The importance of roll scans

I began scanning piano rolls in the late 1970s, and am still at it. There are now many others who have joined in this rewarding activity, for all sorts of reasons. In this article I look at why I've spent some 30 years doing roll scans, and argue the case for roll scanning.

By Peter Phillips

When I started this article, I intended describing *how* I went about producing some 1500 scans of Ampico piano rolls. But the *why* kept creeping in. So when the article started reaching tome proportions, I split it into two parts. This is part 1, where I explain why I spent so much time on an activity that not all collectors agree with. Part 2, to be published later, is my scanning story, from 1976 to the present.

Initially, as Part 2 explains, I got into roll scanning through necessity. It was the only way I'd ever get a decent library of music for my Ampico. When you live outside the USA, government taxes and transport costs can make a $10 roll into a $30 slug. But time has moved on, and although I still play my roll scans on the Ampico, I now have another way of hearing them: a Disklavier.

Mechanical MIDI pianos

The development of the mechanical MIDI piano probably started with the Pianocorder. Although not a MIDI instrument, it inspired companies like Yamaha and PianoDisc to produce a player piano that would play from electronic media. I saw my first Pianocorder in the early 1980s, at the Sydney Opera House. It was demonstrated by a concert pianist and I was bowled over at hearing a reproducing piano without a vacuum pump. I didn't seek to buy one, as although impressed, I felt my Ampico did a better job. But these days, the Pianocorder lives on as a full MIDI instrument thanks to the excellent work done by Mark Fontana.

An MX100 Disklavier was on display at the 1987 AMICA convention, but I had to wait until 1988, when Yamaha displayed an upright Disklavier at the first Sydney International Piano Competition. Working at the time for the media, I was asked to review the instrument, which I did with great enthusiasm. Although I praised it, I still felt my Ampico was better. All the AMICA conventions I've been to since have a solenoid piano on display, with recent conventions also showing MIDI player systems, such as the PowerRoll or the Gerety-Chase MIDI valve system. Times have certainly moved on since the 1970s.

I was finally converted, and fitted a PianoDisc system to my Yamaha G5 piano in 1996. I purchased performances on floppy disks from PianoDisc and Yamaha and for a while enjoyed hearing pianists that were still alive. But despite this, I seemed to listen to the Ampico more than the PianoDisc. Something was lacking in many of these modern recordings.

What I really wanted was to be able to hear my Ampico roll scans on the PianoDisc, which would mean converting them from my file format to MIDI. A colleague, Ross Chapman suggested a way of doing this, a task that was eventually completed. Some readers might not be aware of the *types* of MIDI files used in roll scanning, so here's a brief explanation…

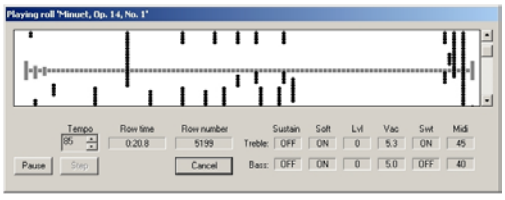
Roll scans and MIDI

These days, roll scans are available as MIDI files. This is the standard used for pretty much all electronically operated musical instruments, from pianos to clarinets. It's not useful to describe the MIDI format, as it gets too technical. Instead, I regard MIDI as a computer-based system that stores musical information for replay on instruments designed for the purpose.

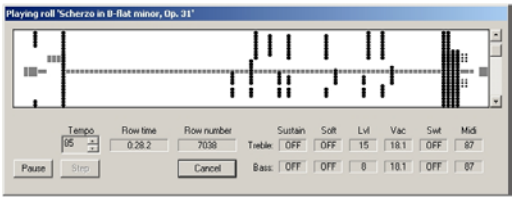
However, there are various types of computer file formats used by roll scanners, including the following three.

The first is the so-called e-MIDI file. This is the type of file you would use to play a pneumatic instrument fitted with a MIDI interface like the PowerRoll or the Gerety-Chase MIDI valve system. An e-MIDI file is simply a MIDI representation of all holes in a roll. Scans of organ rolls and the like are in this form, so the file, when played into an instrument fitted with a MIDI valve system plays as if from the roll.

