THE MONUMENT TO THE FUTILE FORM II: CONCEPTION, SIMULATION AND REALIZATION OF A TENSEGRITY-MEMBRANE SCULPTURE

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ABSTRACT

The sculpture "Monument to the Futile Form II" ("*Monumento à Forma Fútil II*", MFF2) is composed of a textile membrane, anchored to a tensegrity simplex module. It was produced in 2003, at São Paulo, and was initially exhibited, from october 2003 to march 2004, at the hall of the main building of the Faculty of Architecture and Urban Planning of the University of São Paulo (FAUUSP), suspended by a single steel cable. It is currently in exhibition at the Polytechnic School of the University of São Paulo (EPUSP). This paper reports the main ideas behind its conception, and the processes adopted for its design and construction. Artistic conception and development of the MFFII were due to Prof. Ruy Marcelo de Oliveira Pauletti and his students Silvia Lenyra Meirelles Campos Titotto and Telmo Egmar Camilo Deifeld. The authors also acknowledge the support of Prof. Claudia Teresinha Andrade Oliveira, from FAUUSP, and Prof. Célio Fontão Carril Jr., from EPUSP. The motivation for the MFF2 Project was to expose, to the appreciation of the academic community of the University of São Paulo, the geometric and structural peculiarities of taut membranes and tensegrities, realizing an art object of notable scale, and trying to intrigue observers through of the oddity of the shape. Even if underlying principles are well known to researcher in the field, a novel and remarkable artwork was resulted, as suggested by comparison with other works reported on the specialized literature.

Keywords: tensegrity, membranes, structures, sculptures, technological art.

Figure 1. "The Monument to the Futile Form II"

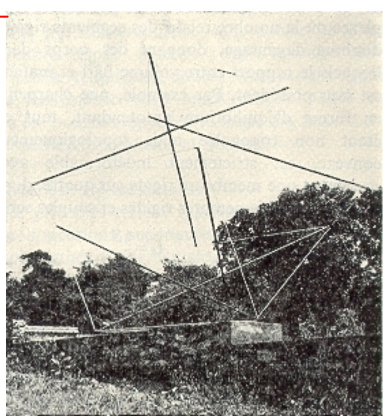
CONTEXTUALIZATION

Tensegrity structures ("***tension*** + ***integrity***") constitute a spatial structural system where compressed bars (struts), disconnected from one another, are connected by tensioned cables. The stiffness of the structure is intrinsically geometric, meaning, in the terminology of structural engineering, that it depends on the intensity of the traction applied to the cables, the structure becoming hypostatic, in the cables go slack[1].

Structures of this type were first conceived during the decades of 1950 and 1960, by architecture researchers and artists like Buckminster Füller, David Georges Emmerich, Keneth Snelson, Marc Mimram e Robert Le Ricolais. It is well known the dispute between Fuller and Snelson, regarding authorship of tensegrities, but it appears that also Emmerich and a few others could claim their discovery, so a communal authorship seems more appropriate.

Among the pioneering works, it can be cited the "Needle Tower" built by Snelson New York, in 1948. The title of the present work celebrates another historical *oeuvre*, the "Monument to the Futile Form", built near Ramboiuillet, France (cited by Emmerich, 1996). It is a 6 bars tensegrity simplex module, different to the 3 bars, prismatic simplex module of the present work.

The use of membranes, by its turn, goes back to antiquity, but its architectonic use was popularized by architect Frei Otto, starting from the end of the decade of 1950. The artistic exploration, with very light and flexible fabrics, started during the decade of 1960, by *designers* like Bruno Munari, and took momentum in the decades of 1970 and 1980, mainly with the works of artist Aleksandra Kasuba. More recently, relevant works have been produced by interior designer Gisela Stromeyer, the architect Allan Parkinson, and artist Ernesto Neto.



