Interactive Hi-Fi Prototype Report

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Introduction

Problem and Solution Overview:

Dance choreographers face many difficulties when visualizing and creating formations using the traditional pencil and paper. Drawing circles to represent people and constantly having to erase to change one part of the formation, holds choreographers back from fluidly creating dances, while also making it difficult for them to share their ideas. Let's Dance is an app that uses a mobile and augmented reality interface to address these problems. Choreographers can quickly create formations with a simple tap to add and drag interaction. Once each individual formation is created, choreographers can add dancer labels, create transitions between formations, and sync the formations to music. Additional augmented reality capabilities, allow choreographers to preview their formations in the space around them, while sharing capabilities let choreographers share their formations with their dance teams. This functionality removes obstacles and keeps choreographers focused on creating amazing dance performances.
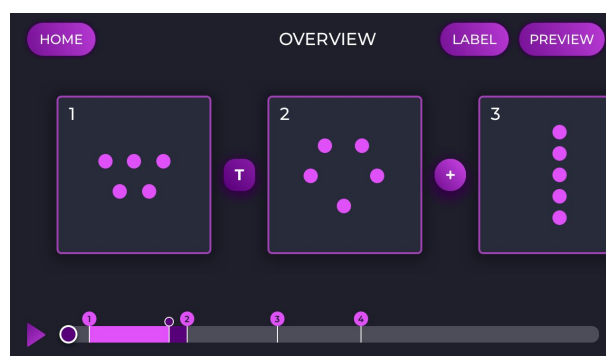

Figure 1. Formation creation centers around the overview screen displayed. From this

screen, dancers can access labelling, previewing, creating, transition, and syncing functions.

Tasks

Simple: Create dance formations

From the overview screen, users can see formation squares with transition circles in between. To create a new formation, they click the formation square which takes them to the formation creation screen. At this point users simply tap the screen to add a dot representing a dancer. They can quickly drag dots to various locations on the screen to test different formations. They can also tap and drag to remove dancers. Clicking save brings users back to the project overview screen. This task addresses the core need of choreographers when blocking a dance, which is creating singular formations. These formations act as building blocks that the choreographer then uses to create transitions and to share.
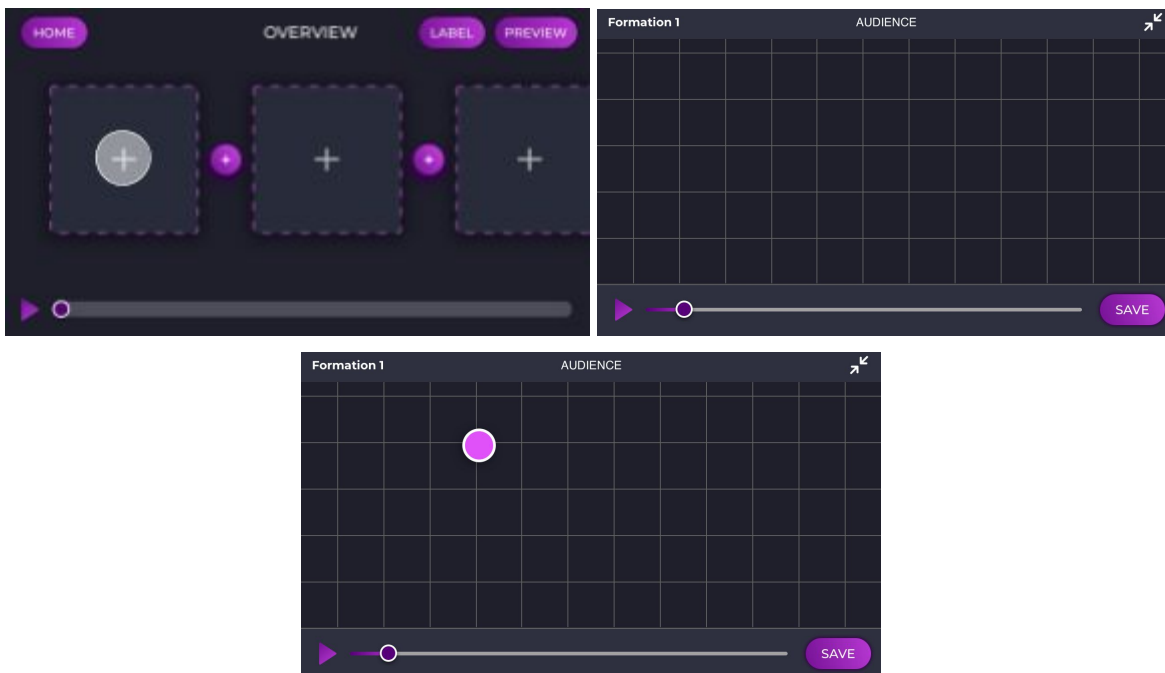

Figure 2. Overview screen leads to formation creation screen where a dancer is added. White semi-opaque circle represents a tap gesture.

Moderate: Sync with music

From the overview screen, users can see the formations they've created populating each square. At the bottom of the screen, they see a scrubbing bar with a cursor. When they tap the play button, the cursor moves, showing the time within the music. Each pink flag denotes the beginning of that formation and each purple flag denotes the beginning of a transition. Users can tap and drag these flags, so that the formations and transitions occur at the right time within the music. This task is important because it allows dancers to note where in the music they will be in each formation.
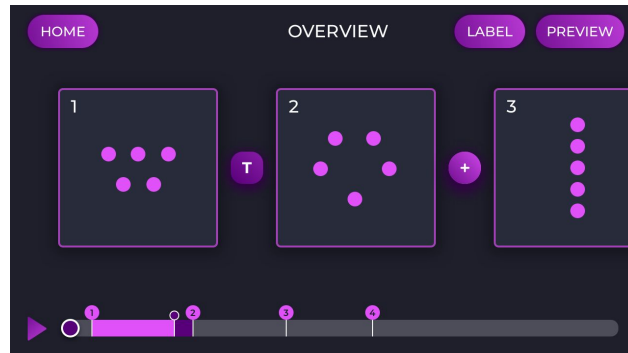

Figure 3. Overview screen with a few formations already created.

