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The Design of Drone Software for the Enterprise Workflow

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Abstract

As part of Airware's objective to becoming the leading software company in the drone industry, a new platform has been scheduled to be built with new features and added capabilities. At the same, the current platform should still be maintained with enhancements to user experience and visual styling. Following a design process that values repetitive iterations of design and justified decision-making models, which are heavily based on user testing and field observations, the final result of this particular project leads to the creation of two separate products. The first one focuses on the redesign of the operator workflow, and the second one introduces an impactful and long-awaited feature called the Progress Module. Both designs have made significant improvements to Airware's software product, proven by many user testing results which will be discussed throughout the report.

1

Introduction

1.1 Preface

The application of drone technology is becoming more of a trend in many industries, specifically the insurance and construction industry. As an enterprise company that produces leading drone software, Airware designs workflows specific to their clients to capture the aerial imagery needed to produce data analytics. An example use of drones in insurance is to survey a building for signs of water intrusion through thermographic cameras. While the traditional solution is to hire a contractor to inspect a building, aerial imagery speeds up the inspection process and improves the accuracy of analytics at a lower cost. [1] In the long run, this can save an enterprise company millions of dollars in human expenses. To improve the capabilities of their software product, a significant turning point for Airware was their decision to acquire a startup called Redbird. The acquisition resulted in two products for their clients: Airware, which focuses on the flight planning workflow, and Redbird, which produces data analytics following the workflow.

When an acquisition occurs, it is normal for reshuffling to occur to merge the two products into one. From an user experience point of view, this process is important to ensuring that the experience remains cohesive for users on both products. As a quick and easy way to solve the problem, Airware chose to keep clients on their respective platforms while allowing access to the other platform through certain entry points. In other words, the aerial data is gathered and uploaded to the cloud on Airware's side and is then processed through Redbird for further analysis. Clients come in contact with both products depending on the stage of the workflow.

1.2 Situation of Concern

Since the current implementation is a temporary solution to the problem, there are many unsolved issues with it and should be replaced as soon as possible. A huge concern is the inconsistent branding and styling of the two products. An Airware client typically starts

off on one interface and is eventually brought to the other one, which looks and feels very different. With the expectation to only be using one unified platform, this may cause users confusion, especially with different logos and overlapping functionalities.

Initially, the proposed solution was an integrated platform that replaces both products at the same time. After working on it for a month, product managers quickly came to realize that the project would take months longer than anticipated; thus, a new plan was called upon. In the updated plan, Airware's current product is to be redesigned so that any existing user experience (UX) issues are fixed. At the same time, Redbird's platform is to be branded more like Airware's to smoothen any transition points between the two. In addition to the visual revamp, a few new analytics features should also be added to Redbird, since the codebase refactor already calls for code to be replaced. Only after this implementation will the originally-planned platform be worked on.

Without a designer at Redbird, it became evident that a product designer was needed to work on the new project. Specifically, the designer would need to redesign Airware's cloud platform and incorporate new features for Redbird's data visualisation software.

2

Design Problem

2.1 Personas and Use Cases

Middle-aged, white men with potentially poor eyesight make up the average demographic of Airware's operators. To be inclusive of this user persona, all designs on the Airware and Redbird platform have been adapted to use slightly larger text and high-contrast user interface (UI) components. In most cases, mobile design by nature should already incorporate these design patterns to accommodate for its small screen size. In Airware's situation, it is also important for their desktop application to follow the same guidelines so that middle-aged operators can easily use the software.

In addition, the typical use case of the product takes place under direct sunlight, causing screens to be difficult to see. By following Airware's design system, which has been through rounds of field user testing, designers are able to ensure that the usability criteria of the product are met. Specifically, the design would be able to meet the criteria of equitable use, which is one of the 7 universal principles of design. [2]

2.2 Airware Redesign

Understanding that the current cloud application is to be replaced in eight months' time, the key reason that Airware's team continues to allocate resources to the redesign is to provide a constantly updated and refined piece of software to their clients. In the enterprise space, companies pay huge amounts for a customized experience; thus, it is especially critical that the product is geared towards each client's needs. Even though the new plan pushes back deadlines for the unified platform, clients will at least continue to see improvements up until that point. By bringing a new designer on board for that reason, her job would be to complete a product breakdown, to determine the most urgent user experience problems based on discussions with product managers, to determine with the help of engineers the low-hanging fruits from resource-heavy tasks, and to suggest redesign options within an appropriate timeframe.

Requirements

Due to the complexity of the project, the redesign was not laid out with specific objectives from the Product Team. Instead, each feature is to be analysed on a case by case scenario in terms of requirements and constraints. From communicating with relevant stakeholders on the project, the following design requirements were established:

- The solution should improve the overall usability of the operator drone workflow.
- The solution should speed up the job creation process (will be explained later on in detail).
- The solution should allow users to go back and make changes if they make a mistake.
- The solution should be prompt in providing user feedback.
- The solution should be adapted for novice or first time users.
- The solution should make product demos more interesting.

Constraints

Aside from the listed requirements, certain constraints also limited the solutions available to the problem:

- The solution must be implemented within the 3-week deadline. Following the third week, the designer would begin the design of features on Redbird.
- The solution must be designed within the technical limitations of engineers on the project.
- The solution must be consistent with the visual styling of the current application. The designer should refrain from introducing new design patterns to the redesign.
- The solution should not sacrifice the user experience of the more experienced users.

2.3 Redbird Feature Design

As mentioned previously, there are two smaller parts to the project. The second part of it involves the design of new features on Redbird's platform. Specifically, the designer is responsible for a feature called the Progress Module.

To give a bit of context, the operator workflow at Airware consists of the creation of individual "jobs". When drones are needed on a project, the client submits a job request to Airware's cloud, which is then processed by the flight operations team. Airware then sends people out onto the field to fly the drone, which in turn collects the relevant data. This process is also known as a flight survey.

Once data has been uploaded to the cloud, it is ready for analysis in Redbird. While the current workflow satisfies the requirements set out for the original cloud software, clients have commented that they hope to compare the progress of a job to a future goal, or even multiple future goals. Ideally, with this feature implemented, clients would be able to upload map layers, also known as Grades, that predict how the future state of land would look like, and evaluate the current state of a job relative to it. From this, clients would be able to predict if the timeline of a job is on track for completion or if a reasonable distribution of money is invested at each stage of the workflow. Any adjustments to planning can then be made in response to the progress reports.

Requirements

The project focuses heavily on data visualization and requires the designer to propose "dumbed-down" solutions to a complex problem. To ensure the best solution is being delivered, a few requirements for the Redbird progress module design were specified:

- The solution should allow users to upload multiple CAD files to cloud.
- The solution should allow users to create customized alignments and grids.
- The solution should be able to generate grids from alignments.
- The solution should allow users to create a cross-sectional progress report.
- The solution should allow users to create a cut and fill progress report.

Constraints

In addition to the requirements, the progress module must be built within these constraints:

- The solution must be implemented within the 5-week deadline.
- The solution must be designed within the technical limitations of engineers on the project.

3

Design Process

The design process at each company differs, and may even vary from project to project. Typically at Airware, projects are initially scoped out with product managers who are in contact with real users of the product. They then pass along the requirements to the designer, who is responsible for obtaining any further information needed on the project. This may include market research, user interviewers, field demos, or run-downs from professionals at Airware. Many Airware employees have years of professional experience on different aspects of drones, and may even hold industry certifications. Often times, they are the best bet to quickly and accurately acquiring information. Once the scope of the problem is fully understood, the designer goes ahead and creates iterations of a design while keeping product managers in check at certain levels of fidelity. The best designs are filtered with the stakeholders involved, and the final design is selected by bringing engineers on board. More often than not, the "final" design undergoes its own sub-iteration cycles to accommodate for engineering constraints.

Prior to implementation, designs are uploaded to a prototyping software called Zeplin, which converts designs into labelled specifications and occasionally some code. Any assets are also uploaded onto the Zeplin software for developers to download. During the process of implementation, a few one-on-one meetings are booked between designers and developers to ensure pixel-perfect execution.

