POLITECNICO DI TORINO
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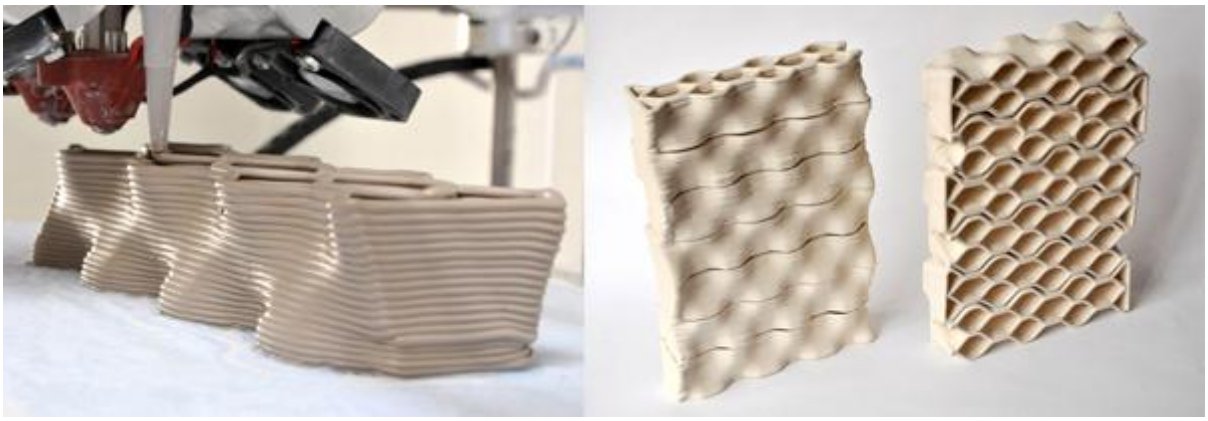
Honors theses

From visual architecture to real architecture: rapid prototyping
by Alberto Garabello and Maria Luisa Marsano
Tutor: Anna Marotta

With *Rapid Prototyping* words we mean all technologies used to quickly produce a prototype using 3-dimensional computer aided design (CAD).
Unlike the traditional mechanical process, which get prototypes removing material from a solid block, with Rapid Prototyping (RP) we create material layer by layer.
RP utilization in architecture is at the time, for the most part, confined to scale models or 1:1 details production.
Nowadays this technology is applied in automotive and aerospace industry, fashion and consumer products.
It's in architecture we wanted to know how to use Rapid Prototyping: to introduce new tools and to set up a new possible development. Since the first survey on additional techniques, we understood this appliance has huge potential: it can change the way we work from design project to large structures.
For this reason in few years many universities and organizations set up new Rapid Prototyping techniques: producing architectural elements through 3D printing.
In Amsterdam a group of architects printed ceramic bricks in order to build modular architectural structures; in San Francisco too architects are realizing ceramic, recycled wood and salt blocks.
Finding a new way to print bricks could be useful to build walls or personalized structures, using recycled materials too; in this way the process is 90% less expensive than current 3D printing technology.



October 2012, B. Peters, *Building Bytes*, in www.deezen.comm
Left: 3D molding process of the ceramic brick
Right: composition of most ceramic bricks for built a wall or a shading system

3D printing would let architects and building contractors to produce hundreds of bricks, all the same, for big walls building, or special bricks for particular needs. It means that there's the chance to solve fast any problem directly on site, fast design changes included.
Buro Happold and *Foster & Partners* are analyzing this technology in order to let it available for a sector market that rewards efficiency at low prices above everything else.
The team is applying additives production process in order to elaborate a concrete printing method that could automate the production even of the most complex architectural components.
Among the many advantages of this technique we count: greater geometric freedom, structural optimization, functional integration; by reducing assembly complexity, all components could be created with empty spaces for ducts and services; double-layer structures gives to the materials insulating properties too.
As each piece is custom-made, there is no waste.
So common interests in this studies are the need to save money and reduce waste.
Like many aspects of contemporary culture, the emerging architecture will not massively spread in a short time, but a brick on another, maybe made on-site, perhaps 3D printed.
Now the size of printers reproducing objects has increased up to several meters in height and width, so reaching the necessary space to create housing panels, in order to replace wood or bricks commonly used in building construction.
Enrico Dini, inventor of the *D-Shape* 6x6 meters printer, can print buildings starting from inorganic materials and sand; related examples of this technique are *Radiolaria*, *Casa tutta di un pezzo* and *Landscape House*.

January 2013, Janjaap Ruijssenaars, *Landscape House*, in www.3ders.org
Photorealistic Render about project Landscape House, can be printed out latest in year 2014 with D-Shape printer

First biodegradable, plant-based PLA bio-plastic architectural structure is from California: assembled on site, the structure will decompose over time.
A similar project is from The Netherlands: the *DUS Architects Studio* projected a Pavilion Printer, to print build the first full-sized canal house in Amsterdam.
Shortly after, London studio *Softkill Design* published a proposal for *Protohouse 2.0*, a house of interlocking fibrous plastic modules that imitates bone growth.
Cambridge MIT Researchers plan to 3D print a small pavilion by imitating the way a silkworm builds its cocoon.

Another method is *Contour Crafting*, a type of 3D printing which use robotic arms and nozzle which deposit by repeatedly laying down layers of concrete moving back and forth; to automatically construct in a single moment and single place and to manufacture large components. This technology has great potential for lower construction cost and superior construction speed.
A natural development of the printing of new buildings will consist of devices that recycle old ones.
The old material will be milled and new compounds used to reformulate a new 3D print.
Another very important aspect is related to the use of local materials: this will bring additional savings, even in a future scenery where these new technologies will be used for human extraterrestrial colonization, such as the Moon and Mars.
In the last decade Rapid Prototyping has changed almost completely its primary use, from simple tool of representation to industrial production of finished objects and structures.
To understand the potential of this technology, our research led to analyze 3D Printing in many areas such as design, fashion, food and medicine, this in order to realize the development of architecture whit this new technique: we think this technology would be useful in emergent countries, with on-site materials, or in catastrophe sites to build quickly new houses, or even to build prototypes for complex on-site operations.
Talking about new technologies, we don't know yet how this materials react to wear or weather conditions, but we can speculate that Rapid Prototyping could became competitive and his use will be improved in the years to come, supporting traditional methods, but not replacing them for sure.

August 2013, Smith-Allen, *Echoviren Pavilion*, in www.7x7.com
Left: picture of 3D printers used for the project for a composition of plant-based bio plastics pavilion
Right: picture of the pavilion finished and inlaid in Gualala River Redwood Park, California

For further information, e-mail:
Alberto Garabello: alberto.garabello@outlook.com
Maria Luisa Marsano: luisa.marsano@hotmail.it