

Digital restoration of the Last Supper by Leonardo Da Vinci and multimedia tools to experience edutainment.

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Abstract: Da Vinci's masterpiece can be understood in a totally new way by digitally exploring the painting and examining details that have been lost for centuries. A Virtual Reality set is able to bring us back like a "time machine" to interactively explore the Last supper room as never seen before. The research, the work and the exposition is actually on show in Leonardo3 Museum, Piazza Scala Milan. (www.leonardo3.net)

Today, The Last Supper is faded and cracked. Thus, these brilliant, saturated colors may appear shocking, but this reconstruction is the closest representation of how the fresco must have looked like when Leonardo painted it, with all the missing parts reconstructed. It is a sort of virtual archaeological reconstruction. The high-definition pictures allowed us to localize the original pigments, "Pixel by pixel, we cloned da Vinci's original pigments, using virtual palette to restore areas where the color is irreparably lost.

In order to complete the fresco's missing parts we turned to contemporary copies of The Last Supper, such as the one by Giampietrino and others.

The reconstruction has indeed revealed some unknown details, such as an ideal city sketched in fragments to the left of Jesus' face, and a salt shaker that appears to have been knocked over by Judas. Multimedia software, and virtual reality has been realized to spread, history, science and heritage in the "edutainment" way, we believe is the future of knowledge.

The work will show the complete digital restoration of the entire arts, including parts that have never been seen before, and an interactive simulation will make everyone "paint" step by step the masterpiece. Virtual Reality as a time machine tool, to explore and understand history and heritage.

Keywords: Leonardo da Vinci, Art, Digital, Education, Edutainment, Virtual reality.

1. Last Supper: What we have today?

The Last Supper is a tempera and oil painting on plaster prepared with two layers of gesso. It measures 460 x 880 cm and was painted on a wall of the refectory of Santa Maria delle Grazie in Milan (Italy) in 1494. In February 1498, the mathematician Luca Pacioli referred to it as already completed. It is the largest of Leonardo's paintings and the only one executed on a wall that has survived. It represents the Eucharist and the meal during which Christ pronounces: "One of you will betray me". Leonardo froze the characters, expressions and gestures in the moment when Christ announces the presence of the traitor.

What we have today, after almost 500 years? The paint is no more the one Leonardo did and only a very little percentage of the original ideas of Leonardo survived. I believe that Leonardo will be ashamed of we have today, but of course is better not touch the original paint any more to make at least survive one little glimpse of the original idea (figure 1).



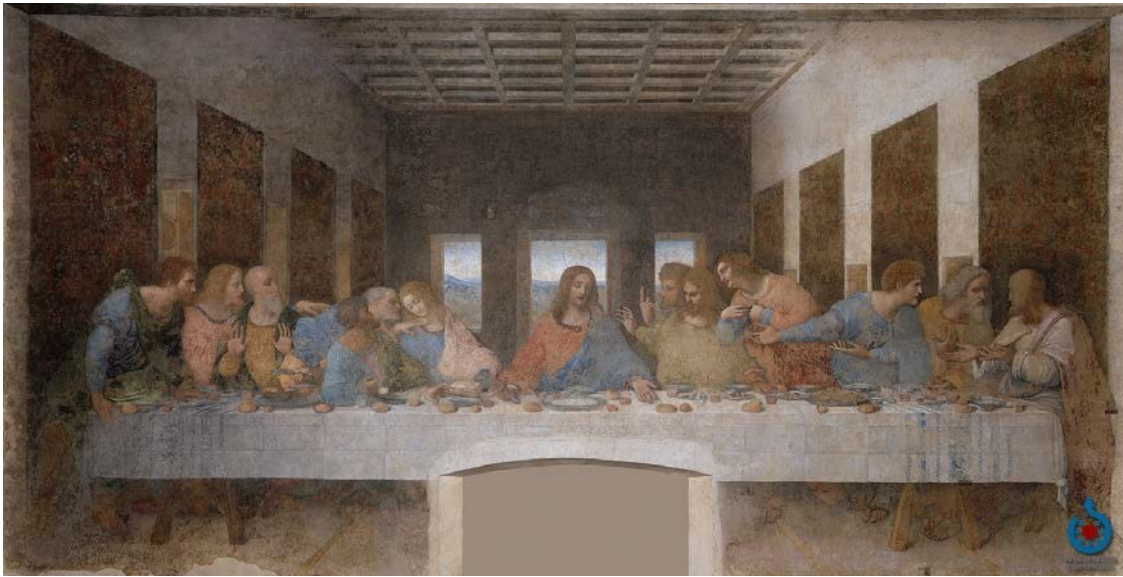


Figure 1. Las Supper as we find it today on books.

