An academic experiment on the design of spatial truss models and teamwork

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Abstract

This paper describes a 'learning by doing' experience conducted during an undergraduate course on Structural Systems at the Faculty of Architecture at the University of São Paulo. The experience was inspired on the educational project 'Design, Assemble and Dismantle (DAD Project)' devised by S.A. Behnejad at the Department of Civil and Environmental Engineering at the University of Surrey [1]. Like DAD Project, the experiment aimed to foster students' skills in design, team work, communication, and problem solving, in a scheme were the design of one group of students is passed through documentation to another group, in charge of construction. Learning by doing is defined by Tony Bates [2] as a teaching method that *enables students to test hypotheses or to see how well concepts, theories, procedures actually work.* However, contrary to DAD (which is based on full-scale models, with a relatively reduced number of members), our experiment considered tabletop-size models, produced from simple materials, but with many hundreds of members, to allow greater geometric freedom.

The activity was divided in two phases: (1) a *design phase* and (2) a *construction phase*. During the design phase, students were asked to research about typical spatial trusses and relevant architectonic references and design some appealing structure, as an answer to a freely chosen architectonic plan. The system should comprise a lattice of about 100 modules (for instance, a 10x10 square grid). Based on the devised structures, the students should then design models with members of length of about 10cm to be produced from paper straws, connected by means of small nuts and bolts. The groups were encouraged to produce geometries presenting single or double curvature, having in mind that a more complex geometry requires more variability of the lengths of the bars, and a more complex assembling process.

The produced models were surprisingly light and robust. Overall, they showed high quality of making and dimensional precision. Students reported that by making these models they gained understanding on how forces flow within in a spatial truss, the importance of thrust for arched and domed structures, and the relevance of minding stability, besides shape and strength. Moreover, assuming successively the roles of designers and constructors, they gained insights on the complexities and amount of work involved in producing and assembling real structures.

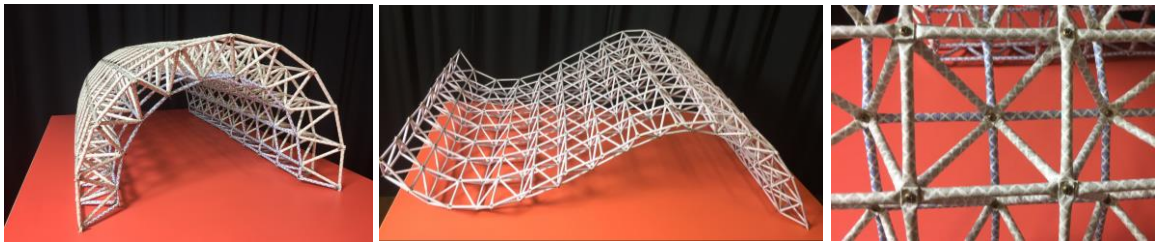

Figure 1 – Two selected spatial truss models and details of connections between bars.

References

[1] S.A. Behnejad. 'Benefits of Full-scale Physical Models in Civil Engineering Education', ASEE's 123rd Annual Conference, New Orleans, USA, 26-29 June 2016 New Orleans: American Society for Engineering Education.

[2] A.W.(Tony). Bates. *Teaching in a Digital Age: guidelines for designing teaching and learning*. Creative Commons Attribution – Non Comercial Internation License, 2015.