Complex: Visualize with augmented reality

From the overview screen, users tap the preview button. This takes them to the AR screen where they map the environment around them. The app then finds a flat surface where it displays the formation that the user just created. When the user hits the play button, the figures move according to the music syncing and formations that the user created. This task allows dancers to visualize the formation in physical space how an audience may view it.
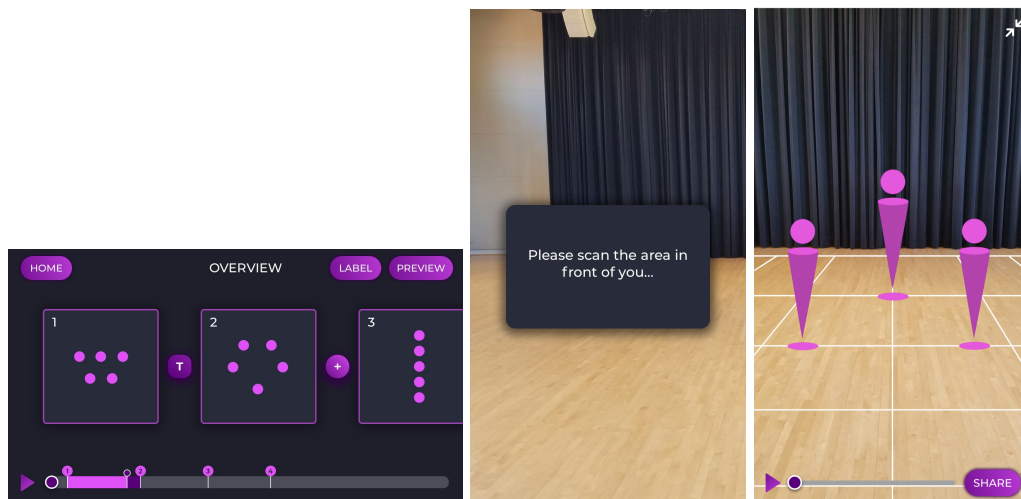

Figure 4. Overview screen moves to the AR screen with figures in 3D space.
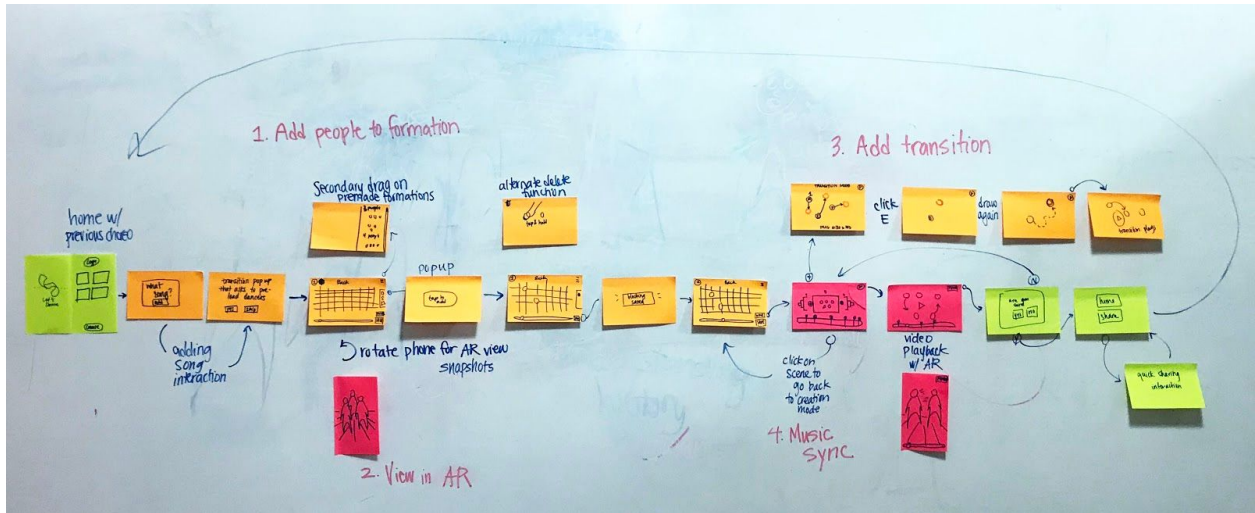
Design Evolution

Initial UI Sketch

Figure 5. An initial mobile interface demonstrated the flow of
creating a formation from beginning to end.

We visualized our initial flow quite linearly, moving from a main formation creation
screen to a main transition creation and music creation screen. This flow would take
the choreographer from beginning to end without excess navigation.
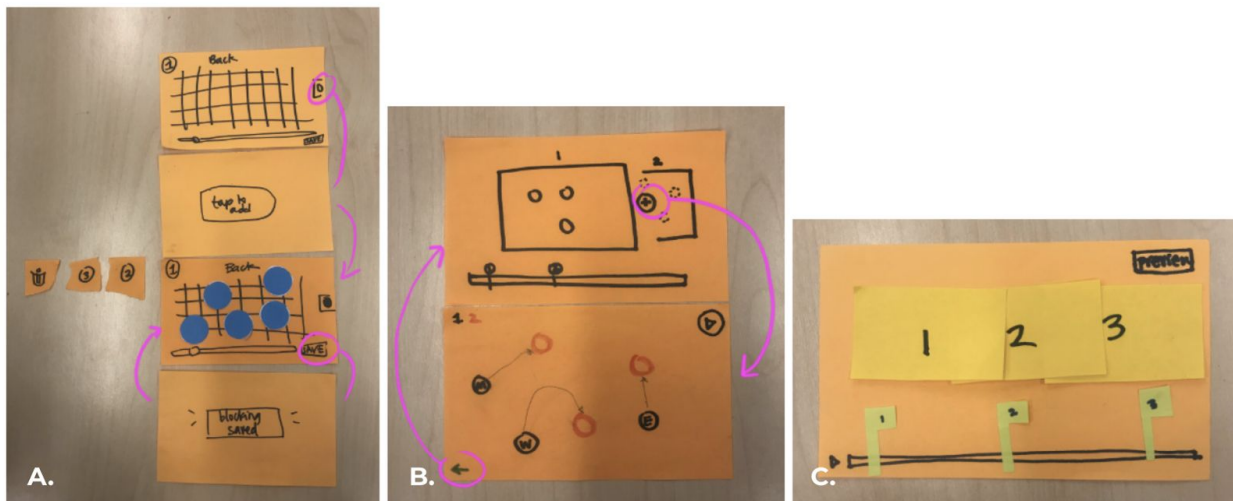
Low-Fi Prototype Sketches

Figure 6.The initial interface was broken into three tasks a) formation creation
b) adding transitions c) syncing with music.

