HOW CAN STUDENTS LEARN TO INTEGRATE FORM AND CONSTRUCTION?

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INTRO: A LACK OF INTEGRATION

In architecture schools, almost all design assignments are organized in the same way as commissions in real architecture practices. They seem to be copies of architecture competitions for professionals, including a list of requirements and wishes made by one or more stakeholders at the start of the project, and including a crit or review with a jury at the end. Students start their project with some sketches, which are further developed in a preliminary design, and at the end they make up design drawings and design details. This sequence works for professionals who master all the aspects of architecture, and therefore can foresee the consequences for the realisation of a preliminary design sketch. But this is not the case for beginning architecture students. For them, not being able to foresee the consequences of their first ideas for the final structure and details, the construction often turns out at the end of the design process as a choice of the less disturbing option to realise the form they designed at the beginning of the process.

CONFRONTATION OF THIS LACK OF INTEGRATION WITH GOOD ARCHITECTURE

This lack of integration makes good architecture impossible, because earlier research proves that in good architecture, more satisfactory solutions encompass more topics of the stated problem at the same time. So these good solutions integrate many topics, including form and construction.

They idea of integration has been formulated in the past in different ways by several authors. Among Rasmussen, the appearance of a building is only one of the several factors of interest. In a good building, plans, sections and elevations must harmonise with each other. Architecture is regarded as something indivisible, something you cannot separate into a number of elements (Rasmussen, 1959). Ideas encompassing multiple topics are also called integrated (Jones 1992) or composite (Goldschmidt 2005). Zumthor considers architecture at its most beautiful when things have come into their own; when they are coherent. That is when everything refers to everything else, and when it is impossible to remove a single thing without destroying the whole. The form reflects the place, the place is just so, and the use reflects this and that. In good architecture, form and construction, appearance and function are no longer separate. They belong together and form a whole (Zumthor 2006). Siza talks about design as the subtle balance of all the facets of the social, functional, environmental, economic and contextual problematic of the project. (Siza, 2010).

But integrating all constraints shouldn't be understood as eliminating all complexity and contradiction. Geers uses internal consistency as the main criterion to distinguish a good project from a bad one, but at the same time he nuances this consistency. Complexity does not and should not exclude consistency. Every proper project engages in the found reality. It is as much part of the real context, as it is against it. It is its mirror and its transformer. A proper project fails, since any possibility to make complexity consistent fails (Geers 2011).

THREE STRATEGIES TO COUNTER THIS LACK OF INTEGRATION

A literature review on didactics and on teaching architectural design, brings up 3 interesting strategies to counter the lack of integration of form and construction in design assignments at architecture schools.

Thematic Assignments

First, thematic assignments simplify the complexity of architectural problems and make it possible to focus on certain aspects. In other words, thematic assignments can help to exercise a refined taste for specific aspects of architecture. The integration of constraints, or more specific for this case, the coherence of construction and form, is one of those important aspects of architecture, which can be exercised with thematic assignments. Hume, when discussing the standards of good taste, explains the importance of a refined taste by isolating different components. He talks about organs being so sensitive that they let nothing escape and yet so precise that they perceive each component of the composition. Because these properties sometimes occur in small quantities or mixed and confused, it often happens that taste by such tiny features is not affected or is unable to provide specific aromas to keep apart in the disorder in which they arise. (Hume, 1745). Isolating these components makes it possible to create sensitivity for them.

Now what are the constraints in architecture that should be ignored just to isolate form and construction? Already about 2000 years ago, Vitruvius wrote that in architecture, account should be taken of strength, utility and grace. During history, architecture gradually evolved from a focus on solids, to a shared focus on the solids and the voids (Giedion 1941) and later sharing the focus also with the context (Frampton 1983). So in 1979, Ching defined the 3 groups of Vitruvius as technics, function and form, and added space as a fourth group and context as an upper scale (Ching 1979).

In the case of a focus on form and construction, the project is to be isolated from context, function and space. Isolation from context will help, as working in a real context would only impose extra site-specific constraints and thereby distract the students from concentrating on the theme. The same is true for the isolation from function, because, besides being able to bear itself, all other functional constraints would lead away the attention of the students from the integration of form and structure. And finally, no attention should be paid to the space created by the construction, as this would also occupy the students' mind during their research on the integration of form and construction.

Working On Full Scale

Secondly, working on scale 1/1, reinforces the focus on specific aspects as proposed with the thematic assignments in the first strategy. This is because by working on scale 1/1, the difficulty of rescaling and problems of representation are both omitted out of the design process and reinforce the possibility of focus.

