Whispering Garden

Performative AI for post-digital interspecies collaboration

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Abstract:

The Whispering Garden explores ideas of post-digital participation within the setting of bio-digital assemblages of interspecies collaboration. As part of the Transindividual Protocols series, the project draws on Gilbert Simondon's notion of transindividuality as the sensual, affectual, and ecological interpretation of the social model of becoming collective, to explore collaborative design methods that address the endemic disconnection of agencies and technological infrastructures within the current digital participatory practice. As an entanglement of matter, technologies and living species, an expanded notion of transindividual subjectivity is constructed as the entry point for the reconceptualization of the collective and extended processes of cognition, describing novel trajectories for aesthetic speculations that transcend matters of organised complexity to introduce neo-baroque principles of instability and polydimensionality.
The paper describes the theoretical and methodological framework that spurred this specific investigation by outlining the results emerging from previous design-research practice that used Galvanic Skin Response (GSR) to map emotional feedback from human participants. Within this line of enquiry, the project further draws on biological and bio-computing studies that used the measurement of extracellular action-potential to determine neural activity and excitation in algal and fungal colonies, as the basis for an exploration of transindividual protocols for multi-agential collaboration. Constructed as a coevolutionary cognitive infrastructure that incorporates parallelism of processing and learning through principles of performative feedback and machine learning, the Whispering Garden offers a critical precedent of a mediated human-biological protocol of communication with the potential to affect spatialised transcalar and translocal assemblages of collaboration.

Introduction

Developed as part of the Transindividual Protocols project, the Whispering Garden contributes to an exploration of the ecological foundations of post-digital participation that, in the attempt of addressing the endemic disconnection of agencies and technological infrastructures within the current digital participatory practice, draws on Gilbert Simondon's notion of transindividuality as the sensual, affectual, and ecological interpretation of the social model of becoming collective, to define collective mediated design protocols that explore a better understanding of the complex nature of collective feedback.

Within this line of enquiry, the project investigates purpose formation and decision-making for the generative design of novel bio-digital assemblages of interspecies and multi-agential collaboration, making use of live electrical measurements from a collection of algal and fungal species in combination with electrical signalling from human participants as indicators of the neural activity of the ecology of the participants (Adamatzky, 2018; Dehshibi and Adamatzky, 2020; Baluška et al., 2006, Boucsein, 2012), to observe how the metastatic evolution of knowledge and the resulting mediated spatial group awareness might influence non-causal generative mechanisms of real-time decision making and purpose creation for interspecies collaboration and creative decision-making in a spatial setting.

Drawing on previous Transindividual Protocols design-research explorations (Papeschi, 2019; Papeschi, 2022) that suggested further research seeking to include in the process of information exchange ranges of weaker agencies and non-human othernesses, the project was designed with the purpose of exploring how automated communication protocols could facilitate emergent dynamics of meaning and relevance formation, before testing the significance of the resulting cognitive constructs through the production of immersive spatial prototypes. Funded by a Leverhulme Study Abroad Scholarship, the Whispering Garden project was developed at Synthetic Landscape Lab, Institute of Urban Design, Leopold-Franzens Universität Innsbruck in 2020-2022, to tackle this specific angle of the Transindividual Protocols project.

This paper first outlines the theoretical and methodological framework that spurred this specific investigation, describing the progress made by the Transindividual Protocols project in its critical questioning of automated authorship, before moving on to detailing the Whispering Garden's technical settings and specific outcomes. The intent is that of tracing an encompassing theoretical and methodological trajectory as a system of reference for the evaluation of the results of the Whispering Garden project in context. The conclusions outline further critical steps for the development of the multi-agential, performative, and trans-scalar co-creative practice that the Whispering Garden project, together with the cohort of its precedents, describes.

Protocols of interspecies collaboration

Formulated as a design-research practice that uses sensing, data visualisation, design speculations and participatory practice, the Transindividual Protocols project explores the aesthetical, technological, and cultural dimensions of transindividuality as a generative model for collective authorship. And with an ecological angle that places humans and their living and non-living co-species as the network of actors that collaboratively addresses the production of space, the project uses Galvanic Skin Response, an indicator of the emotional arousal of participants also used in lie-detection, as a tool for the systematic deconstruction of the human agency and the reimagination of platforms for actionable group knowledge construction, offering the outlook of a collective practice relying on the specificity of its material, spatial and technological infrastructure for the creation of open purposive action.

The project was developed with a series of targeted interventions, ranging from speculative design proposals to participatory happenings and mixed-media responsive installations, together tackling three critical dimensions of transindividual participation, observing: (1) the metastatic mechanisms of collective knowledge aggregation, (2) the generative production of spatial configuration as a live interface for purpose-production through mechanisms of performative feedback, and (3) the definition of hybrid material assemblages for the rendition of the collective intention (Papeschi, 2019; Papeschi, 2022).

The Whispering Garden contributes to this series of investigations with a targeted exploration of ideas of multi-agential collaboration, beyond human-to-human or human-machine interaction, including biological agencies to explore how weaker signals and voices might be given appropriate relevance. As previous investigations had demonstrated how, with the deconstruction of intentional systems of feedback through Galvanic Skin Response sensing methodology, mechanisms of more open group attribution of significance and purpose construction had emerged, the project set to explore how this strategy could remain valid beyond the boundary of human-to-human interaction, and within the context of differently natured ranges of feedback signals.

