‘Do It Yourself’ and ‘digital fabrication’ for new way of founding life

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Abstract. In architecture, 'Do It Your Self' has always been a prerogative of those who need to build a home or a place dedicated to a life necessity with few resources. Even today, as in the past, self-construction is applied in very poor contexts and is implemented using traditional techniques and technologies. Today, however, the new dimension of Digital Fabrication offers a completely new scenario in architecture, including the world of ‘Do It Your Self’. Machines and robots can enhance the possibilities available to those who want to get involved in it. Several companies innovate production processes by connecting the construction traditions of the past with new digital technologies. Young communities in search of self-determination feel the need to be personally involved in the regeneration and foundation of their living environment. Thus, the designer becomes a technical process consultant in the production and an animator of the community that builds its own architecture. Through four examples applied in the four editions of the International Summer Academy ‘Self Made Architecture’, the FabLab team of the Polytechnic University of Bari proposes a new approach to lead the new urban and peri-urban communities to found again their own places of life. The latest experimentation concerns the fourth edition still in the planning phase focused on the application of additive printing in architecture through the use of a mixture of raw earth. This technological advancement can represent a major resource to root the ‘Do It Yourself’ approach in the processes of self-determination of local communities. This project results from the collaboration of the FabLab Poliba group with the development and research department of WASP, an Italian leading company in 3D printing, and from the scientific collaboration between the Polytechnic University of Bari and the Faculty of Architecture of Damascus.

1. Introduction: traditional approaches to self-construction.

The 15th Architecture Exhibition of the Venice ‘Biennale’ [1], curated by Alejandro Aravena, proposed a very broad overview of the so-called frontier architecture where self-construction techniques are often fundamental. The submitted projects show, in most of the experiences, the recovery of traditional techniques handed down from generation to generation, closely linked to the contexts of reference. The work of Manuel Hertz and the National Union of Sahrawi Women in Western Sahara, the experience of Francis Kéré in Burkina Faso [2], as well as the work of Anna Heringer in Bangladesh [3] are all marked by a similar approach: the architect works alongside a local community, often lacking in means and resources, and follows the design and the construction of a housing or services settlement using building traditions that belong to the local culture. This method allows to consolidate the community in a dual objective: responding to a need for life and working on the recovery of its cultural identity. This kind of

experience brought to prominence by such an important architectural exhibition, actually already has similar experiences in the past.

Self-construction in architecture has traditionally been linked to subsistence and to the resolution of problems related to housing needs. 'Self-Made' was used for its affordability: the humbler the house, the lower the social class and the more self-construction was present, both in brand new constructions and in the maintenance of existing buildings. This custom is particularly expressed in the peasant civilization. It has forged people, capable of providing autonomously to their own life needs, from the creation of work tools to the construction of houses, stables and barns. At the basis of 'Self-Made' there is, therefore, the scarcity of economic means, the isolation condition to which these people were subjected. In addition, 'Self-Made' is the expression of a peculiar relationship between man and territory, that is the need for man to possess the surrounding nature, using manual skills as an appropriation tool. In architecture, as in other aspects of human life, there has been a constant and gradual increase in technical complexity, with the consequent determination of specialized professional figures. Over time, the architect-builder, the stonemason and the carpenter have emerged as specialized figures. Their role has begun to be essential in any architectural site that was evolving with a consequent greater complexity, leaving always less space to a self-construction approach, except in contexts of evident poverty and scarcity of resources [4]. We can therefore assert that a well-defined philosophy of self-construction, as an autonomous cultural approach, cannot be imagined before the nineteenth century during which the industrial era marked a turning point. The American experience provides an added value in the use of machines in the product packaging process aiming at reducing the specialization of craftsmanship. During this time, George Washington Snow invented the Balloon Frame system [5]. This system allowed industry to penetrate the building sector, limiting the specialized figure of the carpenter. In fact, the technique has a very simple process, and is suitable to be exported far from the place of production, in the form of numbered elements to be assembled on site without the need for skilled labour. More than the technological advancement, however, it was once again the housing demand, driven by the demographic impulse, that determined this system as the most suitable for the building market. Some experiences show a further application field of 'Self -Made', namely that of housing emergency where scarce financial resources make the possibility of a home problematic, such as the construction of the New Gourna district in Luxor in Egypt, projected and directed by the architect Hassan Fathy [6]. His project, showed in the autographed text *Architecture for the Poor*, can be considered a cornerstone in the birth of a tradition of self-construction that marked, perhaps with less vigour, the entire twentieth century and has exploded again in the contemporary era. He developed a pioneering idea for those times. The old community of Old Gourna was a people who inhabited the remains of the ancient pharaonic tombs in the valley of Thebes and based their economy on the sale of historical artefacts stolen from the site. The Egyptian government, thus, decided to move the community to another area of Luxor, entrusting the task to Fathy. The new neighbourhood would have been inspired by the innovation of a traditional Egyptian architecture, paying attention to the intelligent use of natural resources for cooling and ventilation strategies. The construction would have involved the community, previously trained on the traditional techniques employed. The sensitivity towards traditional architecture and the consequent attention to natural energy sources has produced several design experiments separating immediately from the self-construction. In fact, self-construction has continued to navigate alone in the twentieth century, producing a history of assisted construction experiences and building self-promotion. These phenomena have only focused on one aspect of 'Self-Made', that is reduction of construction costs. Therefore, no technical innovation in the social involvement towards a life project but only a communion of intent to reduce costs, even accepting poor quality of the content. The association of self-construction to the realisation of economic and popular housing, therefore, has remained a very present approach over the last forty years. The most recent examples, such as the Elemental project conducted in Chile from 2003 to 2005 [7], represent the most contemporary declinations of the phenomenon. Self-construction has been associated to Social Housing, an updated form of public housing that invests private capital aiming to a higher quality and to build social aggregation processes too. Today self-construction in architecture, 'Self Made' Architecture, is a lively

