

Inhabiting The Plastisphere? – Architectural Making As a Prelude To Transdisciplinary Sense Making Of Plastics In The Environmental World

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ABSTRACT: In the plastisphere waste-landscapes formed by human consumption are discarded products that often become the place of inhabitation of various inherent earth, and air bound microorganisms (Amarel-Zettler et al. 2020). Yet, whereas the amounts of plastics piled up in our environment and inside our bodies are vast, increasing, due to the everlasting properties of the material, plastics are alien to us (humans of privilege) as a place of inhabitation. Our relationship to plastics is uncomfortable and emblematic of our overconsumption and its social, environmental and economic consequences. Posing the question of inhabitation of the plastisphere, this paper searches a direction to link the microscale potential for nonhuman colonization of disposed plastic as an architectural potential in addressing the pressing macroscale need for decolonization.

The paper hypothesizes that there are qualities to be nurtured in a transient and contingent manner in pursuing a tectonic joinery of ecological relationships between a material, colonizing organisms and resulting performances, inviting opportunities for the benefit of both the needs of human society and the needs of our natural environment. Consequently, this research engages in material experimentation, and the aptitude of a material to be colonized by one or several groups of living organisms without necessarily undergoing any severe deterioration. The paper presents a series of 1:1 prototypes exploring a possible inhabitable afterlife of, specifically disposed plastics, through an iterative process intersecting architectural knowledge and making.

In conclusion, the paper discusses the potential of these prototypes as preludes to the formation of transdisciplinary research collectives and more towards uncovering a viable embodiment and afterlife of disposed plastics in the environmental world through its tectonic incorporation in the built environment.

KEYWORDS: Disposed plastics, Architectural Making, Tectonics, Transdisciplinary, (De)colonization

INTRODUCTION – PLASTIC AS AN EMBLEMATIC CASE

The challenges and potentials of meaningful implementation of new materials in architecture has been a key subject throughout architectural history. Perceived as the DNA of all building and space construction, material types and composites have, through articulation and development, kept at pace with our own societal advancements contributing to demands laid down by us (humans of privilege), for example social, health and welfare societies, influencing approaches to building development as a consequence. Material processing and development were a cornerstone for The Arts and Crafts Movement, that further influenced social and human wellbeing developments of the Garden City Movement. Material technology and production advancements accelerated through the High-Tech era, and up to date contemporary technical and material advancements embrace ecological and digital fabrication crafts, technics and thinking, a subject that has become increasingly present with the increasing pace by which material and construction technology advances (Semper, Mallgrave, and Robinson 2004).

With technological advancements, the metabolism of the built environment has increased its pace, and we are by now well aware of the magnitude by which architectural construction affects the global environmental imbalances that govern a viable path forward (Rockström and Moberg 2014). So, through a quest to bring material advancements as a fundamental player into advancing our own well-being, the immensity and cocktail of unending new material consumption, coupled with our lack of regard to the consequences of the metabolism of the built environment through a flow of materials, has contributed to environmental imbalances, defeating the overriding objectives of creating better societal environments and advancements.

We (humans of privilege) are in no position to continue our misconceived fancy of the new, nor at the scale of architectural construction as a whole nor at the scale of single material applications. Material advancements, though necessary to satisfy current and future demands of our built environment, needs to shift towards drastically slowing down the flow of new materials that govern the current construction practice by inhabiting what is already there and avoid historical patterns and behaviors of demolition and depositing of valuable material regarded as waste (Reductionroadmap.dk). The quest for ingenuity in the gradual exchange of materials, 'stoffwechsel' (Moravánszky 2018), no longer solely concerns meaningful architectural implementation of new materials but requires the development of an architecture of waste materials that we are culturally detached from.