For this purpose, the project draws on a series of reference studies from biology and bio-computing that used extracellular recordings of action potential in biological organisms to measure neural activity, demonstrating how waves of excitation have been measured in a range of different species (Baluška, Mancuso and Volkmann, 2006; Adamatzky, 2018.2; Dehshibi and Adamatzky, 2020). And, drawing on research that detected low and high-frequency electrical spiking as a result of metabolic activities and environmental stimuli in algal and fungal colonies (Adamatzky, 2018; Adamatzky, 2019), it makes use of the engagement of live algae and fungi cultures to explore the design of an adaptive bio-digital construct able to activate mutual mechanisms of learning across multi-agential ecologies of human, machine, and biological entities.

The following paragraphs outline the theoretical framework that spurred the Transindividual Protocols series of investigations, before moving on to a review of the methods and outcomes described by the series of its early design-research interventions.

Towards a Pervasive Transindividual Subjectivity

> *"…information is never found, but always the results out of the tension between two different realities; meaning will emerge only once a process of individuation will clarify the dimension through which these two realities can become a system"* (Simondon, 2001, p.37).

Drawing on the work of French philosopher Gilbert Simondon, the Transindividual Protocols project builds a materialist and ecological foundation for ideas of digital participation. In particular, the project outlines the significance of Simondon's "L'individuation Psychique et Collective", drafted as part of the philosopher's doctoral thesis in 1958, but only published in its entirety in 1989 in French and in 2020 in an English version. In the book, Simondon outlines the ontology of the collective subject in the form of its ontogenesis, building, as an alternative to the substantialist and hylomorphic theories of subjectivity creation, an energetic theory of the process of becoming a subject - l'individuation - in an argument that, by borrowing at large from the natural sciences, sees the physical, psychological, and social processes of evolution as deeply intertwined. The thesis culminates with the description of the individuation of the collective subject as the ontogenetic and metastatic process of psychological and affective events producing the Transindividual, a new type of collective subjectivity that, born from an authentic new operation of individuation, lives its own changes based on its own specific metastaticity (Papeschi, 2019; Simondon, 2001).

By redefining the idea of collective subjectivity as a process of change through metastatic phases moved by psychological and affective events, Simondon also creates the basis for the reconceptualization of ideas of knowledge formation and information exchange, building an argument that, in antithesis to Shannon's theory of communication (Shannon, 1948), describes information as the result of a process of individuation of the system as it emerges from its tropistic and latent tendencies, thus offering not only the basis for a new conceptualisation of the process of becoming collective and building collective knowledge but also, with its transversal materialistic and ecologic approach, indicating the perspective through which a novel post-human and distributed form of authorship can be explored (Papeschi, 2019).

Indeed, the idea of the evolution of the collective subject as an ontogenetic and metastatic process of affective events has been also endorsed within the neurosciences, which has demonstrated how emotional intelligence is essential to rational thinking and social behaviours (Damasio, 1994). And if we consider the theory of Umwelt (von Uexküll, 2010), for which a specific model of the world exists in correspondence with each creature's sensorium, we must acknowledge how this idea extends to all forms of intelligence, each one with its own affectual vision (Di Carlo, 2016). Recent neo-materialist philosophy further expands this notion to include non-living agencies (Bennet, 2010), also supporting an idea of cognition as a hybrid process that extends beyond agential bodies to include socio-cultural and technological constructs (Clark and Chalmers, 1998).

As the resulting entanglement of matter, technologies and living species, this expanded notion of transindividual subjectivity constitutes the entry point for the reconceptualization of ideas of collective and extended processes of cognition that, as a result of today's ubiquitous nature of technology, become

transcalar and pervasive (Di Carlo and Papeschi, 2022), describing novel trajectories for aesthetic speculation that, transcending matters of organised complexity, introduce principles of instability and polydimensionality, also key to Calabrese's definition of Neo-baroque (1992).

Deconstructing the Human Agency

As outlined in a previous publication, (Papeschi, 2019), The HeartBit Walks was developed as a psychogeographic mapping event for the London Festival of Architecture 2018 as the first project of the Transindividual Protocols series to explore the metastatic process of construction of group spatial knowledge via emotional arousal sensing (Galvanic Skin Response). With a gathering point in Hackney Wick, the project explored, through the experiential act of walking, a wide section of the diverse urban fabric between the Olympic Park and Victoria Park in East London, and drawing on psychogeographic methods developed by artist and geographer Christian Nold (Nold, 2009; Nold 2017), it used the collection of Galvanic Skin Response (GSR), to produce maps and immersive representations of the area. For this purpose, a sensing device was developed with a combination of Arduino-programmed GSR and GPS modules. Structured as a two-day public event the project involved 25 participants in short group walks and in-situ group discussions. The results were collected in a rich visual index that by rendering the differently able perspectives with a granular definition offered a multi-scalar portrait of the experience of pedestrian mobility in the area.

