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Digital versus handcraft fabrication. Architectural elements with complex geometry in different contexts, Scandinavia and latin america

(by Héctor Mendoza & Mara Partida)

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This paper focuses on the material implementation of architectural systems which, by their complex geometry, were originally designed and modeled aided by digital tools. But once those systems have confronted the specific conditions of the local industries and socio-cultural contexts, they have varied their hypothesis of digital or handcraft fabrication.
This paper shows two cases from the professional experience gained through specific projects realized by the authors on very different contexts: Mexico and Finland. These projects will highlight not only the spatial and geometric solution, but also the corresponding fabrication of doubly curved surfaces able to integrate, or unify, two architectural elements in a single gesture. We refer specifically to the system 'more than a wall' proposed on the temporary intervention at the Eco Museum in Mexico City, and the system 'more than a railing' implemented on the project for the Gösta bridge in Mänttä, Finland; both projects from the year 2014, and one of them already built.
Both case-studies depart from comparable geometric systems with specific and differentiated fabrication solutions. Although those solutions are coherent with their global projects, both were demanded to move from their original hypothesis of digital or handcraft manufacturing.
In the case of the temporary intervention at the Eco Museum, we focus on the proposal of altering the vertical and angular condition of the walls that define the premises. Walls that, through the strategy of simultaneously smoothing the edges and the continuous variation of the section, achieve not only a reconfigured space in plan, but also generate an area of seat, platform or stage towards its central part; that is why this system is called 'more than a wall'. The material implementation of the system was a key issue. It was desirable to achieve the smooth and continuous optical effect suggested by the digitally designed model.
About the Finnish project Gösta Bridge, that links the park where the Serlachius Museum is located, with the Taaventinsaari Island, we focus on the design and fabrication of one of its secondary elements: the handrail. This element serves as a mediator between museum visitors and infrastructure, presenting a soft materiality, easy to touch, and in harmony with other built and natural elements around the site. The geometry of this contemporary balustrade is described with a doubly curved surface that, in a similar manner as the project in Mexico, varies in section. This element smoothly reconfigures, from railing to bench, providing the place for visitors to stop and sit in order to enjoy the vista; that is why this system is called 'more than a railing'.
Based on original material from the architecture studio, this paper explains different manufacturing options that were studied during the design process until the final solution was found either digital or handcraft. Once confronted with contractors and real construction cost and time issues, the manual or artisan fabrication, proposed by the authors, was suggested to change to the opposite without compromising their own essence and material qualities.

Keywords: handcraft, digital fabrication, professional practice, architectural design.

Digital versus handcraft fabrication.
Architectural elements with complex geometry in different contexts, Scandinavia and latin america

1 INTRODUCTION

This work focuses on the material implementation of two similar architectural systems which, by their complex geometry, were originally designed and modeled aided by digital tools. But once those systems have confronted the specific conditions of the local industries and socio-cultural contexts, they have varied their hypothesis of digital or handcraft fabrication.

Two cases, taken from the authors professional practice are presented here. These projects highlight not only the spatial and geometric solution, but also the corresponding fabrication of a doubly curved surface able to integrate, or unify, two architectural elements in a single gesture. We refer specifically to the system 'more than a wall' proposed on the temporary intervention at the Eco Museum in Mexico City, and the system 'more than a railing' implemented on the project for the Gösta bridge in Mänttä, Finland; both recent projects from the year 2014, and one of them already built.

Both case studies depart from comparable geometric systems with specific and differentiated fabrication solutions. Although those solutions were coherent with their global projects, both systems were demanded to move from their original hypothesis of digital or handcraft manufacturing.

