SugarCube Scanner

Scanner User Experience Design Document

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Revision History

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Document Approval

The following User Experience Design Document has been accepted and approved by the following:

Signature	Printed Name	Title	Date
	Scott McGregor	User Experience Designer	

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1. Introduction

The *SugarCube(TM) Scanner* from SoundFit is intended to enable an audiologist, or staff member in an audiologist office to scan physical ear impressions and transmit their 3D geometries to a distant Audiology Laboratory who will receive that 3D geometry, and produce custom fit *eartips* for hearing aids, communications devices, hearing protection, or swim plugs, instead of shipping the physical impressions as they currently do.

For this alpha release we will only support sending impressions to our alpha test partner lab, *Pacific Coast Laboratories (PCL),* although we envision the ability to send models to other audiology laboratories, hearing aid, communications and other eartip manufacturers in a future release.

1.1 Context of Use and Terminology

This section describes the context in which our service is used, including the affected stakeholders (of which the users are a subset), real and virtual objects handled or transmitted, and software and systems that do the processing. Here we also define the terminology we will use throughout this document to describe those components in the context

For this service to achieve this objective, there will be two "users" of two different pieces of software:

"*scanner user*" The audiologist or their staff member who operates the *scanner software*.

"*modeler*" The laboratory staff member who receives a 3D model using the *model capture software* and prepares an eartip model for manufacturing using CAD eartip modeling software. For the purposes of this release we plan support only *Secret Ear Designer(TM)* from *Cyfex* as modeling software.

The *scanner software*, including the scanner user interface, is all written by SoundFit, and will be described in the first version of this document.

The *model capture software* will initially consist of components written by SoundFit, as well as 3rd party software written by other companies including *123D Catch* from *Autodesk*, and *NetFab* (free version).

🔩 Future releases will automate several of the steps that the modeler will initially have to perform, eliminating the need for the modeler to use *NetFabb*, and potentially at some time to replace *123D Catch* with our own photogrammetry solution.

Using this scanner takes place in a larger context, shown in Figure 1, the Context Diagram. As can be seen from the figure, in addition to the scanner user and modeler, there will typically be an "*audiologist*" (or audiological technician) who takes the physical impression, and the "*patient*", who will ultimately wear the *eartips*, manufactured by audiology lab

("*manufacturer*"). In some cases the audiologist and scanner user will be the same person, and in some cases the modeler and the manufacturer will be the same person.

In addition to the physical *ear impressions*, and the finished *eartips* delivered to the patient, our context diagram shows two 3D models.

The first 3D model is the unprocessed *3D ear impression model* that we get from converting 2D images captured by the scanner into a 3D model produced using a *photogrammetry cloud server* (in our current version using 123D Catch). This ear impression model is used as input to a CAD program (Secret Ear Designer in our current version) which produces as output a final *3D eartip model* that can be sent to a 3D printer for manufacturing the finished eartips, either directly or by creating a casting mold.
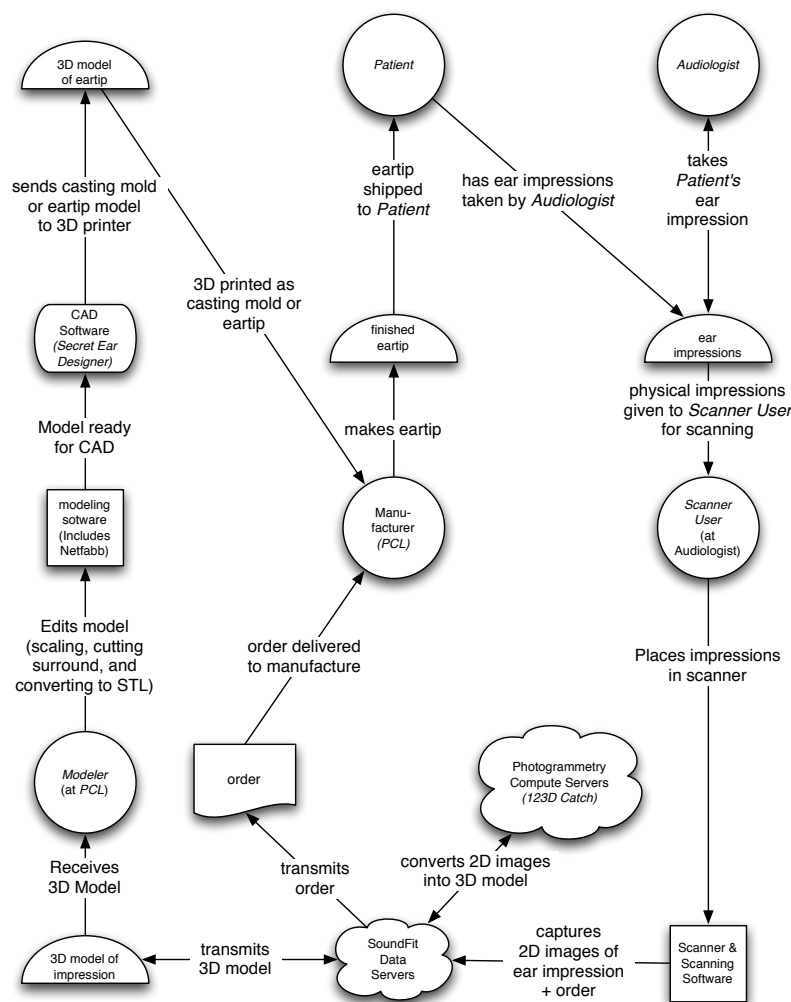
Figure 1: Context Diagram