Being the nature of agile startups, the sprint does not usually end after the first implementation cycle. Especially if the design is part of a larger project, user feedback is retrieved to help determine changes for the next iteration of design. Further user testing may also be introduced to target specific parts of the workflow.

Many features were worked on for both the Airware revamp and Redbird feature design; however only the features with the most impactful results will be discussed in this report.

3.1 Airware Redesign Process

The redesign process is a bit different from that of a normal design. Since there are pre-existing designs to reference, it is important to pick solutions that:

- Fix the main user experience issues
- Maintain visual consistency with the current styling
- Require minimal engineering effort

With results from user feedback and field testing, the designer was asked to provide a list of UX problems for each screen in the application. The list was then discussed with the rest of the team to distinguish between high and low-priority screens. Since there were so many usability problems that needed to be fixed, a modified decision matrix was used to help prioritize the list based on two factors: urgency and engineering effort required.

Table 1: Decision Matrix for Screen Prioritization

Screens	High Urgency	Low Engineering Effort	Total
Weight	**2**	**1**	
Rating: Jobs Creation	3	3	
Score: Jobs Creation	6	3	9
Rating: Geofence Creation	3	2	
Score: Geofence Creation	6	2	8
Rating: Detailed Map View	2	2	
Score: Detailed Map View	4	2	6
Rating: Full Image View	1	3	
Score: Full Image View	2	3	5
Rating: Jobs View	3	1	
Score: Jobs View	6	1	7
Rating: Job Details	2	2	
Score: Job Details	4	2	6
Rating: Edit Job	2	2	
Score: Edit Job	4	2	6

In the decision matrix, each screen was rated from 1 to 3, with the larger number representing high urgency and low engineering efforts. Since the weight is multiplied by the rating to determine the score, higher totals should directly correlate to high-priority screens. Even though all screens were eventually redesigned, the following identifies the three screens of highest precedence:

- Job Creation
- Geofence Creation
- Jobs View

They will be the only screen redesigns discussed in the report.

Job Creation

To create a job for review, the first step should be to enter flight information. Figure 1 shows a screenshot of the current design.

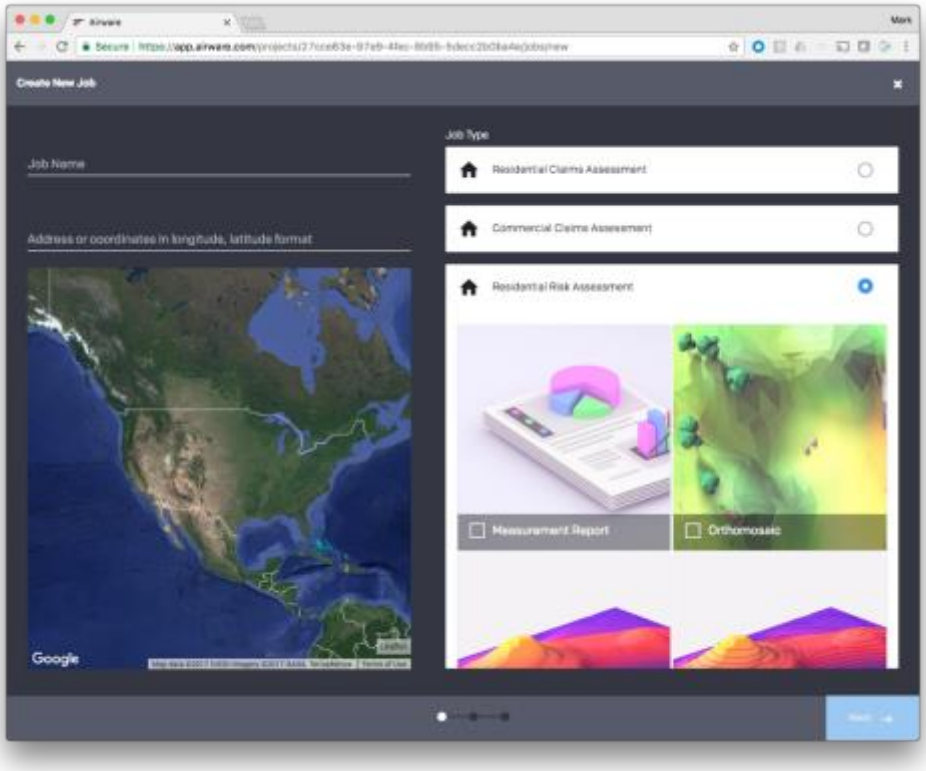


Figure 1: Current Job Creation Screen

To understand problems with this screen, the designer spent a day on field to complete user tests on four different operators. The results of the tests have been summarized in Table 2.

Table 2: User Testing Results for Job Creation Flow

	P1	P2	P3	P4	=
1. Entered Job Name as Job Address					2
2. Skipped directly to Job Address field					2
3. Cannot find the appropriate address listed					1
4. Frustrated with Job Types *					4
5. Blocked from entering next screen due to missing input					1

** Due to the extent of issues experienced by all operators with the Job Types, the user testing results for that section have been grouped into one category.*

From the table, P1 (red) and P2 (orange) represent the two relatively novice users, whereas P3 (green) and P4 (blue) were more experienced. Five different pain points were identified through observing the operators' workflows, some of which affected all operators, some of which only affected one. Since there was a tight deadline to meet, only issues that affected two or more operators were further investigated. Struggles experienced by an individual person tend to be specific to a use case and was therefore lower on the priority chain. By fixing some of the main problems, there is also the hope that some of the minor issues will disappear at the same time.

Analyzing the field testing results above, the first and second points fall under the same category. P1 and P4 both used the job address as the job name, and P2 and P4 filled in the job address first even though it is the second field on the screen. Noticing a trend here, the designer proceeded to conduct individual and group interviews to understand the reasoning behind it. During the group interview session, the operators agreed in consensus that the job address is typically used as an identifier to the job itself. Entering a drone flight zone, the first thought on an operator's mind is the job address, and thus it is important to them

to quickly write it down. It is essential to note that while this indeed accounts for most use cases, certain operators will occasionally be responsible for more than one job with the same address. In this scenario, job name would still act as an important distinguisher.

Evidently, the current order of input fields does not follow a typical drone operator's mental model. As a result, two different designs were proposed to resolve the problem:

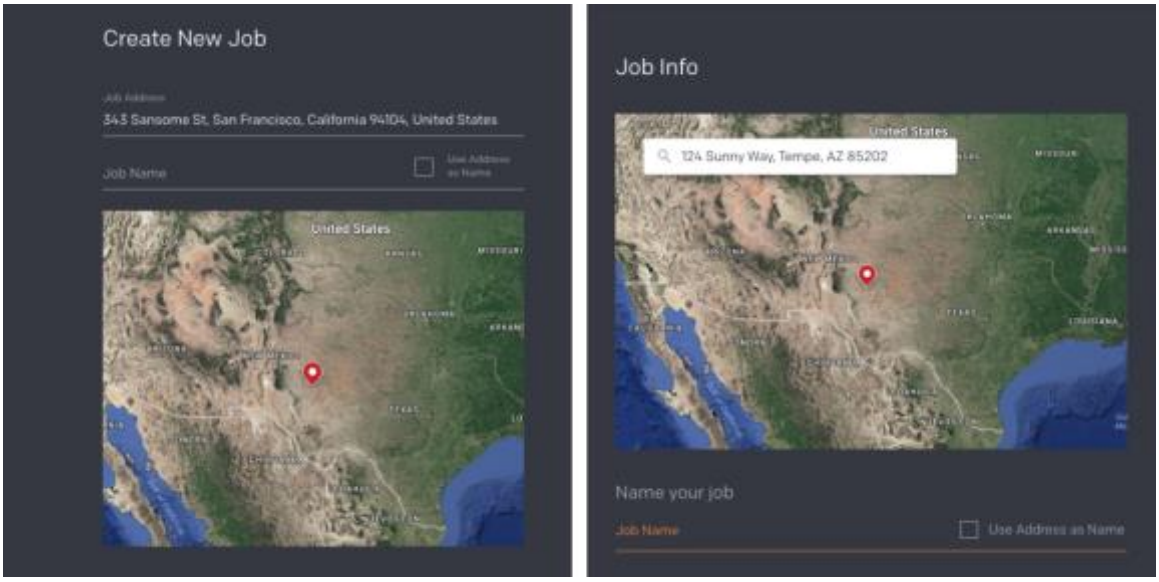


Figure 2: Job Address Design Options

In the figure, both the first and second design were evaluated by the design team; their feedback resulted in another design iteration of this screen which will later be described. While the design on the left follows a mental model where job addresses are considered first, it creates an unwanted physical separation between the job address and map location, causing job name to be sandwiched between the two. This clearly defies Wicken's Proximity Compatibility Principle, which states that "Displays relevant to a common task or mental operation (close task or mental proximity) should be rendered close together in perceptual space (close display proximity)". [3] While this might not be a huge problem for users, it is still not the ideal situation.

