvas while cutting down time on downloading and printing.

Stickie has equal benefits for freelance employees and small organizations that operate from localized workspaces. It could improve their participation in initial stages of brainstorming without asking them to commute for meetings. "I've been working with a housing project upstate that takes 2 hours of travel. We've had several ideation meetings where Stickie would've been helpful and saved us time." – Anezka Sabek

Stickie also showed potential to be integrated in schools and universities. Joseph Ellis, Phd Electrical Engineering, Columbia University said, "We are heavily engaged software development on day-to-day basis. It is difficult for us to find mutually convenient time to recap any progress and lay out the next plan of action. I would definitely use it (Stickie) instead of paper to organize the workflow digitally but in a manner I want to see it. My colleagues can check in whenever they find it convenient."

Verizon Connected Futures Demo

Stickie was also demonstrated at Verizon Connected Futures 2016, hosted by NYC Media Lab[22]. The project was presented to Executives from Open Innovation Lab, Verizon.

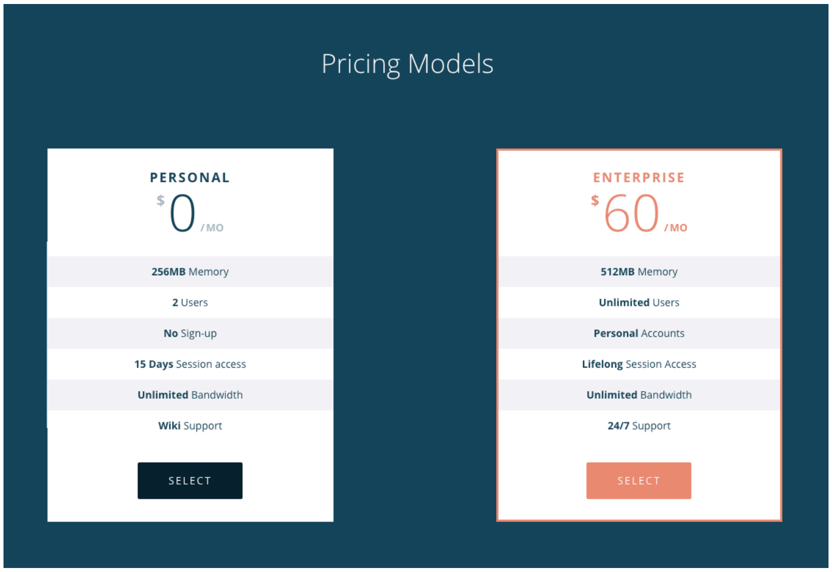


Figure 22 Basic Pricing Chart

Verizon was interested in evaluating business plans for Stickie that can make it a commercially available service on the market. After much consideration, it was decided to open-source the project. One of the benefits of the underlying technology of Stickie is the ability to include a large number people who can access ideation and creative brainstorming sessions. Open-source fundamentally supports this concept by allowing people to use, modify, repurpose it and ultimately contribute improvements to it.

The potential revenue streams were broken down into two channels – Personal and Enterprise.

Future Roadmap

Verizon Open Innovation Lab has also offered to share their cloud hosting services free of charge. "We have a large grid of display's at our office. We'll share your service with our employees who can routinely use it on that and provide you feedback." - Shawn Strickland

The next challenge is to reduce the latency of the interface. Currently it can take up to 2 seconds to transfer an image on to the screen. Every millisecond counts in UI. The next goal is to reduce that time by 10X close to 200ms. Some alternate methods of positioning would need to be devised. It could be working a densely packed QR code or grid of gradients. Some development will be done to minimize the latency of the whole experience associated with Stickie. Beyond that more features will be developed depending upon a detailed market research.

Stickie will always continue to be an open-source project, encouraging participation of people from diverse communities and professions. There is a lot of scope for further technical and user experience development. Within the scope of this thesis, Stickie addressed several challenges and successfully demonstrated a scalable solution for creative brainstorming with consumer technologies.

BIBLIOGRAPHY

[1] SINTEF. "Big Data, for better or worse: 90% of world's data generated over last two years." ScienceDaily. www.sciencedaily.com/releases/2013/05/130522085217.htm (accessed May 12, 2016).

