

SonoSite Ultrasound Plus

Manage your SonoSite machines in a breeze!



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Table of Contents

Cover Page

<u>1. Project Introduction</u>

2. Research Background Research Question v0 Research Question v1 Preliminary Research The two major prompts: Top Quotes: Highlights of Observations and Findings: Relevant: Out of Scope for Our Project: Limitations: Survey Highlights of findings: Interviews

Key Takeaways Research Artifacts Scenarios: Scenarios v1 Scenarios v2 Mindsets (Graphical) Competitive Analysis Future Research Recommendations

<u>3. Design</u>

Design Process Overview Design Principles and Guidelines Major Design Considerations Information Architecture Graphic Major Section/Features Device List Screen

Design Specs Important Design Considerations User Validation Future Work Device Detail Screen Important Considerations Graph View **Design Specs** User Feedback Future Work Dashboard Important Considerations **Design Specs** User Feedback Future Work Reports Important Considerations **Design Specs** User Feedback Future Work Contribution to the HCD field

4. Personal Growth Statements:

<u>Josh Nelson</u> Joey Wang

5. Appendix

<u>Table 1. Participants Profile</u> <u>Figure 1. Demographics Questionnaires and Responses</u> <u>Figure 2. Series of Focus Group Response Stickies</u>

1. Project Introduction

For our UW MS HCDE Capstone project we partnered with a team from Fujifilm SonoSite to research and design a solution for their vision of an ultrasound management experience. Our team consisted of four students (Shreyans, Joey, Kirti, and Josh) who worked together with a team from SonoSite led by David Knapp. The project we undertook was focused around the problem space of ultrasound devices and program management. SonoSites team noted that they were aware through previous research that a problem space and potential opportunity existed within hospitals that struggled with tracking devices and monitoring ultrasound programs. They were seeking a team that was willing to investigate and prepare a vision that they could leverage in the future.

During the winter quarter we began by mapping out a proposal for a project that would kick-off in full during the Spring quarter. This project was a research focused project that would ultimately culminate in the design and validation of a mid-fi prototype. Our final deliverables would consist of two-parts: 1) the research report, 2) the design concept. Together these would act as a communication tool for our vision for what the future of ultrasound devices and program management could look like.

One major challenge over the course of the project was the rapidly unfolding the Covid-19 situation which impacted our team heavily. This situation ultimately prevented us from meeting in-person for the entire duration of the Spring 2020 quarter while subsequently leaving one of our team members locked down in India. This contributed to some of the challenges that we faced in our project and in our research, as communication became increasingly challenging, as did gaining access to industry professionals for generative research.

However, we were able to pivot our project to focus more heavily on speculative exploratory UX research methodology and dive more deeply into design led research practices to extract meaningful insights and directionality. Towards the end of our project we were fortunate enough to have a series of industry professional cognitive walk-through validation sessions of our design which ended in overwhelmingly positive reception towards the concepts our team had developed for our vision of an ultrasound device and program management solution.

The remainder of the document is focused on presenting our research process, key findings, design concepts, validation report and painting a picture for future work that can be undertaken by the SonoSite team in research and design that came from our project.

2. Research

Background

According to our sponsor, SonoSite's current key strategy is to challenge the existing radiology market share and help patients as well as medical providers to reduce uncertainty in diagnosis in a more portable, cheaper and convenient way. It has recently announced a portfolio of Personal Sonographic Assistants (PSA) which is essentially their next generation of devices. Hence a device management portal naturally comes into consideration to align with the business objectives for easier management of existing and future Sonogram machines.

Our sponsor informed us that there is a potential opportunity for them to provide their clients with a superior ultrasound device management experience. One specific example cited by our sponsor is that their clients within large hospitals struggle to identify the location and status of their ultrasound devices. Our primary target users for this project are *ultrasound directors* (*Figure 1*) from medical institutions, or medical directors for brief, who reside at the top of the department hierarchy and manage the ultrasound programs at the hospital.





We worked with the FujiFilm SonoSite (FFSS) design team on the primary research question that we wish to frame our problem space. As the medical directors are often the educator, advocates and opinion leaders of the ultrasound programs, our initial

assumption was that gaining a deep understanding of the problem they face would help us dive into this brand new, yet highly specialized, domain as newcomers. We modified the question along the way, given the different group of research participants we had access to considering the limitations resulting from the COVID-19 situation.

Research Question v0

"How might we help medical directors from the emergency department (ED) improve their ultrasound device management experience?"

Research Question v1

"How might we help medical directors improve their ultrasound program management experience?"

As we progress through the project, the understanding of the mental model of our primary persona, the directors, have led us to hit some sweet spots for their pain points as we have discovered through our final rounds of design validation. We also ended up opening up and partially solving some problems of the other two groups of audience, namely accredited doctors and clinicians, as byproducts.

As we progressed through the project our original understanding of the primary persona the directors - expanded. This led us to discover some new and uniquely painful opportunities areas that we sought to understand and solve in conjunction with our original project scope as they naturally fit together with our existing opportunity area. Ultimately, we ended up expanding the scale of our research question to account for a more generalizable audience that while emphasizing our directors has the subsequent benefit of also supporting more clinicians as a happy byproduct of a program level solution.

Preliminary Research

FFSS design team and we conducted a flying-on-the-wall focus group session with 11 participants (See Appendix Table 1) from various medical and educational institutions. Our sponsors (internal stakeholders from FujiFilm SonoSite) took the lead on the interview to find out the major pain points our customers encountered when they manage the SonoSites machines in their departments while we observed the whole process.

The interview took place in a large meeting room on SonoSite campus as part of the participants' guided tour. The interviewees were separated into two groups and our sponsors interviewed each group for 30 minutes. The first activity was to collect their demographic information, where our sponsors asked the participants to put circle dots on three big posters where the options are listed.

As a high level depiction of demographics (Figure 2), all participants are directors or managers of ultrasound programs and 10 of them come from major academic hospitals. 64% of the participants came from the Emergency Department (ED) (2 of them are from Pediatrician ED (Ped. ED)), while 36% were from the Cardiac Care Unit (CCU). All participants share standard diagnostic distribution meaning they are heavy for Quality Assurance (QA), Billing and Education. Over half of the participants claimed that they have more than 8 ultrasound systems and 21 practitioners within their departments. According to our internal stakeholders, this represents well of the actual distribution of our target audience. All participants are highly enthusiastic about ultrasound technologies as they are directors and advocates of the ultrasound program in their own departments.





