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Research and Practice: Full-Size Practical Constructions for the Development of Innovative Lithic Prototypes

Abstract

La costruzione al vero di elementi architettonici presenta la doppia funzione di verifica del percorso di ricerca sperimentale e di espediente didattico. Nel primo caso permette di effettuare una verifica sperimentale dell'ipotesi sviluppata, creando un punto fermo che possa confermare o confutare il ragionamento in atto. Nel secondo caso dà la possibilità di stimolare nello studente un modo di pensare che coinvolga allo stesso tempo l'aspetto astratto e quello concreto del progetto.

Il legame tra ricerca, didattica e pratica di cantiere è riproposto negli esempi riportati, e costituisce un elemento necessario per procedere proficuamente nel percorso di avanzamento della sperimentazione architettonica.

The construction of full scale architectural elements has the double purpose of experimental control for researchers and teaching resource for students. In the first case model allows to make an experimental verification, creating a reference point to confirm or refute the starting hypothesis.

The second function makes possible to stimulate students' way of thinking, involving both abstract and concrete design aspects.

This link between research, teaching and practice of construction is shown in various examples.

This relation represents a necessary element in order to successfully proceed in the advance of architectural experimentation.

Keywords: prototype, workshop, idea, construction, research

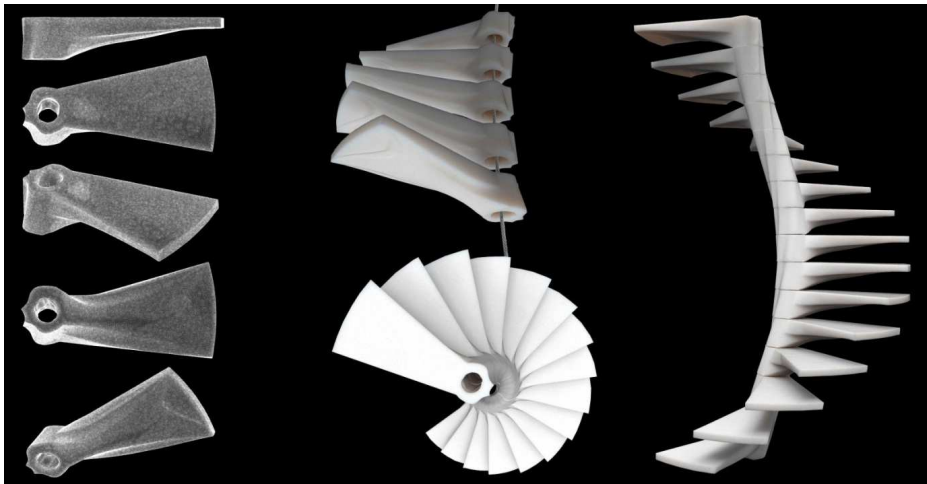


FIG.1. Prototype of the Re-composed Stair – version two

Introduction

Recently, architecture has faced a period of crisis related to a sort of "ideology of design", in which the project seems to be a theoretical entity while its realization represents only the remaining part of a conceptual graphics processing.

The Anglo-Saxon impetus has reintroduced a more pragmatic approach fundamentally connected to know-how, but this approach reaches extreme results by using the prototype to challenge practical possibilities of construction.

Italy seems to follow its nature of intermediate country considering this "theory of practice" in a non-ideological manner and proposing that model according to architecture purposes.

Our aim is to bring back this pragmatic conception to its original function that is a means at the service of architecture and not an end in itself for obtaining extreme shapes.

In a period in which architecture seems to be largely related to the abstraction of design and in which seems not possible to break away from this extreme sink into the purely theoretical speculation, we are trying to get back this learning-by-doing logic interpreted through the filter of a purely Italian romanticism.

The School of Architecture of Bari tries to develop a progressive path from the first to the last academic year: starting from tuff stone construction, extremely malleable and functional to learning, up to complex prototypes during the Thesis Laboratories activities.

Moreover, the so-called "recomposed stereotomy" does a further step: reinsertion of processing scraps through a reverse logic of molding makes the stone life cycle to close and complete.

Methods and Objectives

The link between three-dimensional modeling, rapid prototyping and dry assembly may indeed represent a means of development for the project idea, directly testable through practical confirmation.

The process serves two purposes: the prototype is useful for design strategies because it provides modular elements with formal and structural independence that could be applied in several contexts; furthermore construction made by students provides an important educational resource for establishing a correct design conception.

The prototype is not, therefore, the obvious conclusion of a mental process, but is

itself part of this process.

