CRAFTING NEW ARTEFACTS

Expressing the changing condition of nature, culture and technology

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Abstract. The craft of complex artefacts, questioning technological changes and reflecting social and cultural transformation used to be a common attitude in traditional artisans of the pre industrialized society. Traditional craftsman developed special knowledge and skills, implementing their own tools and techniques. After the industrial revolution, the main focus shifted to mass production, and the personalization of artefacts became labour intensive and more expensive. Simultaneously, with technical specialization and the fragmentation of knowledge, the designer's, builder's and manufacturer's approach became more segregated. Currently, information technologies offer new opportunities to the craft of complex objects. The integration of digital process from conception to fabrication, can transform this situation, and as a result personalization is more affordable. Nevertheless, the introduction of these new techniques or tools is lacking a poetic synthesis for the use of technology, and the social and cultural implications that may result of this use. A competition for a public installation was an opportunity to use digital tools to conceive, manufacture and construct a complex structure with a small budget that would be impossible to attain using only traditional tools. At the same time, this project - genetic landscape- could be seen as a metaphor, alluding to the technological interference on the process of creating a new life, or a second nature.

Keywords: expanding traditional tools; digital craft; complex geometry built-case.

Figure 1. Genetic Landscape - Assembling of the structure in Emo Court, Port Laois (Ireland).

1. Theoretical framework and design context

For the scope of this paper it would be important to set a theoretical framework for the use of the term *genetic landscape*, and the circumstances that surrounded the proposal and the process used for the development.

The concept "Genetic Architecture" is attributed to Alberto Estévez, who described and summarized the term, referring to the manipulation of the genetic information in matter to produce a living architectural creation - altering certain characteristics to produce a desirable construction by means of technologic bio-informatics (Estévez, 2000). The beginning of its application is essentially an economic factor once we decoded the human genome and began the manipulation of genetic information. Building with living materials, like flesh and bones, can raise some ethic concerns from witch we should be aware, but is technically plausible.

Presently, in architecture, the application of genetics is not literal yet; nature and material systems are also being investigated regarding the process of grow and transformation (of information). It is possible to establish a close relation between working with artificial software, and with DNA in the sense that both work with chains of information, generating self-production and growth.

The project Genetic Landscape was a response to an international landscape competition under the theme "roots – gardens that evoke a sense of belonging", and develop a process relating environment and material conditions, from witch form emerged. The starting point was a given plot with a pre-defined elipsóide shape (Figure 2), with 21x10m with an available area of 185sqm, and a brief with general regulations for the construction and use of the space. The term genetic was used regarding the manipulation of a set of conditions, encoded in the generation and used in the fabrication, in a digital continuum. Nature was overlooked as a form of computation.

The process used affected the final solution: there was an open process of becoming instead of an ideal or predefined form, interior and exterior, object and subject where though without a clear distinction or outline in the landscape. The environment was overlooked as a continuum of forces inscribed in the ground- that doesn't implies literal movement but animism - where the memory of formation is present (Lynn, 1999).

Bernard Cache alludes to the virtual capacity of a folding surface, in his inspirational book earth moves: the furnishing of territories questioning the relation between interior (furniture) and exterior (geography) - as the interior is only a selected exterior, and the exterior a projected interior - This represents a shift from the problematic of representation, to a problematic of space and movement, approaching a more topological thinking (Delanda, 2002).

As a literal genetic artefact is yet to come, this proposal uses a metaphor to express and communicate a concept to the general public. As noted by Gaston Bachelard the metaphor, and the integrity of image associated with it, can be useful for science to refer to something that has not yet been discovered. As a garden, the project incorporates living elements associated with an artificial structure resulting in the fusion of both elements - no longer clearly distinct - alluding to the hybridisation happening with the biotechnological revolution. The use of vegetation, grass in the exterior and red vegetation with stones in the center (that could be interpreted as seeds), intents to add symbolic value to this installation with an expressive language, differing from pure imitation or mimic of nature.

The trial and error development of the structure, in a non-linear CAD-CAM chain, searched a sustainable solution: as low-priced, light, resistant and easy to assemble and transport as possible, maintaining the overall intents. This economy of means - material ecology - presented in the project is also something that is very present in the biological world of nature where form is produced with the minimum substance required, and thus is a consequence of material optimisation.

2. Generative conception

This project proposed to develop a topological continuous surface as a result of a negotiation process between internal forces of material and external forces, like the human skin folding and wrinkling.

To accomplish this, a virtual environment with forces fields was generated in animation software (Henriques, 2007) - 3dmax - previously used in entertainment industries (like cinema and video games). Defining the initial and final values of the forces in space and in time – using pre defined spacewarp forces like displace - the program interpolates these values and creates intermediate steps, in an approach that favours an immersive exploration, without recurring directly to the use of programming tools.