1.2 Scope

There are envisioned to be multiple versions of this document and of the software, hardware and services described herein.

This initial version is focussed solely on the scanner user experience.

The second version will describe the modeler user experience.

This document focusses primarily on the user interface by which the scanner user (and in future versions the modeler) interact with computers connected directly to the scanner, or to the modeler's computer (which may be connected directly or indirectly to a 3D printer).   However, the scope of this design also includes the entire user experience, and that is described here as well.

1.2.1 Design Notes:

Because there may be limitations that affect our design, which may be subject to change in the future, we may also include design notes, that can alert readers to possible future areas of change.   These are indicated by indented "sidebar" passages that look like this:

> In the initial design of the hardware, we expect the user to manually operate the drawer. A future design may allow the drawer to be opened or closed under programmatic control.

1.5 Overview

Section 2 of this document describes overall guiding principles, design goals and other considerations.

Section 3 contains specific GUI design specifications.

2. General Description

This section covers overall guiding principles. UI specifications are in section 3.

2.1 Product Perspective

A potential follow on to the ear impression scanner is an ear scanner. Since the end purpose of the ear impression scanner is identical to the purpose of the ear scanner - to rapidly transmit an ear geometry to the manufacturer, much of the user interface can and should be the same, allowing us to treat the impression scanner and ear scanners at simply swappable components that support the same scanning and order processing service.

2.2 Product Functionality and Design Goals

For the service to be considered successful, it must achieve the following goals:

For the *scanner user* (audiologist) :
- **Functionality:**
  - **Scanning:** It must be able to scan and transmit 99% of all impressions. It should only be necessary to ship physical impressions instead of scanning in the most exceptional cases.
  - **Ordering:** In addition to sending scans, the scanner software should transmit an order form that allows the user to specify all the manufacturing specifications to cover at least 95% of all imagined use cases, based on what they can currently specify using their existing order form and process.
  - **Mobility / disconnected operation:** While scanning requires the scanner to be physically connected to the controlling computer during the scan, and while sending the completed scan requires the computer to be connected to the Internet during transmission, a common use case would be for the scanner to be used in a setting where Internet connectivity is not possible.
    - Thus we want to allow the user to do scanning and have the scans queued up for later delivery when Internet service is restored.
    - Similarly, if Internet service is restored at some future time, we should transmit scans captured earlier, even if the scanner is not currently connected.
  - **Account maintenance:**
    - Since the scanner service is provided on a monthly subscription, we need to provide the scanner user information concerning whether their subscription is current or past due, or whether they have exceeded the maximum free scans for their tier.
    - *In future versions* of our service, we envision adding additional functionality that will allow the user to   track orders in progress including tracking orders that are in the care of delivery services, and the ability for the user to view and mark up a 3D model to better communicate adjustments to ear impression (for example, about wax, hair, bubbles, ear canal depth, etc.).   At an even later time, we may allow them to mark up a post CAD model of an eartip to more speedily resolve fit problems. These possible future functions are intentionally NOT included in the first release, in order for the first user experiences to be as simple as possible.
- **Usability:**
  - **Minimum operational steps:**

