

Gourd Guardian: Jack-o-Lantern Tracker

FINAL REPORT

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1. Revised Project Design

1.1 CHANGES FROM SE 491

During the second half of our senior design project, we made several design changes in an effort to better adjust to the needs of our client and deliver the minimum viable product in time for the event. The major design changes are the following:

- No support for admins or visitors to take photos of the pumpkins and recognize the stencil. Due to the limited data we had to train the image recognition model, we predicted we would fall behind the schedule if we pursued it more. We instead focused on developing a viable product that our client can use in the 2023 Spirits of the Garden Event to track the status of the event.
- The Visitor page is no longer available. Since the only use case for the visitors of the event in our project was recognizing stencils, we decided to focus more on admin and volunteer users.
- Admins no longer have a dashboard upon sign-in. Once we started developing the application, we realized the services previously displayed on the dashboard could be more succinctly categorized into Navigation bar items. This change improves the user experience by simplifying navigation and keeping the information where they are most relevant.
- Finally, we decided to make changes to the architecture of our application by migrating to Supabase, where we can take advantage of its user authentication, real-time database, and storage services all in one place instead of manually managing them on our own. Below is the updated block diagram of our application.

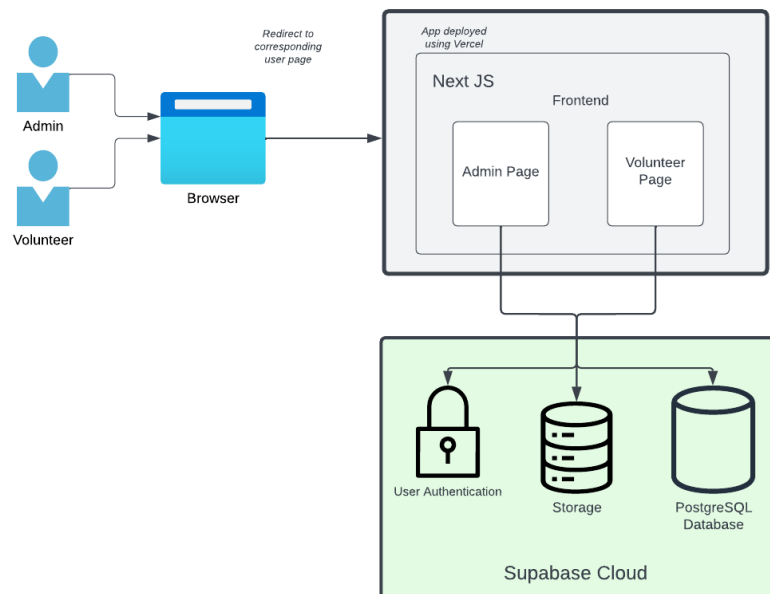


Figure 1. Application block diagram

1.2 FUNCTIONAL REQUIREMENTS

Tracking System for Stencil Status

- a. The app must allow *admins* to...
 - **search** stencils using their code.
 - **edit stencil info** (i.e., name, category, code, image).
 - **sort or categorize** stencils as desired (i.e., by category, status, and week used).
 - **upload stencil PDFs/images** into the system (can be local as long as it's unified).
 - **update status** efficiently (status: printed, cut, traced, and carved).
 - **approve** stencils that are in the pending status queue (i.e., for ensuring that stencil code is written at the back)
 - **print stencils in one go**, using the same print settings for all stencils.
 - **select** stencils that will be used for the current year and which weeks they will be carved or displayed in the event.
- b. The app must allow *volunteers* to...
 - **input stencil code** to see its status (traced or carved).
 - click a button to **start or end the current stencil process**—tracing or carving.

1.3 NON-FUNCTIONAL REQUIREMENTS

- The UI should be intuitive and fluid across mobile or desktop browsers.
- The app must have a search box to type in stencil code for searching.
- The app must include as few clicks as possible for each operation.
- The app must show thumbnails of stencil images so that users can know how it looks without loading another page (i.e., during the stencil selection process).
- The app must not show any possible copyrighted stencil images.
- The app must be maintainable for the admin users to use throughout the years (i.e., let variables be settings editable for admins).
- The app must be accessible in the United States and, more importantly, inside Ames, IA.

1.4 ENGINEERING STANDARDS

- **12207-2017 - ISO/IEC/IEEE International Standard - Systems and software engineering -- Software life cycle processes ([link](#))**

This standard will guide this project's development as it provides a common framework for software lifecycle processes. The project will utilize processes that are defined in this standard that are geared towards agile software development as well as pointers for requirements gathering and documentation.

- **29119-2-2021 - ISO/IEC/IEEE International Standard - Software and systems engineering - Software testing -- Part 2: Test processes ([link](#))**

This standard will guide software testing practices in developing the web app. The group will consult manual and automated testing practices defined in this standard.

- **29148-2018 - ISO/IEC/IEEE International Standard - Systems and software engineering -- Life cycle processes -- Requirements engineering ([link](#))**

This standard will serve as a guide for good requirements definition on the software and how to apply these requirements effectively on the web application.

- **W3C standards: Best practices for mobile web applications ([link](#))**

This is a helpful resource for standards or recommendations for web development. The standards/recommendations regarding mobile web interface, APIs, HTML, CSS, and HTTP will be helpful for this project.

1.5 CONSTRAINTS

- **User experience:** The application must provide an intuitive and user-friendly interface that meets the expectations of the intended primary and secondary audience.
- **Cost-Efficiency:** the app must be designed to be cost-effective and developed with a keen eye on budget, resources, and time constraints.
- **Data Persistence:** Stencil selection and Event management data must stay consistent through each app refresh, ensuring admins do not lose inputted data when refreshing the application.

- **Cross-Browser and Platform Compatibility:** The app must be developed to operate across various web browsers, operating systems, and devices such as desktops, laptops, tablets, and smartphones (for volunteers).
- **Optimal Performance:** The application must be meticulously designed and optimized for swift loading speeds and minimal latency, guaranteeing a smooth and uninterrupted user experience.
- **Security Measures:** Must be developed with security best practices, ensuring secure connections, data encryption, and robust protection against common web security vulnerabilities.
- **Easy Maintenance and Support:** The app must be structured for ease of maintenance and support, incorporating regular updates and ongoing assistance.

