Usability Testing Report:

Common Fund Data Ecosystem Prototype Navigation Program Officer Cohort

Client: Common Fund Data Ecosystem
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interface guru.

1. Introduction

The purpose of this user study was to understand the functional types of information needed by three primary user types - Program Officers, Data Scientists and Researchers - as they interact with a data aggregation platform, the Common Fund Data Ecosystem (CFDE) project. The studies with these user types are being conducted while the user interface is being prototyped in order to inform the development of the actual user interfaces.

The first cohort to be tested are Program Officers. These users are scientists as well as administrators, so their needs, as well as their time constraints when interfacing with their projects, are unique.

To accomplish this goal, six users (five Program Officers and one Program Manager) were interviewed about:

- The ways in which they currently access data;

- How often they need to access this data;

- Which metrics imply success or failure for the projects under their purview.

After this information was gathered they were asked to interact with wireframe prototypes of a soon-to-launch website, and were tested on the ways in which it met, exceeded, or fell short of their expectations for data retrieval.

The role of emotional intelligence in user interface design

A finding that surfaced almost immediately during testing was that Program Officers (POs) do not consider themselves simply as administrators. POs reported strong familiarity with their roles, but described themselves as scientists first and administrators second. In almost every case they expressed their unique position in being able to understand the science while tracking the milestones and progress of each individual project.

An appreciation of what their role truly entails, as expressed by the design and language of this dashboard, would create a bridge of understanding for these users.

The problem with acronyms

The use of acronyms is a well-known problem across a variety of disciplines. While they do streamline the look of a page and save valuable space, the trade-off in user comprehension does not balance the positives. In testing this cohort it became apparent that even such

knowledgeable users wasted valuable time attempting to decode strings of letters, a difficulty easily resolved by spelling out the titles and providing a brief explanation instead.

The importance of time horizons and scheduling

As testing progressed it became clear that time horizons are extremely important to these users. They need to access information "in real time," which to this cohort most commonly means "weekly," or "before the meeting," as one user succinctly put it. With so many projects happening simultaneously, tracking them can become an onerous task without organizational software. Multiple tools, often purpose-built, were utilized by most POs to accomplish their goals. These commonly include spreadsheets, Slack channels, and internal monitoring via the Common Fund Data Tracker.

The importance of the "bird's-eye view"

Most users expressed great value in a "bird's-eye view" of data, with the relevant metrics for all of their projects clearly laid out before them at once. Currently most of those tested are creating their own ways of tracking these milestones using spreadsheets and other ad hoc methods.

One of the metrics most commonly cited as important to a project's success was the number of published results the project generated, as well as the number of citations by others that followed from those results.

While the inputs comprising a "bird's-eye view" may not be within the scope of this specific project, this feedback from testing helps project developers understand what POs are looking for.

Unintended consequences of data visualizations

One metric that held little intrinsic value to Program Officers is the amount of data generated by any given project.

- Since each project is unique, there is no way to truly compare the worth of its findings simply by looking at the volume of its results.

- For this reason many of the users expressed dislike for the pie charts upon first seeing them presented in the wireframe portion of the test.

- This presentation was expressed to be misleading, as projects that generated small amounts of data automatically look as if they take up "less of the pie" than those that create large amounts of data, even if the two programs are creating results of equal worth. This proved alarming to some users since it could be viewed negatively by those without the tools to properly interpret this visualization.

Wireframe presentations

When presented with the wireframes, most users were puzzled by, or actively disliked, the pie charts.

- In contrast, they found the tables and bar graphs much more useful.

- Many users immediately declared themselves comfortable with numbers, and attempted to "back out" how the numerics displayed on the prototypes had been generated.

- These attempts were often stymied by a lack of comprehensible labeling ("Uberon" and "subject" creating the most confusion), graphics and text that were not legible, and a lack of clear interactivity cues.

However, once identified, each of these challenges can be improved by a more intuitive user interface that takes into account the specific needs of Program Officers. Once implemented, this will provide them with useful data that is currently useless only because it is hidden.

Peer pressure: another reason to surface top-level numbers

Another reason to ensure that any user can easily understand the summaries on CFDE dashboards was expressed thus by a PO: "You can provide a carrot or share what one lab has done to encourage others to share. [It's] a passive-aggressive approach but sometimes [you] have to speak to them one-on-one. Reset expectations. [A] reminder that terms and conditions of their award [require] them to abide by conditions."

Support for multiple device types

As interfaces for the CFDE portal are developed, it is critical to ensure that the product will function and display properly on desktops, tablets, and mobile devices. Consumers of information often use tablets; producers of information typically use desktop/laptop computers.

2. Actionable Items

1. **Role-based dashboards** displaying information specifically relevant to a specific user type would increase user comprehension and engagement.

2. The use of **more comprehensible labeling** would increase ease of navigation for Program Officers. Certain terms, such as "Uberon" and "subject," remained unclear despite their specificity. Terms such as these require more context, e.g., "Uberon ontology."

3. Dashboard layouts should **emphasize the three most relevant functions for the user type**. Even small improvements to the layout of the dashboards would create a more intuitive interface.

4. **Consistent interactivity cues** (contextual navigation, color usage, button design, and link styling) would further enhance wayfinding, allowing users to get an expected result when interacting with different pages.

5. User orientation was often problematic, even in top navigation, pointing to a need for a **stronger persistence of navigational cues** from page to page as well as other indicators showing users where they "are" on the website (or underlying application).

6. **Improve legibility of data visualizations** and/or graphics, consistently mentioned by users as hindering the consumption of the information displayed.

7. **Provide robust cues for interactive components**, ensuring these valuable resources are put to use. Program Officers were often unsure which items on each page were interactive.

8. **Increased specificity in labeling** will increase relevance; for example, explaining context for dates on the screen.

3. Demographics

Dates of testing: June 3, 2020 - June 16, 2020

Five of the six (5/6) users tested are currently working as Program Officers. The sixth describes herself as a Program Manager, a position that requires interaction with a great deal of data as well as closely watching the progress of project milestones. Her role, however, requires as much if not more tracking than that of the other users, as reflected in her responses.

All of the users considered themselves to be very familiar with their roles. Four of those tested had been in their current position for three or more years, although the one who had fulfilled that function for the shortest time (three weeks) had an additional 13 years of previous experience at the National Cancer Institute (NCI). Despite this deep understanding, even the user with the most experience (15 years) considered himself only a nine on a scale of one to ten because "I'm always learning new things."
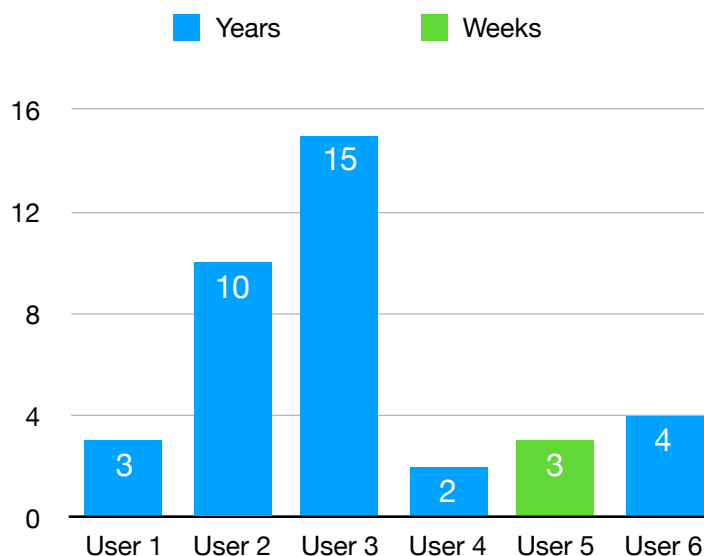
Question: Are you currently a Program Officer?