Figure 2. Demographics of Participants

One thing that is worth noting is that the participants had a previous session on the new Synchronicity portal directly before the interview, so their responses may reflect on the automated study transfer features that were introduced to them. However given the open nature of our interview questions, we feel that their responses are still valuable in finding out what is important, but not so much in terms of ranking or prioritization.

The two major prompts:

- Q1: What are your metrics of success in managing an ultrasound program?
- Q2: What are your common duties/issues maintaining ultrasound systems?

We asked our participants to spend 5 minutes to write down their answers on stickies. Then we collected the stickies, put them up on the white board, and followed the stickies to ask for elaboration on the sticky items (Appendix Figure 2)

Immediately after the interview session, we compiled the notes, took photos and did a short round of debriefing to reach consensus on the key quotes and highlights of findings. We used the prompt "what strikes us the most during the conversation" to put together the key findings list.

Top Quotes:

- 1. 'Being able to trace down people's mistakes in ultrasound utilization is critical for managing the program. A 'stick' model in terms of tracking non-compliance activities, quick glance over machine utilization' P3, P4, P11
- 2. 'I need to prepare reports tailored to different audiences, including people from the medical board of committees as my supervisors and my direct reports' P11
- 3. 'The shorter time it takes for ultrasound scans to increase diagnostic accuracy, the more value ultrasound companies can bring on the table.' P5
- 4. 'It would be nice to have some Tableau type of dashboards for overviews on department KPIs' P6

Highlights of Observations and Findings:

- 1. When one of the participants mentioned how they were able to track if someone has done a bad job of using the ultrasound machine, others had strong resonance towards that experience. During our sessions with both focus groups, the audience mentioned the mental model of shaming and a stick, implying that utilization tracking is critical for the participants to manage their programs efficiently.
- 2. Locating the machine, knowing the battery level, ensuring there is enough hard drive space and data perseverance is fundamental for self-reporting of the systems. One of the participants mentioned that I cannot believe the machines today do not have them.

- 3. Having the images somehow correlated with other measurements and sent to EMR for analysis can further advance the user experience of sonogram systems.
- 4. Poor internet connectivity should not prevent systems from use.
- 5. Reporting on savings in terms of clinic time, reduction on radiology of the sonography systems may further boost the use and adoption of ultrasound programs.

The major pain points and concerns coming out of the interviews were gathered and grouped into two buckets: the ones that are relevant to our design prototype, and the ones are out of scope:

Relevant:

- 1. Reduction in time of doing exams, time spent in radiology (and patient visit)
- 2. Authentication, be able to quickly track down non-compliant utilization
- 3. Credentialing
- 4. Overview on battery usage, health, device labeling / location, post / pre-processing of probes
- 5. Academic program metrics
- 6. Reporting mechanism (pipelining from existing images to other measurements, daily / weekly report on system usage, tableau type reporting) in place and tailored for different audiences

Out of Scope for Our Project:

- 1. Improve the patients' visit experience
- 2. Successful / failed study cases capturing and sharing. Educational library for sharing ultrasound cases
- 3. Ultrasound machine labeling
 - a. Direwolves references
 - b. Numbers (1,2,3)
 - c. Colors
 - d. Humanize systems by giving them vulnerable population names (grandpa)
- 4. Data integrity when performing system upgrades
- 5. Storing, backing up and archiving existing study data

Limitations:

- 1. We feel a lack of contextual background of the information that we gathered. People's verbal descriptions may differ from reality, especially for a highly specialized profession.
- 2. Limited session time, the nature of focus group and COVID-19 situation resulted in missing in-depth inquiries on user stories and motives around ultrasound
- 3. Openness in exploring diversified personas
 - a. Directors could be more interested in overviews, but they are also frequent ultrasound machine end users

Survey

After our initial fly-on-the-wall focus group study and domain immersion with our project sponsor, our team had some understanding of the potential challenges the medical directors are facing when managing ultrasound devices. Our team then wanted to gather some data that would help us validate/invalidate our initial findings from the initial research and help us prioritize areas of focus. We spent a good amount of time with our project sponsor to first come up with the five-bucket model to outline our areas of focus, both from business requirements and speculative potential user needs perspective. These buckets were consolidated and re-labeled over time.

We were eager to know the importance of various KPIs that would potentially help the directors to achieve better ultrasound devices and program management experience. This initial goal was limited by our sponsors and audience's capacity during the COVID-19 situation, but nevertheless, our survey framework went on to deepen our understanding of the problem space and transformed into our initial interview scripts.

The continuous improvements and modification of the survey lasted for over a month, to ensure that the questions are meaningful and the areas we cover are representative and actionable. We launched the pilot view for internal stakeholders before our internal stakeholders helped us send out the finalized survey to actual directors.

The final structure of <u>the survey</u> is shown in Figure 2. :

Questions Responses S		
Section 1 of 8		
FFSS/UW HCDE - KPI Survey Please tell us about you and your institution	¢	:
Section 2 of 8		
Ultrasound System Health In order to have a successful ultrasound program, systems must be ready and available for use. Please share your thoughts by ranking the importance of the following items.	~>	:
Section 3 of 8		
Compliance In order to have a successful ultrasound program, clinicians must comply with standards of the organ Please share your thoughts by ranking the importance of the following items.	¢ nization.	:
Section 4 of 8		
Ultrasound Utilization and Quality In order to have a successful ultrasound program, clinicians need to use ultrasound in their practice is manner. Please share your thoughts by ranking the importance of the following items.	≎ 1 an effe	: ective
Section 5 of 8		
Clinical Goals In order to have a successful ultrasound program, the department should be able to view the quantity ultrasound studies based on clinical parameters. Please share your thoughts by ranking the importance of the following items.	Ç y and qu	: ality of
Section 6 of 8		
Academic Programs Academic programs typically require students, residents or fellows to complete a certain number of to in a period of time.	Ç ultrasour	: nd studie:
In order to have a successful educational program, the department should be able to view the status programs to gauge their completion. Please share your thoughts by ranking the following items.	of stude	nts and
Section 7 of 8		
What did we miss?	÷	:
Section 8 of 8		
Completion Thank you so much for completing the survey!	\$:

Figure 3. Survey Structure

The survey are divided in the following major buckets:

- 1. Demographics
- 2. System Health
- 3. Utilization and Quality
- 4. Clinical Goals
- 5. Compliance
- 6. Academic Programs.
- 7. What did we miss?
- 8. Completion

Section 1 covers the demographic questions on our participants.

