

Vertical: Exploring Collaborative Co-located Content Creation on Mobile Devices

Naveen Shaji
IDC School of Design,
IIT Bombay, Mumbai, India.
nshaji@iitb.ac.in

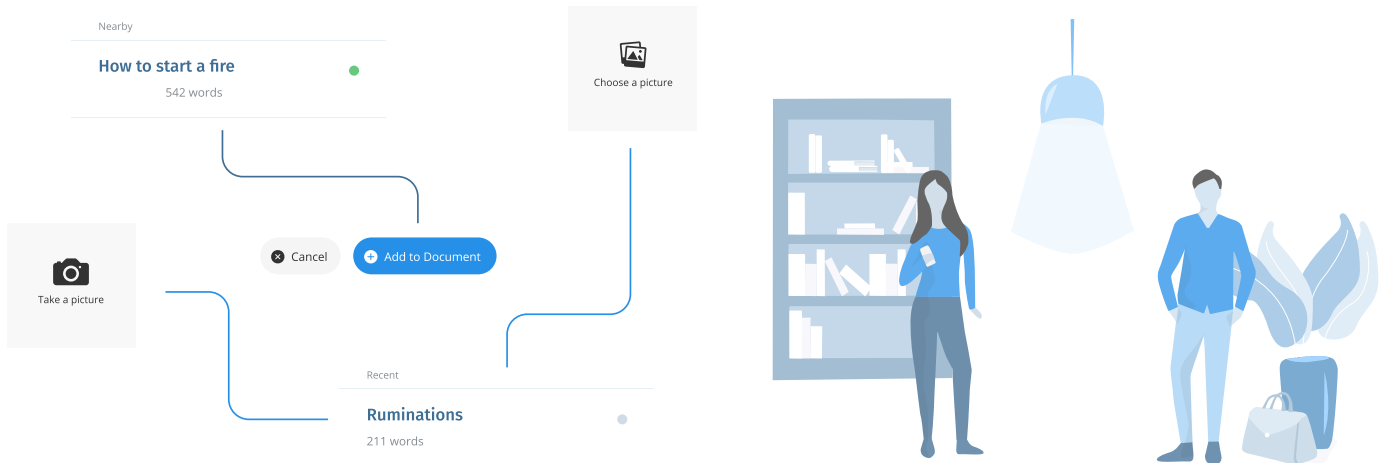


Figure 1. Core idea of Vertical - different interaction components are separated into multiple devices but are joined using network connections. These different interaction components are used by different people together to create collaborative documents in a co-located setting.

1. Introduction

The process of writing on a digital medium is often done by one person on one device. However, most writing involves sub-processes within that feed into the document. For example, research that takes place while writing an academic report or a blog post influences the writing process quite a bit. Likewise, adding rich media to documents and formatting text are all added to the core writing experience, which gives rise to the modern content creation workflow.

Vertical is a co-located mobile content creation platform that explores the interactions between people while they create collaboratively in different co-located settings. It works by separating the more complex aspects of creating a document into multiple devices, which can then be used by different people working together, effectively disaggregating the components of the modern content creation workflow.

The project aims to be an exploratory probe into the kind of interactions that occur while disaggregating the complex task of creation.

2. The Design Process

The Interaction Design process followed while designing the complex interactions that power the experience laid significant emphasis on the learnings from the primary research data as well as from the insights gained from the literary review. User data is aggregated in the form of user personas which then dictate and validate the rest of the design process.

2.1. Literature Review

Quite a bit of research had been done in the areas of co-located interactions and multi-device collaborative, complex creation; however, there are practically none that attempt to combine the two fields.

Previous research suggests that in larger groups, the main challenges are related to group work and social interactions within the group: making decisions and agreeing on a common strategy, coordinating and synchronising actions, and keeping track of the others and the overall task status¹.

