

ROLES, AGENCY AND RELATIONS OF GIGA-MAPS IN SYSTEMIC APPROACH TO ARCHITECTURAL PERFORMANCE: THE SPECIAL PROTOTYPES OF POST-ANTHROPOCENE

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ABSTRACT:

GIGA-Maps are extensive systems maps that combine and relate large amounts of different kinds of data and data representations, to be used and related in a design process (Sevaldson 2013; Sevaldson 2011; Sevaldson 2015). This mapping has no recipe. It is project related and developed according to its particular needs and speculations. The GIGA-Map series in this paper are exhibiting, presenting and discussing the whole collection of this process-based, visual complexity diagramming that has been developed in the framework of Systemic Approach to Architectural Performance. SAAP seeks to investigate the relation between Systems Oriented Design (Sevaldson 2013), and performance oriented design approaches (Hensel 2012) together with the other processes in architecture in the means of its active agency within overall ecosystem, the co-performance. The particularity of SAAP is to demonstrate and develop theories and methods through experimental practice. SAAP involves Time-Based Eco-Systemic Co-Design that is performed by both biotic and abiotic agents, including humans within living built environment. GIGA-Mapping is central to SAAP because it is a tool that visually manages, organizes and relates the complexity within the design-research processes and co-performances. SAAP's particular approach to GIGA-Mapping is focusing on eco-systemic processes and their co-/re-design processes. It maps and generates their relations, meaning environmental, societal and cultural aspects across the habitats of the different species and the biotic and abiotic agency involved, sharing its habitats and playing a part in overall eco-systemic complex food-webs in real time. SAAP's ambition is to understand and design for these complexities when they are overlapped and integrated with the built environment. A successful co-existence across species and within the human built environment depends on the development of new design approaches. Thus, SAAP is based on full-scale prototyping in combination with analytical and generative GIGA-Mapping, both placed into 'real life' built environment. The direct full-scale prototypical engagement with the life-performing eco-system is interrelated with its diagramming, one updating the other by data and relations in their co-design process. This approach is based on 'research by (through) design' (Morrison and Sevaldson 2010; Sevaldson 2010). Taking the notion seriously, it is using the 'real life' as a design-research 'laboratory'. Therefore, SAAP is strongly driven by prototyping in public space, considering GIGA-Maps as well as the full scale prototypes as 'prototypical urban interventions' that can drive extensive generative agencies across the communities (Davidová 2004; Doherty 2005) and while doing that, across much larger systems, introducing the necessary shift to Post-Anthropocene.

INTRODUCTION:

The discussion originates from the 'Systems Oriented Design (SOD)' methodology (Sevaldson 2013) that started to evolve around 2006 in Complexity and Systems Thinking studio lead by Birger Sevaldson at the Oslo School of Architecture and Design. The field emerged from project related experimenting with various types of visual relating of virtual or physical items into complexity maps,

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The diagram illustrates the GIGAmap framework. A central oval labeled "GIGAmap" is connected by lines to ten surrounding rounded rectangular boxes, each representing a component: "Diagramming", "Scenarios", "User Journey", "Collage", "Rich Picture", "Mind Mapping", "Causal Loop model", "Information Visualization", "Service Blueprint", and "Information Visualization". Below the central oval, a large downward-pointing arrow indicates the framework's application, leading to the text: "Rich Design Space, Scenarios, Co-design, Process-maps, Implementation, Ideation Systemic design intervention".

Figure 2: GIGA-Map of the HOLOSLO – The Penetrating of Latent project that emerged from the Complexity and Systems Thinking studio. The map is relating digital and prototyping analyses and design processes with scenarios of design's performances to be co-designed with the ambient environment. (Davidová 2006 – 07)

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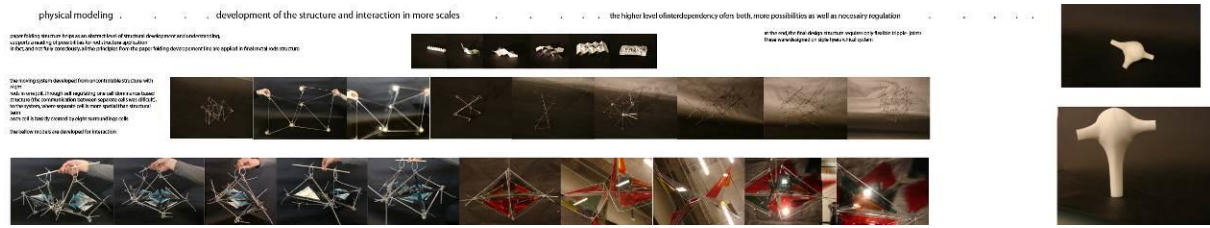