Teaching Backwards

And thirdly, the order in which steps are applied in practice, does not have to be the order in which they should be taught. There are very good reasons to teach "backwards", so there is always something before you is that you already know. Among De Bono, it's useful to teach the "end result" in an early stage, so the student knows what he can achieve while he or she develops his skills (De Bono, 1998). In archtitecture, Zumthor confirms this, saying that the drawing of scale plans also begins with the concrete object, thus reversing the order of "idea-plan-concrete object", which is standard practice in professional architecture. First the concrete objects are constructed; then they are drawn to scale. For Zumthor, all design work starts from the premise of this physical, objective sensuousness of architecture, of its materials. To experience architecture in a concrete way, means to touch, see, hear, and smell it. To discover and consciously work with these qualities - those are the themes of his teaching. All the design work in the studio of Zumthor is done with materials. It always aims directly at concrete things, objects, installations made of real material (clay, stone, copper, steel, felt, cloth, wood, plaster, brick). There are no cardboard models. Actually, no "models" at all in the conventional sense, but concrete objects, three-dimensional works on a specific scale (Zumthor, 2010).

Working backwards in design is also related to the simultaneous development of problem and solution. What you need to know about the problem only becomes apparent as you're trying to solve it (McCormac, 1976). It seems that creative design is not a matter of first fixing the problem and then searching for a satisfactory solution concept. Creative design seems more to be a matter of developing and refining together both the formulation of a problem and ideas for a solution, with constant iteration of analysis, synthesis and evaluation processes between the two notional design 'spaces' - problem space and solution space (Dorst, 2001). Creative design involves a period of exploration in which problem and solution spaces are evolving and are unstable until fixed by an emergent bridge which identifies a problem-solution pairing. A creative event occurs as the moment of insight at which a problem-solution pair is framed (Dorst, 2001). And also, in design, the solution and the problem develop together. Design is emergent - relevant features emerge in putative solution concepts, and can be recognised as having properties to the developing problem-concept (Cross, 1999). Designing is about assessing the answer, not the question (Mau, 2000).

CASESTUDY: AN ASSIGNMENT WHICH CONCENTRATES ON THE INTEGRATION OF FORM AND CONSTRUCTION

All three strategies were applied in a thematic studio assignment last year.

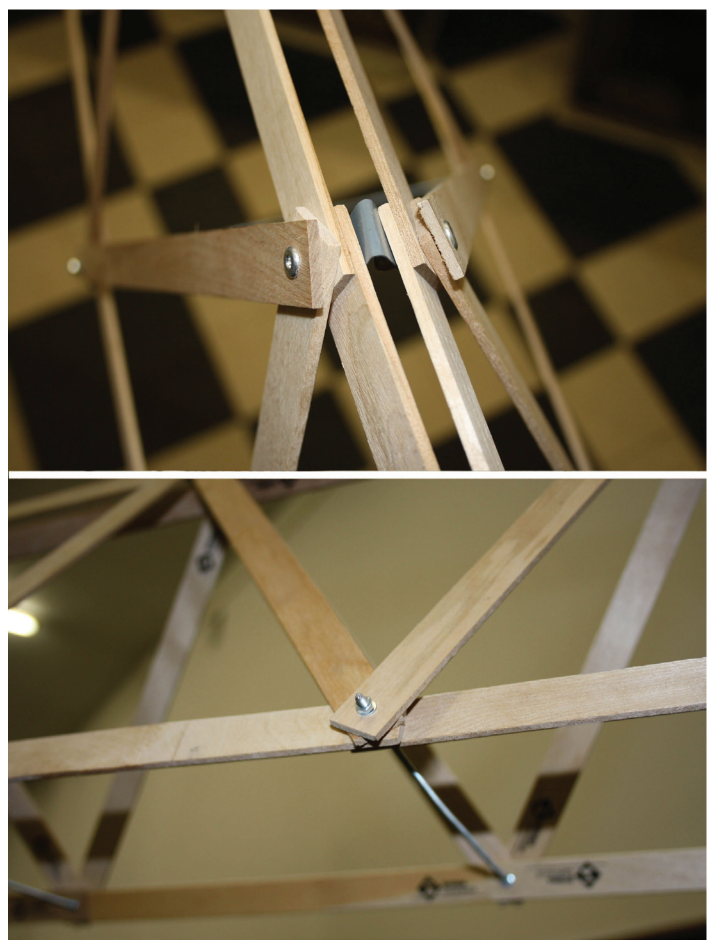

Figure 1. Group SOMM: Strouwen, Ockerman, Mertens, Mertens.