Med-Fi Prototype Design

Feedback from our user testing participants led us to make a few major changes in building the medium fidelity prototype.

1. Clarifying transition durations

   Users were initially confused by the treatment of formations as flags, as this did not display how long a formation and transition lasted. To alleviate this confusion, we added colored bars to denote the duration of a formation as well as smaller flags to mark the start of a transition. We also added functionality of setting a transition duration after creation and error messaging to prevent accidental removal of transitions.
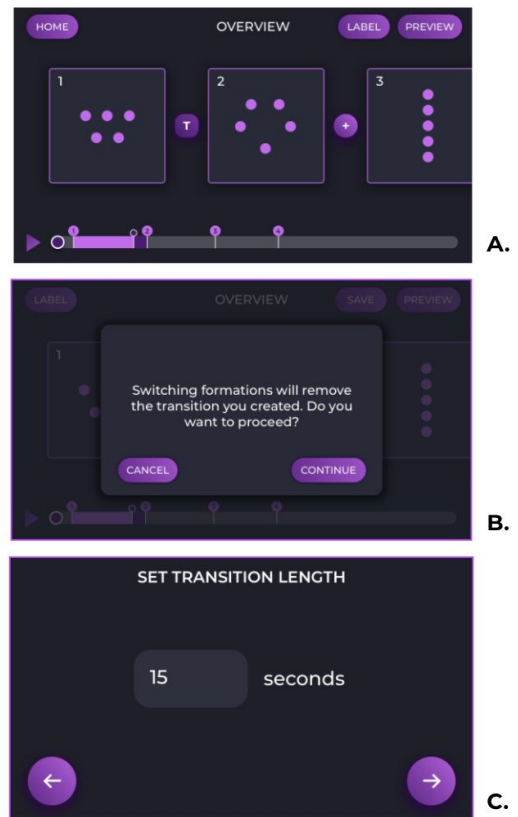
Figure 7. Updated transition creation related screens a) transition flags b) error messaging c) setting transition length

2. Introducing dancer labelling

   Sharing formations with dance teams and denoting who is placed where within each formation is a main use case of our application. We decided to add dancer labelling into the app flow to target this initially missed use case.

Figure 8. Trying to add transitions without labelling dancers first triggers a call to action message.
Clicking into label allows users to tap dancers and name them.

3. Streamlining creation mode
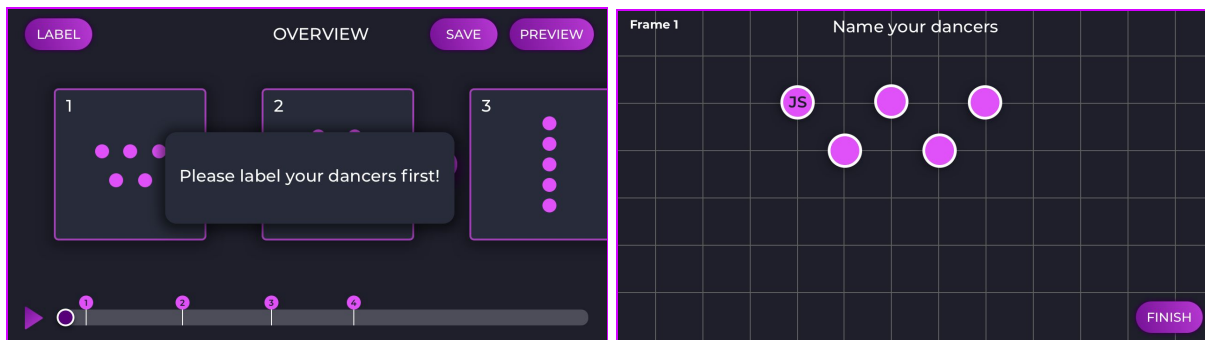
All of our users attempted to tap the screen to add dancers before realizing there was a toolbar of creation tools. To streamline the process of creation, we defaulted the creation mode to the tap to add a dancer tool. This allowed first time users to create without confusion, while leaving functionality for power users.
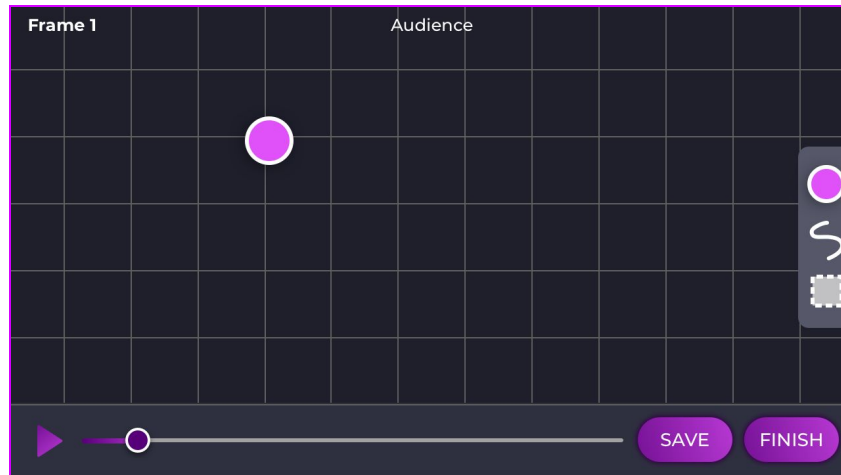

Figure 9. Upon opening the creation screen, the tap to add tool is the default selection.

Other changes we made included: deleting dancers through a long tap (like deleting apps in iOS) instead of a tap and drag, adding more navigation options, and clarifying labelling and button naming.

Major Usability Problems Addressed

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1. Setting Overview as Main Page, Zoom Out to Create

Originally, the mechanism for going back to the homescreen on the "Name" page and the "Overview" page is different. Labelling was inconsistent, and users did not have an overall grasp of how to save formations and sync music. To fix this, we have decided to use the "Overview" screen as the default screen when creating a new project in order to give each project a "home" or reference point in which the entire project could be seen thus far.