This research therefore investigates this challenge at the micro scale of the material itself using plastics as a case. Plastics are associated with low quality and something cheap and of no, or little value. We therefore often dispose of the material after a single, or short-term use. (Geyer, Jambeck, and Law 2017). As a case, our relationship to plastics is uncomfortable and emblematic of our overconsumption and the social, environmental and economic consequences. We embrace the lightness, strengths, durability and ductility of the various chemical chains developed in our laboratories to further develop the needs of society, yet are uncomfortable with the notion of coexistence with this synthetic material, and pursue its removal from our lives, rather than to coexist and colonize. Removal, as a preferred action, has resulted in well documented negative consequences of our global environment. Since plastics invention (Science Museum. UK) today the world collectively has produced 8 billion tons, of which a colossal 6 billion tons is regarded as waste (Mckinsey & company), that is, unwanted material that contributes to that waste landscape of redundancy and illuminates our uncomfortableness with the notion of coexistence of our anthropogenic product (Derrai, 2002; Thompson et al., 2004; Corcoran et al., 2009; Law et al., 2010).

Coexistence on our planet with plastic as a symbol of anthropogenic impact on the environment is uncomfortable, and everlasting. Plastic can degrade biologically but is a slow process (Kulshreshtha 1992; Shah et al. 2008; Cooper and Corcoran, 2010). Plastic in our environment is persistent (Gregory and Andrady 2003) and reacts to environmental changes in temperatures due to polymers inherent ductility. In certain warm climates softened and melted plastic debris waste has fused and mixed with substrates creating a new type of material discovery referred to as *plastiglomerate* (Corcoran, Moore and Jazvac 2014). *Plastiglomerate* has been formed by heat – natural and manmade (fires) whereby there is a fusion between plastic and substrate materials such as rocks, and new formations are made. *Plastiglomerate* is, by definition, not a rock; rocks are formed naturally, whereas *plastiglomerate* is composed of anthropogenic products (plastic) shaped natural actions. Nature therefore has been instrumental in this case in establishing a state of coexistence that we as humans find difficult in the least, and challenging at the most.

Nevertheless, actions, responses and reactions of manmade material composites to our natural environment is a focus of interest for this research in an attempt to explore more amenable relationships to plastics rather than that of uncomfortable and an emblematic of our overconsumption, and to promote long term patterns and behaviors with materials often regarded as waste (Geyer, Jambeck, and Law 2017). Consequently, this research investigates both means of laboratory-based fabrication and nature induced patination as an entrance by which to explore a possible inhabitable afterlife of, specifically disposed and recycled plastics, in and through architecture towards a wider transdisciplinary understanding of how to make sense of plastics in the environmental world and how we as humans of privilege can coexist in meaningful ways with our waste material.

In this matter the paper presents a series of prototypes that result from physical modeling and testing at real scales architecture of and for inhabitation, both physically and emotionally. A significant attribute of the test cases was an acknowledgement of the value of time through deterioration, patination, erosion and non-human colonization, that gives us avenues for engagement, an understanding of our material connections and avenues for inhabitation of the *plastisphere*. Processes of fabrication and assembly also encouraged other unforeseen consequences of the aesthetic that facilitated other transformations of plastics into a viable place of inhabitation for human and non-human species alike and entry points into engaging with disposed plastics as an anthropogenic product of our time.

1.0 METHODOLOGY

1.1 Patination as an entrance

Patination of objects can be seen as a process of change to a material and its surfaces (Pallasmaa 2016). Materials exposed to active daily and seasonal environmental conditions can begin to change. It may be colour bleach from the sun, dirt accretions accumulated through bombardments of airborne organic material through wind and rain, or physical weathering of sharp edges to more smoother geometries by receiving live forces from nature. Humans' use and contact with materials also adds to patination through the process of time and can make visible the use and history of an object and the material it is made from.

it is in that golden stain of time, that we are to look for the real light, and colour, and preciousness of architecture; and it is not until a building has assumed this character, till it has been entrusted with the fame, and hallowed by the deeds of men, till its walls have been witnesses of suffering, and its pillars rise out of the shadows of death, that its existence, more lasting as it is than that of the natural objects of the world around it, can be gifted with even so much as these possess of language and of life. (Ruskin 1849, 162-182)

The patina aesthetic was further popularized by art critic John Ruskin in the 19th century with his romanticizing of the golden stain of time (Ruskin 1849, 221). The broadest definition of patina adds the effects of human use to the effects of natural processes of time. This can be understood as “cultural weathering” (Heath 2016) and includes everything that makes visible the history of an object and how it was used.