Figure 3: Detail of the GIGA-Map of the HOLOSLO – The Penetrating of Latent project that emerged from the Complexity and Systems Thinking studio, showing prototyping design processes that was exhibited next to the prototypes themselves. (Davidová 2006 – 07)

The concept of 'Time-Based Design', that is crucial to this framework, was established by Birger Sevaldson, mainly in the means of relating time to design processes, analyses and scenarios in reference to generative diagrams (Sevaldson 2005; Sevaldson 2004). Systemic Approach to Architectural Performance mainly relates these design processes with the co-design of its prototypes placed into physical environment, and the eco-systemic co-design of their generative performance, preferably in public space.

The tradition of prototyping re-emerged at the start of millennium when for example Bob Sheil, Michel Hensel and Achim Menges were arguing for relating time-based digital processes experimentations and design for performance with full-scale prototyping (Sheil 2008; Hensel and Menges 2006). This prototyping however, was seen as a design process for final products, not for the process of the performance itself. This part was investigated by London based urban office CHORA (CHORA 2017) that questioned the master plan approach and introduced 'urban prototypical interventions' that were placed into randomly chosen locations. These were generating the design through interaction with the local community (Davidová 2004; Doherty 2005).

Systemic Approach to Architectural Performance originates from the fusion of these process-based approaches, while considering the performance of prototypes and mapping placed into 'real life environments' as generative time-based co-design processes of the local eco-system. Systemic Approach to Architectural Performance involves trans-disciplinary research and practice in historical field studies, systems oriented design and other related methodologies, service design, performance oriented design, material research, landscape, cultural and social ecology, environmental art and bio-art. The paper discusses its GIGA-Mapping case studies to find interpretations of the field in the concluding part.

INTERRELATED CASE STUDIES OF DIVERSE CONTEXTS OF SYSTEMIC APPROACH ARCHITECTURAL PERFORMANCE

The GIGA-Mapping in Systemic Approach to Architectural Performance has, due to its nature, several interrelated layers and agencies. Its necessity of media and agency richness has been discussed in separate paper (Davidová 2017e). The build prototypes or existing mapped traditional architectures and specifically their performances, are mapped and related in their GIGA-Maps, integrated in new design proposals. The GIGA-Maps are exhibited (preferably together with the prototypes themselves) in public accessible space. These are therefore considered as prototypes of its special kind, acting for public interaction and discussions resulting in generative co-design agency. Therefore, Systemic Approach to Architectural Performance is both methodology and a 'generative design result'. The author argue that this approach results in how the architectural performance can be met in systemic way.

Ray Project

A responsive solid wood envelope Ray project¹ (Davidová 2016a; Davidová 2014b; Davidová 2017a; Davidová 2014c) focus has been initially placed in effects of relative humidity and temperature on

¹ This research by design has been led by the author in collaboration with Defio, s.r.o. carpenters.

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solid wood panels. However, the extensive GIGA-Mapping of data and long lasting ongoing testing of the screen prototypes in outdoor environment resulted in involvement of both biotic and abiotic agency for its hygroscopicity and other performances (see Figure 5). When the system is closed, it is not allowing the humid and cold air to pass through the boundary. At Figure 4, both of the images are shot at the same day after four years of being exposed to weather and biotic conditions. The prototype got inhabited by blue stain fungi, algae and lichen. These, namely the algae, are regulating the moisture content of wood, thus co-causing its warping. Notice also the organisation of algae habitation caused by the material's fibre direction and position within the design that is affected by material performance and form. Thus, it is organised through its moisture and the organism's abundance and distribution interaction (Davidová 2017a).

The preceding and ongoing GIGA-Mapping of the project was initiating the author's research in responsive solid wood was speculation on such performance through mapping systemic relations (see Figure 5). The research first investigates which wood specie to grow and harvest in relation to local eco-system. Than it investigates an interaction of the material interaction with other species that can co-design the performance. Therefore, co-designing and co-living situation might appear through such, first purely speculated, agency (see Figure 4) (Davidová 2017a). This GIGA-Map was used as a starting tool for all the following projects to be integrated to other maps and to take part in rapid learning and rapid communication processes.