The design on the right-hand side of the figure has its own issues. Even though the proposed solution encourages job address to be entered first without separating it from the

map view, it introduces a new search component to the screen, which goes against one of the constraints stated initially. Speaking to the engineering team, the technical effort required for this implementation is not worth the time spent.

As evident in both designs, the new "Use Address as Name" checkbox allows the job name field to be quickly populated with the address, while still providing users with the option to enter a unique job name. Proven by Principle 2: Flexibility in Use in the 7 Principles of Universal Design, flexibility for different users is incredibly important as "the design [should] accommodate a wide range of individual preferences and abilities". [2]

Noticing the orange-highlighted field at the bottom of the screen, the proposed design on the right also illustrates a state change that solves one of the pain points experienced by P2. During user observations, P2 skipped straight to job address to fill in the field but forgot to return and enter in a job name. When he tried to click "Next" to move to the next screen, he was restricted by the disabled Next button without any form of user feedback. This proved to be very frustrating during the minute that it took for him to figure it out. One of Shneiderman's 8 Golden Rules of User Interface suggests that interface designs should always seek to "offer informative feedback", which is evidently poorly done here. [4] However, with the implementation of the orange color, the user's attention would now be drawn to the missing field, offering him/her the appropriate feedback.

While this design solution is already a promising way to address the lack of user feedback, it is always a good idea to consider the different paths to a problem. From Table 2, the data shows two operators entering in the job address first and two other operators using the job address for the job name; this represents a 4 out of 4 ratio where the "Use address as name" checkbox would be useful. Based on these analytics, the "Use address as name" checkbox should be selected by default as it is the more common use case. Data-driven design prevents users from having to make unnecessary decisions, such as whether or not to tap a checkbox, and provides the most frequently used option as the defaulted one. Only in the unlikely case where operators have more than one job with the same address will it then be relevant for them to uncheck the option. This solution in turn minimizes information access cost, which simply means that users should not spend time determining the correct course of action where unnecessary. [3]

Referring back to the design in Figure 1, there were many aspects of the old design that have still not been address:

- The previous spacing of data products is space-consuming and thus inefficient. The supplementary graphics take up much of the screen and do not accurately reflect the data products themselves. Therefore, it does not make much of a difference whether or not to have them there. From a scalability standpoint, accordion cards are also much harder to maintain once additional data products are added to the list.
- Due to the large spacing issue, it is difficult to see the entire selection of data products without scrolling. To temporarily fix this problem, engineers coded in a "scroll within scroll" so that the job type section and associated data products section both have scrollbars. During user testing, it was evident that operators struggled to access the desired options.
- Each job type corresponds to mandatory and optional data products. In the old Airware design, users are expected to know the mandatory options by heart and select them. If forgotten or remembered incorrectly, they typically run into issues later on in the workflow. This procedure is especially frustrating to novice users as they are not familiar enough with the different job types to be able to identify the mandatory ones. Based on Norman's design principles, this can be considered bad design as it relies long-term memory, also known as Knowledge in the Head, which "typically requires learning, and is not easily retrieved". [5]

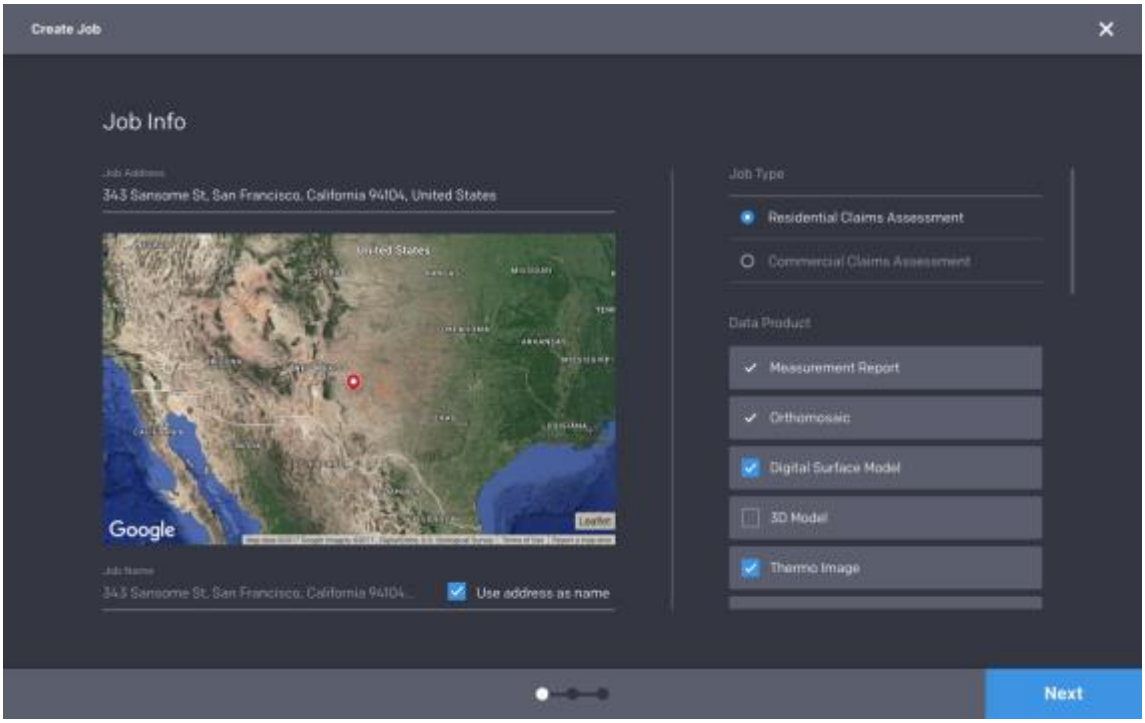


Figure 3: Final Job Creation Screen

Now, looking at the final design on Figure 3, a few changes were made to the right-hand side of the job creation screen to solve the problems listed above:

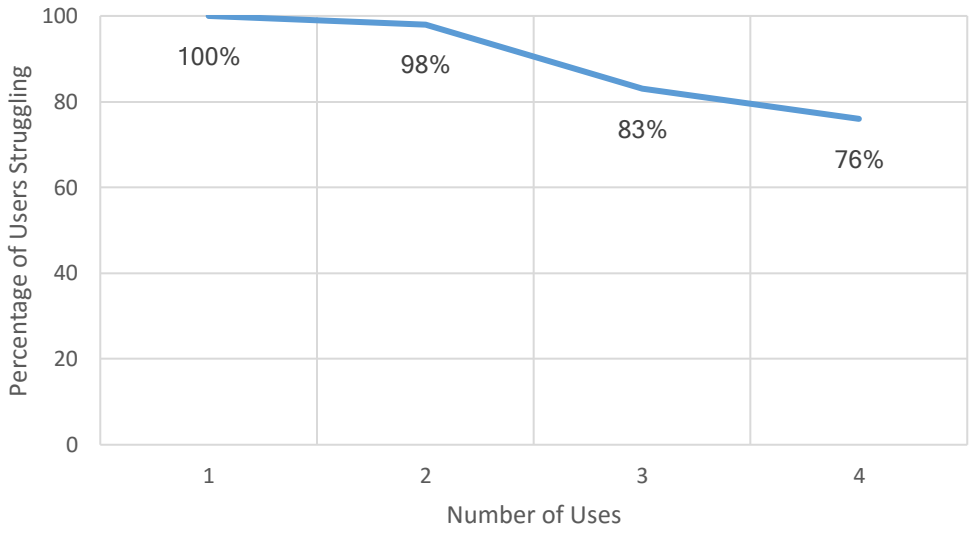
- To remove the double scrolling issue and to prevent data products options from being repeated for each job type, Job Type and Data Product have been split into two separate sections. Based then on the job type that is selected, only the relevant data products are shown.
- To save space, the data products graphics have been removed entirely.
- To maintain consistent styling with the dark UI, all white accordion cards have been replaced with dark UI cards. By convention, the job creation flow follows a dark UI and the rest of the workflow follows a light UI. This is the only section in the product with a light on dark interface, and thus should be changed.
- To differentiate between mandatory and optional data products, a preselected checkbox state has been introduced. Any additional data products can be selected if needed.

With these changes, the job creation screen was brought into production.

Geofence Creation

Part 2 of the job creation process involves defining a geofence. A geofence is an area of land that a drone flies over. Based on the area that is defined, Airware's software calculates the most optimized flight path based on time of flight and battery available. Through interviews and field observations of clients using the web application, this step has proven to be the #1 most confusing part of the operator workflow, especially for first time users. In fact, the data from Chart 1 shows that 100% of first time users are unable to figure out how to add and remove geofence vertices, and 76% of users are still struggling with its functionalities after using the interface 4 times.

Chart 1: Percent of Users Struggling with Geofence Creation



As can be seen in Figure 4, there are no instructions or prompts that indicate to users how a geofence can be defined or modified. While it makes sense to drag geofence points to move them, deletion and addition of vertices are not conventional UI interactions.

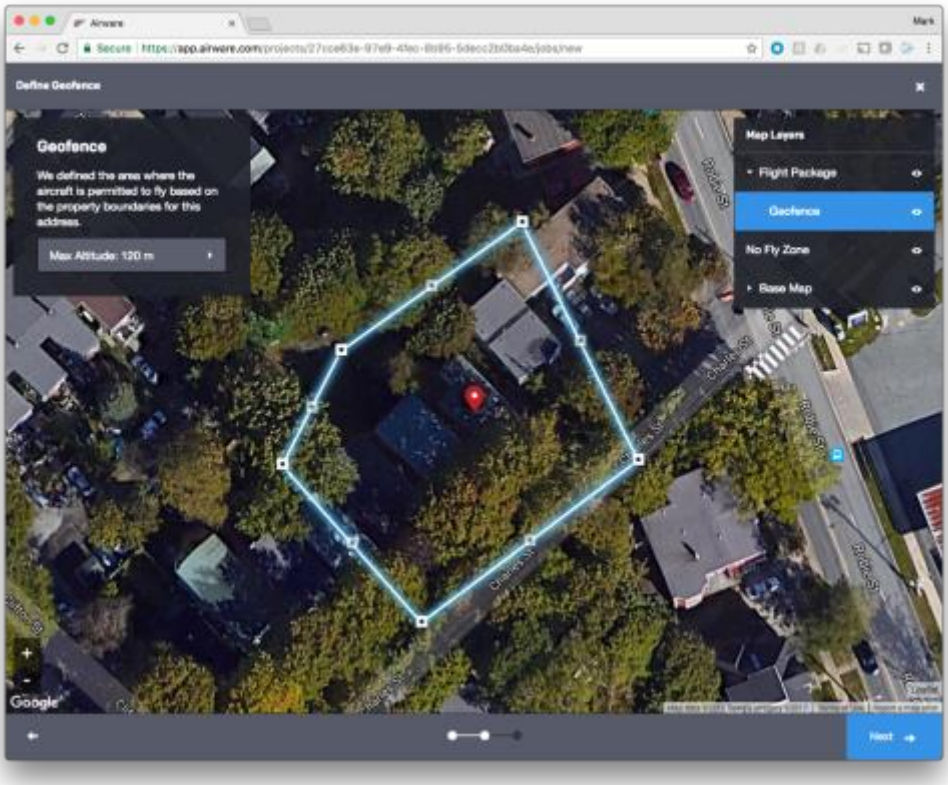


Figure 4: Current Geofence Creation Screen

Many solutions were proposed during the initial wireframing stage of the design process, with two of the most promising solutions being a first-time user experience (FTUE) and on-screen animated prompts. However, when presented with both of these low-fidelity mockups, 8 out of 10 in-field operators commented that they would find more use in having static on-screen reminders. While it is important for designers to be able to consider the problem at hand without being externally influenced, this situation calls for a case where “the user knows best”. Evidently through testing, the FTUE proved to be ineffective in solving the majority of the problem as it would only be seen by first time users. Animated prompts only appeared after a period of time and thus was not a proactive solution to the common problem. In addition, both solutions relied heavily on engineering effort. After multiple iterations, the designer came up with a design proposal that incorporated the suggestions from users, as well as some input from the product team.

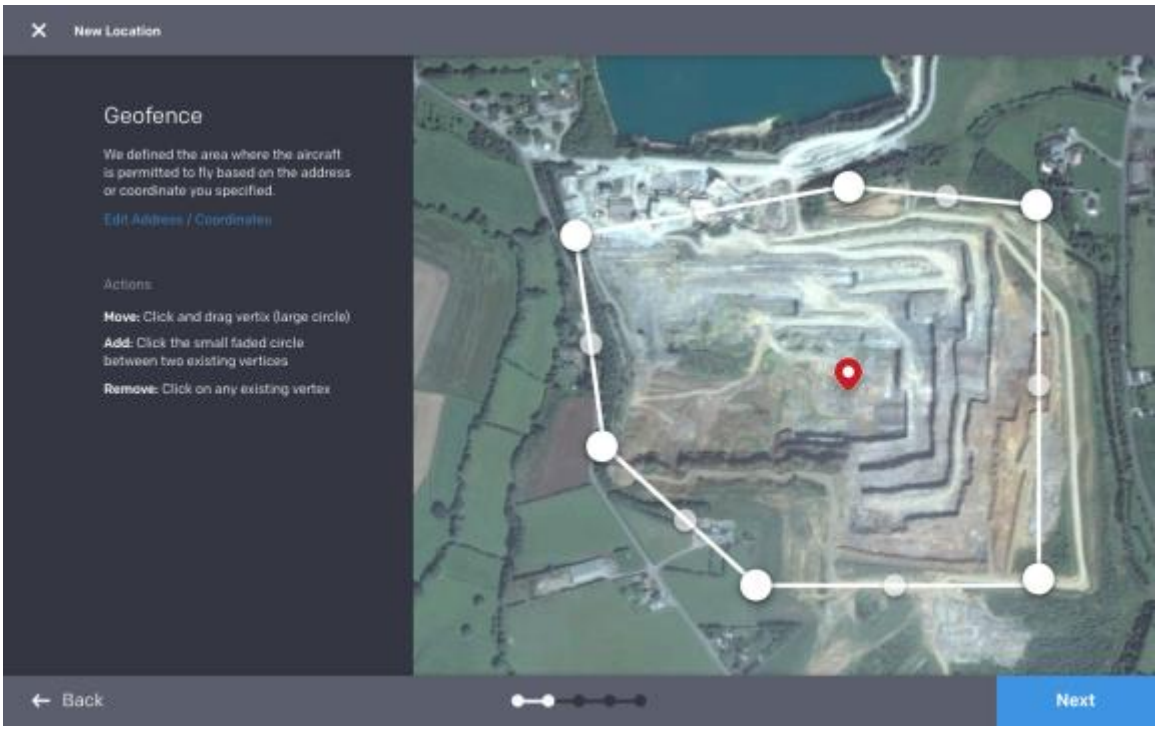


Figure 5: Iteration of Geofence Creation Screen

In Figure 5, the screen now explicitly states the allowable on-screen actions: move, add and remove. The vertices have also been switched to large round circles to be easily differentiated from the smaller, lighter-colored circles, which can be clicked to create new vertices. Previously, users could click anywhere between two existing vertices to add a new vertex. By restricting them to create new vertices between the centre of two points, fewer interactions are available to the user. Minimizing information access cost is part of the 13 Principles of Design and states that it is sometimes better to provide users with less options, since it prevents them from being overwhelmed with too many possible choices. In fact, in most cases, users are more satisfied with a few good options. [3]