The work-flow would work as such:
1. Zoom in to "Create" screen
2. Save formation in "Create"
3. Zoom out to "Overview" with new formation in the project
4. Add a new formation from the "Overview" screen
5. Repeat

In this way, saving from the "Create" screen gives a stronger sense of saving because the user returns to the "Overview" screen, with their new formation in the project.
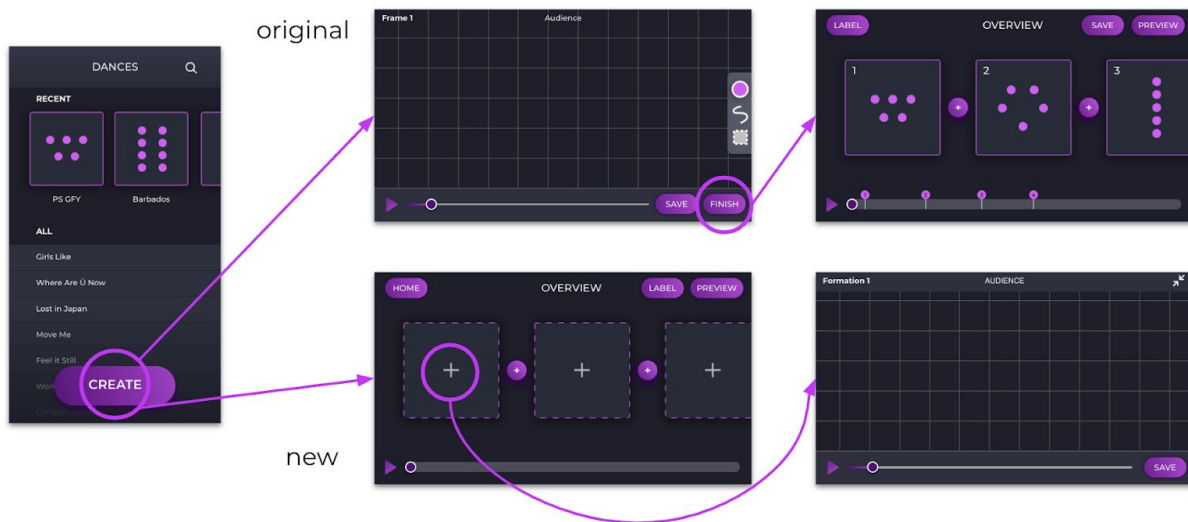

Figure 10. Originally, create took users to the formation creation screen which just increased the frame number when pressing save. Finish would allow users to overview all the formations they had saved. The new flow takes users to the overview screen where they can then create individual formations.

2. Labelling Dancers

Initially, labelling was mandatory for users to create transitions between formations. However, users found this confusing especially because they couldn't label dancers when actually creating the formations so labelling seemed out of context. To fix this confusion, instead of having the label screen pop up when first making transition, we instead will keep an ID for each new dancer that the user creates and enumerate it with letters A-Z. We will keep the "Label" button on the "Overview" screen as an option, but not make in mandatory. Then, at the very end of the project, when tapping "Finish," we will ask if the user would like to label their dancers if they have not done so already. By doing so, we believe it interferes less with the user's workflow by not mandating labeling in the middle of the project.
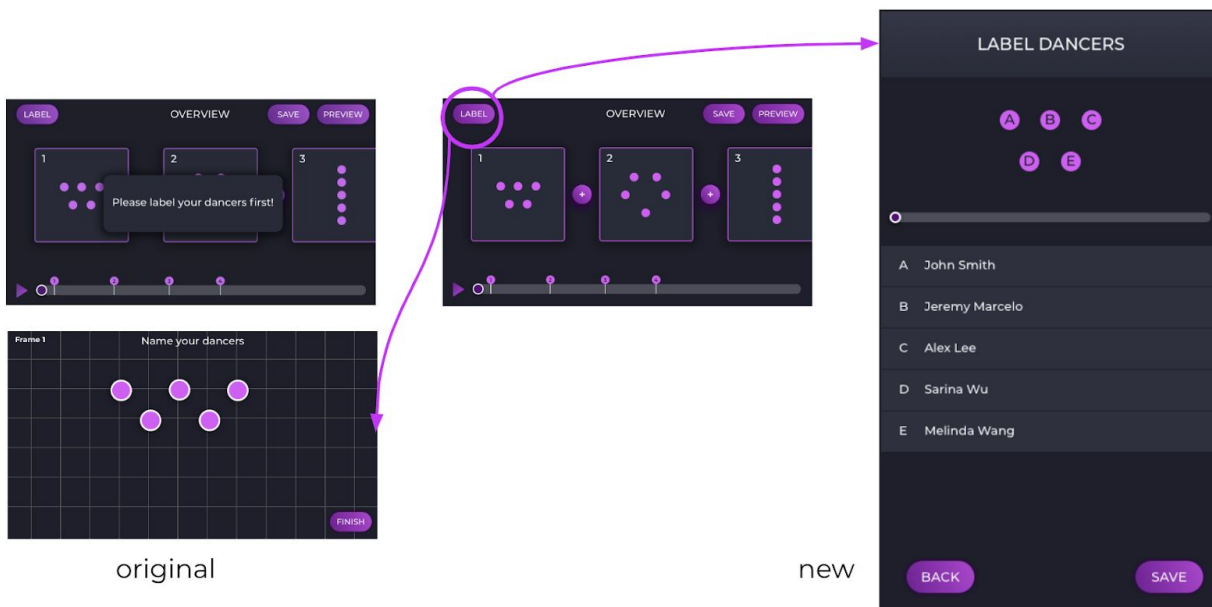
Figure 11. On the left, we see the original error message that appeared when users tried to add transitions without first labelling dancers. The dancer labelling screen was also a cumbersome tap to add. On the right, we see a new dancer labelling screen with automatic A-Z indexing and labelling in list form.

