Deliverable 3.1

3D model of the Opera di Firenze

AURA

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Project Information

"AURA - Auralisation of Acoustic Heritage Sites Using Augmented and Virtual Reality" (project no. 101008547)

Project Website: http://aura-project.eu

Auralisation – the technique of creating virtual soundscapes in 3D models to provide the same immersive sound experience as the music performed in the real venue. AURA will explore exciting new opportunities that auralisation opens up for music performing arts and their traditional and new audiences.

Publisher & Project Coordinator

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3D Model of the Opera di Firenze

The development of the 3D NURBS model of the Opera di Firenze based on the digital surveys, within the project "AURA - Auralisation of Acoustic Heritage Sites Using Augmented and Virtual Reality" (AURA - project no. 101008547), has been fully completed.

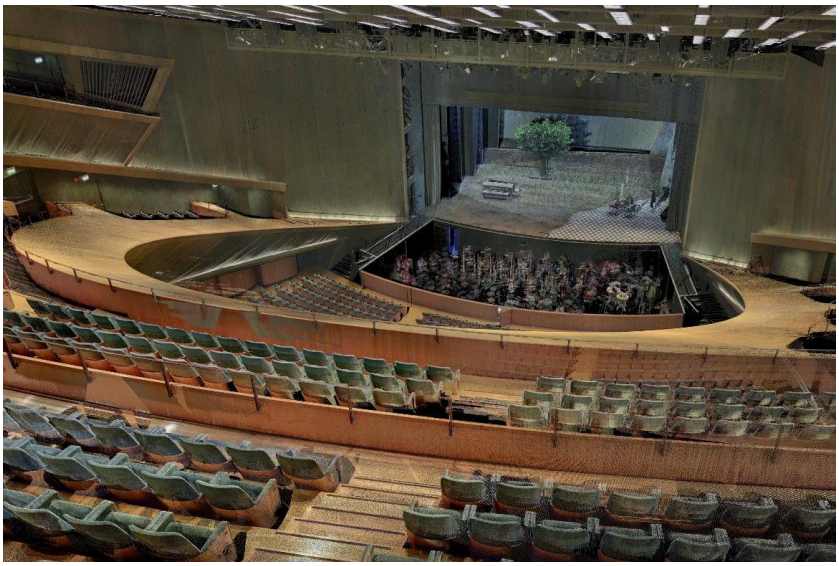
This model will be used to develop the auralisation of the Opera di Firenze (WP3).

Digital Survey

The activity included laser scanning surveys of the exterior, the entrance, and the main hall of the theater, and was carried out by the working team of the Department of Architecture of Florence (DIDA-UNIFI) under the scientific guidance of Prof. Stefano Bertocci.

The laser scanner survey has provided highly reliable metric data, which, mainly coloured point clouds, have been subsequently processed by specific software, thus constituting a three-dimensional database that will serve as a support base for the development of the 3D model.

Coloured point cloud of the external areas of the Opera di Firenze



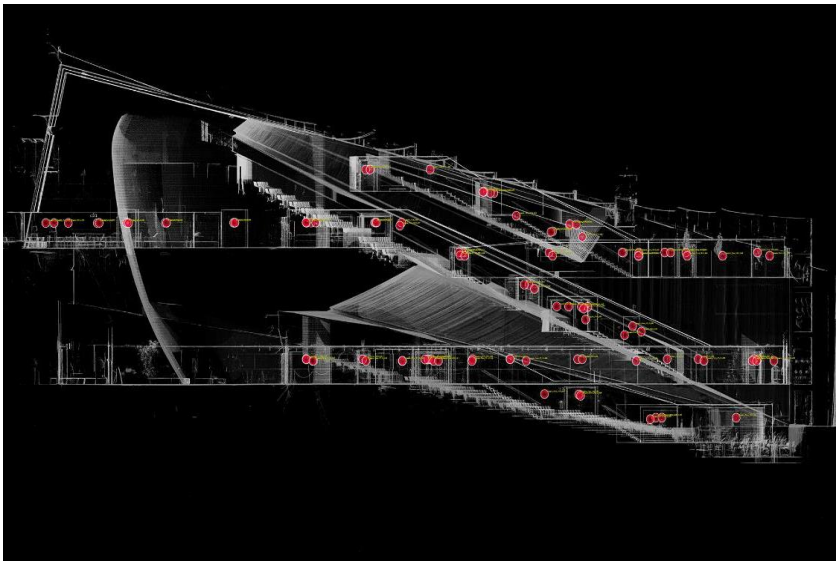
Coloured point cloud of the main hall of the Opera di Firenze