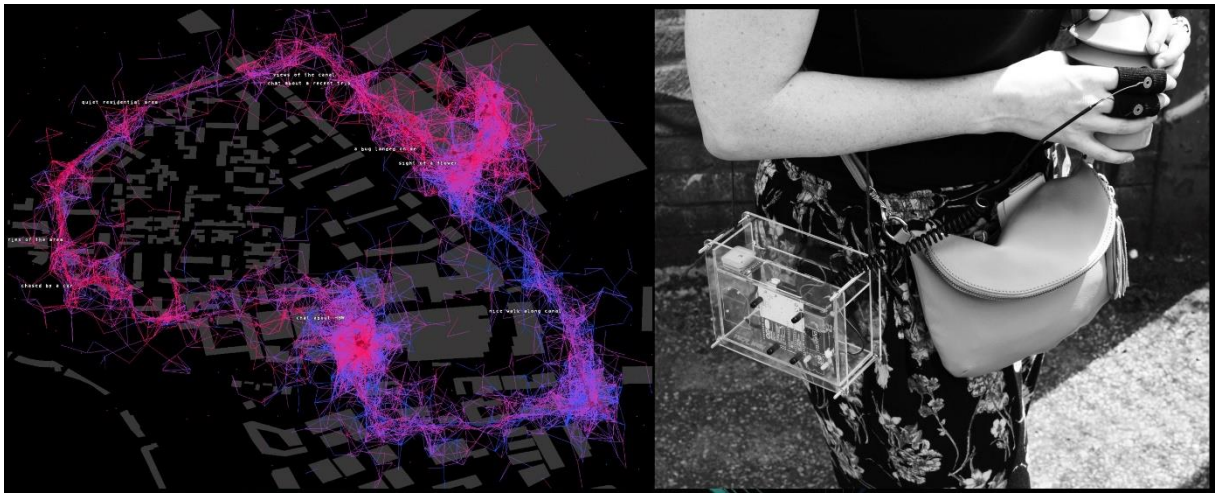


Figure 1: The HeartBit Walks, London Festival of Architecture 2018 (FLOW Architecture)

These ideas were further developed within the Affectual Infrastructures project, produced as part of the 2019 E17 Art Trail. On this occasion, six environmental activists were invited to give situated speeches at scattered locations in East London; augmented with the collection of GSR information the resulting audio recordings were analysed within their geographical contexts to detect data patterns at group level, exploring common spatial and emotional connections and the resulting metastatic formation of novel collective awareness. The results informed the production of spatial configurations through multi-objective evaluation methods and the design of a mixed-media installation that materialised for the audience the layered experiences of the activists (Papeschi, 2019).

Figure 2: Affectual Infrastructures, E17 Art Trail 2019 (Project: FLOW Architecture; Photography: Matthew Booth)

Despite constituting initial attempts in the exploration of two critical dimensions of the digital participatory project, dealing on one side with the mechanisms for collective knowledge aggregation, and on the other with the formulation of platforms for open purposive and generative action, it is through the construction of open archives of a sensual collective knowledge maintaining traceable ties with its sources and narratives, and through the introduction of mediated mechanisms for real-time awareness seeking to engage metastatic processes of group knowledge and purpose production, that these projects contributed as precedents for a collective urban practice that, by dwelling on ideas of open attribution of significance and multi-objective evaluation, offer new models of group negotiation and decision-making in a spatial context (Papeschi, 2019).

What the two projects, however, also pointed out, was the urgent need for some reconsideration of how these metastatic processes of collective knowledge construction and decision-making were to be mapped. As, while it was important to consider the different objectives and sensibilities of the ecology of participants at play, it became also critical the production of a time-based observation method able to map how the very metastatic nature of these processes affected the way in which feedback was produced through time.

Performative Feedback as Protocol of Collaboration

The next two projects of the Transindividual Protocols series drew on ideas of performative feedback as a method of collaboration between human and artificial intelligence, as emerging from ground-breaking cybernetic theory and practice in the 40s and 50s and in antithesis to Wiener's definition of negative feedback as a prediction and control method within circular causal systems. Stemming from the work of Donald Hebb and the concurrent cybernetic explorations on the emergent capacities of learning involving experience-dependent transformations and plasticity, the idea was expanded by the intersection with Varela's Theory of Embodied Mind (1991) which describes human cognition as depending upon the experiences that are contingent with having a body with sensory-motor capacities,

to outline a protocol of interaction that transcending early cybernetic circularity describes performative trajectories of human-machine collaboration (Papeschi, 2022).

These premises were first investigated during a two-week residency at PACT Zollverein Choreographisches Zentrum in Essen (DE) in 2020, exploring ideas of embodied and spatialised communication patterns as the basis for reasoning and inference-making within the context of part-human part-machinic ecologies. For this purpose, the work focused on the construction of a data-management infrastructure that used Arduino GSR sensing and Kinect motion-tracking data transmitted live to a Houdini simulation environment. The resulting immersive experience, titled Inferential Fields, tracked the movement and the live GSR response of a performer tasked, in an exercise of improvisation, with developing dynamics of space occupation through the spatial adversarial interaction with the responsive intelligence, expressed in the form of a large-scale background projection. Coded within the simulation environment with force fields and dynamic perturbations driven by the performer's live signals, the interaction described circular mechanisms of open feedback within the part-human part-machinic ecology.

