

Dupo Main Study Analysis Details

Analysis Details

Overall, we used our research questions and structured interview questions as initial themes for the analysis of the think-aloud and interview data. In addition, we looked at the log data and screen recordings to understand how they make manual edits and use the recommender. Below, we outline how we filtered ‘experimenting edits’ from the log data and tagged reasoning behaviors in the screen recordings.

Filtering experimenting edits

Each manual edit that a participant made was expressed as a Cicero rule. A Cicero expression fundamentally includes a specifier (an element to change), action (the direction of change), and option (property(s) to change). After making a first edit, a user makes the same edit with different values for the same element and property to experiment with that property. In the below example from E4, he made an initial edit to **annotation_6** for the tick’s **dy** (relative vertical position) value (-7). As shown in the **callTime**, right after making that initial edit, E4 made an experimenting edit to the same element and property with a different value (-6). We captured this kind of edits as experimenting edits, defining them as “a series of consecutive rules for the same specifier, action, and option property(s) with different option values.”

An initial edit	An additional experimenting edit
<pre>{ "description": "Edit annotation 6 tick position from mark (dy)", "specifier": { "role": "annotation", "id": "annotation_6" }, "action": "modify", "option": { "tick": { "from": { "dy": -7 } } }, "callTime": "11:28:03 AM" }</pre>	<pre>{ "description": "Edit annotation 6 tick position from mark (dy)", "specifier": { "role": "annotation", "id": "annotation_6" }, "action": "modify", "option": { "tick": { "from": { "dy": -6 } } }, "callTime": "11:28:03 AM" }</pre>
<p><i>Note: microsecond level time was not recorded.</i></p>	

Tagging screen recordings for the use of recommender

We tagged screen recordings into six categories as below. The main goal of this tagging is to understand what kind of reasoning behaviors the participants performed rather than how long they spent for each behavior, or what suggestion they paid more attention to. We note that this tagging is *not* intended for precise time measurement.

