Reinventing Design-Build projects with the use of digital media for design and construction

A survey of 120 educational pavilions

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During the last decade the hype for digitally fabricated educational pavilions has become very popular among architecture schools. A survey with the aim to catalogue and classify educational pavilions revealed more than 120 cases of digitally fabricated pavilions within the last decade. The analysis of the sample of 120 Design-Build projects built during the period 2006-2016 revealed, apart from obvious similarities and differences, the prevailing trends relating to the materials and the technology used for the design, manufacturing and assembly. From the processing of the gathered data a set of typologies emerge, which relate both to morphological characteristics as well as to the design process. The paper concludes by discussing the advantages and critical points of this educational practice and the learning outcomes for both students and educators.

Keywords: Design-Build, Digital fabrication, architectural education, CAD / CAM, pavilions

INTRODUCTION AND PRECEDENTS
Throughout the history or architecture, architectural education had always been one step ahead of the actual praxis with regards to innovation. This is common in several disciplines, as education often deals with experimental methods and innovative practices in order to “create” new knowledge that will later on be adopted by the industry. It is not easy to trace the developments in architectural education, it has always followed several different paths, relating to a range of pedagogical methods, the technological developments, political conditions, the philosophical background and the avant-garde design explorations of the time.

Many researchers agree that introducing new forms of pedagogy in architecture have become a necessity and that architectural education needs to change (Buchanan, 2012; Colomina et al., 2012; Nicol and Pilling, 2000; Salama, 2013). Among them Buchanan considers apprenticeship as an effective way to teach design, referring to the observation of the master to learn the skills of the discipline (Buchanan, 2012). At the same time, digital technologies have changed the nature of architecture and this was inevitably reflected in architectural education. “Educators in engineering schools are experiencing a new pressure to change the way they teach design-related courses in order to equip their students to interact with CAD/
CAM/CAE systems and have a knowledge of their fundamental principles” (Lee, 1999). In this realm, reinventing the well-established tradition of Design-Build projects with the use of digital media for design and construction, appears to be an effective way to blend new technologies with traditional apprenticeship and craftsmanship.

One of the problems that have been identified is that the current generation of architecture students, which are digital natives are taught by digital immigrants. The rush to engage with digital media was further accelerated by the market needs and the digital culture in general. Within this transition phase several educational experiments have taken place, we would however need to discuss those from a pedagogical point of view and relate to learning theories, to evaluate them as source of knowledge. Focusing on digital media in particular, schools across Europe have already gone through several years of experimentation with digitally fabricated Design-Build projects, some of which have proven to be particularly useful for the advancement of education and architecture in general (Figure 1).

Since the early years of architectural education, the design studio has always been the space where the creative work takes place. This is common in the professional and the educational world and it is usually a flexible place for production, model making, drawings, and technology hub, currently enriched with both analogue and digital media. A design studio has its own culture of research by making, experimentation and testing of ideas. “Historically the link between a drawing and the execution of that drawing on site, were much closer and time and place than they are today. A mason might mark out the design on a piece of stone immediately prior to cutting it directly on site. The design studio has evolved as a place that enables design to be developed both far away and far in advance of its actual implementation” (Anderson, 2010). This separation has both advantages and disadvantages. On one hand it gives the opportunity to consider the coherence of the whole scheme prior to construction (Anderson, 2010), on the other hand it broadens the gap between what is designed and what is constructed due to a variety of reasons that relates to the transfer of information, the feasibility and technical competences among others. Current developments, particularly the use of CAD-CAM in a so-called file-to-factory continuum (Oosterhuis et al., 2004) tend to minimize this gap, offering the possibility for a seamless transfer of information and a better overview of the entire process. This is better understood through Design-Build projects, as the student has the opportunity to actively participate in the entire workflow, from design to construction. The practice of design-Build projects is not a new concept in architectural education, it dates back to the previous centuries, emerging from the holistic approach introduced by the Ecole De Beaux Arts in mid-1600, moving on to the BAUHAUS model as an iconic example of practice based education, further evolving through Buckminster Fuller’s domes and the radical experiments of the 60s and 70s (Colomina et al., 2012).

