Playing it by Ear: Piano Roll Preservation in the Stanford Player Piano Program

by Jill Sison and Elizabeth Ryan

Large research libraries often maintain collections of objects distinct from book and paper formats. As a result, library conservation departments can become involved in complex projects with multiple departments and unfamiliar materials. In such a way Stanford Libraries Conservation Department became engaged in the Player Piano Program to repair piano rolls for digitization. The nuances of running thin, perforated paper through a custom-built roll scanner; repairing and replacing roll paper, cores, and flanges; and learning about the musical significance of perforation placement have been unexpected challenges and learning experiences!

Program background

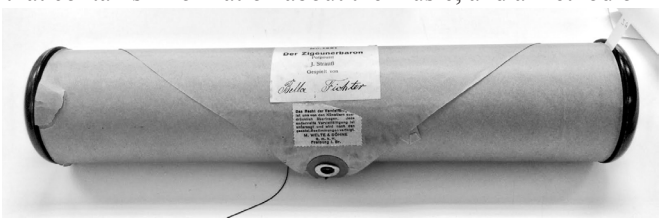
The Player Piano Program "promotes study and research on the player piano and organ, with a focus on historically informed performance practice of the late nineteenth and early twentieth centuries." (https://library.stanford.edu/projects/player-piano-project.) The Program grew out of "*Reaction to the Record, early recordings, musical style, and the future of performance,"* a symposium by the Stanford Archive of Recorded Sound and Music Library that began running in 2007. Discoveries made at the symposium revealed untapped research potential in piano rolls for studying historic piano performance.

Project goals are to collect, preserve, study, and improve access to piano rolls. The program was initiated by the Music Libraries' acquisition of the Dennis Condon Collection of piano rolls and instruments, which includes works by Debussy, Gershwin, Prokofiev, Stravinsky, and many others playing their own works. Additional acquisitions of piano roll collections followed. To promote access and research use, a dedicated scanner that produces digital images and audio files through software analysis was custom-built in conjunction with the Music Library and Stanford Center for Computer Research in Music and Acoustics (CCRMA) and The Center for Computer Research in the Humanities (CCARH).

The Player Piano Program team includes staff from conservation, the Music Library (Metadata, curatorial staff), Archive of Recorded Sound (ARS), Digital Production Group (DPG), music faculty, the Center for Computer Research in Music and Acoustics (CCRMA), and The Center for Computer Research in the Humanities (CCARH).. The conservation department's close work with the program team and the related technical issues in scanning have influenced conservation decisions about repair, replacement papers, documentation, workflow, and other aspects of the project.

Piano roll basics

Player piano rolls are constructed of long sheets of paper with perforations representing prerecorded music punched in specific configurations and wound around a core. Piano roll paper is thin with a slick surface and can easily tear if torqued. The rolls have a leader on one end that contains information about the music, and a method of



attaching the roll to a take-up scroll in the player piano. The trailing end of the roll is adhered to the core, and flanges that fit in the tube secure the roll in place.

A number of manufacturers are represented in Stanford's collection. Manufacturers had different specifications for paper width and color, perforation placement, leader and flange style, core length, and other features.

In the flanges alone, variants are found in orientation (drive or idle side), material (wood, plastic, metal), and securing method in the player (pins, slots, or holes). The leaders may be paper or fabric and may anchor the roll with D-rings, eyelets, adhesive tabs, or hooks.

Piano rolls are typically categorized as either "standard" or "non-standard." Standard rolls have a core length of ~11-¼". Non-standard rolls have cores of greater or lesser length than 11-1/4".