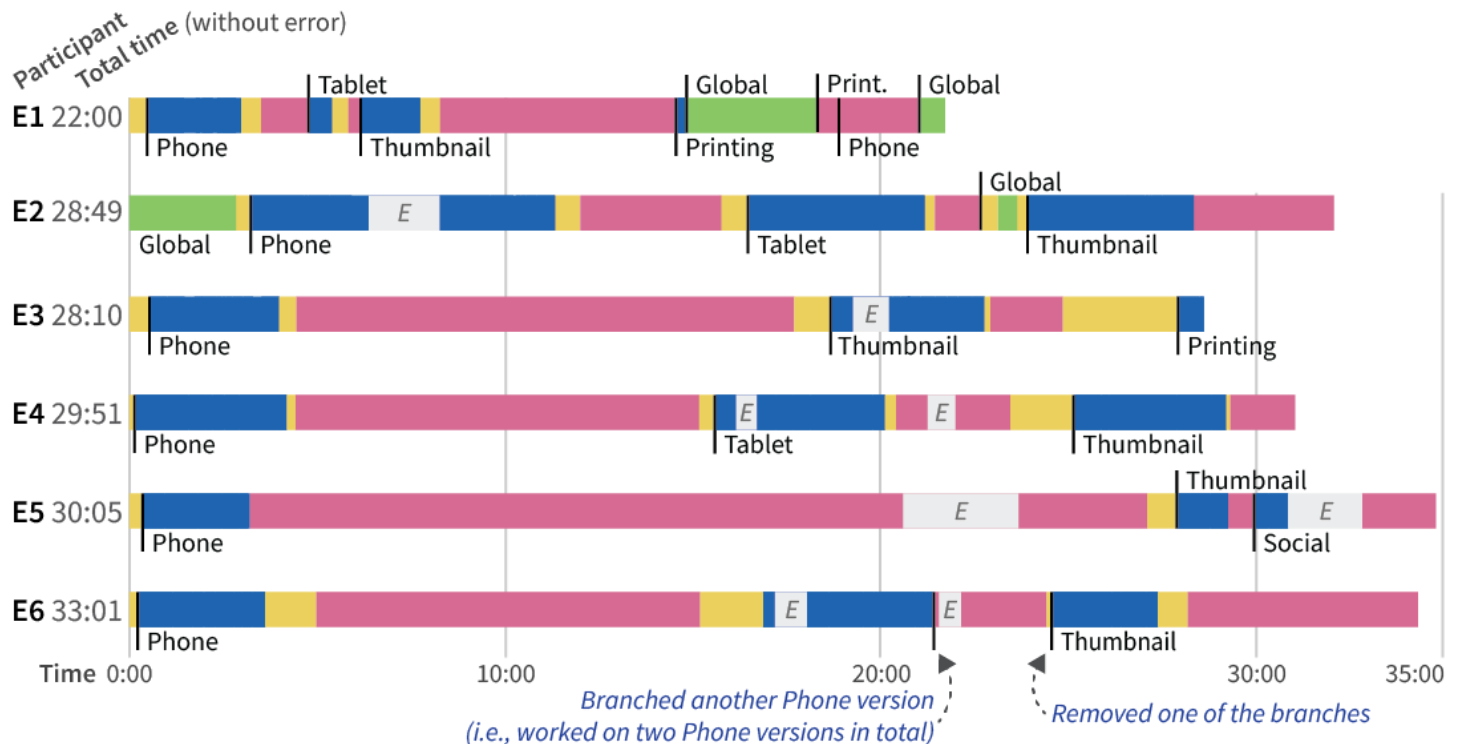
Tag Categories

- **Load and overview**
 - **Obtain *Exploration* designs:** A participant requested *Exploration* suggestions and saw them before they jumped to a specific suggestion(s).
 - **Obtain *Alteration* designs:** A participant clicked the “see similar” button for an *Exploration* suggestion and saw them before they jumps to a specific suggestion.
- **Reason and inspect**
 - **For a single design:** A participant read the descriptions in the *action widget* and made any comment relating to what they likes or not for *one particular* suggestion.
 - **For multiple designs:** A participant compared *two or more* suggestions.
- **Next steps**
 - **Brainstorm possible edits:** A participant thought of potential manual edits they could make for a design suggestion.
 - **Summarize thoughts:** A participant rationalized their motivations or final decisions.

Log visualization (Overall)

Legend

■ Recommender
 ■ Manual edits
 ■ System features
 ■ Thinking about next steps
 E Paused for error



Log visualization (Recommender use)

Legend

Load and overview

- Obtain *Exploration* designs
- Obtain *Alteration* designs
- A participant requested design suggestions and took an overview of them.

Reason and inspect

- For a single design
- For multiple designs
- A participant reason about and inspect designs individually or by comparing.

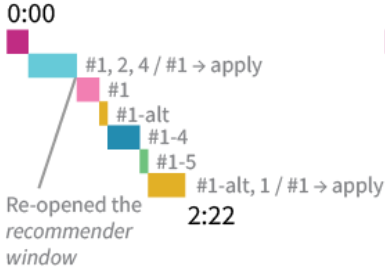
Next steps

- Brainstorm possible edits
- A participant thought of potential manual edits they could make for a design.

- Summarize thoughts
- A participant rationalized their motivations or final decisions.

--- The number of Exploration suggestions

E1-Phone (5)



E1-Tablet (2)



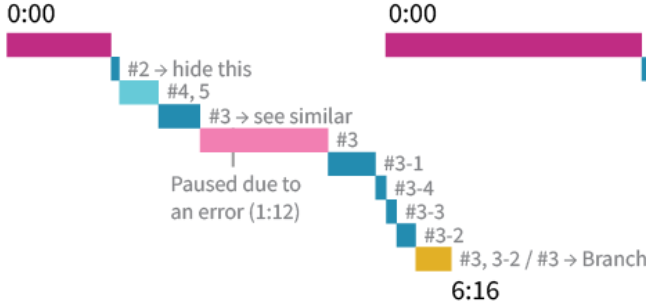
E1-Thumbnail (2)



E1-Printing (2)



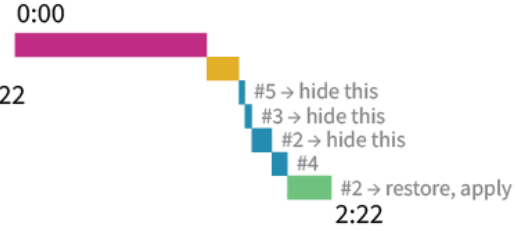
E2-Phone (5)