2 CASE STUDY A

2.1 More than a Wall System. Proposal for a Temporary Intervention at the Eco Museum in Mexico City.

In the case of the temporary intervention at the Eco Museum, we concentrate on the proposal of altering the vertical and angular condition of the walls that define the premises. Walls that, through the strategy of simultaneously smoothing the edges and the continuous variation of the section, achieve not only a reconfigured space in plan, but also generate an area of seat, platform or stage towards its central part; that is why this system is called 'more than a wall'. (fig.1)

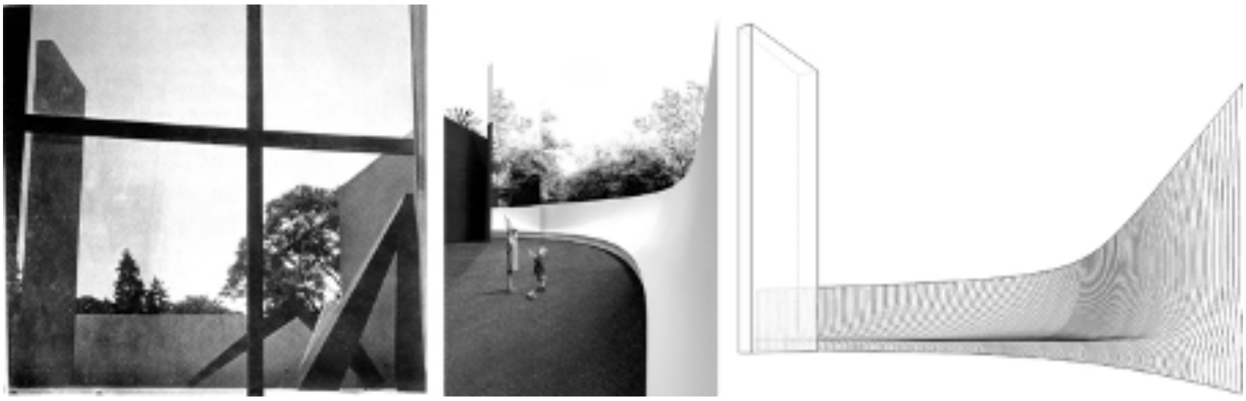

Fig.1 Picture of the Eco Museum's Courtyard in 1953. Rendering view of Mendoza Partida proposal for the temporary intervention in the courtyard. Rulinglines of 'more than a wall' system geometry. Image courtesy of Mendoza Partida architectural studio.

The experimental museum Eco was built in 1952 by the german artist Mathias Goeritz. The courtyard is one of this project's main feature, and since 2010, every year this Institution organizes a design contest that seeks for new ideas of reconfiguring that space. In the proposal, is possible to observe the spatial reconfiguration through the manipulation of the courtyard's limit; the system named "more than a wall" identifies graphically its geometric definition through the ruling lines.

2.1.1 Fabrication possibilities for the system "more than a wall"

The material implementation of the system was a key issue. It was desirable to achieve the smooth and continuous optical effect suggested by the digitally designed model, and the possibility of modeling in Barcelona and fabricating it in Mexico in order to reduce travel costs for site supervision. Also, knowing that this project would be temporary, the durability of the material was not a primary parameter, and therefore, the use of a large budget was out of the question.

During the design process, some options were not considered further, like the possibility of high-tech solutions based on durable construction materials such Ultra High Performance Fibre Reinforced Concrete (UHPFRC) for precast urban furniture like the Bench H2O designed by the architect group H20, or the Lungo Mare reinforce concrete surface designed by EMBT architects. (fig.2)

Fig.2. UHPFRC used on urban furniture on Bench H2o by H2o architects, and Lungomare surface design by EMBT architects produced by precast concrete factoy Escofet.

Because of geometric similarity and finishing aspects, it was reviewed the fabrication and materiality of some furniture elements designed by Zaha Hadid Architects, like the Neil Barret shop in Tokio. On that case, they consulted the Corian specialist Cutting-Edge (1), and the solution they used consisted on large thermoformed and Computer Numeric Control (CNC) milled Corian, solid surfaces, that allowed for fine treatment and chemical welding towards a seamless aspect (Fig.3). Even though it was interesting to research on that possibility, the constrained budget and the temporality of Mexican intervention pushed the exploration towards some other alternatives.

Fig.3. Solid surface material used by Cutting-Edge Corian Specialists for the Neil Barret shop in Tokio designed by Zaha Hadid Architects.

