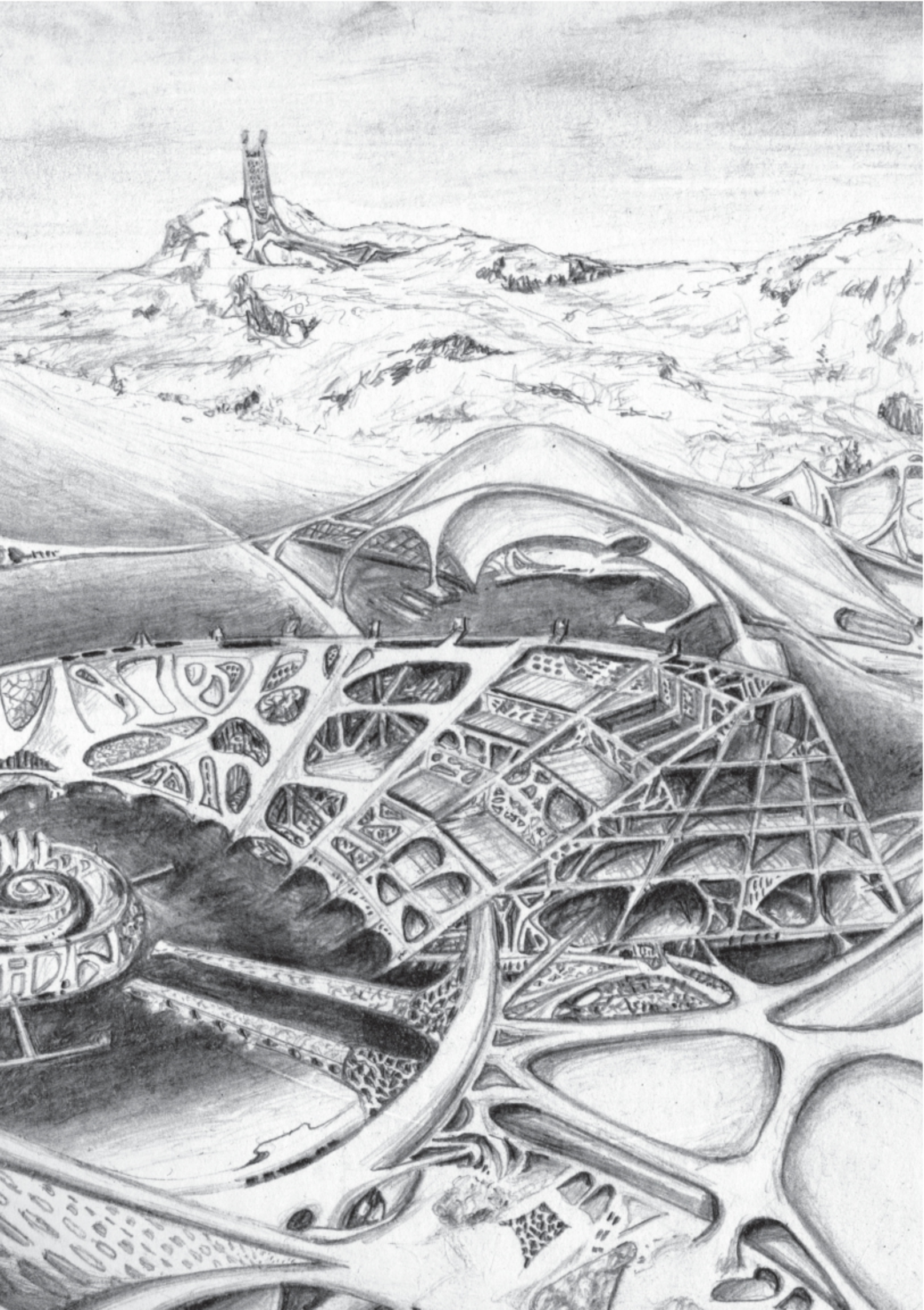


Videre: Drawing and Evolutionary Architectures

Paul Cureton

Abstract

Analysing the works of the seascape architect Wolf Hilbertz (1938 -2007), coral scientist Dr Thomas Goreau, architect Newton Fallis and collective, the paper considers the development of 'self organizing' natural building materials developing a mode of working - *Cybertecture* (Cybernetics & Architecture) (Hilbertz 1970). This investigation focuses particularly on that of Biorock® the mineral accretion technology, and involves a process of creating artificial coral reefs which are stronger and more resilient to degrading factors found on natural reefs. The technology exemplifies an evolutionary environmental system, a coral which is more reliant, tradable, multiplies in growth three to five times faster than normal, protects coastline, and grows fish populations through its constantly evolving habitat (Hilbertz, Goreau 1970, 1992, 2008). Importantly the technology has wide implications for restoring, designing and managing fragile and threatened coral ecosystems thus creating an emerging field of *Seascape Architecture* (Goreau, Hilbertz 2005).