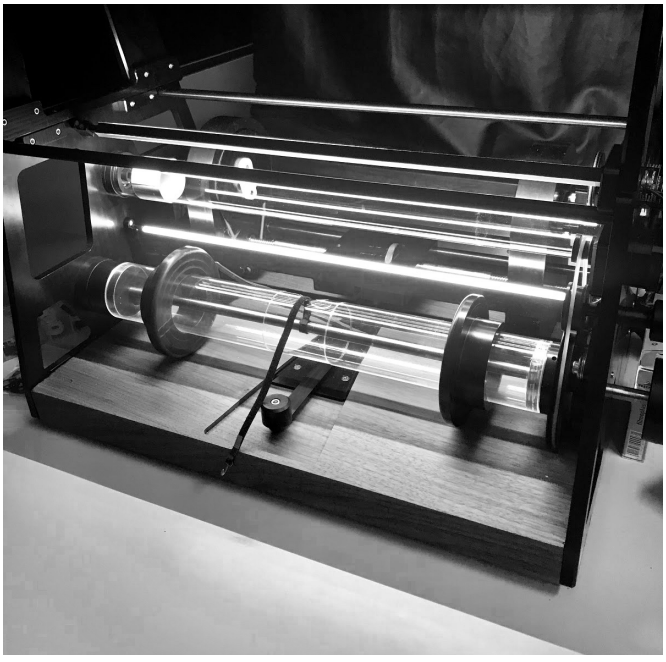
The conservation department's approach throughout the project has been to balance making functional repairs with respecting the artifactual value of the object.

Assessing the damage and preparation for scanning

An initial assessment of a portion of the Condon collection identified 12 % as having preservation issues; i.e., damage through general use and poor storage conditions. With additional collections totaling 19,841 rolls, this project could potentially generate a large volume of work for conservation. Therefore, establishing clear protocols for intervention would be important. Frayed edges, paper tears and holes, folded edges, broken perforations, poorly executed repairs, broken flanges, and damaged leaders are some common problems. Other challenges include previously taped repairs causing planar distortion and rolls with detached and missing cores and leaders.

The conservation department's involvement in the project began during the scanning test phase. The purpose-built scanner in DPG can be adjusted to hold different sizes and types of rolls. The scanner has a holder for the roll on one side of the imaging area, and a pickup spool that the roll's leader attaches to on the other side. The roll is automatically run through the imaging area, allowing an overhead camera to capture a long continuous image.

Overhead lighting lets the camera capture the color and details such as labels and lyrics on the front of the roll, while a backlight shines light through the roll perforations. When the image goes through software analysis, this relatively bright transmitted light is used to determine which areas are perforations on the roll. Based on this information, a midi output is created.

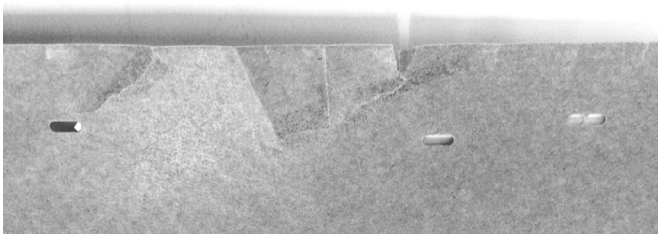


Because of this system, ensuring that the perforations aren't obscured or otherwise distorted is one of the main considerations when making repair decisions for stabilization. Experiments with repair techniques on deaccessioned rolls were carried out, and protocols for repair and handling rolls during scanning were developed during the project test phase. Over time, these protocols have been adjusted as the needs of the project evolved.

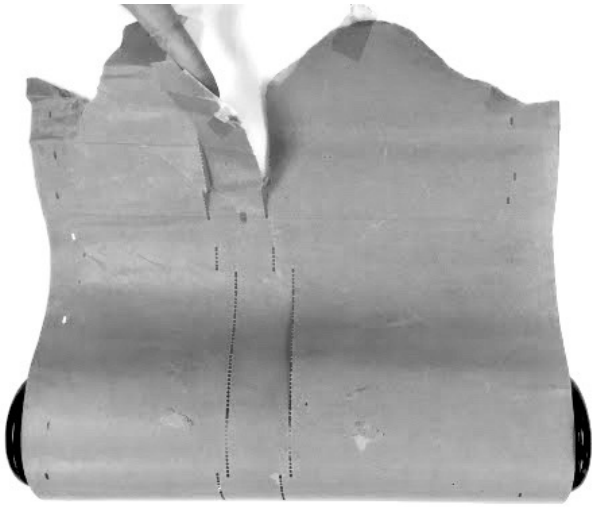
Red-colored rolls manufactured for the Welte-Mignon player piano were the first rolls to be scanned. Often simply called red Welte rolls, these reproducing rolls predate standardization and capture significant classical piano performances. A collection of 19 Spanish- and French-published rolls have also been scanned for an online exhibition. Because our initial protocols were based largely on the relatively uncommon Welte rolls, we revisit them periodically as we get other types of rolls in the lab.

