



Course 11955- Large Scale Structures in Urban Context (1st Part)

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Course 11955

Large Scale Structures in Urban Context (1st Part)

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1 Strategy and Content

Content of the case

The course 11955 is a large design project course where the main strategy is to set a project in a realistic framework through a collaboration with a municipality. Secondly the strategy is the focus on specific design method, and the transition from one design phase to another. The project has a real site chosen by the municipality of Copenhagen for its complexity and obvious problems. The idea behind the course is a transition from a completely blank sheet where gradually more and more disciplines are added: traffic, climate adaptation, solar conditions on the site, history, a new programming and storytelling for the site, conceptual structural design, geometry. The disciplines that are integrated in the design project are added according to a kind of meta version of a commercial project going from the urban scale to detail. The idea is that the new programming and story for the site should be made manifest in a structure. And this structure must be defined in terms of structural design and geometry.

Teaching strategy and learning output

The project aims at ensuring a realistic collaboration with a municipality about solving a real urban scale challenge in the city. The teaching strategy is a sort of method transfer, where engineering students use the methods of artists and architects, while also having periods where they use their own engineering methods. The overall teaching strategy is to start with a very large level of complexity, and through the methods taught to the students, they are made able to handle the complexity and gradually make it operational and fitting to a design project.

The learning output is knowledge of how to preserve the initial conceptual design ideas for the site when defining the project more and more and going from one the design phase to the next. Actually from scratch to a completely geometric and structurally defined proposal.

2 Boundary Conditions

Format of the case

Design studio, B.Sc. Level, 3rd semester, mandatory, 13 weeks, 5 ECTS (135 hours). Course 11955

Group of participants

55 B. Eng. in Civil engineering. Working in groups of 4.

Participation requirements: students must have passed the first two structural mechanics courses, two BIM courses, an architectural history and architectural design course before entering course 11955.

3 Interdisciplinary Character of the Case

The interdisciplinary elements derive from different design phases that are both very artistic and very technical / engineering oriented. The long term, open-ended and complex project serves as a backcloth for both artistic exercises and engineering analysis. Combined the exercises or teaching elements outline a full interdisciplinary design process including artistic, architectural, urbanistic, engineering and mathematical methods. However, the students involved are all engineering students, though from a line of study where emphasis is on design.

The interdisciplinary part of the project is primarily in the very early focus on conceptual structural design. The course is structured in partial deliveries where posters and model photos are uploaded. Just after deciding on the new story or concept for the site the students start working on structural concepts. The idea is as mentioned to make the new programming and story for the site manifest in a structure but the structural design also influences and enhances the initial story. The course 11955 takes place every Wednesday from 8-12. Parallel to this the students have a number of other courses. One of these courses is a geometry course (course 01237) given by the Math. Department. In a joint half day workshop the students present near-finished projects and the geometry teachers take part in an atelier critique of this. The geometry teachers then directs the attention of the students to hidden geometrical problems in their projects. These problems are then addressed in a report that is assessed in the geometry course but the results are implemented in the design project.

4 Methods and Tools

Role of the teacher(s)

The studio course is predominantly student-centered with the teacher as consultant and moderator. Only during few input lectures the role of the teacher switches to a more teacher-centered teaching. However the project is tightly structured for the first 6 weeks with weekly deliveries that must be uploaded.

Methods

INPUT LECTURES short lectures to frame the next design phase and give directions, contextualize it with respect to the goals of the course.

EXPERT LECTURES Lectures on rules of thumbs (zooming out) and structural system design.

GROUP WORK

TASK FORCE TEAMS not working in design team students are analyzing specific task, works as background for the design project (like traffic, wind). The aim is to foster cooperation, sharing information and submitting knowledge from group to group.

DATA COLLECTION urban analysis, conducted by the **task force teams**, that studies:

- Site history from municipal resources
- Current and previous municipal plans and strategies for the site
- Climate adaption plans
- Wind analysis: 1:200 models of 4 places around the site and on the site to conduct wind analysis (wind tunnel)
- Sun conditions in the area (Sketch up 3D model)
- Traffic strategies for the area — especially planned super bicycle lanes.
- The above described is presented in an **A3 SIZE REPORT** and is assessed by the teacher with comments on the intranet and at the oral **PRESENTATION**.