Once you have defined the basic principles of the shape configuration, for example through a process of decoding and recoding of existing characters, you must give it a concrete consistence through the built structure.

The same can serve as “module” for a complex spatial tessellation following the Gothic approach: here the structural possibilities rule the methods of composition and combination of one or more base units, always following the trend of the “visual approach”.

The full-scale prototype allows a level of discussion and revision as part of design development: in this intermediate phase is possible to confirm the initial hypothesis or lead to a sudden change of direction. That brings back research to a high level of concreteness and forces the researcher to consider all the involved aspects, which cannot be postponed to subsequent stages.



FIG.2. and 3. Structural Stone Exhibition, Marmomacc 2013 – Re-Composed Stair (Design: G. Fallacara). FIG.4. Structural Stone Exhibition, Marmomacc 2013 – Tensegrilithic (Design: G. Fallacara, M. Stigliano)

The Prototype Construction as Design Innovation

The event of workshop often arises with the aim of materializing an architectural element during the course of its experimental verification. It focuses on a single structural piece of such dimensions as to be properly managed.

The choice of a prototype that could constitute a “basic module” is not accidental but it’s directed to its possible applications: for a prototype to be actually used, it must be

extremely flexible, self-supporting, agreeable and cheap in terms of time and costs. Starting from these assumptions, workshop provides a perfect opportunity to materialize the designed element and test its actual features: it can mark a turning point in the research development according to its positive or negative outcome, in order to change direction or confirm the work.

In a few words the prototype represents a method to check and implement the design reasoning.

The Prototype Construction as Didactic Experience

Learning by doing is extremely useful not only for scientific research, but also for an initial phase of the students' conceptual training: in fact on this occasion one is obliged to perform a global reasoning that involves artistic sensibility as material concreteness.

Practice make students activate a mental process that reassembles all the design phases in a unique creative development: idea, project and construction are recomposed in a continuous cycle.

The built prototype is a phase of checking and revision, and returns into the cycle through a kind of progressive improvement of results, until the final rebalancing of the various instances doesn't stop the process. The final outcome cannot but be a summary of a perfect constructive and composite mastery.

We can affirm, therefore, that the direct approach to the building is desirable not only to acquire sound knowledge in the field of technology and materials, but also and above all to develop a comprehensive approach to the project.

The three-dimensional modeling is a very important connection aimed to acquire this methodological approach. The ability to prefigure the result and assemble it in an all-round vision, anticipate the practical problems that one has to face. Moreover, CNC machines makes the connection even more immediate: what is abstractly perceived on screen is poised to become the assembling matter in such a direct way as to leave no room for maneuver between the two phases. The model must already have a starting geometric-constructive approach in order to prefigure the technological instruments that will be required in the immediately following stage.

Of course designing new prototypes involves a process of trial and error that is intrinsic to any new experimental introduction, and the direct materic approach makes this process easier to understand. Thinking through the building process and not only through design abstraction becomes natural and immediate. The student change his *forma mentis* and reassembles the recurring conflict between artistic

subjectivity and technology objectivity.

This practical and design exercise has been pursued on many occasions and with different levels of detail, within Design courses or international workshops organized by the Polytechnic University of Bari with the support of external companies, as the SNBR of Troyes or Formedil of Bari. The construction of a complex structure prototype was the purpose of every experience, with the addition of a design exercise for its inclusion in an overall project.

The ultimate goal is to reconnect in a unique conceptual cycle all the aspects that compose the project, from the most theoretical to the most concrete, until you get to a composite hypothesis which might serve as verification of the entire creative process.

In the first part we will present an educational experience aimed at understanding the architectural work: different types of structures and different types of materials are taken into account and the students are called to deal with a real construction site.

In the second part we will present, on the other hand, some prototypes that deviate from traditional stone structures. Trying to get a result innovative, the same methodology of practical involvement of the participants is used: the group, assisted by expert workers, faces practical constructive problems that differ from the traditional expertise.

SECOND VERSION: ARTIFICIAL STONE WITH PERMANENT FORMWORK



Assembly of the staircase for the entire interfloor distance



FIG.5. and 6. Prototype of the Re-composed Stair – version made of artificial stone with permanent formwork

In this case the aim is twofold: architectural experimentation is made possible by the workshop, and in the same time the workshop allows participants to gain valuable skills, conceptual rather than manual. In fact, it is obvious that the practical exercise

restricted to the time of a workshop (1 to 3 weeks in general) cannot be aimed at acquiring specific construction skills, but the direct contact with the architectural product can expand the view: what unconsciously change is the data processing method and its recoding into the project.