1. Tero Jokela, Ming Ki Chong, Andrés Lucero, and Hans Gellersen. 2015. Connecting devices for collaborative interactions. *interactions* 22, 4 (June 2015), 39–43. DOI:<https://doi.org/10.1145/2776887>

Connectivity is a significant impediment to co-located experiences. When internet connectivity is required, reliability and latency can make or break an experience. Research also suggests that while working on larger displays, the need to switch between views is a significant impediment to productivity and engagement. This is consistent with previous work as well¹. People quickly get bored or distracted when they cannot do anything but wait for others to complete a task.

In a study that looked at a co-located photo sharing experience, none of the participants had any concerns over the loss of control over what data comes into the picture since it was a shared experience². This might suggest that loss of control might not be a prominent issue during content creation as well since it is a shared experience. The question of redundancy was also discussed where when multiple users add the same photograph, resulting in duplicates. However, this posed no issue as well in that particular study where the consensus in such a situation chose the objectively better picture. Designation of work items happened seamlessly in this situation where one of the participants figured that other users would be sharing photographs of one of the objectives so, he went on to add pictures of other items that he thought were more interesting. Unusual collaborative behaviour was seen in this study as well when one of the participants enquired if another was adding two pictures when the other replied that he'll add one, and the other person can add the other. There were tensions between participants wanting, on one hand, to maintain shared group identity and to contribute photographs that were similar to the pictures others took and participants wishing, on the other hand, to have a unique character within the group and to provide images that no one else would think to or be able to contribute. This goes to show that the same mechanic could possibly be extended to creative content creation using co-located mobile devices successfully. In a study done by Nokia research about the collaborative use of co-located mobile phones for brainstorming ideas, the researchers observed that in the first round, the participants had assigned themselves roles where one person creates notes, while another person brings in data and research, while another makes high-level

decisions. However, in the next few rounds, all three of the participants shifted freely between the different roles and worked significantly better³. This means that the flexibility that is offered in changing roles has a positive impact on the experience. Seeing what the other person was doing was also reported to be invaluable in making the application work towards their goals. However, in this study, the prototype only let one user type notes at a time, and that led to a break in the collaborative flow and reverted things to a more sequential rather than asynchronous workflow. This means that there needs to be information transparency and non-blocking interaction design that lets users work asynchronously on the document. Information symmetry is crucial - all users should see the contents on the shared tablet and on their own phone⁴.

2.2. Primary Research Insights

I conducted 8 semi-structured user interviews to model multiple personas to aid in the design process. The demographic was multi-national and multi-cultural and included 4 university students, 2 bloggers, and 2 professional content writers.

What do you write on phone	Problems faced	Amount of text usually written on a phone	Writing collaboratively
Writes stuff on phone - notes mainly. Lecture notes - things to remember - Uses notes like a journal sometimes - very private	Inability to see entirety of text entered on screen, inability to research stuff and then write about it	less than 300 unless I have to write an academic essay and I don't have my laptop nearby	The only time I've written collaboratively was when an academic assignment had us all working together on google docs to write the final essay that had to be submitted
Writes poetry and prose, usually on phone only. Uses laptop very rarely for writing and usually because the laptop is a dedicated animation rig which is heavy, big and not very portable	Writing on mobile keyboard is not an issue - is actually faster on mobile keyboard. Having to multitask is painful because sometimes the phone kills the browser while he is writing and it is out of memory. Most writing is creative and does not need references	Have written more than 1500 words on a phone - no joke. It often feels more natural and comfortable than typing on a laptop screen especially for poetry.	Have written collaboratively - but one person did most of the actual writing with others collaborating with ideas and storylines rather than literal words.
I usually just save stuff with a short description of what it is. Happens usually when I'm browsing social media and I find something interesting. I save the link and write a few lines about it. I also write down my expenses and passwords	writing on mobile is way less comfortable than writing on a keyboard. Sometimes I have to send a mail on phone and that is usually very hard due to the small keyboard and the fact that I have to wear glasses to see it properly since the text is so small	No more than 200 words - which is still very rare. Most writing is done by hand or on a computer at the office.	Usually directs others to write for me. I tell them what to type and they type it out for me.
Write posts for social media on phones. Sometimes posts on reddit and blogs. If it's a big piece I usually whip out my laptop because it just feels more comfortable	I don't write anything related to work or academic on my phone because that feels like serious work. I'm also more likely to slack off and turn to social media when I'm on my phone	Around 500 words I guess. It varies on what exactly I'm writing about	Did not write collaboratively at all.
I mostly write quick notes. Sometimes when I'm at events, I take notes on my phone.		200-300 approximately	Usually at events when me and a few work friends attend. We take notes on our phones and then share if it's important content. Collaborated on google docs on mobiles

