

Designing Towards Ecological Environments

A Modular Approach to Structure a Design Studio Sequence

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TIMELY CHALLENGES

Architecture is a process that forms the physical background of every-day life. Both in academia and practice, a contemporary design studio must tackle ecological topics as architecture materializes itself within the rapidly changing natural environment. The premise for this paper are three timely challenges that the world is facing collectively in this stage of Post-Industrialization.

First and foremost, the challenges arising from the Epoch of the Anthropocene. As the repercussions of climate change have started to materialize, the built environment needs to adapt to changing conditions, from sea-level-rise to extreme weather and cultural shifts, as climate migrants need to find new lands.

Second, the challenges correlated with globalized economies and networks which have been a major force causing environmental threats and change. Capitalist democracies in the western world have developed complex logistical processes shipping commodities, goods, and thoughts around the world. These processes have shaped the (built) environment and life especially in urban areas. The relationship between the individual and the collective undergoes change as a consequence of how (political) regimes organize their economies and distribute wealth.

Third, the challenges and opportunities digitalization offers to society. The dematerialization of (urban) landscapes through digital media enables the (re)distribution and access to information, education, and labor. Urban environments need to address these challenges as opportunities to create fairer and healthier places to live.

These three challenges form the context of the studio modules presented here and link the contemporary discourse of architecture to a global cross-disciplinary discourse.

ARCHITECTURAL EDUCATION: GLOBAL CHALLENGES AND REGIONAL RESPONSIBILITY

This paper calls for the education of responsible designers as critical thinkers on their path to become global citizens. As climate change is drawing new edges onto the earth's surface, political boundaries seem obsolete as the factor of geographical location clusters territories beyond man-made borders. The intentional focus of ecological topics in architecture and architectural education must not be a platitude, though the term "ecology" seems to be omnipresent in the discourse of (landscape) architecture and (urban) design from Moshen Mostafavi to Charles Waldheim.¹

Ecology describes the "relationship between living organisms to their environment."² It is a task that needs to be addressed disciplinarily and interdisciplinarily. Especially in architecture, the relationship between the natural and the built, between cultural activities and socio-economic processes and the places they are taking place within, is of highest importance and therefore relevant for architectural education. As Waldheim summarizes "Cities are historically bound up in, and shaped by, economic processes. [...] This complex set of social and economic processes has corollaries in the physical transformation of natural environments into built environments (or indigenous into artificial), the colonization of territories, and the construction of cities."³