Section 2-6 depicted the five-bucket model we initially developed to frame our problem space. In these sections, we ask the participants to rate each individual KPI data under that bucket on a likert scale of 1-7, where 1 means it is least important for them to view such KPI, while 7 means it is most important. Such a rating system turned out to be quite useful when we started prioritizing data groups on our main reporting dashboard.

Section 7 is just an open question to discover any potential areas that we might have missed in this survey. Section 8 asks the participants to leave their contact methods in case they are interested in helping us for our design validation.

Given the constraints of our internal stakeholders' and medical directors' limited availability in the COVID-19 situation, we eventually received 5 responses from actual directors and managers from medical institutions. These participants have a variety of specialties such as ED and ICU internist. They either are serving or served the role of ultrasound program director for medium (50 patients / week) to large (300+ patients / week) medical institutes. An overview of the summary of survey responses can be found at <u>Survey Response Summary</u>.

Highlights of findings:

1. The initial data analysis was shown in Figure 3 below. For Device Health KPIs, we see one or two participants gave ratings of 1 (least important) on some of the data KPIs we listed out, where in Quality of Studies and Academic Programs, participants consistently rated the KPIs beyond 4 (important). This certainly makes sense to us as all our participants come from large academic medical institutions. We see consistent high ratings on the importance of KPI data around Quality of Studies, Clinical Goals, Compliance of device use (i.e. who has not returned or cleaned the devices) and Academic Programs. On the other hand, as these medical directors do not strongly identify themselves as system administrators (which we also discovered and confirmed in our interview), some respondents tend to not be super interested in knowing the device health KPI details.



Figure 3. A glance view of Importance of KPIs; 1 being least important while 7 being the most important.

Based on the initial data we collected shown above, we summarized the importance on the ranking of buckets:

Quality of studies & Clinical Goals > Academic Programs > Compliance > System Health

- 2. 4 out of 5 participants have indicated that their hospitals have designated pods / rooms for ultrasound machines, which became a key assumption to our design.
- 3. Tracking whether an ultrasound machine has been cleaned after use is a big pain point, as visual inspection has been the only way so far, and one participant even replied "currently not tracked". We find that situation aggravates given the current COVID-19 situation and tracking of cleaning has become one of our top priorities.
- 4. One director quoted that the existing tools for ultrasound programs statuses analysis through QPath and Chronicity are "clunky and / or expensive"

Interviews

In addition to the data collected from focus group studies and framework, we conducted online 1:1 interviews with further participants to get deeper understandings of their pain points and mindsets.

The one-hour long interview focuses on two major parts. The first part includes an open ended question and follow up questions to find out what the participants' definition of "a successful ultrasound program" is. The second part walks through our existing scenarios and asks for storytelling and experience sharing, in order to discover the validity and severity of each scenario.

After each interview we debriefed among our team members as well as our sponsors to reach consensus on key takeaways and put them to stickies on our <u>debriefing Miro board</u>. We then sort, prioritize and group them collaboratively to share insights on the research findings and contribute to our ideations and design.

We ended up with three participants for our pre-design interviews. Their bios are also listed in Appendix Table 1.

Key Takeaways

- 1. Directors are typically busy people. P12 has 30 critical care fellows per year for ultrasound education, and needs to conduct 80% of QA on their studies by himself, he runs a busy schedule and has little time to deal with complex, overbearing systems. P13 mentioned that the directors are not there to babysit ultrasound machines, rather they wish to treat patients and not play with technology. P14 mentioned that we shouldn't create additional standalone web portals with more logins for the directors. Therefore we should embrace simplicity, clarity and seamless integration with existing lines of products when thinking about our portal. (P12, P13, P14)
- 2. **Pre / post processing (cleaning and returning) of ultrasound devices** are a giant pain for ultrasound management. Most hospitals do not have a systematic or automated way of tracking down cleaning activities of machines. (P12, P13, P14)
- 3. It is highly desirable for ultrasound directors to be able to find out **the chain of responsibility**. When someone has used the machine improperly or submitted problematic scans or studies that want to know who did it. However, most hospitals cannot afford requiring logins on every ultrasound use, given the current slow and tedious manual login process and the need to quickly utilize ultrasound

machines in emergency situations. Therefore we need to assume the existence a smart login mechanism in place and enable our solution's capability of tracking machine utilization (P12, P14)

- 4. **Overall framing buckets of KPIs make sense.** P14 indicated that they are standard business requirements and all pretty important. The directors frequently run into the situation where they wish to get an overview of how their systems and programs are doing. This mindset is a standard business requirement for medical directors, and they do not need to be prompted by urgent alerts. (P14)
- 5. Thinking about the **proper technological environment** is important. Directors are willing to use their laptops for viewing overall KPIs of their ultrasound program, but they also use compliant mobile devices heavily to check their upcoming appointments and for checking prescriptions. Therefore a mobile experience can be highly valuable to help directors locate a device, get notifications & alerts and take quick actions if necessary. (P13, P14)
- 6. We may have **additional personas** to take into consideration for future design. Clinicians need to locate available devices at a glance; Fujifilm SonoSite sales team may explore insights on ultrasound machine utilization (P13)
- 7. Battery health is not just about remaining percentages, but also the remaining time for use (P13)

In summary, though there were some contrasting thoughts on how people may want to find a machine in a different technological environment, as well as how people may like the idea of being required to login every time when they start using the machine, most of the comments reassured our confidence in the key findings we revealed through our survey results and discussions with our internal stakeholders (mainly the lead designer we are working with), and we leveraged mainly the survey buckets and some additional feedbacks to build out our research artifacts.

Research Artifacts

Scenarios:

Over the course of our project we developed UX focused scenarios and accompanying short narratives that we leveraged to gain a better understanding of the specific use cases, context and situations in which our solution may be used. While our team was originally seeking to develop scenarios based on concrete grounded research, owing to the lack of access to industry professionals from the covid-19 situation we pivoted to developing speculative exploratory scenarios that we used to help us understand the nuances of our design concepts materialization and direction.

