A Newly Developed Scanner for Pinned Barrels

Leonardo Perretti

Mechanical musical instruments are an invaluable source of knowledge about the musical culture from the past centuries; they, especially in their hey-day, were built in an incredible variety of models, types, subtypes, etc. They were spread in a wide variety of environments of the social life: organs playing in fairs, organs for the riders of carousels, barrel pianos and organs along the roads, huge organs in theaters and cinemas, organ clocks and barrel organs in private residences. They were even at the European courts, intended for the amusement of the court and for impressing the visitors, and so on. According to the size and importance of the instruments, and to the public they were addressed, we find all grades of musical sophistication, from the simplest melodies in the small carillons for kids, up to the almost perfect performances of the greatest pianists in the rolls for the reproducing pianos.

Figure 1. An overall view of the pinned barrel scanner.

The media that were devised over time to contain the sequence of musical notes—pinned barrels, paper perforated rolls, cardboard books, paper and metal perforated discs and so on—bring to us their musical content in the same exact form the arranger and the noteur established when they made the object. In a sense, such media are somehow similar to digital media we currently use today. This concept is wonderfully expressed in the introduction of a manual for the notation of barrels, written in France by M.D.J. Engramelle in 1775; he says:

> The Music overall, made to raise the soul by the harmonious feelings that it inspires, suffered unrecoverable losses. We could enjoy still today the performances of Lulli, Marchand and all great men who filled with admiration their contemporaries, should they have had a notation [i.e. a method for notating the barrels]: their best compositions, transmitted by themselves to the posterity on some unalterable cylinder, would have been preserved with all their expressive features, that we can know only by history.[1]

Of course, not all of the mechanical music items bring high-value pieces or sophisticated arrangements; many of them are mere repositions of the score, rigidly transferred to the instrument in a metronomic manner, with no trace of an even simple interpretation. On the other hand, a number of them were made with the insertion of a lot of elements of musical interpretation, allowing us, as Engramelle said, to listen to such mechanical executions as if they were performed by a musician of that time, not to mention the rolls for reproducing pianos, that were made by recording the actual execution of the musician on a master roll working in a specially-made piano. The desire of recording the actual musical execution for a mechanical instrument is not an invention of recent times; it dates from the earliest times of mechanical music: the oldest known treatise of mechanical music, written in the IX century in Baghdad by Ahmad Banu Musa,[2] reports a method for impressing the execution of a flutist on a wax tablet, to be transferred later on a sort of pinned cylinder for a flutist-automaton.

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It should be clear, then, that an analytical study of the "recordings" fastened on mechanical musical instruments could help in improving our knowledge of antique musical

interpretation, by "reverse-engineering" them. This field is still to be explored, at least from an analytical, scientific point of view, and we don't know how far it can lead, mainly as this perspective is somehow "oblique" with respect to the classic methods of the musicological research. Of course, I do not pretend that these studies will lead to radical changes in musicology; I believe we will hardly find a sort of musicological "Rosetta Stone" for mechanical instruments, an item that could revolutionize musicology. Nevertheless, a valuable contribution to the understanding of musical interpretation of the past is likely to come out from this direction, and I think it is worth the trouble.

But, how can we bring forth this ambitious task; what kind of tools and methods can we use?

There are various ways for capturing the musical contents from a mechanical instrument medium. The simplest and more obvious is to record the actual performance from the instrument on tape or on hard-disks by digital equipment. Just to mention the simplest, nowadays a common portable computer with a good microphone could do the job in a satisfactory manner. But, generally speaking, direct recording might be unsatisfactory for our goal, in that the musical performance might be "polluted" by all possible defects of the instrument, and there are still a variety of cases when it is simply impossible to do the job. This happens, for example, when the object is "orphan" of its instrument, or is in such bad condition, that it cannot undergo the stress of even a single performance. Furthermore, direct recording preserves the music, but, when it comes to musicological study, one would need to withdraw the exact arrangement of the piece, so it would be desirable to develop a device for extracting the music from the medium directly, in the form of a sequence of musical events, eventually evaluated by mathematical/scientific means, such as MIDI files or similar items.

In recent years, several of such systems have been devised; they are generally known as "scanners," for similarity with the common devices intended to scan images. Great work has been done with scanners for perforated paper rolls; several types of them have been developed, the better ones based on optical scanning. A group is active on the Internet, whose members have successfully scanned several thousands of rolls (see: http://www.iammp.org).

Another class of musical scanners is the one intended to scan pinned barrels, which is the impetus from which this paper originated.

