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Personal Experiences in Teaching Construction in the New Digital Era

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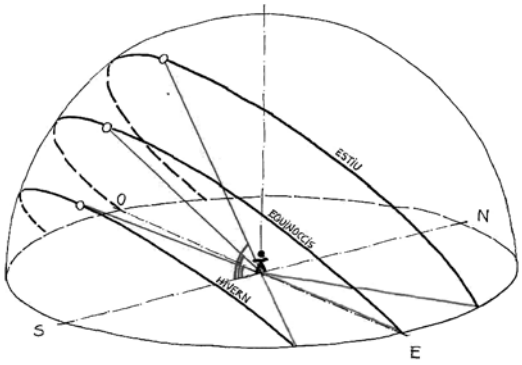
Introduction

The paper will focus and describe the author's experience in everyday teaching and how it had changed along the previous years.

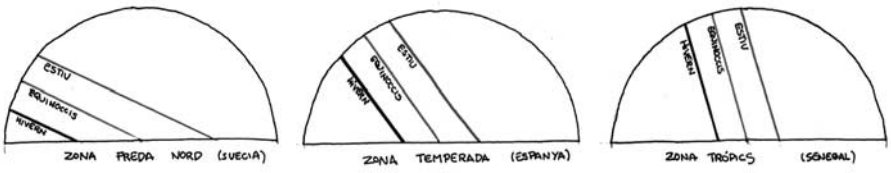
I took two of the subjects I teach. The first one is "Construction1", a compulsory matter in the first year where we introduce the architectural technology to the students. Then, a free elective subject, "Tensile Constructions", a specialized type of Architecture which has been developed during the last fifty years and, consequently, has suffered the influence of the digital transformation in all its strength.

First case: Construction 1

I observed the contents of the subject and I tried to find parts where the influence of the digitalization has been clear and effective. And without having noticed it before I came across to a very recent implementation in one of the themes that constitude the programme of this subject. It was theme 3: "The Architecture as Shelter and Filter". In this theme I've been using for several years some drawings to show the solar path in order to understand the strict relation of the sun in architecture and human life: radiation, heat, shadows, etc. At the same time, to show how latitude influence in the everyday relation sun-earth.



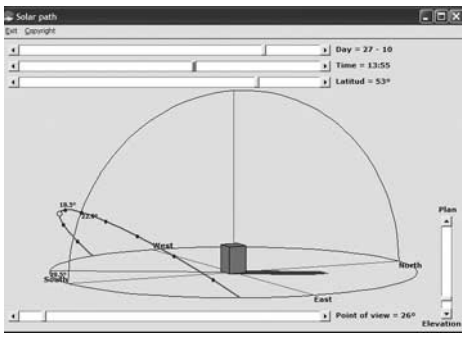
We used an axonometric projection to understand the solar paths along the year, by drawing the equinoxes and solstices. But this drawing serves only for a precise latitude and we should have a different drawing for any other latitude.



These three elevations help to understand what happens in different situations on the globe, but probably we'd like to have more: the poles, the equator, etc.

And here is when the paradox appears. Although I use to write software by myself in a professional way, I hadn't realise I could apply this knowledge to the way I used to teach Construction. So I decided to write a piece of software to explain the same in an interactive way.

The result was the program called Solar Path. It is a fairly simple work, done in a week end (which really questions me why I didn't it before), that shows not only one but several data in just an image:



- solar path along the day in a fixed date and latitude, with the maximum solar height.
- position of the sun in this path in a fixed time (you get the solar height and the azimuth angles).
- the shadow of a prismatic volume, the idea is to show in a graphical way how shadows move in angle and length along the day.

The program is used interactively through a series of scroll bars. First of all there is a group of three bars:

- Day: shows the actual day in a format "day – month". You can move it along for all the days of the year.
- Time: you can change it with steps of 5 minutes.
- Latitude: from -90° (South Pole) to 90° (North Pole), steps of 1°.

The other two scroll bars just change the point of view, so that you can see better the shadow or the sun position at precise times, or the elevation from vertical elevation to a plan.

Obviously the understanding of the whole phenomenon is much better now, not only because you can see many more situations but because you see what happens in motion. The students can just "touch and wait" which is a good way to analyse the behaviour of any event.

The conclusion, however, is that there are, probably, many other subjects we teach in an old fashion way just because we are not aware we can use digital means. And sometimes (not always) these new ways are more efficients in the transmission of knowledge, which is, in the end, what we intend to do.

Second case: Tensile Constructions

This is a completely different case. It is about a free elective subject which deals with a type of construction quite different of the standard ones. Although tensile constructions (ropes and skins) are almost as old as compression (stones) or bending (wood), the truth is that they have not been developed in a technical way until the second half of the twentieth century.

