
DIGITAL DESIGN AND CONSTRUCTION COMMONS AND THEIR ROLE IN ARCHITECTURAL TECHNOLOGY EDUCATION

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ABSTRACT

This paper examines the challenges and opportunities of education of Architectural Technology when it is oriented towards digital design/construction commons and open hardware. In particular, the followed methodology and the obtained results during a course within the defined educational process of the university and a workshop outside the defined educational process of the university are presented and analyzed. What the two activities have in common is the design and development of Open Architecture projects. At the same time, the paper contributes to the discussion according to which the results of education become a "common good or resource" that is shaped and managed not only by the educational community but also by the local society in terms of equality, freedom, and participation. In this case, important questions arise both concerning the methodology and the ontology of the "design

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object" when it is taken for granted that the results of its design are publicly available / shared, in a suitable form so that anyone can study, transform, distribute even implement. Architectural Design and Digital Fabrication have largely become a cognitive activity that produces data and code. The construction industry is gradually adopting the use of digital technologies almost throughout the construction life cycle. Therefore, it is important to discuss the terms and conditions of developing knowledge flow and collaboration communities.

Keywords: construction commons, digital design, architectural technology, educational community, collaboration communities

Introduction

This paper focuses on the opportunities and challenges of education in Architectural Technology when it is oriented towards Open Design, Open Construction and Open Construction Technologies. In particular, the methodology of the development of the teaching process is presented and the results from a course taught in the academic year 2022-2023 at the Department of Architects and Engineers of the University of Thessaly and from an open workshop held in July 2023 in Agios Lavrentios Pelion are described.

Initially, it is deemed necessary to clarify two fundamental positions of this proposal. The first argues that the use of scientific knowledge and technology is neither socially neutral nor innocent. The second concerns the concept of 'crisis'. This text adopts the position of Hardt-Negri [1] according to which the 'crisis' was a characteristic of the 'modern sovereignty' of the 17th century and not of the current 'imperial sovereignty' of the last decades where the 'Empire' turns from global to multi scalar sovereignty and is organized through a flexible network of micro-conflicts. Contradictions (protection - destruction of the environment, development - withering, racism - inclusion, etc.) are everywhere, they are indiscernible, multiplying, and difficult to locate. Therefore, instead of the concept of crisis, authors propose the concept of 'pan-crisis'. The concept of 'pan-crisis' is not an aberration but the very essence and mundusoperanti of modern 'imperial rule.'

Based on the above, the course examines the concept of Openness in Architectural Technology and studies projects with Open Design, Open Construction and Open Construction Technologies practices. Why is it important to explore the relationship between Architectural Technology and Openness?

The results of the educational process become a common good/resource shaped not only by the educational community but also by the local community in terms of equality, freedom, and participation. Furthermore, open design, open construction and open construction technologies contribute towards a paradigm shift in the construction industry and production. At the same time, the construction industry is being computerized and is gradually adopting the use of cutting-edge digital technologies throughout the construction life cycle. The rapid development of digital technologies makes architectural design and digital construction a cognitive activity that generates knowledge, code, and digital data. It is therefore important to discuss the terms and conditions of developing communities of knowledge flow and cooperation. Furthermore, important questions arise about both the methodology and the ontology of the design object when it is taken for granted that the design results are available in common and in a suitable form so that the community can study, modify, and distribute them according to the conditions defined by the community.

Educational process methodology adapted to Open Architectural Projects

The methodology of teaching Open Architecture is based on the common ground between Architecture, Openness and Knowledge Transfer.

Openness

Openness has 4 main general characteristics as identified in the study by Daniel Schlagwein et al [2] and they are (A) accessibility to knowledge, technologies, and resources. (B) transparency of actions. (C) permeability of organizational structures. (D) inclusion and Participation.

Also, Openness has 4 key specific technical characteristics related to the distribution of resources, as identified in the study by Balka, K., Raasch, C. and Herstatt, C. [3] and they are (i) freedom to study (transparency) (ii) freedom to edit/modify (accessibility) (iii) freedom to create (reproducibility) and (iv) freedom to distribute (commercial usability).