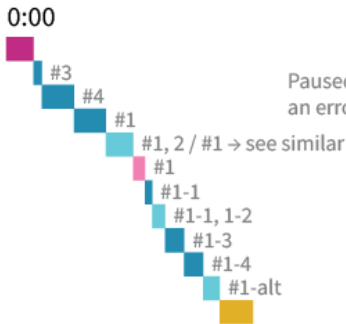
E2-Tablet (5: same as Phone)



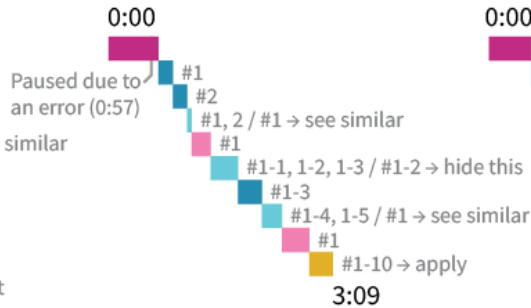
E2-Thumbnail (5)



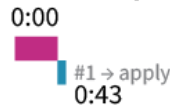
E3-Phone (5)



E3-Thumbnail (2)



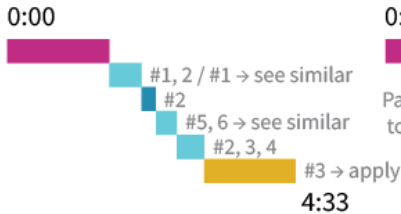
E3-Printing (1)



Suggestion numbering

- #n Exploration suggestion n
- #n-m Alteration suggestion m for Exploration suggestion n
- #n-alt Most Alteration suggestions for Exploration suggestion n
- #A → X A user action X in the action widget for suggestion A

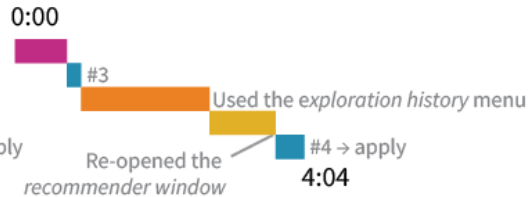
E4-Phone (7)

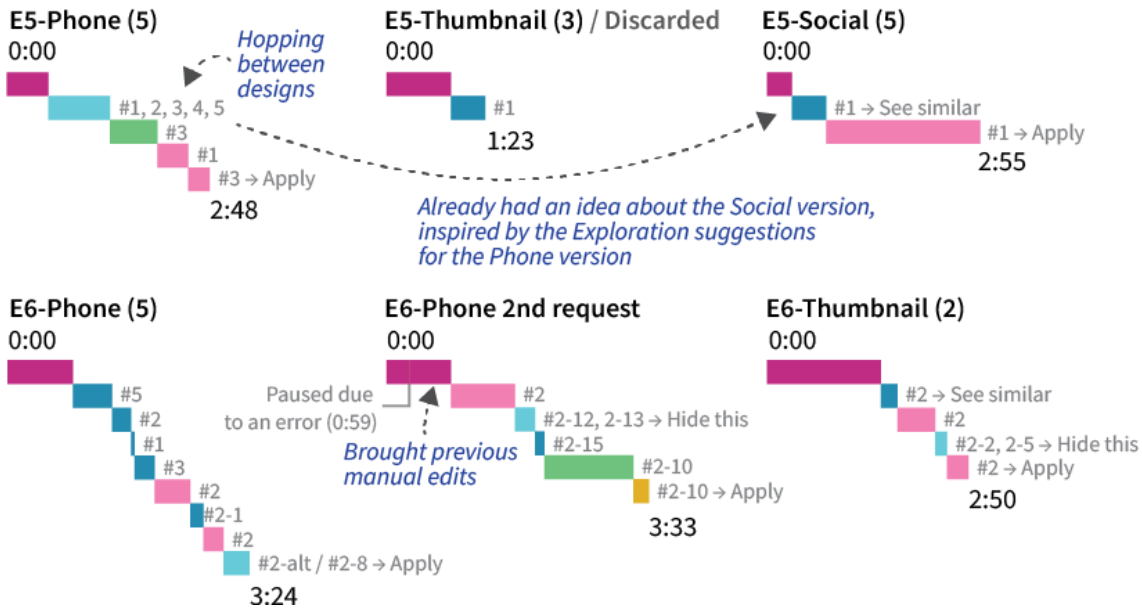


E4-Tablet (1 + 3)