In the present work, it is explored the possibility to fulfill the irregular space generated by the disposition of the bars of the tensegrity module with a stressed membrane, which insinuates through the bars, without touching them, and thus establishing instigating nuances of tension and dialog between these elements, whose geometry, highlighted by strong, primary colors, try to defy the common sense of the observer. Observation of bystanders' attitudes suggests that the intent was satisfactory achieved.

[1] See the references of this paper for more precise definitions on tensegrity.

DESIGN AND EXECUTION OF THE MFF-II

The geometrical configurations of the tensegrity module and of the membrane composing the sculpture were determined both empirically and numerically, with the aid of adequate structural analysis programs (although the geometry of the tensegrity module was already well known, since the original studies of Snelson e Füller). The simulation of the assembling process of the tensegrity module was simulated with the aid of the PEFSYS finite element program. Results are shown in Figure 2. Adjusting the length of only one cable, depicted in red in the figure, the whole structure can be erected. Several steps of the assembling sequence are show in the figure.

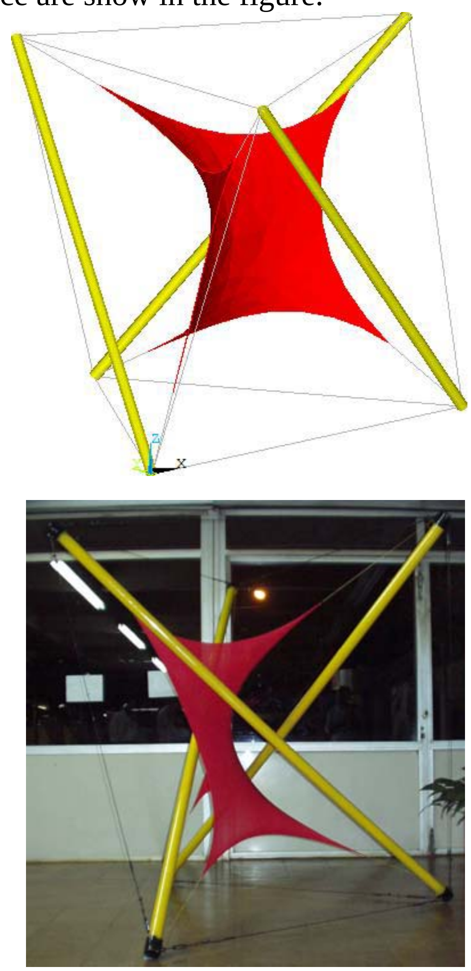


Figure 3. Comparison between the final *Ansys* finite element model, incorporating the tensegrity module, the membrane and the connecting cables, with the real sculpture.

