POLITECNICO DI TORINO
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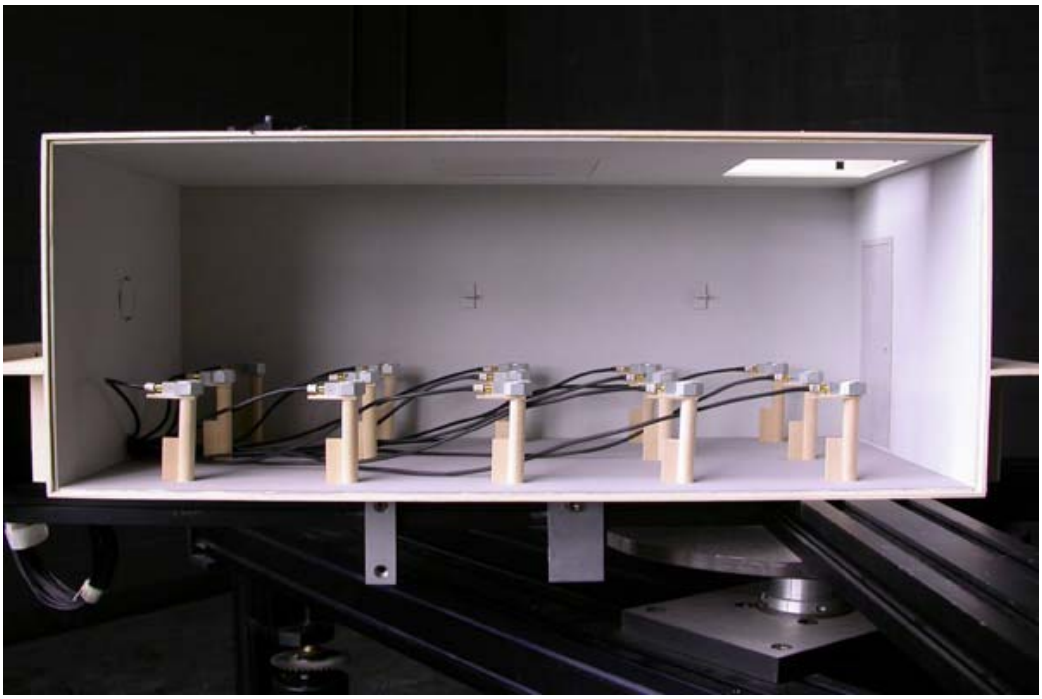
Master of Science in Architecture
Honors theses

Natural light pipes in architecture: characterization of performances through physical simulation on scale models

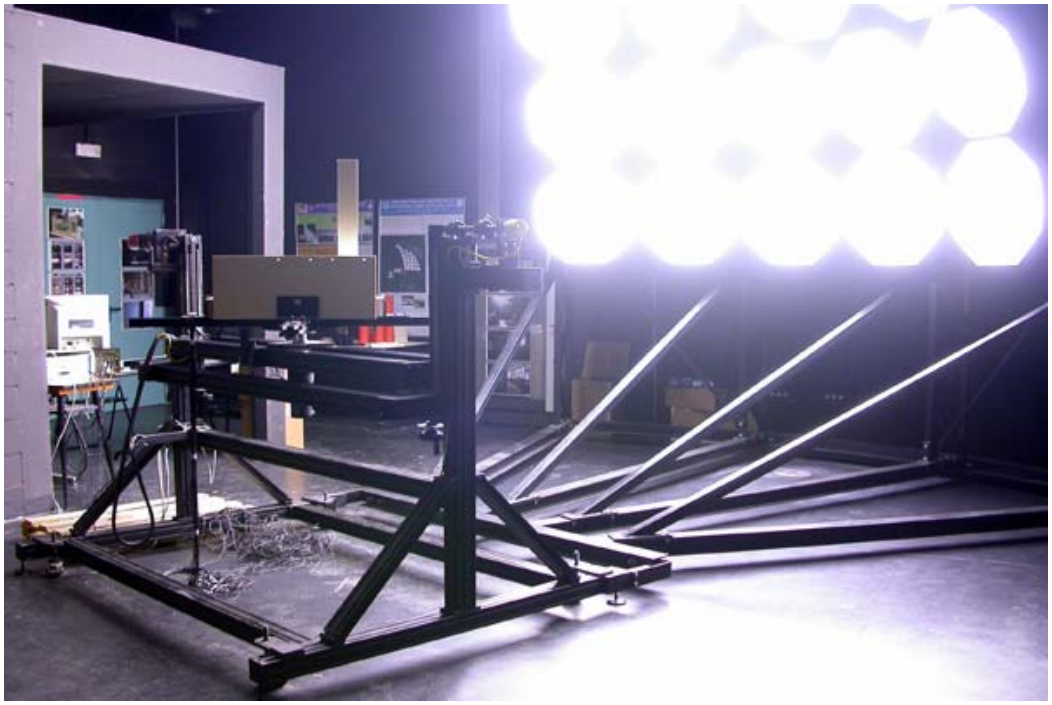
by Fabio Calosso
Tutor: Chiara Aghemo
Co-tutors: Valentina Serra and Valerio Lo Verso

The use of natural lighting in non-residential buildings represents an important contribution to the improvement of the environmental quality of indoor spaces as well as to the energetic performances of the building, allowing a consumption cut in artificial lighting, heating and air-conditioning. Natural light is strictly connected to the visual, physiological as well as psychological wellbeing of human beings. The dynamic and variable nature of solar radiation and the benefits it produces are particularly relevant in those places where people need to spend several hours during the day, such as working environments, offices, schools and hospitals.
Among the most innovative systems for environmental natural light control, a particular category is represented by those ones that capture and transport natural light. These systems constitute one of the most interesting typologies, as they can transport light at an elevated distance into underground buildings or into those buildings with no external openings, or they can integrate lighting in such environments lacking in windows or with a high depth.
The use of natural light pipes has not been much exploited because of the poor efficiency of the systems so far created; besides, those systems had certain characteristics as for their construction, functioning and maintenance, that were extremely complicated, therefore not suitable to be used in architecture on a large scale. The development and the availability of innovative materials with optical properties of reflection and refraction, together with a systematic and specific planning of the morphological and dimensional characteristics, can allow an improvement in the performance of these systems, thus making their use more effective.
The objective of my thesis is the evaluation of the efficiency of such light transport systems, determining by means of experiments their behaviour in an environmental type.
As an instrument for the project, analysis and simulation able to foresee the energetic and luminous behaviour of the system studied, I have selected the testing modality on scale models exposed to artificial sky, having access in the department of Energetics of the Politecnico of Torino, to the CERSIL laboratory, which is supplied with both a sun simulator and a sky simulator with variable luminance able to reproduce several sky conditions.

I have reproduced on scale an environmental type used as an office, hypogean, zenithally lit with light pipes.



I have analysed different typologies of pipes, varying: the finishing materials (specular films, white diffusing painting and OLF microplasmatic films); the pipe length, up to 9 metres (about 10 yards); the section shape, circular or square; the pipe position with respect to the environment, central and eccentric. The patterns have been subjected to several sky conditions at different times of the year and day.



With the purpose of evaluating the environmental characterization and the efficiency of the systems studied, I have carried out both a quantitative and a qualitative analysis, considering the illuminances, calculating the values of daylight factors as well as the uniformity values, taking pictures of the indoor spaces. In my thesis I have also described the methodology used for the research and the results obtained through the experimental analysis.

For further information, e-mail:
Fabio Calosso: jacalo@tin.it