GROUP WORK

DESIGN TEAM collaboration, working together transdisciplinary, influencing others by presentations, exhibitions with gallery critiques and lectures and supervision. During the first two weeks in the autumn part of the course (before the Christmas break), the students together gather information through a task force team structure. The rest of the time, after that, work in design teams until the final presentation before Christmas. This pattern is repeated again in January where the students for the first week, work in task force teams with structural systems and simulations in the software robot. And the last two weeks in January the students again work in design teams, and adjust the universal structural systems to a real project in a real place in the city.

INDIVIDUAL WORK

ARTISTIC AND INTUITIVE EXERCISE where students are given 4 pictures that they should create a story from. This works as a warm up for the individual exercise the students do by the end of the **bicycle excursion**.

EXCURSION The site is visited by means of a bicycle excursion because "super bicycles routes" is the main traffic strategy for Copenhagen.

STORY BOARD students individually write new stories for the site, which also include ideas for new programming as a kind of conclusion or result (synthesis) from the bicycle excursion.

COLLAGE students upload individually 2 A2 posters with the new stories for the site as collages of texts and pictures. This is assessed by the teacher only with individual comments in the intranet.

INTERIM INDIVIDUAL PRESENTATION Based on the individual stories for the site (the two A2s) the **design teams** meet for the first time and decide on two concepts for the project.

SILENT GROUP PRESENTATION the two chosen concepts are presented as 2 Ao posters. The 2 Aos mentioned above are evaluated and interpreted by the teachers without an oral presentation by the students. Graphical communication is important in order to communicate and develop ideas in the design team and it is equally important in order to preserve the character and atmosphere of the project when it becomes increasingly more and more concrete during the progression of the design process.

EVALUATION FOR DECISION-MAKING choosing which kind of structures would be suitable for making manifest the new story for the site and at the same time solve some practical problems in the areas such as lack of recreational areas, noise pollution, large roads as barriers etc.

PHYSICAL MODELS Structural concepts studied through cardboard models in scale 1:200. The structural concepts should both make the new story manifest. Photos of cardboard models of structural concepts are uploaded on the intranet. They are commented orally by teachers during the atelier round.

SUPERVISION in the **design teams** by both architect and structural engineer supervisor. Communication within the group: The students are supervised 4 hours a week or instructed concerning the next weeks delivery. (The rest of the week they have other courses). Communication with the teacher(s): There is one teacher in the course that talks with each student group once per week approximately 20 minutes per group. Discourses carried out: reflections concerning design methodology.

GROUP WORK next steps in the design team are:

- Design of overall structural system
- Structural calculation by means of rules of thumbs and diagrams that explain how the structure works (students learn staad pro in the next semester).
- Zooming in on one special detail (to give the character of the project).

GROUP INTERIM PRESENTATION preliminary version of the final project proposal presented with 5 Ao posters in a workshop with the geometry course. An architect, an engineer and the geometry teacher give atelier critique concerning overall design, geometrical problems, structure and structural calculation.

GROUP WORK next steps in the design team are:

- Integration of ideas for optimizing the geometry.
- Optimizing the graphical communication.

FINAL PRESENTATION is 5-6 Ao poster and a 1:200 models presented to the teachers and the municipality. It has the form of an atelier critique where all the students can hear each other present and the feedback they get. The Ao posters present urban strategy, programming /concept for the new story for the site, the structural design that solves many things in one go and makes manifest the new programming and story for the place, the structural calculation, the static system, the zooming in on one detail, the geometry. If relevant students also have done second round of wind tunnel testing.

Tools

URBAN ANALYSIS study of documents from the municipality

SUN ANALYSIS tool: sketch up model used for mapping the annual sun in the area (and shadows).

WIND ANALYSIS Yool: 1:200 physical model, wind tunnel test, analyze the photos from the wind tunnel test in MABLE

INTERVIEWS AND QUESTIONNAIRES how do the inhabitants see the area (POE)?

STORY BOARD

COLLAGES combination of photos and own sketching to communicate a new story for the site

ANALYTICAL SKETCHING on maps to merge the new story for the site with an overall urban strategy and plan. Creating architectural diagrams that communicate the concepts and make them manifest and operational in the project.