Surprisingly, despite thinking that Figure 5 was a great first shot at the problem, that was not the case when the new user testing results returned. Indeed the new design successfully trains novice users to define geofences, it consequently also increased the frustration levels of the experienced users due the addition of the instructions panel, which covers up much of the map. This revelation led to one final sprint of design iterations. Only this time, the designer focused on laying out information in a highly-visible manner without

being obtrusive to screen. Considering everything from dismissible overlays to on-screen modals to customizable user views, the final design of the geofence screen was settled upon.

Figure 6: Final Geofence Creation Screen

Figure 6 shows the final iteration of the geofence screen that was sent into production. This design saves a lot of the on-screen space, and still relays the information in a clear, highly-visible manner. Depending on whether the users' experience levels, they also have the option to "hide" the information as needed. For new users, the modal is expanded by default so that they are initially exposed to the capabilities of the geofence screen. Once the user hides the popup for the first time, it remains closed until he/she taps on the question mark icon again. By targeting the experience to different users, Airware's design once again satisfies an important usability principle called equitable use. [2] To add on a fun touch, the icon interaction comes with a nice bouncing animation that visually enforces the location of the icon in the user's memory. It makes use of the principle of multiple resources, which suggests that information can be more easily perceived using more than

one sensory channel. [3] By applying the principles of usability, the design successfully reduces friction points for users of all levels of expertise.

While redesigning the screen to optimize for geofence creation, a few other changes were also added to fix some of the minor issues noticed during field observations. The changes are reflected in Figure 6.

In the map layers section of the old design, tapping anywhere along the text field activates the downwards expansion of any sublayers, leaving only a small tappable area for the layer visibility toggle, as represented by the eye icon. In reality, map layer visibility is toggled on and off much more frequently than the downward expansion arrow. Typically, the operator uses only a few map layers and leaves the section expanded based on his/her layer preferences. Since Airware's software stores the user's settings after each use, there is not a constant need to collapse and expand layers even though it is a good-to-have for customization purposes. By switching the eye icon and the downward arrow, the primary user action is now activated by tapping the majority of each legend field, with a smaller tapping area for the more infrequent interaction. Although unlikely, the proposed design still satisfies the need to collapse a field to support the use case when there are large amounts of map layers. Specific to that use case, the entire legend can then be collapsed altogether using the dropdown icon beside the Map Layers text.

In many modern day software applications, the back button and the close button are mistakenly used interchangeably. Noticing the inconsistency in Airware's platform as well, the exact differentiation for the usage was established in geofence creation screen (Figure 6) and adapted to other parts of the application for consistency. Specifically, in the proposed design, the close button should always be placed at the top right corner of the screen or modal, whereas the back button should be at the bottom of the screen in line with the dotted workflow navigator. Based on its positioning, it becomes very clear that the close button exits the entire workflow and that the back button returns users to the previous screen. To further illustrate the point, the actual word "back" has been added beside the back navigation arrow, as well, the entire "back" button is now located to the immediate left of the "next" button. The Proximity Compatibility Principle states that similar

functionalities should be located closer together to support the user's mental model, and the navigation design in Figure 6 makes good use of this. [3]

Finally, the last feature redesigned was the base map layer. In the current design (Figure 4), "Base Map" is a layer type under "Map Layers". In the proposed design, the base map layer has been taken out and relocated to the bottom left of the screen as a map toggle. Toggles are not components that should belong under map layers, which are of a different selection type. Toggles by nature are mutually exclusive selectors, meaning that when a base map is selected, a different base map cannot be selected at the same time. [6] By contrast, multiple map layers can simultaneously be toggled "on" as seen before in Figure 6. Since there are only two base map layers to toggle between, one of them must always be the current state of the map. Thus, the design proposal suggests that the base map toggle be placed beside zoom in and out icons on the bottom left of the screen. To help users differentiate between the two base map layers, a small live preview is used as the background of the toggle. Users can now switch between Street View and Satellite View with one easy tap. Commonly used features like base map toggles should not be hidden under a layered menu setting, and should rather be at a high-visibility location.

Following this redesign, new UX patterns were established for map layers, back and close buttons, and base map toggles, and were later integrated throughout all of Airware's designs. The entire objective of the redesign was to fix usability issues, and even these small changes have made a difference in the consistency of the application.

Jobs View

While there were many parts to Airware's redesign, the sections that were analysed were the ones that made the most impact on the product. With a constraint being the 3-week deadline of the project, most of the features focused heavily on reducing the frustration levels of users at different stages in the workflow, as well as improving the overall efficiency of the product. The introduction of a new Jobs View was another impactful feature that addressed two major requirements:

- The product should be tailored to first time users.

- The design of a screen should be intuitive enough for clients to quickly understand product demos.

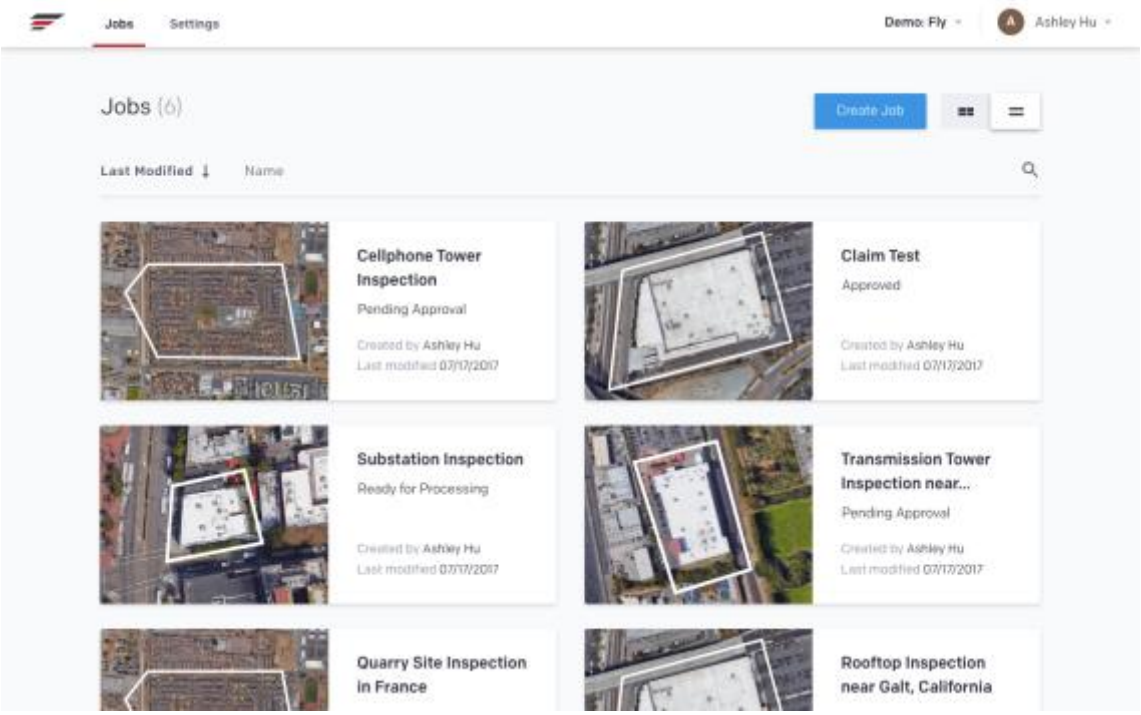


Figure 7: Card View Design for Jobs

Prior to the redesign in Figure 7, all jobs were displayed in the form of a list as shown in Figure 8. While lists are efficient for comparing data and conserving space, it is not the most effective method to display information for most use cases of Airware's platform. Because it is highly uncommon for there to be more than 10 jobs per project, fitting 6 cards a page still does not require a lot of scrolling for users. In addition, since jobs are by default ordered in a time-based fashion, the first few cards are usually the most relevant to the operators; thus it is unnecessary too show more than a few jobs within the viewport of the screen.

