# A multimedia approach for the digitalization and the protection of great statues[1].

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## Abstract

Starting from a previous contribution to CHNT 2018, from the title "Great Satues and seismic vulnerability, a photogrammetric approach for early safeguard" [Tanganelli et al.2019] others studies will be brought to the attention of the conference participants, in order to respect the multidisciplinary approach of RESIMUS PROJECT, to combine knowledge in order to prevent risk to the museum's collections in case of earthquakes. In the last work, the RESIMUS working method was applied to Giambologna's statue of *Oceano*, placed at Bargello National Museum, in Florence and to the homonym fountain in Boboli Garden, where it was originally located. Now, other studies and insights conducted to the same theme, will be shown: the matching qualify between the original *Oceano* and its copy, the comparison between the seismic analysis of Bargello's sculpture and the whole complex of the Fountain, a 3D print model in photopolymeric resin and finally a multimedia project of augmented reality, where the results of seismic analysis are projected on the 3d print model by reading a target.

## Previous studies

In the last work presented, were shown the results of a laser scanner and a photogrammetric survey, conducted both on Oceano's original copy and on the whole complex of the Fountain in Boboli Garden.

Then, in line with the procedures of Structure from Motion/Image Matching (SfM/IM) software [Guidi et al. 2015], where the shape of an object is reconstructed through the collimation of points from a set of photos, were obtained the two models.

Later, starting from the model obtained with the surveying instruments, the FEM model used for structural analysis was obtained by making the initial model a series of transformations to make it suitable for an easy analysis with calculation software. At first step, the number of polygons was reduced through the Quadratic Edge Collapse Decimation procedure in MeshLab software, after which, it was implemented and transformed from a surface model into a volume model with Strauss 7.

## New studies

Once the two models of the original copy of Oceano and its reproduction were processed, it was possible to carry out the so-called Matching Qualify, a comparison based on the overlap. Two software were used, Geomagic PRO (Fig.1) and Cloud Compare, this last freeware. Both processes generated similar results, which testify to a faithful reproduction of the copy. They also testify to the good conservation of this last one, despite the exposure to the atmospheric agents of the Boboli Garden.

The only parts in which the matching is not 100% are those due to the lack of coverage during the survey phase, since these are areas difficult to reach by survey instruments.

Then, the analysis of the fountain was followed by the same procedure applied in the last work to the statue of *Oceano*: the statue of the god, the group of the three Rivers, the granite basin and the stone base were taken as a single continuous body. In the lower part of the basement the X, Y and Z shifts were blocked to simulate a joint at the base. This hypothesis has allowed evaluating the effects produced in linear elastic field by seismic actions in terms of stress states (Fig.2) and displacements. In line with the position of the statue,

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there is a concentration of efforts at the ankles, typologically similar to that of the Bargello. After that, Modal analysis has provided the natural frequencies of the main modes of vibration and has defined alpha and beta coefficients, according to the classical formulation proposed by Rayleigh [Chopra 1995] to be used

in the dynamic analysis over time. Finally, dynamic analysis were performed in order to evaluate the possible response of the statue-pedestal as a single set. The seismic input was obtained through the *Itaca* database [2008] from 7 accelerograms of real seismic events, compatible with the elastic spectrum proposed by the Italian code [NTC2018] for the site of Florence, with a soil type B and a return period of 1950 years. They provide results both in terms of displacement and of stress states. For all analysis, no significant displacements are ever achieved in the three main directions.