ANALYTICAL DRAWING choosing a place in the structure where to zoom in and create a detail (section) in 1:50.

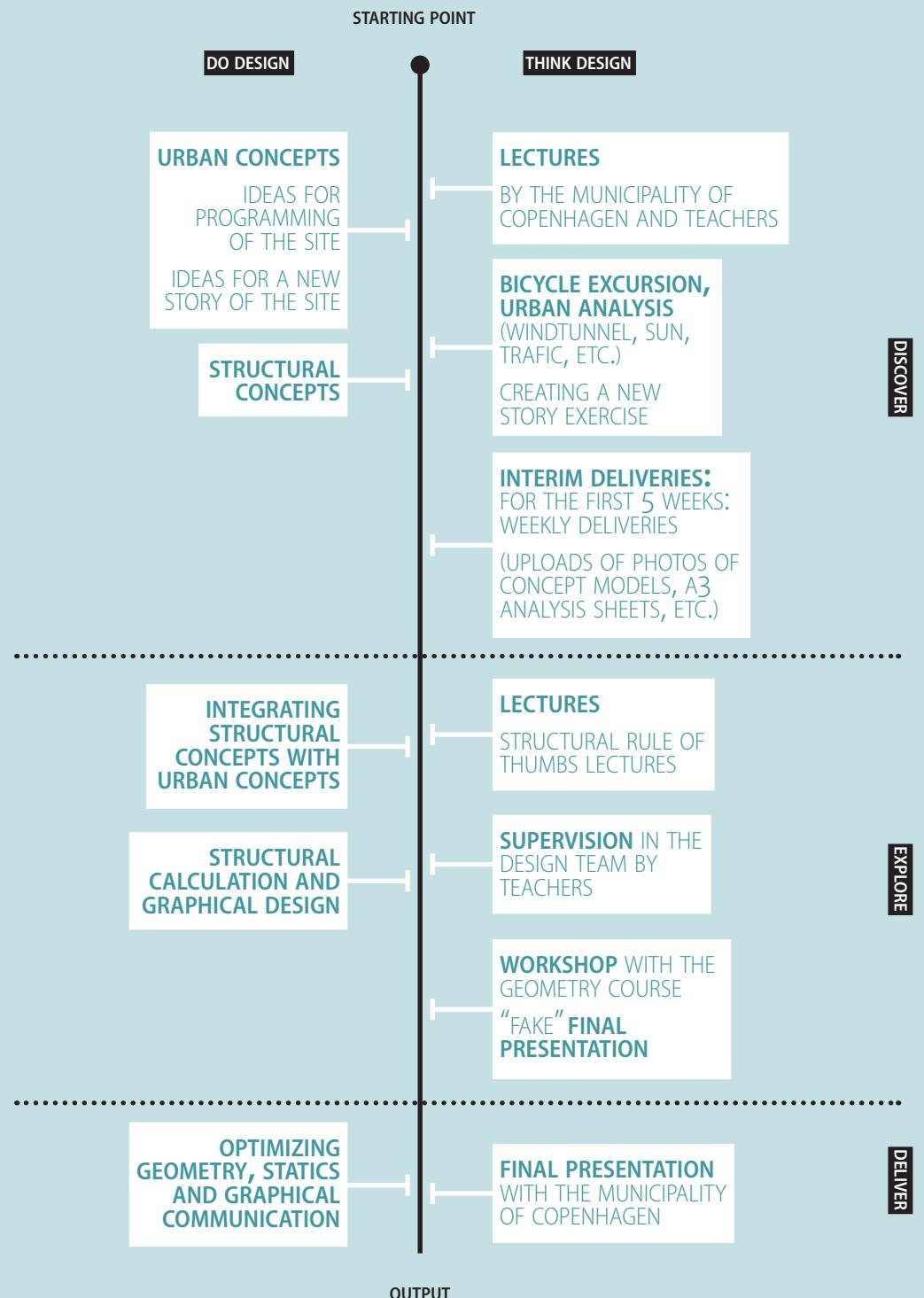
PHYSICAL MODEL conceptual structural design by means of card board models in 1: 200 and structural rules of thumbs

SIMULATION of structural system through ROBOT or other professional finite element software — supplemented by rules of thumbs.