My Involvement

I devoted my attention to this subject around 13 years ago, while restoring a valuable organ-clock, for which it was needed to get the music from the barrel. I built a rudimentary scanner, that was precise enough for the job, but it was limited in that it had been tailored for that particular instrument, and could not be used for others with different sizes and features.

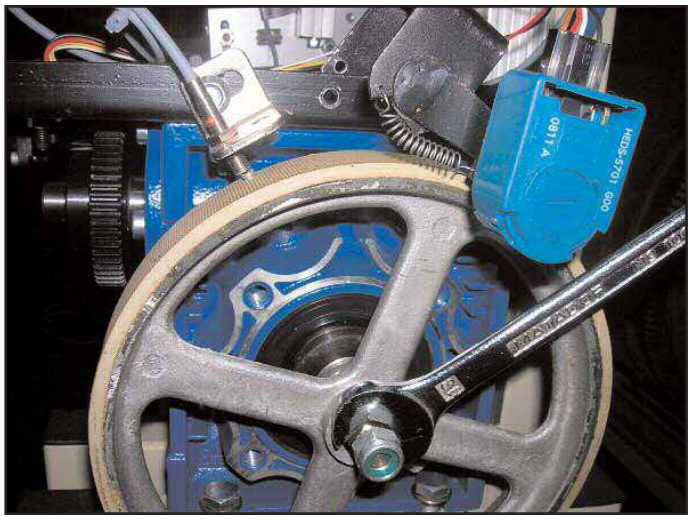

Figure 2. The rotation motor with the wheel and the encoder.

Some years later I had been commissioned to restore the barrel organs belonging to the Royal Palace in Caserta (Campania region, Italy). These instruments are two wonderful automatic pipe organs built in Vienna, Austria in the 1820s; the amazing aspect is that they are endowed with a total of 89 barrels. In consideration of their top-quality materials and musical features, I proposed to make a study of the music contained in the barrels, and resumed my previous project of a barrel scanner, now devised in such a way that it can read all types of barrels. I discussed this with Franco Severi, President of AMMI (the Italian Association for Mechanical Music) who greatly encouraged the project. I also started collaboration with Flavio Pedrazzini, a fellow AMMIer, who is an expert in industrial automation. Flavio took the direction of the project and did most of the actual work; my role was reduced to collaborator and supervisor, and developer of part of the software. Flavio also involved in the project two colleagues of his, Niccolò Perego, who is an expert in Progammable Logic Controller (PLC) and Luigi Mastrosimone, who is an expert in software development. The device was completed in January, 2009.

The scanner has been built using the components that are usually found in industrial servo-machines (**Figure 1).** It is essentially made with a special frame carrying the needed elements. At its right edge, a support is placed, which bears the motor that rotates the barrel, with a wheel attached, and an optical encoder for measuring the rotation (**Figure 2**). Another vertical rod, intended to sustain the opposite edge of the barrel, is attached to the base of the frame, and can slide on a binary, so that the correct distance from the motor can be adjusted, matching the length of the barrel. Above the barrel there is a horizontal bar with a small carriage, which is moved laterally by an endless-screw bar with its step-motor [*snail cam—ED*], for precise positioning. The bar can be adjusted in height, to match the correct position of the sensor with respect to the diameter of the barrel. The carriage bears the sensor, which currently is a simple lever, with a