Knowledge

Knowledge transfer, on the other hand, involves the combination of explicit and implicit knowledge. Explicit knowledge represents knowledge that a person is aware of and can be easily transmitted to others. In the case of architecture, it may for example include written specifications of materials and drawings. Tacit knowledge represents internalized knowledge that a person may not be conscious of, and which is transmitted unintentionally. For example, the techniques of carving a stone, the techniques of processing a piece of wood, the techniques of applying mortar to masonry, the techniques of masonry construction, etc. Therefore, we can categorize the subject of Architectural Technology into (A) Knowledge of the design and study of an Architectural project. (B) Knowledge about the construction and implementation of an Architectural project. (C) Knowledge of the Technologies and Tools for the construction of an Architectural Project.

Architecture

The third part of the methodology concerning Open Architectural Technology is based on the subject of Architecture which is divided into design, construction, and construction technologies and tools. Based on the above three cognitive sub-fields of Architectural science, the concept of Openness is approached. Based on the above, the students are asked to develop an Open Architectural Project (in this case urban furniture). They choose the degree and type of openness and adapt the design to their initial choice. Open Design is about access to information and knowledge about drawings, texts - specifications, code, diagrams - procedures, images.

Open Construction is about access to information and knowledge on construction materials, factory production and on-site construction. Finally, open technologies are about access to information and knowledge on industrial, laboratory and manual tool production. Central to the didactics of Open Architectural projects is the choice of the form of information and resource exchange between Sharing, Collaboration, Crowdsourcing and Commons.

The work of Priavolou C. and Niaros V. [4] served as a guide for the compilation of the central questions that the participating students are asked to think about, in order to proceed with the design of open architectural projects. The main questions are the following:

- Is the technical data of the Architectural project available (CAD files, computer code, etc.)?
- Are the instructions for assembly and construction available and easy to understand?
- Is the cost of construction materials available?
- Is there a guide available on how users can contribute to the construction?
- Is one or more of the file formats used in an editable format?
- Are the assembly instructions published in an editable format?
- Is the financial budget for construction, services and materials published in an editable format?
- Is the appropriate license that allows users to commercially reuse the results of the architectural project used?

The case of ‘Open Design, Structures and technologies’ course

The course ‘Open Design, Construction & Technologies’ is taught at the Department of Architecture, Faculty of Engineering of the University of Thessaly. The course introduces the concept of Openness in Architectural Technology, and studies projects with Open Design, Open Construction and Open Construction Technologies practices.

The general objective of the course is to familiarize students with the concept of Openness in Architectural Technology and in particular with Open Design, Open Construction and Open Construction Technologies practices. They are required to understand, manage, and master the relationship between Architecture and Openness.

Specific objectives of the course are:

- The definition, description, classification, and correlation of projects related to 'Open Design', 'Open Construction' and 'Open Construction Technologies'.
- The implementation of an integrated development process of an Architectural project in terms of Openness. The objective is to have students go through and adopt all the stages from the initial conception to the final realization of the construction, while defining the conditions of Openness of the project.
- Encouraging for the development of an open knowledge community for construction data
- Knowledge of participatory methods and the way to involve the community and stakeholders in the planning and implementation processes of a project. Integration in the design of the commitments resulting from the collective processes. Understanding the challenges and benefits of stakeholder participation in the planning process.
- The ability to use interdisciplinary networks of experts, to develop creative thinking and the ability to use different technologies to solve problems. Developing Communication and interaction skills.

For the academic year 2022-2023, the scope of the project was the design and implementation on a scale of 1/10 or 1/20 of a structure supporting artistic activities (festival infrastructure). The structures were part of the 'Design Campus' project [5], a participatory design project for urban sustainability in which the 'COMMONSPACE' and 'LUDD' teams participated, in Elefsina, in the context of the European Capital of Culture activities. As part of the course, it was proposed structures to support artistic activities (festival infrastructure) to be designed, which were placed within the former municipal camping 'Oasis' in Elefsina.

Each team delivered in an open format all the necessary elements (description text, drawings, code, cad/cam files) that would make the project open according to the terms and conditions (licenses, etc.) defined by the teams themselves. The open projects were made available through the digital platforms github, instructables and wikifactory. The choice was free. The hyperlinks to access the open projects created during the course are available in the appendix of this introduction.

