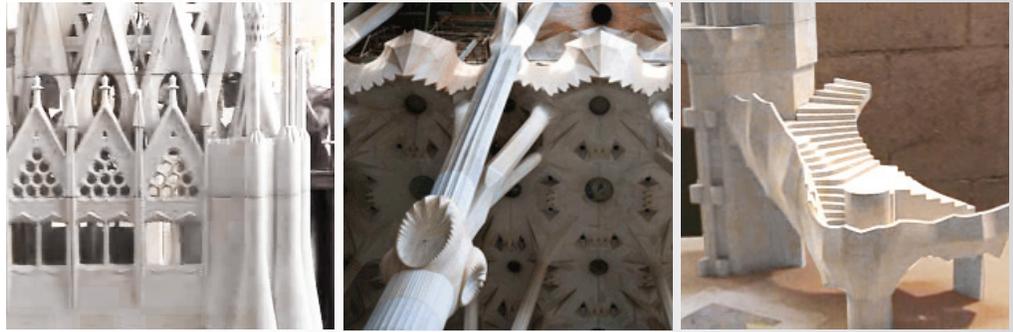


Sagrada Familia: Conceived and Projected in 3D

Two 3D Systems Spectrum™ Z510s help architects at Sagrada Familia follow Gaudí's method while saving time and money.

- **Sagrada Familia** – Expiatory Church conceived by Antoni Gaudí.
- **Challenge** – Complex, unusual forms and shattered guide models.
- **Solution** – 3D printing with two Spectrum™ Z510 3D printers.
- **Results** –
 - Better models, including functional parts.
 - Less material needed.
 - More models, faster.
 - Better communication and understanding.
 - Fewer errors, saving time and money.



3D models of Sagrada Familia printed on a 3D Systems Spectrum Z510.

At the end of 1883, Antoni Gaudí was commissioned to carry on the works of The Expiatory Church of La Sagrada Familia, a task which he did not abandon until his death in 1926. Since then, different architects have continued the work following his original idea.

When work began on the church in 1882, architects, bricklayers and masons were using a very traditional two-dimensional approach. Gaudí realized that the geometry they were dealing with required a different methodology. The 2D charts were not useful, except for axis and column layout purposes.

The complexity of Sagrada Familia's forms forced Antoni Gaudí to switch to a three-dimensional approach. The Sagrada Familia design required 3D models to visualize architectural solutions and analyze structural feasibility. From the very beginning, Gaudí gathered a team of expert model makers and sculptors to study solutions that were either later discarded or are displayed today.

“Due to the complexity of surfaces and forms, working with Gaudí's designs in 2D does not make sense from an architectural point of view,” said Chief Architect Jordi Coll.

Gaudí was a visionary and an innovator who experimented with forms and concepts, and he always used the latest technology available at the time.

Goal

Since Gaudí's death in 1926, seeing a finished Sagrada Familia has been the dream of all

his disciples, architecture lovers, and the Catalan people — even more so since during the Spanish Civil War, Gaudí's workshop was vandalized and most of his writings, drawings, photographs and 3D models were destroyed.

Numerous materials and documents were saved by collaborators, along with pieces of the shattered models, which became the starting point of a great challenge: finishing the construction of the temple, just as Gaudí would have wanted.

Challenge

The present Church Technical Office and management are charged with studying the complexity of Gaudí's original project, a task that involves:

- Inventory and organization of plaster model fragments from the remains of the original shattered models.
- Developing hypotheses to figure out the missing parts.
- Producing 3D models in plaster prior to the job projection.
- Projecting and verifying the construction plan of the church.
- Constructing the real parts (concrete, stone, and Catalan vaults).

The moulds and the models that survived, as well as photos, documents and drawings, help guide the project. Gaudí's original models are restored, reproduced, revised and modified as many times as necessary, in order to guarantee

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– Jordi Coll
Chief Architect



3DSYSTEMS™



3D models help the team to solve the overall puzzle.

“If Gaudí was alive today, he would have brought 3D technology to its maximum exponent, since much of his work was already conceived tri-dimensionally.”

– Jordi Coll
Chief Architect

fidelity to the original project and technical feasibility.

For decades, this task was carried out in a hand-crafted manner. However, producing all of these parts manually was a long and costly process. It had also generated very high costs in material stock, since the human hand could not produce appropriate models in scales smaller than 1:25.

Since funds for the construction of the temple come solely from donations, the completion of the Sagrada Família seemed, at times, like a very remote dream.

Solution

Architects Jordi Coll, Jordi Faulí, and Mark Burry began researching cutting edge technologies used in aeronautic and automotive engineering, such as 3D CAD software.

After interpreting the data, they generated a 3D file of the target part. That allowed them to better understand the mathematics and proportions inherent to Gaudí’s designs, slowly revealing, through years of study, the secrets that lay therein.

A true revolution arrived with the introduction of 3D printers, which allowed the materialization of 3D CAD drawings in an automatized way, with unprecedented detail, accuracy, and in only a few hours.

The Sagrada Família technical studio acquired two 3D Systems Spectrum Z510 3D printers, which are making the team’s task much easier. The staff can devote most of their time to research and recomposing shapes, in order to calculate and solve the overall puzzle. As a result, 3D CAD files of the parts are generated, and the Spectrum Z510s continue to print impeccable parts.

Results

Better models: The Spectrum Z510s are able to reproduce small details effortlessly and with better accuracy than the human hand.

Less material: The machines can print an initial process at 1:50 and 1:100 scales (and at Gaudí’s scales of 1:10 and 1:25) and the leftover material from printing sessions is reusable.

More models, faster: Large build chamber and fast print jobs (2-3 cm in Z axis, per hour).

Better communication: Increased understanding between the technical office and the constructors of the final concrete or stone parts.

Fewer errors: Saves time and money.

Functional parts: The plaster-like material from 3D Systems is similar to the one utilized for the original models, which allows for assemblies between historic and contemporary parts.

The Sagrada Família is expected to be closed by 2010, and to be complete before the end of the first third of our century.

Conclusion

Just as Antoni Gaudí would have done, the best technology is being applied to accomplish the construction of the building, with excellent results. Thanks to the introduction of 3D CAD and 3D printing, the production of 3D models has become a fast and affordable task. Speed has been a crucial factor in expediting the error-testing process and therefore, the incremental progress of the construction.

One hundred and twenty-five years later, thanks to the wonders of 3D technology and the vision of Sagrada Família’s present chief architects, the interior of the cathedral is close to being finished true to Gaudí’s original vision and method concept.

“If Gaudí was alive today, he would have brought 3D technology to its maximum exponent, since much of his work was already conceived tri-dimensionally,” said Coll.

Interestingly enough, many are not surprised by the fact that the genius of Gaudí would fly on the wings of 3D technology.



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