Our scenarios included the following key assumptions:

- 1. Ultrasound devices' location can be tracked in real-time by a least granularity level of a room. I.e. The ultrasound device is now in Building W. West Wing Room 218.
- 2. Powerparks are available as a series of designated locations for the ultrasound devices.
- 3. The ultrasound devices require a user login every time.
- 4. SonoSite machines do not have backup / archival of studies issues or any hard drive capacity issues
- 5. Ultrasound education is a primary area of interest of our persona (given 12 / 13 participants we have so far come from academic institutions)
- 6. There is a way to track if the probes are cleaned

Scenarios v1

Link to Scenarios v1 Document

Our first scenarios were heavily influenced by task analysis UX methods with situational triggers acting as a key defining element that our narratives hinged upon. These scenarios were further designed to build upon the research framework we had developed in our Survey development. Specifically our scenarios were built across these categories:

- 1. System Health
 - a. Including Ultrasound Device Utilization
- 2. Compliance
- 3. Quality Assurance
- 4. Academic Programs
 - a. Including Clinical Goals

The structure we developed for our V1 scenarios is as follows:

- 1. Narratives
 - a. Intro + Solution
- 2. Why "help me..." statement
- 3. Task Definition:
 - a. Base Knowledge
 - b. Triggers
 - c. Desired Outcome
 - d. Require Knowledge
 - e. Artifact
- 4. Natural Connections

In total we produced 11 short narratives focused around our scenarios to help understand the problem space and begin communicating our design solutions.

During the course of validation for our scenarios v1 through interviews [see above section] we learned the following:

- 1. Focus on critical information:
 - a. Our initial scenarios were not clearly focused on presenting product opinionated information for directors to leverage quickly.
- 2. Environmental Context of Use:
 - a. Our initial scenarios did not properly account for the environment in which the solution would be used.
- 3. Directors do not have time or desire to "babysit"
 - a. Our initial scenarios pivoted around a "proactive" trigger situations which were not likely to be real-world example owing to directors' limited time and desire to not be micro-managers of their department.
- 4. Do not have us sign into another "thing"
 - a. Our scenarios were based on having a separate new piece of software for hospitals to use.

Scenarios v2

Link to Scenarios v2 Document

For our next round of scenario iteration we focused on making changes to our narratives and refining the structure of the various elements for improved clarity. These scenarios pulled from exploratory design work in addition to the feedback we received from our previous concepts.

The structure we developed for our V2 scenarios is as follows:

- 1. Solution Narrative by Persona
- 2. Why "help me..." statement
- 3. Triggers
- 4. User Task Flow
- 5. Artifact
- 6. Resolution Statement
- 7. Map to Persona Mindset
- 8. Natural Connections

This structure provided our team with more actionable directions for our design to leverage as we moved forward. Specifically it painted a more clear picture of the specific user flow required to get from the beginning to the end of a finite controlled and specific task as opposed to our previous scenarios which were wider explorations of our potential solutions environment. In total, for Scenario v2 we produced 9 refined narratives that we leveraged within our design concept.

During the course of developing our new scenarios there are a few concepts that our team uncovered but did not have the time to fully explore during the course of the project. Specifically:

- 1) Narratives focused different personas.
- 2) Narratives around the various business perspectives.

We knew from the start that we were going to focus our solution on management of many devices which indicated a specific type of person would be the most apt to using our solution. However, we would've liked to have been able to explore through narratives some of the other story lines that could've illuminated areas our team had not considered which may have proven to be of value for more than an isolated persona.

Additionally, we knew that SonoSite stood to gain from not only developing a solution to help their clients but that there was also potentially to push notifications from a marketing and educational standpoint to bring to light their newer technology as well as their other solutions that could be leveraged by their clients. This is an area that we recommend exploring in future versions of this vision.

Lastly for our second round of scenarios we actually explored a few narratives that simply did not make it into the design. One in particular was the concept that focused on support tickets for ultrasound devices. We uncovered in our cognitive walkthroughs that this is an area of particular interest for ultrasound directors, and while our narrative spells out a potential map of this solution it has not yet been fully explored or validated.

Mindsets

While our team had originally aimed to develop Persona's based on a Mindsets modeling method as a unique technique for understanding the underlying motivations of our user base. We eventually ended up pivoting back to a more traditional persona model owing to our lack of industry professional interview/feedback opportunities which stymied our

ability to gather meaningful data required to develop comprehensive spectrums and influence analysis.

However, we did ultimately end up with a more traditional persona that we reviewed through the lens of influences which is considered a key variable and strategy that we pulled from our original exploration of the Persona Mindsets. Our goal with our personas analysis was to help complement our scenario analysis with a comprehensive understanding of the "why" behind the actions that they are taking. Through the development of a more traditional persona, coupled with a close look a influences we hoped to address some of these questions.

Below is our Primary Persona:



We uncovered during the course of our project other personas of note which are worth further investigation in the future owing to their direct or indirect relationship with the primary persona and/or the solution itself. Specifically, a closer examination of the needs of a Clinician as well as a Fellow within an ultrasound department and program would be recommended. The unique nature of the roles lends itself to different requirements for our solution to truly optimize their experience. One stark example would be their reliance

on mobile devices compared to desktop solutions as well as their desire to see distinctly different information in the form of alerts and data centric dashboards.

Owing to our projects' focus on ultrasound directors we simply did not have time to focus effort on continued persona exploration for these additional user groups.

Competitive Analysis

Link to documentation

As the primary objective of our project is to improve the ultrasound device management experience for medical directors, we dived into the Mobile Device Management (MDM) problem space to obtain ideas on how these web portals and services help people manage their mobile devices. We studied the commonalities and differences in terms of features, design choices and visual layouts among three mainstream MDM tools available in the market, namely:

- 1. VMWare AirWatch
- 2. ManageEngine Mobile Device Management Plus
- 3. JAMF Now

We regularly referenced during the design process one competitor in particular, JAMF Now device dashboard (Figure 6). We were attracted to the simplicity of their for data layout and styling and pulled design inspiration from them for our initial design sketching.

The dashboard includes 'onboarding a device', device sorting, list / detail views of devices and small icons on the top left corner of each data tile to highlight devices that need attention. More detailed discussions are depicted in the later Design sections.