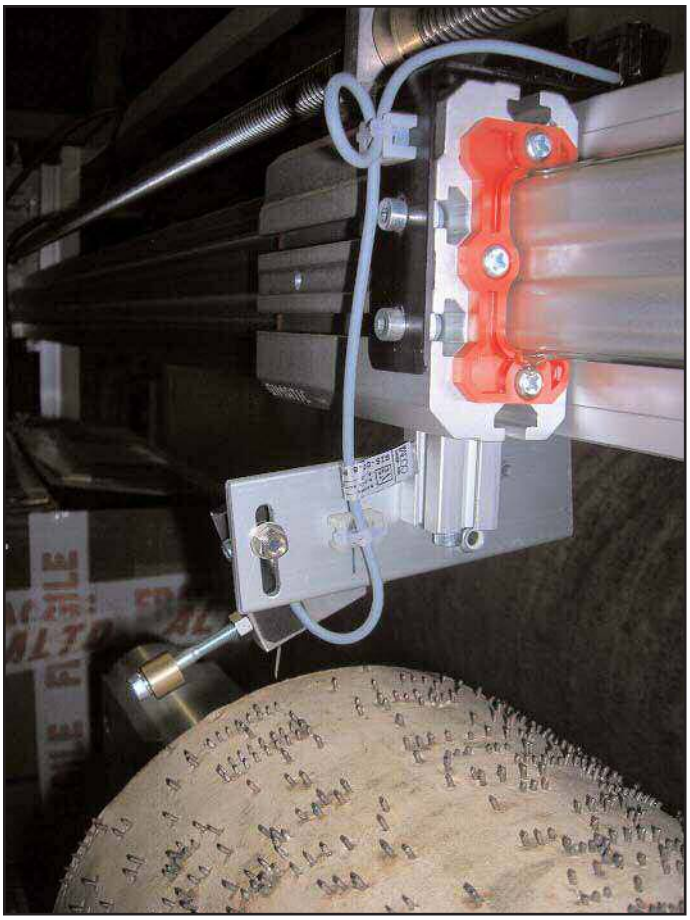

Figure 3. The barrel with the carriage and reading head.

micro switch, imitating the usual key-frame keys; the pressure of the key can be regulated at will (**Figure 3**). We are planning to add a laser sensor, as a future upgrade, so as to realize a contactless device. A metal box above all completes the scanner, and contains the PLC, the power supply, and the other electronic cards that manage the device (**Figure 4**). The machine can read barrels for pianos and organs up to a length of 150 cm and a diameter of 50 cm. Due to the size of the sensor it cannot read the small barrels of carillons for now.

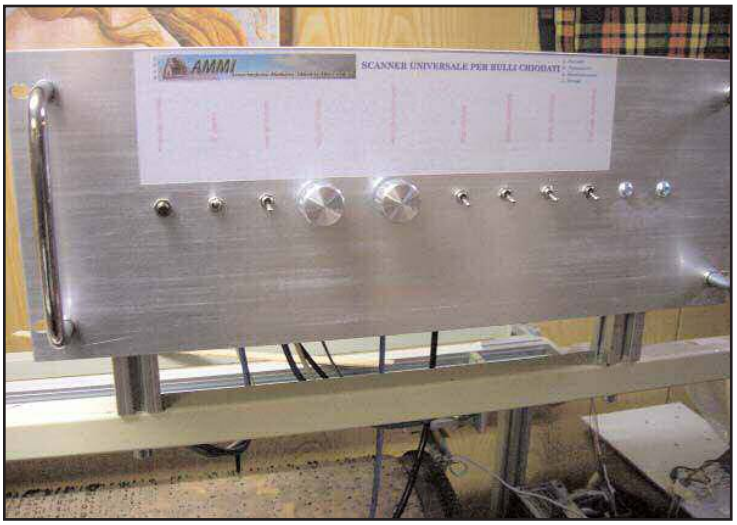

Figure 4. The control panel of the barrel-reading machine.

The core of the machine is a PLC, working by a specially written program developed by Niccolò Perego. According to the instructions received from the computer, the PLC manages the motors, continuously checking the angular position of the barrel, and the state of the sensor, and sends to the computer the data related to pins. The computer software, written in Visual Basic by Luigi Mastrosimone, dialogues with the PLC, and collects the data, that are finally issued as a text file (**Figure 5**). Notes on the barrel are scanned one line at a time, then the operation requires one barrel revolution for each key (or the number of spiral rounds for spiral barrels). The passage from one key to the next is accomplished automatically, according to the settings for the specific barrel, supplied at the beginning of the process. The device supports both linear and spiral barrels; reading of spiral barrels is accomplished by gradually moving the carriage laterally, by small increments, synchronously to the barrel rotation.

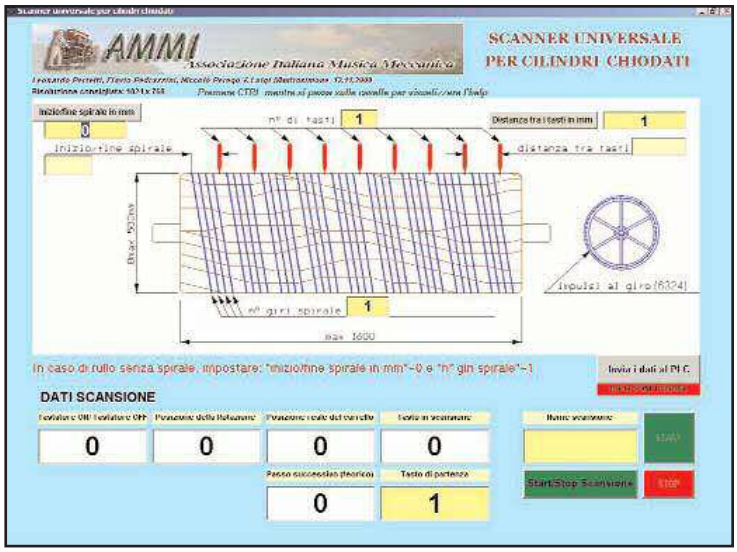

Figure 5. The computer controll screen.