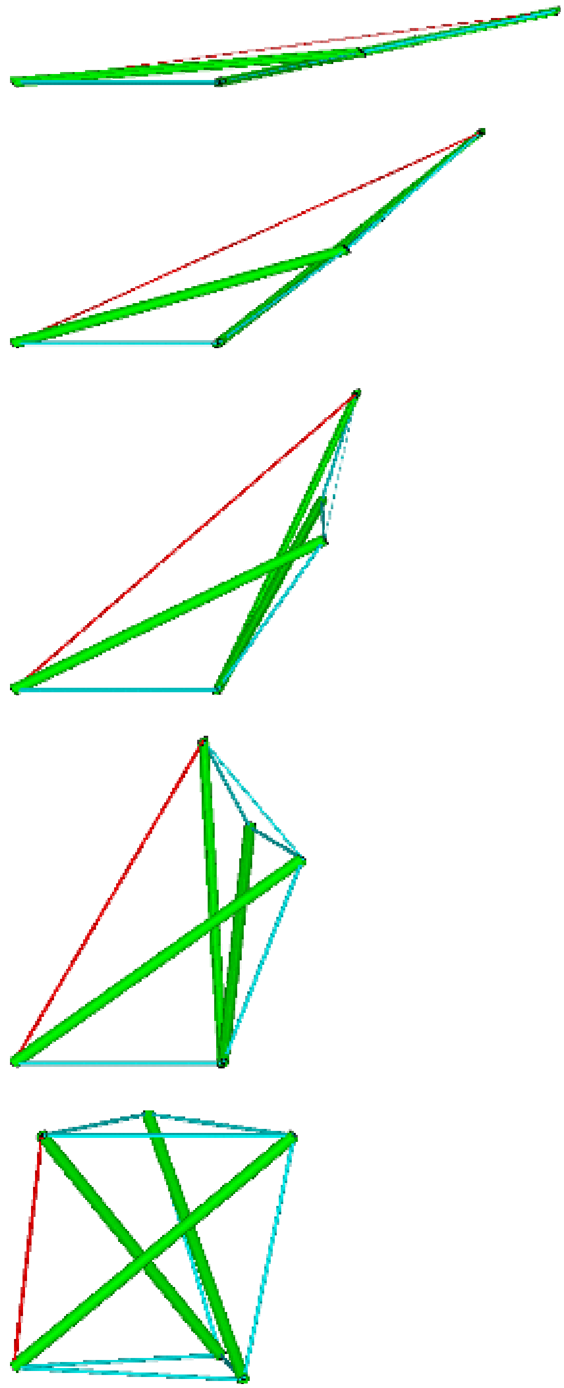


Figure 2. Numerical simulation of the assembling of the tensegrity module.

The tensegrity module was built from PVC hydraulic pipes, as well as steel cables, caps and fasteners, according to dimensions numerically determined by the PEFSYS program. Feasibility of stretching a membrane in-between the bars of the tensegrity module, without touching them, was initially guessed through sketches, then physically tested on the real module, with a piece of white Elanca fabric. It was concluded that the idea was feasible, but a more flexible and isotropic material should be used.

The final form of the membrane was then determined both in a 1:4 scale mock-up, using pantyhose fabric, and numerically, by means of nonlinear static analysis, using the *Ansys* finite element code. A comparison between the complete Ansys model, including the tensegrity model, the connecting cables and the membrane is done in Figure 3.

Figure 4, by its turn, shows the 1:4 mock-up, in which some cables were substituted by rigid bars, to easy manipulation. Once a satisfactory form was obtained for the membrane, size measurements made on the 1:4 pantyhose pattern were transferred to a 1:1 pattern, made of red Suplex fabric.