The next option consisted on the fabrication of a large surface by assembling small scale pieces, pieces than could belong to a tessellation pattern extracted from the overall geometry. The reference on this case was the art installation at the University of Michigan Museum of Art in 2011 called "Photoformance" coordinated by their Dean Mónica Ponce de Leon. It was achieved not only a continuous surface, but dynamic and visual properties through the use of translucent plastic PETG (glycolised polyethylene terephthalate) pieces that were CNC milled on a workshop and assembled on site. A similar solution could have been implemented for the Eco Museum installation in a sense that design could be defined and controlled in Barcelona and having the tessels ready to be cut and mounted abroad. (fig.4)

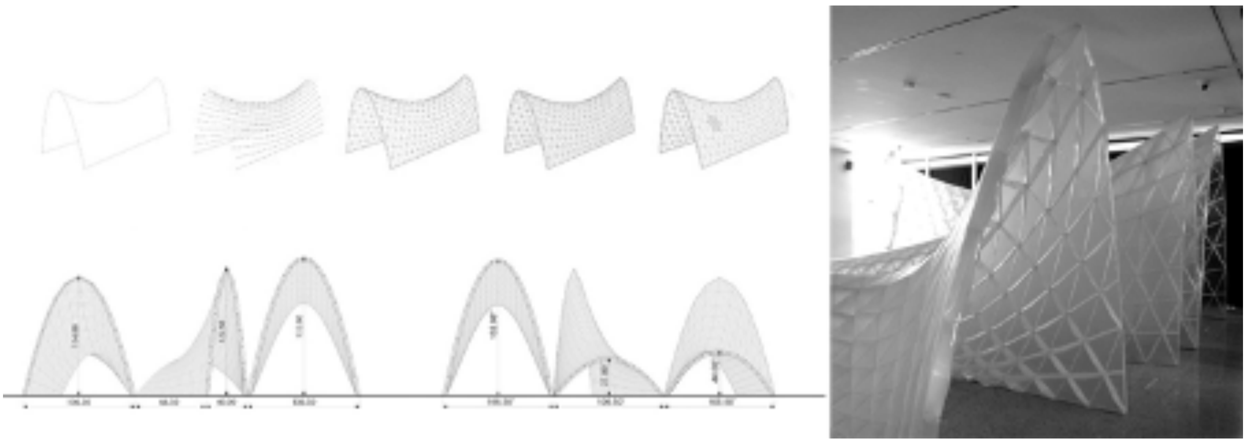

Fig.4 Doubly curved surface Rhino model for the digital fabrication of the Photoformance Art installation at University of Michigan Museum of Art

For the actual proposal, the surface had to be strong enough to hold live loads. The system was meant to work as a bench or as performance platform too, and the solution needed a structure that was not originally planned. It was necessary to use a solid but light material; a material easy to sculpt, and to mount, inexpensive, and recyclable.
Finally, it was decided, as a true hypothesis, the use of high-density polyurethane foam blocks smoothly detailed with a digitally controlled process by a 5-7 axis CNC router. Foam blocks could be brought to the site already shaped and simply having them placed on site.

Even though local contractors agreed on the feasibility of the proposal, they drove the attention to hand crafting possibilities pointing fiber glass elements used for fair stands, advertising elements, or specially shaped boats or swimming pools. It was suggested that if instead of using digital fabrication process we use local handcraft techniques; the price would be lower and the fiberglass layer would fit into the budget and will present a sharper and solid aspect.

It was took as a precedent the handcraft manufacturing process of the advertising stand of ‘Melissa’ shoe brand in Brazil. That work, done by local contractors, reproduced a 10:1 scale shoe designed by Zaha Hadid. A giant 4 meter tall physical model, built manually using wood ribs and foam, followed by a large process of sanding and a final layer of fiber glass and automotive gloss finishing. The key issue there was the “manual” sanding process achieving the smooth base where fiberglass was layered on top of it. The image summarizes the process: ribs as hidden structure, and the rough pieces of foam in between. And after some long hours of sanding, the geometry of a complex and smooth volume was achieved (2).

The shiny finishing in this case was accomplished to imitate the plastic material of the original scale brand shoes. (fig.5)

Fig.5 Handcraft fabrication process of a digital designed complexed geometry shape. Fiberglass finished on top of foam block and wooden ribs structure.

The system "more than a wall" instead, would show a matt and opaque finishing comparable to the original museum wall texture. The system was only part of a more complex solution that integrated other elements meant to reconfigure the perception of the museum courtyard temporarily, like the use of reflective surface that contributes altering the perception of the original space.