Answers:

- Users 01 - 05 - Yes

- User 06 - "[I'm a] Program Manager; I'm not an officer on any of the grants, but I do watch for milestones. I make sure [all] the components are on task and communicating."

Question: How long have you been a Program Officer?

Answers:

Question: How would you score your familiarity with this role on a scale of 1 - 10, with 10 representing the greatest familiarity?

Answers:

Users	Number	Comments
User 1	9	
User 2	10	<laughs>
User 3	9	"I'm always learning new things so I'm not at 10."
User 4	8	
User 5	8	"NCI skills are transferable. NIH policy is the same across institutes. Very similar to the CFDE, so a lot of what I picked up there works here."
User 6	7	"Vague term, we all use it in different ways."

"[I] get sinking ships back up above the surface."

4. User Specialty

The interviewed Program Officers (5/6) describe themselves as scientists with deep research interests who also happen to be administrators. Four of the six users tested had over 15 years of research experience in the biological sciences before moving into their current administrative roles.

*"A scientist and an administrator...
Must be a scientist to do the administration well."*

"As a PO I must be much broader, know who to talk to."

Question: How would you describe yourself?

Answers:

- User 01 - "A magician [doing] science management and administration...[I] get sinking ships back up above the surface."

- User 02 - "A scientist and an administrator. Must be a scientist to do the administration well. [You] must know the science to understand. Rarely are POs not scientists."

- User 02 - "As [a] PO, [I] focus on genomics. [I] get involved with a lot of data-intensive programs...I have enough expertise to be a fake expert. As a researcher, I have one focused area [Epigenetics and transcriptional translations, fundamental cell bio]. As a PO I must be much broader, know who to talk to."

- User 03 - "More scientist than [an] administrator. Despite having to do tons of administrator stuff."

- User 04 - Both.

- User 05 - Other, "Depends [on] who I'm talking to.I'd say a scientific administrator."

- User 06 - "Administrator."

Question: How long have you been in your field?

Answers:

- User 02 - 20 Years, including current role

- User 01 - 4 - 9 Years

- User 03 - 27 Years

- User 04 - 17 Years   "Genomics and biology research focus."

- User 05 - 16 Years   "Almost 14 years doing cancer proteomics at NCI."

- User 06 - N/A   "Light, non-Ph.D. scientific background. Some of us didn't go that route."

5. Comfort with Informatics

While the level of comfort with the concept of informatics varied among Program Officers, every user qualified their answer to encompass both sides of the user vs. contributor equation. The majority of those tested were adept at using the necessary tools to gather the output data, but most knew little about the process of generating the data they were using.

"I can use the tools but not generate the data."

Question: How would you rate your level of comfort with informatics, on a scale of 1 - 10?

Answers:

Users	Number	Comments
User 1		
User 2	7	
User 3	3	
User 4	8	"Eight for understanding. Six for genomics data analysis."
User 5	7	
User 6	1 or 6	"In the concept of data science or reporting tools? One for Data Science. Six for reporting tools. I can use the tools but not generate the data."

Question: What does "informatics" mean to you? What is your level of comfort with informatics?

Answers:

- User 01- "The study of stuff I just don't know; the study of understanding how information can be turned into knowledge. I'd love to learn more but I'm at such a remedial level. I'd like to be able to use the data to generate the graph. I have no idea how to get there. I know they relate, but I don't understand all the information that comes out of the CSV file."

- User 02 - "I know a lot about the research, both standard activities and where things are going, but I could never do it myself. The coding. I understand the limitations and how the tools are used but not how to generate the tools. Could use them, not generate them."

- User 03 - "For what I do, I don't need the data that much. For the data coordination center projects, I have to look at metrics, not raw data."

- User 05 - "Decent GUI [makes it] clear where to go, [is] intuitive, takes me to what I expect I'm going to see, not a lot of extraneous information that I don't want to see. I can use the tools but not develop the applications."

- User 6 - NA

6. The Importance of Time Horizons and Specific Milestones for Program Officers

All users tested stated they needed to know the status of their projects in "real time," but most further qualified this by saying that "real time" actually meant within a few days or a week. For many, tools such as dedicated Slack channels kept them apprised of the status of their projects in between official updates.

The Program Officers reported assessing their projects annually, but most expected weekly updates as well. The ability to configure the frequency of reporting would be of benefit to this cohort since each project is unique, with an individualized set of parameters and milestones.

The measure of the success of projects varies widely, but there are a number of metrics used by most Program Officers to assess the majority of their portfolios. These include tracking schedules against specific milestones such as the production of data and "counting anything that can be counted."

"Real time means within a couple of days... not right this instant."

In addition, every user tested spoke about the importance of external and internal publications, citations, and website usage as markers of how well any particular project was doing.

Question: Do you need to know the status of projects in real time?

Answers:

- User 01 - "Yes"

- User 02 - "Often no but sometimes yes. Weekly calls with [the] NCI program currently. On Slack with them to communicate [in] real-time."

- User 03 - "Yes and no. Not for the RNA program, but yes for others. For some keeping track of status is [an] important milestone. Not for others. Real time here means within a day or two, that's a fair amount of time."

- User 04 - "Real time means within a couple of days... Not right this instant."

- User 05 - "Real-time means within a day or two, but actually means before the meeting."

- User 06 - "Sometimes. Real time means almost every week. I have to know when things [are] shipped."

Question: How often are projects assessed?

"Anything you can count can be a metric."

Answers:

- User 01 - Weekly.

  "I like to know weekly where things are. When I get deliverables I do a lot of my own research. I don't like to burden the researchers with my needs... Every few months I look over project reports... EVM reports... Can see if [there is] 'underperforming or underspending.'"

- User 02 - Monthly.

  "Monthly, but it's a mix. As time goes on it switches from building to ingesting data. Goes to quarterly or less often; only if someone needs to be poked. For [the] first few years issues are on the DCC (Data Coordinating Center) side, after that issues are on the data-generation side. "

- User 03 - Daily, weekly, and monthly.

  "Depends. For extracellular RNA it's monthly or less. For Pain, it's weekly, or even daily would be good."

- User 04 - Daily.

- User 05 - Weekly, monthly, annually.

  "Every two weeks. When we talk about projects we don't always know when data was updated. But it would be useful to know that. In [a] previous job at NCI, I'd hear something at a project meeting and then those numbers wouldn't align with what would be in the database. It is problematic. [F]inancial reports connected with projects [happen] every month, annual progress reports [are] going to be more detailed so there are some things that must be detailed on an annual basis."

- User 06 - Weekly.

  "I'm always checking in on every data set to make sure where it is, where it's going, and that we've checked all the boxes to make sure it's been QC'd so we can coordinate across platforms."

Question: What triggers your need to assess a project?

Answers:

- User 01 - Schedule, funding, personnel.

  "If I anticipate a cost overrun... Or if there is extra funding coming in that I can supplement something with... If I have a concern with leadership. Or if our goals don't line up... So I can tie everything back to our goals. Do it routinely, every month. Or more often if there's a concern."

- User 02 - Schedule.

  "Annual progress reports must be done... Make some assessments then. Written into official bios of a grant."

  "If you can't measure it,
  you can't change it."

- User 03 - Other.

  "How worried you are about the potential success or failure of [the] project... We also keep track of publishing. Like counting knockout mice since the knockout mouse project was producing mice. Anything you can count can be a metric. Potential problems too: Pain Project, in this time of COVID... Will people want to be recruited? If you can't measure it, you can't change it."

- User 04 - Schedule, funding, personnel.

  "When new things happen in a program we check. And there is routine monitoring."

- User 05 - Schedule, funding.