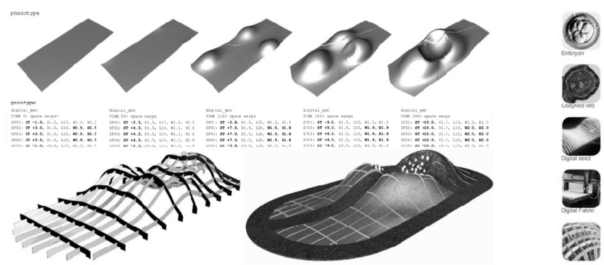

Figure 2. Generative concept – a force warping like the human skin. Defining the values of the forces they inscribe in the surface, that is translated and materialized through digifab

The internal forces of the surface were attributed by different parameters to an initial nurbs surface assuring topological continuity while the external forces that represent pathways and contextual data were changing in value and position, folding the surface. To define their location and intensity different variation were tested. The final fitness of the solution was set regarding the limits of the material, the desirable slope of the access paths and the physical boundaries of the available site. Manipulating these factors helped create a formation that could not be clearly outlined from outside, favouring an "introspective" exterior space, and setting a scale that would allow interpretations by the user through vicarious experience.

The shifting values of forces modulated the surface, in an indirect, or bottom-up, manipulation. Like in an artificial selection, a single moment of the form was chosen in an evolutionary design process. The forces applied constitute a generative code -genotype - that became a physical reality after the assignment of material- resulting in a phenotype - in an analogy to natural biological systems. The properties assigned to the final construction, in a trial and error approach, enabled the structure to become a tangible reality.

Other research approaches utilize genetic algorithms, imported from genetic engineering to find a solution for a problem. This was not suitable here and a more experimental approach was used, favouring a more intuitive search. Doing so research is not limited to a specialized knowledge that is familiar only to a certain number of specialists but is more related with a technique, rich enough to produce a family of solutions that could not be configured in advance, and would be difficult to attain with traditional tools. While this choice would not lead to direct scientific results, it doesn't limit the selected factors and their interrelation in a potentially deterministic way. Architects like Greg Lynn, François Roche and Bernard Franken, among others, could be overlooked in some projects as an example of giving primacy to the use of technique over a technological specialized knowledge.

3. Material development

This project, included in a competition proposal for an installation, was constrained by time, space, and budget restrictions, as well as by security requirements.

To materialize this double curved surface a wood structure was incorporated. The system extrapolates the internal forces and singularities of form, and in this sense, the original forces were embedded in the final solution through material exploration. An expedite constructive logic by components was developed, in an integrated CAD-CAM process, regarding the geometrical singularities and inherent characteristics of the form, physical boundaries of materials, fabrication, transportation and final construction.

Like topography, part of the structure was covered with soil and different vegetation, defining different areas and thus emphasizing the natural/artificial ambiguity of this construction, a metaphor of the changing times in which we are living.

After the digital model was developed, some scale models were built for evaluation purposes. A prototype was fabricated using a CNC laser machine, with 50x20x7 cm (scale 1/20). This model, although very light (with only some hundred grams) and with narrow sections (only half millimetre thick) was good for testing the connections between the transversal and longitudinal beams, which used a simple assemblage connection to increase the rigidity of the structure. As a result of this test, an external ring to close the structure was introduced in the design.

The chosen material for this structure, due to the limited life span, was a waterproof MDF alloy (medium density fibber board). Waterproofing was important to assure dimensional stability due to the ship transportation and to guarantee the required durability for a three-month installation.

To optimise the structure, a system of nine longitudinal and seven transversal beams was used, thereby obtaining an average span of 1.5x0.5 m. The final dimensions of the wooden boards were 1.9 cm thick and 30 cm height. These dimensions were the result of an empirical fine-tuning process that tried to balance material resistance with the overall weight, using a series of prototypes.

It was not desired, neither feasible, to build the beams in single pieces. The dimension of the standard board was used as reference to divide them. The connection between the different parts of each beam used a combination of an assemblage process and additional screwed bars, to give additional rigidity, thereby overcoming the transverse moments.

Initially, the joints between the different parts of each beam were not to be visible. For this reason, it was avoided the use of complex join systems like dovetail connections, hidden connection, or dowel joints, which would imply a longer construction time and the recourse to specialists for the assemblage.

The digital process enabled to design and to label (number) all the different parts that were fabricated and cut using a cnc-milling machine. The final non-standard structure with the dimensions of 19 x 8 x 2.5 meters has 164 different parts, with more than 300 connections, all using the same system. To obtain the same result using traditional technology would have been nearly impossible, given time and budget constraints, as well as technical difficulties involved in the individual production of each part that such a process would require. The structure was fabricated and pre-assembled in factory before it was transported to the site. The fabrication process took approximately two weeks, the pre-assemblage took 2 days, and an additional day was necessary to disassemble and pack everything.