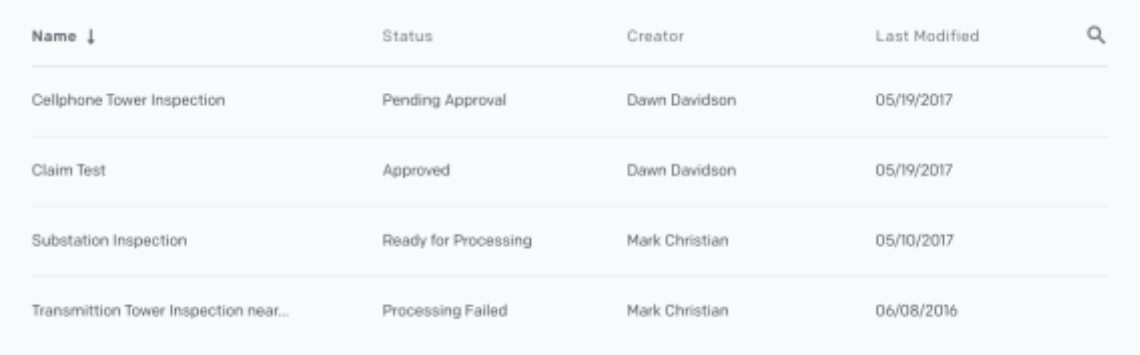


Figure 8: List View Design for Jobs

When an operator is responsible for multiple flights, it benefits the operator to have visuals on screen which can help identify the location of the flight within clicking into the job. Following the Airware style guide, information hierarchy helps draw out the most important pieces of information, i.e. it is visually evident that the name of the flight proceeds the importance of the job status. List items on the other hand tend to have the same font and font size due to its limitations within a table.

Specific to the two use cases mentioned before, the addition of a card view especially improves the first time experience and product demo experience. These two use cases are both very important to Airware as an intuitive first time experience reduces operator training time and an engaging product demo can bring the company large sums of money. Unlike consumer-facing companies, enterprise startups do not rely on the number of sales, but rather the dollar quantity of each sale.

As a first-time user, the operator would only be able to see one demo card and nothing else. In this scenario, a list of jobs looks particularly empty since there is only one item. During product demos, clients generally prefer visuals to help understand the capabilities of the product. Since drone applications are still a very unexplored space in the technology industry, it is sometimes very difficult to gather large clients on board due to the risk that new technology poses. Being ahead of the bandwagon, it is essential for Airware to capture the interest of any potential clients and to ensure that they see the value in Airware's product. With the new card design, potential clients can already see a preview of the drone flight path, along with any completed analytics, prior to clicking into a job. The glimpse of

the functionality assists in grabbing their interest in the product. Since implementation, Card View has been the only view used in Airware's product demos.

For these reasons, card view has become the defaulted view on the Jobs page. If needed, users can always resort back to the list via the toggle at the top right corner. Beyond a certain number of jobs, the software automatically reverts to list view to support quick scanning and efficient use of space. Excluding developer unit tests, this limit has never been reached to this day.

3.2 Redbird Feature Design Process

Being a new product that has been integrated in Airware's workflow, this is the perfect opportunity for changes to be made on Redbird's platform since the codebase is to be replaced anyway. As part of the redesign, one main feature was specifically added as per requested by many clients: The Progress Module.

The goal of the progress module is to provide users with a workflow to create their own data analytics that they can compare to. Operators can upload map layers to the cloud monitor the current progress on the field relative to that. For example, if the purpose of the job is to pave a road, it is important to clients to have a constant, updated understanding of how much of the road has been filled so that the appropriate measures can be taken to finish the project on time.

To kick off the second part of the sprint, market research was done on competitive products to understand how other map interactions work. The report will dive further into specific competitive analysis results for specific parts of the feature. Maps in particular are difficult to design due to the number of interactions that are associated with it, such as zoom and pan. The problem is especially challenging as a result of the heavy data analytics required for this project, which involves additional map interactions that might not be conventional to users.

In this project, since there were so many design aspects to the Progress Module and many different entry points where operators may be included in the workflow, the IA chart was an important step to sorting out where new screens should be added and to preventing any repetitive entry points. The designer is expected to propose a solution that keeps the

workflow as simple as possible while maintaining the design consistency throughout the application.

Product-Specific Use Cases

To understand objectives of the progress module, the designer interviewed the clients who recommended this feature to begin with. During their interview, many clients described the user scenario of this product, as well as how it would fit into their current workflow.

Currently, operators submit a request to the cloud and wait for approval. Once the request has been approved, they go out onto the field to fly the drone and retrieve aerial data which is then uploaded into the cloud. This data represents the current state of a job. Ideally, with the addition of the progress module feature, the operator would be able to upload multiple CAD files to the cloud to compare with the current state of the job. From these uploads, the operator would be able to interpret the amount of area that still needs to be cut and filled for an area of interest, as well as the elevation difference between the current and final grade. The reason that multiple CAD files can be uploaded is to allow for different checkpoints to be monitored in the job process. For example, an operator might want to understand how much more needs to be cut and filled to meet the deadline at the end of the month. The same operator might also want to know how well the job is progressing relative to the final state of the job a full year later. Usually, clients using this product are on large construction projects; thus there are many checkpoints along the way.

Specific to Redbird's platform, two different use cases need to be considered, both of which share the user scenario described before. The first use case targets the creation of a quarry, which is a large area where materials are extracted for mining. [7] Many parts are involved in this workflow, such as construction path optimization, analysis of safety berms and blocks, and blasting operations. In order upload future grades for quarries, a stationing layer needs to be uploaded along with the grade to properly overlap the CAD file on top of the aerial data. All data can be viewed as map layers that are piled on top of each other and that can be toggled on and off as needed. For the scenario of quarries, the operator has the option to upload a grid with labelled coordinates. This grid is overlapped above the uploaded future grade which is above the aerial image captured by the drone.

Figure 9: Quarry Use Case

The second use case of the progress module is for haul roads. Haul roads are long, windy paths designed for the bulk transfer of materials. [8] The stationing required for this situation is much different from that of quarries as roads use an alignment instead of a grid to position the future grade on top of the drone data. Alignments are simply one long, curvy vector layer with predefined coordinates along the path. Unlike quarries, where straight cross-sections of grids can be used to identify sections of the area, haul roads follow a path and do not take up much area. While it may also be useful to upload a custom grid, most of the times it is more useful to generate a grid from the uploaded alignment. That way, this automates some the operator's, and the grid still follows the path of the alignment.