Through the application of such technology, an accreted city of coral is envisioned - *Autopia Ampere*. The early stage of the project involved large scale hand drawings of possible outcomes and issues in construction and production (Fallis 2010). The drawings of *Autopia* can be considered as heuristic and also visionary in the testing of ideas - (Videre, Latin. *to see*). The author's composite drawings present this vision as a method to understanding the project as a form of 'dialogic drawing' (Dee 2004). From this basis there is a consideration of the role of hand drawing, its decline and its relation to other visualization techniques-arguing the case for the maintenance of this particular 'visionary' species (a morphological type) of drawing in architectural practice (Evans 1996, 2000). This is a type of drawing which arguably can 'influence' and 'work out' to provide or image heuristically charged solutions, spaces and structures to our changing climate.

Keywords

Seascape Architecture, Autopia Ampere, Drawing, Visualisation, Mineral Accretion, Hilbertz, Goreau.

Introduction

"Cybertecture is a concept to reverse a historical process radically." Wolf Hilbertz

"The old falls down, times change, and new life blossoms out of ruins." Goethe

Examination and integration of the mechanisms of evolutionary processes can yield a raft of experience which can then be drawn from, of the processes of things. The desire for heuristic evolutionary architectures that are "self-organizing environmental open systems capable of forming higher orders of organization"[1] is collectively being reshaped towards new technologies that address our environmental impact. A heuristic approach is to enable change, a new life as Goethe places it. The heuristic method is one of discovering and finding, projecting solutions borne out of the now. To this end the seascape architect Wolf Hilbertz (1938 -2007), coral scientist Dr. Thomas Goreau and Newton Fallis, Forest Higgs & collective, from the late 1960s researched and articulated categorical imperatives[2] for natural building materials that created a symbiosis of man, animal, plant, technology and nature.[3] These imperatives included renewable building materials with low to moderate states of energy that could be naturally grown whilst also supporting biodiversity.[4] It was through examination of the phenomena of natural organization that a cybernetic function (utilising computer technology that determines the frequency of this natural change) could enable these new structures and materials -what Hilbertz called *Cybertecture* (CYBERnetics & archiTECTURE), analogous to living systems, control mechanisms that organize materials in a self-determined manner. Hilbertz attempted to outline an evolutionary environmental system "which organises the space-time continuum eco-systematically."[5]

He based the system on three sub sections first, a sensing structure subsystem akin to a living organism, it requires a material to sense such environments. Secondly, a material and reclamation system which manipulates the sensing structure to the needs of the user. Thirdly, a computer system which would act as a decentralised nervous structure organises the sensing and reclamation systems to adapt to the total needs of the user. It would have reversible capabilities and could balance itself against any disruption. The system would absorb and be capable of higher level tasks of organisation and complexity and symbiotic processes.[6] Such work, it was hoped, would create an autoplastic system – open systems being regulated by the law of nature only – "creating, changing and terminating, in an in-deterministic manner, diversity and contexture."[7] Architecture was to be seen as a material in transition and experiment which would never be completed: "it will incessantly explain and form the world out of it's very self-anew and thus, at any given time, will be the best of all architectures."[8] Such goals to Hilbertz could only be realised through the integration of the hard and soft sciences and the arts - architecture and engineering essentially - moving beyond a 'responsive environment' towards an 'evolutionary environment' - a socio-cultural and environmental solution. This evolutionary environment works on the premises of dynamic stimulating interrelationships and rich connections, "between man, his extensions and nature; being simultaneously beginning and end, originator and result, producer and user."[9] Such visions and alternative thinking are similar to those of Soleri, Buckminster Fuller et al, belonging to both an enriching pedagogic mode for studio practice, but which also have radical challenges to accepted systems and ways of working, as Vesley remarks, "what we know contributes to what we make, and what is already made contributes substantially to what it is possible to know."[10] Accepting

*(left) Autopia Ampere, After Newton Fallis (1970) and Wolf Hilbertz (1978), 2009, Pencil, 23.5cm * 13.8cm.*

such patterns, the identification of the possibilities of coral structuring and the pressing need to conserve the unique marine habitat so essential to life that Hilbertz develops, demonstrate such heuristic methods which in turn represent the original (visual) representations at a conceptual level – a cycle evolving pattern of thinking.