1.6 SECURITY CONCERNS AND COUNTERMEASURES

The application can be accessed by anyone with the link, be they at the event or not. In order to make sure that only intended users can access the application and update the pumpkin data, we took the following countermeasures for user authentication:

- **Volunteers:** the volunteers accessing the website are asked for the event passcode that is set by the organizers each time. This makes sure that only the volunteers present at the event can update pumpkin statuses.
- **Admins:** all admins are required to present a valid email and password to sign in. No ordinary user can create an account, as all admin accounts must be directly registered with Supabase.

Moreover, the application ensures security over the following:

- **Sanitization of input data:** every input collected from the user or admin is sanitized by Supabase to prevent injection attacks.
- **Storage:** The user authentication is handled securely by Supabase Auth which ensures that the access tokens and keys are encrypted at the application level before storing them.

2. Implementation Details

2.1 EVOLUTION OF APPLICATION ARCHITECTURE

During the planning phase of our senior design project (SE 491) we developed a rough stretch of what our application will look like. Due to the change in the requirements and the priorities of the functionalities, however, we made adjustments that would better suit us and the client.

2.1.1 Proposed Architecture

I. Block Diagram

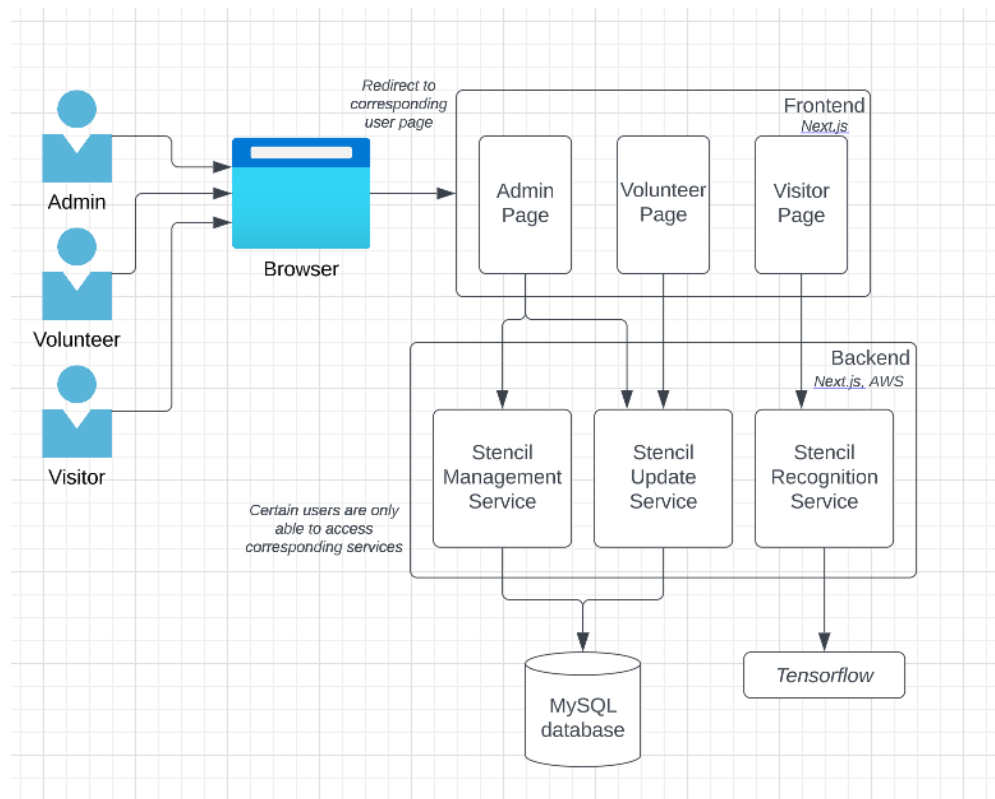


Figure 2. Proposed block diagram

Users will access the app using a browser. Admins will mainly use a desktop browser, while volunteers and visitors will use a mobile browser. These users will access the app through different URLs showing the corresponding pages. The frontend and backend sides of the app will be written using the Next.js framework. The stencil recognition will use Tensorflow. Each frontend page uses a certain service in the backend. Stencil management pertains to event-stencil mapping, whereas stencil update pertains to the creation, deletion, or update of stencil information. The stencil recognition part of the app will use Tensorflow for model/image training.

2.1.2 Implemented Architecture

I. Block Diagram

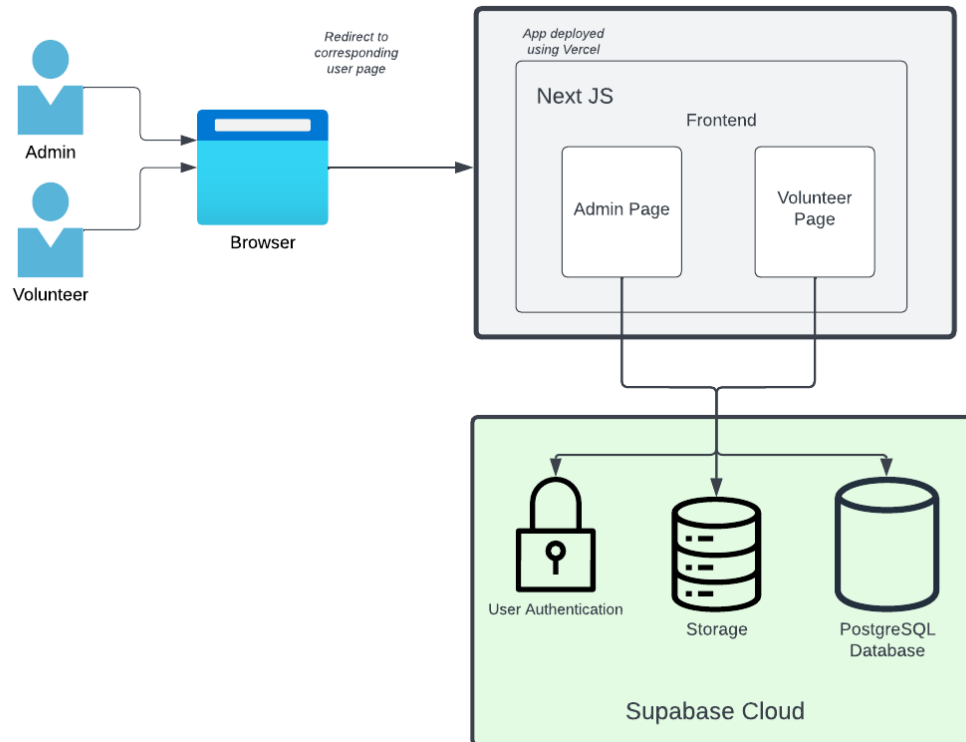


Figure 3. Implemented block diagram

We focused on delivering the minimum viable product for the 2023 Spirits in the Garden Event and the Stencil Selection Gathering for 2024. Therefore, we gave the stencil recognition functionality the least priority along with the Visitor user, whose only need was the recognition feature. Moreover, instead of hosting the application on the university server, we switched to deploying it with Vercel. As for the back-end services, we took advantage of the low-cost high-quality services offered by the Supabase: user authentication, storage, and database management in real-time.