Based on some other heuristic violations, we are including the following changes:
1. Changing setting transition length from type input to a scroller. (not implemented in our prototype due to technological limitations)
2. Clicking in to old choreography brings up an initial screen with choreography summary and share option so users don't have to go to overview screen to preview to share. (not implemented in our prototype due to technological limitations)
3. Integration with spotify and mp3 uploads for music. (Wizard of Oz in our prototype)

4. Increased error messaging when exiting out of screens without saving or when changing formation order.

List of Level 3 or 4 Heuristic Violations

2. H10 Help and Documentation / Severity 3 / Found by: B, C, D
Uploading a song on iOS as an .mp3 is an extremely difficult and confusing task. Files are not supported as well as a computer, for example. There needs to be a clear way to get the sort of data that you are looking for.
What will the interface for choosing a song look like? Does it have to be in Apple Music or Spotify? Files? This will be a tradeoff between technical feasibility and flexibility of use. Feasibility is somewhat outside the scope of this class, but because I have heard you express interest in continuing this project beyond class, it is a point to consider.
Fix: Add some explanation of how to get an mp3 onto an iPhone, or integrate with 3rd party service
Our Fix: We are integrating with Spotify (using Wizard of Oz techniques with a pre-uploaded song for the Hi-Fi prototype)
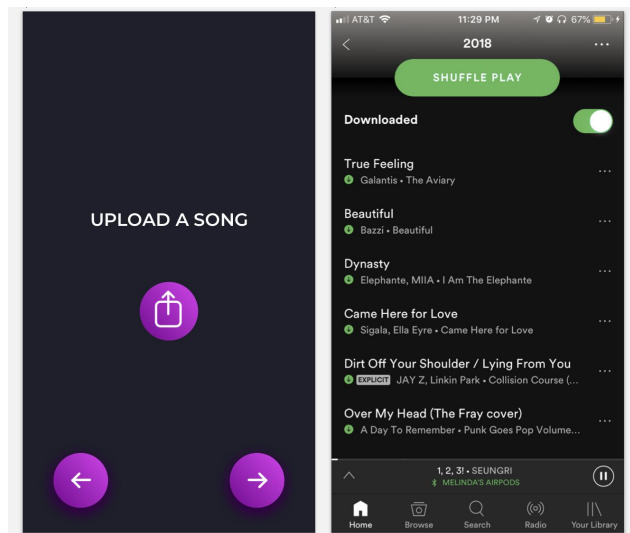
Figure 12. Uploading a song button takes users to Spotify to choose a song.

4. H5 Error Prevention / Severity 4 / Found by: A, C, D
After creating your initial formation, you exit thinking that everything is good to go. However, when you go to make a transition, it notifies you that you need to label your dancers, something that was not an option when creating the formation.
Fix: Make a way such that you can label the dancers from the create page itself, instead of getting the false sense of completion after saving the formation. OR Automatically assign a number to each dancer, and give the option to manually assign names later.

Our Fix: Labelling dancers has been overhauled, as explained above

5. H4 Consistency and Standards / Severity 4 / Found by: A, C, D

Closely linked to the previous violation, how does labeling the dancers work? Does this need to happen for all of the formations, or only the first one? Is the reason why this comes after the first create page because you need some baseline of people to label?

Fix: Make the process of labeling dancers more clear. It feels like a late addition to the functionality of the app, probably find a way to make it more fundamental to the workflow.

Our Fix: Labelling dancers has been overhauled, as explained above

6. H6 Recognition over Recall / Severity 4 / Found by: A, B, C, D

There is potential for confusion when working with certain combinations of dancers. If some of them have the same initials, it can be difficult to keep track of which is which, which places additional mental load on the user

Fix: Consider using unique colors, numbers, or some other identifier, along with initials for each of the dancers to give an even stronger way to differentiate between dancers.

Ignored: We disagree with the severity that this issue was given. While we have marked down using color and other methods to differentiate dancers as future components, we believe that the baseline A-Z labeling is unique enough and that using initials is the first customization option we would like to support.

7. H10 Help and documentation / Severity 3 / Found by: B, C

It is unclear why the preview functionality needs to be in portrait mode, instead of landscape. Is there a design choice of why this is the case? In many usage scenarios, having the phone in landscape would provide a much larger field of vision and be very helpful

Fix: Consider explaining the use of the vertical FOV, or enable horizontal to use more real estate.

Our Fix: This was a limitation of the mid-fi prototype. Preview mode was intended to provide video playback of the entire project in landscape, and flipping it to portrait mode would enable AR. We were not able to implement the video playback due to technological limitations, so we had the "Preview" button take people to AR.

9. H3 User control and freedom / Severity 3 / Found by: C

No good way to escape the dialogue when giving a name to a dancer. Should have a way to escape re-labeling a dancer if it was an accidental action

Fix: Provide a back button during the label dancer phase.

Our Fix: Labelling dancers has been overhauled, as explained above

10. H3 User control and freedom / Severity 4 / Found by: C

It is not immediately clear how to edit the name of a single dancer. Does that require re-labeling all of the dancers? Or can going to the label screen and selecting only one overwrite all of the others?
Fix: Make it more clear how to edit a single dancer.
Our Fix: Labelling dancers has been overhauled, as explained above

11. H2 Match between system and the real world / Severity 4 / Found by: C
When adding transitions between different formations, the paths drawn are linear. For some use cases, this is all good, but very often dancing requires more intricate transitions. Is there a way to draw more complex paths, that also have some sort of rigidity to them?
Fix: Make it clear how to generate more complex formations by drawing the individual paths for each of the dancers themselves
Ignored: This was a limitation/Wizard of Oz feature from the medium-fi prototype. We would like to implement more complex paths in the future, but due to technological limitations were not able to implement this feature for the Hi-Fi prototype.

15. H2 Match between system and the real world / Severity 3 / Found by: C
It is not clear what happens when I click on the bottom bar of the screen what action I am performing. It might be more clear in a real model, where I can actually drag stuff around, but in this iteration it is slightly spooky and unclear of what action I am performing.
Fix: Make it more apparent how the bar represents the data, and make the message more clear on the implications of making an edit
Our Fix: Sync up bottom bar with top carousel in Overview (as you drag and swap formations, have it swap in the carousel). We were not able to implement this in the Hi-Fi prototype due to technological limitations.