  "Every two weeks. When we talk about projects we don't always know when data was updated. But it would be useful to know that. In [a] previous job at NCI, I'd hear something at a project meeting and then those numbers wouldn't align with what would be in the database. It is problematic. [F]inancial reports connected with projects [happen] every month, annual progress reports [are] going to be more detailed so there are some things that must be detailed on an annual basis."

- User 06 - Weekly.

  "I'm always checking in on every data set to make sure where it is, where it's going, and that we've checked all the boxes to make sure it's been QC'd so we can coordinate across platforms."

Question: What triggers your need to look for specific data points about a project?

Answers:

- User 01 - "If there are any dependencies on a project. Can [I] see this on GitHub?"

- User 05 - "Congressional inquiry, if [the] NIH director asks about status, or [the] Council of Councils. [It] could be out of sync with the other timelines. [If] the numbers weren't updated, the links were broken, the numbers didn't look right."

7. Frequently Utilized Management Tools

In general Program Officers are relying upon their own expertise to create management tools for themselves using spreadsheets such as Google Sheets or Excel. The milestones used to measure the success of each project vary, but the need to track them consistently against their metrics remains constant.

The Common Fund Data Tracker was given high marks by users, who relied upon it to chart many projects at once. The fact that this tool can be used to share progress and data among interested parties while restricting viewing invitations to only the cohort for which it is initially intended is also of value.

"Usually the submissions of data are Google Docs. A written narrative."

A feature that would allow users to chart how many times a given project had been cited or had its data accessed by the broader research community would also have great value to Program Officers. Currently there is no coordinated way to view this information despite the fact that POs repeatedly said they use these metrics to help justify funding for their projects. The quality and prestige of the publications in which cited research appears is a further useful dimension that these users are now tracking by hand.

**Question:** What types of software or online tools do you use most frequently?

Answers:

"I like to use shame as a weapon and if you see data points plotted over time you can see who is doing a good job and who is doing good work"

- User 01 - "Don't use it much. In the past [I] have used Hive or Microsoft Project or FileMaker Pro (easier than Access). For this project [I'm] not tracking as many projects or milestones so [I] use Excel."

- User 01 - "Github [is the] first place I look. Google Docs."

- User 02 - "Track manually, data coordinating sites for projects, download statistics from DCC sites. Usually the submissions of data are Google Docs. A written narrative."

- User 03 - "We use Excel... It's written but in an Excel spreadsheet in some way. No graphs, no charts, just numbers. It would be nice to see more clearly the change from this report to that report, that might be better in a graph."

- User 03 - "PubMed... Often we want to see a set of specific data points over time. I like to use shame as a weapon and if you see data points plotted over time you can see who is doing a good job and who is doing good work..[I use] NIH internal resources that keep track of grants. QER is the name of this."

- User 03 - "I do think that sharing with data producers is of great value. They are all competitive people and if they can see that they aren't the number one data producer they will want to produce more without me pinging them."

> *"On a scale of 1 - 10, Data Tracker is an 8. Incredibly useful."*

- User 04 - "Impact 2, analysis tools developed by the NIH. [These] meet my needs... Covers a wide spectrum of needs."

- User 05 - "Google Analytics, Excel."

- User 06 - "Data tracker built by CF, Slack [for parallel convos about Data Tracker], email, Excel, Google Analytics. On a scale of 1 - 10, Data Tracker is an 8. Incredibly useful. What's missing right now is custom alerts for me. Like if someone uploads a file that I need to see right away. There are 39 projects. [We need a] really efficient way of labeling so that we can all filter and see what we're looking for."

- User 06 - "If there's a visualization in Data Tracker I haven't used it yet... Oh, they do have ACTION. It tells you what's missing. I didn't even know. Typically looking at one file at a time when I'm in Data Tracker. On [the] Data Tracker screen I look at STUDY DESCRIPTION first. LAST UPDATED second. We all know we're working on the same thing because of the versioning. Data Tracker enables all the right people to be able to look at the right file. I start with STUDIES, [then] look by keywords."

Below, examples of a software application commonly used by Program Officers (Common Fund Data Tracker) showing how a cluttered field of view can impede even robust functionality. The user who employed this application during testing did not realize there was additional, significant functionality in the ACTIONS column.
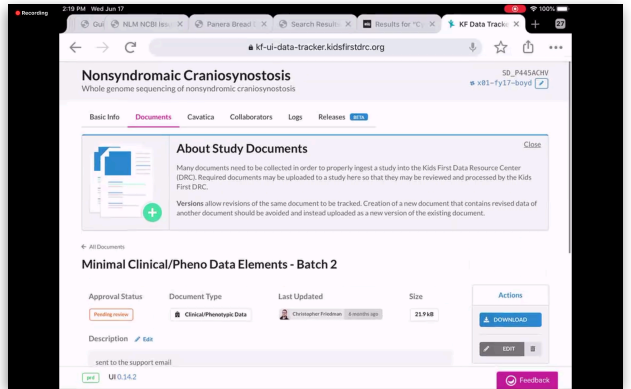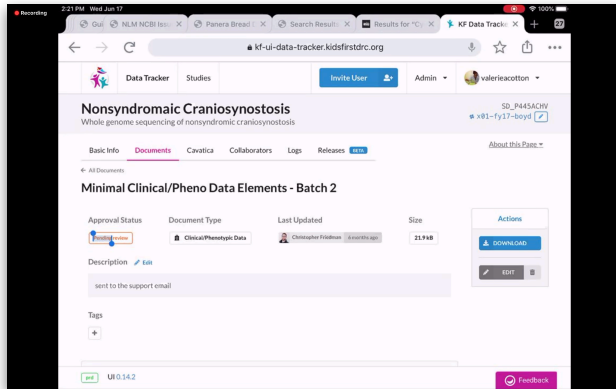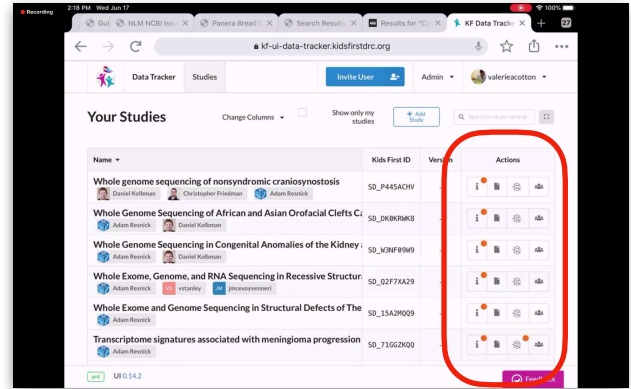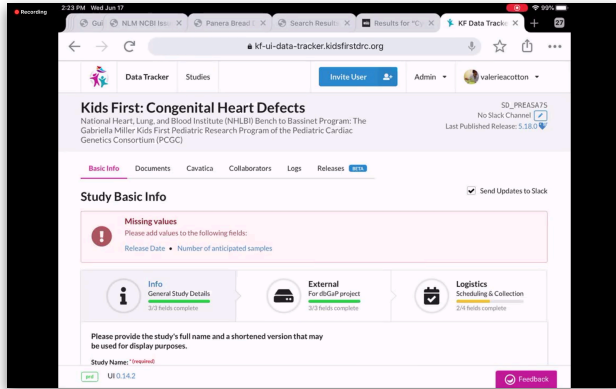
Question: How do you know when someone has used the data?

Answers:

- User 02 - "The only way to know what someone has done with the data is if they cite appropriately when they publish. Not [currently] tracking the data in preprint servers, but probably should be. Has its own preprint channel."