The use case flows in the same way as before, where an admin or a volunteer loads up the website and is redirected to their corresponding pages. The pages ask for authentication that is handled securely by Supabase, and then they query the storage and the database accordingly to get the relevant information about stencils.

2.2 TECHNOLOGIES USED

- **NextJS:** We chose NextJs because it's a popular React framework and because of its easy integration with many modern technologies. NextJs makes developing the front-end of our application significantly easier as compared to other alternatives.
- **Vercel:** Our client needs the application to be usable for many years to come, so we had to migrate from the university server to something cost-effective. Vercel provided the exact solution we needed: deploying NextJs applications for low-cost on their platform. It was especially useful with its feature to auto-deploy the development branches so that we could test them before merging into the main.
- **Supabase:** with its free tier, this cluster of high-quality back-end services provides just what we need:
 - User authentication: our project uses user authentication on both the volunteer and admin sides of the application. The service provided by Supabase enables a secure authentication that also guards against known string injection attacks.
 - Storage: with up to 1GB of storage limit, we store all of our stencil PDFs and images in Supabase storage. The querying and retrieval times are ideal for our app.
 - PostgreSQL database: one of the reasons we migrated to Supabase was because we could easily adapt our previous MySQL database to the new PostgreSQL. To enhance the user experience further, we utilized the real-time update feature of Supabase.

2.3 TIMELINE

One of the main objectives that our team set was delivering a working solution that would increase the workflow at the Spirits in the Garden event this year. In order to achieve that objective, we needed to adjust our timeline from the planning stage of the project.

There were two main sprints in development overall, where one focused on the implementation of the event management system, and the other took care of the stencil selection process. Moreover, we also had to add the migration from our old architecture to a new one as a milestone which was completed in parallel with other tasks within the first sprint.

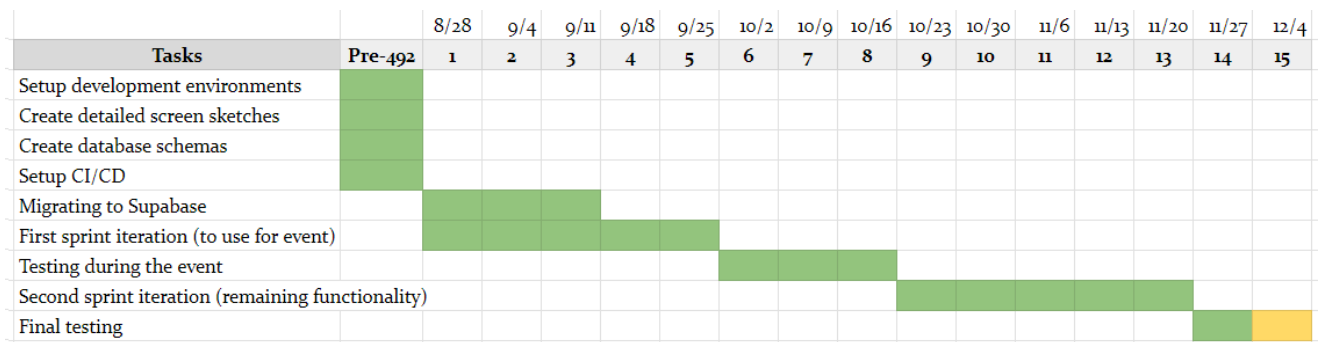


Figure 4. Updated Project Schedule/Gantt chart (per week)

3. Testing

3.1 TESTING PROCESS

Throughout the development cycle of the project, we tested our application both during the sprints and after each major sprint. In each of the sprints, we made sure that the individual units and components in our application were functioning as intended. However, the team paid more attention to doing System Integration Testing after each sprint and the final User Acceptance Testing.

3.1.1 System Integration Testing

Our team met with our client bi-weekly to discuss the bugs since the last meeting and possible new feature improvements in our application. We constantly worked towards fixing bugs that were identified when testing two or more components together by our client and their team.

After the first sprint, our application was extensively tested by the actual users of the Spirits in the Gardens event. The event involved carving over 1300 different stencils by more than 100 volunteers who participated. Some of the component interactions that were evaluated during the event are the following:

- Volunteers should be able to successfully authenticate
- Admin should be able to successfully authenticate
- Volunteer locks should correctly lock the volunteer side of our app to a specific year and week
- Volunteer locks should correctly lock the admin side of the app
- Admin event management page should correctly update based on the statuses submitted by the volunteers
- The event progress tracker should track the number of pumpkins marked completed by volunteers and admins
- Volunteer submissions should appear on the correct phase of the pumpkin status (tracing/carving)

After the second sprint, the application was tested by the client team during the Stencil Selection Process for 2024. Some of the component interactions that were tested include:

- Stencil selection correctly updates the event management page for that year and week
- The filtering by categories should update the stencil collection shown on screen
- Selecting a particular stencil should correctly update the totals shown on screen
- Updating the stencil information (stencil name, category, etc) should reflect the update in both the selection screen and event management screens
- Uploading a new stencil should add the stencil to the same screens
- Deleting a category should remove the category from the filtering list











3.1.2 Acceptance Testing

Our acceptance testing was done bi-weekly with our client and during our final meeting. Client acceptance is very important in this deliverable and, thus, a large decision-making tool in our process. Each week leading up to the first week of October 2023 consisted of the tests with the client. Then, a trial run of the event occurred. Our team was available on-site to solve any problems that arise. Based on feedback, and issues that occur, our team worked around the clock to ensure that our app can perform as expected in the event for years to come. During our final gathering with the client and their team, we evaluated all the following requirements that were initially set.

3.2 TESTING RESULTS

We fixed any bugs and errors that were reported in System Integration Testing and Acceptance Testing. For the final quality evaluation with the client, we went through the requirements and the following is the result.