<https://www.instructables.com/THE-GATE-OF-NOWERE/>



The case of ‘Open Timber Structures - Chatzini square, Agios Lavrentios’ summer school

The workshop ‘Open wood constructions - Chatzini Square’ (see [6]) took place from 12 to 15 July 2023 at Chatzini Square in the village of Agios Lavrentios, Pelion, with Dr. Dimitris Psychogyios, Architectural Engineer, Assistant Professor of the Department of Architecture, Faculty of Engineering, University of Thessaly, as scientific supervisor. The initial discussion on the content, objectives and point of implementation was attended by Patra Theologidou Architectural Engineer, MA Conservation Studies, Professor Kostas Manolidis, chair of the Department of Architectural Engineering University of Thessaly, and Dimitris Psychogyios. Subsequently and gradually, residents, representatives of local institutions, volunteer professionals and students [see contributors] joined and contributed to the workshop. The workshop was supported by the Department of Architecture Engineering of the University of Thessaly and was part of the ‘OpenVillage / Open Village’ initiative launched in 2017 by residents, local institutions, and friends of Agios Lavrentios. The aim of the initiative is to contribute to the discussion and the required actions and policies for local development through the use of local cultural and natural resources. Patra Theologidou is responsible for the planning and organisation of the Open Village activities.

The resources

The workshop ‘Open wood constructions - Hatzini Square’ has certain characteristics of Commons as identified in the work of Bauwens Kostakis, Pazaitis [7]. In particular, a community (participants) was formed for the creation of goods (equipment for public space and knowledge for the creation of equipment for public space) with rules and standards (regulatory framework) defined by the community.

At this point it is noted that the workshop can be analyzed through the prism of A) Common Knowledge and B) Common Urban Green. In the first case the emphasis is on the didactics of the Architectural Object (the resource is the knowledge to create the Architectural Object). In the second case the emphasis is on the ontology of the Architectural Object (the resource is the physical infrastructure and space).

Knowledge is intangible, intellectual, and abundant, while physical infrastructure is material and subject to material, technological and spatial constraints, and it is important to limit and control its use. These are inextricably linked issues, and the distinction is made mainly for methodological and scientific observation purposes. It is important to note that this paper focuses mainly on Common Knowledge for the

creation of the Architectural Project rather than Architectural Project itself as Common Good.

The Community

In addition to the identification of common resources, a second important element concerns the community created, and the reasons for the members' participation in it. From the initial conception of the idea and planning to the completion of the workshop and full operation of the space, approximately sixty (60) people participated with varying degrees of involvement. It is an informal community of students, volunteer local professionals, volunteer residents, members of local agencies and associations, and faculty. According to the expression of interest of the participants, the following elements emerged:

As for the identity/status:

- 70% students
- 10% professionals
- 20% other

As to experience in respective workshops, scale 0 (no experience) to 5 (very much experience):

- 18% experience 0
- 33% experience 1
- 31% experience 2
- 8% experience 3
- 6% experience 4
- 4% experience 5

In terms of expectations from the workshop, the popular keywords were:

- Knowledge
- Skills
- Wooden constructions
- Participation
- Collective effort

- Publicspaces

From the above it can be concluded that the community was not homogeneous. Two main categories of priorities emerge, on the one hand, the acquisition of knowledge and skills for wood construction and on the other, the creation of infrastructure and equipment for Hatzini Square. Nevertheless, through joint action and collective effort, the workshop was the catalyst for the development of a 'social process' which created the shared resources of intangible knowledge and physical urban space. In terms of Architectural theory, common knowledge about the Object of Architecture and a common Architectural Object was at the same time produced.

The Social process

The organizing of the social process includes four distinct sections: (A) Definition of content, objectives, actions, and limitations. (B) Open participatory planning, The open call for consultation and open participatory planning. (C) Open process of tools and materials, The open call for contributions of tools and materials for the implementation of the project. (D) Open participatory construction process, The open call for an open participatory construction process

(A) Definition of content, objectives, actions, and limitations

As mentioned, the workshop took place in the context of the 'Open Village' activities. Initially, the content, which concerned the implementation of wooden urban furniture (seats, protective railings, etc.) in Hatzini Square of Agios Lavrentios, was defined. In Hatzini Square there was already equipment that was in poor condition, unfinished and in a state of abandonment. It was initially proposed to restore the existing structure and to implement a bench as a prototype. Upon consultations and after securing the necessary construction materials, an integrated approach was decided that would consider the exceptional local characteristics, the existing functionality, and the hosting of a series of activities such as the 'music village' and the available local construction materials, in particular the chestnut timber found in the area. The participating organizations at the first phase were the 'Open village', the municipal unit of Agios Lavrentios and the Department of Architectural Engineering of the University of Thessaly.