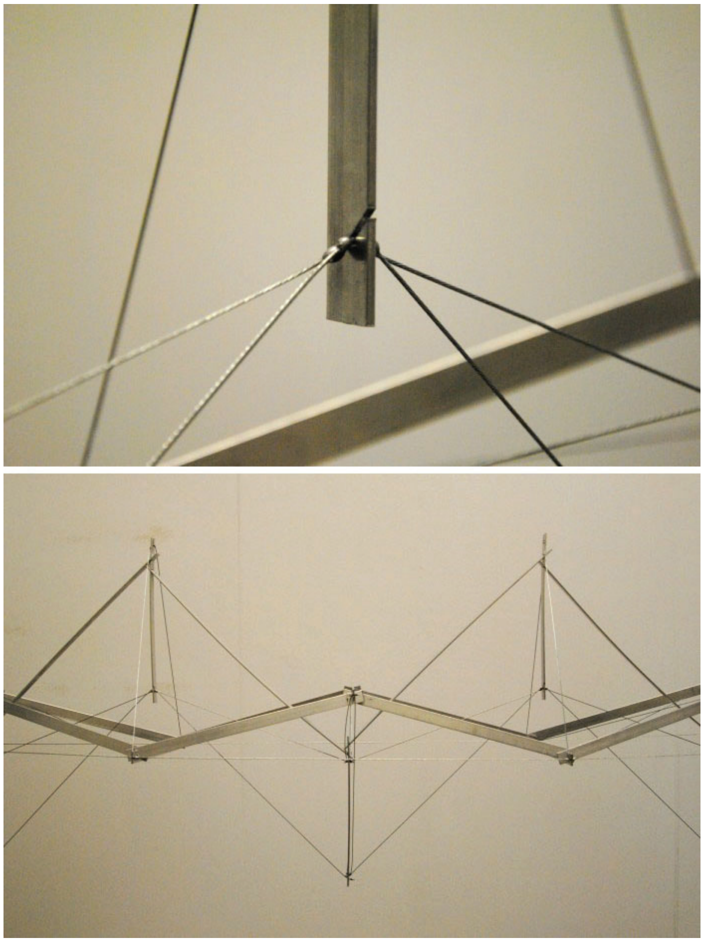

Figure 2. Group DSSV: Dekeyser, Salaets, Stas, Van Droogenbroeck.

Method

The project started where the design process in practice often ends: namely the details. The students explored the formal and constructive aspects of possible connections between 2 parts of the same or different materials. This was done by building and exploring these connections in reality on scale 1/1. Therefore, students brought all kinds of materials, in all kinds of forms, with them to the design studio to experiment with. They worked with the obvious wooden battens and steel wire, but also with textiles, paper and plastics. Several variants and combinations were investigated and given form. The use of intermediary devices like nails, screws, wire and plastics were tested and their formal qualities evaluated.

During the second week, students explored the form and the constructive properties of vertical or horizontal structures, created by frequently repeating that connection. The structural qualities of these structures, like sections, buckling length, global stiffness were examined together with their formal qualities, like their elegance, compositional qualities and harmony. These combinations of connections delivered at their turn feedback for revisions and optimisation of the joints and details. At the end, some groups were

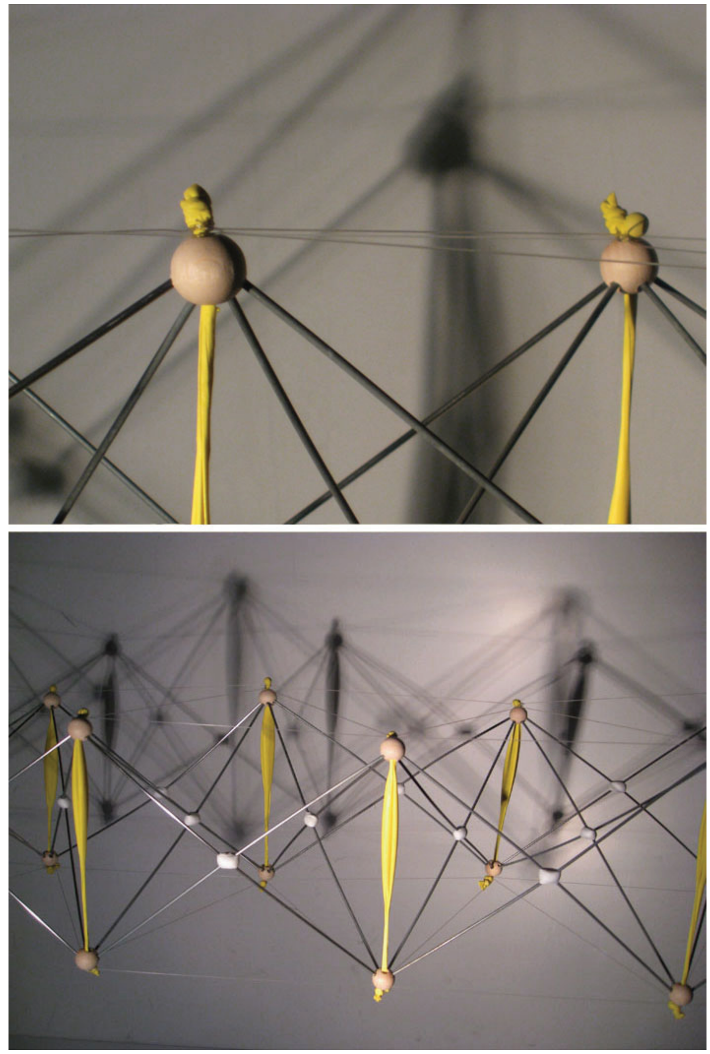

Figure 3: Group CDDV: Carmeliet, D'Haese, De Beukelaar, Verheyen.

able to harmonise detail and whole, form and structure.