As educators, we need to constantly link architectural creation to

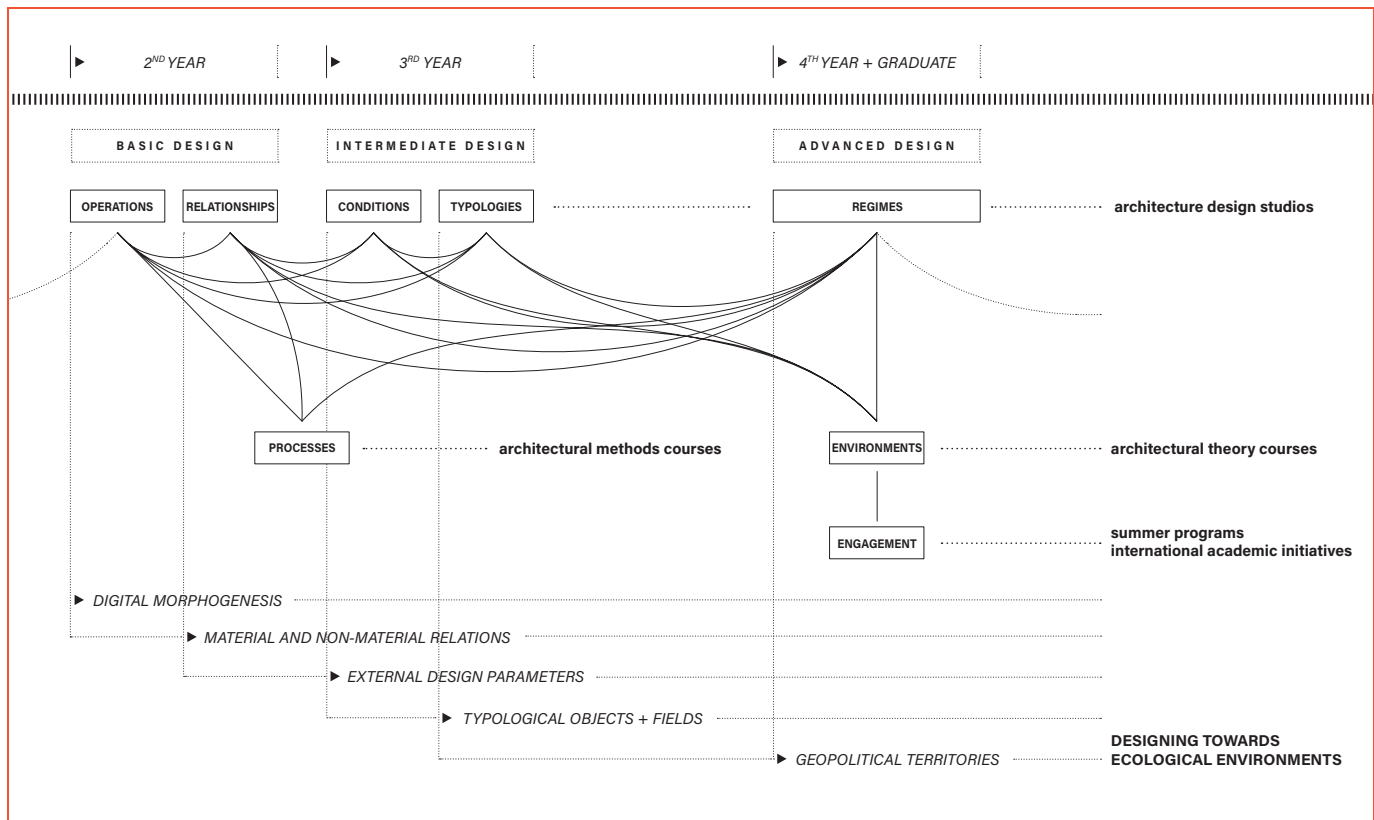


Figure 1. Module Overview: This diagram shows the placement of the modules within an architecture curriculum (either 5-year, or 4+2 program). Besides the five studio modules, the links to architectural methods, theory, and study abroad courses are shown. All modules have been taught between 2015-2019 at the University of Texas at Arlington. (Diagram by Oswald Jenewein)

the (historical) processes, which enabled human settlement in specific places, to the impacts of human activity on the transformation of these places. This includes but is not limited to the built environment. Therefore, the education of an architect must not be seen as theoretical or unrelated to reality but as a product of cultural activity shaped by global trends and regional phenomena. Architecture always takes place within the real as long as progressive projects address contemporary problems through visionary concepts and designs.

The physical analysis of a place starts with the very surface, the basis of architectural creation: land. Architecture as a phenomenological discipline must include the natural beyond the built environment and more: "drifting clouds, night and day, as well as feelings" according to Christian Norberg-Schulz.⁴ The relationship between building and land demands to be renegotiated in a time, where changing weather patterns shift the edges of land and water and hence change the foundation of physical creation. Consequently, a vernacular component in design education requires location-related parameters to be addressed.

Architectural education should develop projects which take on regional responsibility while connecting a region to its geopolitical role holistically. This approach helps students to redefine their relationship to their surroundings.

STUDIO MODULES

Architecture as a cultural practice needs to be linked to and understood as a consequence of history. Architectural education located within different academic units needs to be on the forefront of merging digital and biological spheres. Much like history itself, digital design processes have become a continuous process of transformation. The modules described in this paper summarize five design studio courses, instructed over the past two years, to demonstrate a modular course sequence which aims to convey a general understanding of architecture as part of the emerging systems in the Post-Industrial Era.⁵

The sequential modules titled *Operations*, *Relationships*, *Conditions* and *Typologies* lead to the final module *Regimes*. These studio courses range from foundation level to advanced courses in the graduate program. The modules are interconnected components depending on each other. While a module represents a semester-theme, all modules are, to a certain extent, part of all semesters. Each module informs the next and builds upon the previous theme. The modules ideally adapt to changing internal or external parameters and focus on a particular studio topic, student skill-set and allow for evolving projects.