(B) Open participatory planning, The open call for consultation and open participatory planning

Following, the Department of Architecture and Engineering organized an open invitation for participation in the open workshop of wooden constructions for Hatzini Square. About 45 people registered to participate. The workshop was organized into

two sections. The first one was implemented online and the second one in situ. In the first phase, three online meetings were held. The first web meeting involved an initial introduction of the members and their networking, a description of the goal and desired outcomes of the workshop, the limitations of the materials and constructions, material and equipment specifications, and the spatial boundaries of the intervention. The second web meeting included a seminar on wood, its properties, processing, and industrial products. After the seminar, open drawings and photos of the existing space were provided to design the equipment of the space. All the participants had the opportunity to elaborate on their ideas and make concrete proposals for the implementation of the project. The Department of Architectural Engineering was responsible for the collection and management of the material. The proposals were collected, categorized, and given to all participants. The third online meeting of the participants was then held, during which the ideas were presented by the authors and a final draft incorporating the results of the consultation was compiled. Minor modifications were made by experienced participants mainly in terms of adaptations to materials and construction methods.

(C) Open procedure for tools and materials, The open call for contributions of tools and materials for the implementation of the project

Once the specifications of the construction were established, the quantities of the construction materials and the necessary tools were determined in detail. The Architectural Engineering Department and local professionals provided free tools for the project. The local community also undertook the transportation of materials from the sawmill to the construction site. The wood used had been cut from woodland owned by the community and had undergone initial treatment by the local wood sawmill. The type of treatment and cross-sections of the wood had been determined in the design phase.

(D) Open participatory construction process, The open call for open participatory construction process

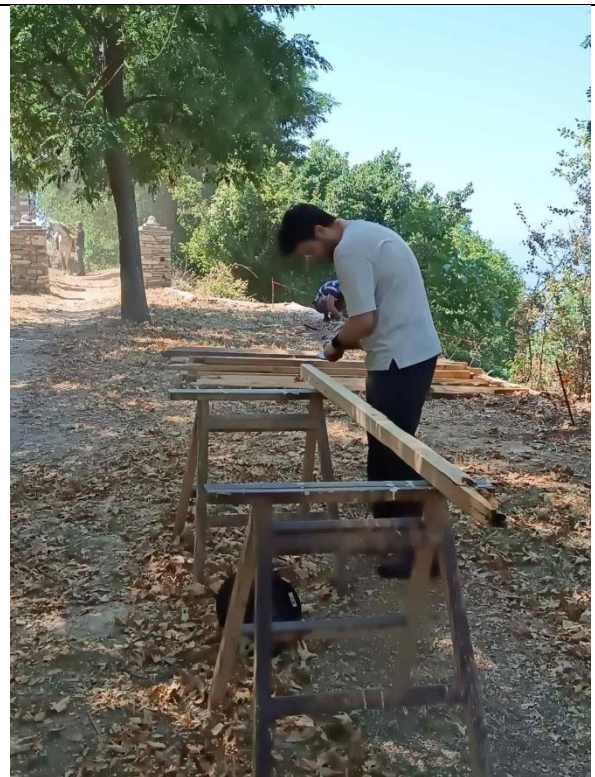
The participatory construction process lasted four days. It involved all involved parties, students, volunteer local professionals, volunteer residents, members of local institutions and associations and teaching professors. On the first day the wood was processed, the wood was marked out, and the location of the structures was determined. The second day was devoted to field preparation, wood preparation and excavation of the foundations. On the third and fourth day the assembly and final placement of the structures took place. The participants were divided into groups and the construction site was organized into two sections. Each group had participants of graded experience, and all were able to deal with all the construction procedures, initial preparation, painting, excavation, assembly, and final finishing. At this point it

is crucial to mention that during the project the experienced participants supervised and intervened, where necessary, in the handling of the tools because there was a risk of industrial accident or damage to the machine due to misuse.