The handcraft fabrication solution for the system is shown in the picture:

1: one inch pine plywood ribs separated around 40 cm.

2: Wood bracing to hold horizontal displacement.

3: Infill of expanded polystyrene blocks, not cnc milled but manually sanded instead.

4: Fiber glass and resin layers.

5: Fine textured matt finishing. (fig.6)

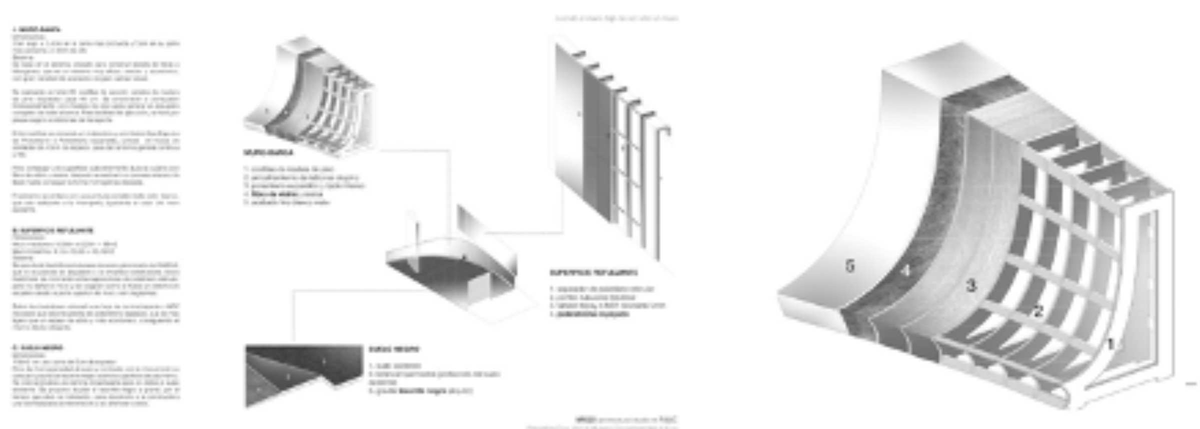

Fig.6 Final handcraft fabrication solution proposed by Mendoza Partida for the system 'More than a Wall' on the temporary intervention at the Eco Museum in Mexico City. Image courtesy of Mendoza Partida architectural studio

3 CASE STUDY B

3.1 System More than a railing. Gösta Bridge, Mänttä Finland.

The Finnish project Gösta Bridge is a piece of infrastructure that links the park, where the Serlachius Museum is located, with the Taaventinsaari Island. We focus on the design and fabrication of one of its secondary elements: the handrail. The geometry of this contemporary balustrade is described with a doubly curved surface that, in a similar manner as the project in Mexico, varies in section. This element smoothly reconfigures, from railing to bench, providing the place for visitors to stop and sit in order to enjoy the vista; that is why it is this system is called 'more than a railing'.

The bridge is a seamless piece of folded corten steel plates that besides following a structural geometry offers a suitable materiality texture. Even though corten steel provides a compelling aspect, it was considered necessary to add a softer layer in contact with museum visitor's hands. (fig.7)

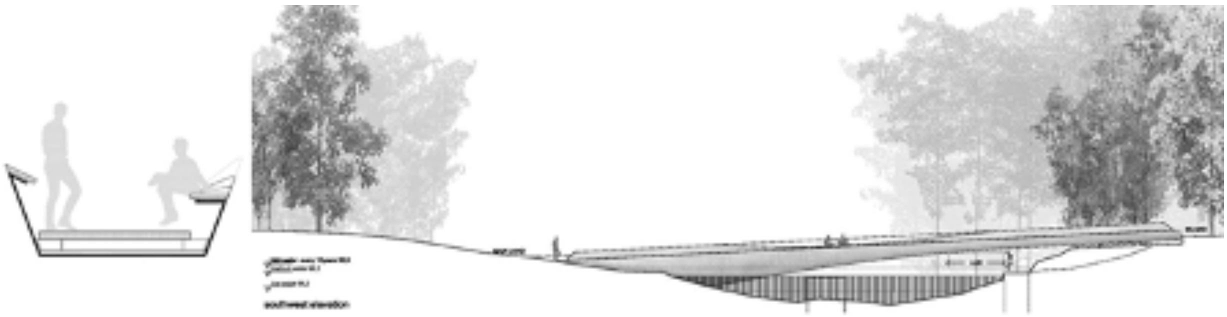

Fig.7 Gösta Bridge. Folded corten steel plates. Wood layer as railing and bench. Section and Elevation. Image courtesy of Mendoza Partida architectural studio