Figure 2. Aggregation of primary research data to generate personas that were used at every step in the design process.

1. Maria Husmann, Alfonso Murolo, Nicolas Kick, Linda Di Geronimo, and Moira C. Norrie. 2018. Supporting out of office software development using personal devices. In Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI '18). Association for Computing Machinery, New York, NY, USA, Article 27, 1–11. DOI:https://doi.org/10.1145/3229434.3229454
2. James Clawson, Amy Volda, Nirmal Patel, and Kent Lyons. 2008. Mobiphos: a collocated-synchronous mobile photo sharing application. In Proceedings of the 10th international conference on Human computer interaction with mobile devices and services (MobileHCI '08). Association for Computing Machinery, New York, NY, USA, 187–195. DOI:https://doi.org/10.1145/1409240.1409261
3. Andrés Lucero, Jaakko Keränen, and Hannu Korhonen. 2010. Collaborative use of mobile phones for brainstorming. In Proceedings of the 12th international conference on Human computer interaction with mobile devices and services (MobileHCI '10). Association for Computing Machinery, New York, NY, USA, 337–340. DOI:https://doi.org/10.1145/1851600.1851659
4. Sus Lundgren, Joel E. Fischer, Stuart Reeves, and Olof Torgersson. 2015. Designing Mobile Experiences for Collocated Interaction. In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '15). Association for Computing Machinery, New York, NY, USA, 496–507. DOI:https://doi.org/10.1145/2675133.2675171

People create content primarily on their desktop or laptop computers. Even though collaborative creation is not new, most people who work together to create a document usually leave it to one person who works on writing consistently. In contrast, others support the writing process by bringing in sources, information, and media. This is usually how more prominent internet companies handle content creation, with teams working on research and the editors who draw conclusions from the study to write the final draft of the document.

A few problems came up as reasons why users generally avoid writing on mobile phones. Most mobile operating systems close background apps if the phone is low on memory. This means that you cannot efficiently research and write at the same time. A lot of content is often taken from websites. Depending on the kind of work, more than half the textual content can be indirectly based off of other websites. Pictures also need to be downloaded to phone first before you can use them in your work. Users also reported that smartphones are distractive mediums which prevents them from using them in any context that they deem serious.

2.3. Aggregating Research Data

Personas work as a useful tool to ground the design process by making it easier to relate to the user at every step of the way. The primary research insights funnelled into three personas that could help the design process as well as have their own user journey through the platform.

Luke, Ann, and Sarah are the three primary personas modelled from research findings with their own unique user goals and needs.



Figure 3. Illustrations of Luke, Ann, and Sarah, the three modelled personas that work to add empathy to the process.

Luke is a methodical thinker who likes to plan everything as early as possible. He truly believes that creation works best when executed after proper planning. Luke continually looks for ways to improve his workflow and process to be more productive. In

fact, in a lot of scenarios, he had used his phone to write long reports and write-ups for work and does not have a preconceived prejudice towards writing on mobile phones. While writing, Luke likes to start out by defining the various sections, then doing his research, before finally actually typing it out. He rarely adds rich media like images and videos to his content.

Ann is more of a face-it-when-you-see-it kinda person who prefers the flexibility of being able to adapt to any situation over achieving perfection in a particular case through planned effort. She observes each problem and faces it with a relentless persistence without worrying or thinking about the future. Ann likes to jump in straight away and get started with writing first and then doing her research when she feels the need. She almost always adds images to the content.