17. H10 Help and documentation / Severity 3 / Found by: A, B, C
It is unclear how to accomplish the second task, given the UI. It would be helpful to have some visualization of the flow of the music itself, to know where the transitions go with respect to the formations. I detail more about this in my recommendations paragraphs
Fix: Make the syncing of the music and the actual formations/transitions themselves more clear. Potentially use fine-grain scrubbing with graphic of sound waves.
Our Fix: We would like to incorporate fine-grain scrubbing but are not able to due to technological limitations with the Hi-Fi prototype.

23. H5 Error prevention / Severity 3 / Found by: A
During the creation of a project, at the Upload a Song screen, the field looks like a text box you can type in, when in fact the desired user input is to click Upload. Users may attempt to click the text box to choose a song.

Fix: Remove the field and simply have an Upload button.
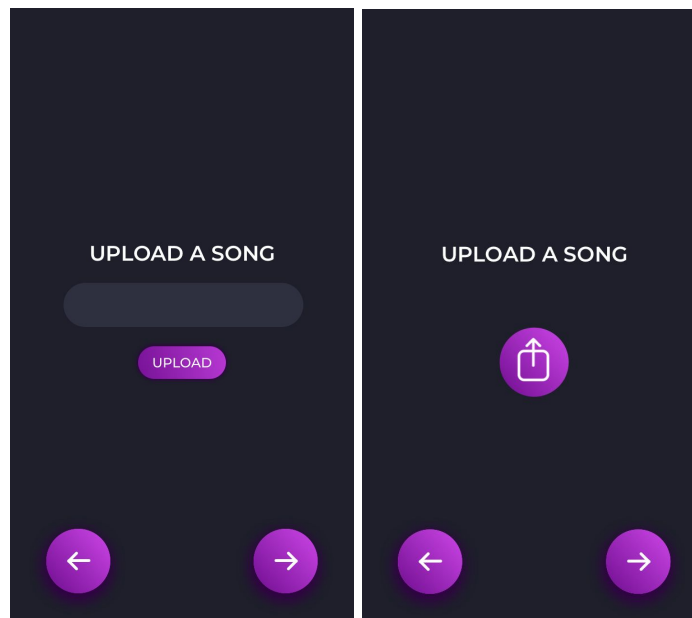**Our Fix:** Changing Upload a song text to Upload button

Figure 13. In the old screen on the left, the lightened area seems to indicate a typing field.
We removed this confusing field and replaced it with a simple upload icon.

24. H4 Consistency and standards / Severity 3 / Found by: D
When editing a formation, you have both a Save and a Finish button. It is unclear why you would need both. Finish implies that the choreography is done. Also, not sure why it doesn't auto-save.
Fix: Eliminate Finish and Save buttons. Save is replaced by auto-save. Finish can be replaced by a back arrow in the top-left corner.
Our Fix: Finish button is removed from Create screens (replaced with an Overview icon)
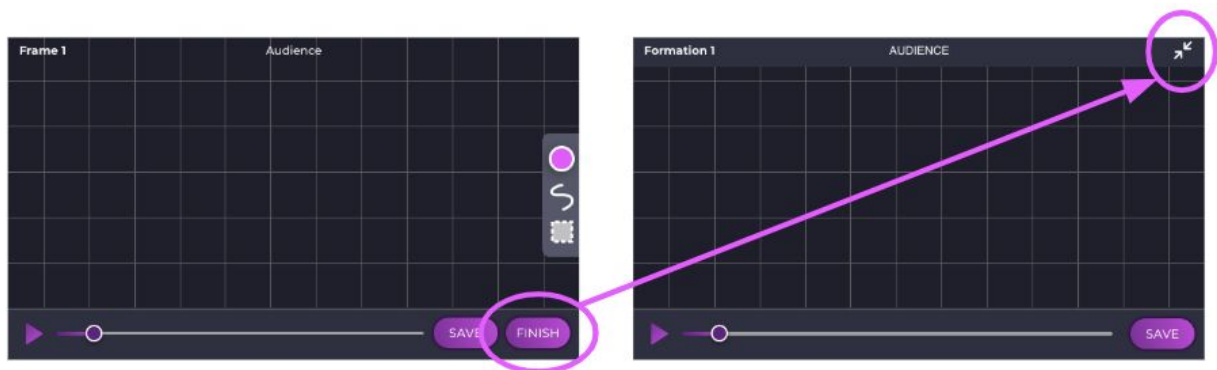

Figure 14. On left, the Finish button from the medium-fi prototype.
On right, the new Overview icon in the Hi-Fi prototype.

25. H10 Help & Documentation / Severity 3 / Found by: B

At the Formation Setting screen, the user is expected to understand the different settings on the sidebar (i.e. adding circles is the same as adding dancers). However, I still don't understand what the squiggly line nor the dotted rectangle mean. Moreover, the user is expected to hold down a user to delete them when I was hoping to drag a dancer to a trash icon.
Fix: Create a tutorial mode for a user's first project explaining each setting available.
Our Fix: Removed the bar, since we are currently only supporting adding dancers
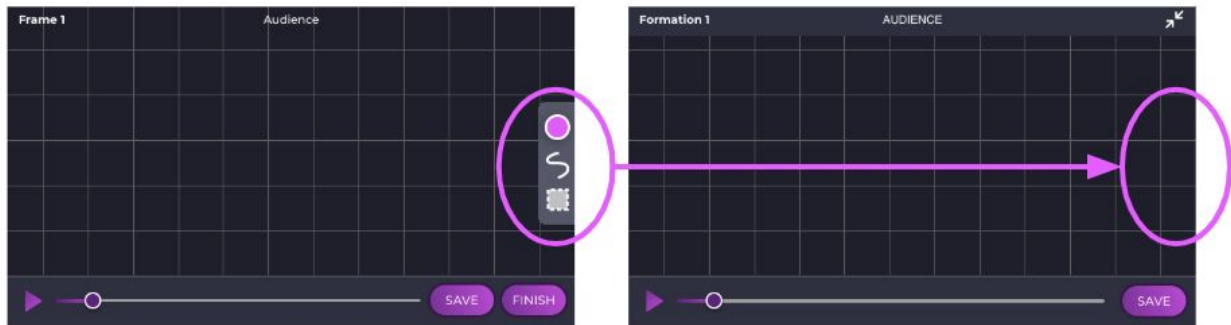

Figure 15. Removed the sidebar

29. H2 Match between system and the real world / Severity 4 / Found by: A, D

The timeline that shows the overview of the formations implies that there are only a few formation changes throughout the whole song. Looking at dance practice videos online there can be even 7 or so formation changes in the first 30 seconds of a song, which would quickly overwhelm the timeline. The timeline you currently have can probably support just about 45 seconds or so of music.
Fix: Make the timeline scrollable so that it's easy to see multiple formations in a longer sound sample.
Our Fix: We would have liked to make the timeline scrollable but were not able to implement it due to technological limitations.