5 Process and Implementation

The teaching takes place in a realistic framework given by the site in Copenhagen. The project is divided in project phases that are introduced by lectures given by employees from the municipality and by the teachers. The students form 5-6 person design teams. The first two weeks of the course the design teams are not in operation but members are distributed in urban analysis teams that study site history, municipal plans and strategies, climate adaption plans, wind (wind tunnel of 1:200 models) and sun conditions in the area and traffic strategies for the area. They produce an A3 landscape size report for all the design teams to use later on as background material.

Then the site is visited by means of a bicycle excursion and the students individually write two proposals for a new story for the area. The first meeting in the actual design



team is when the students present their individual proposal for a new story for the area for each other in the design team.

The structural design part of the project is introduced very early — just after the basic concept and new story/programming for the site.

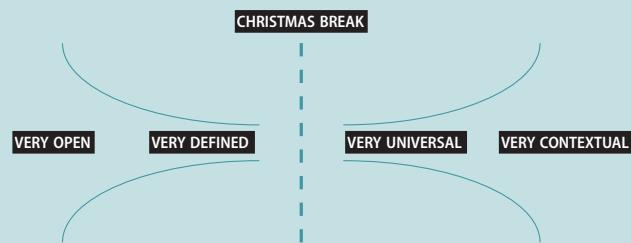


FIGURE 1: Overview of the course structure and the phases of the design process.

- 13 week courses organized in one block of 4 hours per week.
- There are elements of discover, explore and deliver in the entire process but the first 4 weeks are more discover, then 4 weeks with explore (the integration of structural concepts) and the deliver phase is omnipresent however the 1.200 model and the 5 Ao posters towards the end of the project demands at least 2 weeks in the final part of the project.
- Lectures and discussions are grouped in the first half of the project course. There are no lectures in the second half of the course.

Development of the Contents | Outputs

See Case Tree in: Page 51.

DO DESIGN: these are more or less the tools and their outcome

THINK DESIGN: these are more or less the methods and their outcome

6 Reflection

Reflection on the teaching strategy | Methods | Tools

This teaching strategy is focusing on structuring an open-ended interdisciplinary design project by presenting design methods with specified tasks and tools that make up method elements from urban planning, artistic work, architecture and engineering, and math/geometry. The aim is to arouse attention concerning the movement from one design phase to the next – how design decisions are made. To achieve this, both very artistic exercises and very engineering oriented exercises, are presented to the students.

Since it is the first time in their study that students are to create such a large project a lot of care and optimization has been made during the 12 years that the course has existed in making the process understandable to the students. A set of well-structured lectures, matching the weekly delivery descriptions, draw an interdisciplinary path for the students to follow in the overwhelming open space of such a large project. This clarity in the organization leaves students the space for observing the interfaces from one phase of the project to the next.

Reflection on the quality of the outcome

The quality of the outcome is higher than what could be expected from 3rd-semester students, because they are introduced to a step-by-step interdisciplinary design process.

Reflection on the learning output

Especially the January course is very intense and demanding, however, this tour de force gives the students a chance to learn how to maneuver in a large design project by themselves. In the January part of the course students are supposed to utilize themselves the interdisciplinary design process taught to them during the autumn.

The projects, in general, showed a very high level in all design phases and a great care for the transition between the different design phases.

The students work very hard and their workload is a lot more than what is formally required. This is not a problem because they could get an average assessment, but they choose themselves to work harder to get a better grade, or more importantly, because this project exposes the potential of integrated design which was why they chose DTU architectural engineering in the first place.

Reflection on the interdisciplinarity

The interdisciplinarity of the different exercises that make up the entire project is the main focus of the course.

The integration of urban planning concepts and structural concepts from very early in the design process is the engine in the work with interdisciplinarity in the course 11955. It is an experience for students that they see for themselves that structural design can generate architecture – even on an urban scale. They are told in lectures that infrastructural projects today have to honor much more than just bridging from A to B, but in this course they experience that it can be done.

The integration of mathematical geometry and structural design (and urban design) is done by the simple 'tool' of a half-day workshop.

Comment on the case

Yes the aims are achieved.