2. The Leonardo3 project

Always one to experiment, Leonardo executed this painting in oil rather than using classical fresco technique. He thus produced a masterpiece that several artists admired and copied immediately. Unfortunately, the painting began to disintegrate in the 16th century due to the oil technique and humidity. Today, despite restorations, it is only a faint shadow of what it was originally. In the year 2006 The private center of Leonardo Da Vinci studies, Leonardo3 has embarked upon an important virtual restoration that will bring the painting back to light as it originally appeared in the 16th century. In fact, initial interventions have already restored the colour in the missing areas, in turn revealing elements that have never been seen before, such as the bell tower to Christ's left, and all the tree. But the work of Leonardo does not stop on the square frame today we figure as the "Last Supper", all the surfaces around and the roof where painted and decorated. The room was also a real monk's refectory full of tables, things and maybe also tapestries, like the virtual one Leonardo painted. So the real room and the real work of Leonardo is very far from the empty white, poor room we have today (figure 2).



Figure 2. Today only a part of the painting survive in an empty room

3. digital restoration of the Last Supper

According to the history of the Last Supper, what we see today is a far cry from what Leonardo actually painted, even after the excellent restoration that was finished in 1999. In fact, the oil and tempera paint Leonardo used began to flake off just a few years after its completion.

Numerous restorations and attempts to repaint it since then have further damaged the original. (figure 3-4).



Figure 3. Paint studies



Figure 4. Surfaces today

Although the most recent restoration sought to cancel the effects of all those preceding it, it only succeeded in rescuing a ghost of a painting, over 50 percent of which had been destroyed (figure 5). Several parts of the painting have been lost and it's very difficult for us to realize how wonderful it must have looked to those who saw it shortly after its completion.

In 2007, the Leonardo3 research center began a process of digital restoration to bring the colors and forms that have been lost back to light. In addition to other paintings by Leonardo and our knowledge of the technique he used, the many copies made by other artists from 1497 onwards have been essential to our task. These paintings have allowed us to reconstruct not only the missing piece of the table and Christ's feet, but even more importantly the colors, which must have been a great deal more vibrant than they are today.

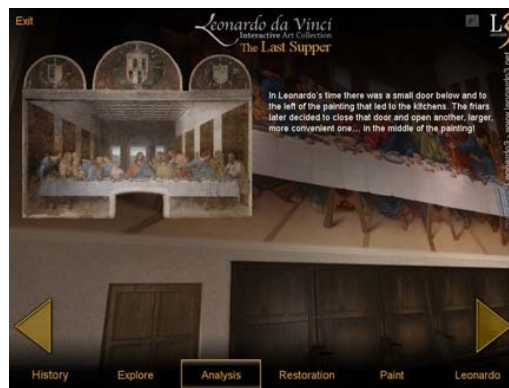


Figure 5. Less than 50% of surface restored



Figure 6. 1500's copies of the Paint

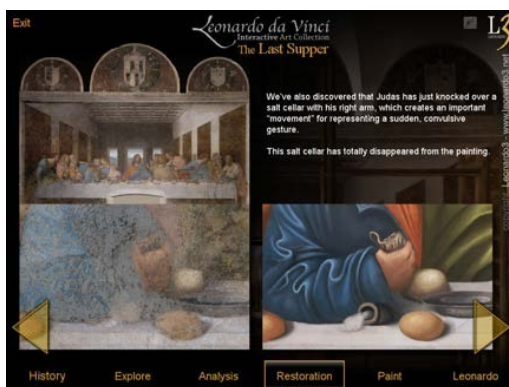
The restoration has uncovered several details that are difficult to see in the original painting, including plates of fish, slices of orange and a bell tower rising in the background to Christ's left.

**Figure 7.** Background digital restoration.**Figure 8.** Original wall structure

In the background of the left-hand window is a bell tower, but the image has almost disappeared due to the painting's deterioration (figure 7). Following some poor restorations, in 1726 a hole was made in the wall to create a door, thus destroying the lower central part of the painting (figure 8).

We've also discovered that Judas has just knocked over a salt cellar with his right arm, which creates an important "movement" for representing a sudden, convulsive gesture. This salt cellar has totally disappeared from the painting (9-10).

We've been able to reconstruct several different elements of the painting by referring to copies made by other artists and similar details in the painting itself whose forms and colors we've "cloned". To reconstruct the piece of orange, for example, we cloned and distorted other painted details to cover the part of the slice that's been lost.

**Figure 9.** Giuda digital restoration.**Figure 10.** Table digital restoration.**Figure 11.** Pietro digital restoration.**Figure 12.** Reconstruction of lost details

We've also made use of Leonardo's preparatory studies for the digital restoration. In fact, some of these drawings can be perfectly superimposed onto the painting and have helped us to fill in the interplay of light and dark that's almost totally absent from the painting.

Although the lunettes above the painting seem less important, their restoration has also revealed some never-before-seen details. For example, the background, which is brown today, was originally blue to represent the sky and was covered with gold stars.

As for the three shields, which have almost completely disappeared, a parchment from 1498 is the most important document we have to reconstruct the upper lunettes. In fact, the three coats of arms and the letters are the same as those on the parchment.