OPERATIONS

To design, we need to know how to operate within and manipulate the properties of space. Translated into a contemporary language of (digital) design and formal experimentation, space is defined by geometric entities, a set of precisely calculated lines and surfaces that form volumes. Generating and manipulating geometries requires an understanding of the relationship between parts and between the whole and its parts. At a foundation studio level, (design) operations form the basis for developing a three-dimensional skill-set to perceive, form and transform space as a geometric entity. Understanding the design and qualities of a geometric object, the properties of space, its parts, and the dependencies between the parts, allows to zoom out and relate the object to other objects and to a datum.⁶

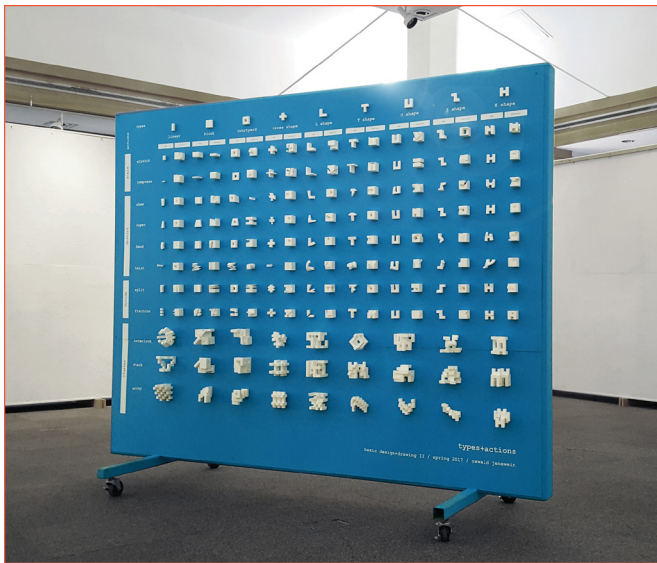


Figure 2. Types and Actions: This panel shows typological studies on basic Euclidean geometries. These geometries are being modified through a series of spatial actions. The final iteration applies different alignment strategies on clusters assembled by repetitive pieces. (Oswald Jenewein)



Figure 3. Coastal Mutant: This project methodologically applies the concept of additive transformation to relate a series of cubic volumes to each other and to a datum. The structure is elevated on pillars which serve as regulating grid. (Oswald Jenewein, Marcos Craine, Nate Wade)

The assignments titled “Digital Morphogenesis” investigate geometric transformations on basic Euclidean geometries, additive, repetitive, and subtractive operations, as well as alignment strategies from objects to the application of objects on a field (datum). Three-dimensional NURBS-modeling requires the precise construction of geometries and allows to apply important design operations which originate from the pre-digital world. Students understand the computer not as a tool of representation, but as a tool to generate form.⁷

Alongside with developing skills in spatial thinking, design and (descriptive) geometry, methods of architectural representation form a major component of this module. Sketching and drawing remain to be absolutely essential for architects both analog and digital, however, this paper strongly advocates for the implementation of digital design as an integral part of architectural education from the very beginning, and ideally even before entering architecture programs. Analog and digital processes of design have a symbiotic relationship supporting not excluding each other. The language of architectural design has started to borrow biological terms as the concepts of transformation and growth have become more relevant than Fordist assembly. As digitalization has become an integral part of almost every part of society, higher education needs to embrace, to then utilize, technological progress.

As the goal for each studio module is to prepare the next one, the emphasis shifts from operations on objects to the relationship between objects towards the end of the semester. An abstract datum is no longer just a surface, but evolves into the notion of ground. Scale and proportion start to be related to the ecological scale of living beings rather than just introducing the concept of human scale.

RELATIONSHIPS

Once we deal with several objects, the notion of orientation, scale, and placement becomes significant. While the object becomes secondary, the relationship from the object to its (geometric) surroundings and ultimately the relationship to other objects moves to the foreground. These relationships between objects and their surroundings require thinking beyond the part and a group of parts: any given datum, the concept of place and its topographical, yet still geometrical, qualities need to be addressed as an external premise to a project.

This module is built around a narrative that links a formal design concept to a programmatic idea of events that take place within and around architectural design. Like at the beginning of each semester it is essential to first develop an understanding about the individuals and their talents, skills, and perhaps shortcomings in the respective studio. An advanced understanding of design operations and 3D-modeling should be a given, yet it cannot be expected that each studio member is at a similar level. The first assignments serve the purpose of summarizing the previous module in an advanced and condensed way.