During the last two decades, with the emergence of digital tools, the hype for digitally fabricated student pavilions has been further boosted by Avantgarde architecture schools, such as the Architectural Association in London, the ETH in Zurich and the ICD in Stuttgart and it has been propagated at light speed across the globe. This new trend has been boosted by the introduction of new media in the architectural practice (CAD/CAM) and the culture of open
source code across disciplines. In addition to that, there are numerous reasons that facilitated this surprisingly fast diffusion of ideas and practices, among which we can undoubtedly identify the sharing of information through the web, the social media and the internet of things. Within the scope if this paper, educational pavilions are considered as vehicles of innovation, they are at the same time artefacts as well as experiments that test out new ideas in both education and praxis.

**DESIGNING AND CONSTRUCTING PAVILIONS**

As two of protagonists of this trend and authors of the book “Making Pavilions” explain, the premise of a temporary, sponsored, architecturally experimental London summer event pavilion was inspired by the Serpentine Gallery (Self and Walker, 2010). The main concept is to test architectural ideas through making. One of the reasons that led to the survey on Design-Build projects is the necessity to identify current trends in contemporary architectural education, understand the modus operandi of contemporary Design-Build projects, compare their morphological characteristics and reflect on the technology used to design and construct them.

More specifically, and within the particular realm of architectural education, Brett Steele, director of the Architectural Association in London, alludes to the common belief that “architecture is only ever learned by getting your hands dirty” (Self and Walker, 2010). He explains that this is done through the construction of physical prototypes, 1:1 models, whose “working difficulties and eventual results offer the designers vital insight and understanding into how they take a next tentative step forward”.

The hype for digitally fabricated pavilions, coincides with the broad use of internet, the emergence of open source tools and ideas and is in line with the global rise of the MAKER movement which in turn touches upon well established educational concepts. The MAKER movement praises the virtues of constructionism propagating the idea of learning by making. This is in line with the ideas of Montessori about acquiring knowledge, “He does it with his hands, by experience, first in play and then through work. The hands are the instruments of man’s intelligence” (Montessori and Chattin-McNichols, 1995). Beatriz Colomina. Professor of Architecture at Princeton, affirms that it is pedagogically useful to take people outside the design studio, and to actually “produce media” in the form of a prototype, a publication, and exhibition. The actual production is a pedagogical approach, the model of the isolated scholar within the boundaries of the university lab is deemed inadequate in our times, architectural research calls for a collaborative and interdisciplinary environment.

Design-Build educational experiments aspire to offer multiple learning opportunities, they encourage the shift from passive listening to active learning, with the aim to produce new knowledge through active engagement in a broad spectrum of mental and physical activities. The design and building of a pavilion is a participatory exercise rejecting the role of an architect as solitary genius, and encouraging the contemporary idea of collaborator. In his book Learning by Building (Carpenter, 1997) the author William Carpenter highlights the importance of craft in architectural education. He claims that this type of experiences inspire architects and artists to see construction as a creative act, drawing upon examples from the work of renowned artists such as Richard Serra and Donald Judd and presents case studies of Design-Build experiments at Universities of Oregon, Washington, Michigan, Cranbrook and Yale.

This research has catalogued and classified Design-Build projects of the last decade with the aim to understand the modus operandi of both the design and production process as well as the educational aspect of teaching architectural technology through full scale constructions. The survey reports on the type of pavilion, the school were the design and construction took place, the location where it was built, the duration of the construction, the year it was built, the materials used, the technology that has been used for the design, manufacturing and assembly (Figure 2).
COLLECTION AND ANALYSIS OF THE DATA

The data was gathered through different sources and media, including bibliography, conference papers, websites and blogs, complemented with site visits, interviews and documentations. The pavilions are grouped according to geographic location, chronology, materials used, CAD/CAE/CAM tools employed. The classification and analysis of the 120 samples offers an overview on main trends. The taxonomies of Design-Build pavilions mainly relate to the construction method or governing formal principle. It is clearly seen that both the design as well as the construction highly relate to the digital media that has been used for the design, engineering and manufacturing.

According to the obtained data, the school that produced the biggest quantity of pavilions during the last decade is the Architectural Association, counting more than 20 full scale pavilions in the last decade. This is easily understood by the entire school’s tradition, the machinery and equipment at Hooke Park as well as the experimental nature of the school’s curriculum. Following the AA, ETH Zurich, ICD/ITKE in Stuttgart are pioneering in the construction of pavilions. Among the runners-up are the University of Tokyo, Columbia University, MIT and TU Darmstadt. According to the data gathered, most of the pavilions were built as temporary installations, some of them were relocated and very few of them were designed to be permanent structures.

