Graduation Plan for AE students

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Studio

INTECTURE (Architecture Engineering)
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Title

Robotically Aided Regionalism: Reawakening stone stereotomy through robotic fabrication.

Graduation Project

Problem Statement

Since the industrial revolution and the introduction of 'modern' industrialised materials, the idea of elevating an abundant and local material through crafts, into a tectonic system has become less relevant. The notion of achieving more with less through material knowledge and craftsmenship has been replaced by more extravagant materials which have less limitations. In the case of stone, its association with the high degree of craftsmanship and labour costs required also resulted in its decline of tectonic expression and performance. Stone nowadays is no longer seen as a moldable material which can be well crafted into a system which takes full advantages of its properties, but as a standard unit to be simply assembled on top of each other. This decline in demand in the art of stone stereotomy is becoming reduntant in an alarming rate and in danger of being lost.

Objective

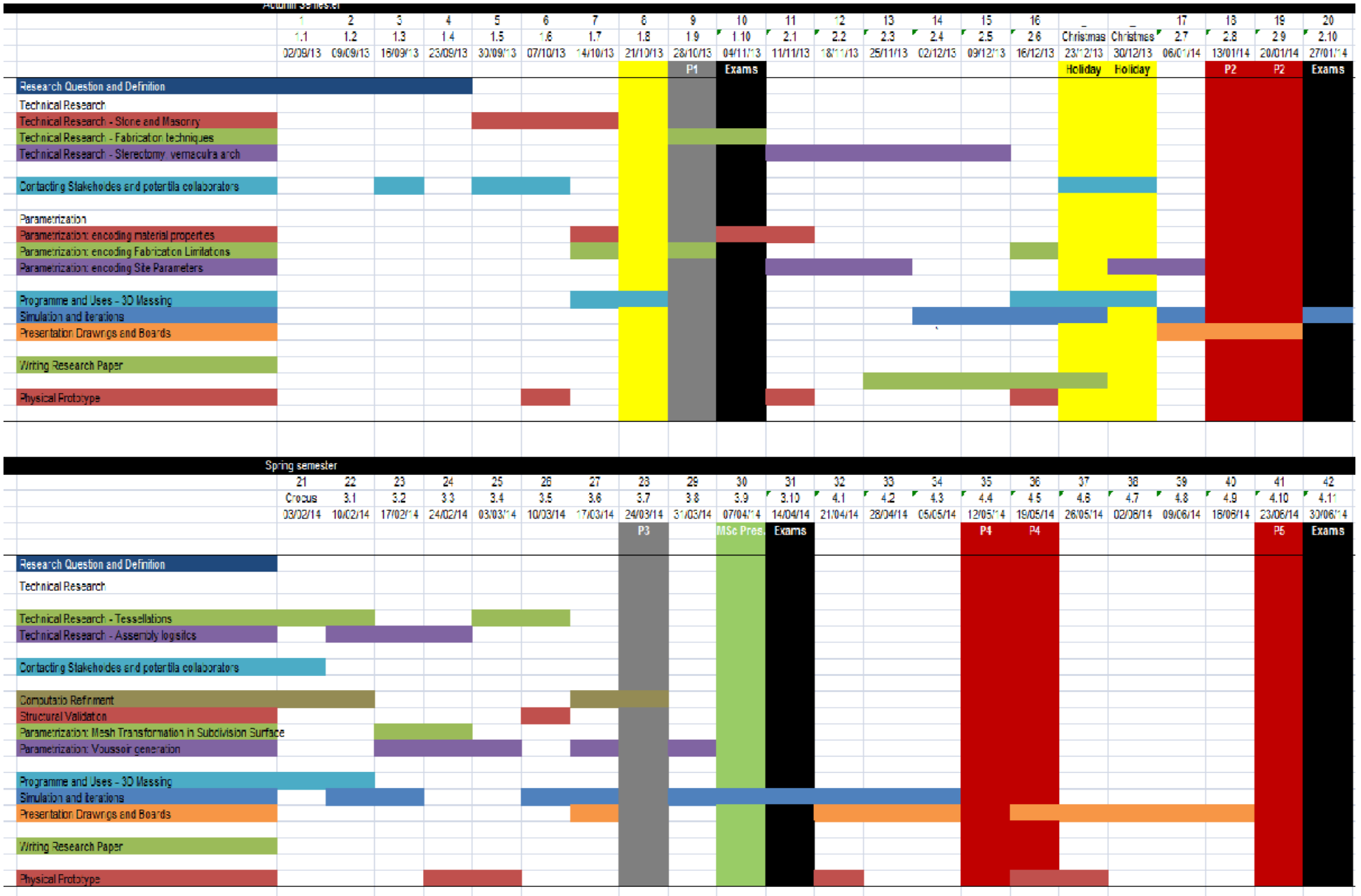
This research is an attempt to reawaken the use of stone as a building material from the everyday and the mundane into an architectural language which takes into account the physical properties of the material and respects the cultural significance of stone architecture while imprinting a contemporary zeitgeist with the aid of computational tools and robotic fabrication.
The research evolved from three premises and beliefs: 1) The need of an integrated approach in the design and construction of architecture. 2) The need for a contemporary and exciting language for stone masonry structures. 3)The belief that digital design and fabrication technologies can help in the reinterpretation of local traditional skills and construction techniques such as stereotomy which are becoming redundant due to high labour costs.