This is done through different criteria that are directly exemplified by the overlap between virtual model and built model.

Types of Practical Workshop: Examples and Targets

STAGE "SANTI QUATTRO CORONATI" (First year – Architectural Design)

Promoter Institutes: Polytechnic of Bari in collaboration with Formedil Puglia

Scientific Coordinator: Prof. Claudio D'Amato

Architectural project: Prof. Giuseppe Fallacara

Supervision of construction: Prof. Fiore Resta

Professors: Giuseppe Fallacara, Marco Stigliano, Nicola Parisi, Francesco Scricco

The stage "Santi Quattro Coronati" is a three weeks workshop addressed to students of the first year. Its goal is the basic education on technological issues and materials. The common issues considered are the structure discontinuity related to specific construction methods.

The aim is to create an effective relationship between conceptual practices and implementation on site. In this way we try to convey the design approach towards the overcoming of design abstraction in favor of a "tectonic" logic, where the meaning of construction is clear through the form. The learning of the design discipline begins through the identification of critical issues in architectural construction.

The workshop carried out in 2014 focused on the execution of three prototypes, everyone referred to a different theme depending on its material.

The "Dome" topic is developed with three materic variations: masonry, iron and wood.

The three versions correspond to specific building techniques:

1. Masonry: Construction technique with "stick";
2. Steel Construction technique "geodetic dome";
3. Wood: Construction technique "folded developable panels"

Specificities of every material allow comparing theoretical knowledge and actual behavior of the structure on which one have to work.

The first dome aims to the practical application of a traditional technique for the

spatial definition. The external surface is shaped through horizontal bands with convex section.



FIG.7. and 8. Stage Santi Quattro Coronati: Masonry Dome



FIG.9., 10. and 11. Stage Santi Quattro Coronati: Geodetic Dome



FIG.12. and 13. Stage Santi Quattro Coronati: Wood Dome

The second aims to investigate the issue of truss structures through the efficiency of spherical shape: the main issues are therefore the rigidity of the triangular mesh and the composition modes of spatial tessellation in relation to "steel" features, like durability and resistance.

The third deals with the spatial composition of wooden panels, once again manipulated to obtain a domical shape taking advantage of the intrinsic deformation skills of the material itself.

The specific architectural declination is interpreted according to the material.



FIG. 14. and 15. Stage Santi Quattro Coronati: Dome with crossed arches

The design approach differences become even more obvious through this parallel comparison. The geometric trace of all the full-scale prototypes along with their construction, problem solving and relationship experiences between workers and student represent the basic elements of the entire stage.



FIG. 16 and 17. Stage Santi Quattro Coronati: Students at work

In all these workshops specific methods of construction have been investigated, with particular attention to stone architecture in which the close correspondence between construction and form is very clearly expressed.

STAGE “RE-COMPOSED STEREOTOMY” (Fourth year – History of Stereotomy)

Promoter Institutes: Polytechnic of Bari in collaboration with Tarricone Prefabbricati
Architectural project: Prof. Giuseppe Fallacara



FIG. 18. 19 and 20. Re-composed Stereotomy Workshop

The course of History of Stereotomy analyzes more specific issues about composition and processing techniques about stereotomic structures, both in stone and artificial stone. The progress of students' awareness reflects the different nature of this experience that does not concern only with the constructive comprehension but also with its application to non-conventional areas.

In particular the workshop 2012 focused on the construction of a full-scale project, or a significant part of it, previously developed by the students both with 3D modeling and through the realization of a small-scale *maquette*.

The stage purpose was to realize a stereotomic product by using the traditional technique of the concrete mold for obtaining a complex shape.

In this case the attention is paid to the study of a negative shape, the mold, from which to obtain a countless amount of objects by molding.

Each student was called to design a small prototype or an architectural element, in stone or wood, linked to the issues proposed during the course of History of Stereotomy: walls, floors, vaulted systems, etc., with particular preference to the topic of the spiral staircase.