Acquisition and Processing of Laser-Scanner Survey Data

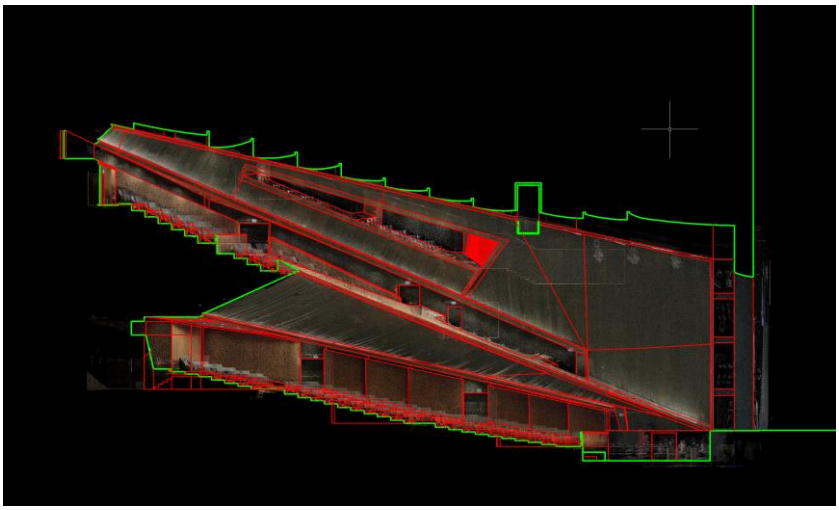
For the laser-scanner survey of the Opera di Firenze, two different instruments were used, a Z+F Imager 5016H and a Faro Focus M70, both with phase difference technology, through which about 300 scans were made: 200 for the acquisition of the external environments and 100 for the internal spaces.

The large amount of data obtained from the laser-scanner survey campaign was subsequently processed, starting the phase of the registration of the point clouds. In this way, the approximately 300 scans were aligned, and after verifying the correct union, a single global point cloud was developed.

From this global point cloud all the 2D elaborations necessary to have a solid metric base for the development of the 3D model have been realised.



Point clouds alignment phase



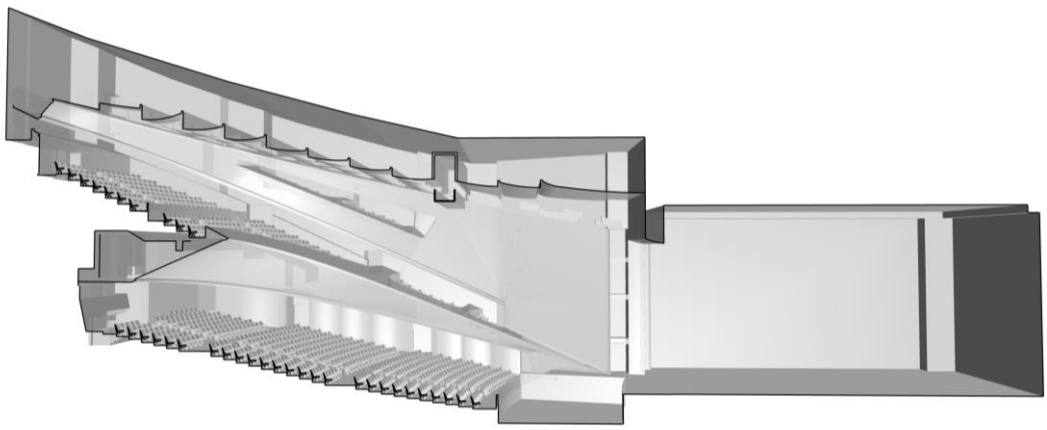
2D Data elaboration phase

3D Model

Based on the results of the laser scanner surveys and their post-processing, a highly descriptive 3D NURBS model of the main hall of the Opera di Firenze was developed.