E4-Thumbnail (4)





Tagging outcome (detail)

User	Device type	Start time	End time	Tag(s)	Suggestion(s)
E1	Phone	10:47:50 AM	10:48:08 AM	Obtain <i>Exploration</i> designs	
E1	Phone	10:48:08 AM	10:48:49 AM	Readon and inspect (for multiple designs) → Apply #1	1, 2, 4
E1	Phone	10:49:08 AM	10:49:15 AM	Re-open the recommender window / Obtain <i>Alteration</i> designs	1
E1	Phone	10:49:18 AM	10:49:35 AM	Reason and inspect (for a single design)	1-4
E1	Phone	10:49:42 AM	10:49:48 AM	Brainstorm possible edits [about moving an annotation]	1-5
E1	Phone	10:49:49 AM	10:50:12 AM	Summarize thoughts / Apply #1	1-alt
E1	Tablet	10:52:08 AM	10:52:45 AM	Obtain <i>Exploration</i> designs	
E1	Thumbnail	10:53:30 AM	10:54:20 AM	Obtain <i>Exploration</i> designs	
E1	Thumbnail	10:54:21 AM	10:54:55 AM	Brainstorm possible edits [about modifying the map background]	1
E1	Thumbnail	10:54:55 AM	10:55:06 AM	Close/re-open the recommender window / Apply #1	1
E1	Printing	11:01:58 AM	11:02:10 AM	Obtain <i>Exploration</i> designs → Apply	1s
E2	Phone	12:56:02 PM	12:57:30 PM	Obtain <i>Exploration</i> designs	
E2	Phone	12:57:31 PM	12:57:36 PM	Reason and inspect (for a single design) → Hide this	2
E2	Phone	12:57:37 PM	12:58:10 PM	Reason and inspect (for multiple designs)	4, 5
E2	Phone	12:58:11 PM	12:58:45 PM	Reason and inspect (for a single design) → See similar	3
E2	Phone	1:01:06 PM	1:02:26 PM	Obtain <i>Alteration</i> designs / Paused due to an error (1:12)	3
E2	Phone	1:02:27 PM	1:03:04 PM	Reason and inspect (for a single design)	3-1
E2	Phone	1:03:08 PM	1:03:15 PM	Reason and inspect (for a single design)	3-4
E2	Phone	1:03:16 PM	1:03:23 PM	Reason and inspect (for a single design)	3-3
E2	Phone	1:03:24 PM	1:03:40 PM	Reason and inspect (for a single design)	3-2
E2	Phone	1:03:41 PM	1:04:10 PM	Summarize thoughts / Branch #3	3, 3-1
E2	Tablet	1:09:19 PM	1:12:55 PM	Obtain <i>Exploration</i> designs	
E2	Tablet	1:12:56 PM	1:14:01 PM	Reason and inspect (for a single design)	1
E2	Thumbnail	1:16:45 PM	1:19:27 PM	Obtain <i>Exploration</i> designs	
E2	Thumbnail	1:19:27 PM	1:19:54 PM	Summarize thoughts [motivation for thumbnail designs]	
E2	Thumbnail	1:19:55 PM	1:19:59 PM	Reason and inspect (for a single design) → Hide this	5