The materials used for the construction of pavilions are displayed in the following chart (Table 1). It is seen, that the most usually encountered material is timber and this may be explained by a variety of reasons. Timber is an ecological material that is easily

Table 1
Materials used in the construction of Design-Build projects
available in most countries and relatively cheap in comparison to other materials. There is a huge body of knowledge on wood processing, therefore, there are great resources, equipments and processes that the students may use for the fabrication of pavilions. On top of that, timber is a soft material that can easily be processed by CNC milling machines as well as by manual mills and routers. Timber is relatively light and easy to carry and assemble and there is a huge variety of different qualities, ranging from raw material, to plywood, laminates and composites. The material properties of wood with regards to deformation, stiffness and tolerances renders it as a great material for design experimentation.

The great majority of these constructions are designed as an assembly of components (Table 2). This may be explained by the fact that the fabrication laboratories (fab labs) in the universities have a capacity of a determined, relatively small cutting and printing area, and the sizes are constrained by the available equipment. The modular elements are usually differentiated to respond to design requirements, while being in line with the global fashion in architecture, the parametric variation and differentiation of component based systems. The component logic also relates to the assembly process, which in the majority of cases is done manually by the students without making use of industrial equipment such as cranes.

There is a certain level of prefabrication before the final assembly. “In these non-standard constructions we can easily identify two main trends (Figure 3): a) Differentiated components, displaying mass customization at component level, which have a standard method of assembly, b) Standardised components that explore new assembly methods, ie non standard placement of the material with the use of robots. Both approaches obviously relate to the parametric processes of initial form generation and the possible differentiation induced in different scales, at component or assembly level” (Symeonidou, 2014).

The Design Media used are primordially parametric CAD systems providing an easy link from design to construction, a seamless connection of media from design to production in a “File To Factory Continuum” (f2f). The materials used for the construction of pavilions show a clear preference for timber (more than 50% of the examine cases). Being a relatively cheap, environmentally friendly material that is easily available in most countries together with the abundance of knowledge on wood processing, makes timber an ideal material for the fabrication of pavilions. On top of that, timber is a soft material that can easily be processed by CNC milling machines as well as by manual mills and routers. It is relatively light and easy to carry and assemble and there is a huge variety of different qualities, ranging from raw material, to plywood, laminates and composites. The material properties of wood with regards to deformation, stiffness and tolerances renders it as a great material for design experimentation.

The manufacturing technologies used for the construction of components are displayed in charts (Table 3). We can observe that more than half of the pavilions were constructed using CNC milling machines for cutting, and these are usually combined to several processes such as bending, folding, form-
ing, sectioning, interlocking, several of which are also identified by Iwamoto in the book “Digital Fabrications” (Iwamoto, 2009). The type of processing relates to the morphology of the pavilion. Based on that the survey revealed 18 distinct taxonomies: Folding, Bending, Shell, Cellular, Reciprocal, Sectioning, Stacking, Cladding, Tensile & Tensegrities, Layered, Intersecting, Weaving, Aggregate, Suspended, Pneumatic, Branching, Lattice (Table 4).

The connectors used to assemble components are also seen as an important design feature, and usually very indicative of the innovative character of the design, the hierarchical levels of sophistication as well as the materials used for the pavilion. It has been observed that the majority of pavilions employ conventional connection strategies, such as steel bolts or cable ties. However in few occasions there is a great level of inventiveness and innovative design thinking with regards to the way each component is connected to one another.

### Table 3
Manufacturing technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNC milling</td>
<td>5%</td>
</tr>
<tr>
<td>Manual</td>
<td>9%</td>
</tr>
<tr>
<td>Robotics</td>
<td>1%</td>
</tr>
<tr>
<td>Laser cutter</td>
<td>2%</td>
</tr>
<tr>
<td>CNC milling and forming/molding</td>
<td>3%</td>
</tr>
<tr>
<td>Standard elements</td>
<td>10%</td>
</tr>
<tr>
<td>Mould forming</td>
<td>10%</td>
</tr>
<tr>
<td>Steam bending</td>
<td>4%</td>
</tr>
<tr>
<td>3D scanning &amp; robotic milling</td>
<td>5%</td>
</tr>
<tr>
<td>Biological printer</td>
<td>2%</td>
</tr>
</tbody>
</table>