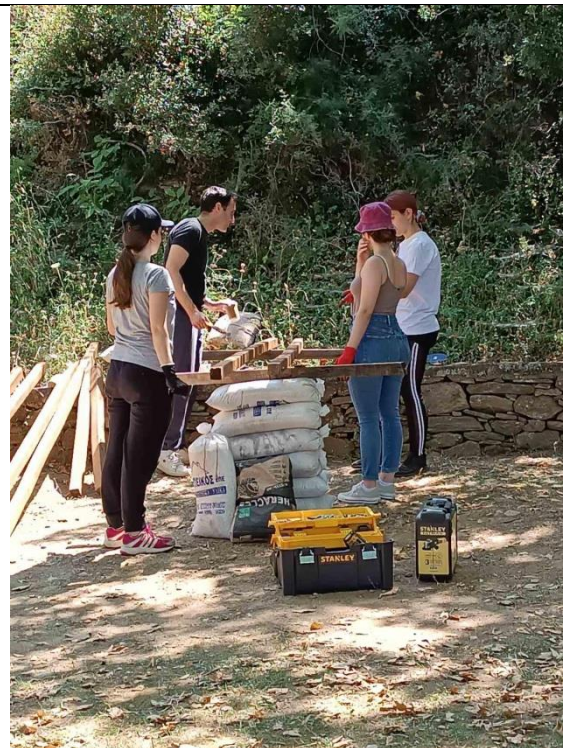
Arch. U.Th.



<https://www.facebook.com/photo/?fbid=247383948051694&set=pcb.247384651384957>



<https://www.facebook.com/photo/?fbid=247383948051694&set=pcb.247384651384957>



Conclusion

The introduction of Open Architectural Technology and the Digital Commons into the curriculum of a polytechnic school undoubtedly broadens and enriches the field of study in Architecture. At the same time, however, it faces several difficulties, the basis of which lies on the one hand in the specificity of the subject of Architectural Technology, and on the other, in the complexity of the parameters related to the changes brought about by the emerging economic, social and political system of commons.

The case of ‘Open Design, Structures and technologies’ course and the case of ‘Open Timber Structures - Chatzini square, Agios Lavrentios’ summer school are complementary actions because they addressed the issue of teaching Open Architectural Technology from a different angle. The first one took place within the university and within the framework of the organized curriculum. The second one took place outside the university, in direct association with the local community and outside the formal curriculum. It was a social experiment from which important conclusions can be drawn.

In the course ‘Open Design, Structures and technologies’ open projects were developed by small working groups and the opportunity was given to explore the specificities and limitations of openness at the level of design. Limitations in the sharing of CAD files were identified due to the skills that users need to possess both in terms of understanding the drawings (correct projections, sections, structural axiometry, etc.) and in terms of editing the drawings, as specific knowledge of program handling was required. The degree of detail and analysis of a project is also critical. In proportion to the scale of the project, more information and plans are required to enable its implementation at a future stage. In addition, prototyping at scale provides additional knowledge about the construction but does not address technical issues that arise in the final construction. Furthermore, more complex constructions require specific knowledge and experience of specification and regulation issues.

The case of ‘Open Timber Structures - Chatzini square, Agios Lavrentios’ summer school, is an action with many participants and many involved parties. It is also about an integrated project from a construction point of view in a public space. The need to support the project by an experienced working team with high technical training and specialized knowledge has been identified. The team faced complex technical issues such as material specifications, construction site organization, safe and efficient use of cutting and processing tools. In addition, the consultation time was limited and did not allow for meaningful participation of all stakeholders. Furthermore, the priorities

of the members regarding the outcome of the project were different, which generated disagreements that have not been incorporated in the final outcome.

Further research needs to be done on the terms and conditions of the development of knowledge flow and collaboration communities. The implementation of similar projects will allow more secure conclusions for the development of appropriate teaching methodology. Specification, safety and specialist knowledge and techniques issues are critical. In any case, access to Knowledge, Innovation and Technology seems to be the key in the fight against all kinds of exclusion.