A second type is the Bar/Ann format, developed by Wayne Stahnke. This format is used with Richard Brandle's WindPlay, a program to operate the PowerRoll. The Bar file is similar (but technically different) to an e-MIDI file; the Ann file stores information such as roll title, pianist, composer, year produced, etc. The main problem is the need for two computer files per roll scan. Advantages include being able to use WindPlay to play a Bar/Ann file into a pneumatic piano via a PowerRoll, or into a standard MIDI piano like a Disklavier. A nice feature in WindPlay is a graphic showing the roll, synchronised to the music, moving across a tracker bar.



WindPlay playing an Ampico eroll: Minuet, Op.14, No.1 (Paderewski), played by Rachmaninoff.



WindPlay playing an Duo-Art eroll: Scherzo in B-flat minor, Op.31 (Chopin), played by Hofmann. Notice that the tracker bar image changes to suit the type of eroll.

The third type is perhaps the most important, as I believe it's the key to keeping piano roll music alive in the 21st century. This is the *emulated* MIDI file, where the roll's expression coding (if present) is converted to an equivalent MIDI volume by a program called an *emulator*. Standard rolls don't have expression coding, so an arbitrary volume is used for all notes.

Also called a standard MIDI file (SMF), most roll scan MIDI files are of this type. This is the type of file played on a Disklavier or any standard MIDI piano. WindPlay has emulation software, which is why it can provide the two types of output: e-MIDI for a pneumatic piano, or standard (emulated) MIDI for a solenoid piano.

Emulated MIDI

The principle of emulation is relatively simple: the expression coding on a roll is converted into a number (called a *velocity value*) somewhere between 0 and 127, where 127 is the maximum volume. In MIDI, each note (or MIDI event) has a velocity value. A MIDI piano can play each note at a different volume, unlike a pneumatic piano, where there's only two different volumes possible at any one time.

So, with an emulated MIDI file produced from a roll scan, it becomes possible to hear an Ampico, Duo-Art or Welte roll on a modern instrument. And it's here things get tricky. It would seem that emulating expression coding is simply a matter of mathematics. I learnt the hard way some years ago when I built an electronically controlled vacuum regulator for a Duo-Art. It all just seemed a matter of decoding a four-bit binary number to get 16 volume levels. How wrong can you be!

Instead, a Duo-Art has far more than 16 volume levels. But how? Theories include the number of notes being played at the time, inertia in the regulator, position of the knife valve and so on. I'm sure programmers will

figure out all the many parameters for a Duo-Art emulator, and I know there are people in various parts of the world currently working on this.

Emulating Ampico expression

Fortunately, the same is not so true for Ampico. I can't comment on the current state of Welte emulation, except to say that the emulated roll scans I've heard so far do not sound as good as the roll when played on a real Welte. But back to Ampico.

Charles Stoddard (inventor of the Ampico) developed a vacuum regulator that uses feedback. This means, within reason, that the vacuum level you get is pretty much what the expression coding demands. That is, the system compensates for the number of notes being played, and in general produces a predictable vacuum level. Good news for emulation software.

My Ampico roll scans are now in all three of the MIDI file formats I've described, but it's the emulated MIDI files I listen to on the Disklavier that replaced my PianoDisc in 2001. It took some doing before I felt the files were sounding like Ampico rolls, and I still find things I need to modify with hand editing. Even so, I believe I am now getting the best results I have ever had from these roll scans.

I can compare the same performance on the Disklavier and the Ampico (they sit next to each other), and I typically find the Disklavier gives a wider dynamic range and a better overall performance, without any background noise. But importantly, the result is so close that it becomes difficult to tell which instrument is playing.

Having made a case for an emulated MIDI file as an alternative to an Ampico roll, I'll now briefly look at other reasons for creating an electronic "image" of a paper roll.

Reasons for making roll scans

There are two basic uses for roll scans: producing more paper rolls from a "master scan"; or playing roll scans into an original or modern instrument to recreate the music. You might think a "master" scan can do both, but not quite. It comes down to timing.

As collectors know, a hole in the tracker bar of a pneumatic instrument must be uncovered by an amount equal to or greater than the size of the valve bleed before a note can play. When less than this area is exposed, the valve will either fail to respond, or turn the note off. That is, the note plays for a *shorter* time than the time taken for the roll hole to completely pass a tracker bar hole.

When a roll scan is used to operate a roll perforator, the timing is somewhat different. The perforator must be operated from the scan to create holes in a paper roll that are exactly aligned to those in the original master. That is, a punch is activated at the leading edge of a master hole, and deactivated at the lagging edge. That is, the punch is "on" for a longer period than a note in a piano for a roll hole of the same length.