The described teaching strategy is applicable to third semester students with an architectural engineering background. Often these kinds of projects appear in the 10th semester as key stone projects of MSc students. However, it is important to introduce early on the notion of and methods to deal with interdisciplinarity, because it then becomes a backcloth for all later disciplinary teaching and learning.

Comment on the communicative structure:

The challenge of the course is the need for both engineering and architect's supervision of the design teams which is very demanding for both the architect and the engineer. The communicative structure is organized around the weekly uploads and the lectures and task descriptions that are attached to the weekly uploads.

Climatic Architectural Device

Autumn Studio 2015

Master of Architecture in Extreme Environments

EMANUELE
NABONI +
OLGA POPOVIC
LARSEN

Royal Danish Adacemy of
Fine Arts, Denmark
Institute of Architectural Tectonics

1 Strategy and Content

Content of the case

The proposed semester studio explores the idea that designers can create customized tools named "architectural devices" to research and comprehend the magnitude and the quality of hyper-specific site conditions and inform design. The devices are designed and fabricated by students attending the Master of Architecture and Extreme Environments at the Royal Danish Academy of Fine Arts School of Architecture. They range from body equipment to body shelters an up to spatial installations. The devices are sensitive and reactive to bounded conditions, adapting their form, aspect, color, light, and position. The tools visualize the hidden potentials for regenerative solutions interrelated to the cycles that characterize a place (e.g., thermal, water, flora and fauna, human cycles).

Teaching strategy and learning output

The devices are adopted in the context in extreme climatic conditions. They are situated in difficult areas as a mean of learning how to capture sensitive data. The devices retrieve information of energy potentials, pollution, temperature, breezes, humidity, rainfall, sky condition, light quality and their interplay. A variety of devices reveal how they form a link to fine-tuned design tactics. The teaching is thus aiming at an individual exploration of the space and the development of an awareness of environmental factors. The studio is aiming at a complete prototype proposal from a research phase to the construction and the testing on site. This is the primary teaching output.

2 Boundary Conditions

Format of the case

Semester design studio, master level, 10 weeks

Group of participants

20 M.Arch. students; specific set of skills is required: research abilities, modelling and fabrication skills, scientific approach, structural and material understanding

3 Interdisciplinary Character of the Case

The design exploration within the studio is based on the definitions both their problems across the borders of: architecture, structural and material engineering, climate analysis, environmental studies, fabrication, chemistry, physic, biology, chemistry, ecology. The disciplinary perspectives are integrated.

4 Methods and Tools

Role of the teacher(s)

The studio course is predominantly student centered with the teacher as consultant and moderator. There are a group of researchers involved into climatic design, sustainable design, simulation modelling, data acquisition, material understanding, structural behavior, constructability aspects and technique. Several input lectures are provided by specialists from different fields ranging from biologist to anthropologists.

Methods

INDIVIDUAL LECTURES: short lectures on climatic, sustainable design and use of tools, materials, structural design, deployable and transformable structures with direct input into the architectural device character and scopes

THEMATIC WORKSHOPS: Group of 4 works in the first weeks to create a test facility for their device, the test facility reproduces extreme conditions that students will find in place once they reach the extreme environment

REQUIRED READING: a collection of theoretical and technical texts is selected by the students that operate a literature review, which students have to work though in parallel to the device development. This should help to confront their practical work with the ongoing discourse in science.

FABRICATION: students make-fabricate their devices, that have to be light-weight and lightweight to transport by plane, ready for deployment and use on site

TESTING: students test their device reproducing the extreme conditions in self-made testing rooms

REVIEWS: summary of weekly developments on the base of physical models of the prototype.

COMMUNICATION of the basic ideas and findings only though precise drawings and diagrams.

EXTREME ENVIRONMENT ONSITE VISIT: students locate their device on site and collect data in a real extreme environment

FINAL PRESENTATION: each of the students presents the outcome of their designed prototype. Reviewers are internal and external with a critics visiting from abroad.

PORTFOLIO DOCUMENTATION: the studio does not end with the final presentation but rather with a final documentation that functions as reflection of the process. Students are required to prepare a graphical portfolio. Findings are used to inform an architectural development of an architectural proposition, which happens in the second semester.