Figure 6. Competitive Analysis - JAMF Now device dashboard

Future Research Recommendations

Items that are specific to people new to this domain:

- Leverage the Survey for more quantitative data collection
 - Our original aspirations for the survey were to collect 10+ responses to examine, however, we were only able to collect 5. We would recommend recycling the survey in the future and leveraging it to gather more quantitative feedback. The responses that we did gather from the survey indicate that we produced a good framework for understanding the problem space, but we are left wondering "what do we not know." This is something that we believe could be resolved through more responses.
- Contextual inquiry may improve our understanding of the targeted audience
 - Conduct contextual analysis
 - Given the situation of COVID-19, we are not able to observe directors' behaviors in their clinical / office environment, so our most current assumptions and research artifacts derive from participants' descriptions during interviews, which can differ from reality.
 - Validating Scenario V2 Narratives
 - While our cognitive walk-throughs touched lightly upon the Scenario v2 model we would have preferred to have had more focused

sessions on understanding the narratives we produced and believe that there are future insights that can be derived from a more tightly focused session with industry professionals on the scenarios.

- Development of Personas V2
 - Our personas were the result of a pivot made late in our project. In their current state they lack the proper validation required to have confidence that they are indeed a sound representation of our target audience. It's also likely that additional development could provide a stronger and more robust understanding of the mindset injection that we had within the persona. Specifically related to: influences and feelings, which we believe could be used to derive unique perspectives of the design.
 - We used Director as the leading persona for our value add for our design prototype. As an outcome we discovered that a lot of the experience can be leveraged towards clinicians and nurses as well. Certain experiences for different groups of personas, on the other hand, may require the system to be more proactive than reactive. I.e. it could be more helpful to push alerts and notifications of a non-compliant record to a clinician rather than the director. Hence we recommend some research to be done there.
 - Contextual inquiry can improve the personas, given that different EMED requirements among different regions may result in additional sets of target users (i.e. International Users, Nurses, Device Administrators as well as other support roles serving as the middleman, etc.). We believe further contextual studies can help uncover all potential users that we might have missed to create more diversified and fitting experiences.

Items specific to our proposed solution:

- Understanding Key "assumptions" & developing real-world constraint models.
 - Our research was heavily speculative during the course of the project. One area that we would suggest future work is in understanding our key assumptions and developing a real-world constraint model for a solution that could more closely map to a real-world product roadmap. Some examples of such research include feasibility studies on smart badge login, how exactly should we be tracking cleaning and reprocessing of devices and probes, how can we design powerparks as part of the integrated service, device and other ultrasound appliances (*such as device cables, jel, gloves, and other feasible hygiene products*) location tracking.

• Support Ticketing System

 One of our scenario narratives that did not ultimately make it to the design focused on the idea of being able to submit support tickets quickly through the ultrasound management system. While our team did not pursue the idea within the design with any complex user flow we did ensure that we alluded to it and asked specifically during our validation sessions if this would be a worthwhile consideration for them. Overwhelming the response was "yes." However, it quickly becomes more complex as there are three potential places that a support ticket may go to, and depending on hospital guidelines and politics there may be "official" and "unofficial" ways of resolving issues. Specifically it would be good to have a better understanding of how a ticket may be submitted to the internal biomedical (bio-med) technical support teams within hospitals, in addition to local area sales representatives for hardware, and lastly to the device manufacturer themselves. This alone could represent a comprehensive product feature and we believe from our quick peek into the opportunity space that there is potential for real value-add in accounting for this aspect moving forward.

• Value of Exporting Dashboard & Data

 During the course of validation of the dashboard it was mentioned numerous times by our industry professionals that these dashboards would be incredibly useful for potentially sharing and/or included within the reports to upper management. We did not extensively study this area but it is worth calling out that in future research this could be potentially incredibly valuable for streamlining an otherwise tedious and cumbersome manual task. One thing to highlight specifically within this is how the data may be represented visually upon exporting it from the primary system into a PDF style document. Visualizations were noted as one particularly annoying area where directors would often invest time creating them to present to upper management and in doing so push off other pressing issues.

Ultrasound auxiliary equipment

 Throughout our last rounds of validation it was expressed numerous times that being able to monitor and track the system health of an ultrasound device is great, but truly only represents 1 part of the equation. To that point it would be great to explore ways in which the auxiliary equipment (gels, shelves, cables, etc...) could be included into our dashboards and alert systems to proactively help directors not only manage their devices but to further improve the internal systems.

3. Design

Design Process Overview

The design phase lasted for about 1.5 months. It involved brainstorming and sketching, low-fi wireframes, med-fi wireframes and cognitive walkthroughs. We followed the Rapid Iterative Prototyping method during this phase and there were several rounds of designs involved between initial sketching and med-fi wireframes. Validations (through stakeholder meetings and cognitive walkthroughs with end users) happened throughout the design phase which became the basis for the next round of iteration.



Low-Fi Designs

The low fidelity designs were built in Balsamiq. All the designs are available here.

Hi-Fi Designs

The Hi-Fi designs were built in sketch and made interactive using Invision.

1. Sketch Design

2. Invision Interactive Prototype

Cognitive Walkthroughs

We conducted 7 cognitive walkthrough sessions.

- 1. The first session was a group of 4 designers from SonoSite. And the second session was with the design director of Sonosite. Both these sessions were with internal stakeholders. This helped us uncover design issues from a designer point of view.
- 2. The third session was with another internal stakeholder with a sales background and has great understanding of how our design might impact end users.
- 3. The remaining 4 sessions were with external users who are directors of the Ultrasound program at their hospitals.

For each of these sessions we have asked the participants to accomplish a list of tasks that covered all the major components of our design. For each of the tasks, we asked the participants to share their thoughts on the flow and the information that was presented.

All the notes from these sessions were converted to a sticky note in Miro.com board and grouped for easy understanding.

Design Principles and Guidelines

Given the above research and artifacts, we derived the following broad design principles and specific guidelines to establish foundational theories for our team to start ideating and designing in a controlled direction:

1. Seamlessly Fit The Environment - Our solution is used by hospitals dealing with life-saving critical situations and an already overloaded technology capacity. Our solution is designed to meet our users where they are by incorporating features and behaviors in a way that people expect.

(P13: "Hospital directors may carry around an iPad or iPhone to accomplish their daily goals, such as checking their appointments or prescribing" P14: "I see values in locating ultrasound machines using a mobile device")

Guidelines:

- 1. Specifically our solution will be designed as a cloud-service solution providing access for our users no matter their location.
- 2. Additionally our solution will be designed as a web-first solution that has a responsive design capable of supporting our mobile user needs with ease.
- 1. **Efficiency Focused** Every second our solution takes away from a user doing their job is a second that could be spent saving a person's life. Our solution is focused on providing mission-critical information clearly and without distraction.