Sarah is the glue that holds people around her together - often the most socially active and enthusiastic among her friends. She wants to make sure that everyone gets along well and has a good time - to a fault where she considers that way more important than the work output. Sarah is more likely to follow the way someone has written something and create along those lines. She rarely uses her phone for writing content other than notes that are a few lines long at most.

2.4. Specifications

The goal of the design process is to design a system to qualitatively observe the complex interactions that take place during the relatively novel concept of co-located mobile creation while adhering to industry best practices. It is not an attempt to make a commercially viable product that is ready for the market.

The platform should be a progressive web app to support as many devices as possible, but can also be supported by native apps that take full advantage of the hardware and sensors on phones to provide a more seamless experience.

Users need to have privacy and control over the data that they wish to share with other users on the platform, even in a co-located setting. The document created at the end of a collaborative session should be available to all the users who worked on it.

The application should be self sufficient - the client should carry a server instance that can then be used through an offline personal hotspot and enable other users to connect to it to include as much functionality as possible without online content. In such instances, the platform should gracefully degrade into an offline application running locally.

2.5. Information Architecture

Once the scope of the solution was defined, the information blocks were identified and were grouped logically after a few card sorting studies were done with some users.

This led to an Information Architecture that was both meaningful as well as centred around the user.

Previous research¹ shows that flexibility in choosing the roles and shifting between them at any time proved to be an invaluable asset for a better experience. This has been an important consideration while designing the information architecture. Users need to be able to switch between the different roles available through a simple and easy to use navigation item or gesture.



Figure 4. The designed Information Architecture for the platform. This was then implemented through User Flows.

2.6. User Flows

The primary user flows were drafted out based on ease of use and familiarity - which draws on existing interaction design paradigms in use today to not add more complexity. These were based on the anticipatory design ideology, where the goals of the users are anticipated using the generated personas to make achieving goals easier and engaging.

These user flows are illustrated in **Figure 6** with the help of personas.

2.7. Wireframing

As an intermediary step after charting the user flows, the wireframing was generally done on paper to facilitate rapid iterations. The data and structure defined in the Information Architecture had to connect with the User Flow to produce a seamless experience.

This is also where the most amount of the work went in from an interaction design perspective.

During Wireframing, the significant concerns were usability and communication. From research, we understand that communication is essential for engagement which is crucial while designing multi-user systems that rely on more than one person to accomplish the shared goal. Information transparency was a key consideration, as learned from previous research. Users would always be able to see who was doing what at any time.

2.8. Visual Design

Having consistent design guidelines in place is always important. I put together a quick style guide before starting out designing the surface of the app. I've used a Fibonacci series to define the font sizes, as well as the layout spacing. This ensures a highly consistent design experience.

I started out by creating molecules - small elements which are made by combining two or more atoms, or single function elements. These atoms are then combined to form molecules which are larger building blocks of the user interface. Molecules are put together to build more significant components called Organisms that ultimately make up a view in the app. I'm following Brad Frost's atomic design² system here.

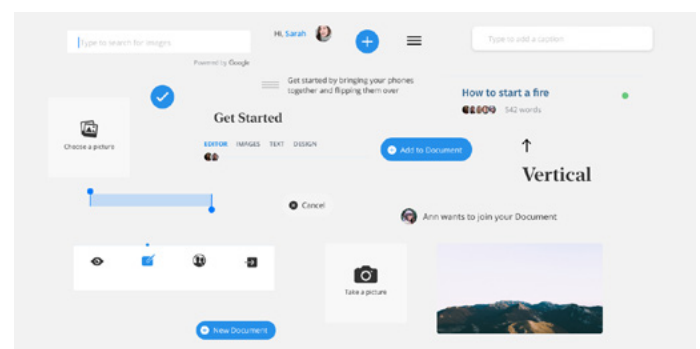


Figure 5. The Atomic Design ideology was used to organize the components and develop a visual and organizational structure for the platform.