E2	Thumbnail	1:20:00 PM	1:20:05 PM	Reason and inspect (for a single design) → Hide this	3
E2	Thumbnail	1:20:06 PM	1:20:22 PM	Reason and inspect (for a single design) → Hide this	2
E2	Thumbnail	1:20:23 PM	1:20:35 PM	Reason and inspect (for a single design)	4
E2	Thumbnail	1:20:36 PM	1:21:12 PM	Restore → Reason and inspect (for a single design) → Apply	2
E3	Phone	8:28:23 AM	8:28:46 AM	Obtain <i>Exploration</i> designs	
E3	Phone	8:28:46 AM	8:28:53 AM	Reason and inspect (for a single design)	3
E3	Phone	8:28:54 AM	8:29:20 AM	Reason and inspect (for a single design)	4
E3	Phone	8:29:36 AM	8:29:47 AM	Reason and inspect (for a single design)	1
E3	Phone	8:29:47 AM	8:30:10 AM	Reason and inspect (for multiple designs) → See similar #1	1, 2
E3	Phone	8:30:11 AM	8:30:20 AM	Obtain <i>Alteration</i> designs	1
E3	Phone	8:30:21 AM	8:30:26 AM	Reason and inspect (for a single design)	1-1
E3	Phone	8:30:27 AM	8:30:37 AM	Reason and inspect (for multiple designs)	1-1, 1-2
E3	Phone	8:30:38 AM	8:30:53 AM	Reason and inspect (for a single design)	1-3
E3	Phone	8:30:54 AM	8:31:09 AM	Reason and inspect (for a single design)	1-4
E3	Phone	8:31:10 AM	8:31:22 AM	Reason and inspect (for multiple designs)	1-alt
E3	Phone	8:31:23 AM	8:31:51 AM	Summarize thoughts / Apply	1
E3	Thumbnail	8:46:32 AM	8:48:11 AM	Obtain <i>Exploration</i> designs / Paused due to an error (0:57)	
E3	Thumbnail	8:48:12 AM	8:48:23 AM	Reason and inspect (for a single design)	1
E3	Thumbnail	8:48:24 AM	8:48:38 AM	Reason and inspect (for a single design)	2
E3	Thumbnail	8:48:39 AM	8:48:35 AM	Reason and inspect (for multiple designs) → See similar #1	1, 2
E3	Thumbnail	8:48:36 AM	8:48:55 AM	Obtain <i>Alteration</i> designs	1
E3	Thumbnail	8:48:56 AM	8:49:18 AM	Reason and inspect (for multiple designs) → Hide this #1-2	1-1, 1-2, 1-3
E3	Thumbnail	8:49:19 AM	8:49:38 AM	Reason and inspect (for a single design)	1-3
E3	Thumbnail	8:49:39 AM	8:49:55 AM	Reason and inspect (for multiple designs) → See similar #1	1-4, 1-5
E3	Thumbnail	8:49:56 AM	8:50:18 AM	Obtain <i>Alteration</i> designs	1
E3	Thumbnail	8:50:19 AM	8:50:38 AM	Summarize thoughts / Apply	1-10
E3	Printing	8:55:45 AM	8:56:21 AM	Obtain <i>Exploration</i> designs	
E3	Printing	8:56:22 AM	8:56:28 AM	Reason and inspect (for a single design) → Apply	1
E4	Phone	10:16:30 AM	10:17:56 AM	Obtain <i>Exploration</i> designs	
E4	Phone	10:17:57 AM	10:18:23 AM	Reason and inspect (for multiple designs) → Hide-this #1	1, 2
E4	Phone	10:18:24 AM	10:18:35 AM	Reason and inspect (for a single design)	2
E4	Phone	10:18:36 AM	10:18:53 AM	Reason and inspect (for t designs) → Hide-this	5, 6
E4	Phone	10:18:54 AM	10:19:16 AM	Reason and inspect (for multiple designs) [Comparing 4 vs. 2, 3]	4, 2, 3
E4	Phone	10:19:17 AM	10:20:33 AM	Summarize thoughts / Apply	3
E4	Tablet	10:31:57 AM	10:33:33 AM	Obtain <i>Exploration</i> designs / Paused due to an error (0:33)	
E4	Tablet	10:33:34 AM	10:34:01 AM	Obtain <u>drastic</u> <i>Exploration</i> designs*	
E4	Tablet	10:34:02 AM	10:34:30 AM	Reason and inspect (for a single design)	4
E4	Tablet	10:34:31 AM	10:36:09 AM	Reason and inspect (for multiple designs)	2, 1
E4	Tablet	10:36:10 AM	10:36:29 AM	Summarize thoughts / Apply	2
E4	Thumbnail	10:41:30 AM	10:42:14 AM	Obtain <i>Exploration</i> designs	
E4	Thumbnail	10:42:15 AM	10:42:26 AM	Reason and inspect (for a single design)	3
E4	Thumbnail	10:42:27 AM	10:44:14 AM	Use system features (exploration history)	
E4	Thumbnail	10:44:15 AM	10:45:10 AM	Summarize thoughts	
E4	Thumbnail	10:45:11 AM	10:45:34 AM	Re-open the recommender window / Apply	4