Overall design question
How can computation and digital fabrication be used to reawaken the idea of stone as a moldable material in which its physical properties are exploited to extend its tectonic expression and performance? How can this approach be utilised for the design of a cultural public building that respects its strong historic setting while imprinting a contemporary zeitgeist?

Technical Research Question
How can computation and digital fabrication be used to reawaken the idea of stone as a moldable material in which its physical properties are exploited to extend its tectonic expression and performance?

Methodologies
The study will formulate from the limits and opportunities in the choice of material and fabrication technique. More specifically, robotic fabrication techniques and the physical and mechanical properties of limestone will be researched and used in combination to investigate an approach for a renewed tectonic expression in stone.
As stone is a very well known building material, history and vernacular architecture will be considered as the main teachers in this matter. The task here will not be to emulate what is already known but mostly to understand the way stone was used and reinterpret and enhance it with the wide range of state-of-the-art computational and fabrication tools. The main material characteristics studied are; Compressive and tensile strength, Thermal absorption, Permeability, Porosity and workability. In order to present concrete findings, the study will be placed in a southern Mediterranean context. While particular material characteristics might vary slightly, the methodology is still relevant in other regions with similar climate conditions and material characteristics. The structural strategy researched will revolve around the assumption that stone has no tensile strength. For this reason, the theories on compression-only structural systems in equilibrium (funicular structures) will be investigated with special focus on thrust network analysis and Spring-Particle systems. This section will be a combination of literary research and hands on experiments in setting up computational models, which would simulate material behavior.
The second part of the research will be focused on the fabrication limitations and other on-site processes that could enhance the performance of the architecture in question. The research will benefit from open source information regarding recent innovations in digital tools and new ways in using the full potential of robotic fabrication. (scanning the stones, cutting stones from the quarry, nesting, assembly of parts, cutting size, tessellation of surface, geometry limitations,) The Robotics Lab in Rotterdam, managed by Jelle Feringa will also be used to run physical experiments in parallel with the digital to validate the whole research and show that the stone components can be fabricated.
The literature review and hands-on experimentations will give the information needed for the development of a computational setup, were site parameters, structure, programmatic needs and fabrication limitations will be integrated. The two parts of the study will eventually combine to show how these findings could be used in a hypothetical design project.

Planning


Autumn Semester
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02/09/13 09/09/13 16/09/13 23/09/13 30/09/13 07/10/13 14/10/13 21/10/13 28/10/13 04/11/13 11/11/13 18/11/13 25/11/13 02/12/13 09/12/13 16/12/13 23/12/13 30/12/13 06/01/14 13/01/14 20/01/14 27/01/14
P1 Exams Holiday Holiday P2 P2 Exams
Research Question and Definition
Technical Research
Technical Research - Stone and Masonry
Technical Research - Fabrication techniques
Technical Research - Stereotomy, vernacular arch
Contacting Stakeholdes and potential collaborators
Parametrization
Parametrization: encoding material properties
Parametrization: encoding Fabrication Limitations
Parametrization: encoding Site Parameters
Programme and Uses - 3D Massing
Simulation and Iterations
Presentation Drawings and Boards
Writing Research Paper
Physical Prototype
Spring semester
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Crocus 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 3.10 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 4.10 4.11
03/02/14 10/02/14 17/02/14 24/02/14 03/03/14 10/03/14 17/03/14 24/03/14 31/03/14 07/04/14 14/04/14 21/04/14 28/04/14 05/05/14 12/05/14 19/05/14 26/05/14 02/06/14 09/06/14 16/06/14 23/06/14 30/06/14
P3 MSc Pres. Exams P4 P4 P5 Exams
Research Question and Definition
Technical Research
Technical Research - Tessellations
Technical Research - Assembly logistics
Contacting Stakeholdes and potential collaborators
Computatio Refinment
Structural Validation
Parametrization: Mesh Transformation in Subdivision Surface
Parametrization: Voussoir generation
Programme and Uses - 3D Massing
Simulation and Iterations
Presentation Drawings and Boards
Writing Research Paper
Physical Prototype

Relevance

The project is mostly a showcase of an integrated design and fabrication methodology. The integrted system is mostly relevant in reinstating stone stereotomy as a language in contemporary architecture. The integrated system makes it financially feasible for such a tectonic expression to be used. The design project could exhibit the way this system could lead to an architecture language which bridges local traditional stone to contemporary aesthetic and performative requirements.

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