- Once installed and in regular operation, the scanner user should be able to easily scan and send impressions along with filled out order forms with a minimum of operational steps. The user should place an impression in the scanner, initiate the scan, remove the impression and, if connected, transmit the scan with a minimum number of keystrokes, mouse moves, button presses, physical actions, and mental processing.
- Ideally we would get down to one button: scan.
- At this time it is impractical for us to build a system that would automatically control the drawer and sense the presence of a new impression, so we know that there will also be some physical interaction with the drawer.
- **Minimal Learning Effort:**
  - The service should have a minimum amount of functionality and operational idioms to learn.
  - It should be learnable in 15 minutes, with no manual, and most users should find they can learn it just by watching it being used once.
- **Minimal Set up Effort:**
  - The system should have minimal effort to set-up, configure, and place into operation.
  - Ideally, all that would be necessary is for the scanner to be connected to a power source (wall current or USB) and to wirelessly access any available internet connection, however, this level of automation is not considered viable at this time. What does seem practical is that the scanner user connects a power cable, connects a USB Cable, and runs a simple installer program that installs the software
- **Robust Error Handling:**
  - The system should sense its operational state as much as possible so that the user does not have to diagnose problems that prevent operation. This includes diagnosing the following conditions:
    - no power to scanner,
    - no USB connection to scanner,
    - scanner motor failure,
    - scanner camera failure,
    - scanner lighting failure, and
    - data transmission problems
      - transient (intermittent connection) and
      - permanent (never able to access).
- **Order handling:**
  - Order processing will be custom to each lab, and will use order forms or processing that they currently support. Ideally, that order processing can be done offline and doesn't require a live Internet connection, though some labs do all their processing over the web -- in which case a live connection would be required.
  - Because order handling may be lab dependent, and because ultimately a scanner operator may wish to send scans to multiple manufacturers, we would like to isolate the scanning from the ordering handling as much as possible. At the same time, we do want to make it easy to initiate a scan, or initiate transmission of a scan as part of the scanning process.
- **Reliability:**

- During our alpha test, we want the scanner to successfully capture and transmit a scan without need for a rescan in 95% of all scans sent.
- During Beta test, we want reliability to reach 99% of all scans without a rescan.
- **Performance:**
  - Each scan should be completely captured in not more than 1.5 minutes (3 minutes for a pair).
  - Each scan package should be transmittable to our cloud server via a 1 Mbps connection in under 5 minutes.
- **Security:**
  - The data captured by the scanner and transmitted via the cloud servers to the modeler should be stored and transmitted in a secure manner.
    - Secure data should be protected from inappropriate:
      - **alteration,** including loss and destruction, and
      - **access** by unauthorized persons
    - Specifically: user identifiable information should be stored and transmitted separately from image or model data, so that if an image or model is stolen it cannot be tied to an individual without also having access to a user record containing personal identification information.
    - Conversely, having access to the personal data record does not include the model or images associated with scans for that individual.
- **Accuracy:**
  - Scanner users will judge accuracy based on the resulting eartips -- they have no way to meaningfully assess the accuracy of the scans themselves. From the patient and audiologist standpoint, if the resulting eartips are indistinguishable from those made today the scan will be considered accurate.
  - Therefore, scanner accuracy is actually determined by the requirements of the Lab. Competing products cite a resolution (which is not the same as accuracy in any case) of 50 microns. But in the process of modeling using Secret Ear Designer adding or removing 100 microns during smoothing processes are common. and most printers can't resolve more than 50 microns anyway. So we are targeting a resolution between 50-100 microns.
- **Robustness to Computer Platform:**
  - In this release we plan to support only Intel PC architecture computers for controlling the scanner. At some future date, we might also want to consider supporting tablets or smart phones as controllers, but this is not being designed now.
  - Ideally the scanner software would work on both Windows and Macintosh OS computers based on the Intel platform. The system MUST work with Windows 7 and Windows 8, and it is highly desirable that it work on Windows Vista and XP OS as well.
- **Supportability and Maintainability:**
  - The scanner should not require any user servicing over its entire expected lifetime.
  - Each scanner should identify itself in operation so that we can monitor both its frequency of use and its frequency of failure.
  - The scanner software should provide operational and preventative maintenance information to SoundFit that enables us to determine the reliability of the scanner hardware and its software in the field.

- Should a customer report a problem, the scanner state should be query-able or capable of running self-diagnostics that can assist in the diagnosis and repair of the unit.
- Customers should have a way to report problems about the scanner during working hours and to get prompt customer support response when they call.
- If a unit is malfunctioning, the user should be able to swap out their unit for a new unit.
- Auto update: SoundFit should be able to push software updates out to scanners each time they connect to our servers.
- **Marketable:**
  - Because our target scanner user is an audiologist and a substantial majority of audiologists are women, especially young women the product should be visually appealing to them.
  - The product should be recognizably different from our competitor's scanner, both in external appearance, and in the GUI screens. Competitors GUIs are based on very conservative "Windows Gray Boxes" type designs. To distinguish ourselves from the competition we want our GUI to be bold and colorful.
  - Some of our channel partners (that is, the *manufacturers* in the context diagram, e.g. hearing aid companies and audiology labs) may desire to dedicate space not only to their own logo and branding, but also potentially to advertising a new product on the scanning control pages.
- **Availability**
  - The Scanner User software is expected to be available 24x7x365. It is expected to have 99.95% uptime. Swap out units delivered next business day should restore a user with a malfunctioning scanner to operational status within 2 business days.
  - The Scanner software must interact with SoundFit's cloud data and cloud computing services. These are expected to have 99% uptime, and no outage is expected to last beyond one business day.
  - As we gain more experience we expect Availability times to increase further.
  - Mean Time Between Failures for the hardware should be > 30 days, and system outages should also be greater than 30 days.