P14: Directors are super busy. Synchronicity profile on clinicians "busy, busy busy"

Guidelines:

- a. Specifically our solution will focus on developing quickly digestible dashboard data visualizations to help our users digest information without the need for multiple touchpoints.
- b. Additionally our solution will intelligently read the user's information to provide mission-critical information to them presorted to accommodate large institutional use.
- 2. Minimize Cognitive Load Our users exist in work environments flooded with things competing for their time and energy. Our solution accomplishes this by minimizing the cognitive load required to navigate by leveraging quick interactions and by optimizing on speed throughout the entire product.

P13: "Do not give doctors another login."

P11: "I need to tailor reports for different audience"

Guidelines:

- 1. Specifically our solution will rely on streamlined information across the product that doesn't require the complex navigational depth.
- 2. Additionally our solution will focus on simplified industry-standard terminology which will increase the speed at which a user can ramp up, while subsequently ease the time required over a long-period of identification.
- 3. Established Industry Standards Our solution is designed to complement our users seamlessly, empowering, protecting, and elevating their practice. Our

solution is engineered to leverage pre-configured industry standards which baseline information throughout the product.

Internal Stakeholder: "Directors have no time nor interest in mashing and play with data" Survey response: "QPass is heavy and clunky." P12: "The more things we can automate the better" P13: "Directors are not there to babysit machines. They'd rather leverage those time to treat patients" "Directors / clinicians are busy people"

Guidelines:

- a. Specifically our solution will leverage industry standards within the product to provide our users an initial opinion.
- b. Additionally our solution will auto-generate reports that sync to our industry standards to provide an initial perspective into the data collected.
- 4. **Professionally Tailored** Our solution is designed for highly skilled and trained professionals because of this our solution visual style, aesthetic design and content strategy are focused on making the experience refined, polished and tailored to their expectations. (i.e. a typical group of audience that we engaged conversations with are all equipped with 10+ years of professional medical as well as 5+ year of ultrasound training)

Guidelines:

- a. Specifically our solution will accomplish simplicity through a reductionist design perspective that brings forward only need-to-know information that helps our users accomplish their jobs.
- b. Additionally our solution will be focused on providing industry accurate terminology while leaning heavily on a neutral and official tone for communication.

Our design and Synchronicity

Sonosite has an existing product called Synchronicity which is a task management system for the clinicians. It has functionalities around Worksheet management, Ultrasound study management, and Academic Program management. One of the things that came up several times during our research was, "don't give another login to the clinicians to remember." Additionally our design strongly complements the existing functionalities of Synchronicity. Which is why our design is supposed to be built on top of the existing Synchronicity infrastructure.



Information Architecture

Major Design Pages

Device List Screen

This page lists all the ultrasound devices that have been added to the system. The primary purpose of the screen is to -

- A. Help directors to be able to make sure that their devices are healthy and have a quick glance at the system status.
- B. Help clinicians to find an appropriate device when they want to perform a study.

What a user can do on this page

- 1. Locate a device
- 2. Choose a device based on their preference
- 3. Find a device that needs attention and take appropriate actions.

Design Specs



1	Sort the list by: a. Relevance b. Distance	
2	Filter the list by: a. Pod/Department b. Status c. Probe Type available	
3	Show map (change the view to #)	
4	Image of the device	
5	List of all the probes available with the device	

6	Name of the device; Device type
7	Battery time remaining on the device
8	The current location of the device
9	The current status of the device
10	Button to go to device detail page (#)
11	Search for a device by name or device type



1	Device currently in use (blue color)
2	Device ready to use (green color)
3	Device out of service (red color)

4	Current location of the user
5	Button to hide the map
6	Option to change the floor being displayed in the map
7	Option to zoom in and out of the map

Important Design Considerations

1. **Battery Percentage** - Battery of ultrasound devices deteriorate over time. A battery at 100% might last for 45 mins when it's new and might only last for 25 mins at 100% when it gets old. In our research we found that this can be a very common situation.

"[It is important] knowing how longer this device will run and is it ready to use for what I need the device"

2. Sort by Relevance - One of the primary purposes of the page is to let users find a device when they need it. To be able to do that, they want a device that is close and also available. A device that is very close but being used by someone else, or a device available but very far might not be ideal for a user. "Sort by relevance" will take into consideration both the factors and sort the items.

"I would sort the device from most usable to least usable"

3. **Probes/Transducers** - This is one of the important considerations to decide which device to use. Not all probes are ideally suited for a specific study. For example, for a heart ultrasound study the clinician needs a device that has a Phased Transducer available with it. Not all devices support a specific kind of probes and devices which support them might not have one available at the time. Which is why it's important to display this information.

"depending on examine type I'd need to check Probes. "

"If certain machines are more cardiac or TE capability... not every one of them may have a specific type of probe"

"One of my oldest peeves - only a specific probe can be used for a certain thing"

4. Map View - Locating a device to use is one of the primary purposes of the page. Given that clinical work can often be time critical, it is important for clinicians to be able to locate the device quickly. Which is why we decided to have a map view along with the list view.

"Ideally there is a map to locate the machine (in hallways)." "If there's a map I can choose the closest one."

"....I like the concept of the map"

"There's an inherent geography in my job"

User Validation

The design for this page was very well received during all our validation sessions. Currently directors have no way to look at their devices' health. They have to go and look at individual devices which can be very time consuming. This solution can greatly reduce the efforts required in doing such tasks.

"This would be extremely helpful. Right now if someone wants to know how their machines are doing they would have to go to every machine and turn it on - it's extremely time-intensive"

Future Work

Although we received great feedback during validation on our design, there are a few components which we were not able to test well. Some future research and validation on them would help strengthen the design.

1. Map View - In the design used during the cognitive walkthrough, users struggled to understand a few components on the map view. Also, though evaluating the task users performed, we felt the need to have a more seamless experience between

map and list view. Our final design (which is above in this document) is a refinement based on those data. Future user testing on the design is recommended.

2. Sort/Filter - During the cognitive walkthrough, the sort and filter options were not functional in the design. Although we did ask the users what they might expect there. Our current designs specification lists that. But more research and user validation is recommended.

