two rediscovered manuscripts of Leonardo da Vinci
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TWO REDISCOVERED MANUSCRIPTS
OF LEONARDO DA VINCI

Page
5 THE STRANGE VICISSITUDES
OF LEONARDO'S MANUSCRIPTS
By Paolo Galluzzi

8 THE MADRID NOTEBOOKS
By Anna Maria Brizio

11 THE ELEMENTS OF MACHINES

15 LEONARDO'S THEATRE IN THE ROUND

16 LEONARDO THE MUSICIAN
By Emanuel Winternitz

19 SPECIAL 16-PAGE SUPPLEMENT

LEONARDO DA VINCI
AS TOLD TO CHILDREN
By Bruno Nardini

37 THE STORY OF THE COLOSSAL HORSE

40 LEONARDO AND THE STRIFE-RIDDEN
RENAISSANCE
By Eugenio Garin

45 THE GLORY OF PAINTING
Reflections on art in the Madrid II Manuscript
By Carlo Pedretti

2 TREASURES OF WORLD ART
Florentine gracefulness (Italy)

COVER
This is one of the most striking of the
hundreds of drawings in two long-lost
manuscripts by Leonardo da Vinci redis-
covered recently in Madrid's National
Library and now being published in fac-
simile for the first time. Drawing repre-
sents the head and neck sections of the
outer mould of a colossal bronze equest-
rian statue which Leonardo undertook
to execute (see full story page 37).
Leonardo's mind was like a moving
searchlight, constantly probing into the
darkness, illuminating one subject, then
rapidly passing on to another. Crammed
with brief notes and sketches, done
with unfailing precision, the Madrid
notebooks give us a deeper insight than
ever before into Leonardo's work in
mechanics, military engineering, geome-
try, perspective, optics, casting, and
many other subjects.

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ALTHOUGH Leonardo has always been extolled as "the universal genius", his musical thought and his musical activities have received little serious attention and have never been treated systematically. It is characteristic that the standard works of Leonardo, even in our century, do not mention music at all, or content themselves with quoting remarks by Vasari, the author of the famous Lives of the Painters.

Leonardo was, in fact, profoundly occupied with music. He was a performer and teacher of music; he was deeply interested in acoustics and made many experiments in this field that had immediate bearing on music; he wrestled with the concept of musical time; and he invented a number of ingenious musical instruments and made improvements on existing ones. He also had some highly original ideas about the philosophy of music that were intimately connected with his philosophy of painting.

Vasari records that "after Lodovico Sforza became the Duke of Milan, Leonardo, already famous, was brought to the duke to play for him, since the duke had a great liking for the sound of the lira; and Leonardo brought there the instrument which he had built with his own hands, made largely of silver but in the shape of a horse skull—a bizarre, new thing—so that the sound (l'armonia) would have greater sonority; with this, he surpassed all the musicians who met there to play. In addition, he was the..."
Leonardo was a highly proficient musician. He invented some new musical instruments and improved others. He was deeply interested in the construction of drums and sketched many different kinds in his notebooks. He wanted to extend the musical possibilities of drums and also make them easier to play through various methods of automation. This drawing (opposite page) of a mechanized military drum in the Codex Atlanticus with its battery of drumsticks looks like part of a street musician’s one-man band. The axle of the carriage wheel drives a central cogwheel which then turns other cogs which activate the five drumsticks on each side of the cylindrical drum.

In his work in art and science, Leonardo gave much attention to studies in anatomy, such as the drawing above of the larynx and trachea (now in the Windsor Collection). This probably inspired in him the idea for the two musical pipes, above left, in a drawing from the Codex Atlanticus. Leonardo wrote that the pipes changed their tone “in the manner of the human voice”, and there is a close resemblance between upper opening of the larynx shown here and that of a recorder.
of keyboards; increasing the speed of playing; extension of tonal range to make it possible, for instance, to play melodies on drums; overcoming the quick fading of the sound of plucked strings, by giving the instruments an endless bow; enriching comparatively simple instruments to make them capable of polyphony or a wide range of successive tones; and even having a polyphony of the sounds of bowed strings at the control of a keyboard.

Leonardo was greatly interested in the construction of drums. He not only tried to make them easier to play but also expanded their musical possibilities, such as tonal range, far beyond the limitations of the conventional instruments of his time.

Leonardo endeavours to enrich the traditional function of drums by making them capable of producing chords and scales. For this he tries two different methods. One is the combination of several drums or skins of different pitch into one single instrument. The other consists of devices to make one skin produce tones of different pitch in rapid succession.

This aim is realized in various ways: either through the introduction of side holes, or through the use of scissor levers or screw devices to change the tension of the skin while it is beaten, or through slides that open and close a large hole in the resonating body, or, finally, through mechanisms that detach the skin cover from the body of a pot drum.

Among the many musical instruments contrived by Leonardo, the viola organista is by far the most complicated. No less than six different pages in the notebooks contain sketches for it.

The drawings are all concerned with the idea of a stringed instrument with keyboard, in which the strings are set into vibration by a mechanical device—a wheel, a bow with a back-and-forth motion, or a belt of hair moving across the strings as a sort of endless bow. Such an instrument would fill a big gap in the multitudinous array of instruments, not only in Leonardo’s time but also in our own.