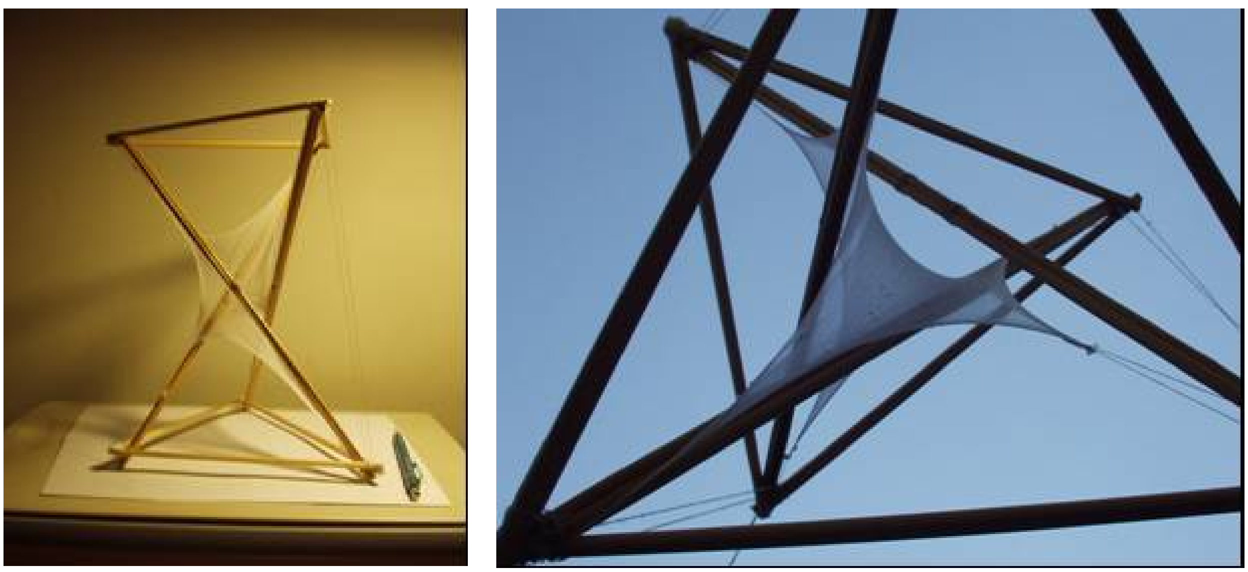


Figure 4. 1:4 scale mock-up of the MFF2, using pantyhose fabric and wood sticks

Figures 5(a) and 5(b) show the tensegrity module being prepared for the first viability test, with the Elanca fabric. Figures 5(c) and 5(d) show the final Suplex membrane being set up on the tensegrity module. Students mutinied against the idea of dismantling the structure to paint the PVC bars, so the assembling was covered with plastic bags and spray painted, as shown in Figure 5(e). After completion (Figure 5(f)), the sculpture, which is actually very light, was transported by the authors from the Civil Engineering building to the Architecture building (in a walk that was somewhat of a happening by itself), where it was hanged from a steel cable attached to roof of the building lobby. Figure 6 shows some additional views of the sculpture in exhibition at the Architecture building.

Figure 5. Several steps of the production of the MMF2

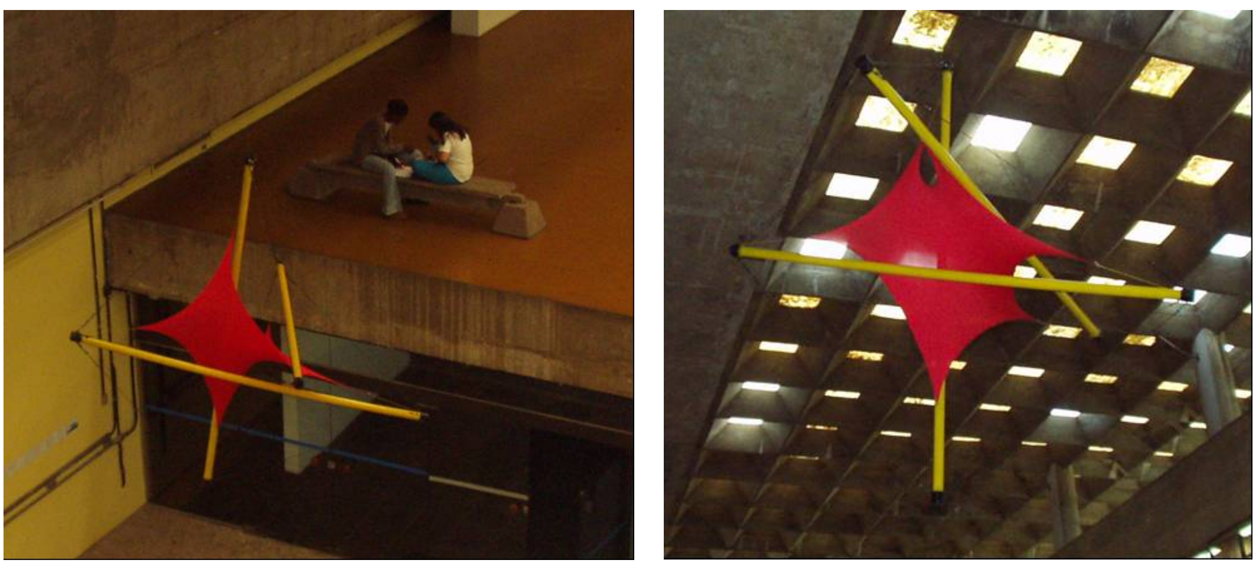


Figure 6. The MFF2 at exhibition at the lobby of the Faculty of Architecture and Urban Planning of the University of São Paulo

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