Device Detail Screen

This page shows detailed information about a particular device. This includes all the information available on the device listing screen and in addition also a utilization log of the device and actions like "Request Support" and "Run Diagnostics" The primary purpose of this screen is to:

- 1. Help directors to dig deeper into device health and utilization data.
- 2. Help directors to take actions on the device like request support.
- 3. Help directors look at the history of the device
- 4. Help directors identify compliance issues specific to a device

Design Specs



1.	Actions: a. Request Support b. Run Diagnostics	
2.	Button to open a user guide specific to this device type	
3.	Button to check for the update information	
4.	Time Filter: 24 hrs, 7 days, 1 month, Custom	
5.	Switch between list and graph view	

Important Considerations

1. **Graph View** - The primary purpose of this page is to help directors be able to look at the device utilization history and be able to look at patterns and also identify any issue with usage or compliance. The graphical view representation helps users to easily digest the information in minimal time.

"I like the timeline to know what's been going on it" "I really have wanted this device overview so I can understand the use"

User Validation

During design cognitive walkthrough, participants liked the graphical presentation of device utilization to understand the usage, issues and any patterns. One participant pointed that they would like to see the location (for ex: room no.) where the study was performed. To be able to tell if clinicians are bringing back the devices to their home location after use, they would like to be able to view the location history of the device. One other participant pointed out that they would like the capability to export the utilization log (excel and pdf).

"I can tell hospital that when you buy us a machine it gets used for 6 continuous hours a day compared to x hours in other department"

"[the system] should tell me the travel history the device"

"[I would like the] hard data export capability"

Future Work

- 1. The graph view seems to be valuable for users, but further research is recommended to know what other relevant information can be shown (like the location history).
- 2. The list view is useful for users to look at log information and studies done on the device. But some participants said that showing study information is not relevant here and they want to see it somewhere else. So, further research is recommended to explore what information is useful and relevant to show in the list view.

"I didn't think it needed image quality --- hey man I want it all somewhere, but I guess I could see what score I'm giving to a resident on an M-Turbo and see if residents are getting different scores based on different machines, but I don't think I'd expect to see it right here."

Dashboard Page

This page serves as a place to have a quick glance on how the department/hospital is doing overall. The page includes metrics and graphs on studies, Quality Assurance (QA) and Compliance. The user also has the option to create new reports (under Reports section) and then add it here on the dashboard. The primary purpose of this page is to:

- 1. Help directors have a quick glance of how their Ultrasound program is doing
- 2. Help directors know who is going great and who is slacking
- 3. Help directors understand trends in ultrasound device usage

Design Specs



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50-	50.	Dr. Vanushka Resident	55	10
40.	40-	Dr. Peter Muta Resident	46	10
20-	20-	Dr. Seti Segal Resident	30	10
10-	0-	Dr. Mat Muta Resident	26	10
Mon Tue Wed Thu Fri Sat Sun SEE MORE	Mon Tue Wed Thu Fri Sat Sun SEE MORE	SEE MORE		
	10 + ADD REPORTS			

1.	Overview a. Total studies b. People c. Studies by clinician type d. Studies by exam type	
2.	QA a. Studies by QA score b. People c. Average QA score d. QA progress: QAed educational, QAed clinical e. Late Vs Not-late QA f. Gold standard g. Interpretation as presented	
3.	Compliance a. Cleaning issues b. Return issues c. People	
4.	Filter by user group	
5.	Time filter a. 24 hours b. 7 days	

	c. Month d. Custom	
6.	Card level: Sort By	
7.	Card level: Sort Order	
8.	Export	
9.	See more button	
10.	Anchor tag: Overview, QA, Compliance	
11.	Add report	

Important Considerations

- Standardization of dashboard Per our primary persona, the target users (ultrasound directors) are busy people. The design should do a good job in making it easy for the users to get the routine task of overviewing the metrics and graphs of usage and performance. Which is why the design has a default set of metrics and graphs which are important to the users based on survey and the interview.
- 2. Allow for customization Although default dashboard is great, users might want to look at data differently based on their own situation. Which is why the design allows for creating custom reports and then has the ability to add those reports to the dashboard.

User Validation

1. Overall, participants really liked the dashboard and information shown on it was useful for them. They also liked the idea of being able to click more and slice and dice the data to suit their needs.

It's nice because a lot of this currently requires exporting to excel and running stats on.

"That's a lot of data" [in a good way]

"I think this layout is quite beautiful and go into "see more" to go in and adjust the details."

"I really like it, it doesn't feel noisy; those are pretty much the main ones."

2. The QA section on the dashboard seems to be useful for participants to help them see QA progress.

"QA progress is helpful; clinical and educational separation is good; clinical needs more attention and priority"

"I do like the education scans divided out"

3. Keeping track of cleaning an ultrasound device is a giant pain for hospitals. This seems to be valuable information for users to help them keep their devices clean and healthy, and also to encourage people in the department/hospital to follow compliance guidelines.

Future Work

1. Some participants showed their interest in having an automated notification feature for sending a notice to people who aren't compliant.

"If we could automate a notice to users to this would save me time"

"One resident is leaving it dirty - they. [admin] should receive notification immediately."

 There was a mixed response for Gold Standard data metric. So, more research is recommended to confirm if it's the right and useful information to show. Additionally it can be part of global settings where the system admin has the ability to enable to disable the Gold Standard (which would reflect both in Worksheet and Dashboard metrics). "For my colleagues in emergency medicine - who use it in billing - Then you cannot order a Gold Standard based on the models - There are payment issues. It's complex. Fee for Service."

"[I feel uncomfortable] when people say, 'are your studies official'? All of our submitted studies are billed, QAed; Be careful when comparing our studies with G/S i.e. CAT scans finding the stone; ultrasound."

Reports Page

This page has two main tabs - academic report and comprehensive report.

The academic Report tab displays the list of all the academic programs and can further look at all the worksheets and students in the program along with some high level metrics associated with the program.