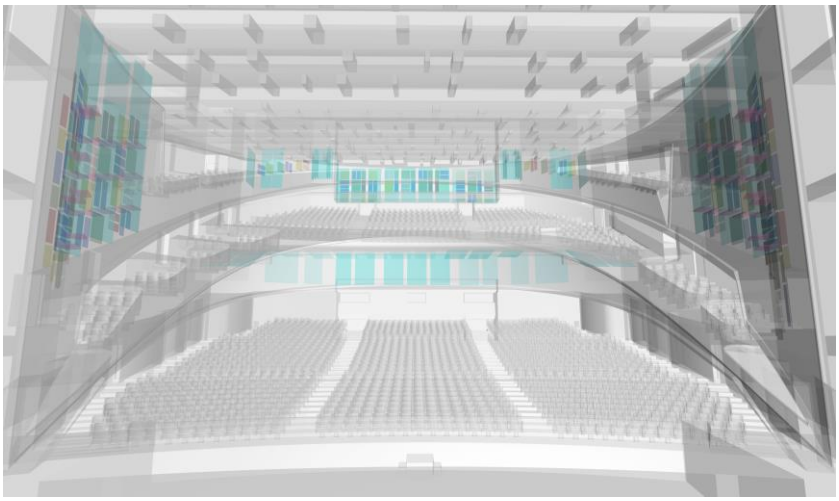
Each element present in the main hall has been geometrically modeled in 3D to obtain a digital twin on which all acoustic studies will be carried out.

The volumes and solids belonging to the 3D model have been geometrically simplified in some points, due to construction irregularities, but a level of accuracy of max 5/10 cm was still maintained compared to the point cloud.



Prospective section view of the untextured 3D model of the Opera di Firenze's main hall

In addition to the architectural elements, also the acoustic panels and the acoustic curtains have been modeled, based on the technical documentation.



Prospective view of the acoustic elements with the main hall, such acoustic curtain (cyan) and acoustic panel (colours)

Prospective view of the textured 3D model of the Opera di Firenze's main hall

Classification of the 3D Elements and Development of a Materials Database

This activity involved a preliminary study of the materials of the single elements present, carried out through on-site inspections.

Each of these elements has been catalogued and divided into typological categories, and for each of these a different material has been associated.

This methodology has been followed to facilitate the development of the subsequent auralisation process, which require the subdivision of the elements of the 3D model by single material, in order to associate them with the acoustic parameters.