It would combine the polyphonic possibilities of the keyboard with the tone colour of bowed strings and thus would be something like an organ with string timbre instead of wind timbre, and in addition it would provide the possibility of producing crescendos and decrescendos by finger pressure.

Although it is not known in what order Leonardo made his sketches, it is possible to arrange the drawings in a logical sequence if we assume that Leonardo progressed from less workable solutions to more practical ones. In fact, he proceeds from an instrument with a bow moving back and forth across the strings, to one with a friction wheel, and finally to several versions of a revolving band of hair that sets the many strings into vibration.

The most workable, and apparently ultimate, solution is in Manuscript H, where we find a sketch of a perfectly consistent, workable keyboard instrument with an endless bow (archetto), a belt of hair moved by a motor attached to the side of the sound box and passed across the strings by means of two small rollers. Leonardo also designed a mechanism permitting the player, by pushing the small projecting buttons, to select the desired strings and draw them against the archetto.

We do not know, however, how near Leonardo came to the actual construction of the viola organista or whether he ever made working models. Today, with an electric motor in place of one using weights or springs, the construction of the instrument would be greatly facilitated.

We must finally consider two instruments which have special interest because their invention seems directly inspired by Leonardo’s anatomical studies; in fact they are applications of mechanisms Leonardo found in the human body. The first is in the Codex Atlanticus, where we find, among numerous small sketches for various machinery, drawings of two pipes.

Every connoisseur of musical instruments will recognize immediately two recorders by their characteristic heads and mouth holes. Their basic structure has not changed substantially since Leonardo’s time. Beneath the upper end held by the player’s lips is a hole with a sharp edge which is struck by the air-stream emanating from his mouth.

Ordinarily recorders have on their sides six finger holes which are closed and opened by the fingertips of the player to produce the distinct tones of the scale. But Leonardo’s recorders...
look strange. The one on the left has two broad slits on the side of the tube, and the other has one long, thin slit.

Fortunately we have an explanatory text in Leonardo's most beautiful calligraphy, running from right to left: "These two flutes do not change their tone by leaps as most wind instruments do, but in the manner of the human voice; and one does it by moving the hand up and down just as with the coiled trumpet and more so in the pipe a; and you can obtain one eighth or sixteenth of the tone and "moving the hand up and down" evidently means not to stop pre-arranged finger holes, but to move along the slits to change pitch gradually, or as we say today, to produce glissandos, or gliding tones.

Where could he have found the idea or a model for his glissando pipes? The clue lies in the words "the human voice", though I must confess that I found the solution by chance and then had it confirmed by Leonardo's own words. The model for our glissando pipes is found in the larynx, and it is significant that Leonardo calls the larynx "the human voice", applying this term to the machinery that produces the voice as well.

Leonardo made designs of the larynx and the trachea, now in Windsor Castle, in which we recognize immediately that the upper opening resembles that of a recorder. Furthermore, in accompanying texts in the anatomy manuscripts the trachea is called fistola, which is also the name of a vertical flute such as the recorder.

There is, though, one flaw in our analogy: Leonardo wrongly attributed the change of pitch of the human voice to the narrowing or widening of the cartilage rings of the trachea and failed to observe the function of the vocal cords in the larynx. This failure was probably caused by the technical difficulty of dissecting the small and fragile larynx. (By the way, Leonardo's drawings are thought to have been based on the anatomy of an ox.)

Still, we have in Leonardo's glissando recorder a new musical instrument which opened, or could have opened, a new musical horizon; which works well (some reconstructions that I have made function perfectly); and which was patterned after an anatomical analogy, that of the larynx, even though Leonardo misunderstood its actual function. Hence we have here a positive result built upon wrong premises.

The Madrid Codices contain only a few pages devoted to musical matters, but they add considerably to our knowledge of Leonardo's interest in music and musical instruments and to our comprehension of his indefatigable mind, so overwhelmed by new ideas, associations, and technological imagination that he could cope with this onslaught only by jotting down passing thoughts, often so sketchily that important details, which he evidently took for granted, are neither delineated nor explained in his comments.

One of Leonardo's drawings of musical instruments in the Madrid Codices is of a bell with a wide rim. Instead of a clapper inside, two hammers strike the rim from opposite sides. To the left of the bell there is a mechanism including what seems to be a set of four keys operating on a tracker action that in its turn controls four levers ending in oval heads. In my opinion, these heads must be clappers. The accompanying text says, "The same bell will appear to be four bells. Organ keys with a fixed bell. And when struck by two hammers, there will be a change of tones as in an organ."

Acoustically important in this explanation are the indication that the bell is firm, neither swinging nor equipped with a clapper in the manner of a church bell, and the statement that it produces "a change of tones", which is in all probability one of pitch, not of timbre.

Thus Leonardo must have believed that the upper section of the bell has ring-shaped areas that produce tones of different pitch if they are slightly muted when the rim is set into vibration by the hammers. It is interesting that Leonardo, here as in many other of his musical inventions, tried to obtain from one instrument what could normally be produced only by several instruments or by an entire set of instruments.