reality. 'Do It Yourself' in construction is a slogan widely present in numerous experiments and real construction sites. There is also a fruitful application of self-construction in the so-called 'underdeveloped' geographical contexts, where numerous design groups propose projects of houses and work places in existing communities which are dedicated to particular production activities. This is the case, for example, of Anna Heringer's work in the Dipshikha Electrical Skill Improvement, in Rudrapur, Bangladesh [3]. In these cases, there is a wide attention to the reuse of traditional materials and techniques, typical of the places concerned. Self-construction is also a resource in the 'ad hoc' prototype production in emergency situations, becoming an obligatory choice [4].

2. Method.

After an introduction on the origins and the evolution of 'Do It Yourself', the paper highlights the multiple potentialities of self-construction through different application examples carried out by research groups from the Polytechnic of Bari. The purpose is to confirm the broad application of a self-construction approach. Finally, the paper focuses on the possibility to use self-construction as an instrument of self-establishment of young communities, stressing the scalability of the presented approach and its coherence with the SDGs objectives.

3. The role of digital in self-construction.

The new frontiers of digital manufacturing and automation open a range of possibilities for everyday life. Although these technologies have immediately found a favourable field of application in industrial production, they could have great cultural relevance also in local contexts, particularly close to 'Do It Yourself', in architecture and territory transformation [8]. The application of the digital world to manufacturing and production is completely changing the balance of skills among the actors of the processes, including in building and architecture. The experience of a carpenter and the expertise of a decorator are the result of decades of professional assistance next to an experienced master. This approach to training is now on the way to extinction, while a greater predisposition of the new generations to investment in digital technology training prevails, even in the poorest contexts. The ability to know how to make a complex process with one's own hands fails. Whereas, the ability to operate numerically controlled machines that reproduce the same complex process through a number of automated work processes, is advancing. That complexity, characterising the world of construction, has shifted to the field of the project that goes beyond CAD (Computer Aided Design). In fact, it also deals with the CAM (Computer Aided Machine) and the G-code production processing, the so-called machine language. These technologies, applicable to architecture, can open a new season for self-construction, being able to innovate and make the traditional construction techniques efficient. The discriminant is precisely the dissemination of the know-how needed for the management of technological tools. Therefore, a profound change in education is required, so that all age groups may be more permeable to technological knowledge, according to a Fab Lab approach. It would allow users and educators to learn by designing and creating objects of personal interest, to grow by realizing something for oneself, with mutual learning and mentoring, to acquire a deeper knowledge of machines, materials, designs and engineering processes towards innovation, looking for solutions and ideas for one's own life [9].

Since 2013, a research group of the Polytechnic University of Bari has begun an experimentation path within the International Summer Academy 'Self Made Architecture' on the application of digital manufacturing techniques in self-construction sites involving local communities and the university world.

The first and second editions, organised in July 2013 and April 2015, involved the Faculties of Architecture of the Polytechnic University of Bari and the Atilim University of Ankara, in two projects related to specific needs of the respective local realities. The first experience concerned the experimentation of a construction system in small pieces that would allow a community of farmers and breeders to build their own agropastoral settlement in the Apulian Murge. The project focused on the recovery of the load-bearing masonry construction through the use of a suitably shaped ashlar to be self-blocking and a prototype of a wooden slab in mutual-structure that allowed to cover large spaces using

pieces no longer than one meter and a half, so light and easy to handle (figure 1, 2). During the summer school, a housing module was built to verify the actual simplicity of the construction system. The research group from Bari edited an illustrative assembly book used by the Ankara group without knowing the prototype. The entire production of the pieces was carried out with the support of companies with numerically controlled production lines that performed the works set by the designers of the Polytechnic University of Bari (figure 3).