Appendix A

‘Open Timber Structures - Chatzini square, Agios Lavrentios’ summer school participants (list of names in alphabetical order)

Agapitos Giannis
Aldebbeh Ward OmarAhmand
Anastopoulos Georgios
Avradopoulou Anna
AvthelaChryssoula
Balakoudi Niki
Batsiloglou Stavros
Boutsouki Sophia
Chasekidou Marialena
ChoulevaThomai
Deligiannis Giannis
Drikou Aspasia
Drosou Maria
Eleftherakis Michalis
Fatsis Apostolos
Fountoulis Stavros
Fraggogiannis Nikos
Fragogiannis Kostas
Galanakis Georgios
Garaganis Vasilis
Georgalas Dimitris
Giakoula Christina
Goulapsi Eirini
Grigoriadis Panagiotis
Katopi Glykeria
Kleisiari Katerina

Kolaogrias Ilias
Koukiou Zeta
Ktenas Apostolos
Lazarou Giota
LekidouEuthimia
Malamoglou Evgenia
Manolidis Kostas
Mantziou Eleni
Markopoulou Anna
Meggoudi Ioanna
Nika Eloiza
Ntaopoulou Elena
Oikonomou Anastasios-Rafail
Pachaki Magdalini
Pagonis Nestoras
Papachronopoulou Christina
Papaspirou Demeter
Pistolis Athanasios
Psychogyios Dimitris
Sakka Nikoleta
Saranti Sofia
Stamatellou Maria
Sxiza Barbara
Theologidou Patra
Tzavella Ioanna
Xatzigeorgiadou Motsi
XatzivaggeliAgoritsa-Anna
Zachou Dimitra

Tools for the summer school were provided by:

Wood workshop Kostas Fragogiannis
Wood and metal workshop, department of Architecture, University of Thessaly, Academic Coordinator: Maria Vrontissi,

Materials for the summer school were provided by:

Local authority of Agios Laurentios

Wooden mill - Agios Laurentios

Appendix B

‘Open Timber Structures - Chatzini square, Agios Lavrentios’ summer school links

- <http://www.openvillage.gr/>
- <https://www.facebook.com/people/Open-Village/100083402706055/>
- <https://www.facebook.com/photo/?fbid=247383494718406&set=pcb.247384651384957>

‘OpenDesign, Structuresandtechnologies’ course links

- (2023) Kalogrias, H., Pistolis, A., Fragou, T., Psychogyios, D., (supervisor) «The gate of nowere»<https://www.instructables.com/THE-GATE-OF-NOWERE/>
- (2023)Boutsouki, S., Xatzivaggeli A., Psychogyios, D., (supervisor) «Artistic Installation»<https://github.com/sopharia/Artistic-Installation->
- (2023) Aivaliotou, S., Politi E., Psychogyios, D., (supervisor) «Exhibition furniture»<https://wikifactory.com/@elepoliti/%CE%B5%CE%BA%CE%B8%CE%B5%CF%83%CE%B9%CE%B1%CE%BA%CE%BF%CF%82-%CE%B5%CE%BE%CE%BF%CF%80%CE%BB%CE%B9%CF%83%CE%BC%CF%8C%CF%82>
- (2023) Papaxronopoulou, X., Sxiza M., Psychogyios, D., (supervisor) "Shade park / guide Oasis,<https://github.com/xristinapxr/Shade-park-guide-Oasis>
- (2021) Skordou, N., Psychogyios, D., (supervisor) ‘Open Cultural infrastructures’ <https://natalisk91.wixsite.com/open-design-lightwei>
- (2023), TsinidisA., Psychogyios, D., (supervisor)«Zenith game»<https://www.thingiverse.com/thing:6046243>

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Sotiriou Gioka and Tzaferi, Mystery 41 Design Campus
<https://2023eleusis.eu/en/events/mystery-41-design-campus/>

Psychogyios, D., 'Open Timber Structures - Chatzini square, Agios Lavrentios' summer school, <http://www.arch.uth.gr/el/activities/3027>

Bauwens, M., Kostakis, V. and Pazaitis, A., 2019. Peer to Peer: The Commons Manifesto. London: University of Westminster Press. DOI: <https://doi.org/10.16997/book33>