Tomorrow's Affairs

Analysis of today
Assessment of tomorrow

By: Tomorrow's Affairs Staff

How robots and AI contributed to the restoration of Notre Dame's beauty

Modern technology played a major role in saving Paris's Notre Dame Cathedral, even as its arches and roof burned in April 2019, causing fear for the fate of one of the world's most beautiful buildings.

Drones equipped with cameras then rose above the Paris Cathedral and directly sent an image of the roof on fire to the headquarters of the firefighters, who were thus able to organise their actions swiftly and with enormous precision.

At the same time, firefighters sent "Colossus," a remote-controlled heavy firefighting robot, into the heart of the fire. Where men could not tread, "Colossus" entered on its tracks, trampling over the burning ruins and bringing fire hoses with it to extinguish the fire.

There is no doubt that high-tech inventions saved the church from immediate collapse. Moreover, the consequences of the fire would have been incomparably greater if it had occurred only ten years earlier, potentially leading to the cathedral's complete destruction.

Only with the beginning of the restoration of Notre Dame did modern technology take centre stage, and it played a key role in one of the largest actions of global solidarity to save the gem of French and world cultural heritage.

How to get the original look?

The first challenges began with the fact that the building, which was constructed between the 12th and 14th centuries, has no construction records that could have helped the restorers.

How to restore the structural elements that are more than eight centuries old, then the roof, and particularly the artistic details, which are so many on the most famous Gothic cathedral in the world, and which perished in a fire five years ago? How to guess the materials used, their texture and colour, if the builders have no records from the time of construction?

The development of the so-called "digital twin"—a 3D projection of Notre Dame—played a crucial role in overcoming this significant challenge.

> "We combined data showing the cathedral before the fire, after the fire, and during the restoration" - Livio De Luca

This model was made using the vast knowledge of the cathedral, its details, the materials used for construction, and the structural and static performances.

Livio De Luca, who led the team for the digital restoration of the cathedral, said that this huge job included not only data related to the shape of the building and the materials used for its construction but also all the scientific research that has been done on the cathedral so far.

"We combined data showing the cathedral before the fire, after the fire, and during the restoration," said De Luca, an architect from the French National Centre for Scientific Research.

AI also helped in rebuilding

Naturally, AI also played a significant role in the reconstruction process, particularly in the reconstruction of the arches that were destroyed. The remains of the arches, with the help of AI, gave a picture of what they originally looked like, down to the smallest detail, as well as their position on the cathedral.

Architects and engineers used information from a vast database about the cathedral to examine the structure in detail and develop solutions that both matched the original and, in many cases, improved it.
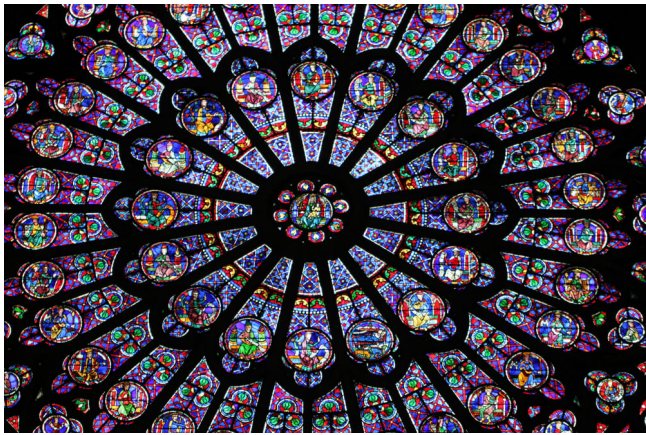
Digital restoration techniques allowed access to numerous historical references and archives, which gave restorers access to the original appearance

Digital restoration techniques allowed access to numerous historical references and archives, which gave restorers access to the original appearance. This process not only restored the destroyed and damaged parts of the building structure, but also brought back the original colours, textures, and other details used by the ingenious builders 850 years ago.

The monitoring system had to provide accurate real-time information about the static condition of the building and its structural integrity at every moment of the five-year renovation, which enabled timely interventions by restorers.

Exchange of knowledge

The restoration of the Paris Gothic cathedral, the city's symbol, involved more than a thousand experts, engineers, technicians, and restorers over the past five years.

Notre Dame would have waited much longer than 7 December this year for its opening if this army of experts had not been constantly networked and together used the global knowledge of construction and of Notre Dame specifically, contained in digital archives.

> It was more than restored—it was reborn

An interdisciplinary approach during the renovation was a priority. The 2019 disaster mobilised the global science and engineering community, accelerating reconstruction through knowledge sharing and the use of digital databases.

On Sunday, after five years of restoration, Notre-Dame's rector, the Rev. Olivier Ribadeau Dumas, held a mass and said that no one alive "has seen the cathedral like [that]. It [was] more than restored—it [was] reborn."

Along with people's knowledge and skills, technology has made a decisive contribution to this endeavour.