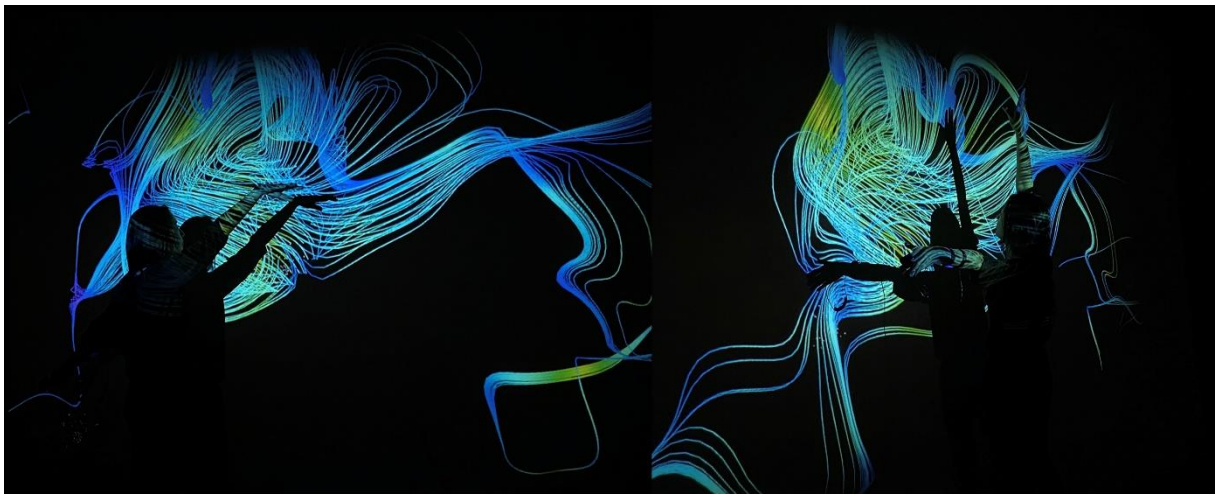


Figure 3: Inferential Fields, PACT Zollverein Choreographisches Zentrum, Essen (DE), 2020 (FLOW Architecture)

These ideas were further investigated and tested for their potential to widen participation, within the Pervasive Eyes Asturias project, where the use of performative feedback as a method for collective spatial cognition and sense-making was further explored within the settings of immersive geographical representation and analysis. Firstly, exhibited at LABoral Centro de Arte y Creación Industrial, Gijón (ES) in 2021, the project was built as a VR installation that used the spatialised visualisation of photographic and text media information from the social media platform Flickr to construct an immersive archive of the collective affective connections to Central Asturias. Visualised as a three-dimensional map of the area, the experience was accessible by two participants equipped with Wi-Fi GSR sensing devices; while accessing the information, the emotional arousal of the participants was tracked through GSR sensing and used to additively inform the generative organisation of a three-dimensional proximity graph mapping the history of the collective response to the experience. As such

the process described mechanisms of collective knowledge formation and learning leading to the construction of the virtual environment as a collectively informed navigational system.

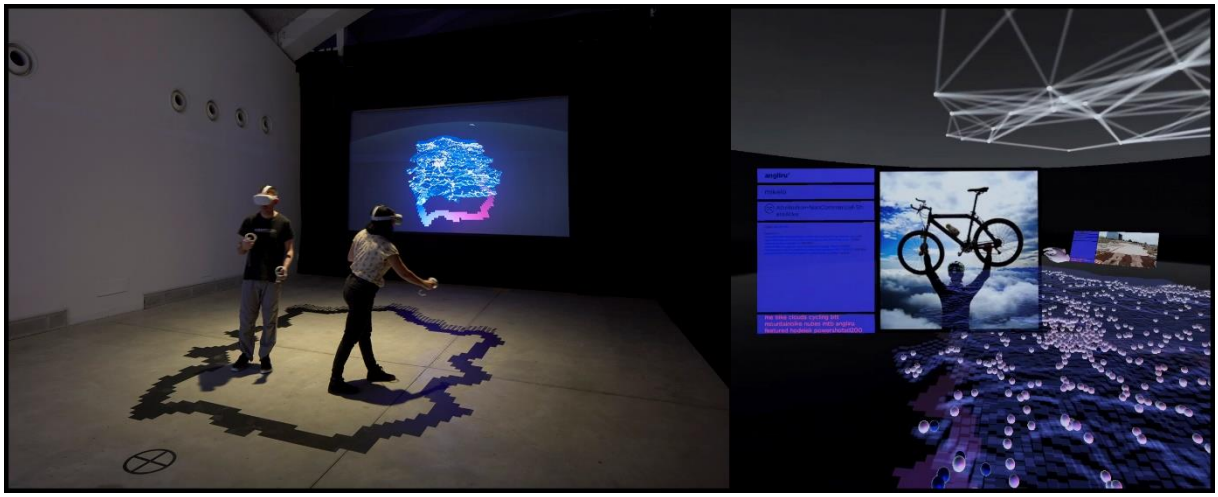


Figure 4: Pervasive Eyes, LABoral Centro de Arte y Creación industrial, Gijón (ES), in 2021 (Project: FLOW Architecture, Photography: Courtesy LABoral, © Marcos Morilla)

Together, the Inferential Fields and the Pervasive Eyes Asturias projects, explore notions of spatialized inference and the emergence of embodied conversational models through the performative interplay of human and synthetic agencies, further broadening through their attention towards live interaction and performance mapping, our understanding of the mediated metastatic processes of knowledge construction and reasoning within part-human part-machinic performative ecologies. And in doing so, they also outline the potential to engage wider audiences with large sets of information, outlining opportunities to engage the participants in translocal explorations and collaborative cognitive experiences with the potential to inform trans-scalar spatialised organisations of collective meaning. And while pointing towards widening the experimentation with the inclusion of a broader range of differently-natured signals, the projects also point towards the need for a more in-depth understanding of the faceted mechanisms of automated collaboration allowed by the same relational assemblages of human, biological and machinic intelligence that they suggest.