"Visitors to [the web] site is a measurement of success"

- User 05 - "Visitors to [the web] site is a measurement of success, the maps of where the users are coming from is nice, and which web pages within the site are getting the most visits. I would look at it by time, especially if we did a press release or released a new dataset, that's always nice to see if there's a spike in users. We would have an email blast to [alert people that the data was up.] [I] would hope that the information would travel beyond the email list. Hard to tell if it does. [I] Had an email list of 2000 people, international, but we don't follow that closely to see who checks it out. The PI of the DCC should know how many people are using their data."

- User 05 - "Would download and look at that. This was a pipeline project. Lots of samples, look at that. We are looking for quantifiable data, but also user experience."

"More information is better than less. It is optimal."

- User 06 - "Google Analytics maps of where users are coming from, most visits, time, [of usage] e.g. does upload of new data set trigger more usage? I should know."

Question: Do you use one resource for extended periods of time/ use multiple resources for short durations / other?

Answers:

- User 01 - "Coffee pot several times an hour and [I] always have email running in [the] background... Always have shared folders open... [I] work remotely. CTU problems can arise. [I] always [use] Google Docs and Excel, also Word, and of course now, Zoom. I like multitasking, used to having a lot of input. More information is better than less. It is optimal."

- User 02 - "Multiple. Short, longterm, medium."

- User 04 - "Multiple resources for a short duration."

- User 05 - "Extended periods - I get set in my ways... If something works I keep using it. I'm not an early adopter."

"Looking at hundreds of grants at once."

- User 06 - "Extended [periods] - [The] most useful feature of Data Tracker is [the] project repository. The way they are tagged. I'm familiar with the icons so I know what they mean.

Question: What file formats are most useful?

Answers:

- User 02 - "[I] download sometimes. [I] use internal NIH tools. Usually for looking at groups of projects, not single projects. Looking at hundreds of grants at once. Often Excel files. [I] utilize Excel, but [am] comfortable using others."

8. Assessment, Characterization, & Justification of Programs

Given that there are so many ways to measure the success of any given project, and that the timelines and milestones are so disparate, it makes sense that this cohort values the idea of a single dashboard upon which to view all of their projects at once. Several also broached the idea of a "tickler" that would serve as a reminder when certain tasks needed to be performed or people queried.

And yet an even more helpful tool would be any way to more accurately measure the ways in which generated data is cited, used, and circulated. These users are devoted to the idea that Common Fund data is intended to serve the greater community, and would like to see how this plays out in practice, a metric that would in turn help to justify their programs.

"The best way to get more money is to show what you've done."

Question: What metrics, analytics, or tools would help you best assess your program's status?

Answers:

- User 01 - "Tickler system for when deliverables are due would be very helpful. And a tickler system for when things are due but they haven't responded. Ideally, everyone would trace back to goals and objectives. The best way to get more money is to show what you've done. Enforce a traceability matrix, [that] would be helpful. I know how much we are planning to spend so I know the metric of the funding plan. I adopt what I get to my nomenclature."

  "A better way of tracking data usage beyond downloads would be great."

- User 02 - "A better way of tracking data usage beyond downloads would be great. That's a major challenge." But then, "there's also the people who go to the site and look at one gene and now have an idea. [They] don't use a big bolus of data but use small bits to confirm a hypothesis. Really hard to capture [this usage of data], if not impossible."

- User 03 - "The number of things counted. And the number of publications to date. Also the number of prestigious publications, Nature, etc. Patients recruited, etc. Number of knockout mice produced, etc."

- User 04 - "Gantt chart from the external investigators."

- User 05 - "Number of users, amount of data downloaded, amount of data available, which datasets are downloaded most frequently."

"I find [the] complaints very useful. And the nature of the complaints."

Question: What metrics, analytics, or tools would help you best characterize your program?

Answers:

- User 01 - "Who's using the resource, what they've found useful, what they haven't found useful... I find [the] complaints very useful. And the nature of the complaints. If someone repeatedly can't do what they're trying to do. [It] can be an end user or a data contributor. Is it a clinician trying to use the resource? A clinical trial testing a drug? Ideally, we'd have a system for them to register if they are a biostatistician, or a postdoc, or a clinician, etc. [I] wanted to leave it open to the user to see if they wanted to tell us. [It] would be helpful to have but don't want to discourage users."

"If it's a community program you want the program to benefit the community."

- User 02 - "Metrics around data reuse is a major goal for many Common Fund programs. It shouldn't benefit just the people who are funded. Should benefit the broader community. Seeing how people utilize protocols would be a benefit."

"We hand-curate most things."

Question: What types of metrics, analytics, or tools would help you justify your program's funding?

Answers:

- User 01 - "Progress toward goals, if there are any tangents towards things... document the tangent. Rational on why we weren't able to fix a problem? Did we spend what we thought

we would spend where we thought we would spend it? Don't know until I get there and think that would be a nice metric."

- User 01 - "Would love to see a dashboard that would have my projects... about a dozen projects... With how much funding is left, what are the resources left? Who are the key personnel? When are the key personnel on vacation, emails for key personnel, a to-do list to click when something was done that would automatically email a person as something was done, a calendar that would show me my next 14 months."

"What they [senior leaders] want, really, is anecdotes of scientific successes."

- User 02 - "My experience with senior leaders is that these metrics are nice and important to have, but what they want, really, is anecdotes of scientific successes. Could be a cool thing that came out of funding the research. If you spent 30 million dollars I would hope you'd have that. But a cool thing would be to show that someone else used the data and made a great scientific finding. [We] don't really gather those stories now. We hand-curate most things."

- User 03 - "I have to do this often - [a] dashboard of publications from the project, I always have a slide to track this... [And the] quality of the publications (*Cell Science*, *Neuron*, *Nature*), but different projects require different ways to justify them. [Usually the] number of citations of works. Publications that have used the data or resources generated by the program but are not funded by the program. If it's a community program you want the program to benefit the community.

"There's no optimal way to justify a program as a template. Each program is different."

Also, [the] top three cool findings to convince an institute director... that the program is worthwhile."

- User 04 - "It's manageable. Not optimal. There's no optimal way to justify a program as a template. Each program is different. It's challenging to make that matrix to assess the program, but once it's made it's not difficult to follow."

- User 05 - "Number of users, amount of data downloaded, amount of data available, which datasets are downloaded most frequently? Now that we're in the cloud it would be good to see how many people access it since it isn't being downloaded so much anymore."

Question: What is the most difficult part of finding this information?

Answers:

- User 02 - "How many datasets are generated, we should know what's going on, but the further out step of finding the 'really cool things' they did with that data. We can have metrics of downloading, citing the data, but that last bit has to be done by hand, probably no matter what. But if you could find that out better, the final step becomes easier."

Question: Is there a way to encourage people who download data, other than saying it would be nice if you cited us?

Answers:

- User 02 - "Yes, I could envision hackathons, challenges, to build a community of people who are using the data. I could totally see that with the CFDE. Connecting those, how we connect them, what the challenges are. Could see that as a nice hackathon."

Question: Of the online resources, you currently use to assess the status of a project, which one best meets your needs for completeness, accuracy, and timeliness?

Answers:

- User 01 - "My Excel file or my FileMaker Pro. My personal set-up. Has my EDM"

Question: Of the online resources, you currently use to assess the status of a project, which one is easiest to use?

Answers:

- User 01 - "Shared drives typically... NIH has made a move to a really clunky thing called Box, which I hate... Google Drives were taken away but they were great... They were accessible. I could get it from my phone, from my computer, from anywhere I am. Now [I have] to go down to [the] basement and log in. My son has stolen my iPad from me. It would be easy to look at it on that, but my phone is the next best thing. It was great to not have to be on VPN to access Google Docs."

- User 02 - "Nothing comes to mind."

- User 04 - "A checklist for program staff. That's what we use."

- User 05 - "Google Analytics - Not sure if others use it, but I would think so."

Question: How are you currently accessing historical project information?