Requirement	Priority	Status:
The admins can search stencils using their code.	High	✓
The admins can edit stencil info (i.e., name, category, image).	Medium	✓
The admins can sort or categorize stencils as desired (i.e., by category, status, and week used).	High	✓
The admins can upload stencil PDFs/images into the system (can be local as long as it's unified).	High	✓
The admins can update status efficiently (status: printed, cut, traced, and carved).	High	✓
The admins can approve stencils that are in the pending status queue.	High	✓
The admins can print stencils in one go, using the same print settings for all stencils.	Medium	✗
The admins can select stencils that will be used for the current year and which weeks they will be carved or displayed in the event.	High	✓

Volunteers can input stencil code to see its status (traced or carved)	High	
Volunteers can click a button to start or end the current stencil process—tracing or carving.	High	
The app must allow visitors and admins to use their phone cameras, take a picture of a jack-o-lantern, and display which category it's from.	Low	
The UI should be intuitive and fluid across mobile or desktop browsers.	Medium	
The app must include as few clicks as possible for each operation.	High	
The app must show thumbnails of stencil images so that users can know how it looks without loading another page (i.e., during the stencil selection process).	Medium	
The app must have a save button (or automatic save) so that user progress on edits/selections would not be lost.	High	
The app must not show any possible copyrighted stencil images.	High	
The app must be accessible online through a browser on mobile and desktop.	High	
The app must be maintainable for the admin users to use throughout the years.	High	

4. Context: Related Products and Literature

Our project has been specifically designed to meet the needs of our customers, and currently, there is no similar software available in the market. While a previous group of computer science majors has attempted a similar project, they only completed a sample product with a low level of completion, and we have not considered reusing their ideas.

The following are the advantages of our application over theirs:

- More visually appealing and user-friendly interface.
- Fewer operational steps and time saved due to our simplistic design.
- A comprehensive application where the admins can manage the event besides simply keeping track of the pumpkins.
- Significantly faster response time of the UI and real-time updates from the database
- Cost-effective because the application is designed to run on the lowest cost tier of the services used.

The following are the disadvantages:

- The weeks of the event are fixed (to 2), whereas it's flexible on our competitor's application
- The instance running the backend logic can be turned off and on as needed on the previous application

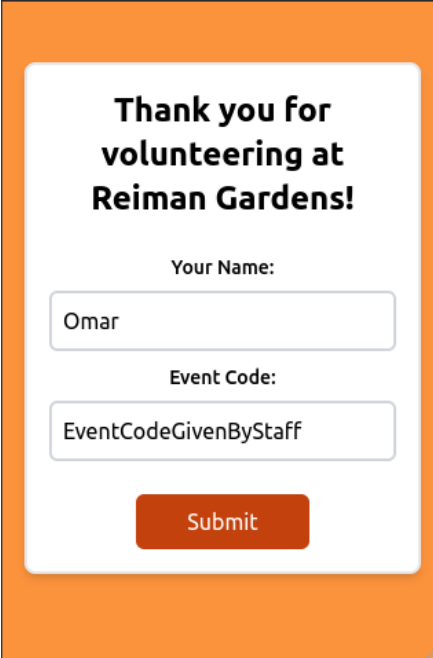
5. Appendix I - Operation Manual

5.1 INTRODUCTION

Our web application serves as a comprehensive solution for stencil management, ensuring efficient organization and reuse of stencils from previous years. The app simplifies logistical challenges and empowers volunteers to help the admin keep track of the stencils more easily. With features to track printing, cutting, tracing, and carving progress and provide detailed stencil information, our application aims to elevate the entire event experience, making Spirits in the Gardens more enjoyable and memorable for participants and visitors. By embracing technology, our app ensures a seamless and innovative approach to managing this beloved tradition, guaranteeing the continued success and growth of Spirits in the Gardens.

5.2 VOLUNTEER LOGIN

When the volunteer goes to the link <https://gourdguardian.vercel.app/>, they are presented with an authentication page. To authenticate, the volunteer needs to type their name and the event passcode that was given to them by the event staff.



The image shows a login form with an orange background. At the top, it says "Thank you for volunteering at Reiman Gardens!". Below that, there are two input fields: "Your Name:" with the value "Omar" and "Event Code:" with the value "EventCodeGivenByStaff". At the bottom, there is a "Submit" button.

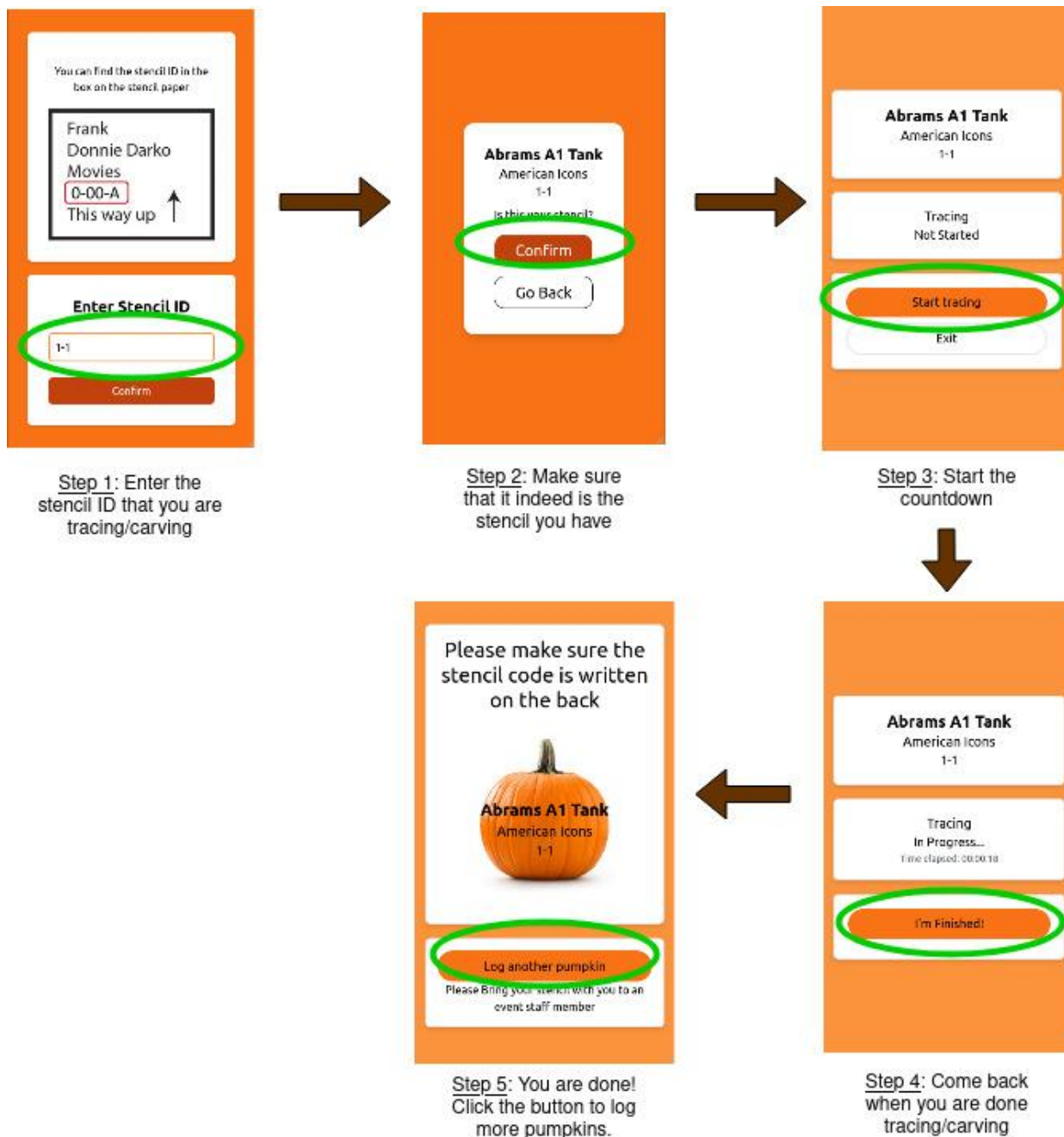
**Thank you for
volunteering at
Reiman Gardens!**