The main semester project in this module is titled “A Story of Mutants, Parasites, and Hybrids”. Students work in teams of two, as group-work is a critical pedagogical approach in the Relationships module. While the teams explore new methods and processes of (digital) fabrication and (digital) representation, they constantly align

their narrative, of a fictional traveler, to their design. This character travels through different conditions: from the coast, to the city, to the mountains. The first three-week project is a Coastal Mutant. Coastal describes the condition as the task is to have a datum that could either be land or water at different times. The structures designed by the teams are elevated on pillars which simultaneously serve as spatial regulating lines and are the basis for introducing structural systems. Through additive and subtractive transformation a set number of volumes get spatially transformed to generate a sequence of mutations redefining the relationship between the volumes from first to final iteration. The second project is an Urban Parasite, a structure situated on a roof top or in an alleyway of a city. The task is to utilize an existing building and the internal circulation to access the parasitic structure, which formally strongly differs from the host building. Through a continuous process of transformations, the design method challenges the teams to morph a smooth single-surface geometry. This project needs to be completed within ten days. The final project, the Alpine Hybrid, is a project that merges landscape and architecture into a hybrid. Exposed to extreme slopes, the teams develop concepts utilizing topography lines for their designs.

For all three projects, the production of physical study and final models provides skills in 3D-printing, lasercutting, casting, and in using CNC routers.

Preparing the next module, the projects aim to relate geometric ideas to a formal yet generic condition in which their narrative informs the design concept and vice versa. Through experimenting with different materials and physical models the notion of materiality, natural light and orientation become relevant. The development of a narrative, of a fictional character, asks students to address global, ecological issues. A marine biologist, a former petrochemical engineer, or a climate activist become representatives of timely collective problems of society. While the teams expand their knowledge on these issues, the focus remains on design. The narrative is a playful task of secondary importance not claiming to solve any problems but to support a design concept.

CONDITIONS

As the surroundings steadily become more detailed in the previous two modules, they move towards concrete site-conditions contextualized into the natural, cultural and built environment of a place. The design of an architectural object is not just strongly connected to a specific site in a specific place, but the exposure to these site-conditions becomes a premise for design decisions on both the scale of the object and the surrounding field. A set of ecological parameters inform the design in addition to formal investigations of the (built) context. The investigations focus on the territory of the Gulf of Mexico as a prototypical (industrial) landscape along the coast. Field trips are an integral part of this semester, as well as community meetings off-campus to develop and gather first-hand experience and to understand architecture as part of a local, or regional community. Students see the logistical infrastructures of a seaport, corroding industrial facilities, or hear from locals how their lives are being impacted due to the operations of a coastal city. The goal is less to

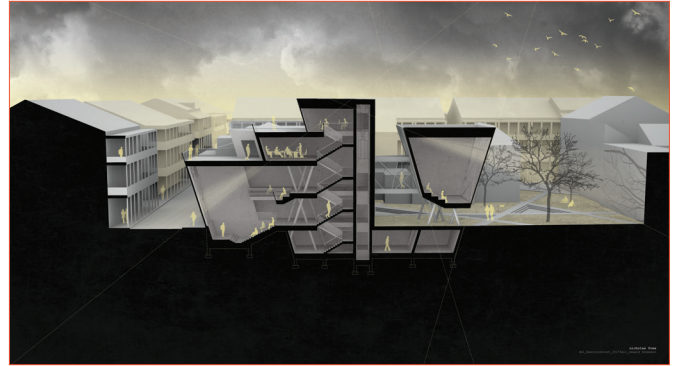


Figure 4. Urban Hybrid: This urban infill projects aims to reduce the base surface covering the ground. Sectionally, two auditoriums relate interior to exterior space. (Oswald Jenewein, Nicholas Foxx)

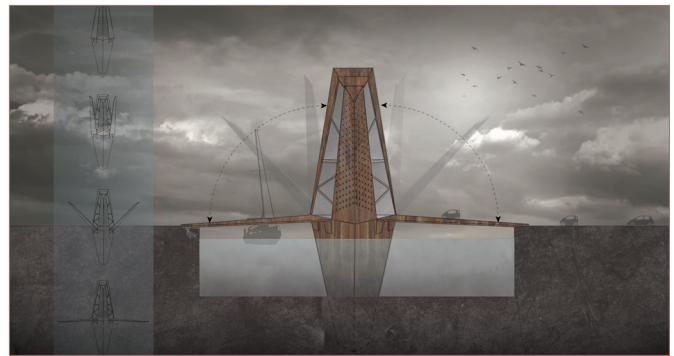


Figure 5. Shoreline Shelter: This project is the outcome of a typological transformation from lighthouse to a self-sustaining shelter which also serves as a connecting bridge. (Oswald Jenewein, Nicholas Foxx)

learn about a specific city but more to understand how local problems and perhaps solutions may be translated to other cities and settlements along the Gulf Coast.