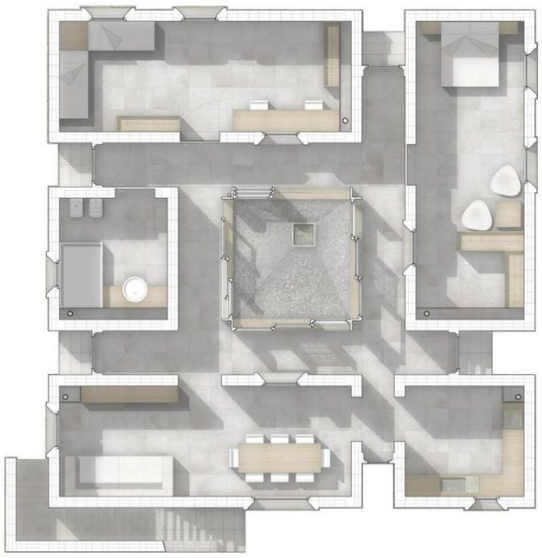

Figure 1. Plan of the accommodation developed by the 'Self Made Architecture 01' project.

Figure 2. Elevations and sections of the accommodation developed by the 'Self Made Architecture 01' project.

Figure 3. The prototype created during the 'Self Made Architecture 01' summer school.

The second experience realised in Ankara concerned a zone of the city centre with degraded areas due to collapsed historic buildings whose ruins have been reused to fill hollow walls made with wooden modules cut with numerical control machines (figure 4). Even in this case, in an overturned way, the group coming from Bari has implemented the construction starting from the pieces prepared by the Ankara group. The prototype of the second edition was imagined to be applied in emergency contexts where the ruins could play a role in the reconstruction of the transitory habitat. In these two first cases, the experimentation concerned the application of mutuality as a potential in the world of self-construction through the simplification and repeatability of the constructive act by adopting simplified forms.

An update of contemporary architecture, that many have experimented in even more complex experiences is the case of the extensive quality experimentation carried out by the research group of the ETH in Zurich which in numerous works have demonstrated how digital and robotics can lead to more complex forms [10] also implemented by the FabLab Poliba research group during the third edition of the International Summer Academy. The need was the creation of a prototype for the coverage of an archaeological site that the companies of a production area in Puglia intend to finance and self-build. In this case the experience was conducted with a Summer School with twenty-seven young people from various countries selected through an international call who worked on optimizing the shape and conformation of the pieces through the use of generative software, like 'Grasshopper', in order to obtain a funnel module which, repeated, can also cover large areas with very few anchor points on the ground, all in traction except the boundary. The prototype characterized by all different pieces and anchored on precisely defined points was created using laser cutting with the G-codes realised by the participants. The final assembly experience was shared with the entire community that supported the initiative (figure 5).

Figure 4. A moment in the construction of the prototype of the 'Self Made Architecture 02' summer school.

Figure 5. A moment in the construction of the prototype of the 'Self Made Architecture 03' summer school.

4. The digital 'Do It Yourself' in the construction of young communities.

Self-construction, as we have seen, is linked to subsistence situations. As such, it has always been connected to rebirth and redemption desires which come true involving the people concerned in the real reconstruction of their habitat and community [11]. Focusing on the humanitarian and housing emergency, resulting from various catastrophic events, it is possible to note how the 'Do It Yourself' approach suits well with the new philosophies in the field of humanitarian relief. The management of some recent major emergencies seem to have taught that the supply of shelters, be they permanent or transitory, is not the best viable solution. This also results from the tendency, by NGOs and international agencies, to consider the supplied shelters (be they transitory or permanent) as a finished phase "rather than as an uninterrupted process that begins with a damaged or destroyed house and ultimately leads to a return to a completely safe home" [12]. The solution is not to build houses, but to make the communities affected by disasters able to respond autonomously to their needs: improving the involved government tools, ensuring transparency regarding land properties; launching information and training campaigns. It is also possible to extend these conclusions beyond emergency cases, for example to meet the need of young communities, far from traditional production processes, which can find new lifeblood for their own self-determination in the use of technology. Such need stands in opposition to an unsustainable maxi-community model and finds its answer in the formation of self-determined micro-communities with an evolution of architects and designers. A useful correspondence to these new figures can be the designer in emergency situations. In this regard, in an interview with the magazine *Boundaries*, the architect Ian Davis analyses what he thinks are the main challenges for the technical staff engaged in an emergency. He focuses on the architect and underlines how, in emergency situations, listening and understanding is essential when searching a right solution - unlike some teaching environments with the idea that the solution to a well-defined problem leads to a well-defined building. The listening and understanding approach leads the interested communities to start processes to "build stronger communities, strengthen leadership, generate jobs, create safer conditions and transfer new skills to others" [12]. Sometimes designers do not consider the forces, necessary for the reconstruction of a community, already existing in the community itself, in its craftsmen, traders, families and students. The designer we mean, therefore, must be a versatile and flexible professional, capable of great social commitment and of making contact and compromising with these contexts. His task is not to be a creative designer, but a silent leader, almost from a distance, who offers the communities more than a range of viable roads, but the support to continue along a self-identified road. He is the so-called 'choral architect' by Carlo Ratti [9]: a technician who does not imagine already tailored visions of the future, but skilfully manages a community process towards a direction that arises, evolves and is realized through the community itself.