The product of the scanner, as said, is a text file containing the data related to pins in a raw form, according to a predefined scheme. Conversion to MIDI is made by a software converter developed by me, based on an Excel sheet with special macros. Pin data are imported in a table, sorted according to time, and then converted to MIDI and distributed in separate tracks according to the structure of the instrument. Simple instruments with just one section, such as, for example, a simple barrel piano, require just a single track, but complex instruments, such as orchestrions, need one track for each pipe rank, percussion, piano section and so on. Addressing notes of the barrel to the correct tracks is made according to configuration tables stored in separate files, specifying the features of each instrument, in a predefined scheme.

A short demonstration of the scanner at work can be found at:

http://www.youtube.com/watch?gl=IT&hl=it&v=LvBxip2xC48

Preservation

I have described the importance of the conversion to digital for the purpose of musicological research, but surely this is not the only field of application. Another very important and perhaps more obvious field of application is preservation. Generally speaking, pinned barrels are deteriorated by worms, moisture and careless handling; the paper of perforated rolls becomes more and more fragile, while entire collections of rolls or discs are thrown away because they are regarded as "outdated" or "low technology" items and precious mechanical instruments are stripped from their cases, which in turn are then sold as mere bar-furniture! So, translation to digital form can be a great help in preserving the music from destruction, although durability of digital media (hard disks, CDs, DVDs etc.) is debated today.

Figure 6. Reading a cracked barrel.

Conversion to digital can also help for rebuilding damaged or unusable items. Here is an example of a possible application that we are currently bringing forth.

A beautiful barrel piano, belonging to the Museum of Villa Silvia in Cesena (Emilia Romagna region) has been restored recently. Its barrel, containing ten scores, is affected by cracks and deformations, and cannot be recovered to normal use, so it has been decided to make a copy (**Figure 6**). By the use of the barrel scanner, we have picked, pin by pin, the exact scores; at present (May 2009) all songs have been scanned. The scores, converted to MIDI, are being amended by our colleague Marco Gianotto, from the errors due to deformations and other defects of the barrel, so as to rebuild the exact original "noteur sheet." It will be checked against the original barrel, and then used by Marco to make the new barrel. In this way, we are able to make an exact copy, pin by pin, of the barrel; it is easy to understand that a similar job, without the use of the scanner, might be accomplished only at the cost of long and painful various processes.

Final Thoughts

The scanner will be officially presented at the Festival of Mechanical Music of Longiano (Emilia Romagna region), to be held on September, 2009, and will constitute a part of an integrated system called **S**istema **I**ntegrato di **S**cannerizzanione, **A**scolto e **R**iproduzione (integrated system for scanning, listening and reproducing—SISAR) designed to scan all kinds of mechanical music media. The SISAR will be operative at the Museum of Villa Silvia in Cesena which is also the headquarter of AMMI, in a dedicated space. At present, it includes the barrel scanner described here, a scanner for cardboard books and books for Racca's Piano Melodico, and a reader for perforated paper rolls, designed for the rolls of Barbieri's automatic organs, which match the specifications of standard rolls. We are planning to extend the abilities of SISAR as widely as possible by the addition of new devices, as time and resources will permit.

Figure 7. The scanner with the team: left to right: Franco Severi, President of AMMI; Luigi Mastrosimone; Niccolò Perego; Leonardo Perretti; and Flavio Pedrazzini.

Notes

1. M. D. J. Engramelle: *La Tonotechnie, ou l'art de noter les cylindres* Delaguette, Paris 1775, Avertissement, II.

2. (Ahmad ?) Banu Musa: الالة التي تزمر بنفسها (*The instrument which plays by itself*), IX century; English translation in H. G. Farmer, *The organ of the ancients, from eastern sources*, Hinrichsen, London 1931, p. 88.

Leonardo Perretti lives in Casalnuovo Monterotaro (FG), Italy. He is a professional restorer of antique pipe organs and mechanical musical instruments. He collaborates with AMMI for the promotion of the mechanical music in Italy, and for the application of new technologies to the restoration and conversation of antique musical instruments.