Figure 10: Haul Road Use Case

Understanding how the use case of the grid versus the alignment can be confusing to differentiate, the following settings section was designed to guide users through the uploading process. If the toggle is set to “Use Custom Grid”, the Grid Generation section below is hidden so that irrelevant information is not shown. This follows one of Nielson Norman’s Usability Heuristics called Aesthetic and Minimalistic Design, which emphasizes that “Every extra unit of information […] competes with the relevant units of information and diminishes their relative visibility.” [9]

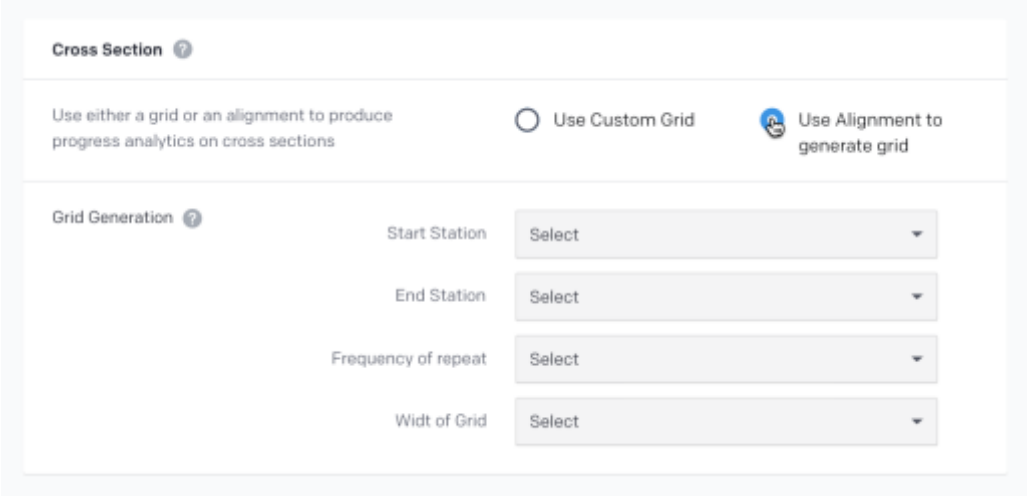


Figure 11: Grid Generation Settings

For quarries, operators will generally use this option with an alignment. For all haul roads, it is best practice to upload an alignment so that the future grade layer is properly aligned with the aerial map layer. For this to happen, operators attach an alignment in the previous settings section and select “Use Alignment to Generate Grid” in this section. The use of the toggle makes it clear that the options are mutually exclusive and that one option must be selected at all times. If no alignment has been uploaded, the “Use Alignment to Generate Grid” toggle is disabled, directing users to upload a custom grid instead. In contrast, Grid Generation is hidden if a grid has already been uploaded.

In an iteration leading up to this design, settings were split up into 2 sections: Cross Section and Grid Generation. If users chose “Use Alignment to Generate Grid” for the cross section, then they would go on to the next section and enter details for grid generation, i.e. start, end, frequency, and width. Otherwise, they would simply leave the section blank. From user testing with the design team, many commented on how the described upload process was disjointed from one another. It was unclear in conveying that either option needed to be selected at any given time. In addition, there was no prompt that led users to the grid generation process. Some users would not fill it out even though they only uploaded an alignment, and it confused other users to leave it blank even though they already uploaded a grid. The final proposed design follows the concept of a Tab component, which only displays information relevant to the selected tab. Similarly, the active toggle state acts as a tab which alters between hiding and showing the additional grid generation.

When designing for complex systems, it is important to ensure flexibility in the usage of the platform. The design proposal shown above allows operators in both use cases to be effectively guided through each respective workflow without confusion. Unnecessary options should not be given, and users should always be able to make changes to their decision if necessary, as proven by Principle 5 of the 7 Universal Principles of Design: Tolerance for Error. [2]

Core Functionality

There are two main functionalities to the progress module: Cross Section and Volume. After the future grade has been correctly aligned on top of aerial drone data, elevation and volume are metrics used for progress analysis.

Cut and Fill

From clicking on any of the grids in Figures 9 and 10, a small modal pops up from the center of the grid providing information on the cut and fill of the selected area. As seen in Figure 12, this modal analyses the amount of cut and fill completed relative to a specific grade, which can be changed in the "Compare to" dropdown in the design below.

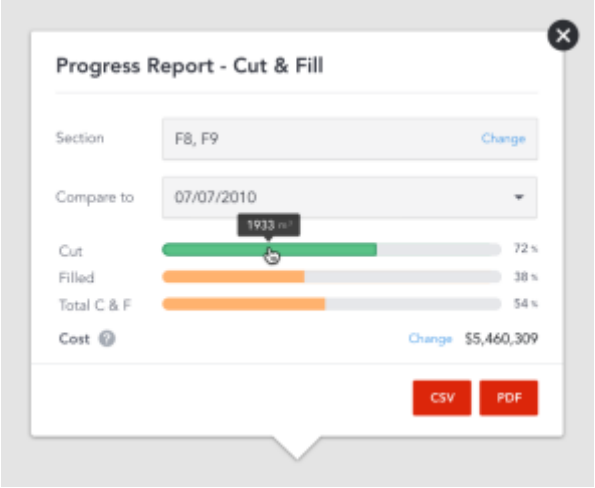


Figure 12: Cut and Fill Report

When the requirements of the project were initially defined, product managers wanted the design to be as simple as possible due to engineering limitations, even recommending that the number values should just be laid out in a list form. However, working with operators on the field, they are usually exposed to many numbers at the same time and it can be difficult to pick out the more relevant ones. In addition, numbers are important to a certain extent, but often, the visualization of numbers can convey information more clearly. For example, comparing a data table to design on the left in Figure 12, the progress bar clearly showcases the amount of material that has been cut relative to the goal. If an

operator would like to see the information in more detail, they can then hover over the bar to get the specific value. From interviewing in-field operators, the percentage tends to be the more important value, since operators have access to much larger and more detailed dashboard when in front of a computer in an office.

When designing a solution to a problem, it is sometimes necessary to take a step back and reanalyse the requirements of a project from a user's point of view. Without field observations, the design would have follow the specific suggestions from a product manager, which would not have been the best way to display the information. Evidently, in the proposed design the percentage value is obviously visualized, whereas the volume is more hidden.

To tailor the modal towards each project, the design allows operators to select the orange, green and red zones of the process bar. In the beginning, the design used each ~33% checkpoint to change colours. From speaking to clients, it became clear that a good and bad zone can vary greatly from project to project. While 50% completion might be very behind for one project, it might be a huge step up for a different project. Thus, in the settings menu, operators are allowed to define the ranges for being behind, on-time, and ahead of schedule. This not only allows accuracy in terms of the colour representation, but also provides flexibility and control for the operator to tweak the ranges if there are any timeline changes. This is an important concept described in Wicken's Principles of Display Design. [3] These ranges also play a role in the cost calculation of the report, which factors in time, cost of labour, and cost of material.

One key aspect of the cut and fill report that underwent many iteration cycles was the section selection interaction. From Figure 12, the cut and fill popup is triggered from selecting one or multiple grid items. While the requirements and constraints were loosely defined in the beginning of the project, field operators follow a very specific mental model when it comes to map interactions. While it is easy to design for the map interaction of one grid item, it becomes very difficult to incorporate multiple select since clicking the map already activates a popup. Therefore, the designer's job is to propose a solution where clicking the map does not trigger any other interaction, so that operators are able to select more than one grid.

Keeping in mind that any complicated, customized map interactions are expensive for engineering implementation, as maps consist of so many layers that any additional or customized ones become challenging to add, the designer turned to competitive market research to understand how other product handle multiple select interactions. The three most promising solutions came from Redfin, Photoshop and AutoCAD. The following chart describes the pros and cons of each:

Table 3: Multiple Select Pros and Cons Chart

Company	Solution	Pros	Cons
Redfin	Using an intermediate modal to choose between single and multiple select	Differentiates between single select and multiple select very clearly. Users will not forget how to do either since the intermediate modal always pops up.	The current solution for single select allows the report to immediately popup. With the addition of an in-between modal, it will reduce the one-click efficiency of single select.
Photoshop	Having a multiple select icon on the side that can be activated by clicking it (similar to pan, zoom)	Easy to access multiple select state. Easy to toggle state on and off.	Clusters the screen with more icons. Bad pattern to follow because will end up like Photoshop.
AutoCAD	Shift + click to multiple select with a reminder tooltip on hover	Does not require any additional UI components.	Not a conventional way to interact with a map layer. May be difficult for users to pick up.