Ecotones of Indeterminacy

As already outlined elsewhere (Di Carlo & Papeschi, 2022), an approach to collaborative automation and mediated collective authorship as an inherently transindividual practice entails a series of strategies oriented toward the definition of emergent meaning that includes a focus on the orientation towards procedural indeterminacy. This is an idea that draws on Hayles' description of hybrid human-machinic processes of cognition (Hayles, K. 2014), an argument which stems from her interpretation of artificial intelligence as the cognitive non-conscious, a form of intelligence displaying cognitive abilities that, antithetically to the case with humans, cannot be described within the range of consciousness and unconsciousness, but operate at levels that are inaccessible to introspection.

On these premises, while considering the relationship between human cognition and the cognitive non-conscious, Hayles argues further how human interpretation could enter algorithmic analysis at different stages to form a dialogue that de-facto structures the potential outcomes of a hybrid cognitive process, outlining how in such a context a part of the interpretation process could be then outsourced to automated intelligence, with the meaning of the information produced becoming ultimately intimately linked to the specific design of the process of interpretation as well as to the context of the interpretation itself, opening multiple new opportunities for the interpretation of ambiguous information.

Responding to Hayles' argument, Parisi further argues how despite it remains impossible for non-conscious cognition to build causal links, it is possible for cognitive processes performed by non-conscious entities to expose *"temporal lapses that are not immediately accessible to conscious human cognition"*. This is a process that sees algorithms establishing new emergent patterns of meaning, forming - what Parisi names - coevolutionary cognitive infrastructures, agential ecologies, that based on the idea of indeterminacy as a model for automated and hybrid cognition, avoid primary level of feedback based on prescriptive outcomes and incorporate parallelism of learning and processing (Parisi, 2017).

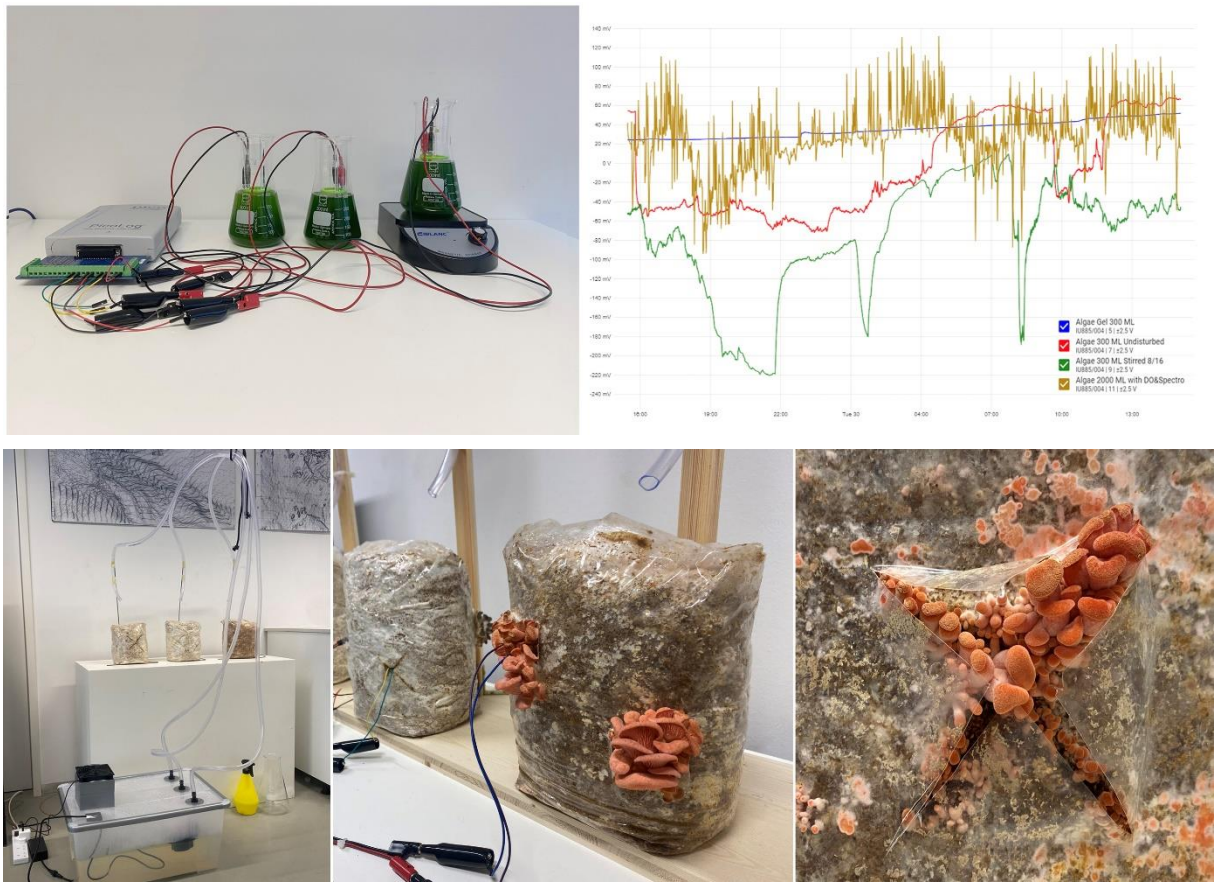
Drawing on these premises, and with the aim of exploring how the metastatic evolution of knowledge might influence non-causal generative mechanisms of real-time decision-making and purpose creation across multi-agential ecologies within spatial settings, the project draws on previously explored ideas of performative feedback, incorporating strategies of parallelism of processing and learning through principles of machine learning, to explore the construction of a coevolutionary cognitive infrastructure as a critical precedent for a mediated human-biological hybrid cognitive process.