1. Andrés Lucero, Jaakko Keränen, and Hannu Korhonen. 2010. Collaborative use of mobile phones for brainstorming. In Proceedings of the 12th international conference on Human computer interaction with mobile devices and services (MobileHCI '10). Association for Computing Machinery, New York, NY, USA, 337–340. DOI:<https://doi.org/10.1145/1851600.1851659>

2. Brad Frost Atomic Design Book - <http://atomicdesign.bradfrost.com>

2.9. Designed User Flows

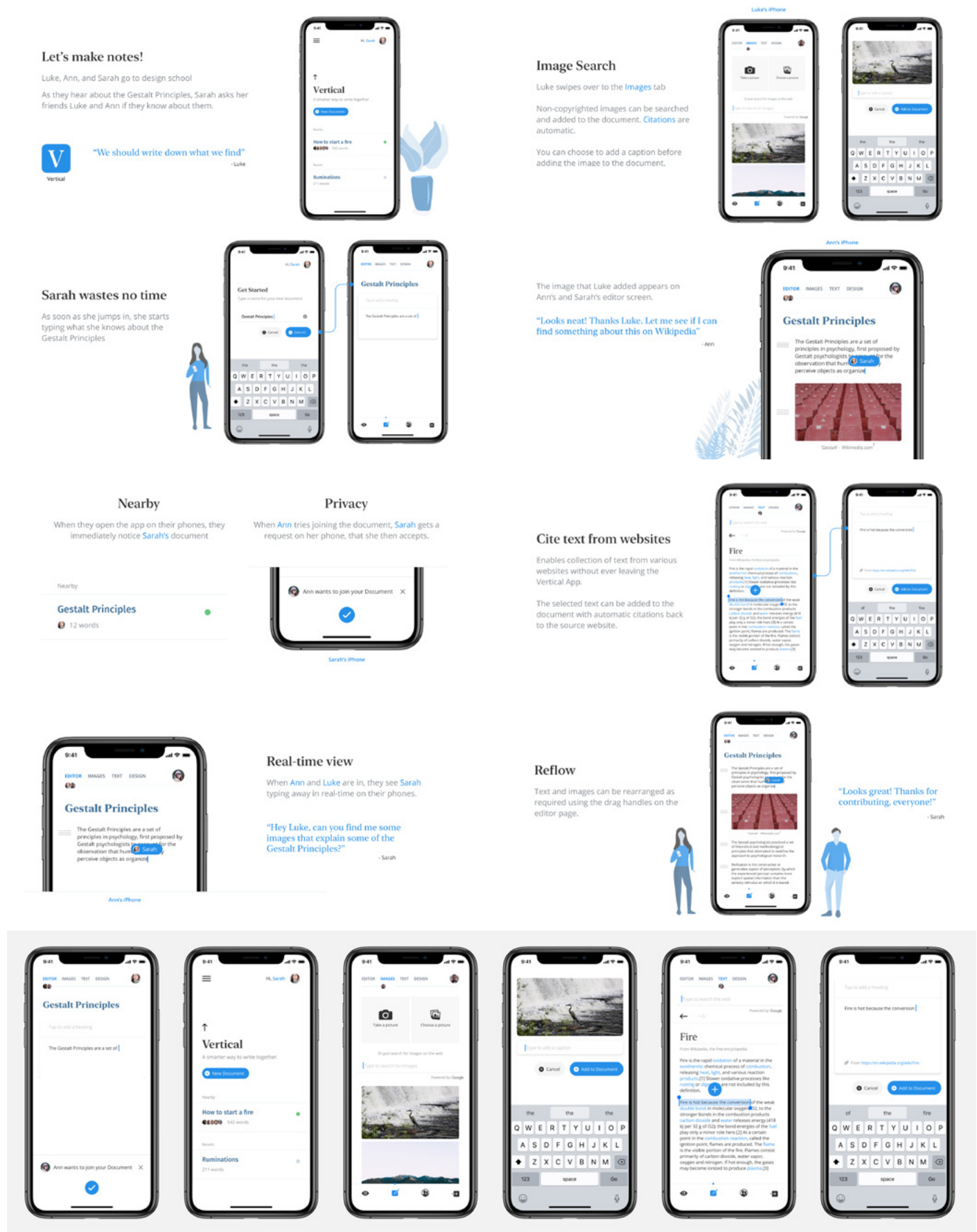


Figure 6. User journey maps using the personas working on the designed experience. As an iterative design process, this was improved multiple times after generating user journey maps for each scenario and running a persona through the steps.