### Table 4
Types of pavilions

<table>
<thead>
<tr>
<th>Pavilion Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folding</td>
<td>18%</td>
</tr>
<tr>
<td>Bending</td>
<td>3%</td>
</tr>
<tr>
<td>Shell</td>
<td>3%</td>
</tr>
<tr>
<td>Cellular</td>
<td>3%</td>
</tr>
<tr>
<td>Reciprocal</td>
<td>2%</td>
</tr>
<tr>
<td>Sectioning</td>
<td>2%</td>
</tr>
<tr>
<td>Stacking</td>
<td>2%</td>
</tr>
<tr>
<td>Cladding - laminate</td>
<td>2%</td>
</tr>
<tr>
<td>Tensile - Tensegrity</td>
<td>2%</td>
</tr>
<tr>
<td>Overlapping - layered</td>
<td>2%</td>
</tr>
<tr>
<td>Intersecting - Waffle</td>
<td>2%</td>
</tr>
<tr>
<td>Weaving</td>
<td>2%</td>
</tr>
<tr>
<td>Aggregate</td>
<td>2%</td>
</tr>
<tr>
<td>Suspended</td>
<td>2%</td>
</tr>
<tr>
<td>Pneumatic</td>
<td>2%</td>
</tr>
<tr>
<td>Branching</td>
<td>2%</td>
</tr>
<tr>
<td>Lattice</td>
<td>2%</td>
</tr>
<tr>
<td>Seeding</td>
<td>2%</td>
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### CONCLUDING REMARKS ON MAKING PAVILIONS AND LEARNING OUTCOMES

The scaling up of a model is a very complex exercise. Even if a model seems to function in a 1:10 scale, the full-scale model would require a thousand times the material volume, considering x y z dimensions (10 x 10 x 10). This is also one of the reasons why 3D printed models would not easily scale up without changing fabrication strategy, as it would require 1000 times the amount of material and fabrication time of a 1:10 prototype. Scheurer, one of the founders of the Swiss firm Design to Production explains that “methods that create complex form from homogenous materials are very convenient and simple to use on a model scale, but when naively applied at full architectural scale, they inevitably and very quickly reach a point where they lead to both very inefficient production processes and overly massive structures” (Kolarevic and Klinger, 2008). Therefore component based structures are in the majority of cases the way to go, for designing and fabricating a 1:1 structure within an educational context. Architecture has been traditionally built from components and diverse building elements standardized in the course of the years to particular shapes and sizes that emerged from the market demand in the building industry. The established standardized elements have in a sense been optimized for a particular use and construction strategy. However non-standard architecture evidently requires non-standard components, and it is within this new emerging field of innovative architecture where most educational experiments take place.

In the majority of the projects, emphasis is given on the surface, both with regards to design as well as to fabrication. How a surface is manipulated, controlled, divided, connected to other surfaces, machined and assembled is a key concept. As Brett Steel remarks, this “is not a coincidence, nor some kind of imaginary, epistemological imperative. We must remember that nearly every aspect of projects like these is being driven by software that is entirely surface-oriented in its underlying mathematics, the
very same surface mathematics that are, of course, now also being utilized in the machines, making possible new output technologies, such as 3D printing, milling or laser-cutting” (Kolarevic and Klinger, 2008). Therefore the form and fabrication strategy is closely related to the technology employed for the design and construction.

Though there are several publications, videos and online material that explain the design and construction process, very little has been said or written about the difficulties faced and the mistakes that occurred during the process from design to construction. The survey, was complemented by discussions and interviews that focused on the design process, the educational strategy and most importantly the difficulties and mistakes that occurred which are not usually documented in publications or other media. In such processes, mistakes are seen as a vehicle for further exploration, trial and error is a common routine in an experimental set-up, therefore they are not to be seen as a negative result in an exploratory design process, rather as an indication for further investigation of one particular aspect. From an educational point of view, it is important to reflect upon the process; the aim is not simply to construct an artefact, but to learn from the limitations and mistakes, seek alternatives and evaluate every decision in relation to feasibility, time and cost. Only experience that is reflected upon can yield new knowledge, according to Kolb, “Learning is the process whereby knowledge is created through the transformation of experience” (Kolb, 1984).