The methodology of cultural weathering to encourage states of coexistence and engagement through engaging in new processes of production in this research was examined therefore by two principal methods, energy injection and human insemination techniques.

1.2 Energy injection to foster transformation consequences

In a process of material transformation from 'raw base product' to a useful designed and fabricated component, heat needs to be applied to plastic so that it bonds, softens and can be directed to desirable casts and formwork. The plastic will then cool, and processes are carefully controlled to ensure no imperfections of shrinking, flashing, an excess of material, and air bubbles etc. This research explored, through real scale testing, implications of encouraging transformations of the material and imperfections of heating and cooling by consciously not controlling the process of fabrication of components in normal manners, with specific goals to explore its habitation potentials. This was done by not restricting movement of the material whilst cooling, over 'cooking', under 'cooking', open formwork rather than pressed and closed within controlled formworks, and encouraging gravity to maneuver the material in semi-uncontrolled manners whilst the plastic is soft. With a less rigorous control one can encourage other unforeseen consequences of the aesthetic and facilitate other transformations of plastics into a viable place of inhabitation for human and non-human species alike.

1.3 Human insemination techniques to encourage habitation

To encourage places of inhabitation and colonization for human and non-human species alike the research explored, through real scale testing, implications of adding organic alien compounds during the process of form making. With active participation through embedding alien organisms, the plastic reacted by cracking open in part, and embedded the organic material into the body of the plastic and its surfaces to create habitats for human and non-human spolia that establish abilities for colonization and bio receptivity. Through an act of adding biogenic organisms' materials started to come to life through uncontrolled responses and challenged our industrialization processes of material production that usually consciously eliminates growth and alien habitation and colonization's. The alien materials ranged from seaweed, earth, sugar, salt, horse manure - all easily biodegradable but all providing nutrient sources as substrates for organic growth, and all encouraging the plastic to respond in different ways.

2.0 FINDINGS – PROTOTYPING THE INHABITATION OF PLASTICS

The research follows iterative prototyping processes where knowledge has been accumulated via explorations of specific material performances, from laboratory to construction mock-ups focusing on the architectural qualities embedded in control of production techniques and facilitating longer term patinas of material surfaces to extend the aesthetic beyond common judgements. Experiments have therefore been focused on how the inherent material qualities drive a design brief towards specific investigations to explore aesthetics induced through production, patinas from human and non-human forces, and colonization obtained over time while exposed to external climate conditions.

Experiments carried out through iterative prototyping processes can be categorized into 4 chronological parts: 1, Polycarbonate Blue Wall; 2, Incubator Growth; 3, Green Habitations, and 4, Plastic Pringles.

2.1. Polycarbonate blue wall

The material type of interest was recycled polycarbonate that was formed through heating in metal forms with applied pressing with jigs on the top surface to establish imprints through making and cooling. Jigs were made to encourage pressing of a top plate and to present relationships between plastic and human interactions. Two jigs were constructed that could be placed upon the metal frames. The first was an x-shaped jig (fig. 1) consisting of 9 bolts that could press upon the flexible top plate. This allowed pressure to be exerted down onto the top plate whereby the pressure could be adjusted. It did not however allow the possibility of lifting the top plate. A second jig was therefore constructed (fig. 2). This consisted of 6 evenly distributed pressure points. 3 were made to exert pressure down, and 3 to lift the top plate up. These were welded to the top plate meaning there were more possibilities of regulating the specific force and contact with the top plate to the polycarbonate plastic.