Tools

PROTOTYPE: The Architectural Devices are brought, deployed and tested within the territory in question. These assemble act as hyper-specific study agents and as experimental measuring medium to scrutinise, measure and cooperate with the complex environment.

TEST ROOMS: An introductory, experimental driven phase, aims to perform climatic and material tests based on scientific research methods.

FABRICATION WORKSHOP (e.g. metal workshop), targeted at constructions, are devised to satisfy the demands of scientific research while studying practical, visual and spatial entanglements. There is a specific requirement on lightweight transformable structures.

FIELDWORK, implies the installation of the device, its fine tuning and the acquisition of data. The investigation pursues a site-specific climatic and environmental investigation.

CLIMATIC AND ENVIRONMENTAL TOOL: a series of equipment is used by students: thermal cameras, drones, 3D scanner, data loggers of any type of climatic and pollution conditions.

Chronological development

See Case Tree in: Page 59.

10 weeks long studio organized four phases:

- An introductory, experimental driven phase, aims to perform climatic, material and structural tests based on scientific research methods.
- The second phase, targeted at constructions, is devised to satisfy the demands of scientific research while studying practical, visual and spatial entanglements.
- The third step, the fieldwork, implies the installation of the device, its fine tuning and the acquisition of data.
- The fourth phase presupposes the breakdown and processing of gathered data.

Development of the contents | outputs

- In the first phase, students create artificial test rooms. Also, they could exercise with the modelling of materials that they could detect in the extreme locations.
- The devices are made of an organic composition (biotic) and a synthetic (abiotic) material.

- In the second phase of prototyping, students operate in the manufacturing workshop. Performances and costs are discussed with researchers in sustainable design, building physics, material, structure and industry manufacturers.
- Assembling the final prototype is a design hurdle in itself, as limitations in transportation are a restriction. A lightweight, transformable and easy-to-assemble design, which partially relies on local materials is essential.
- The fieldwork phase is concerned with surveying and mapping the environment through the constructed device.
- Beside gathered knowledge from the process, students examine local phenomena and can ascertain design hypotheses instantly.
- As opposed to developing a hypothetical or uncertain interpretation of the site from data such as weather file and environmental records, the architectural device enables the direct measure of local microclimates and ecosystem and the examination of regenerative ideas, this before fixing any design option.
- The fourth phase, is about reporting in graph all the measurements that were made on site, data are interpreted and processed and the "learnt lesson." described.

5 Reflection

Reflection on the Teaching Strategy | Methods | Tools

Engaging through design and manufacture before the departure to Brazil, students were able to construct devices to chart specific conditions related to a chosen field of interest. Drawing inspiration from different science and technology domains, and with a specific focus on climatic and natural cycles, students devise were able to visualize and measure phenomena (amplification of the phenomena) while testing solutions able to engage and control the phenomena itself, thus providing design inspiration for the site regeneration

Reflection on the quality of the outcome

The architectural devices establish a visual clarity and hierarchy that manifest the details of complex phenomena. The complex phenomena understanding and control by design was achieved by the means of the interdisciplinary process.

Reflection on the learning output

Students learnt how to research, gather knowledge from different disciplinary domains. They learnt to synthesize data from different formats to inform design. They learnt how to test the validity of design choices by onsite verification. They also experimented with aesthetic potentials arising from scientific data recording and presentation.

Reflection on the interdisciplinarity

The interdisciplinarity is manifested in one object. The architectural device is aimed to relate to climatic processes, biological sciences, sophisticated structural and mechanical

engineering, material science, chemistry, physic, component design and fabrication, etc. having an artefact that display the interdisciplinarity was found to be a perusable method to communicate strategy derived from a multiple domain.

Comment on the case

It was found difficult to communicate the multiple performance offered by the devices in a clear report format. While the architectural potential communication was fully communicated, it is necessary in future to adopt reporting methods (e.g. data collection) derived from scientific disciplines. This may be beyond the scope and needs of an architectural education, but if developed in partnership with other/more scientific or engineering students may benefit the latter. As the devices are quite creative and ambitious the collaboration may also lead to the development of novel components, devices or approaches that can benefit society.

Comment on the communicative structure

Communication within the group | with the teacher(s). Discourses carried out. The communication happened mainly on individual bases. Each student also engaged with different disciplines and expertise depending on the specific research design path.