Given the heavy work load the project could potentially generate for conservation, it was important to distinguish between acceptable damage for scanning and damage that required intervention. Working with DPG, conservation chose a test roll with minor edge tears to determine acceptable damage levels for successful scans.

The test run revealed that rolls with minor tears like this could be successfully run through the scanner.



This knowledge eliminated the need for conservation work on rolls with minor problems and allowed us to focus on more significant damage like this (below).



Conservation has addressed damage in these broad categories: roll paper tears and damaged or missing piano roll components such as leader attachments, cores, and flanges. Tackling these repairs, however, first required acquiring some specialized equipment and supplies!

Specialty equipment and supplies

A number of rolls that came to conservation were missing specialty parts, such as cores, flanges, and leader attachments. These components are necessary for scanning and needed to be replaced. Fortunately, some piano roll replacement parts are still commercially available. ARS worked with dedicated piano roll collection care and repair communities to source suppliers for these items, which include new standard cores and flanges, as well as D-rings for leader attachment.

Core and flange replacements for non-standard rolls are not readily available, commercially or otherwise. Therefore, compatible core measurements were derived from Welte rolls in the lab. The cores were custom-ordered from a mailing tube company. Fortunately, the slightly tricker-to-replace Welte flanges are not attached to the core and can be easily removed. DPG was able to obtain a spare set. Instead of needing to source a replacement pair of flanges for each roll, the spare set is temporarily swapped into flange-less Welte rolls for the purposes of scanning.

Conservation has also obtained two specialty manual repair systems through the piano roll community; one is a fixed-width tabletop device for standard rolls, and the other is a set of adjustable holders that clamp onto a table for non-standard rolls. Some initial repairs were done on the bench, but these devices allow for quicker and easier scrolling through rolls, while keeping everything aligned and tensioned. The same type of tabletop device is also used in ARS for their studies.

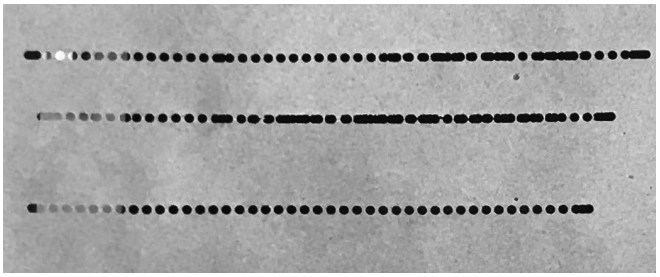
Repairs

Repairs described here will focus on the relatively uncommon red Welte rolls, which have comprised the bulk of conservation's work thus far. Repair decisions were based on physical stabilization for scanning, retaining perforation information for software analysis, and efficiency.

Tear repairs

Our default repair material on the red Welte rolls is Filmoplast R. This repair tissue is thin, flexible, and efficient; therefore, well-suited for high volume repairs on this water-sensitive roll paper. Occasionally a dry wheat starch paste is used for tears with a heavy scarf. For other rolls, we've also used a light Japanese paper mend - generally Hidaka Washi Tengucho - when Filmoplast R has felt too heavy or has not adhered well to the paper. Filmoplast R or wheat starch paste also works for detaching leader material. Fills on the main part of the roll are done if needed for stability with the Tengucho and wheat starch paste.

A technical challenge presented early in the project was how to repair extended tears across very thin paper bridges between closely spaced perforations. This damage was seen in both the test rolls and the first batch of Welte rolls. Long mends of thin Japanese paper that covered the tears and perforations were tried. While the paper was translucent to us, it blocked enough light that the software couldn't differentiate between the paper and the perforations. The thought of repairing each thin bridge was daunting, to say the least.



Surprisingly, though, it turned out these thin bridges don't necessarily need repair to be physically scannable or analyzed correctly by the software. As we found out, the scanner runs the roll more smoothly and tightly than we are able to on our manual table - if it doesn't present issues for us, then it rarely presents issues for the scanning operation.

The midi conversion is also unaffected because when perforations are grouped together at their closest (and therefore more likely to tear), they are read by an analog player piano as a single, held key strike rather than multiple key strikes of the same note. This means a close enough perforation grouping would create the same sound regardless if any of the bridges between the perforations were torn or not. Since the software bases its midi output on analog player piano interpretation, it does the same for tears in close perforation groupings.