3.5.6 Portability
- The scanner unit is small enough (9"x9"x9") and light weight enough that it is easy to move it from location to location. However, it is designed for use in an audiologist office and is not ruggedized for regularly moving from place to place, and the case may break if dropped. Dust in industrial or construction settings might cause the unit to fail.
- Future units may be redesigned in a way that is more rugged.

2.3 User and Scanner state diagrams

The user should be kept appraised of the state of the scanner system whenever they are operating it. There are three sub-systems which operate independently for the most part, each with it's own set of states, therefore the total state of the system is best thought of as a triplet containing each of the current states for each subsystem.
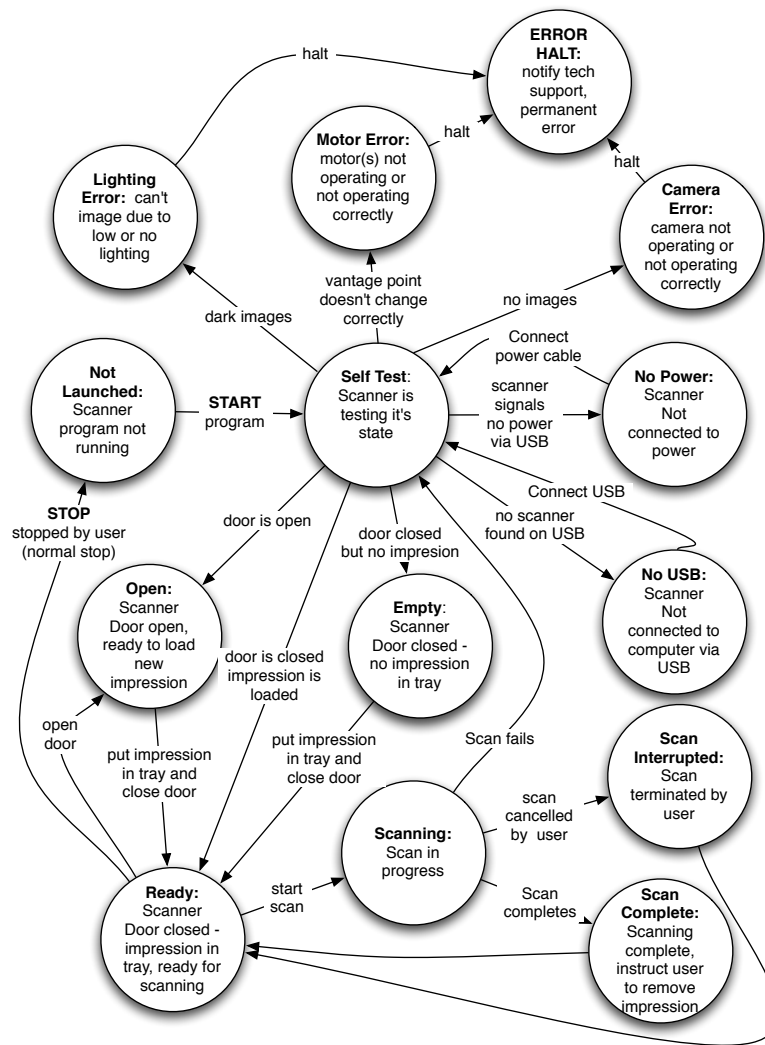
Figure 2: Scanner State diagram
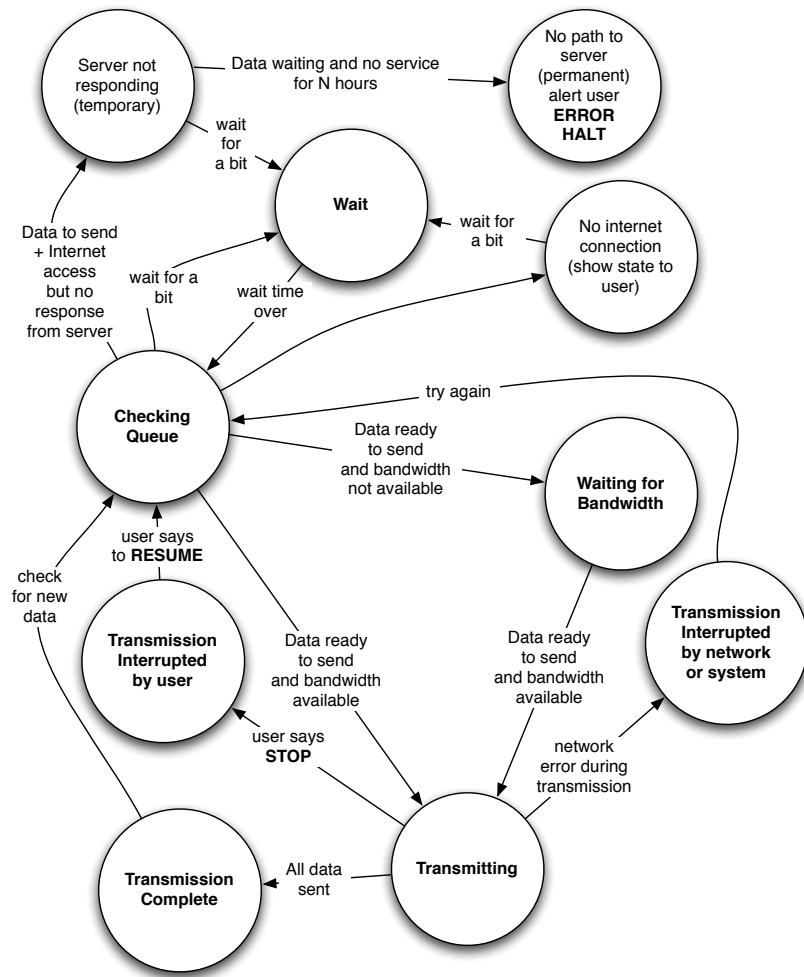
Figure 3: Transmission State diagram
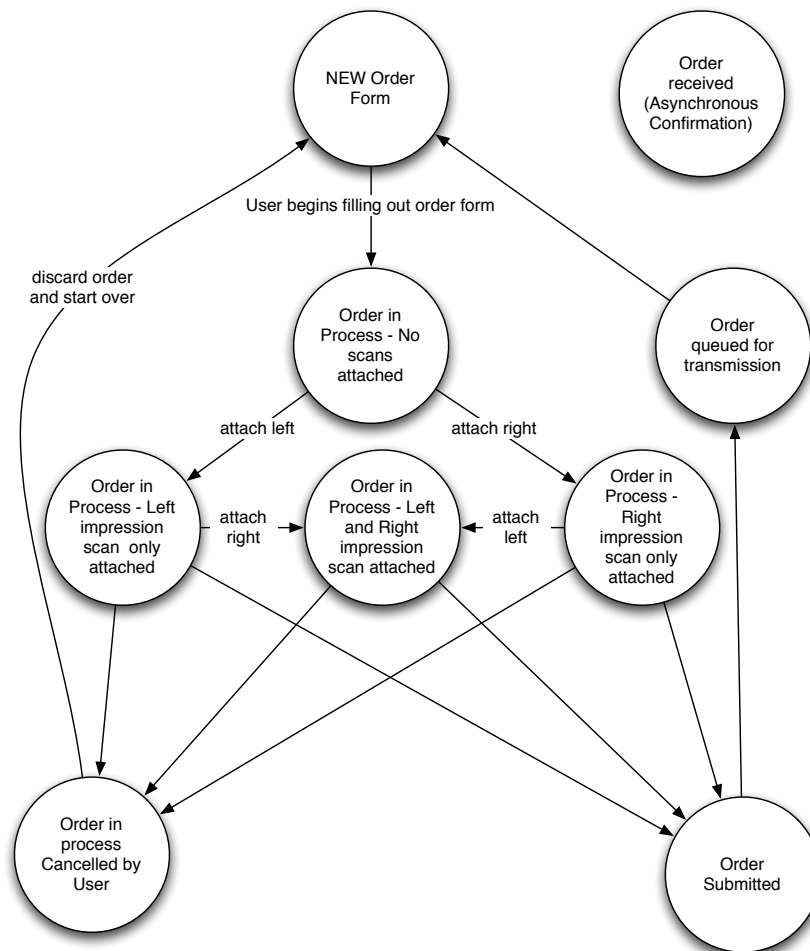
Figure 4: Order Processing State diagram

2.4 General Constraints

This subsection of the UXDD should provide a general description of any other items that will limit the developer's options for designing the system. (See the IEEE Guide to SRS for a partial list of possible general constraints).