In this context fits the fourth edition of 'Self Made Architecture', still in the planning phase, which focused on the application of additive printing in architecture through the use of a mixture of raw earth. This project results from the collaboration of the FabLab Poliba group with the development and research department of WASP, a leading Italian company in 3D printing, and from the scientific collaboration between the Polytechnic University of Bari and the Faculty of Architecture of the University of Damascus. The goal of this research is to imagine a new settlement process that uses self-construction for resettlement in Syria, plagued by the destruction of the war vicissitudes since 2011, of new communities of young people eager to return to their country after the conflict has ended. The work is focusing on the use of a technology already developed by Wasp, namely the Big Delta, with the extrusion of a clay mixture, to design a residential settlement linked to the cultivation of land on the outskirts of Aleppo. The idea is always the direct use of the forces, skills and abilities of the communities. However, these are changed communities, now more tied to a technological approach to daily life than to a traditional one. In this sense, the implementation of traditional construction techniques on raw earth [13] with the use of machines, such as the Big Delta, does not seem impossible (figure 6,7). The project and the prototype open to interesting research perspectives on the massive resistance capacity of solid load-bearing structures built using digital manufacturing processes [14], as already investigated in various research laboratories, including European ones.

Figure 6. Pre-visualization of the design hypothesis developed in the context of 'Self Made Architecture 04'.

Figure 7. Pre-visualization of the design hypothesis developed in the context of 'Self Made Architecture 04'.

5. Scalability and coherence with Sustainable Development Objectives (SDGs).

The self-constructive approach that animates experiences, such as the fourth edition of 'Self Made Architecture', presents a vast field of applications. In fact, it is not limited to the Syrian case but is

applicable to many other similar contexts, be they of post-war or post-catastrophe emergency as well as to contexts of simpler housing needs, with fabrics and communities' transformations. It is a response to some basic needs for human life, such as the need for a shelter and that of social life. As such, it is applicable to minimal subsistence contexts and, in appropriate circumstances, also to the transformation of what already exists, to the search for new ways of living and how to live the community, to build it, also in its physical sense. Technological contamination of the more traditional self-constructive approach, the implementation of traditional local techniques and the possibility of using materials retrievable on site, contribute to increase the possibilities of application of this approach.

A similar way of understanding self-construction agrees with some of the objectives for the Sustainable Development (SDGs) outlined by the United Nations. Putting every man in the possibility of creating his own shelter, a home, cheap but safe, qualitative, energy efficient and for this reason sustainable, allows in the first instance the removal of an individual from a precarious state of life and health and, in this sense, to "ensure health and well-being for all and for all ages" (objective n.3 SDGs). The innovation of traditional techniques, the use of clean technologies and materials available on site improve the sustainability of the interventions, further contributing to the achievement of the aforementioned objective and to obtain "resistant infrastructures, sustainable industrialization and innovation "(objective n.9 SDGs). Furthermore, such approach to self-construction, on the one hand presupposes digital know-how and, on the other, allows the diffusion of this same knowledge to people who initially could be far from it. They could participate to the processes, learn new techniques, knowledge and ability, obtaining the possibility of "providing a quality, fair and inclusive education, and learning opportunities for all" (objective n.4 SDGs), according to an inclusive Fab-lab style. 'Do It Yourself' becomes a way to respond to a need for rebirth, for communities plagued by catastrophes or wars and are isolated or disrupted, to lead the rebirth of peripheral shreds of cities, distant from the central areas of economic, culture and services gravitation. 'Do It Yourself', therefore, turns into a tool to "make cities and human settlements inclusive, safe, long-lasting and sustainable" (objective n.11 SDGs) and "to promote lasting, inclusive and sustainable economic growth [...]" (objective n.8 SDGs).

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