This implies that the MIDI files for a perforator and a musical instrument will have different timing. In some cases it might be hard to hear the difference, but you'll soon hear it during trills and rapid repeats. At worst, bridging between holes can cause a single, long note to play as repeating notes, or vice versa, where rapidly repeating notes are interpreted as a single note.

So when the term "archiving" is used, one should question just what is being archived. Is it the roll itself, or the music contained in the roll? I suggest these are two different forms of archiving, and both need to be looked at differently. Julian Dyer recently

wrote about methods of producing a "punch master" from a roll scan, and then using this master to cut duplicate rolls with a perforator. He explains the difficulties and how he overcame these.

In other words, he and others in the Rollscanners group are working on perfecting the art of roll scanning, with the aim of being able to use these scans to produce duplicate rolls that potentially have a higher quality than those produced in the 1920s. I recommend their website at www.iammp.org and urge anyone getting into roll scanning to become a member of the group.

I believe that, while archiving the rolls themselves is most important, the music is paramount. This is the main legacy of the player piano era, and while the instruments and the rolls will always have a most important place, the music is likely to have a wider appeal.

Methods of archiving piano rolls

Piano rolls can be archived in various ways, including making duplicates of existing piano rolls. Duplicate rolls can be produced from a MIDI master file (as described above), or from an existing paper master (if available). But ultimately, the paper roll has limited use. Hopefully there will always be collectors interested in the preservation and maintenance of pneumatic instruments and paper rolls, and the master scans now being made will ensure collectors in the future will have rolls to listen to. I disagree that roll scanning will put roll manufacturers out of business, instead it can only help them in their cause.

But it's the music that is helping drive the push into roll archiving. The piano roll has a unique place in history as being the first use of digital recording techniques to record a live musical performance. These days digital is everywhere, so it stands to reason that people today will try and marry these early digital recordings and current technology.

The most common way of converting a roll into a MIDI file is with a roll scanner. There are various types of roll scanning devices, the optical type being the most popular today. My scanner uses a different method: air, in which small electro-pneumatic sensors are operated by air flowing through a hole in the roll. I describe my scanner and playback system in the other article, titled *My roll scanning story*.

Another popular method is to connect, in some way, a reproducing player system to a keyboard that can record the performance of a roll. For example, pushing a Welte vorsetzer up to a Disklavier. Some collectors have even built Ampico or Duo-Art vorsetzers for this purpose. I recall that the library of roll music for the Pianocorder was recorded by playing rolls on a multi-system vorsetzer into the Pianocorder itself.

PianoDisc offers a collection of Ampico roll performances in its *Masterpiece Collection*. These were recorded by fitting a PianoDisc record strip under the keyboard of an Ampico. Hit the record button, start the roll playing and voila! Unfortunately the results are rather poor, either due to an incorrectly adjusted Ampico or shortcomings in the recording system.

The case against roll scanning

There are some who feel that converting a reproducing piano roll into a MIDI file is doing the hobby a disservice. And there's good reasons for saying this. The first is the quality of some of the files being produced. Those currently being offered by PianoDisc are certainly not as good as the roll played on a well adjusted Ampico. Emulating piano roll expression from roll scans is still an imperfect science, and some of the scans currently available have discernible changes in tempo.

One commentator has suggested today's roll scans are tomorrow's Musak, as copyright restrictions don't apply to much of the music. Personally, I'd rather hear a piano roll than some of the stuff one is subjected to in many supermarkets. And if piano roll music becomes commonplace, as it once was, then what's the problem?

Not everyone agrees on the concept of archiving rolls in electronic form. Some argue that electronic media has a finite lifetime and is therefore not suitable for archival purposes. I won't pursue this, except to say that over 25 years of computing I've never lost a file, even those from the Apple II. A major reason is regularly transferring files to newer forms of storage media (eg, CDRom) as it becomes available. I doubt today's storage media is the only form we'll ever know, and in the meantime it should prove reliable enough until transferred to the next type of media.

So stop this scanning business they say. As collectors of mechanical musical instruments we should concentrate only on original pneumatic instruments and paper rolls. And there's the catch: the word *only*. Surely it's ok to do both. The reality is that the membership of organisations like AMICA comprise two sorts of people: those whose interests lie mainly with restoring and preserving the originality of mechanical musical instruments, and those, like me who extend the interest into new arenas.