Results

The group SOMM (Strouwen, Ockerman, Mertens, Mertens) formed classical 2-dimensional trusses with small battens, normally used for mixing paint. And they also managed to join these simple flat trusses in a 3-dimensional way using simple steel sheets and rods, thereby realising a triangle in the third dimension, and at the same time managing stability in this direction.

Another group, namely DSSV (Dekeyser, Salaets, Stas, Van Droogenbroeck), made a 3-dimensional truss, using different sorts of metal for parts being pushed and parts being pulled. Flat aluminium rods for those being pushed, and steel wire for those being pulled; exploiting the difference of both to realise a detailed connection between them by simply making a small incision in the flat rod, where the steel wire could be fixed.

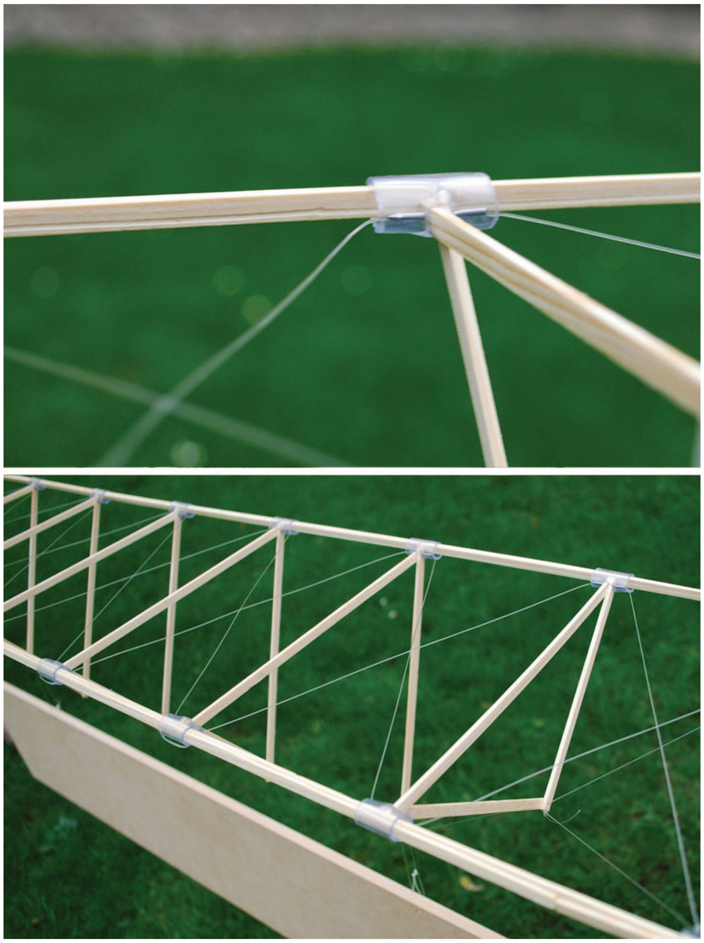

Figure 4. Group DDRV: Daniels, De Ceulaer, Rutten, Vankriekelsvenne.

The group CDDV (Carmeliet, D'Haese, De Beukelaar, Verheyen) also made a 3-dimensional truss by using not only different forms of the same kind of material, for parts being pushed and parts being pulled, but by also differing the materials themselves, namely steel rods for those being pushed, fish wire for horizontal parts being pulled, and balloons for vertical parts being pulled. Connections here are realised not by substraction (like with the incisions in the steel rods made by the group DSSV), but with an extra part. This extra part is in chewed paper for the connection between steel rods, and it is in wood for the joint between totally different materials, making it possible to connect the balloons with the steel rods and the fish wire.

A fourth group, DDRV (Daniels, De Ceulaer, Rutten, Vankriekelsvenne), also used an additive part to detail their joints of their truss made of fish wire and wood. Here, the extra part is cut out of plastic tube, making it possible to connect the different materials in a very elegant way, reinforcing the longitudinal direction of the truss.

CONCLUSION

During the whole design process, the formal aspects of what the students were constructing, were visible and at the same time, the constructive qualities were tangible with there hands on a full size scale. While not paying attention to a context, nor to function, they were able to concentrate on the integration of form and construction, on the link between on the one hand the structural qualities of these structures, like sections, buckling length and global stiffness and on the other hand their formal qualities, like their elegance, compositional qualities and harmony.

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