The railings were planned as that extra layer, easy to touch, and in harmony with other built and natural elements around the site. The consequent material option for the system was to use wood; especially since the Serlachius Museum was built mainly out of wood, from structure to finishing

3.1.1 Fabrication possibilities for the system "more than a railing".

The system was studied through a digital model, but those diagrammatic schemes were intended to be indicative and not definitive. When modeling those, it was already assumed that the system "more than a railing" would be manually crafted, taking advantage of the local Scandinavian tradition of working with wood. (fig.8)

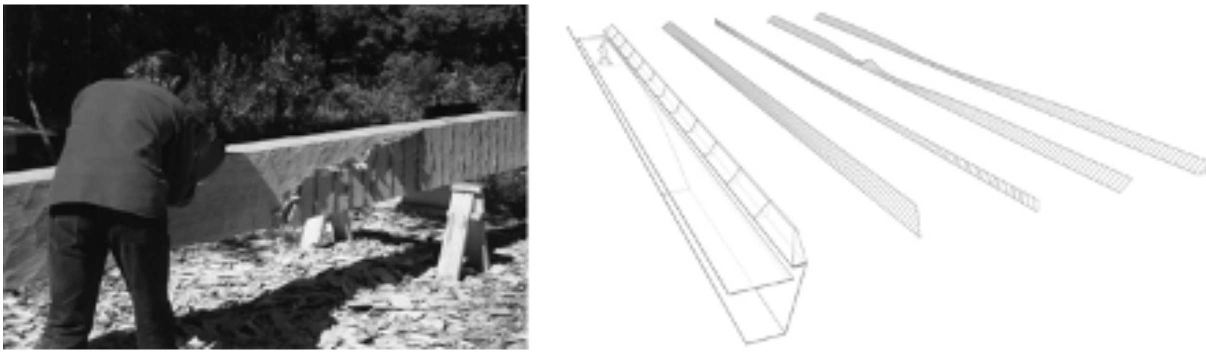

Fig. 8 Traditional hand hewing process and digital study models of the system more than railing. Courtesy of Mendoza Partida architectural studio

It was proposed to hand hew solid Siberian larch logs. It is a traditional process in Nordic cultures, and conceptually it was chosen to give logs an uneven surface as a reminiscence of the hand-made boards from earlier time exposing a higher contrast with the complex and updated geometry.
Local engineers suggested that, due to weather affection on material durability, it was preferred to use glue laminated timber instead of solid logs. Project solution pushed towards two 22m long pieces with a small joint in the middle since material expansions will happen at both ends. (3) Those glulam pieces would come with a continuous section which subsequently would be modified and hewn by hand.
After consulting with engineers, this hypothesis was confronted with contractors and real construction cost and time issues. It was clear for them that the manual or artisan fabrication, originally proposed, was possible, but they offered to sculpt the wood with digital control cutters (5 axes CNC) in favor of saving production time, and reducing the cost to one third of the price for the handcraft process. It was a relevant gain for the client that the project, without compromising the main idea, had to change it description towards a finer and more detailed process.
The non-definite digital model, used originally to explore the geometry and function of shape, was slightly modified in order to transform it in to instrumental object file to control the CNC router. Instead of two long segments, the "more than railing" system was adjusted to smaller divisions in order to fit the cnc milling table that local producer provided.