Figure 4: Ray 2 Responsive Wood Envelope Prototype a) in Semi-Dry April Weather When the Screen is Partly Open for Boundary Exchange between Exterior and Semi-Interior; b) After April Light Rain

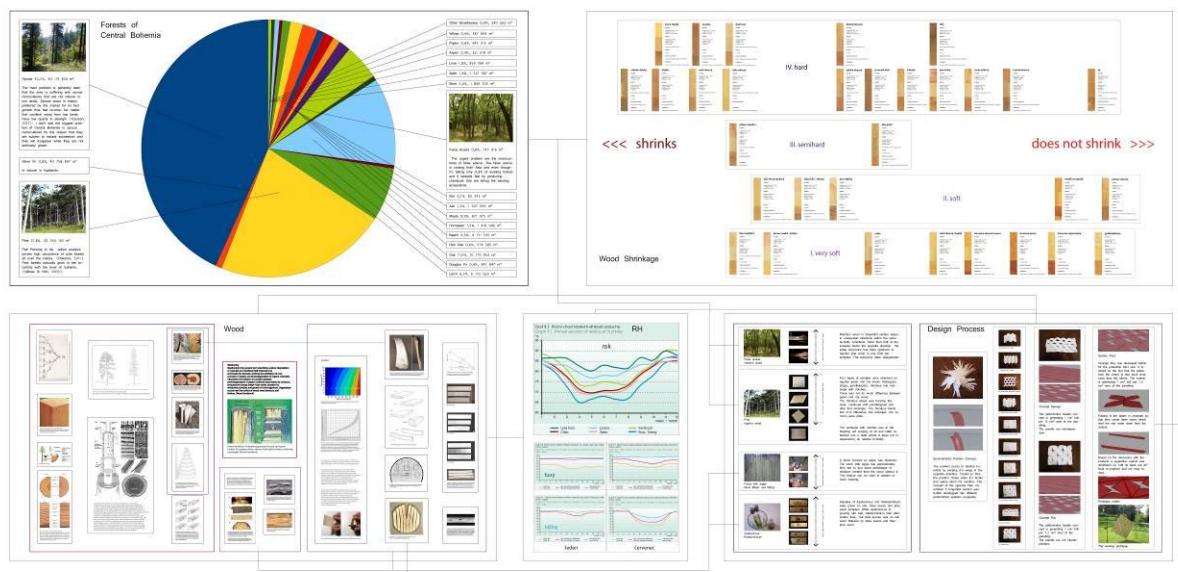


Figure 5: The Ray GIGA-map showing trans-disciplinary and trans-agency relations, observations and speculations within the project. (Davidová 2013 – images from Forest Products Laboratory, 2010; Hoadley, 1980; Menges, 2009; Němec, 2005; Tolasz & Coll., 2007 or photographed by the author, used with the courtesy of USDA Forest Products Laboratory, Taunton Press, Achim Menges, Grada and Tolasz) – please, zoom in at Systems Oriented Design's Giga-Mapping Gallery (Sevaldson 2017)

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LOOP Project

LOOP – The Environmental Summer Pavilion II (Davidová 2014a; Davidová and Prokop 2016) transdisciplinary studio course covered students of architecture and urbanism, environmental design and wood engineering². The studio resulted in a full-scale responsive wood pavilion (see Figure 6), that was afterwards followed by EnviroCity multi-genre festival (Davidová and Kernová 2016) organised by the author's NGO, Collaborative Collective.



Figure 6: LOOP: The Environmental Summer Pavilion II (Photo: Okamura 2014)

² The project was lead by the author together with Šimon Prokop and Martin Kloda at the Faculty of Art and Architecture at the Technical University of Liberec and the Faculty of Forestry and Wood Sciences at the Czech University of Life Sciences in Prague.

Loop Students: Alena Novotná, Anna Hrušová, Antonín Hůla, Barbora Slavičková, Jakub Kopecký, Jiří Fáber, Jiří Pokorný, Petr Tůma, Tereza Jílková, Radim Sýkora, Eliška Antonyová, Tereza Lišková, Filip Janata, Tomáš Kytka, Marie Kortanová, Vojtěch Holeček, Martin Vaniček, Jakub Hlaváček and Petr Havelka.