The Comprehensive Report tab allows the user to create a new report from any raw data available to the system along with the ability to get routine emails or

The primary purpose of this page is to:

- 1. Help directors dive deep into data shown on the dashboard and analyze it further.
- 2. Help directors create new reports from raw data
- 3. Help directors look at saved reports (which are also available on dashboard)

Design Specs



1.	Filter by user group
2.	Time filter a. 24 hours b. 7 days c. Month d. Custom
3.	Filter
4.	Email report
5.	Save report

6.	 Breakdown by a. Exam type b. Clinician type c. QA score d. Submission Status (Late, Not Late) e. Gold standard (True or False) f. Interpretation as presented (TP, TN, FP, FN) g. Study Type (Educational or Clinical) h. Compliance Issues
7.	Graph
8.	Table

TP - True Positive

TN - True Negative

FP - False Positive

FN - False Negative

Important Considerations

Show graph and table - As there are people associated with each study done, who are responsible for maintaining and improving the quality of the ultrasound program, we decided to show a table of people with the graph. This would help directors identify people responsible for both increase and decrease in the quality of the ultrasound program.

User Validation

Due to the time constraints in this project, we were not able to do any validation on the page.

Future Work

Future work is strongly recommended for the design of the page and what the experience of creating a report, saving/exporting and adding it to the dashboard looks like.

4. Conclusion

Above we have outlined the research and design methods that we applied during the course of this project that helped us iterate and evolve our project over time. We mapped out our key findings from not only our research and speculative exploration but also our design validation studies and discussed areas that we would recommend future exploration (for both research and design) should the team at SonoSite choose to pursue this project in the future.

Even though our team was beset by the challenges of not only the Covid-19 global pandemic but the rapidly evolving social landscape we are proud of the final deliverable that we produced. It is important to provide a shoutout for the team at SonoSite that helped us along the way as we were consistently meeting with their team multiple times a week (and weekends) to help digest the domain, understand the feedback and move forward our concepts to align with their unique business to the best of our ability. Without their continued support from beginning to end this project would have not been possible.

As a final deliverable associated with our project our team produced a small marketing video that captures the essence of our capstone project in 2.5 minutes. You can find it at the link here. Please note that we rebranded the video and contents with a fake generic brand so that we do not run the risk of damaging the SonoSite brand.

In conclusion, this was a brilliant challenge for our team and a great opportunity for us to explore executing upon all of our lessons and learnings from the Human Centered Design & Engineering department at University of Washington. We hope that moving forward SonoSite is able to leverage this work to not only help inform their own concepts but further capitalize on the vision produced as a catalyst for change within their organization and see the value in applying a human centered approach to their products and services.

5. Personal Growth Statements

Everyone

How did the project help you grow as an individual and as a designer? What surprised you? What did you learn from it? What were your big "eureka" moments? How did the project stretch you and help you get out of your comfort zone?

Josh Nelson

This project was fantastic as it really did rely on the cumulative experiences of everyone in the team (sponsors team included) to drive forward and adjust to the project's externalities. Our team was regularly meeting 3-4 times a week if not multiple times a day to adjust to the challenges we faced. As a designer myself it was great to be able to stretch my legs a bit with regards to the research, where our team really had to pivot in order to meet the expectations that we had set for ourselves. The area that I found the most personal growth in was learning how to apply speculative research strategies to design concepts for real-world validation. That all said, one thing that really struck me at the end of the project is that even given the circumstances surrounding the project because our team invested so heavily in communication during the project we were still able to keep ourselves on track and make sure we all walked away feeling successful having learned something new.

Joey Wang

What I got the most out of this project is the capability to plan and execute upon a project and come up with meaningful research and design in a difficult time. We were positioned in a difficult situation for all people globally. Our team members have faced the challenges of getting stuck abroad and handling various family situations throughout the project. Less frequent face-to-face connection has made planning milestones and communication much more challenging, both technically and emotionally. Our research activities were also heavily limited by our sponsors and audience capacity, and our student team still felt a lack of real contextual experience and deep immersion on the research subject. However, we were still able to speculate and conduct some research through design activities to drive out solutions that were highly received by both our sponsor and our audience, which has been an incredible journey. Our team's motivation of getting meaningful design out and really trying to leverage the limited resources to push forward and help our target audience will be something I won't forget for a long time.

Kirti Kumari

The experience of working on this project is totally different from other projects I have worked on. For most than half of this project, I was stuck in India due to lockdown and it was challenging for me to collaborate with my teammates due to time difference and technical issues, but thanks to my teammates for their being cooperative. Despite all challenges and circumstances, we were able to achieve our target. As a UX designer, It was a great learning experience for me to collaborate with researchers and get insights which helped me to make design decisions. Other than that, It was my first experience designing a dashboard and worked on visual design from scratch. So, I learned new skills and new tools for working remotely. Given the current situation and healthcare being a challenging domain itself, I also learned how to design with minimal research insights and data available and most importantly how to drive research questions by designing.

Shreyans Gandhi

The project had its own challenges owing to the niche domain of Ultrasound along with the COVID-19 situation. But I am very happy with the final output of the project. Remote collaboration can be challenging as designers,

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Shrevans Gandhi spgandhi@uw.edu

6. Appendix

Table 1. Participants Profile

P1	MD, Assistant Professor, Pediatrics Baylor College of Medicine
P2	MD, USACS United States Acute Care Solutions
Р3	MD, Assistant Professor, Emergency Medicine KUMC- University of Kansas, Kansas City, KS
Ρ4	MD, Assistant Professor/Director Pediatric POCUS Fellowship; Baylor College of Medicine & Texas Children's Hospital
Р5	MD, MS, MBA, Vice Chief for Quality Management NY Presbyterian- Brooklyn Methodist Hospital, NY
P6	MD, Assistant Professor of Medicine Cooper University Hospital, NJ
P7	MD, Asst. Professor, Pulmonary & Critical Care Medicine KUMC- University of Kansas, Kansas City, KS
P8	MD, Assistant Professor/Director MICU Baylor College of Medicine Medical Center, Houston, TX
Р9	MD, RDMS, RDCS, RVT, Asst. Professor & Core Faculty Virginia Commonwealth University Emergency Medicine
P10	MD, Assistant Professor Critical Care Medicine Jefferson University Hospital, Philadelphia, PA
P11	MD, Director of Point of Care Ultrasound (POCUS) Inova Fairfax Hospital, VA
P12	MD, Assistant Professor of Critical Care Medicine and Emergency Medicine, University of Pittsburg, PA Director and Educator of POCUS

P13	FFSS Director of Experience Design
P14	MD, FFSS Senior VP, Chief Medical Officer Former Clinical Assistant/Associate Professor of Emergency Medicine, University of Southern California, CA

Figure 1. Demographics Questionnaires and Responses





Figure 2. Series of Focus Group Response Stickies



Figure 3. Sketches and wireframes



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