Your Name:

Event Code:

5.3 VOLUNTEER PUMPKIN LOGGING

On tracing and carving days of the event, volunteers can log their pumpkin's status after signing in. They just need to enter their stencil ID and then start carving pumpkins. Whenever they are done tracing or carving, they can return to the application and click the "I'm finished!" button as below.

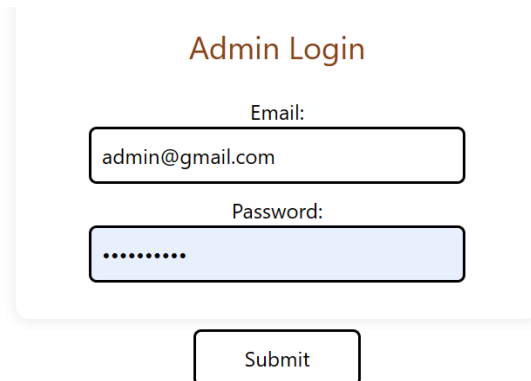


5.4 ADMIN LOGIN

The admin can access the admin site by accessing the link:

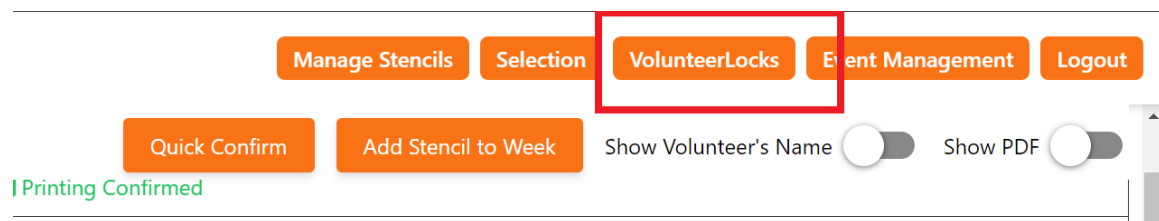
<https://gourdguardian.vercel.app/admin/status>.

Enter the user's email and the password, then click "Submit" to log in to the system.



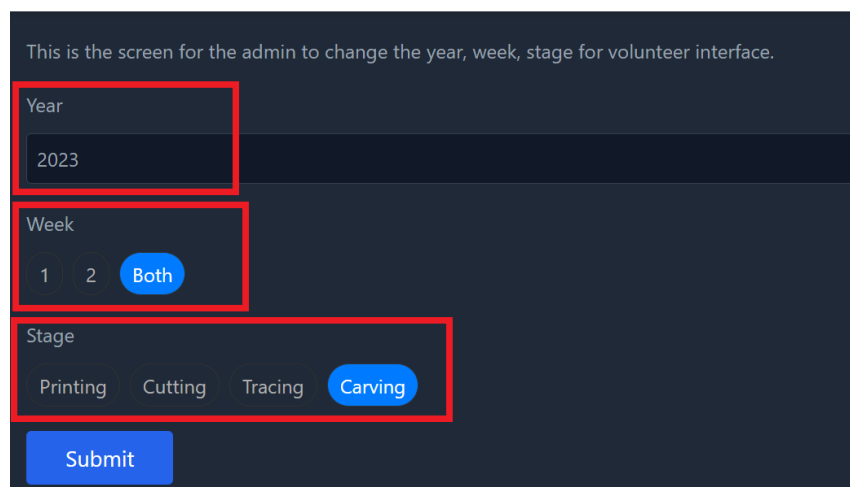
The image shows a login form titled "Admin Login". It contains two input fields: "Email:" with the value "admin@gmail.com" and "Password:" with a masked password ".....". Below the fields is a "Submit" button.

The admin can limit the access of volunteers by using the "VolunteerLocks" feature. Click the "VolunteerLocks" button on the top navigation bar to access the volunteer lock menu.



On the "VolunteerLocks" screen, enter the event year, the week you are working on, and the current stage to lock the volunteer from updating the wrong data. Then click the "Submit" button to save the access lock.