Answers:

- User 03 - "Poorly... Usually [I] have to go find it... Usually at a data coordination center or at a SharePoint site."

- User 04 - "We need to do this analysis a lot. [We] need to see past procurement for a program to initiate [the] analysis. [We] have internal systems to get the information but also it's public."

- User 04 - "They are always trying to optimize the information on their side so it changes."

- User 05 - "I guess I [do], but through my own files."

- User 06 - "Yes, sometimes. dbGaP. Data Tracker. Otherwise, [we] have to get it through secured email and that takes forever."

Question: How would you like to access historical project information?

Answers:

- User 02 - "That's usually restricted information."

Question: Do you download data sets?

Answers:

- User 02 - "No"

Question: Do you upload data sets?

Answers:

- User 02 - "Yes"

"If [it were] all in one place you'd have to worry less about people coming and going and so losing information through attrition."

Question: Given the resources you are using today, if I gave you a magic wand, what would your ideal one-stop solution look like?

Answers:

- User 02 - "Something like Slack can be particularly valuable in the early days... [Slack] can be more efficient than sending a bunch of emails. Some dashboard of data sets. If you had an idea of when you expected someone to submit data. Hard to know when someone is late. Science moves at the speed that science moves at. For example, tissue collection for a proteomic study of tumors is coming from several places. [S]o having a dashboard that showed how those were moving through the system would be helpful. Schedule and time would be nice to see."

- User 03 - "Be great if it was all in one place, of course. If [it were] all in one place you'd have to worry less about people coming and going and so losing information through attrition. Not that information leaves with them but that the knowledge of where the information lives is lost."

- User 04 - "I don't think there's a wand. It's out of my imagination, I think. <laughs> I don't know."
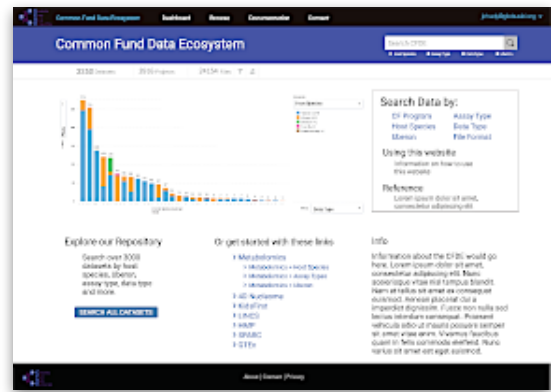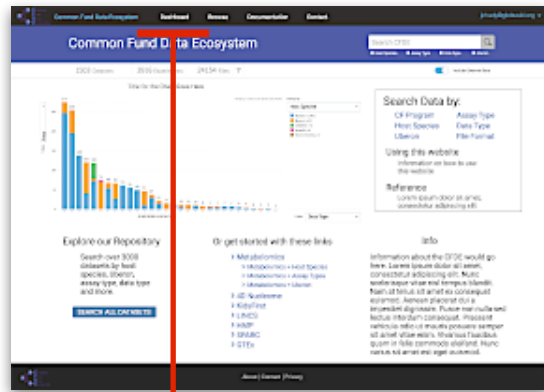
9. Program Officer Impressions of CFDE Wireframes

User response to the CFDE portal prototypes was mixed, with users reporting initially that they understood the interface yet later finding that its behavior and functionality was unclear.
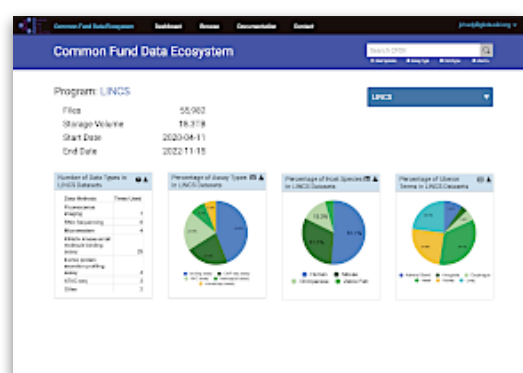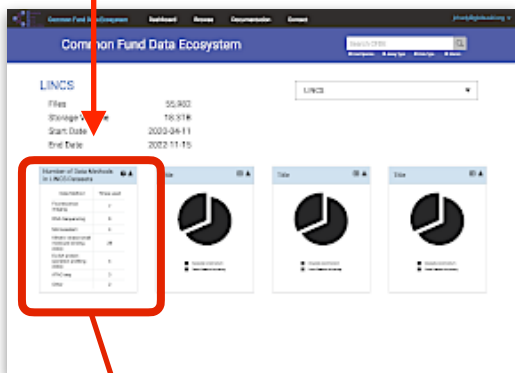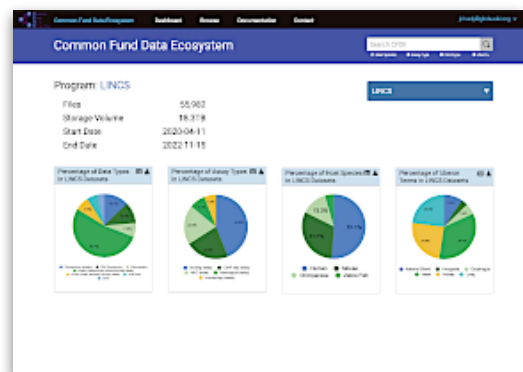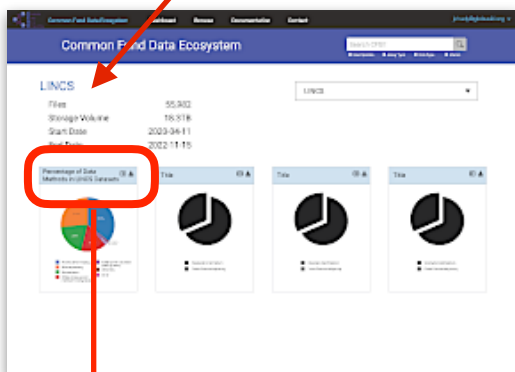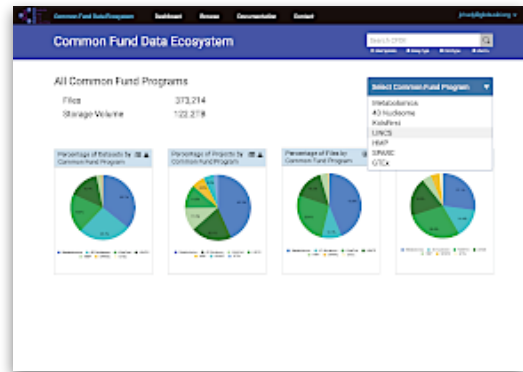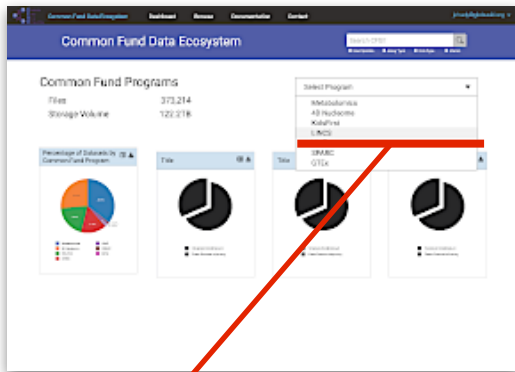
- Every Program Officer tested had a negative or at least skeptical reaction to the pie charts upon first viewing. Only one user understood the toggle icons at the top of each pie chart.

- Since POs are heavy users of spreadsheets, their responses were more positive when encountering tables and bar graphs, and upon closer examination of the data provided. Legibility issues, clashing colors, and unclear labeling further clouded user orientation, but most users expressed a desire to interact with the data despite these limitations.