We are sometimes called 'experimenters', and are often a cause of concern to preservers. When I began fitting my eroll player system to Ampicos here in Australia, some collectors felt I was interfering with the instruments' originality. As a result, I took great care to ensure my system did not change the external appearance or operation of an instrument, and that it could be removed without leaving any lasting damage. So there is a way experimenters and preservers can live together. In many ways, we complement each other, with preservers keeping a close eye on experimenters, and experimenters pushing new boundaries that can result in new people coming into the hobby of mechanical music.

The case for roll scanning

As I see it, the long term future of mechanical music lies with mechanical MIDI instruments, such as the piano or pipe organ. These days there are many collectors who own a Disklavier or equivalent, with some in our club not having anything else. These people belong to the club through their interest in the technology, the history and the music. Not necessarily the modern music, the piano roll music.

There are now many talented people working on perfecting roll scanning technology and emulation software. I believe the Ampico emulator in WindPlay does a very acceptable job, sufficient to convince me that I'm hearing on my Disklavier the sounds intended by Ampico editors. But importantly, those scanning piano rolls are creating a library of files that can be accessed by future generations. All that's needed is for these scans to contain an exact image of the original roll. And this is being achieved now by many of those scanning rolls.

Terry Smythe is now well known around the world for his altruistic efforts in making his roll scans freely available. Some of Terry's early files might have tempo errors, the emulation of some of the reproducing rolls is not perfect, but many people all over the world have been introduced to the wonders of piano roll music through his efforts. Importantly, Terry has provided a library of roll scans accessible to all. Those who are not satisfied with the scans can modify them, on the way learning more about piano rolls. If anyone doubts the extent to which Terry's scans have increased

the interest in piano rolls, check out http://members.shaw.ca/smythe/feedback.htm. I also get many complimentary emails about my roll scans, usually from people who would otherwise never have become interested in piano roll music.

Recently, Terry presented constructional details of the roll scanner he built. Based on a design by Richard Stibbons (from the UK, who has also developed Ampico, Duo-Art and Welte emulators), my guess is that this will generate a lot of interest among collectors around the world. As Terry points out, if he can do it, so can anyone else. But, the detractors might say, this will get everyone into roll scanning. I fail to see the problem as it will simply expand the interest base.

Another altruistic roll scanner is Warren Trachtman, who has a website containing over 400 roll scans from various types of rolls. (See http://trachtman.org) These are available to all for free, within the limits of copyright restrictions. Warren's website also gives a good explanation of the scanning process he follows, along with a description of each type of file produced by his scanner. Essential reading for those wanting to develop a roll scanner.

Others producing roll scans include Spencer Chase, who has produced a large library of Duo-Art scans, in both e-MIDI and standard MIDI formats. (See www.spencerserolls.com)

Wayne Stahnke is perhaps the best known, as like me, he started scanning rolls back in the 1970s. Wayne's contribution to the technology is legendary, and he has available a collection of Welte, Duo-Art and Ampico erolls. Some of these have been edited (eg the Rachmaninoff erolls) and produce remarkable results, as can be heard on the Telarc *Window in Time* CDs.

The future

The current reproducing piano roll expression emulators could be seen as "work in progress", but some are good enough now to give a very convincing performance. Tomorrow, who knows how much better emulation software will be. My guess is a lot better. Importantly, the attraction of a huge collection of music from roll scans will mean more people get interested in such music. It also means the music will not languish in the hands of a few collectors. Instead it will be available to anyone who's interested.

In summary, it's my belief that roll scans will keep piano roll music alive for the foreseeable future. True, some of the results are not yet perfect, but we have to start somewhere. Even now, as you read this there are likely to be many people around the world listening to piano roll music on their MIDI piano. And as the word gets around that this library of music is indeed fantastic, interest will only pick up. Perhaps some of these people might also become interested in pneumatic instruments, and help keep the hobby alive.

But without the roll scanning fraternity, all that will be left after we're gone is pretty much what we started out with: paper rolls and pneumatic instruments. Great for a museum, even better for those into the hobby, but not much of a legacy to leave our children, who for the most part are not interested anyway. But leave them something they can play on their iPod, and things are not so bleak.

My website address is www.petersmidi.com, which also has my email address. I welcome your comments, both for and against anything I've said in this article.