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The studio design process was investigated in better depth in separate paper for RSD 3 Symposium: 'Generating the Design Process with GIGA-map: The Development of the Loop Pavilion' (Davidová 2014a). The EnviroCity festival advances the concept of the Rich Design Research Space to public space. This allows extensive public and other participants to engage and participate in the enactment and the discussions of the performance and other issues regarding the pavilion. The performance here has three major layers:

a) the responsive solid wood performance of the pavilion that absorbs and evaporates moisture based on ambient relative humidity and temperature, thus moderating the micro-climate and generating climate comfort; Here the performance is co-designed by the design-related material bio-morph properties and its interacting abiotic environmental agents.

b) the performance of its users in interaction with the pavilion – The festival's multi-genre performers, such as dancers, musicians or designers were specifically invited to express themselves in relation to the performative object the pavilion and the related design-research. All the other human or non-human visitors found their own opportunities of use. Therefore, all of these biotic agents co-designed the pavilion's performances and interpretations, taking their role in the performing eco-system, next to the abiotic agency.

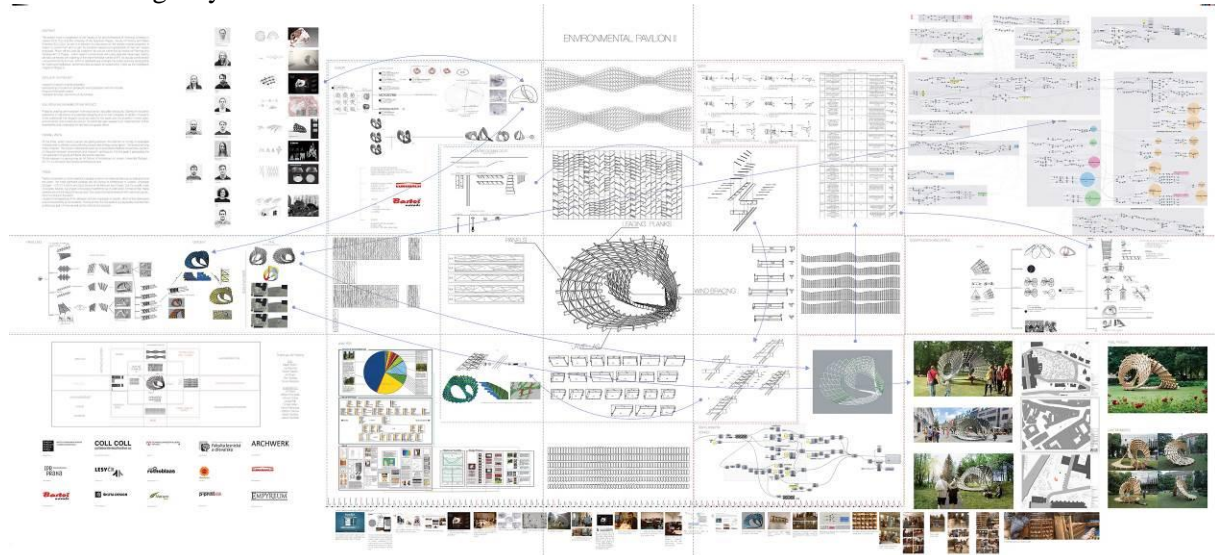


Figure 7: The digital re-designed GIGA-Map serving for exhibition and public debate purposes in reference to the performing prototype (GIGA-Map responsibility: Hrušová & Pokorný 2014)

c) the performance of the exhibited digital GIGA-Map (see Figure 7), is presenting the work's context, often addressing the tacit levels and therefore generating understanding, motivation and discussion. This dialogue is part of a continuous co-design of the project and its agendas on two layers – bringing new inputs to the designers as well as generating acceptance for the research and involving new participants and issues. The project's mission thus also includes several DIY modifications and extensions.