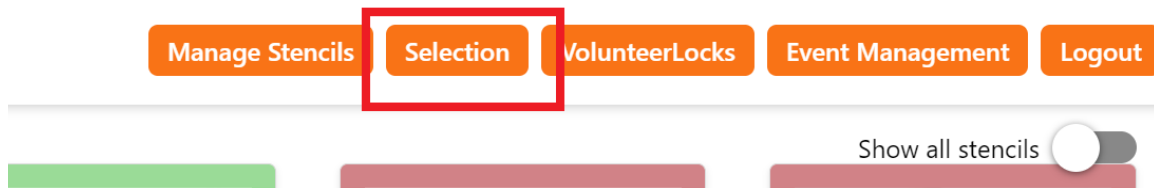
GourdGuardian



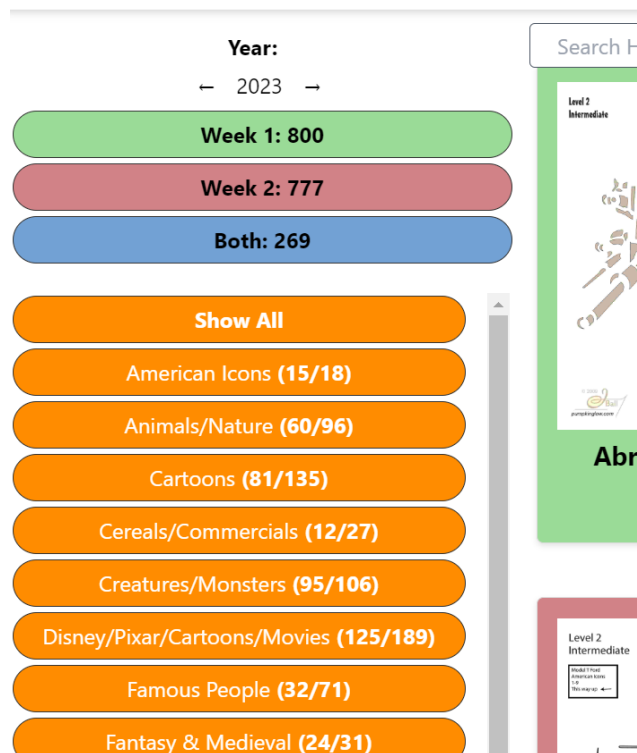
The image shows the "VolunteerLocks" screen. It has a dark background and a light text area at the top that says "This is the screen for the admin to change the year, week, stage for volunteer interface." Below this are three input fields: "Year" with the value "2023", "Week" with the value "Both", and "Stage" with the value "Carving". A "Submit" button is at the bottom.

5.5 STENCIL SELECTION

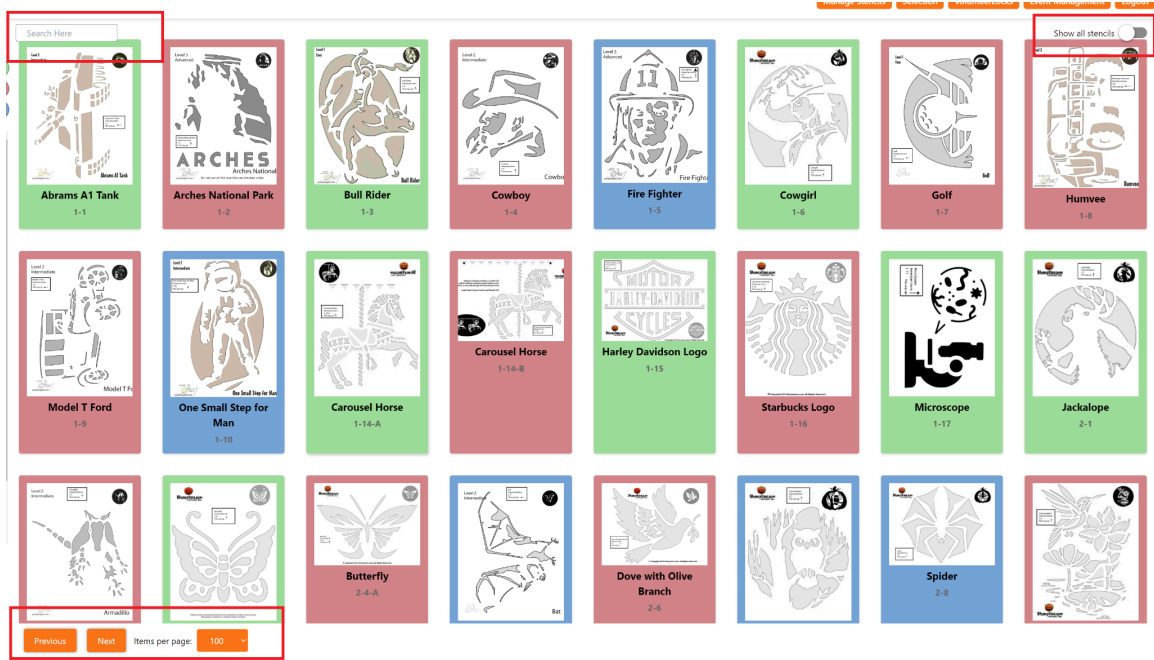
The admin can access the “Stencil Selection” menu by clicking the “Selection” button on the top navigation bar.



On the left panel, you can select the year of the event and filter the stencils by category. Click on the category name to filter by category. Click on “Show All” to show all stencils. Click on the arrow next to the year to move to the next year or return to the previous year. There is also a counter with the matching color of selected stencils for week one only, week two only or both weeks.



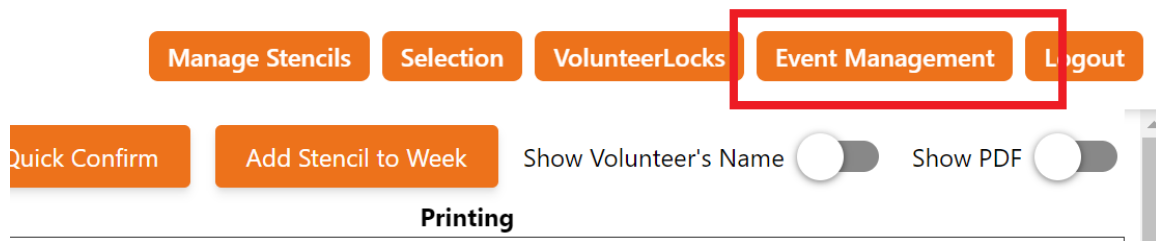
On the main screen, the admin can enter the stencil ID or name into the search box on the top left to search for specific stencil. The admin can click the “Show all stencils” toggle on the top right of the screen to show/hide the stencil that does not have a PDF file or image. The admin can also click the “Previous” or “Next” button to move to the next page. They can also change the number of stencils showing on one page by changing the “Item per page” value.