2.5 Assumptions and Dependencies

This subsection of the UXDD should list each of the factors that affect the requirements stated in the UXDD. These factors are not design constraints on the software but are, rather, any changes to them that can affect the requirements in the UXDD. For example, an assumption might be that a specific operating system will be available on the hardware designated for the software product. If, in fact, the operating system is not available, the UXDD would then have to change accordingly.

3. Specific Requirements

This will be the largest and most important section of the UXDD. The customer requirements will be embodied within Section 2, but this section will give the D-requirements that are used to guide the project's software design, implementation, and testing.

Each requirement in this section should be:
- *Correct*
- *Traceable (both forward and backward to prior/future artifacts)*
- *Unambiguous*
- *Verifiable (i.e., testable)*
- *Prioritized (with respect to importance and/or stability)*
- *Complete*
- *Consistent*
- *Uniquely identifiable (usually via numbering like 3.4.5.6)*

Attention should be paid to the carefully organize the requirements presented in this section so that they may easily accessed and understood. Furthermore, this UXDD is not the software design document, therefore one should avoid the tendency to over-constrain (and therefore design) the software project within this UXDD.

3.1 External Interface Requirements

3.1.1 Hardware Interfaces

The Scanner hardware consists of the
1. scanner unit,
2. scanner tray (which slides open and closed),
3. removable impression holder (made from 2 thumbtacks)
    1. The impression holder is is made from a piece of ferro-magnetic metal.
    2. There is an indentation in the base of the scanner tray that has the same shape as the impression holder.
    3. There is a magnet in the base of the scanner immediately below the indentation where the impression scanner goes.
    4. This enables the user to quick and safely place impressions on holders, and to ensure that the impression holder is properly help in the correct place.
4. USB cable,
5. 110V power cable with transformer.

3.1.2 Scanner User Interface components

The GUI defined below is designed for a target use with a desktop computer capable of displaying windows at least 768x1024 in size without a scroll bar.

In the initial design, all windows are presumed to be that size. Future versions of our GUI may allow for different layouts for computers, tablets, and mobile devices of various form factors.

The Scanner GUI consists of the following windows:

1. *Launch icon*
    1. This is the icon that appears when you put the SugarCube application on the desktop or in a folder opened in icon view. Double clicking this icon launches the application.
2. *Splash page window* (first page shown while launching)
    1. This page should be a single image that can be quickly displayed while the rest of the software is loading. It lets the user know that they successfully launched the SugarCube application (in case they weren't sure if they had launched the correct application, or if they were not sure that their launch command (typically a double click on a desktop icon or single menu item had been successfully processed. This helps avoid people attempting to launch the software multiple times.
    2. When the software launches, it should verify that another version isn't already running. If another copy is running, an error message should alert the user, and when the message is dismissed the program should close to avoid conflicts over who controls the USB port.
    3. Once the software has loaded enough to bring up the *Order Processing Page,* the splash page is closed automatically
    4. If launching the *Order Processing Window* will take more than 2 seconds, an animated *processing indicator,* such as a spinning wheel or grow bar shall be displayed until the new page has loaded.
3. *Order Processing Window*
    1. The Order Processing Window consists of 3 frames:
        1. *The Header Frame*
            1. Main branding area (by default, SugarCube, powered by SoundFit logo)
                1. When scanner has web access, Image is hot linked (by default to SugarCube.co)
                2. Clicking on this hot link brings up the destination page in a separate window
            2. Secondary branding area (by default, PCL)
                1. When scanner has web access, Image is hot linked (by defaults to ShopPCL.com)
                2. Clicking on this hot link brings up the destination page in a separate window
            3. "Order Processing" Title.
            4. Scanner and Transmission status indicator(s)
            5. When the SugarCube supports sending to multiple manufacturers, this frame will also house the controls for selecting among the different manufacturers so that the scanner user can chose the manufacturer their want their scans to go to, and that selection will cause different Order Forms to be loaded in the Order Form Frame.
                1. This area also shows the *Scanning Status*, and *Transmission Status*.
        2. *The Order Form Frame*
            1. The Order Form is determined by the manufacturer who will receive the molds.
            2. Because the specifics of these forms vary from manufacturer to manufacturer, the precise layout of the manufacturer form is not covered in this document,

and where we need to implement the form that will be the subject of a separate document.

1. To the degree we control the order form, we should remember most information from scan to scan to minimize the need to retype information from order to order. An exception is that the patient information should be presumed to change with each order and should therefore be blanked if possible.