In the majority of projects practical issues of fabrication and assembly, reconfirmed the educational aspect of mistakes and the importance of teamwork in problem solving among others. As it was also confirmed through the interviews, decisions taken at each stage highly depend on the available time and resources. From the examples discussed here, it has been seen that not all difficulties can be anticipated and several problems have to be solved on the spot. However the difficulties that are faced in certain circumstances, always serve as prior experience for future projects, and this is where the role of the educator becomes crucial. The effectiveness of learning through mistakes, lies in the fact that one has to realize the reasons in order to provide a solution. This is an amazing opportunity for students to reflect-in-action (Schön, 1990, 1985) and learn through making. This realization is in line with Kolb’s experiential learning model, where critical reflection leads to new decisions (Kolb, 1984).

Evaluating the Design-Build projects, it is understood that construction experiments are of incredibly high educational value as the “explicit knowledge that is only achievable through physical making is made communicable and reproducible through a process of reflection” (Geissbühler, 2014). The software used and the digital fabrication strategies have a direct repercussion on the constructed object. However, after the initial fascination with the medium, students tend to seek methods to twist and tweak the established methods, thus producing new knowledge. In turn, the additive or subtractive methods of manufacturing play a crucial role in the design process, defining the necessary steps for a file to factory continuum.

By trying things out physically, an architectural idea can be easily classified according to the engineering expression “it works” or “it doesn’t work”. This no matter how acid it sounds, it does indicate whether something can be constructed and be functional. According to Charles Walker, the physical act of “making things” has two important aspects, that relate to the pedagogical approach of learning by doing (Self and Walker, 2010).

- The actual construction offers a “profound sense of accomplishment when finished” which is a very central part of most educational processes. There is a direct feedback on the work produced, it involves critical thinking, self-assessment and self-motivation and reward.
The possibility of “craft”, meaning the refinement and modifications that are made through “physical and repetitive engagement with the specific material itself”

Since the introduction of computers and CAD software for drafting, the actual interaction with materials, has been practically lost, or limited to exclusive detailing when an architectural object falls outside the range of standardized detailing. Walker explains that “true craft in construction can only be achieved through physical labor that leads to a deeper and more sophisticated understanding of what it means to build, as opposed to what it means to draw or to speculate” (Self and Walker, 2010).

Within the collaborative design processes that are employed for the design and fabrication of Design-Build projects, models and prototypes are both design tools as well as presentation tools. They are media for presenting an idea, but also experiments for material performance or assembly sequence. They investigate tangible and qualitative characteristics that cannot be evaluated on the computer screen. While digital models prove effective with handling numbers, forces, physical simulations and other quantitative data, built prototypes offer themselves as means for evaluating qualitative data. Materiality and tactility can only be experienced by constructing an artifact. Thus the combination and convergence of analogue and digital media supports the school of thought of Learning by making.

Design-Build projects provide a very fertile ground for teaching construction, innovation and inventiveness. The immediacy of gaining feedback from fabricated prototypes through assembly and testing of both components and nodes, is a great asset. In agreement with the doctrines of problem-based learning, students are able to assess the structural performance of the artefact locally and globally, and thus pinpoint optimized node solutions, both with regards to functionality and material resistance, as well as considering construction logics and assembly sequence.

Jason Griffiths in his paper for the EAAE-ARCC Conference in 2008 suggests that “digital fabrication in architecture can be roughly categorized in two ways: Those that we can use today and those that we cannot” (Griffiths, 2008). Educational construction experiments prove to aliment both categories, as they are driven by the desire to innovate and educate. With Design-Build projects students gain an experiential understanding of architectural structures, they train their intuition to understand material limits, as for example the breaking limit of a wooden component. This knowledge implicitly or explicitly is fed into their future designs.

An important aspect among the learning outcomes is the collaboration among student groups as well as between students and external consultants or industrial partners. This requires a clear distribution of tasks in the form of construction-management which emerges naturally within the group. At the same time, as these activities are rather intensive within a small amount of time, it has been very often highlighted by the educators, that construction experiments have been a good team building exercise and have helped students to develop the capacity to work under stress in a team environment. Moreover, these projects are characterized by high motivation in students, as there is tangible feedback of their work and satisfaction with the constructed result. The teaching briefs presented in this dissertation were developed based on the research on learning theories and the results were evaluated and presented.