To select stencil, the admin can click on the stencil picture. The color around the stencil picture will change, indicating that the stencil was selected. Click one time for week 1 (the color will change to green), two times for week 2 (the color will change to red), three times for both weeks (the color will change to blue), and four times to unselect the stencil.

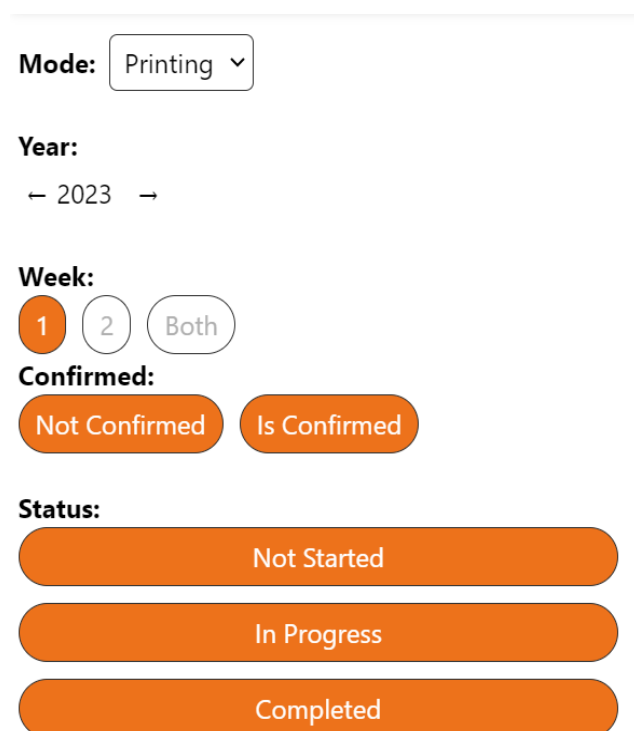
5.6 EVENT MANAGEMENT

The admin can access the “Event Management” screen by clicking the “Event Management” button on the top navigation bar.



On the left panel, the admin can change the current mode from Printing/Cutting/Tracing/Carving. For each mode, the top navigation bar will change the color accordingly to distinguish the difference between each mode. The admin can also change the year by selecting the next/previous arrow next to the year.

We have three filters applied to all stencils on this screen: Week, Confirmed, and Status. The orange indicates that the filter option is on, and the white one is off. The admin can filter the stencil from week 1, week 2, or both. They can also track whether the stencil was confirmed/not confirmed as well as Not Started/In Progress/Completed.



Search Here Quick

StD	Title
1-1	Abrams A1 Tank
1-3	Bull Rider
1-5	Fire Fighter
1-6	Cowgirl
1-10	One Small Step for Man
1-14-A	Carousel Horse
1-15	Harley Davidson Logo
1-17	Microscope

Previous Next Items per page: 100 ▾

On the main screen, the admin can enter the stencil ID or name into the search box on the top left to search for a specific stencil.

The admin can also click the “Previous” or “Next” button to move to the next page. They can also change the number of stencils showing on one page by changing the “Item per page” value.

The admin can click the “Show Volunteer’s Name” toggle on the top right of the screen to show/hide the volunteer name on the stencil table.

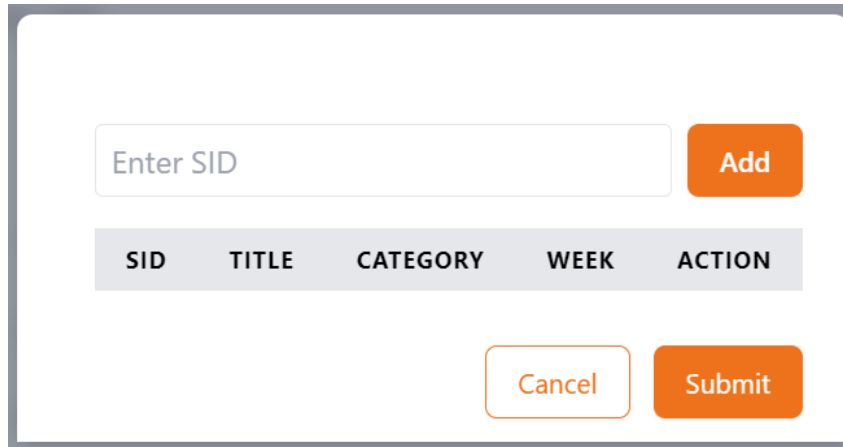
The admin can also click the “Show PDF” toggle on the top right of the screen to show/hide the stencil picture on the left panel. To show a stencil picture, hover the mouse on the stencil ID of a specific stencil.

Manage Stencils
Selection
VolunteerLocks
Event Management
Logout

Quick Confirm
Add Stencil to Week
Show Volunteer's Name
Show PDF

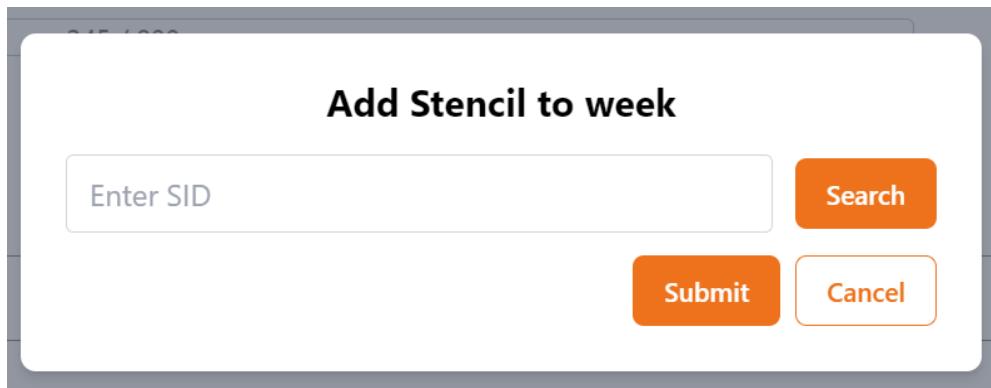
Printing

To use the “Quick Confirm” feature, click the “Quick Confirm” button. The pop-up menu will appear to allow the admin to confirm multiple stencils simultaneously. To use this feature, enter the stencil ID, click “Add”, then continue to enter another stencil ID and click “Add” until all the stencils are need to be confirmed are on the list. Click “Submit” to update all the status of the stencil on the list to “Confirmed,” or click “Cancel” to go back.