FIG. 21. 22 and 23. Re-composed Stereotomy Workshop : Processing of the step

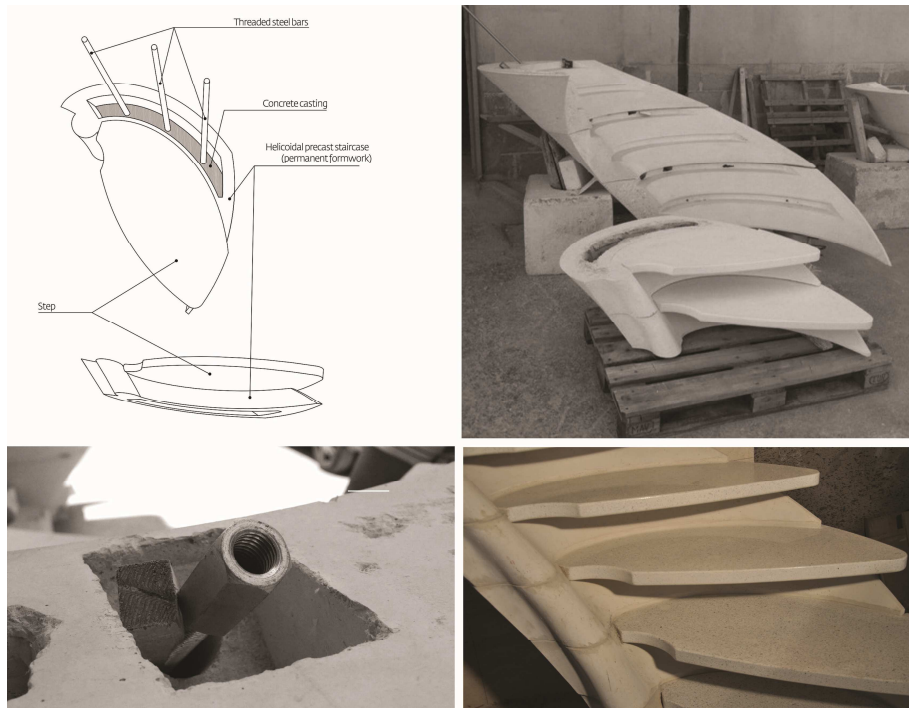


FIG. 24. Re-composed Stair – version one

The primary educational goal was to lead the student to a complex design through

the proposed methodology, in the double aesthetic/structural meaning. The work was done at different scales: from general to particular.

The theoretical concepts of virtual modeling classes find here a match in actual practice. The experience strengthens the principle that the power of design concepts lies in their feasibility.

SPECIALISED STAGE – (Last year – Thesis Labs)

Thesis laboratories go one step further on this path: the experience of construction is performed trying to develop new design methods for innovative elements.

Starting from the latest, we propose two examples of lithic experimental prototypes.

The study of the construction element has been approached in a comprehensive manner and each one has been interpreted through the assumptions of design speculation.

The goal is to recreate an ideal learning path for the project, starting from the idea up to the tangible output of the object.

LITHIC TREE - Stage “Stereotomy, new and old practices”

Promoter Institutes: Polytechnic of Bari in collaboration with SBNR – Troyes (France)

Architectural project: Prof. Giuseppe Fallacara



FIG. 25. and 26. Lithic Tree workshop

The stage, conducted during July 2014, concerned with the construction of a lithic branching structure with passive reinforcement.

The element is naturally suitable for modular composition, but its self-supporting nature gives it a strong character.

The potential applications have made interesting the experimental verification: the processing of the ashlars was carried out through numerical control machines, as well as that of the decorative panels created by the students during the workshop. The assembly was, therefore, carried out very quickly through a dry assembly.



FIG.27. 28. and 29. Lithic Tree prototype: final result

FLEXIBLE ARCHES

Promoter Institutes: Polytechnic of Bari in collaboration with Mecastone
 Architectural project: Prof Giuseppe Fallacara



FIG.30. and 31. Flexible Arch Workshop

Another example concerns the Flexible Arch Prototype: the so-called "flexible arch" aimed to make the applications of arched structures very cheap and easy, with the aid of some assembling expedients.

The arch has been designed for an assembly without frameworks and it was positioned by simply lifting the ashlar, previously shaped and held together by a glass fiber tissue.

The arch shape is obtained by lifting it in three points: their weight allows to recreate the joints' hinges.



FIG.32. Structural Stone Exhibition, Marmomacc 2013 – Flexible Arch (Design: C. D'Amato, G. Fallacara)

Conclusion

Each experience has attempted to reconnect the practice of project to its execution. The architectural elements have been progressively complexified in accordance to the presumed critical capacity of the student. Anyway, every prototype has always been designed to fit the limiting conditions of an overall project, in order for the practical experience to be brought back to the primary goal: the "recomposition" of the different aspects that compose the design practice. In fact, many of the errors that may be found in our field can be ascribed to an excessive tendency of "abstraction".

These type of theoretical/practical on-the-job trainings can create an important transversal synergy between research and academic teaching: the concrete proof of construction allows to verify the initial conjectures and enables the student to compose a complete method of mental processing that takes into account technical feasibility and concrete procedures.

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