The first project, a typical urban infill site in a dense urban center, for instance in New Orleans, asks to combine the program of a community engagement center with a coffee house and a plaza design, connecting two streets through a courtyard. The focus here is to thoughtfully address real site-conditions through the design of a building and plaza which add to the given context.

The second project aims to prepare the Typologies Module, and starts with a typological question in a coastal condition. A future scenario is developed to inform a process of typological transformations. For instance, around the typology of a lighthouse which becomes a "Shoreline Shelter": a building type which will be necessary in a future of severe storms, flooding, and sea-level rise, so the scenario. This structure may leave convention behind and tackles students' playfulness and imagination to experiment with forms and ideas beyond feasibility. Figure 5 shows a Shoreline Shelter that aims to block access to a man-made ship channel while connecting two parts of land that used to be one. The bridge becomes a self-sustaining shelter in case of storms and emergencies.

The Conditions Module allows external, site-specific parameters to

not just inform the design, but also the very type of a building. While architecture responds to the context formally in the first project, it responds typologically in the second one. Preparing the Typologies Module, form becomes secondary, while typological studies become the focus.

TYPOLOGIES

In this module, architectural typologies are defined as complex systems of interconnected parts and programs, embedded into a specific place that need to address a set of material and immaterial parameters, internally and externally. In an evolutionary process, the geometric object has first become a spatial entity, to finally become a complex architectural being. Increasing the complexity of an architectural project is not just tied to an increased scale, advanced digital skills of form-making and generating, fabrication or animation, it is, to a greater degree, the respectful understanding of architecture as an interconnected part of its surroundings. The goal of this module is, to investigate the idea of a type to eventually develop hybrid typologies for future scenarios.

The type and its opportunity to generate a field of types demands large-scale investigations. Students analyze certain typologies, from housing to industrial types, to then start a process of typological transformations. The goal is to filter the (formal) essence of a building to then apply a code on a certain territory developing a

typological field.

The semester project titled “Coastline Morphologies” asks students to indicate a specific area for their territorial studies. All areas are located along the shore of the Gulf of Mexico. The Gulf is approached as common ground between Mexico, Cuba, and the United States. The cities within this geopolitical territory are part of different countries and regimes but collectively face the impacts of industrialization and climate change.

Groups of two students analyze a chosen field around a seaport in either Mexico, Cuba, or the United States. Through a series of drawings, the morphologies of the natural and built environment informs the teams about specific and generic characteristics of the respective city. Major urban and building typologies are analyzed to understand how the settlement process has occurred historically. In particular, the projects focus on industrial fields within or adjacent to existing cities. The Gulf of Mexico and its global role for producing, refining, and distributing oil and gas is an ideal case study for industrial port cities which rely on the petrochemical industry. These facilities often include fields of oil tanks, repetitive cylindric volumes based on a grid system. The project in Figure 6 shows a future scenario for Texas City, located near Galveston Island in Harris County, Texas. The proposal is based on a script which identifies all cylindrical volumes to redefine lots based on groups of oil-tanks. The goal is to cluster tanks and empty areas into new lots which allow for future development. While the tank typologies remain geometrically, their function is being