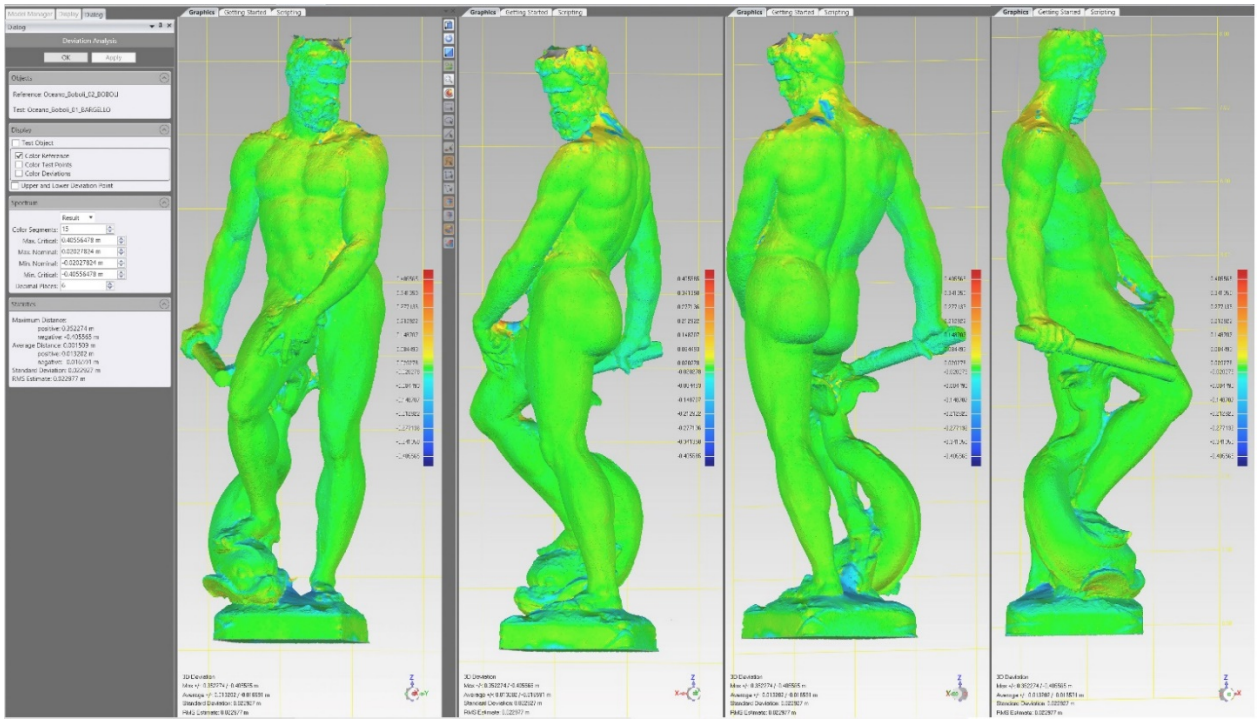

*Fig. 1. Matching Qualify conducted with Geomagic Studio 2013.*

At the end of this multidisciplinary survey, aimed at putting into practice the working method proper to the RESIMUS project, but trying to add something innovative to previous research, it was decided to implement the contents of the previous research, with the realization of a multimedia project. (Fig.3)

As a first step it was decided to carry out a 3D printing of the original *Oceano* copy, after which it was decided to project on it the results obtained from the seismic analyzes conducted with the dedicated calculation software.

The final result is that of being able to view, through any mobile device, the texture applied, both on the model printed in 1:20 scale, and on the real Giambologna's sculpture that can be visited at the Bargello National Museum.

This, also in a didactic and informative perspective, wants to be a tool aimed at bringing young people to the world of art and architecture.