3. Some manufacturers handle all their ordering through the web.
   1. For these manufacturers, the Order Form Frame will hold a live web page from their web site.
   2. For scanner users who want to send scans to that site, the user can only place orders while the computer is connected to the web.
   3. *Error Handling:* If the computer is not connected to the web, an error condition occurs and an error is displayed in the error window that explain that operation with this manufacturer requires web access

4. *Order Submission Message Area:*
   1. Immediately after we submit an order, we provide a confirmation message in the Order Form Frame area.
   2. After the

3. *The Footer Frame*
   1. The footer contains the following buttons which allow the scanner user to launch a scan directly from the order processing window.
   2. The buttons are:
      1. Scan Left / Rescan Left
      2. Scan Right / Rescan Right
      3. Discard order
      4. Submit order
      5. View transmissions
      6. Manufacturer's order processing website
         1. This button is disabled if the scanner is not connected to the web.
      7. Quit Sugar Cube Application
   3. The Scan buttons toggle between Scan and Rescan and also have a color change so that scanner users know at a glance whether they have already completed and attached a left or right scan to this order.
   4. The footer may contain an optional advertising area.
   5. In future versions we may allow users to access order and package tracking through an interface we provide.
      1. When that happens, more buttons may be added to the footer.
      2. For this first version, these capabilities are provided by allowing the user to visit a manufacturers website where order inquiries can be processed by web users.
   6. In future versions we may allow users to view, markup or even edit a 3D model.
      1. This capability would also be accessed via a button in the Footer. It is not expected to be available in the early releases.

2. Note that users can also use this form to place orders for supplies, or for re-orders -- without scanning, simply by entering the proper SCANID that they want to use in manufacturing.
3. To the extent possible (which may depend on the order processing system of the manufacturer) every time you create a new scan, the scanID should be AUTOMATICALLY entered into the appropriate field in the order form as soon as the scan request begins.
    1. Where the manufacturers order processing system won't allow us to directly update the ScanIDs automatically, we will display the scan IDs in the footer immediately beneath the Scan Left and Scan Right buttons. This will make it easier for the user to copy and paste the data into the form if doing so automatically isn't allowed.
4. Scanner Controls window
    1. Header Frame:
        1. Main branding area (by default, SugarCube, powered by SoundFit logo)
            1. When scanner has web access, Image is hot linked (by default to SugarCube.co)
            2. Clicking on this hot link brings up the destination page in a separate window
        2. Secondary branding area (by default, PCL)
            1. When scanner has web access, Image is hot linked (by defaults to ShopPCL.com)
            2. Clicking on this hot link brings up the destination page in a separate window
        3. "Scanner Controls" Title.
        4. Scanner and Transmission status indicator(s)
    2. Scan Frame:
        1. Scan image area
        2. Information area
            1. Information Title area
                1. Place Impression in Tray
                2. Scan in Progress
                3. Scan Complete
            2. Information Detail
        3. Thumbnails area / Progress bar
        4. Advertising area
            1. When connected to the web, these can be rotating web ads with hot links to landing pages specified by the channel partner (manufacturer) or by SoundFit.
                1. Clicking on this hot link brings up the destination page in a separate window
            2. When disconnected these are just images rotated from a library which can be updated any time the scanner is operating in network connected mode.
        5. Footer Frame:
            1. Control Buttons area
                1. Begin Scan / Cancel Scan
                2. Return to Order Form
            2. The footer may contain an optional advertising area.
5. Transmissions Management window

1. The Transmissions window appears whenever there are order+scan packages waiting for transmission.
2. Header Frame:
    1. Main branding area (by default, SugarCube, powered by SoundFit logo)
        1. When scanner has web access, Image is hot linked (by default to SugarCube.co)
        2. Clicking on this hot link brings up the destination page in a separate window
    2. Secondary branding area (by default, PCL)
        1. When scanner has web access, Image is hot linked (by defaults to ShopPCL.com)
        2. Clicking on this hot link brings up the destination page in a separate window
    3. "Transmissions" Title.
    4. Scanner and Transmission status indicator(s)
3. Transmissions Frame
    1. We list the OrderIDs awaiting transmission or in transmission, including their attached ScanIDs, and date/times submitted, in a scrolling list, so users can see what is pending.
    2. When a transmission is completed successfully, we mark a "sent" indicator next to the order line.
    3. The transmissions frame is rebuilt from scratch each time the application starts up, so it will only have scans that weren't sent prior to start-up and what has been scanned in the current session.
    4. Users can select waiting orders, and the current order being transmitted and cancel them. If they do this the order and scan data is discarded without transmitting.
    5. In future versions we may allow users to "open" a pending order and re-load it into the order processing window for further editing. This is not planned for the first release.
4. Footer Frame
    1. Control Buttons area
        1. Pause Transmissions / Resume Transmissions
        2. Return to Order Form
    2. The footer may contain an optional advertising area.
6. Error Dialog window
    1. Because processes such as scanning and transmitting can proceed in an unattended manner, we want to allow users to minimize their wait time by working on tasks such as filling out order forms while those other processes go on in the background.
    2. We can use status indicators in the Header sections so that users will always be able to see the status of any scans or transmissions in process, at a glance.
    3. However, when errors occur in these asynchronous processes, users might not notice the subtle changes in the status indicators since their attention will be elsewhere (e.g. to filling out an order form).
    4. To ensure that scanner users see important error, warning, and status messages which SHOULD interrupt their other work, we may use Error Dialog windows which will be displayed on top of all other windows, to ensure they are visible.