Bio-Climatic Layers in Traditional References and their GIGA-Mapping

The research that resulted in the ratification of Systemic Approach to Architectural Design field originates from the need of practice to adapt to recent climate change and biodiversity loss. It claims that such adapted architecture has to consist of gradient of heterogeneous bio-climatic layers with diverse level of their boundaries penetrations. This concept is present in traditional architectures from extreme climates such as north, ocean open shores or inland deserts. Today, we experience mix of such climate extremes even in formally mild climates, such as in Czechia, the Central Europe (Czech Republic Ministry of the Environment and Czech Hydrometeorological Institute 2015). Therefore, the research claims, we need to learn from these architectures, because our traditional architectures from the mild climates were not adapted for such situations (Davidová 2016b). The following GIGA-Maps are often exhibited through events such Relating Systems Thinking and Design conferences (P. Jones

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GIGA-Mapping Svalgangs and Skuts



Figure 9: GIGA-Mapping Svalgangs and Skuts (Davidová 2017, photos used: Davidová and Raková 2016 and 2017). - the map of Norway is a public source from: Central Intelligence Agency (Central Intelligence Agency 1998); the macro climatic diagrams (yr 2016) are used with the courtesy of yr.no – Please, zoom in the RSD6 Proceedings to see details (Davidová 2017c)

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This study investigates the architecture adapted to extreme climates. It notices that this is built of several non-discrete layers; offering layered boundary penetration of both biotic and abiotic agency, interacting in the means i.e climate control, dwelling, use, work, etc.

The initial winter data and the second updated summer data GIGA-Map (see Figure 9) of svalgangs (see Figure 8) and skuts maps the discussed traditional semi-interior spaces in Norwegian traditional architectures, their performances and opportunities of use in relation to environmental data, biotic and abiotic agency, penetrability and local and spatial distribution. This time, the GIGA-Maps serve as various levels of consciousness data relations of the observed prototypes that evolved over generations and environmental performance interactions adjustments to feed the research by design. Please, note the bio-climatic layers of grass roofs (see Figure 8).

There are different concepts of boundary penetrations in these architectures. The, by now, discussed concept is the responsive solid wood that reacts to relative humidity and temperature due to its tangential section. The tangentially cut solid wood planks in peering structure air when the relative humidity is low while disabling the circulation of the humid air into the structure in high humidity environment (Larsen and Marstein 2000). Another concept of the semi-interior spaces responsive boundary is what the author calls the '*Transformer*' because it can be fully unfolded or enclosed based on the use and climatic preferences (see Figure 8). These two envelopes' performances, with the physical openings kinds and sizes agencies were considered for further investigation for applications. This variety of penetrations offer i.e. storing, working, cross-species social, sheltering and habitual opportunities, while moderating the environment of the enclosed parts of the houses. This series of speculative mapping, started with a pure question on climatic distribution from the exterior through the semi-interior to the interior raised several more related investigations and speculations. One of the conclusion there is that the more extreme climate, the more opportunities of co-living with other species these traditional architectures offer (Davidová and Raková in press).

GIGA-Mapping Cave Dwellings



Figure 10: Combination of Subtractive and Additive Building Layers that developed for variety of seasonal use over time and cultures with different preferences in still inhabited city of Göreme (Photo: Davidová 2016)

The investigation from the extreme political situation settlements in semi-arid, non-infertile land that lasted over hundreds years can well support en route to adaptation to our similarly envisioned future. The cave dwellings can be found all over the continents (Vegas et al. 2014). However, they seem to be

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most extensively developed in desert and semi-desert climate areas. The following mapping represents an onsite investigation of Cappadocian caves mainly around the area by city of Göreme. The dwellings developed over time and cultures, layering non-discrete, heterogeneous spaces of bio-climatic layers (see Figure 11), combining additive and subtractive building techniques (see Figure 10). The GIGA-Map (see Figure 12) concludes, that for the climate transition between the bio-climatic layers, the size of the openings and their word axis orientation is not so critical as opposed to ventilation stream and the combination of the additive and subtractive techniques (Davidová and Uygan 2017). The ventilation stream is co-designed by biotic and abiotic agency, such as co-living with pigeons in upper levels (see Figure 11), placement of farm animals in the exits of the caves, the heat of the air that is generated by them and the cooling air generated by the underground water at the lowest levels of the underground cities. This co-living situation was also crucial for food production for all, generating fertilizers, agriculture and then again food for human and non-human animals.