Leader attachment repairs

Two different leader attachment types have come to conservation so far: reinforced eyelets on Welte rolls, and fabric tabs with D-rings on the Spanish and French rolls.

Reinforced eyelets are created by a metal grommet being punched either directly on the leader or on a small extended tab. The reinforcements are often fabric or cardboard discs, or additional paper on the verso. A string is common for securing the piano roll when it's closed. As a result of stress on this area, the eyelets are often damaged. They may be partially or fully torn away and the eyelet area is often permeated with adhesive.

For torn eyelets, a layer of heavy Japanese paper, such as thick Yukyu-shi, is used for initial loss fills. Larger fills can have an additional layer of Perma/Dur for added strength and to better match the thickness of the adhesive-permeated paper.

Fabric tabs with D-rings are tabs adhered to the tip of the leader with an extension that folds around a small D-ring. The damage here has been mostly wear-and-tear on the fabric where the D-ring attaches, as well as adhesive failure and loss of D-rings. Wheat starch paste and Japanese paper are used to reinforce weak areas and mend splits in the fabric, and missing D rings are replaced.

Sometimes a larger portion of the leader is missing. Often this is just due to extended mechanical damage, but we learned from ARS that another reason for missing leaders (and cores) in the Condon collection was that Dennis Condon, the previous owner, had spliced some of his rolls together for a longer playtime.

To do so, he removed the leader of one roll and the core of another and taped the two along the cuts (as well as taping over perforations on the first roll that normally signals the player piano to rewind). For the Library's purposes, we are undoing the splices, removing the tape, and attaching new cores or leaders to the rolls.

When a larger portion of the leader is missing, a replacement is made with Perma/Dur - chosen for its slickness and similar weight to roll paper - with the grain running long to match the roll paper. An eyelet is made on the new leader by punching a hole at the tip and adhering a ring of heavy Japanese paper for reinforcement. The roll paper is trimmed to a straight edge and the new leader attached with Filmoplast R and a penciled-in label.

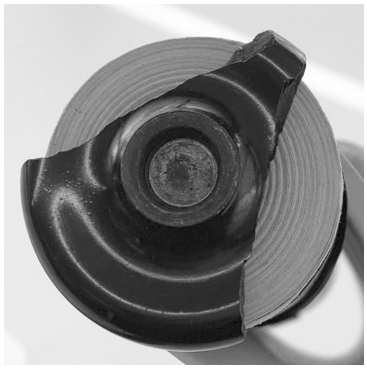
Non-paper repairs

Core repairs

Core repairs have either been roll reattachments or full replacements. Reattaching rolls is done by attaching a short stub of Perma/Dur that's long enough to wrap around the original core with offset strips of Filmoplast R on either side. The roll is trimmed to a straight edge if needed, and the stub is attached to the roll. Full core replacements are done in the same way, as both core types obtained in the lab are acidic. Full replacements are done when either the core is completely missing, or the flanges are both unusable and unremovable from the core.

Flange issues

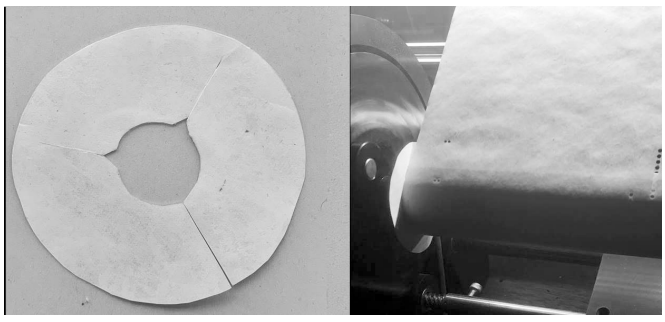
Flange issues are due to either loose flanges or endcap damage. For loose flanges where we're keeping the original cores and flanges, we have created removable spacers of ⅛" Volara, cut into a doughnut. New replacement flanges can also have layers of Japanese paper and wheat starch paste built up directly on them.



Endcap damage is when the part of the flange outside the core has portions broken off. With care and practice, the scanner operators can scan rolls with a large amount of the endcap missing, but there is some risk that the paper edge may catch on the remaining part of the endcap or be difficult to keep aligned.