As evident in previous mockups, the third option was chosen as the final solution to the problem. To choose between the three options, the design was adapted based on the user testing results. During user testing, 15 operators were asked to rank three low-fidelity mockups of the above options in the order of one to three, with one being the most preferred and three being the least preferred. The option that was most preferred was option 3, with its tabulated sum leading option 2 by 12 points.

Through post-testing interview, there were a few reasons why option three was preferred over other options:

- The primary user persona of the Redbird application are men with experience with CAD softwares. Unlike Photoshop, which uses an icon to activate selector states, CAD softwares typically use shift and click to select multiple items. CAD programs also use click and drag for multiple select; however, that is not an option for maps since click and drag is a designated interaction for pan. Thus, the mental model of most operators is already aligned for the shift and click action and does not require much effort to pick up.
- Option three is the easiest mode to activate once operators are familiar with it, since it does not require any additional steps. Instead of remembering to toggle a state on and off, it is much simpler to let go of the shift key when not in use. Essentially, option three requires less thinking if the operator knows the interaction.
- It does not clutter the workflow with more icons or screens. The only extra component that operators see is a hovering tooltip.
- It was originally a concern that certain computers would not handle shift and clicks as well as others. This is no longer a concern because Airware now provides operators with standardised hardware, including computers, thus the hardware capabilities should not vary significantly from operator to operator. This keeps the product consistent among users and makes sure they are engaging with the newest technology.

The multiple select interaction was one of the hardest features to design for because there was no similar design pattern throughout Airware's or Redbird's platform. Thus, to come up with a new interaction required more data to back up a decision then a normal

design would. Now, operators are able access the cut and fill popup with one click, or be prompted to shift and click to open up the pop up for a few selected grid items.

Cross Section

The final feature to the Redbird project is the cross-sectional report. As another requirement of the project, the users should be able to get a cross sectional comparison to a future grade from clicking on any grid or alignment. Figure 13 showcases the use of the report on a quarry.

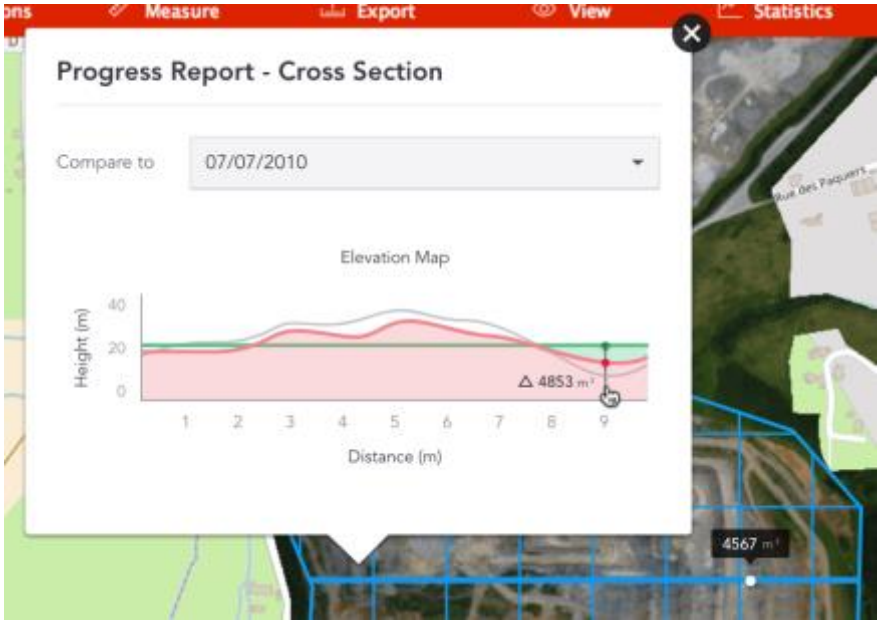


Figure 13: Cross Sectional Report

When an operator clicks on one of the uploaded or generated lines on the map, the report popup appears with information on elevation height relative to a chosen grade. This future grade, which is usually named as the date the goal should be met, can be changed to any other grades under “Compare to” depending on what has been uploaded. From there, operators can see the current cut and fill progress, the red line, compared to the selected future grade, the green line. The colored in area between the red and the green is the difference in elevation height, and can be shown by hovering over any x-value along the elevation map. The interaction is also reflected on the actual grid as represented by the white dot on the blue lines. In the Figure, a triangle beside a value represents the specific

difference in height, whereas a simple value without a triangle represents its exact height at that location. The grey line shows the original grade from the day one of the job.

In most cases, the purpose of the job is to blast the land and make it flat, which is why the grey line appears the most elevated compared to the flat green line. If the representation of any colored line is forgotten, there are many hover actions that have been designed to remind users, i.e. a tooltip with the text “future grade” shows up if the user hovers along any point on the green line.

Throughout the design of the cross-sectional report, an additional requirement from introduced from the initial problem definition. Operators should now be able to control the width of the cross section that they select. Originally designed by engineers, a “drag” solution quickly implemented as a temporary solution. In Figure 14, operators can drag the left and right sides of the elevation map to control the width of the selected cross section, as well as the center of the x-axis to move the cross section over.

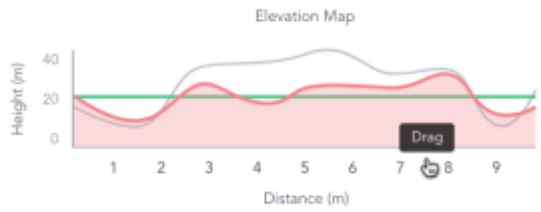


Figure 14: Width Adjustment Option on Elevation Map

During testing, there was a lot of negative feedback regarding the complicated drag action. Even though there is a tooltip to explain how the width can be adapted, it is best to stray away from complex actions within modals. Through the same user testing, it was determined that operators should be allowed to draw their own customized cross section instead of being able to control the width of a cross section. Since the cross-section modal is activated from clicking an alignment or grid, it is confusing to adjust the width of the view without seeing any changes reflected on the alignment or grid itself. By giving operators the choice to create a custom cross-sectional area, this solves the problem

separate from the concept of any alignments or grids. Figure 15 shows an example of an operator defining his own cross-sectional area.

Figure 15: Custom-Defined Area

As a result, the open-ended solution also opens up the pattern to be used in other map interactions. For example, a custom cut and fill area can also be created to allow flexibility in the volume analytics produced by the progress module. In this case, operators do not even have to select grid areas for analysis and can draw out an area more relevant to their area of interest.

4

Conclusion

4.1 Discussion of Results

Throughout the process of the project, the designer went through many iterations of designs and user testing before arriving at the final solution. The following were the initial requirements for Airware's redesigned platform:

- The solution should improve the overall usability of the operator drone workflow.
- The solution should speed up the job creation process (will be explained later on in detail).
- The solution should allow users to go back and make changes if they make a mistake.
- The solution should be prompt in providing user feedback.
- The solution should be adapted for novice or first time users.
- The solution should make product demos more interesting.

Upon implementation, the redesigns received extremely positive feedback from clients, representing the designs were successful in addressing many of the problems that they were experiencing. In fact, user satisfaction was boosted by 56% following the release of the updated software to the public.

The following were the requirements for Redbird's progress module feature:

- The solution should allow users to upload multiple CAD files to cloud.
- The solution should allow users to create customized alignments and grids.
- The solution should be able to generate grids from alignments.
- The solution should allow users to create a cross-sectional progress report.
- The solution should allow users to create a cut and fill progress report.

Since the Redbird feature is still in production, it is difficult to acquire quantitative results on the success of the designs. However, based on user testing results discussed in

the report, Airware predicts that the design will be successful in providing clients with an effective solution to job progress tracking.

4.2 Recommendations

Many of the client recommendations have already been included in the iteration cycles of design. As it is now a good place to move forward with the unified platform, one recommendation is to improve the integration of Airware and Redbird. Even though the two both satisfy their individual clients, the design solutions discussed above to not solve any of the integration problems between the two platforms. Time and engineering effort are both huge limitations, but once time is invested into the creation of the unified platform, Airware's product will definitely surpass any other drone software solutions currently on the market.

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