The screenshot shows a pop-up menu for the "Quick Confirm" feature. It contains a text input field labeled "Enter SID" with a placeholder text "Enter SID". To the right of the input field is an orange button labeled "Add". Below the input field is a table with the following headers: "SID", "TITLE", "CATEGORY", "WEEK", and "ACTION". At the bottom of the pop-up menu are two orange buttons: "Cancel" and "Submit".

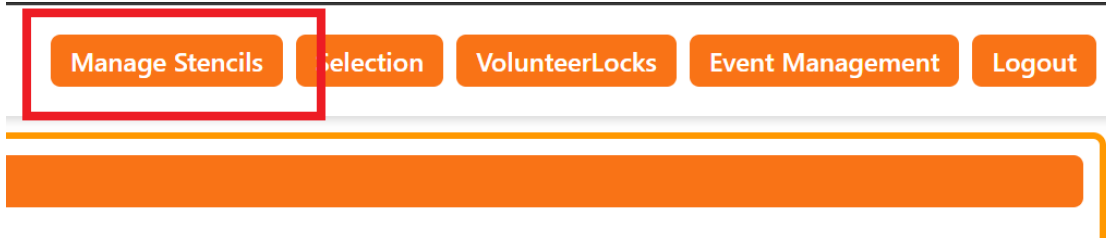
To use the “Quick Add” feature, please ensure the week and the year are set up correctly on the left panel before clicking the “Add Stencil to Week” button. The pop-up menu will appear to allow the admin to add stencil to a week of the event. To use this feature, enter the stencil ID and click the “Search” button to ensure the stencil you want to add is correct. Then, click the “Submit” button to add that stencil to the selected week on the left panel or “Cancel” to go back.



The screenshot shows a pop-up menu titled "Add Stencil to week". It contains a text input field labeled "Enter SID" with a placeholder text "Enter SID". To the right of the input field is an orange button labeled "Search". Below the input field are two orange buttons: "Submit" and "Cancel".

5.7 STENCIL MANAGEMENT

The admin can access the “Manage Stencils” screen by clicking the “Manage Stencils” button on the top navigation bar.



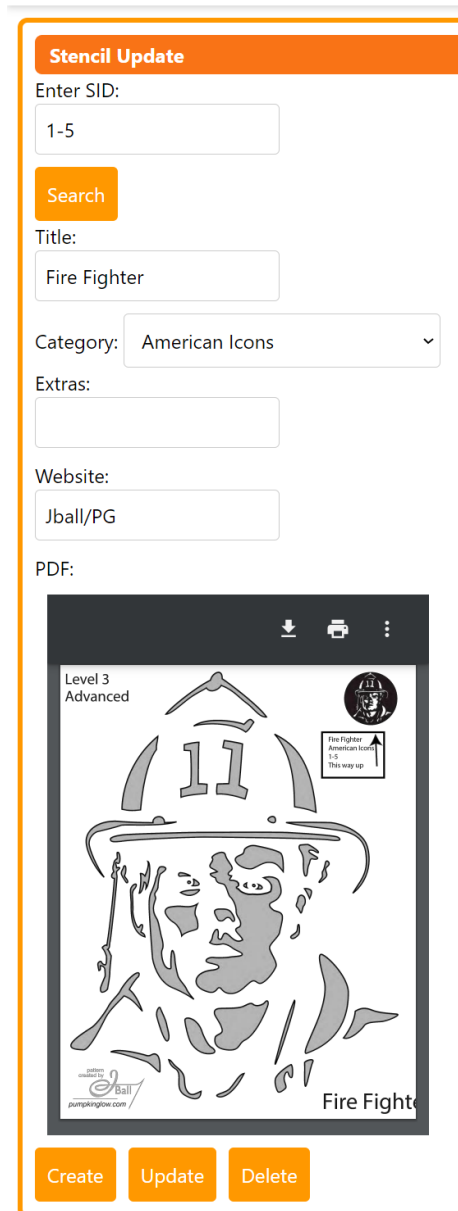
To add a new stencil, enter the stencil ID and click the “Search” button to check if the stencil exists in the system. If the stencil is not found, enter the title, select the category from the drop-down menu, enter extra information and website. Click the “Create” button to create a new stencil.

To update the existing stencil, enter the stencil ID and click the “Search” button to look for the stencil information. Then, update the information if needed. Click the “Update” button to update the stencil information.

To delete a stencil, enter the stencil ID and click the “Search” button to look for the stencil information. If the stencil is found, click the “Delete” button to delete the stencil from the database.

The PDF file of a stencil will be displayed if the stencil has the PDF file on the cloud server.

NOTE: when creating a new stencil, you should add a PDF file and JPG file related to this stencil by using “Stencil PDF Upload” and “Stencil Image Upload” below.

A screenshot of the "Stencil Update" form. The form has an orange header with the text "Stencil Update". Below the header are several input fields: "Enter SID:" with a text box containing "1-5", a "Search" button, "Title:" with a text box containing "Fire Fighter", "Category:" with a dropdown menu showing "American Icons", "Extras:" with an empty text box, "Website:" with a text box containing "Jball/PG", and "PDF:" with a preview of a stencil. The preview shows a fire fighter's face and helmet, with the text "Level 3 Advanced" and "Fire Fighter" visible. At the bottom of the form are three buttons: "Create", "Update", and "Delete".

Stencil PDF Upload

Enter SID:

Choose a PDF file:

 No file chosen

To upload a PDF stencil file, enter the stencil ID and click the “Choose File” button to browse the file you want to upload. The selected file must be in PDF format. Then, click the “Upload PDF” button to upload a PDF file to the server. NOTE: If the same stencil's PDF file exists on the server, clicking the “Upload PDF” button will override it.

Stencil Image Upload

Enter SID:

Choose a JPG file:

 No file chosen

To upload a stencil image, enter the stencil ID and click the “Choose File” button to browse the file you want to upload. The selected file must be in JPG format. Then, click the “Upload Image” button to upload a JPG file to the server. NOTE: If the JPG file of the same stencil exists on the server, clicking the “Upload Image” button will override it.

Category Update

Enter CID:

Category name:

To create a new category, enter the category ID and click the “Search” button to check if the category exists. If the category is not found, enter the category name. Then, click the “Create” button to add a new category.

To update the existing category, enter the category ID and click the “Search” button to check if the category exists. If the category is found, update the category name if needed. Then, click the “Update” button to update the category.