The Whispering Garden

The Whispering Garden project initially dedicated a period of study to the observation of the dynamics of action potential in Chlorella cultures. For this purpose, drawing on measuring methods and scheme of electrodes devised by Adamatzky (2018), it employed an ADC-24 High-Resolution Data Logger (Pico Technology) with galvanic isolation with Pomona test leads for superior noise-free resolution and a range of customised electrode holders that were made to fit standard large neck Erlenmeyer flasks. Chlorella cultures were observed for periods ranging from 24h to 1 week and in flasks ranging from 300 ml to 2000 ml, in a quiet state and in stirred solutions at intervals. As well a series of experiments explored Chlorella in gel media, made with 1gr of Schauch HVDE 235 Multifunctional Superabsorber for every 100 ml of Chlorella solution.

Drawing on further studies that measured (Adamatzky, A., 2018.2) low-frequency and high-frequency spikes in fungi as spontaneous phenomena and as well as a response to controlled environmental stimuli, the project further explored the measurement of waves of excitation in fungal colonies. For this purpose, using the ADC-24 Pico Logger with Pomona test leads, firstly a substratum fully colonised with Pleurotus Ostreatus was observed for a 1 week period. Further, the study observed in intervals of 1 week to 1 month, fully colonised fruiting blocks of Pleurotus Ostreatus and Pleurotus Djamor in the

process of fruiting, as driven by controlled hygrometric conditions of the environment of observation. The design of specific bags for cultivation and fruiting was also explored using pre-conditioned mixtures of hydrated and sterilised wood chips substratum and grain spawn colonized with Pleurotus Ostreatus.

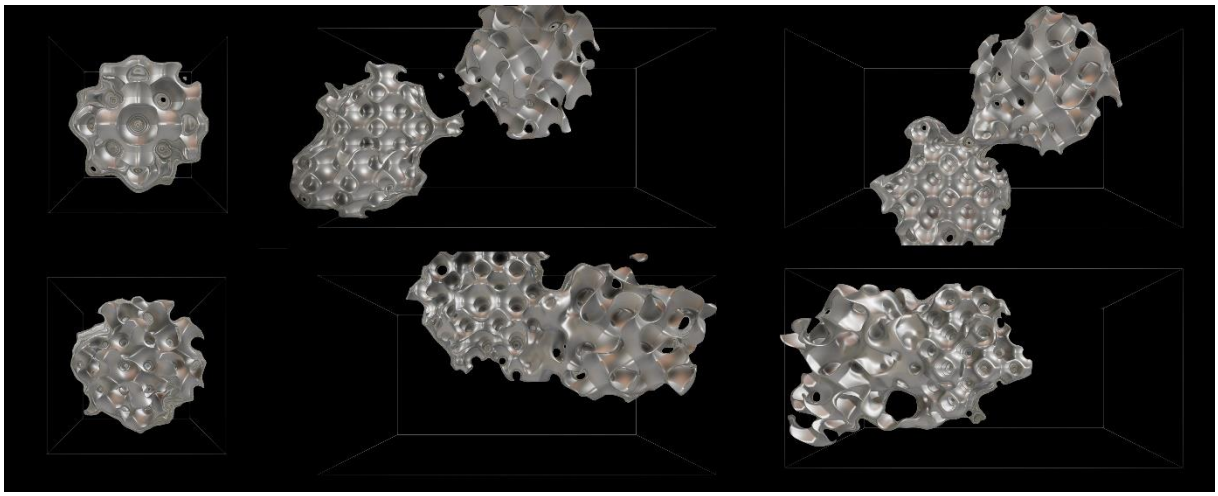


Figures 5 and 6: The Whispering Garden, measuring the dynamics of action potential in Chlorella cultures and in fully colonised fruiting blocks of Pleurotus Ostreatus and Pleurotus Djamor with ADC-24 High-resolution Data Logger (Photography: A. Papeschi, M.Kupstova).

The project moved on to the design of the digital infrastructure for communication, developed in VVVV visual language programming. The signals of the algal and fungal colonies, measured using ADC-24 Pico Logger with Pomona test leads, were imported into VVVV using the Pico Logger REST API via HTTP requests. The GSR signals, captured with a Wi-Fi GSR sensing device assembled combining a WeMos D1 ESP8266 battery charged Wi-fi board programmed in Arduino with a Grove GSR sensor, were imported using MQTT communication protocol.

Initial studies in VVVV Fuse investigated the formal interaction of a Gyroid and P-Schwartz three-dimensional scaffoldings driven by the live signals of the algal and the fungal colonies and rendered as Signed Distance Field (SDF). Exploring the dynamics of negotiation of space and the transitional organisation generated by proximity, speed, level of noise and morphological integration, the study describes a metastatic and multilinear formal language as the domain of the aesthetics exploration of the project. Within the prototype of the installation, the animated visualisation of an artificial landscape is

introduced with a sectional point of view as the terrain for the interaction of the two scaffoldings, that, in a process of underground excavation, modifies the existing solid appearance of the terrain creating a cavernous and porous system of voids.