Figure 11: Pigeon Houses higher up and Human Dwellings lower down in the Valley of Zelve (Photo: Davidová 2016)

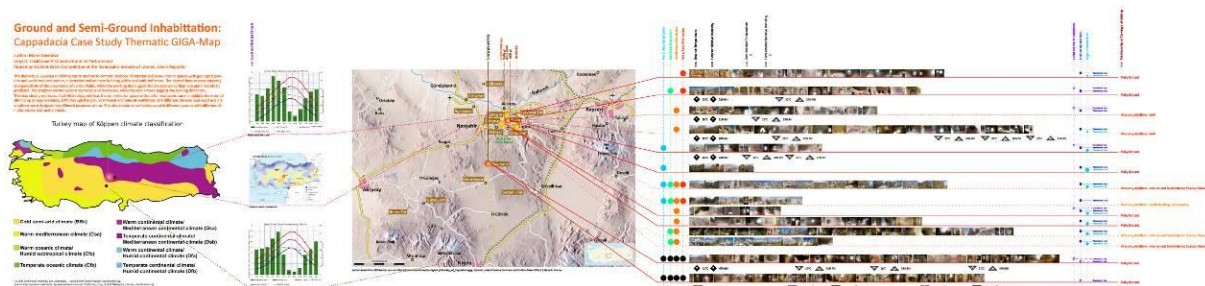


Figure 12: Ground and Semi-Ground Inhabitation: Cappadocia Case Study Thematic GIGA-Map. (GIGA-Map and images of caves by Davidová 2016. Turkey map of Köppen climate classification has been used under creative common licence (Zifan 2016). The Map of Cappadocia has been used under creative common licence (Dörrbecker 2009). The Climate and Temperature Diagrams are used from Climatemps.com with expired copyright in 2015 (Climatemps.com 2015b; Climatemps.com 2015a), Climate Zones Rainfall in Turkey map used with the courtesy of Fanack (Fanack 2016)) – Please, zoom in the RSD6 Proceedings for to see details (Davidová 2017d)

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INTEGRATION OF ABOVE STUDIES TO ARCHITECTURAL AND URBAN DESIGN PRACTICE

The above investigative studies and specifically their mappings evaluated and led to experimental design proposals, layering non-discrete, bio-climatic, heterogeneous spaces of built environment. These studies offer many design-research trans-disciplinary interpretations of variety of layers, scales and impacts.

Responsive Transformer: The Bio-Robotic Adaptive Architecture



Figure 13: Responsive Transformer in enclosed composition, that can be reorganized based on the environmental and social settings (Visualization: Collaborative Collective 2016)

Responsive Transformer³ (see Figure 13) is a synergising competition entry of this research for eco-systemic settlement. The project is integrating the concepts of bio-climatic layers, applying responsive envelope Ray bounding semi-interior space offering biotic and abiotic exchange and dwelling, such as svalgangs, ground tempering and underwater cooling ventilation flows, additive green roof insulating layer offering ‘*edible landscape*’ (Creasy 2004) for variety species, including humans (see Figure 14). These structures can re-transform based on the social or environmental settings in a similar way as concept ‘transformer’ (see Figure 8) through co-design of its biotic and abiotic users (Davidová, Zatloukal, and Zímová 2017). The work was concluded from the preceding GIGA-Mapping studies on co-living and co-performance.

³ The project was designed by trans-disciplinary team of architects from Collaborative Collective, building and mechanical engineers from Experis SDKM and landscape ecologists from CoolAND, lead by the author.