- Users immediately tried to validate the numbers they were seeing. The toggle between the pie-chart view and the table view of data was unhelpful, since users had to remember the percentages they saw in the pie chart in order to compare them to the table.

- Further clarification of terms, fully explicated acronyms, action-oriented language, and a more intuitive layout would alleviate much of the confusion.

Visual Reference

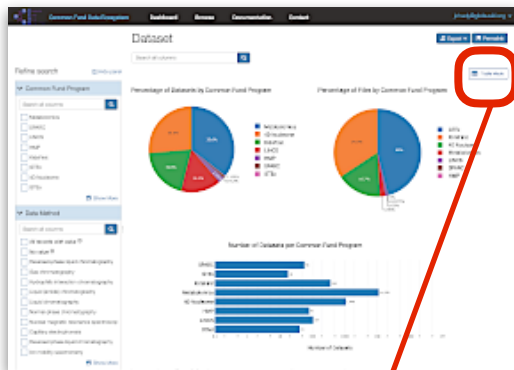Initial Wireframes   Revised Wireframes

Most user did not perceive past this point
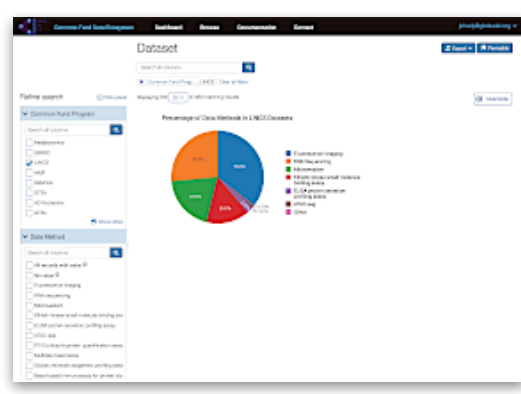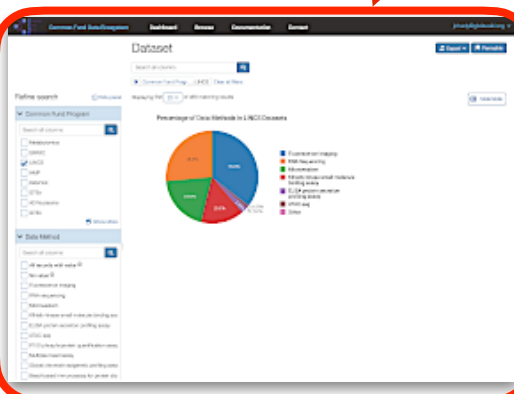
CFDE wireframes affordance - 1 landing page

Question: What is your initial impression of this screen?

"I'm annoyed I can't see the little numbers on the top of the bar graphs. And I can't read the labels on the axis."

Answers:

- User 01 - "I want to look more at it."

- User 02 - "I like it, nicely spaced."

- User 03 - "I'm annoyed I can't see the little numbers on the top of the bar graphs. And I can't read the labels on the axis."

- User 04 - "I'd like to increase the font. To make the graph more clearly labeled. It's very helpful the labels [show] how many datasets there are, [and] how many files there are."

- User 05 - "There's a graph, a chart."

- User 06 - "What is that table?"

Question: Where did your eye start on this screen?

Answers:

- User 01 - "The chart."

- User 02 - "Bar graph - I like that. It suggests we are doing something right since ours looks like this."

- User 03 - "First couple of blue bars on the left."

- User 05 - "Graph."

- User 06 - "The chart."

Question: What three items did you notice after that?

Answers:

- User 01 - 1: Info box, 2: SEARCH DATA BY, 3: datasets at the top (the numbers).

- User 02 - 1: Outline around the box, 2: Links, 3: "Less interested in [a] block of text.

- User 03 - 1: Header, 2: "I didn't notice anything else."

- User 04 - 1: Blue bar, 2: Graph, 3: EXPLORE OUR REPOSITORY.

- User 05 - 1: EXPLORE OUR REPOSITORY, 2: GET STARTED WITH THESE LINKS, 3: GROUP BY HOST SPECIES, "but the print is pretty small."

- User 06 - 1: EXPLORE OUR REPOSITORY, 2: SEARCH ALL DATASETS, 3: "I wanna press that button."

Question: What do you think you can do here?

Answers:

"There are already ways to look at things by project. [I] would rather look across them."

- User 01 - "Filter by assay, data types. The search bar tells me that. There is SEARCH BY too, but I'd just use the search box. [I] think it would open a new window."

- User 02 - "[I] could look at different data sets from different Common Fund programs. Can't see what's on the X-axis of the graph, but it's for different types of data sets is what I'm inferring, but I guess it's just a mockup. I would guess someone would start engaging by clicking SEARCH DATA BY or by individual programs. Doing it by Common Fund Program would be less interesting than by species, assay, etc. Other filters, then [the] program would be more interesting. My idea of this is to link across programs. Nothing on this screen makes me think that this is a comparison. But what do you mean by compare? [I] would like to see this by data type rather than by program. Simplest [way] would be to search by other things first, not have CF first. There are already ways to look at things by project. [I] would rather look across them."

- User 03 - "Count datasets from the different Common Fund programs of host species, because I can see 'host species' on the screen."

- User 04 - "Define data type, human data by age, group, blah blah."

"I don't know what Uberon is?"

- User 05 - "I'm trying to read the X-axis. Oh, more labels would go here. <laughs> I think it's files available per program."

- User 06 - "Search through a list of datasets after posting the SEARCH ALL DATA SET button."

Question: Is there anything on the screen you'd like to mention?

Answers:

"I always want to have an overview."

- User 02 - "I don't know what Uberon is?"

- User 03 - "Oh, I see. It does have a 'Search data by.' I didn't see it before because the graph totally sucked my brain in. I don't expect to interact with the graph. But I'm visual, so I went to the visual thing first. I went to the left because I read left to right. If you want people to use the search box maybe put it on the left."

- User 04 - "SEARCH DATA BY. Is [it] help a help desk? I think I could interact with data sets. And I just noticed the dashboard at the very top. I always want to have an overview. What kind of resources? I'm curious about this. <She is the first person to mention this> I'm currently on the CFDE homepage. On [the] dashboard, I'd hope to see an overview of this ecosystem. I'd like to see, like, how many human genomes you have? Or what kind of data sets you can see here? There are different consent rules about humans. So it's complicated. But hopefully, you'd be directed to that link."

"I think it's an entry point to see Common Fund program data. It would be nice if it said that explicitly somewhere though."

- User 05 - "Info text. That's a lot of text! I'm only going to read that if I need to."

- User 06 - "I wish the buttons were prettier. They don't look super friendly to click [on], but I think you could. I understand host species... Uberon, I believe that is about body region? An ology?"

- User 06 - "I'm kind of cognizant of seeing that CF everywhere, so I guess it's a Common Fund site. I think it's an entry point to see Common Fund program data. It would be nice if it said that explicitly somewhere though."

CFDE wireframes affordance - 2 dashboard

Question: What is your initial impression of this screen?

Answers:

- User 01 - "Not terribly informative. If I could click on the pie chart and drill down, that would be good. The little box may have the underlying data associated with it. It would have the data that comprised the pie chart. I find pie charts hard sometimes, to figure out the details [that are] available. Not sure how informative it would be for frequent users."

- User 02 - "[It's] How different programs are divided."

- User 04 - "My feeling is if I could interact with this page? Too small to read. This is helpful, but not THAT helpful."

"What is the value? What is a subject?"

- User 06 - "I'm not sure what the percentage means? I guess, I don't know what data sets mean there? But are we talking about released data sets? What is the value? What is a subject?"

Question: Where did your eye start on this screen?

Answers:

- User 01 - "Colorful pie charts."

- User 02 - "Four pie graphs."

- User 04 - "How many files?"