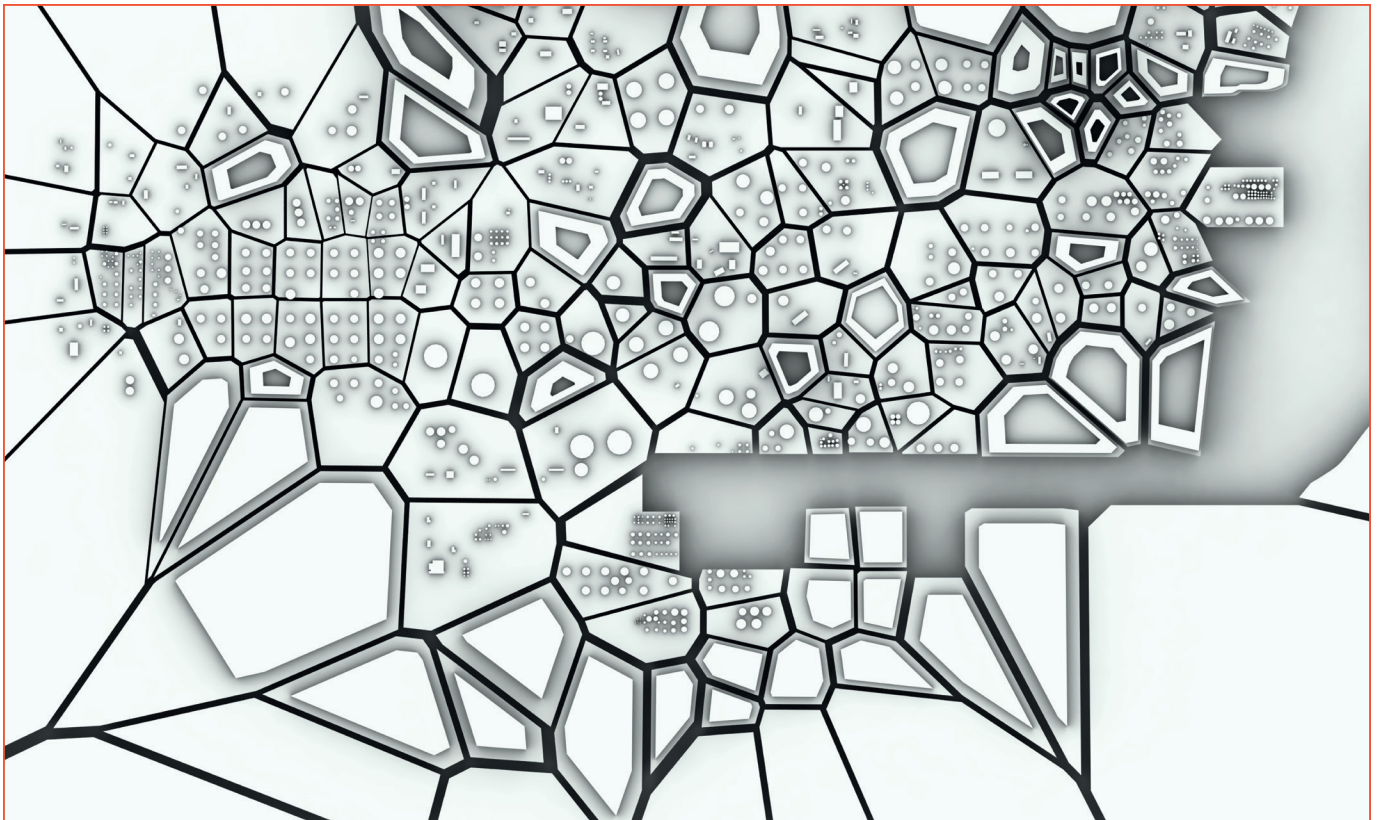


Figure 6. From Oil Tank to Server Farm: This project re-plots a field located in Texas city and transforms former oil tanks into server farms. (Oswald Jenewein, Ali Golnabi, Victoria Hernandez)

transformed from oil to server tanks, the empty lots may be used for offices, services, or even housing to create a mixed-used development. As land forms the basis of architectural creation naturally, geometrically, and legally, this formal strategy applied to a given territory programmatically clusters the landscape based on existing and proposed (building) typologies. The type becomes the formal DNA of a place to (in)form the generic growth model for the respective field.

The Typologies Module, the extraction and then generic application of (building) types to a specific territory aims to help students to zoom out of the object scale and to pursue their design through the idea of type rather than form.

REGIMES

The focus shifts beyond the scale of architecture or the city to the network of Spatial Regimes. These Regimes, or rules, demand architectural decisions derived from natural conditions and cultural contexts related to the phenomenon of place. They rely heavily on socio-economic factors, logistical processes, geopolitical trends, and how societies are organized. Systems thinking is an integral part of this module. A site-condition becomes a representative of culture, of people, cities, states and countries. Holistic analysis demand to further introduce the concepts of abstraction and to utilize diagrams to inform the design phase. This module is research-heavy and built around interdisciplinary collaboration with public and private stakeholders.