36. H6 Recognition not recall / Severity 3 / Found by: A

In the AR Preview mode, there doesn't appear to be a distinction between the dancers like there is in the birds' eye view perspective, which means choreographers must remember who is who in the formations. This can get very confusing very quickly, especially since the sprites in the AR view are all the same.
Fix: Label the AR figures, or else have the option for replacing their faces with a dancer's profile, or else color them differently.
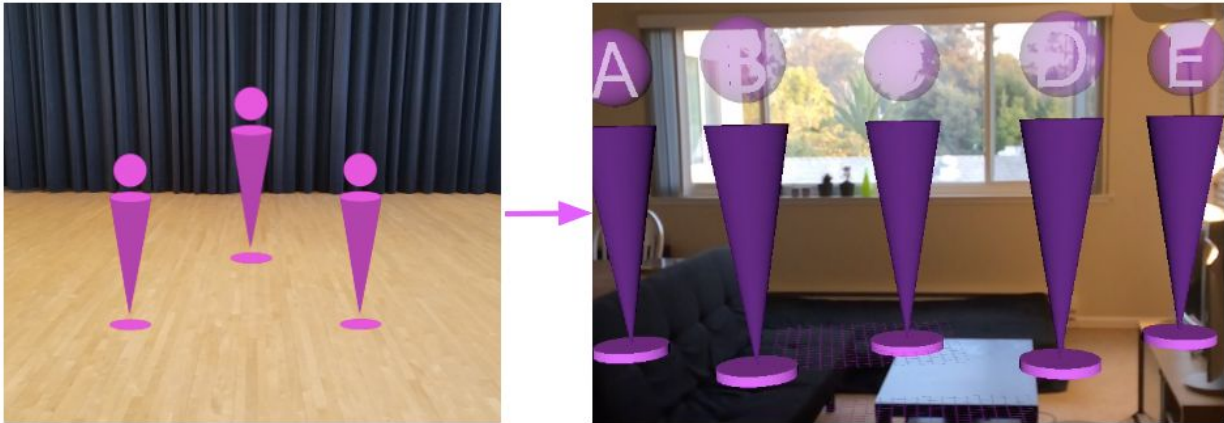**Our Fix:** AR figures are labeled

Figure 16. Labeled dancers in AR

37. H5 Error Prevention / Severity 4 / Found by: A

It is unclear what the rationale is in creating the formations of dancers and whether it starts with the formations themselves or the dancers we have. Once we start with the initial Formation Setting screen, does that initial screen set the maximum number of dancers available in the dance? What happens if, for example, the first screen has 5 dancers and the second has 6, and we are currently in the Transition Path screen?

Fix: There are numerous ways to approach fixing this problem. One way is to set the number of dancers at the very beginning of the piece, and ensure that all dancers are accounted for in the formation (on-stage/off-stage, where they are, etc.). Alternatively, there could be a bank of labeled dancers we can add to a new formation, or we already start from a previous formation and drag the dancers to their new positions.

Our Fix: Formation 1 is where dancers are added, and in later formations they are simply moved around. This is not reflected in the Hi-Fi prototype to preserve task flow in the hard-coded choreography we demo and show how dancers could be added.

42. H6: Recognition not Recall / Severity 4 / Found by: B, C

After uploading a song the song name is never shown again, and cannot be found in any details.

Fix: Add a song name in the details of a dance (perhaps on the home screen a force touch would lead to details, length, song name, number of formations, etc.). Or from home screen clicking on a dance doesn't immediately take you to choreographing and editing. Could have detail page of dance with previously listed info. Consider your use case when a dance is done and the choreographer doesn't want to immediately jump into editing (can be overwhelming, but rather view key summary points of the dance they have created).

Future Implementation: An intermediary screen between the home screen and project editing that displays meta information about the project, including the music used, number of formations, transitions, dancers and project name.

43. H6: Recognition not Recall / Severity 3 / Found by: B
Preview mode removes all of your formation flags and transition highlighted sections to the scrubber, user needs to therefore remember approximate time rather than jumping to key formations/transitions.
Fix: Leave formation flags in during preview, but limit editing capabilities.
Our Fix: Leaving formation flags in preview with no editing capabilities. This is not shown in the Hi-Fi because we did not implement the video playback preview mode or the scrubbable play bar in the AR preview mode (due to technological limitations).

45. H7: Flexibility & Efficiency of Use / Severity 3 / Found by: B
Creating each formation from scratch each time is a major bottleneck to choreographing (assume choreographers often reuse formations and there are many standard formations).
Fix: Have a set of premade formations, as well as ability for choreographer to create their own presets, then either build in real time or select from presets while creating a full dance.
Future Feature: We deemed this to be outside the scope of the prototype but agree that having preset formations that users may choose from is a good way to improve efficiency of use and have included it within our future features.

47. H3: User Control & Freedom / Severity 4 / Found by: B
Uploaded song can never be changed for a dance after it is created.
Fix: Add an edit button which can change song and overall time for the dance.
Ignored: An assumption we made was that the use of our app is predicated on having a particular performance to choreograph for, in which the music is already chosen. Perhaps this assumption can be tested in the future.

48. H1: Visibility of System Status / Severity 4 / Found by: B
There is no way to view the actual overall time or current time in the scrubber.
Fix: Understand you want minimalist design but consider when scrubbing adding a current time it's at appear and disappear with touch to that section.
Future Implementation: Though outside the scope of the prototype, we wish to incorporate this feature in the future along with a fully functional playbar.