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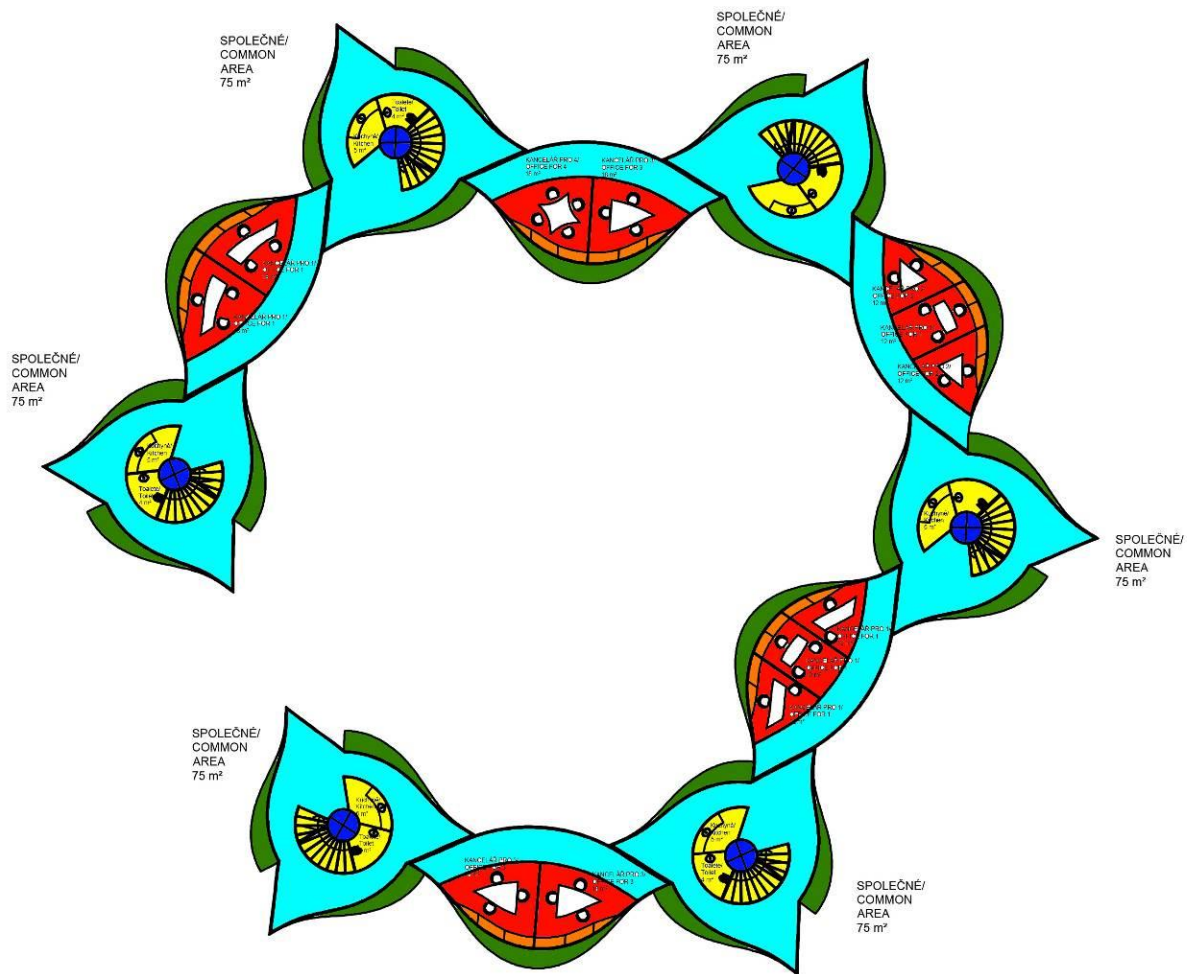


Figure 14: A detail of Bio-Climatic Layers within the project: The layers in the cells show green surface roofing, tempering storage space, climatized office space and blue semi-interior space, moderated by Ray envelope. The joints are equipped with natural ventilation system from the underground layers of a water reservoir and tempered unfrequently used rooms (Davidová, Zatloukal, and Zímová 2017; Davidová 2017a) (Drawing: Collaborative Collective 2016)

COLridor

COLridor is a trans-disciplinary co-design through GIGA-Mapping and full-scale prototyping project⁴. The project gathers all the above collected data, findings and speculations for co-design and co-implementation of the eco-systemic prototypical urban interventions, to co-generate socio-cultural eco-systemic urban bio-climatic layers in urban environment. These interventions, covering the second EnviroCity multi-genre festival, that ranges from TreeHugger responsive wood insect hotel (Davidová and Prokop 2018) (see Figure 15) and actions such as seed bombing both to interact with food chain to cultural and social generative events, such as local NGO's picnics, dance and artists performances, lectures, workshops, the project's GIGA-Map (see Figure 16) exhibition, etc. serve to motivate the city community for cross-species co-living situation (Davidová and Zímová 2017; Davidová and Zímová in press).