As the previous modules gradually lead into the Regimes Module, it is again the Gulf of Mexico and its adjacent industrial port cities along the coast which forms the territory for the studio projects. The regime of fossil fuels symbolizes the premise for this module as it links political decisions and industrial production to the culture of this coastal territory. These landscapes of oil are being approached as environments transitioning away from fossil fuels, at least that is the scenario the studio and research projects propose under the title of "Post-Oil Environments".

Post-Oil Environments acknowledge the changing environmental conditions as a direct result of burning fossil fuels. They describe the current transition-period away from carbon-dependency towards a collective ecological awareness of human-based climate change.

The burning of fossil fuels has become a spatial regime demanding transformations of the built environment. Post-Oil Environments link climate change directly to the burning of fossil fuels rather than to the western processes of industrialization and mass-consumption, as these phenomena could have been powered by sustainable sources of energy that emit fewer greenhouse gases. The studio projects approach these transformations through design, focusing on typological studies in context of resource extracting industrial cities along the Texas Coast and the Gulf of Mexico.⁸

The Texas Coast is a symbol of the Industrial Age: on the one hand largely undeveloped and sparsely populated, on the other hand an icon of oil-based cities depending on the economic power of the fossil fuel industry. The drilling-oriented industry along the shore has shaped the coastal environments ever since the mid-19th century. The coastline has been altered to allow for heavy industry and major

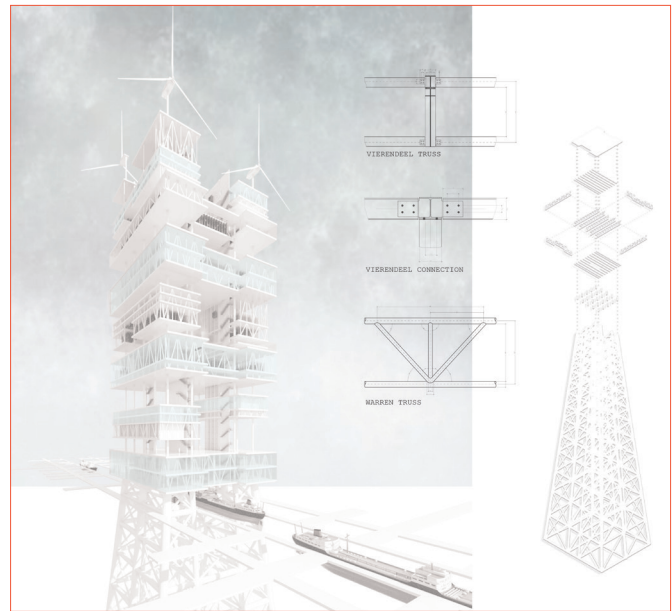


Figure 8. Farm Foundry: This project transforms an off-shore oil-rig into a self-sustaining hydroponic farm and harbor. (Oswald Jenewein, Clarissa Steier)

seaports. The economic success of many cities directly relies on the resource-based industrial production.⁹

The research and design projects are based on typological studies, aiming to define and design solutions for future (urban) developments within the discipline of architecture. This disciplinary approach is informed by and connected to community outreach projects and interdisciplinary collaboration within and beyond the academic world.

Engaging with local experts, communities, institutions, universities, NGOs, and private stakeholders is both a premise for the design and research projects, as well as a key-method in the design thinking process. Establishing long-term partnerships and bringing back project outcomes to the local communities is important. In addition, a variety of events, from lectures to exhibitions, help to support the process of exchanging thoughts and raising awareness. The design projects address a set of changing climate conditions, strongly connected to the feedback and information gathered while meeting with experts and local communities in the field. Methodologically, each design project starts with a typological analysis of the given (urban) context to understand and respect the architecture of a place.

The general goal is to mix existing building typologies with industrial typologies to then combine and transform these types into a hybrid typology with infrastructural components which best fit a future scenario within the context of a Post-Oil Gulf Coast. The projects range from strategies for abandoned off-shore oil-rigs to programming infrastructural landscapes along major streets and bridges, to creating safety-zones during storms and for post-disaster management.