Having studied numerous cases of educational pavilions placed within the urban context, it is evident that in their great majority they represent contemporary architectural culture, they comprise of structures that employ new design and construction methods. By placing such artifacts in public spaces, they disseminate the findings of a broader design research agenda to the local community and engage users to appropriate them, change them, use them and involve them in their everyday life. The aforementioned pavilions are punctual events, and off course they cannot be said to change the physiog-
nomy of a city, however they do change the way the academic world interacts with the city; merging cutting edge knowledge and urban culture, establishing a dialogue between the university and the city. Due to their scale and style, the pavilions oscillate somewhere between art and architecture, between the size of urban furniture and building, this leads to a very unique form of creative freedom (Baker, 2014) and they can serve as a potential source of inspiration for the rest of architecture (Jodidio, 2011). This growing trend of pop-up spaces and pavilions leads to the inoculation with fresh ideas and motivates the community to practically engage in similar design-build projects, generating small changes within the city, which however lead to greater changes in the way knowledge is experienced and communicated.

In more than one cases, the combination of tools and methodologies of design and construction can propel the emergence of new ideas that combine traditional craftsmanship and digital techniques. According to Burry “today’s students are far more aware of other disciplines and their respective ways of working, combined with intimate association through sharing the same digital tools, points to a new era of design collaboration regardless of how ‘digital’ as individuals we are inclined to be. It is for this reason that I believe the academy should resist both any tendency for conservatism or a total rush into technology. Rather, it seems best that they seek to consolidate both traditional and digital design processes within teaching programmes lest we lose the skill to pass on skill - the malaise currently besetting some schools of fine art” (Burry, 2005)

The study of pavilions may offer an insight of the direction where contemporary experimental architecture is moving. There is obviously some convergence of trends in the majority of projects. However, those that do not fit into the established categories are those indicating fertile field for future investigations. While component based wooden elements is an undoubtable trend and an easy starting point for design explorations in 1:1 scale (in the sense that both materials and fabrication methods are long known and tested), however it is non modular projects such as ICD fiber pavilions that constitute a real breakthrough in construction methods, utilizing and synthetizing known processes into brand new construction methods. This is not to say that all future architecture and research will move towards that particular direction; nevertheless it is an example of synthesizing known processes (such as weaving) in un-known / un-tested scales (such as building scale). Innovation is achieved by relating phenomenologically unrelated research fields and processes. Therefore, interdisciplinarity lies in the core of innovative thinking.

The educational impact of Design-Build projects is manifold. Apart from being a highly motivational activity, it integrates several aspects or architectural knowledge, and therefore proves to be a fertile ground where a student can combine different skills and competences ranging from composition, to computation, logistics, construction technology, detailing among others. Instead of focusing on isolated and often disconnected courses, like learning software tools, or theory, or technology, Design-Build projects offer themselves as a platform for capitalizing the knowledge gained in other courses, see how different bits and pieces fall together aiming at a cohesive architectural praxis. Chad Schwartz in his article Debating the Merits of Design/Build: Assessing Pedagogical Strategies in an Architectural Technology Course, highlights the benefits of this practice for learning about architectural technology, “Design/build in a technology course has the potential to grow directly from the lessons of construction and assembly. Design, guided by real constraints, offers a significant platform for learning, especially for novice students still in their first years in the program” (Schwartz, 2016).

It has been seen throughout the research that hands-on learning experiences are very efficient with regards to learning. A hands-on approach is timeless, it has always formed part of architectural education, earlier in the form of scale models, nowadays also in 1:1 scale. The learning process does not depend
on the medium (be that analogue or digital), Design-Build projects is a highly adaptive teaching approach that can perfectly fit the teaching of digital media, enriching the virtual world with the necessary notion of materiality. A 1:1 prototype helps to highlight errors, pose future questions in quest for new knowledge. Mock-ups are both educative and experimental, they “link tool and process in the course of learning how to build” (Hailey, 2014). It has been proven that traditional learning theories are perfectly compatible with digital media. Therefore combining the established knowledge in learning methods with new media we devise research and teaching methodologies that push the limits of design experimentation, offer students the opportunity to take risks reflecting in action and promote innovation. Students acquire a working knowledge and practical experience with tools, techniques and methodologies of design and construction. The knowledge gained is not the result of direct instruction from teacher to student, but the result of a natural self-organized skill sharing that occurs within the group. This educational approach has numerous benefits and is seen as a great learning opportunity for the generation of digital natives, as it possesses the unique ability to blend analogue and digital media, with craftsmanship and design thinking.

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