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3.2 Graphical Design Guidelines

Appearance:

1. Text Fonts, Styles and Colors for:
    1. SoundFit Logo:
    2. SugarCube Logo:
    3. PCL Logo:
    4. Titles:
    5. Headings:
    6. Body text:
    7. Buttons:
    8. Labels:
    9. Text Fields
    10. Hot links (clickable text)
2. Graphic objects: Colors, line styles, line widths, margins, borders, backgrounds, foregrounds, gradients, shadows for:
    1. SoundFit Logo
    2. SugarCube Logo
    3. PCL Logo
    4. Photo and Video Image Displays
    5. Status Information areas
    6. Error Information areas
    7. Warning Message areas
    8. Window backgrounds and styles
    9. Scroll bars
    10. Buttons
        1. Disabled
        2. Default selection
        3. hover actions
        4. corner styles
        5. gradients
    11. status icons
        1. corner styles
        2. gradients
    12. thumbnail images
    13. progress indicators (spinners and grow bars)
    14. tables and grids

Layouts, Location and Sizes:
  Header
  Footer
  Image Area

Information Area
Status icons
thumbnails
Control buttons
Close, Maximize and Minimize buttons
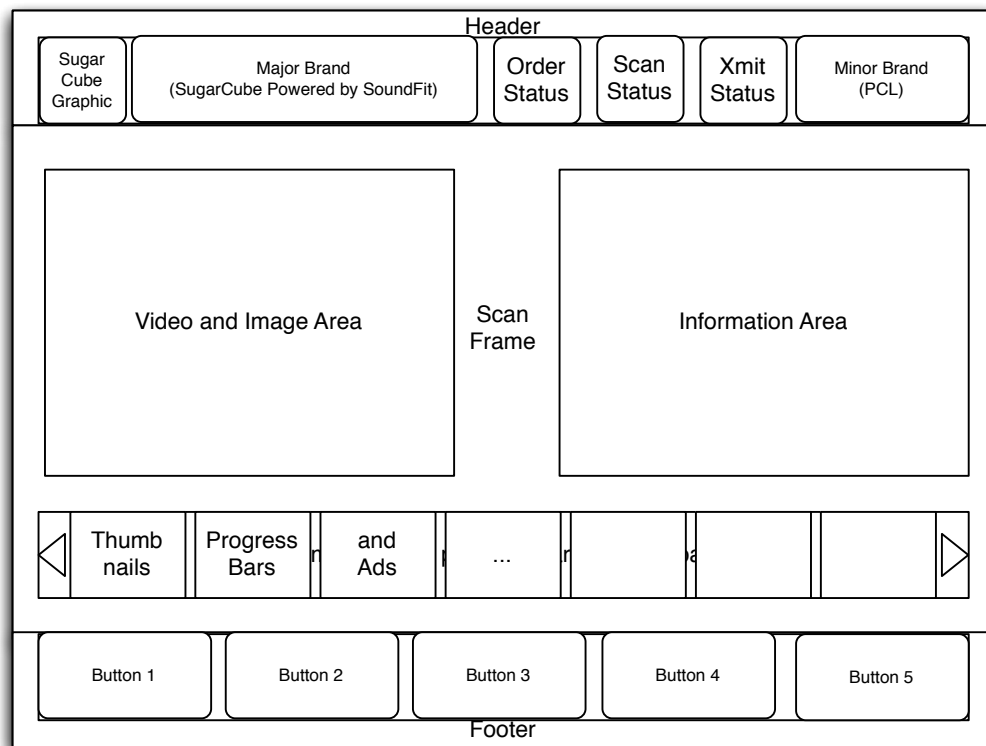Menus
Form elements

3.2.1 Scan Layout

Figure 5:Scan Window Layout

3.3 Use Cases

3.3.1 Use Case #1

3.3.2 Use Case #2

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