COD	Element Description	TYP	Element Type / Component Description	MAT	Material Description
AB	Acoustic Background	**A**	Stage 01 vertical acoustic background	**abg-01**	Acoustic background 01
		B	Stage 01 fly acoustic background	**abg-02**	Acoustic background 02
		C	Shell 02 slanted walls acoustic background	**abg-03**	Acoustic background 03
		D	Hall cover acoustic background	**abg-04**	Acoustic background 04
AC	Acoustic Curtain	**A**	Vertical acoustic curtain	**acu-01**	Acoustic curtain 01
		B	Horizontal acoustic curtain	**acu-01**	Acoustic curtain 01
AP	Acoustic Panel	**A**	Acoustic panel with horizontal stripes	**apa-01**	Acoustic panel 01
		B	Acoustic panel with vertical stripes	**apa-02**	Acoustic panel 02
		C	Curved acoustic panel with 1 m radius	**apa-03**	Acoustic panel 03
		D	Curved acoustic panel with 2 m radius	**apa-04**	Acoustic panel 04
		E	Horizontal acoustic shelves	**apa-05**	Acoustic panel 05
BE	Bench	**A**	Spatial bench reference	**ref-02**	Reference blank material 02
		B	Wooden bench structure	**wod-10**	Wood 10
		C	Bench fabric pillow	**fab-02**	Fabric 02
CN	Cornice	**A**	Shell 01 cornice lined with plaster	**pla-01**	Plaster 01
		B	Shell 02 cornice lined with plaster	**pla-01**	Plaster 01
CO	Cover	**A**	Hall cover lined with plaster	**pla-01**	Plaster 01
		B	Light lock cover lined with plaster	**pla-02**	Plaster 02
		C	Shell 01 cover lined with plaster	**pla-01**	Plaster 01
		D	Shell 02 cover lined with plaster	**pla-01**	Plaster 01
DO	Door	**A**	Door lined with plaster	**pla-02**	Plaster 02
		B	Door lined with wood	**wod-04**	Wood 04
		C	Metal door	**met-01**	Metal 01
FL	Floor	**A**	Light lock concrete floor	**con-01**	Concrete 01
		B	Stage 01 wooden floor	**wod-07**	Wood 07
		C	Apron wooden floor	**wod-07**	Wood 07
		D	Orchestra pit wooden floor	**wod-07**	Wood 07
HR	Handrail	**A**	Orchestra pit wooden handrail	**wod-04**	Wood 04
		B	Shell 01 wooden handrail	**wod-04**	Wood 04
		C	Shell 02 wooden handrail	**wod-04**	Wood 04
LA	Lamp	**A**	Metal lamp structure	**met-04**	Metal 04
		B	Glass lamp structure	**gla-02**	Glass 02
LI	Lining	**A**	Shell 01 surface lined with wood	**wod-03**	Wood 03
		B	Shell 02 surface lined with wood	**wod-03**	Wood 03
		C	Shell 01 surface lined with perforated wood	**wod-09**	Wood 09
		D	Lateral walls lower plastic lining	**pls-01**	Plastic 01
NE	Net	**A**	Shell 01 metal net	**met-05**	Metal 06
		B	Shell 02 metal net	**met-05**	Metal 06
SD	Stand	**A**	Stand wooden structure	**wod-11**	Wood 11
SE	Seat	**A**	Spatial seat reference	**ref-01**	Reference blank material 01
		B	Metal seat structure	**met-05**	Metal 05
		C	Wooden seat structure	**wod-08**	Wood 08
		D	Seat fabric lining	**fab-01**	Fabric 01

ST	Step	**A**	Audience wooden main steps	**wod-01**	Wood 01
		B	Audience wooden steps	**wod-02**	Wood 02
		C	Shell 01 wooden main steps	**abg-01**	Wood 01
		D	Shell 01 wooden steps	**wod-02**	Wood 02
		E	Shell 02 wooden steps	**wod-02**	Wood 02
		F	Apron wooden steps	**wod-07**	Wood 07
WA	Wall	**A**	Hall walls lined with plaster	**pla-02**	Plaster 02
		B	Apron walls lined with plaster	**pla-02**	Plaster 02
		C	Stage 01 walls lined with plaster	**pla-02**	Plaster 02
		D	Orchestra pit walls lined with plaster	**pla-02**	Plaster 02
		E	Audience back walls lined with wood	**wod-04**	Wood 04
		F	Audience back walls lined with perforated wood	**wod-06**	Wood 06
		G	Audience lateral walls lined with wood	**wod-05**	Wood 05
		H	Shell 01 walls lined with wood	**wod-04**	Wood 04
		I	Shell 02 walls lined with wood	**wod-04**	Wood 04
		J	Shell 02 walls lined with plaster	**pla-01**	Plaster 01
WI	Window	**A**	Metal window structure	**met-02**	Metal 02
		B	Glass window	**gla-01**	Glass 01
WW	Walkway	**A**	Walkway metal structure	**met-03**	Metal 03

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