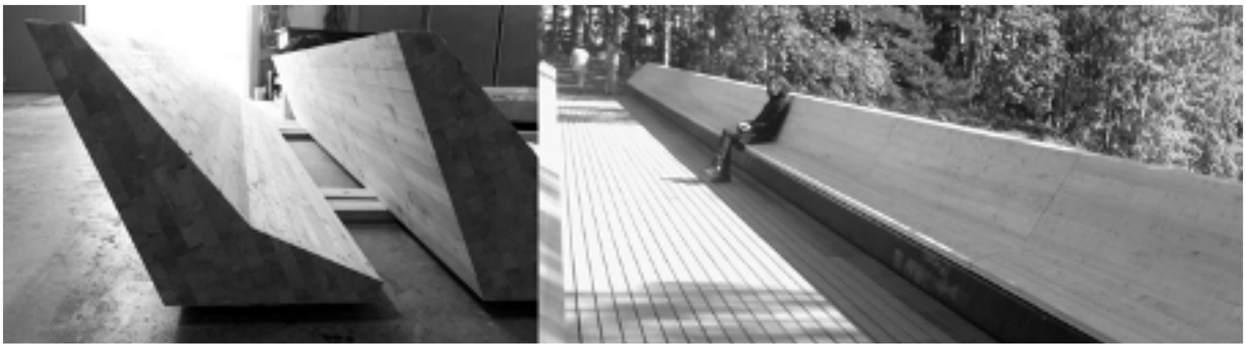

Fig.9 Pieces of the Digitally modeled system 'more than a railing' digitally fabricated with larch wood gluelam CNC milled. Detail of the Gösta Bridge.

4 CONCLUSION

From the practice of our discipline, this paper works as a record of the path that a design process takes once a spatial idea is visualized, modeled and modified in order to achieve the most coherent fabrication solution. Both examples show how a material solution, despite its conceptual coherence, is subject to change once is confronted to realization.

Digital fabrication technology, in some contexts like Finland, where manual construction price is high, is offered as an alternative to save cost and time in the materialization process. In other contexts, like in Latin America, digital fabrication has an elevated cost in relation with what is possible to achieve manually. Each of those cases, without compromising their own essence, had a drift in the method and changed from traditional to digital fabrication and vice-versa.

Héctor Mendoza & Mara Partida, march 2015

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NOTES

(1) Corian Specialists that offer customized solutions for complex fabrications; 3 axis and 5 axis CNC, thermoform in 3D, with experience in consulting contemporary architects. Cutting Edge. The Corian Specialists (n.d) Retrieved January 10, 2014, from http://www.cuttingedge-uk.com/corian.htm

(2) The complete fabrication process of this model has been summarize in a video document, and could be seen at: http://youtu.be/tH__AUxugvo

(3) Gösta bridge total length is 48 m. Railing total length is 44m. Two 22m long pieces allow playing with a small seam on the central part of the bridge in order to push larger material expansion towards the ends

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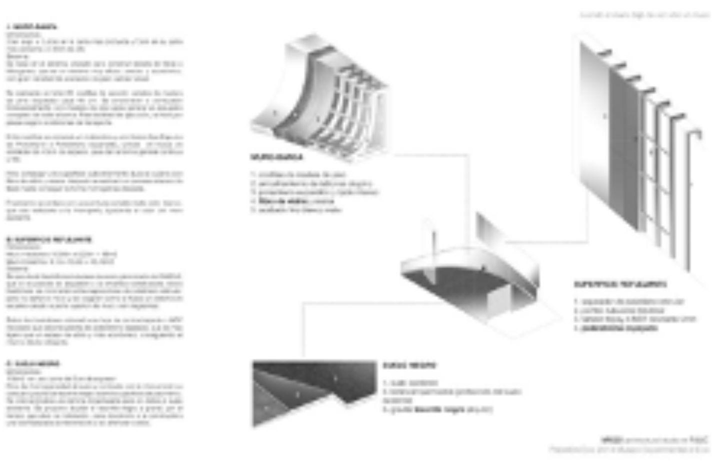

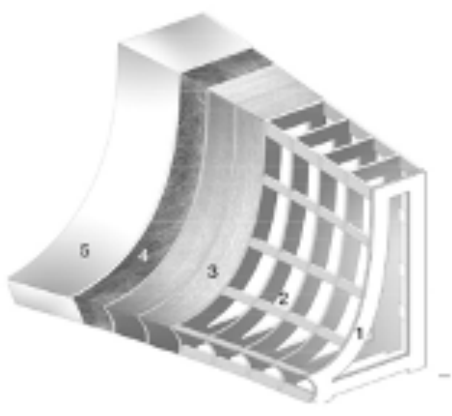

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