Prototype Implementation

Tools

How they helped:
React-Native and Expo as tools for development of the main portion of the app served us well in rapid prototyping and being able to development for both iOS and Android.

The ability of React-Native to readily display changes to the project allowed for efficient use of time when building our project and seeing each component come together. In addition, using the Expo client to build our project was extremely quick, taking less than a minute for new, fresh builds of our app.

Expo's included framework allowed us to use existing components such as the SVG graphic tools to draw lines for our transitions or set up the orientation of the screens, both of which were extremely helpful the development of the separate screens. It would have been impossible to create the transitions screens without the help of the existing graphics tools.

For the augmented reality (AR) portion of the app, we used ARKit, Apple's augmented reality framework, and coded for native iOS using Xcode 10.1. This meant there was a large amount of support online for implementing common features in AR apps, such as recognizing surfaces in the real world and placing objects on a surface. This accelerated our ability to bring AR visualization into the app. There is also a lot of resources online for creating UI for iOS through Xcode.

How they didn't:
However, there were some aspects of React-Native and Expo that hindered the development process. Firstly, both react-native and expo are relatively new tools and updates for each occur frequently. During the course of the project, several updates occurred for Expo and at least one for React-Native that broke aspects of our app. Additionally, the documentation for React-Native was limited in both its information of the tools and its usefulness in diagnosing problems. There were a number of connection issues that caused several delays in our development process that included several internet issues as Expo required internet access in order to send the app data over to the testing phone or simulator. Furthermore, it sometimes had random issues where it would fail to understand the "expo start" command in the command line causing us to just change the entire development computer and start over in a new computer.

Debugging with React Native proved to be a challenge as well. Whenever the app would not build, save for some errors such as missing punctuation, React-Native does a poor job in providing information about the error or how one might fix it. Searching for an error message or error code in several forums can yield a multiple of responses that each deal with a completely separate issue.

Finally, in using Expo to first build our app, we had much difficulty ejecting it from Expo and attempting to transfer it over to XCode. After several attempts, each ejected project would fail to build within XCode and we ended up not being able to link the main app with the AR portion.

We began development on Expo through React Native before we realized that Expo did not support AR development on Android devices. It only supported iOS development using ARKit, so our only hope for integrating our app was to develop our AR portion using ARKit.

Trying to develop using ARKit was difficult in that it required having access to a Mac and an iPhone, which were limited resources on our team. Also, on-campus resources that had access to Macs (such as the computer cluster or various libraries) generally did not support Expo or React Native development, which led us to rely on developing AR for native iOS. It was also difficult to align all device versions (between the Mac version, the Xcode version, and the iOS version on the development iPhone) to have a stable development platform. Thus, hardware necessities caused a significant delay in the development of the AR portion of our app.

Also, the default plane detection through ARKit relies on good lighting and an abundance of detectable features to detect surfaces, which results in sometimes spending a while scanning for surfaces before being able to place the dancers.

When it came time to integrate the non-AR portion of our app with the AR portion, we found that Expo did not easily export to iOS, especially when relying upon Expo-specific frameworks. In the end, we were unable to cleanly integrate the two portions in native iOS without re-doing significant amounts of work.

Wizard of Oz
The main portion of the app contains the following Wizard of Oz techniques to give the look and feel of a complete product:
- Both previous projects and new projects route to the same project Overview screen in order to linearize the flow of the prototype
- In order to add dancers to the create screen, you have to tap specific portions of the screen which cause the opacity to change from 0 to 1 and make the dancers appear on the screen
- Default formation cards are rendered for any project's 1st and 2nd formation

- A third, hard-coded formation card is rendered when the user saves the 3rd formation
- Both transition add buttons route to the same transition creation screen
- A dialogue modal pops up when attempting to move formation 3 before formation 2, though no action occurs afterwards

The AR portion of the app has buttons whose functionality is not implemented: the exit (top right) and the share (bottom right) buttons. These buttons indicate features that we would like to implement in the future.

Hard-coded Features

The main portion of the app includes several hard-coded features:
- Previous projects
- Number of formations and transitions for each project
- The same music for each project, new or previous
- The transitions made during transition creation
- Transition and formation flags on the playbar of the Overview screen. Specifically, only the 3rd formation flag is draggable
- The formation cards rendered for each formation in a project's Overview screen

In addition, for any customizable formation, there is a 5 dancer limit as well as a fixed starting position for each dancer.

The AR portion of the app animates hard-coded formations and transitions, along with hard-coded labels for the dancers.

Missing and Future Features

For the main portion of the App, we are currently missing and planning to implement a state functionality that allows users to save their formations, transitions and projects, as well as be able to maintain them between app sessions. Moreover, we plan to integrate the preview button on any project's overview screen with the AR app into one, cohesive app.

Focusing in on the formation and transition creation capabilities of the app, we would like to be able to add more than the 5 dancer limit to our app, anchor dancers to the grid's intersections, as well as draw and maintain custom transitions. Also, we would have a set of premade formations as a potential start to a formation, rather than having each formation be made from scratch.

Additionally, we plan to allow users to either upload music from their device and/or be able to import a song via the Spotify API for each project. Further, we would like to implement a fully functioning playbar that allows users to not only control the music of the project but also manipulate the placement and duration of formations and transitions.

Finally, we would like to enable users to export and share their projects in some format so that others within the choreography may be able to see and practice the formations too.

For the AR portion, we would like to implement a scrubbable play bar, share functionality, and the ability to exit back to the Overview screen. Future features that would enhance the experience include the ability to scale the dancers (by making a pinch gesture on the screen), the ability to rotate the dancers, and the ability to move the dancers. It would also be helpful to create an adaptive UI for other devices and allow switching to landscape mode for a wider field of view.

Summary

For many dancers, the act of drawing out dance formations and transitions is a chore that they must get through to communicate to their team. The formation creation process becomes something to quickly get through, rather than a place for real ideation and imagination. With Let's Dance, we hope that dancers will utilize the mobile interface to instead focus on visualizing new and creative formations and performances. Throughout the quarter, we have prototyped with a wide range of dancers in order to accommodate as many use cases as possible. As we move forward, we would like to implement more functionality to give dancers more flexibility in creation, and also to give dancers more inspiration when creating choreographies.