Through a simple production process, it was difficult to be extremely accurate with exact temperatures, pressure and time being exposed to heat. Cleaning and deforming of the metal forms over time also became factors difficult to control resulting in visible traces of human interference. All these partially uncontrollable actions influenced the overall characters of the components. Some were under 'cooked'. Some over 'cooked'. Some free from dirt and others stained by the metal rust and human interference (Getting the plastic out of the mold).

All imperfections induced as consequences of the human process of making developed a methodology of influencing the design parameters - that is through production and fabrication a design intent became responsive to the results and 'teased' the component ensemble design demonstrating ways of navigating between the 'dead' non-human material of plastic, and human actions. The final ensemble of components has been assembled as a facade and has been placed outside to test and encourage long term patina to study how an artificial material that has been produced by semi-controlled methods can engage in natural processes and thereby promote aesthetic consequences and qualities.

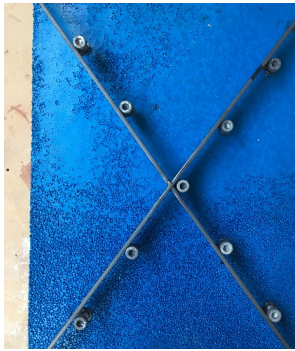


Figure 1: Polycarbonate panel showing the x-shaped jig position. Source: (Author 2022)



Figure 2: Second jig consisting of 6 evenly distributed pressure points. Source: (Author 2022)



Figure 4: Detail of Polycarbonate panel assembly showing collage of imperfection characteristics created by top plate pressure application. Source: (Author 2022)



Figure 5: Polycarbonate panel assembly – façade - showing collage of imperfection characteristics created by top plate pressure applications. Source: (Author 2022)

2.2. Incubator growth

The material type of interest was recycled HDPE shredded plastic that was sourced from a domestic recycling centre and formed through heating piles laid on to metal trays. Recycled plastic was shredded and the shavings mixed with an energy rich garden earth that, when heated created a vast collection of small cavities. These holes became places for micro-habitations that was encouraged whilst in a light and heat incubator environment. By not using specific molds and frames and relying on the natural formation and inherent angle of repose of the composite material when piled up broke down thresholds between controlled and non-controlled environments. When heated, the plastic bonded and sank to a flatter formation and fused, in part, with the earth. Within an incubator environment mycelium and moss was encouraged to grow thereby presenting a new composite of co-existences between anthropogenic products (plastic) and non-human existence.

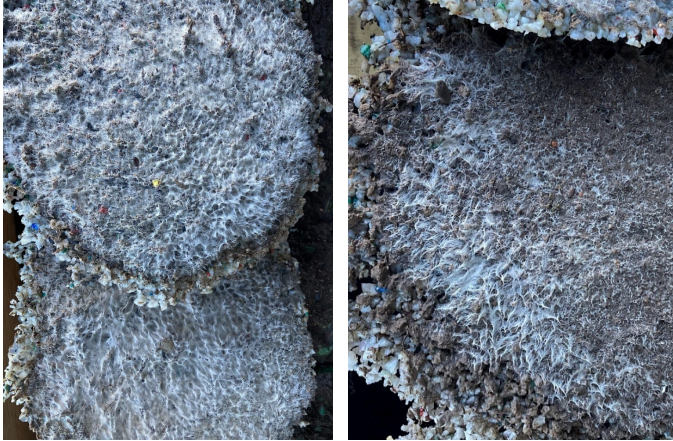


Figure 6: Mycelium and moss growth in an incubator environment. Source: (Author 2023)



Figure 7: Mycelium and moss growth in an incubator environment. Source: (Author 2023)

2.3. Green habitations

The material type of interest was industrial processed recycled HDPE that was formed through heating in metal forms with no applied pressing. Cavities were created during the melting process by adding organic material to encourage micro-habitations. The alien materials ranged from seaweed, earth, sugar, salt, horse manure, water, sawdust - all of which are easily biodegradable. Water sprayed on to the plastic when hot, was in particular rather successful to encourage cavities, or bubbles of air that were formed through steam. Seaweed also reacted well to reacting with plastic when hot, also creating air cavities, and generally fusing with the plastic to create a well-bonded composite. Sugar was tested as well due to the sugar content in seaweed. Sugar proved to be very instrumental in increasing the overall volume of the final component in the same way as yeast expands flour during the baking of bread. The physical experiments have been placed outside to test and encourage long term colonization through non-human natural processes.