I.e. the intervention TreeHugger has three basic bio-climatic layers of its own:

- a) an exterior surface inhabited by algae moderated by terrain and word axis orientation;
- b) variety of climatic chambers for variety of species of insects, moderated by variety of responsiveness due to original position in trunk of wood on envelope Ray, terrain and word axis orientation;

⁴ The project was a collaboration among Collaborative Collective, CoolLAND, the Faculty of Forestry and Wood Sciences at CZU in Prague, the Faculty of Art and Architecture at TU of Liberec and the local community

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c) the living tree itself on which the structure is parasiting, generating a living insulation.
The project also covers larger impact layer, when offering the ThreeHugger parametric code for downloading and local specific adjustment for DIY.



Figure 15: TreeHugger insect hotel after half year of explosion to abiotic and biotic agency and co-habitation. (Photo: Davidová 2018)

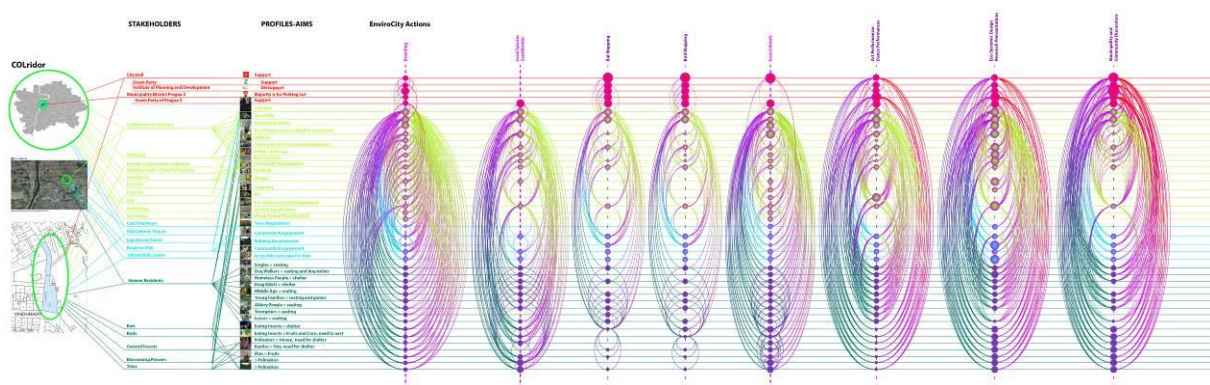


Figure 16: COLridor and EnviroCity GIGA-Map showing different scales, stakeholders and their agency speculation on planned actions that is still exhibited at the location to generate public and specifically stakeholders' discussion and motivation (Davidová 2017) – Please, zoom in the RSD6 Proceedings for to see details (Davidová 2017b)

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DISCUSSION AND CONCLUSIONS:

It appears that in Systemic Approach to Architectural Performance, the GIGA-Maps are inseparable from the biotic and abiotic performance of its prototypes. In fact, they are themselves prototypes of its kind, securing the projects' developments through generative agency co-design involvement and interaction. There seem to appear two kinds of mapping though without clear boundaries – a) project process based and – b) registering and speculations based. Though these two are fully interrelated, they seem to have often different organisation of their relating: – a) timelines and cross-related bounded fields and; – b) matrixes and feed-back loops. While the first one serves for rather for communicating purposes, the second one rather for recalling and documenting the memories. All of them use images for enacting and relating tacit knowledge with hard data and have generative and, in its sense, co-designing character. They help to engage, involve and internalize the designers as well as the audience and generate the project's mission understanding, acceptance and the discussion over it that leads to project's trans-disciplinary co-design. Exhibiting of these also extends the project to different extends of inspirations and DIY variations by both, professionals and amateurs.

The discussed three layers of performances, the material, the user and the GIGA-Map, influence each other and generate the real life '*Rich Design Research Space*', the '*real life laboratory*'. The cross-relation between the layers seems to be crucial for project's generative real time performance as well as for this field's design-research development. As, in a way, an extended item of the GIGA-Map, the eco-systemic prototypical urban interventions enable larger eco-systemic co-design, performing with a '*real life*' generative agency – being a time-based over-evolving '*design result*'. This research therefore argues, exemplifies and proposes a particular path to that with today climate extremes and biodiversity loss we need to shift to Post-Anthropocene to preserve humanity. This means to co-create habitable and edible environmental input that can regenerate former anthropocentric 'cultural' environment into co-living situation. This shift cannot come directly but in similar manner as natural succession, through generative interventions, evolving over time. This again needs human engagement and acceptance, where trans-disciplinary Co-GIGA-Mapping is supportive and generative on its own.

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