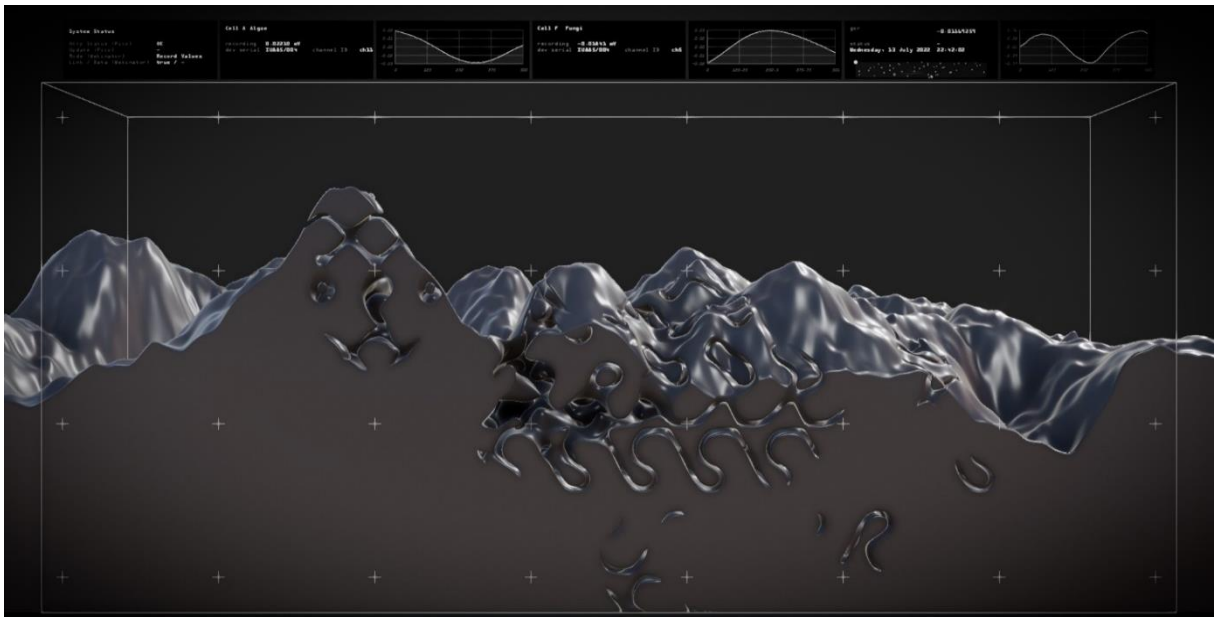


Figure 7: The Whispering Garden, 2022. Exploration of dynamics of Gyroid and P-Schwartz three-dimensional scaffoldings in VVVV (FLOW Architecture); Figure 8: The Whispering Garden, 2022. The adaptive landscape visualisation (FLOW Architecture).

Within this setting, machine learning methods are used to interface the live electrical signals from the multi-agential ecology (algae, fungi and humans) with the drivers of the live visualisation. A regression model is set up with the use of Wekinator, a standalone software providing machine learning algorithms accessible directly via interface programming through VVVV. Using an automated approach to the training of the model, specific conditions of the live action-potential signals are set to start the training of the model for brief intervals; in particular, a combination that searched for the contemporary positive waves of excitement in the algal and fungal media was considered during the first installation of the project.