E5	Phone	11:23:05 AM	11:23:40 AM	Obtain <i>Exploration</i> designs	
E5	Phone	11:23:41 AM	11:24:32 AM	Reason and inspect (for multiple designs) [Comparing 1, 3 vs 2, 4, 5]	1, 3, 2, 4, 5
E5	Phone	11:24:33 AM	11:25:12 AM	Brainstorm possible edits	3
E5	Phone	11:25:13 AM	11:25:38 AM	Obtain <i>Alteration</i> designs	1
E5	Phone	11:25:39 AM	11:25:53 AM	Obtain <i>Alteration</i> designs / Apply	3
E5	Thumbnail	11:50:36 AM	11:51:30 AM	Obtain <i>Exploration</i> designs	
E5	Thumbnail	11:51:31 AM	11:51:59 AM	Reason and inspect (for a single design)	1
E5	Social	11:52:45 AM	11:53:03 AM	Obtain <i>Exploration</i> designs	
E5	Social	11:53:04 AM	11:53:33 AM	Reason and inspect (for a single design) → See similar	1
E5	Social	11:53:34 AM	11:55:41 AM	Obtain <i>Alteration</i> designs / Apply	1
E6	Phone	10:54:00 AM	10:54:55 AM	Obtain <i>Exploration</i> designs	
E6	Phone	10:54:56 AM	10:55:28 AM	Reason and inspect (for a single design)	5
E6	Phone	10:55:29 AM	10:55:44 AM	Reason and inspect (for a single design)	2
E6	Phone	10:55:45 AM	10:55:47 AM	Reason and inspect (for a single design)	1
E6	Phone	10:55:48 AM	10:56:04 AM	Reason and inspect (for a single design)	3
E6	Phone	10:56:05 AM	10:56:34 AM	Obtain <i>Alteration</i> designs	2
E6	Phone	10:56:35 AM	10:56:45 AM	Reason and inspect (for a single design)	2-1
E6	Phone	10:56:46 AM	10:57:02 AM	Obtain <i>Alteration</i> designs	2
E6	Phone	10:57:03 AM	10:57:24 AM	Reason and inspect (for multiple designs) / Apply #2-8	2-alt
E6	Phone**	11:10:39 AM	11:10:58 AM	Obtain <i>Exploration</i> designs / Paused due to an error (0:59)	
E6	Phone	11:11:49 AM	11:12:24 AM	Obtain <i>Exploration</i> designs / Bring my edits	
E6	Phone	11:12:25 AM	11:13:18 AM	Obtain <i>Alteration</i> designs	2
E6	Phone	11:13:19 AM	11:13:35 AM	Reason and inspect (for multiple designs) → Hide this	2-12, 2-13
E6	Phone	11:13:36 AM	11:14:01 AM	Reason and inspect (for a single design)	2-15
E6	Phone	11:14:02 AM	11:14:58 AM	Brainstorm possible edits [moving mark labels]	2-10
E6	Phone	11:14:59 AM	11:15:11 AM	Summarize thoughts / Branch #2-10	
E6	Thumbnail	11:18:20 AM	11:19:56 AM	Obtain <i>Exploration</i> designs	
E6	Thumbnail	11:19:57 AM	11:20:10 AM	Reason and inspect (for a single design) → See-similar	2
E6	Thumbnail	11:20:11 AM	11:20:42 AM	Obtain <i>Alteration</i> designs	2
E6	Thumbnail	11:20:43 AM	11:20:52 AM	Reason and inspect (for multiple designs) → Hide this	2-2, 2-5
E6	Thumbnail	11:20:53 AM	11:21:10 AM	Obtain <i>Alteration</i> designs / Apply	2

*For the Tablet version, E4 requested “more drastic transformations” after seeing only one Exploration suggestion with minimal changes (resizing), because Dupo by defaults does not suggest drastic changes for a tablet version when the source design is for desktop devices

**E6 requested *Exploration* suggestions two times for the same Phone version.

Suggestion numbering

- #*n* Exploration suggestion *n*
- #*n-m* Alteration suggestion *m* for Exploration suggestion *n*
- #*n-alt* Most Alteration suggestions for Exploration suggestion *n*