[2] Day, Michael. "The long-term preservation of Web content". Web archiving (Berlin: Springer, 2006), pp. 177-199. ISBN

[2] Day, Michael. "The long-term preservation of Web content". Web archiving (Berlin: Springer, 2006), pp. 177-199. ISBN 3-540-23338-5.

[3] "Timeline Highlights." Computers. Accessed May 12, 2016. http://www.computerhistory.org/timeline/computers/.

[4] MediaArtTube. "Myron Krueger - Videoplace, Responsive Environment, 1972-1990s." YouTube. 2008. Accessed May 12, 2016. https://www.youtube.com/watch?v=dmmxVA5xhuo.

[5] 1996 Computer Science Challenges for the Next 10 Years. February 5, 2010. Accessed May 12, 2016. https://www.youtube.com/watch?v=7jwLWosmmjE.

[6] "Bruce Sterling's Design Future Manifesto: Viva Spime!" Boing Boing. October 26, 2005. Accessed May 12, 2016. http://boingboing.net/2005/10/26/bruce-sterlings-desi.html.

[7] Sena, Pete. "How The Growth Of Mixed Reality Will Change Communication, Collaboration And The Future Of The Workplace." TechCrunch. January 30, 2016. Accessed May 12, 2016. http://techcrunch.com/2016/01/30/how-the-growth-of-mixed-reality-will-change-communication-collaboration-and-the-future-of-the-workplace/.

[8] "Planning Office Spaces." Workspaces. Accessed May 12, 2016. http://www.planning-office-spaces.com/workspaces.html.

[9] Choi, Jenn. "How Companies Are Using LEGOs to Unlock Talent Employees Didn't Know They Had." Quartz. September 15, 2015. Accessed December 20, 2015. http://qz.com/503512/how-companies-are-using-legos-to-unlock-talent-employees-didnt-know-they-had/.

[10] "Boards." Boards. Accessed May 12, 2016. http://nas.sr/boards/.

[11] Good, Robin. "Online Collaboration Tools." ZEEF. Accessed May 12, 2016. https://online-collaboration-tools.zeef.com/robin.good.

[12] Doorley, Scott, and Scott Witthoft. "Insights-Design for Primates." In Make Space: How to Set the Stage for Creative Collaboration, 23.

[13] "Methodologies." Design Thinking Methodology. Accessed May 12, 2016. http://designthinkingmethodology.weebly.com/methodologies.html.

[14] Post-it® Plus. Computer software. Version 1.2.4. ITunes Store. October 16, 2015. Accessed May 12, 2016. https://itunes.apple.com/us/app/post-it-plus/id920127738?mt=8.

[15] Doorley, Scott, and Scott Witthoft. "Insights-Design for Primates." In Make Space: How to Set the Stage for Creative Collaboration, 23.

[16] Randhawa, Jaskirat. "Stickie." Vimeo. November 20, 2015. Accessed May 12, 2016. https://vimeo.com/147418107.

[17] Randhawa, Jaskirat. "Stickie: User Test." Vimeo. December 30, 2015. Accessed May 12, 2016. https://vimeo.com/150319691.

[18] "Ke:tai." Ketai Library. Accessed May 12, 2016. http://ketai.org/.

[19] Krause, Kevin. "Google Demos Open Project Screen Sharing." Phandroid. September 27, 2013. Accessed May 12, 2016. http://phandroid.com/2013/09/27/google-open-project/.

[20] "THAW." Tangible Media Group. Accessed May 12, 2016. http://tangible.media.mit.edu/project/thaw.

[21] Fowler, Martin. "TwoHardThings." Martinfowler.com. July 14, 2009. Accessed May 12, 2016. http://martinfowler.com/bliki/TwoHardThings.html.

[22] "Verizon Open Innovation Challenge Funds $250,000 in Research and Prototyping Projects to NYC University Teams." NYC Media Lab. February 3, 2016. Accessed May 12, 2016. http://www.nycmedialab.org/verizonchallengeannouncement/.