CONCLUSION

This paper retrospectively summarizes the process of implementing the modules presented in the previous paragraphs. The overall goal to

address the three timely challenges, Climate Change, Globalization, and Digitalization, in context of constantly understanding the built in response to cultural activity, within the natural environment, is of highest importance. It is the relationship between all these related parts rather than the parts itself which has become the main agenda.

Empathy towards the individuals within the group and the group as a collective has been critical for the success of the studios from foundation to graduate level. The pedagogical tool of creating an inclusive work-environment where (ideally) everyone feels welcome, but also needed, allowed for some outstanding projects and a high standard of overall quality of the projects.

The fact that students do not follow this path of modules in the general curriculum, but only pick one or two modules within their studies, did ultimately not create a big problem. Yet, the understanding that all modules need to become part of every module, to a certain extend, was crucial for each group to relate their projects to this concept of Designing towards Ecological Environments. While graduate students in the Regimes Module needed input in Operations, the studios at Operations level were engaged in a discussion on Spatial Regimes, eager to learn more.

Exhibiting final projects in venues outside the university has helped to create a discussion around the topic beyond academia. The collaboration with local community groups has been extremely beneficial for the students to learn about and understand issues people living in a certain area might have.

Most importantly, the task of higher education must be the education of critical and independent thinkers. A university should not be a school in a sense of requiring a level of autonomy demanding the individual to become aware of his/her strengths and weakness but especially about his/her (architectural) interests. Ideally, students should be able to relate their designs to both the academic discourse in architecture, but also to a larger discourse beyond architecture and design. As ecology already describes a relationship, Designing towards Ecological Environments challenges the collective awareness of designers to constantly relate their projects back to environmental considerations. Ecological components must become parts of architecture and architectural education on every level from foundation to graduate studio.

The challenge is of course, to not participate in the culture of climate populism, only using and abusing ecological topics to create an environmentally branded image. In fact, the architectural responses to environmental topics are limited as architects have to rely on a variety of engineering disciplines, natural and social sciences. Though interdisciplinary collaboration is absolutely necessary to tackle the disastrous problems man-kind caused for the planet, architecture must develop a disciplinary response to remain relevant in finding solutions in these most pressing issues of our time. The architect is usually not conducting material research, nor social studies, or experimenting in a biology lab. While all these disciplines are extremely relevant and valuable, they are "other" disciplines. Architects need to work interdisciplinary but should not try to take over other disciplines.

This series of modules which aims to pedagogically guide students towards collective ecological awareness simultaneously proposes a

typological approach. Methodologically, these typological investigations lead to transformations and aim to address changing natural conditions through the very core of the architectural discipline which is, according to Rafael Moneo, the type.¹⁰ In particular, the typological relationship between object and ground may be seen as a disciplinary contribution of architecture to the pressing environmental issues, many of which tie back to the very basis of architecture: land.

Notes

1. Referring to Mostafavi, Mohsen, Gareth Doherty, and Harvard University. Graduate School of Design. *Ecological Urbanism*. Baden, Switzerland: Lars M. Iler, 2010.
2. The term "Ecology" as defined in the Oxford Dictionary: <https://dictionary.cambridge.org/dictionary/english/ecology>, accessed on 05/20/2019
3. Waldheim, Charles. *Landscape as Urbanism: A General Theory*. Princeton, NJ: Princeton University Press, 2016, p. 69
4. Norberg-Schulz, Christian. *Genius Loci: Towards a Phenomenology of Architecture*. New York: Rizzoli, 1980.
5. The "Fourth Industrial Revolution" as described by Klaus Schwab and the World Economic Forum defines these thoughts. See <https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab>,
6. The basic idea defining some assignments of this module is based on di Mari, Anthony. Yoo, Nora. *Operative Design: A Catalog of Spatial Verbs*. Amsterdam, Netherlands: BIS Publishers, 2013.
7. Kolarevic, Branko. *Architecture in the Digital Age: Design and Manufacturing*. New York, NY: Spon Press, 2003, p. 13-17
8. Parts of this paragraph have also been published by Oswald Jenewein, online <https://www.posttoilenvironments.com/>, accessed on 06/18/2019
9. Blackburn, Jim. *A Texan Plan for the Texas Coast*, First edn, College Station, TX: Texas A & M University Press, 2017, p. 54-73
10. The "type" as core of the architectural discipline as described by Moneo, Rafael. *On Typology*. Cambridge, MA: MIT Press, 1978.