From the first edition of this course (six or seven years ago) I've put the attention in the fact that shapes (forms) are not as free as they are in the other constructions. Tensile structures require shapes that adapt themselves to the tensile forces producing results as catenaries (hanging), spheres or cylinders (pressured), or double curvature (anticlastic).

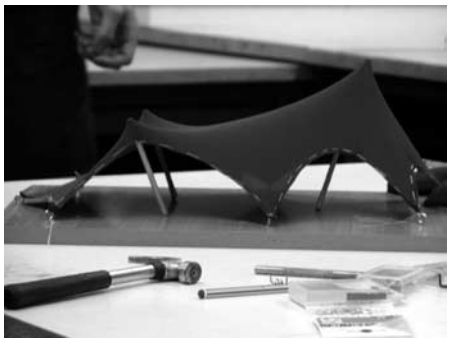
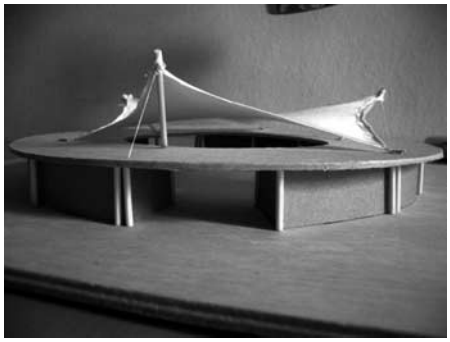
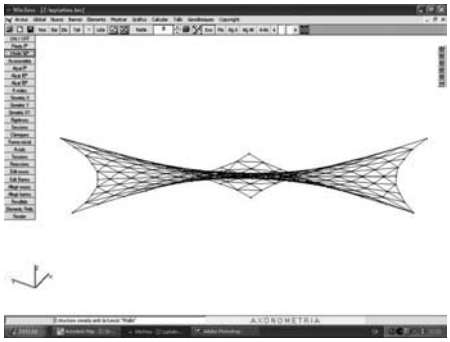
So, one of the major points to be studied in this subject is how to find these shapes. That's call form-finding. We propose 5 ways to do it.

1) Mathematical method: Using equations representing surfaces: spheres, cylinders, hyperbolic paraboloid, etc.
2) Constructive method. Ruled surfaces, the way that concrete shells are built, although they are *compression shapes*: hyperbolic paraboloid, etc.
3) Model method. Using very deformable and elastic material (latex, Lycra, etc.) we can achieve complex irregular shapes.
4) Simulation method. Using computers we can simulate the processes done in the three former methods, particularly in the method 3. Of course we need specialized software and this is a serious inconvenient in a school, since this type of software is not common (therefore expensive)
5) Soap bubbles. This method is only suitable for pneumatic structures. Although the shapes are not permanent and sometimes very ephemeral, it is an easy and funny way to create and analyse different possibilities.

During the recent years I always recommended the third method to the students. There were several reasons to do it. The main one is that they recognise the suitability of the shape at the same moment they create it. They notice if the surface is stressed or not. They see how small changes in the geometry cause wrinkles. They have a 3D model to work on it, to photograph it and use it for photo-composition, etc. In fact, drawing plans and elevations of these shapes is quite difficult without specialised software.

But I must admit, and I explain this fact to the students, that most of the real work done in this field, all over the world, has been done using the fourth method. Thus, it is not strange that they insist in asking me to use some software to make their proposals. At first, I was reluctant to let them use computers instead of making models. But when I began to change my mind and facilitate them specialized software, to work with their designs, I had a surprise when I saw how they used both methods.

They always begin working on models and drawing sketches, and when they have achieved a certain level of decision they move to the software. And not all of them, there is always a group of students (those who are not so friendly with computers)

who never use the software. Of course they know they should use it if the project must be real, but the exercise is focused on the design of the whole and construction details, not in calculating and manufacturing the membrane.

During the last twenty years I've heard so many times complains from my colleagues about the use of computers in teaching and learning architecture. About the possible loss of the students capability of drawing by hand, about the loss of the students capability of calculating simple structures, and so on. I agree with them sometimes, but from time to time I realise that students chose the use of computers just when they need it and keep on using manual skills. Our fears are unfounded somehow.

Our effort, as teachers in this New Digital Era, must be focused on discerning how the new tools that are there (and there is no sense in neglecting them) can be used to complete, enhance and sometimes *substitute* the tools that we have been using for years. Our task as professional teachers in a University can not be a task that encourage to avoid the use of the new means but a task to show how to use old and new tools together. I'm sure students expect *that* from us.