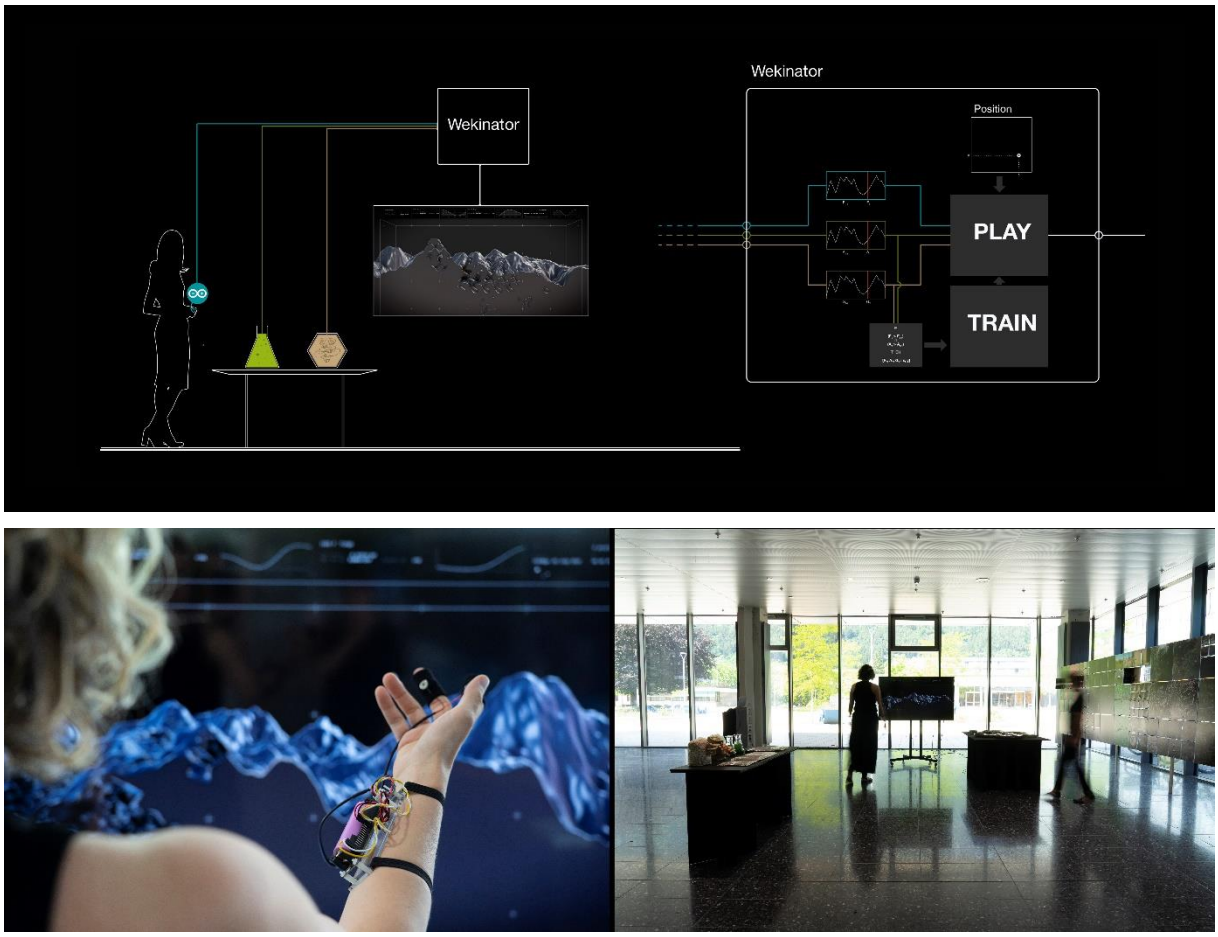


Figure 9: The Whispering Garden, 2022. Diagram of the data infrastructure and of the machine learning process (FLOW Architecture); Figure 10: The Whispering Garden, 2022. The GSR wearable sensor and the interaction with the interfaces as installed at the Host Institution (Project: FLOW Architecture; Photography: K. Enzinger).

Evaluation and Significance

The results outline the construction of the prototype of a responsive mixed media installation that, as an assemblage of machinic, biological and human intelligence articulated through the interfaces offered by the responsive visualisation, the set of sensing apparatuses and the presence of the biological and the human participants, attempts the expression of a transindividual protocol of performative collaboration described by non-linear correspondences and parallelism of processing linked to the history of the interactions amongst the ecology of biological and artificial participants. As such, the prototype describes the potential for the emergence of indeterminacy as a model of automated knowledge aggregation and collective learning, introducing new opportunities for the interpretation of ambiguous information and emergent decision-making for spatial organisations.

Figure 11: The Whispering Garden, 2022: the prototype of the installation at the Host Institution (Project: FLOW Architecture; Photography: K. Enzinger)

Constructed as an adaptive informational environment the visualisation expresses the pattern of interaction of the multi-agential participants through their non-conscious/unconscious affective response to each other presence and the environment, offering to the human audience a terrain for reflection on the potential of open and automated mechanisms of performative participation and their ability to engage weaker voices and signals from biological and artificial intelligences.

In such a context, the resulting construct displays the ability to connect different intelligences and their narratives in a collaborative cognitive infrastructure describing an approach to multi-agential and automated collaboration that, as observed within previous iterations of the Transindividual Protocols series, maintains trans-local and trans-scalar capacities. This is an ability that is further enhanced within this case study, by the intersection of a diverse range of biological and synthetic resource-thinking and their diverse capacities for interacting with the environment at different scales and in different conditions, in a process that describes compelling trajectories of further speculation with regard to the operability of such platforms and their potential to inform novel distributed and pervasive architectural and urban organisations of meaning and matter.

Along these trajectories, the project contributes to the definition of an ecological and post-digital practice that, informed by the layering of machinic, human and biological parallel learning and decision-making, and as a result of the close interaction of the technological infrastructure with the varied affective capacities of the multi-agential ecology of participants within a performative setting, describes a multi-linear and poly-dimensional aesthetic as a novel terrain of investigation and encounter for multi-agential collaboration within the context of spatial practices.

A revised production of the project would certainly benefit, from exploring further ideas in regard to the operability and contextualisation of such co-evolutionary cognitive infrastructures, observing the pattern of the response of the biological intelligences within different environmental conditions, ranging from controlled to uncontrolled environments and developing further speculative ideas in regard to the applications of such infrastructures within the realm of the built environment at the intersection of different scales of operation. The project would also benefit from a longer and more structured period of

observation of the interaction between the multi-agential ecology of participants and the resulting formal outcomes, to evaluate the outcomes of the metastatic processes of open attribution of significance and emergent purposive spatial action resulting at group level.

Authorship Information

The HeartBit Walks, Affectual Infrastructures, Inferential Fields, Pervasive Eyes Asturias, and The Whispering Garden are projects by FLOW Architecture (Annarita Papeschi & Vincent Nowak). The projects were developed as part of the PhD research project Transindividual Protocols: New Territories of Participatory Architectural and Urban Practice by Annarita Papeschi, supervised at UCL The Bartlett School of Architecture by Prof. Marjan Colletti (UCL), Prof. Mario Carpo (UCL) and Prof. Claudia Pasquero (UIBK/UCL).

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