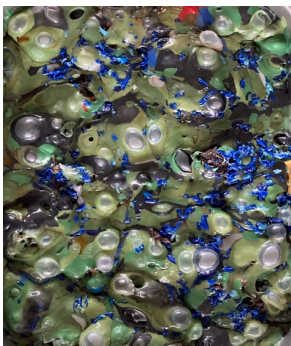


Figure 8: Experiments with applying water to the hot composite of plastic and seaweed. Source: (Author 2023)

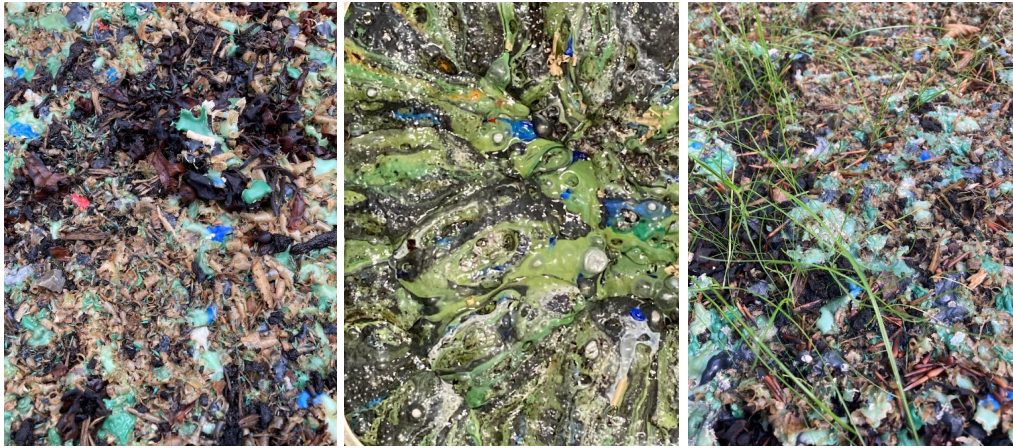


Figure 9: Experiments of placing the composite panels outside to test and encourage long term colonization through non-human natural processes. Here the plastic has been mixed with seaweed and sawdust. Source: (Author 2023)



Figure 10: Allowing gravity to allow the hot plastic to sump and stretch in the mold. Source: (Author 2023)

2.4. Plastic pringles

The material type of interest was industrial processed recycled HDPE. The material was not laid into specific molds and frames but, like 2, Incubator Growth, relied on the natural formation and inherent angle of repose of the composite material when piled up. When heated, the plastic bonded and sank to a flatter pancake-like formation and was left to cool. As the plastic cooled it began to naturally deform. Plastic will shrink back to its original volume before being heated - and expanded - usually around 10% at its maximum. Usually, this is calculated in any plastic casting processes and controlled with specific formwork. As the plastic piles were not placed in a mold and only laid out on a metal plate, it was completely unpredictable how the plastic would deform and reform. The thickness of the plastic tended to indicate that the thicker the plastic, the less likely it would deform, meaning the outer edges of the components bent and twisted the most, usually in all 3 axes, creating a double curve-like form similar to the shape of the common crisp, 'pringles'. Through kinetic explorations of natural processes through cooling, new composites were produced to challenge our own associations of plastic as a usually well controlled material serving the principle role of providing a product for our own existence.