- User 05 - "Pie charts."

Question: What three items did you notice after that?

Answers:

- User 01 - 1: The B&W pie chart, 2: "The numbers at the top. Not sure if this info is worth this whole page. Numbers aren't saying much."

- User 02 - "Trying to understand what they are? Move through them, first, second, etc."

- User 04 - 1: Select Common Fund Program button <first to see this>, 2: Pie charts.

- User 05 - 1: TOTAL STORAGE, 2: charts "to see what they're showing," 3: drop-down menu.

Question: What do you think you can do here?

Answers:

- User 02 - "I don't know? I guess there's a little download thing, then a place maybe you can change the graph type. I don't know what this screen is for?"

- User 04 - "If you can click in and see what kind of data is inside? As a PO, I care about this data, but from a researcher POV I don't know if they care, they care what they can do with data types. If it will direct me to somewhere with more details, that would be helpful."

- User 05 - "Access metrics about CF data, filter it by [the] program... Metrics are in the titles of the pie charts."

CFDE wireframes affordance - 3 dashboard with data table

Question: What is your initial impression of this screen?

Answers:

"I like tables. I'm very sensitive to numbers."

- User 01 - "Could be the data from the colorful pie chart. I would be inclined to add up the data sets and numbers... To check the numbers... Verify the [pie chart] numbers and... Because there's no sums, no percentages listed beside the numbers. It's not that the pie charts are less helpful, it's that a percentage doesn't tell me how many, it tells me how much of 100% it is. R[ight] justification for the numbers table would make it really easy to show the data. The question is how many data sets are in there?"

- User 02 - "Total number of data set by each program."

- User 03 - "I don't like the colors. I think the colors [in the pie chart] need more contrast."

- User 04 - "I like tables. I'm very sensitive to numbers. Does the download button mean all the data? The download would maybe be the pie chart. I guess it's the pie chart. Or [a] table? That's my impression. Or maybe it's both?"

- User 05 - "Looks similar to the previous ones... Pretty similar to the previous one, but we do have a table. It's easier to get raw numbers from this table. As opposed to looking at the percentage. I kinda like the raw numbers better. It's more intuitive. I know how to get the percentage if I need it. But I could always back out the raw numbers from the percentages given the number of files."

"The percentage of datasets by Common Fund Program is a scary one. I hope they don't make their funding decisions based on that."

Question: Where did your eye start first?

Answers:

- User 02 - "The chart first."

- User 03 - "Those are cool numbers to have. The percentage of datasets by Common Fund Program is a scary one. I hope they don't make their funding decisions based on that. Some programs will have a lot of data and another will have less data. One might be more successful, but it might just be designed to produce more data. Some are designed to make more technology. I think it's valuable information, but I think it's possible that what is done with information could be troublesome."

Question: What three items did you notice after that?

Answers:

- User 02 - 1: Percentages - "I don't know what the first pie graph is showing? I have no idea what 'Project' means? I have no idea why you would say a number of funded groups?" 2: Subjects - "I'm guessing this is a compilation, to use some kind of common language about samples. Some are people, some are cell lines? 'Subjects' probably cover both cell lines and individual patients. The term is not clear to me. Could have a definition of what was meant here. The terminology is going to be challenging - You don't want to call a human a sample. Subject does NOT mean topic."

- User 03 - "The next three pie charts... Not sure what these mean?"

Question: What do you think you can do here?

Answers:

- User 03 - "I think I could use these to see similar goals. That's about it."

- User 05 - NOTE: Did NOT notice the icons above the pie charts. "But after seeing it change to a table, and the other to download, I assume the size of what I'm downloading would be pretty small. I think it would be a CSV file or an Excel file that would look an awful lot like that table."

- User 05 - "Same as the previous screen. Total programs available and which the data comes from."

- User 05 - "Can't tell the timeliness of this data. It would be nice if there was a time stamp on the corner of the screen to know when the data was most recently updated."

CFDE wireframes affordance - 4 dashboard

Question: Do you have comments on this screen?

Answers:

- User 03 - "Same thing about the colors, [I don't like them.] I kinda like the table, maybe because I'm used to Excel spreadsheets.The bottom part of the pie charts is almost impossible for me to read."

- User 04 - "Focus on the Common Fund program. On the right, there are seven different programs I can seek records to."

Question: Where did your eye start on this screen?

Answers:

- User 02 - "Dropdown menu."

Question: What three items did you notice after that?

Answers:

- User 02 - "Dropdown menu... I did notice the control before. [Then] pie charts... I would expect the pie charts to only show LINCS but then they would all be 100% so what use would that be?"

Question: What do you think you can do here?

Answers:

- User 03 - "Might expect to be able to click on the pie chart, get more information. I imagine [they] are clickable?" After icons are pointed out, "maybe the little window thing takes you to a spreadsheet? The other looks like a pawn, [or] a chess piece. Not sure what the other controls might do?"

"The ability to compare is something I would -definitely want."

CFDE wireframes affordance - 5 select program

Question: Now that you have seen some other screens, do you have comments on this screen?

Answers:

- User 01 - "Gives the user the opportunity to drill down. I would assume it would show some information about links on this screen. It wouldn't be intuitive with a drop-down... The ability to compare is something I would definitely want."

- User 02 - "This is not what I would expect. It's totally different. The pie graphs are totally different. I would expect if you had everything on the first page that you would drill down more into that. The percentage of total data sets is now the percentage of different types of data sets? I guess. Maybe. I don't know?"

- User 03 - "Same ol', same ol'."

- User 04 - "This is specifically LINCS."

"That's an abomination to cover data."

Question: Where did your eye start on the screen?

Answers:

- User 04 - "Program: LINCS"

Question: What three items did you notice after that?

Answers:

- User 04 - "1: The number of files, 2: details of pie charts. Data type, species type."

Question: What do you think you can do here?

Answers:

- User 03 - "Now, I kinda like it if you could click on the program of interest. That's an abomination to cover data."

"I don't think everyone knows what LINCS is, though. [It] would be better to put the full name there."

- User 04 - "This is helpful to me [in] doing my role... I don't think everyone knows what LINCS is, though. [It] would be better to put the full name there. Give more space for the name of the program and have a full description of what type of program. It would be more helpful."

CFDE wireframes affordance - 6 LINCS dashboard

Question: Now that you have seen some other screens, do you have comments on this screen?

Answers:

- User 01 - "I would guess [that] these are immunological, chemical tests, [or] something like this? Most useful component is what's used to generate data sets."

- User 03 - "Dates for when the program started and ended, that's a plus. You can know if the program stopped."

- User 04 - "I like the table. It's very good for me. Could create more space for tables and pie charts if the first page had the full name of the program. I don't understand the 'Times Used'? Oh, maybe it means used by researchers to search in the system. But would that matter? I don't know? I think most are external researchers. I think this system is for researchers. I don't know if they are interested in this kind of stuff? We are, sure. But I don't know if [the] researchers are? Could distinguish external vs. internal users?"

- User 05 - "It looks like the small print under the pie charts is more important, and it's different from what it was previously. I don't know what the start date and end date are?

First pie chart is types of data, how it was produced? Second is assay. Third is species. Fourth... I'm not familiar with that term, 'Uberon?' This is helpful, it gives a good snapshot. The most important number is files. What you don't have is the number of samples? When I'm looking at it, I'd want to know how many samples it's coming from? How many cell lines? It would be nice to use that."

Question: What would you do next to continue assessing the status of a project?

Answers:

- User 02 - "Seeing different labs, seeing different information could be useful in this format. I guess Uberon is some sort of semantics language. Seeing different tissue types could be interesting. I guess the navigation doesn't seem intuitive... Showing different things."

Question: Where did your eye start on this screen?