3. Prototyping

I felt that the experience could be prototyped quickly using the web as a medium, considering it also opens up more devices to be used in testing. The web application was developed with JavaScript powering the front-end and a Node.JS server running ExpressJS and sockets relaying information between the different connected clients.

The underlying technology is implemented along with most of the interface elements; however, not all the features outlined in the design are functional in the prototype yet. The prototype is a work in progress and will be updated in the days to come to completion.

Currently, the prototype supports text and media input from over 10 users at the same time with changes occurring being reflected on every device within a few milliseconds on local networks. You can also see the user status updated live as users join or leave the session.

More features like user profiles, authentication, and multiple sessions all require another back-end server to function efficiently without interfering with the server that handles the low-latency sockets connections that ensure that user actions are always reflected realtime on connected devices. This adds considerable complexity - especially multiple sessions in realtime on one server, and requires time to build. Another approach is to move the low-latency sockets server to the mobile device itself so that it would broadcast a WiFi signal that enables other devices to connect to it. However, this requires shifting away from the web as a platform and all the advantages that come with it.

4. Looking Forward

Upon completion of the functionality in the prototype, an exploratory probe will be done with a selected set of users which will help in identifying the Interaction patterns as well as an idea about the qualitative analysis of such a system. This can be used as inputs for the next round of the iterative design process.

The system can also be extended to the emergent user markets by integrating other services like multi-language inputs and can be tested among emergent users where the power of collaborative creation can spearhead a rise in digital production while empowering the less-savvy to get started with a lower barrier for entry.

A user testing study could help in corroborating the insights from previous research and see how much the findings hold when applied to a more complex task such as content creation. This could pave the way for even more complex tasks like video editing and coding being disaggregated to multiple devices for collaboration.

```
111 |  
112 |  
113 |  
114 |  
115 |  
116 |  
117 |  
118 |  
119 |  
120 |  
121 |  
122 |  
123 |  
124 |  
125 |  
126 |  
127 |  
128 |  
129 |  
130 |  
131 |  
132 |  
133 |  
134 |  
135 |  
136 |  
137 |  
138 |  
139 |  
140 |  
141 |  
142 |  
143 |  
144 |  
145 |  
146 |  
147 |  
148 |  
  
quill.on('selection-change', ()=>{  
  socket.emit('cursor change', [quill.getSelection(), socket.id]);  
});  
  
quill.on('text-change', function (delta, oldDelta, source) {  
  if (source == 'user') {  
    socket.emit('text update', quill.getContents());  
  }  
});  
  
socket.on('text update', function (msg) {  
  let x2 = quill.getSelection();  
  quill.setContents(msg);  
  quill.setSelection(x2);  
});  
  
socket.on('cursor change', (wew)=>{  
  console.log('cursor change recieved')  
  cursors.moveCursor(wew[1], wew[0]);  
});  
  
socket.on('create cursor', (ayy)=>{  
  console.log('create cursor recieved')  
  cursors.createCursor(ayy[0], ayy[0], 'blue');  
});  
  
socket.on('user added', (n) => {  
  $('#userlist').children('.item').remove();  
  for (let i = 0; i < n; i++)  
    $('#userlist').append('<div class="item"></div>');  
});  
  
socket.on('user removed', (n) => {  
  $('#userlist').children('.item').remove();  
  for (let i = 0; i < n; i++)  
    $('#userlist').append('<div class="item"></div>');  
});
```

Figure 7. The prototype logic handling through a lightweight socket server.