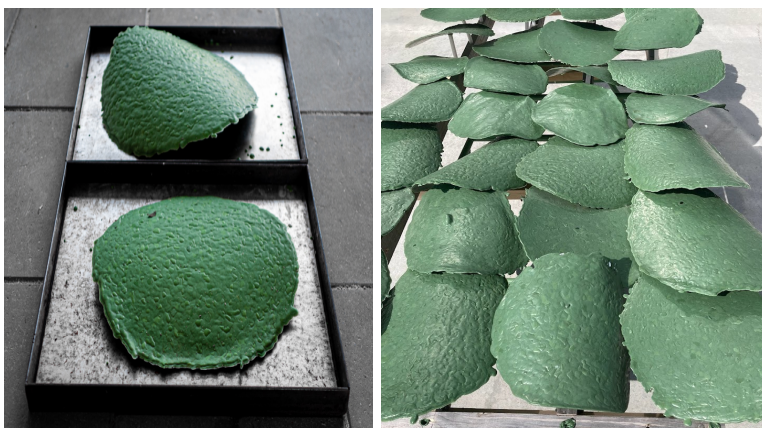


Figure 11: Plastic bent and twisted when cooled. Source: (Author 2023)

3.0 DISCUSSION – ARCHITECTURAL MAKING AS PRELUDE TO TRANSDISCIPLINARY RESEARCH

A recurring focus of the research is an attempt to discuss the perspectives of the work towards transdisciplinary environmental sense making-research of plastics in our societal, and environmental world. There are embedded relationships between the materials we manufacture and use - and eventually discard - and our own emotional attachment, or detachment. That is to say, we have a difficult relationship with our own material production, particularly with increasing concerns in respect to our own welfare and well-being, and the world as a whole as our environment attempts to navigate a coexistence of our anthropogenic products (Derraik 2002; Thompson et al. 2004; Corcoran et al. 2009; Law et al. 2010).

Plastic is present and influential in our lives. We have proved through our own daily existence a complete dependency of this man-made product, yet it is alien to us (humans of privilege) as a place of inhabitation. Plastics are associated with low quality, and even in our language we refer to plastic as a metaphor to describe the cheap and the fake. Disposal of the material after often short-term use has become our preferred pattern of behavior (Geyer et al. 2017). Disposal meaning, out of sight, out of mind. So, do we think of plastic in these detrimental terms because of the material itself, or because of our behavior of use and disposal, or because of our own difficulty as a place of inhabitation, coexistence and colonization - human and environmental?

The research production has been developed and processed through material experimentation and engagement through processes of fabrication as an attempt at outlining transdisciplinary perspectives by using the prototypes as preludes and means of communication and reflection of our own perception of an anthropogenic product and our behavior through use and disposal. Ensembles of multiple - usually anthropogenic products - in our built environment creates space and atmosphere, thereby intrinsically bonding material with our immaterial realm of human perception, imagination and comfort. (Pallasmaa 2014). The research focuses on plastic as a material that is very present in our day to day existence and our survival, and discusses how embracing a synthetic materials' natural processes of transformation when exposed to external climates and alien colonizations can allow places for inhabitation through our cognition and emotional connection, acknowledging that there is no cognition without emotion, even though we are often unaware of the emotional aspects of our thinking to challenge our relationships, judgments and preconceptions (Johnson 2007). An architectural space is perceived with our very existential experience and cognition. As soon as we have made first-hand judgment and assessed a place as enjoyable, inviting or other, we become attached to certain values. Ensembles of multiple materials stacked, screwed, nailed, glued that make our built environment require from us a stand point for engagement and emotional inhabitation, and comprehensive grasping of the ambience of a spatial entity can be understood from the point of view of biological survival (Pallasmaa 2014).