4. Transportation and local assemblage

The final structure weight was approximately 850 Kg and it was possible to transport it in two pallets of 2.50 x 1.35 x 1.00 m. The organizers of the event where surprised with the small dimension of the packages, almost like an Ikea packed furniture. The personal presence of the author in Ireland assured the coordination of the assemblage process of this structure, which immediately caught the attention of construction workers and staff.

The Pre-assemblage required good levelling and a rigorous setting of the ground and the site limits to avoid additional stress on the structure. It was also necessary to find out the best constructive sequence, to give progressive consistency to the structure while it was being assembled, which would have been very difficult to fully test on the computer.

The material has some hidden data that could only be revealed in a confrontation digital/material. These data advised a particular sequence of assemblage, starting from the lower part of structure, gathering and positioning the first pairs of the transversal section, and then assembling them with the first longitudinal rows (also aggregated in pairs of two). The first connections were important to assure the right direction of the structure by adjusting the angles between them. With this process of placing alternate pairs of beams in different directions, the structure gained increased strength and stability until the highest parts were placed and the structure was completed. A local engineering team proposed instead, starting from the highest part to allow earth to be placed while the structure was being built. However, by doing so it would have been difficult to assemble and hold the first parts without using a crane and additional supports, as well as to guarantee an adequate direction and the correct angles between the beams – which could place additional stress on the structure and risk collapsing during assemblage. Therefore, it was decided to follow the building sequence proposed at the outset, which had already been tested with success. As a result, construction was terminated in one day and a half, using three workers at the site.

After the structure was finished, it was partially filled with earth and nutrients, and this work took one day more, as foreseen in the initial budget. The final vegetal surface was accomplished with the help of specialists, and it was used to emphasize the designed object. In the “guts of this monstrous creature” there were placed rolled white stones amidst red foliage - in what could be understood as the seeds of this organism, genetically modified by us. The different materials were used to emphasize the threshold natural/artificial.

Figure 3. Photos from the assembling process in place.

5. Results

The pairs’ time/cost and quality/scope were balanced with success in Genetic Landscape, thereby defying the traditional manufacturing process that relies on standard components. The proposed alternative process benefited from know-how gathering in previous projects and from important feedback on the behalf of the different participants in the project, linking the production chain and favouring accuracy of the final construction.

Using traditional techniques, this structure with 20 x 8 m, and more than 160 unique components and 300 joints, would have been difficult to design and expensive to build. Only by integrating the entire process using digital technologies, it was possible to attain this complex and personalized installation, bred in a digital laboratory, executed and pre-assembled in factory, transported and built in a very short period of time, and kept the low pre-established budget.

The installation was concluded with success, in a fast and rigorous execution of the idealized form. Aesthetically, the structure could be more expressive or architecturally interesting – without being covered (even though partially) with soil and vegetation – but this solution could limit the usability of the garden and bring security problems. Nevertheless, even not consciously, the partial covering of the structure with vegetation can relate this installation to some of the Celtic landmarks that settled and organized human and natural space in Ireland (and in vast parts of Europe), and that now some land art movements tend to return to.

Figure 4 : Final installation – appears like a “Land Art” camouflaged at Emo Court Gardens. Suddenly a path can be revealed to enter the guts of this hybrid creature.

5. Conclusion

Can technology expand creativity? The way we think and built, and the tools we use for both, are related to our cultural context and education. Depending on the degree of knowledge we acquire, tools can expand or constrain our capacities. In the beginning of the 80’s, the computer started being used in architecture, mainly as a substitute for labour work. The use of computer assisted design (CAD), particularly Auto-cad, led to a visible common pattern in the presented solutions. This is an example of how the use of technology in an earlier stage limited design capacities. Nowadays, these tools and their abilities have improved, and we can now see more complex curvatures, and that is related with the development of the *nurbs* curves (non-uniform-b-splines).

The craft production, in its most successful approaches, strives for a continuous improvement, of thinking and making, as the apprentice develops his own tools. This learning process is influenced by local conditions and universal values; in other words, tradition and innovation represent two different sides of a dual phenomenon. In this project, genetic landscape, technology is recognized also in this dual aspect, as concept and technique. While manipulating the animation tools, there was an idea of how to build this form. The development of the idea evolved on several stages. In other words, technology was used in an inclusive way and is not only regarded as an expression of economic power. This happens, for example in "high-tech" architecture, where the relation with more archaic values is missing. Without a global vision of the production process, integrated development of material and constructive options, assemblage system and joints strategy or transportation method, this project could not have been achieved.

In this case study both conception and construction limitations were overcome, evoking a virtual genetic creature yet to come. The implementation of ideas and abilities, expressing a cultural interpretation of the world, produces newborn artefacts. Metaphorically speaking, as wizard apprentices, we are developing our own tools and building a new race of crafts, Frankenstein beings and genetic landscapes.

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