MA[ria] M[a]X[imilianus] SF[ortia] AN[gliae] CO[mes] P[a]P[iae] - LU[ovicus] MA[ria] BE[atrix] EST[ensis] SF[ortia] AN[gliae] DUX [Mediolani] - SF[ortia] AN[gliae] DUX BARI (Massimiliano Sforza, Ludovico Sforza and Beatrice d'Este, Francesco Sforza the Second, Duke of Bari) (figure 13-14)

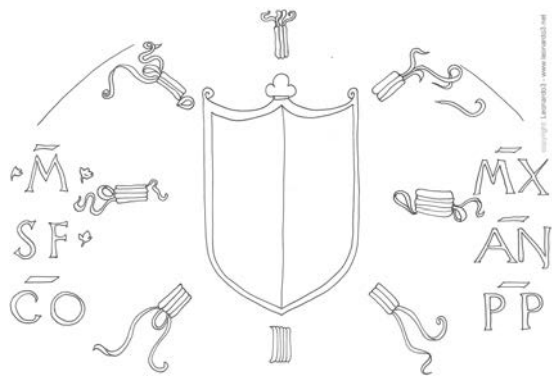


Figure 13. Center shield reconstruction



Figure 14. Document reference

An unexpected subject also emerged. We have reconstructed the image of a snake (or a dragon) that Leonardo drew with two pieces of fabric on top of the main coat of arms, which lines up directly above Christ. (figure 12) We're not talking about the stylized dragon on the Sforza coats of arms but a real serpent that Leonardo portrayed as though on the surface of the shield, wrapped around a piece of fabric. Perhaps Leonardo was poking fun at the patrons? After reconstructing the entire painted surface, we patiently calibrated the colours by referring to the parts that have survived, the copies made by other artists and the colours in other paintings by Leonardo.

Although the restoration continues (and could seemingly go on forever), our reconstruction is one of the first to bring lost details and colours back to life so that we can see what the painting might have looked like as soon as Leonardo completed it. Thanks to this digital restoration, which brings back to life all the details and colours that have been lost, people can examine and explore The Last Supper as it looked right after it was completed (figure 15-16).



Figure 15. Hi res digital restoration.

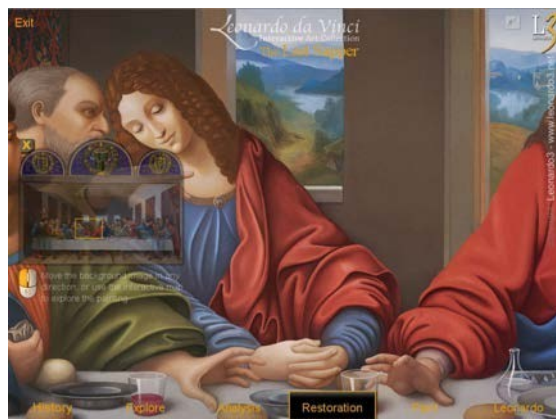


Figure 16. Hi res digital restoration.

4. Multimedia tools for heritage

The work done is fully described in details inside multimedia stations and videos that Leonardo3 has translated in many languages and exposed in several Da Vinci expositions around the world. In the 2017 A book and multimedia DVD , was published by Leonardo3 [1]. What is fascinating is the simple and direct approach of younger researcher of 5 years old, that feel technology as their own new languages. Of course adult people, simple visitors or scholars can have access to all informations, documents, animations and hi resolution images that are produced for this work with this stations. This provide a new way of spread history, science and art. Edutainment is “the” world, Education with Entrainment, a true powerful tool for knowledge (figure 17).



Figure 17. Last Supper multimedia room in the Leonardo3 museum, piazza Scala, Milan, Italy.



Figure 18. Last Supper multimedia station in the Leonardo3 exhibition in San Marino.

5. Next step: “The time machine”

During 2016 we worked on a interactive, real time 3d experience where the user can “walk” inside the Last Supper room as it was in the 1497. Using the last software techniques, used in Hollywood movies and video game industry we create a 3d environment that give the user the unique experience to “look” as it was. This software can be used also with Virtual reality systems.

Users are invited to wear the Oculus rift (VIVE is supported too) and walk in the Last supper room to see all details and items in a virtual environment. It is like a “time machine” to be able to experience history in an incredible way. The Virtual Experience of the Last supper is one of the

best attraction of the Leonardo3 museum (figure 19).



Figure 19. Last Supper Virtual Reality station, in the Leonardo3 museum, piazza Scala, Milan, Italy.



Figure 20. Screenshot from Discovery News Documentary, multimedia touch experience to explore the Last Supper paint, New York, Leonardoexposition.



Figure 21. Screenshot from Smithsonian Documentary, documents and paper of Leonardo



Figure 22. Interpretation of the Last Supper room as in 1497 , frame from the Virtual experience in the Leonardo3 museum.

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Links

Main website: www.leonardo3.net , www.goo.gl/LTFGfT

Last Supper DVD: www.youtube.com/watch?v=Royl373MX0Q

Discovery video: www.youtube.com/watch?v=z2-njV2UtSs

Smithsonian video: www.youtube.com/watch?v=PgnY-MnxGys

Multimedia Last supper tool: www.youtube.com/watch?v=yp8Fmcf4m58

Rai5 il Cenacolo: www.youtube.com/watch?v=NInk93Eu3fg

LS Leonardo3 museum and Last Supper: www.youtube.com/watch?v=MfFwLjWEIzU