The research suggests that means for confronting emotional engagements to navigate a coexistence of waste of our anthropogenic products can be made possible through an act of both applying energy, and inseminating non-biogenic material with biogenic products. Through applying energy and non-human insemination, plastic starts to come to life and offer unpredictable responses. This unpredictability allows us as humans to engage in other ways and displace the shackles we bear when addressing our own unforgiving waste by offering insights into how timeless, artificially laboratory constructed products can, through wear and tear, follow and replicate our own course of adaptation - and aging even - as we navigate through time.

The experiments conducted consciously encouraged responses by offering processes of production that were uncontrolled when compared to usual processes of producing plastic products. The approach of offering significant reduction of control established imperfection to flourish and acknowledged nature's way of establishing states of coexistence of anthropogenic products (plastic) like plastiglomerate (Corcoran, Moore, Jazvac 2014) in our very lives and the environments we construct.

Imperfection is in some sort essential to all that we know of life. It is the sign of life in a mortal body, that is to say, of a state of progress and change. Nothing that lives is, or can be, rigidly perfect; part of it is decaying, part nascent.... And in all things that live there are certain irregularities and deficiencies which are not only signs of life, but sources of beauty. All admit irregularity as they imply change; and to banish imperfection is to destroy expression, to check exertion, to paralyze vitality."

(Ruskin 1853)

A typical building material must also confront an external environment that too is not controlled. Material is susceptible to heat, to rain, to snow, to wind, to ultra violet deterioration. All live forces as such of which materials naturally act and react through weathering, erosion, patination, discolouring, and producing chemical reactions like rust, resistance and accommodation.

Geometry and form speak of permanence, whereas materials – through the very laws of nature – trace the passing of time. Modernity has been obsessed with novelty and a perfectionist formal language that does not register this.

As deterioration, erosion and entropy are the unavoidable fate of all material constructions, the ideal of perfect and unchanging form is bound to be a momentary illusion, and eventually a false ideal. (Pallasmaa 2016, 57)

Biogenic and non-biogenic material engineering presented in this work has been conducted in an intuitive and low technological framework. Temperatures needed for encouraging transformations are akin to baking bread. Even the time spans are similar. There is no specialist equipment needed and the components produced reflect that. The very processes adopted give us opportunities and scope for scrutinizing the potential of plastics as a viable place of inhabitation for human and non-human species alike, through an embodied architectural confrontation with the material and offers an exchange between materials, as building blocks of our built environment, and the immaterial realm of human perception and imagination. Transforming synthetic material through hands-on and basic manufactured processes, coupled with natural processes of transformation when both mixed with alien biogenic materials and exposed to the external climate can allow places of inhabitation and

challenge our relationships and perceptions that are often alien to us (humans of privilege) as a place of inhabitation.

CONCLUSION

Contemporary building construction provides frameworks for the clear needs of human comfort and habitation whilst navigating with an unpredictable external environment. In pursuit of better, environmentally sensitive building constructions and envelopes, we need as a profession to engage in environmental responses, not as rejection in keeping nature at bay, but through inclusion. To 'work' with nature. To nurture forces that materials confront and embrace accretions time and weather impose. This research has attempted to embrace single building components, the processes of making and the processes of contaminating anthropogenic products (plastic) with nature-based materials to facilitate a closer discourse between biogenic and non-biogenic materials and encourage states of coexistence that we as humans can have a closer affiliation with. The work suggests through acknowledgement of environmental forces and attributes a closer affiliation can be achieved. The work encourages an examination of means of production, but has remained at the small scale and although suggests a non-laboratory approach it is nevertheless a product of small-scale laboratory like testing. To fully embrace this type of material investigation the work needs to be scaled up and engage in mass production-like techniques and begin the difficult discourse between what we do, and, what we should do.

In conclusion, this paper discusses the potential of manufacturing prototypes as preludes to the formation of transdisciplinary research collectives juxtaposing chemistry, engineering, psychology, sociology (Gauri, Hinge and Otzen 2023) and more towards uncovering a viable embodiment and afterlife of disposed plastics in the environmental world through its tectonic incorporation in the built environment.

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