A shim made of laminated Mylar and Tyvek works as a failsafe when larger portions of the endcap are missing. There is generally a small space between the roll edge and the flange that the shim is thin enough to sit in.

To insert, the split is opened and lined up with the biggest loss on the flange. The shim can then be gently worked into the space, with the flange loss creating extra room for the middle portion of the shim to flex into if needed. Then the slit is rotated around to the flange loss and taped to secure. If there is not enough left of the original endcap to secure a shim or it is missing completely, the core is removed and replaced with a new one.



Previous Repairs

Over time and through use, piano rolls have been repaired with a variety of materials with mixed success. Previous repairs have been found throughout the roll paper, and also to various roll components - cores, leaders, and flanges. Many of these are still holding up and are left in place if they are not interfering with scanning or analysis. Our main concern is with repairs that are no longer functioning.

Previous paper tear repairs were commonly done with translucent pressure-sensitive adhesive tape. In the Condon collection, many short strips of tape cover paper tears. Losses were generally ignored, but in one case, a roll was found with small fills of white paper attached with tape. We remove and replace previous tear repairs if they are partially detached, brittle, or misaligned; trap folds underneath them; or overhang perforations or the edge of the paper.

We've also found cores that have been reattached in the past with centered strips of adhesive tape. These fail when tape becomes brittle.

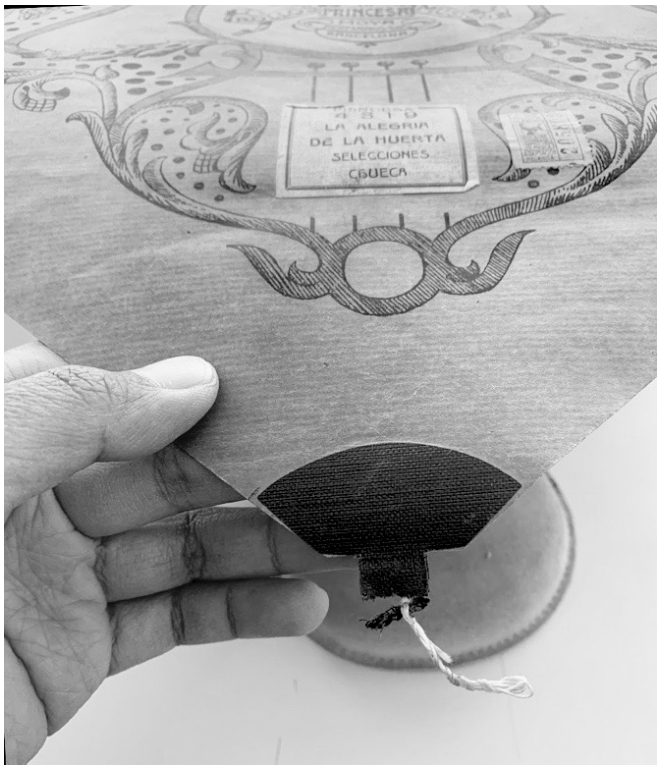
Previous repairs on leader attachments include commercial replacement parts; yarn or thread loops in fabric tabs; and rubber bands. We replace these if they are no longer functioning or causing damage to the piano roll.

Previous flange repairs are generally adjustments made to secure loose flanges. These are typically layers of masking or translucent tape around the portion of the flange that extend into the core. On some wooden flanges, that portion forks into 4 prongs, similar to an old-fashioned clothespin. Fabric layers have been found packed between the prongs, which seems to be another way to adjust the flange tightness.

These adjustments have generally fared well, and only need a spacer added if the flange is still loose. Further down the line, as rolls from different manufacturers and time periods arrive in the lab, we anticipate having to adapt materials and techniques to the particular physical quirks of each type. Despite its seemingly simple format, there is still a lot to learn from working hands-on with piano rolls!

We look forward to our continuing support of the Player Piano Program which is expanding awareness of and access to this perhaps previously underappreciated, historically significant music storage system.

photos by Elizabeth Ryan and Jill Sison



For more information about the Stanford Player Piano Program:

The Player Piano Project, Stanford Libraries https://library.stanford.edu/projects/player-piano-project

Stanford University Piano Roll Archive online exhibit https://exhibits.stanford.edu/supra

KQED: Century-Old Player Pianos Come to Life at Stanford https://www.kqed.org/news/10493594/player-pianos-come-to-life-at-stanford