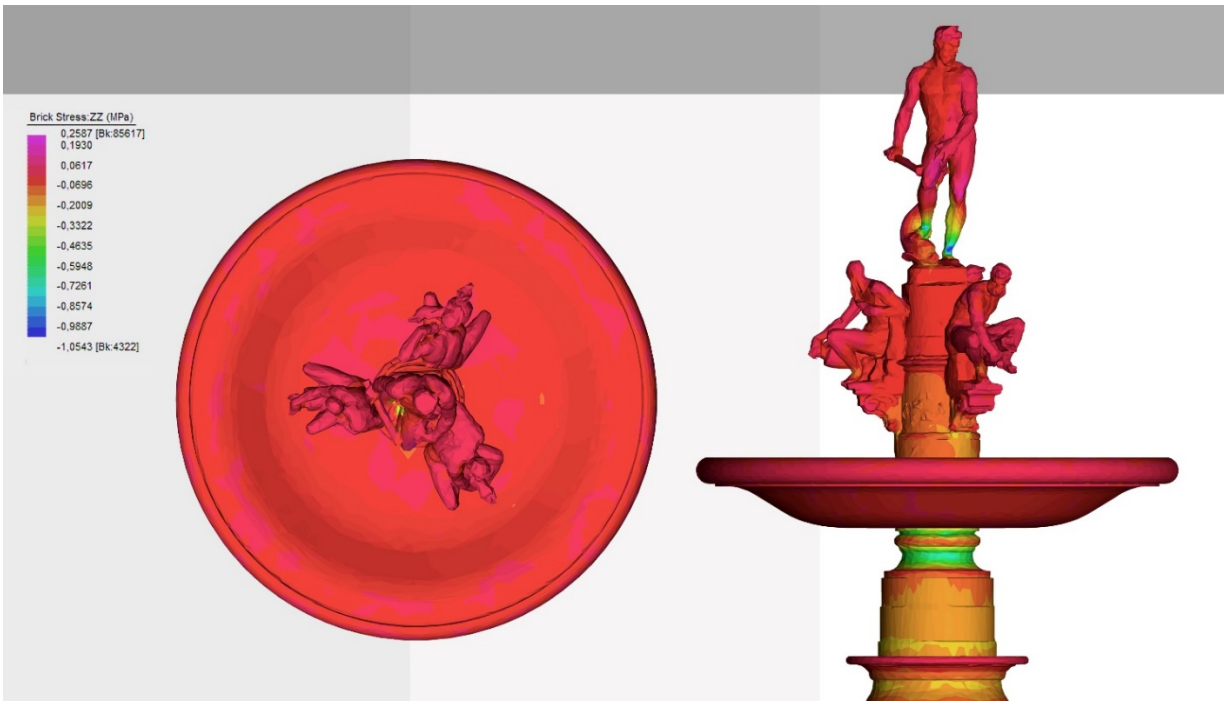


*Fig. 2. Static analysis for vertical loads conducted with Straus7: views of the stress states ZZ of the Fountain.*

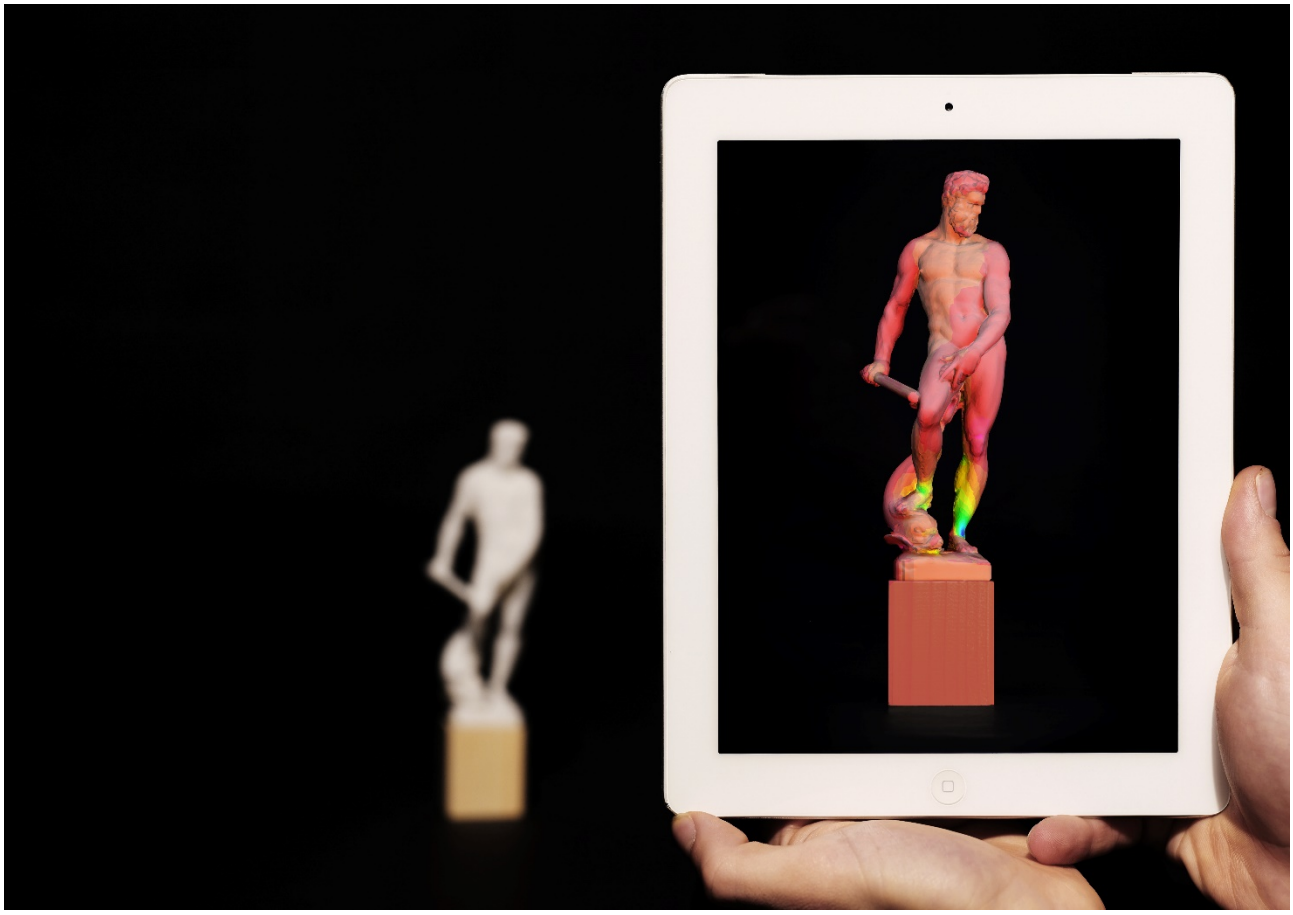

*Fig. 3. Augmented reality: projection of seismic analyzes on 3D printing model.*

## References

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