Answers:

- User 01 - "I like the numbers showing how many files. But, I don't know what the start and end dates mean. Can't be the start and end of the data collection."

- User 03 - "Looking at the pie charts, information is too small to read, some of it way too small. But the page, in general, is not too cluttered, there's not too much crap on it. So, that's good."

Question: What do you think you can do here?

Answers:

"I know what all these acronyms stand for but most people don't."

- User 03 - "These things are all okay, but I'd rather see publications. [I] Usually go to PubMed or QVR. [I] Would like to see how many, which are high profile, how many citations they have. High profile equals impact. [I] would like to see all pubs that used LINCS data and all that are not funded by them. That would be particularly of interest because you wouldn't have a lot of pubs using the data until later. But we could measure the impact of the data during a much longer time frame which we don't usually do but is important to do."

- User 03 - "[A] problem with many CF programs is that the common scientific masses don't know about it so they won't use the data. Orienting, brief text would be helpful. I know

what all these acronyms stand for but most people don't. It depends on what your audience is. I would define better what you're going to get when you're on the pages with the links. Even all other POs don't know what these mean."

- User 04 - "I wouldn't expect the number of people accessing this information to be on this chart, but usage statistics could go here. It is important."

- User 05 - "[It] would be nice to see compatibility with datasets from other programs. We're trying to make datasets interoperable with each other. So if there was a heuristic that said yeah, LINCS cell lines data is interoperable - harmonized - with other datasets. How much of the LINCS data is in the harmonization pipeline?"

CFDE wireframes affordance - 7 LINCS dashboard with data table

Question: What would you do next to continue assessing the status of a project?

Answers:

- User 01 - "[It] would be good to have information boxes. Explanations. Going to get a lot of biochemists that use this, in general clinicians will use this, but I have no idea. It would be good to have explanations. Right justified numbers would be helpful. Would like to have an option to go to all other data sets."

- User 02 - "Chart provides some useful context to the numbers. As to who is the audience for the information I don't know - I mean, I don't know?"

> *"I don't find pie charts useful."*

Question: What do you think you can do here?

Answers:

- User 01 - "To me, a really useful way to use this screen space would be a way to see how often this method has been used? The pie chart could break that down. Yes, the pieces would be related to the LINCS dataset. If I'm shopping at Best Buy [and] it says 'compare this item' and it gives you some kind of side-by-side table... For me I like tables. It would be useful to compare all of the projects. Have 13 of them currently."

CFDE Wireframes Affordance - 8 LINCS dashboard

Question: Now that you have seen some other screens, do you have comments on this screen?

Answers:

- User 02 - "This dataset is a way of creating a shopping cart for the data you want to analyze. Whatever the CFE has is listed here. I can select, deselect. [It] Tells me how many records there. I have seen this kind of dataset before. I did not notice the control until you pointed it out."

CFDE wireframes affordance - 9 LINCS dashboard

Question: Now that you have seen some other screens, do you have comments on this screen?

Answers:

- User 02 - "This does not seem that useful. Seeing these percentages, I don't know what that tells me? The audience is probably people who would download and analyze those data sets."

CFDE wireframes affordance - 10 LINCS dashboard

Question: Now that you have seen some other screens, do you have comments on this screen?

Answers:

- User 02 - "I think this is useful but, I wouldn't use this for assessing projects. But it would be useful for people who wanted to use the data."

CFDE wireframes affordance - 11 LINCS dashboard

Question: Now that you have seen some other screens, do you have comments on this screen?

Answers:

- User 02 - "I don't find pie charts useful."

Question: What 3 things would you like on a dashboard?

Answers:

- User 02 - "It depends... I'd like to see where things are deviating from timelines. But I don't know if that's really appropriate for this. This is downstream of that. So, it's not really tracking the progress of the individual programs."

Question: If given a magic wand, what would you like?
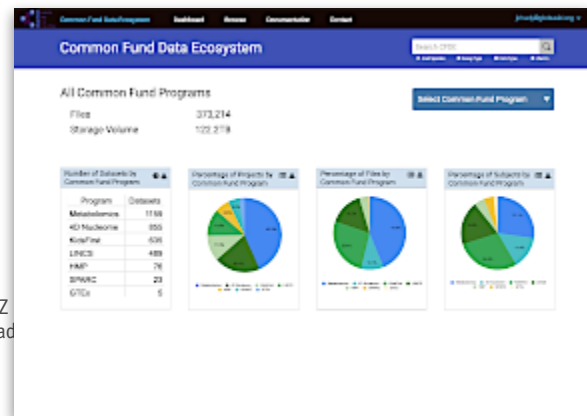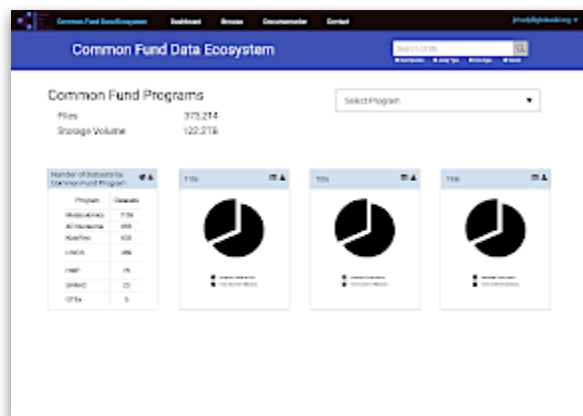
Answers:

- User 02 - "I don't know... I don't see anything in this prototype that would help me do my job. I think researchers are the audience. Not me... I think there are some nice aspects to this. But it wouldn't make my job easier. Harmonization, or something that captures the lack of harmonization would be useful. The metadata model is not the same across programs. [It] could highlight where harmonization needs to occur. Knowing where I need to downline the raw data, where there are gaps that will make certain analysis harder. Where terminology is different."

"The public should know about the data."

Response to refined wireframes

After the initial test with users 1-5, the development team provided improved wireframes for the last test subject. The improvements to the interface demonstrated significant differences in the user's comprehension of functionality. Populating pie charts and adding color to controls improved affordance.

Please see visual reference on Pg. 30 for full wireframe sets

User 6 response

Question: What do you see first?

Answers:

- User 06 - "I see the CF PROGRAM button first. [I] Want to click it. It made me realize that each column, each bar, is a CF program. Colors must represent assay, that's what's picked automatically, but it's not what I would pick."

Question: What can you do here?

Answers:

- User 06 - "I can't wait to find out? Search by species."

Question: What would you do first?

Answers:

- User 06 - "Big blue button (SEARCH ALL COLLECTIONS) at some point I might read the bottom stuff. Not sure?"

Question: What do you see first?

Answers:

- User 06 - "It looks like our dashboard."

Question: What can you do here?

Answers:

- User 06 - "I would click on that button."

Question: What would you do first?

Answers:

- User 06 - "Click through."

Question: What's the most useful thing here?

Answers:

- User 06 - "Anatomy by CF program. I would want to understand the type of data being captured. Is there heart disease data, kidney data?"

10. Exit Interview

- User 01 - "This was fun! I've done things like this before... I like the sneak peek at what's coming."

- User 02 - "I'm passionate about sharing data, so I'm happy to do this. It's fun."

- User 03 - "Most people don't know about these resources and this data. The public should know about the data. Should 'advertise' the data... Make it easier to understand for all users including POs."

- User 05 - "Having access to raw data would be of value. At first glance, it's a bit harder to understand but as you get used to it it would be helpful. I see the drop-down. So, I could probably include or exclude species, look at only humans or only mammals or something. So, I guess you could interact with it. I'm more data driven than visual. Especially the data type. How much came from each program? Which programs contributed to the RNA sequence? Based on the rest of the presentation, I would expect it would take me to a page with pie charts."