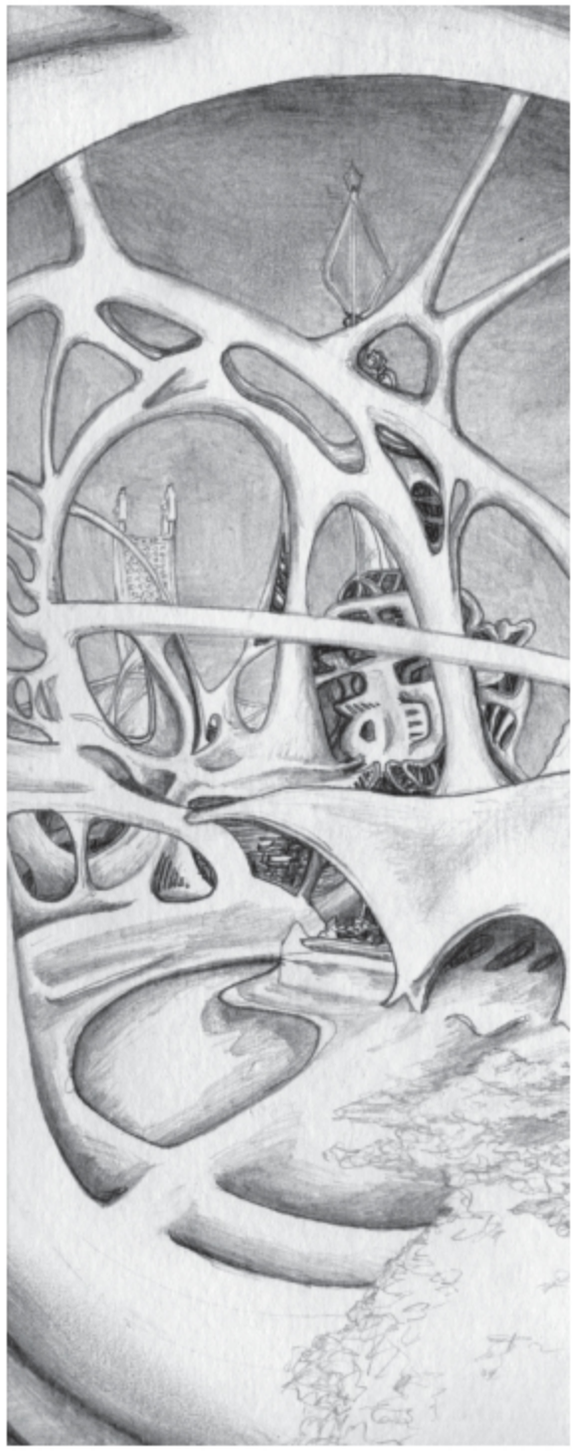
Coral Arks

The piloting of mineral accretion demonstrated a harmonious ocean building material called Biorock® (also called Seament, Seacrete, or Mineral Accretion). Applying an electrical charge powered by photovoltaic or wind generators to a sunken steel mesh armature (usually construction grade rebar) would charge and repair or create new coral reefs as well as being self-repairing.[11] The electrical charge would crystallise materials and create walls of calcium carbonate. Small coral tissue would then become attached to the Biorock reef structure and both accelerate growth when the electrical charge is sustained. The coral is left with more metabolic energy, reproductive cability and environmental resistance in the process. Thus, it becomes stronger by age, is more resilient and multiplies in growth three to five times faster than normal and protects coastline.[12] The Biorock corals "are more intensely pigmented, have higher growth rates and better developed branching and growth morpohology",[13] than those genetically identical and growing in the same environmental conditions. Pigmentation of corals plays an important role in the regulation and absorption of solar radiation and thus their ability to grow within harsh environments. The reefs can also be grown in areas where water quality is an issue. Likewise the reefs can be specified to any shape or size including depth, all depending on the form of the rebar in the original specification.

The new structures on various damaged coral sites have attracted juvenile fish, moray eels, sea urchins, sea cucumbers, crabs, squid, shrimps, bivalves, and even dolphins were previously the reefs were significantly damaged from storms.[14] As some coral reef estimates indicate that 25% of the world coral population is dead[15] the imperative for not just palliative but active intervention in this environment is clear. The artificial reefs are termed 'coral arks'. The arks also provide economically sustainable fishing areas, converting fishermen to fish farmers, conservators of the sites, thus destroying a dangerous spiralling downturn on the marine resources of natural destruction and human decimation.[16] In comparison as Hilbertz and Goreau claim, coral reefs would be the most valuable ecosystem for over a 100 countries worldwide if their economic and environmental services were properly accounted for and properly managed.[17] The arks coastline protection limits erosion and is substantially cheaper to implement than concrete seawalls. This has been implemented in the Maldives creating a Biorock breakwater- causing the beach to grow by fifty feet in a few years by absorbing the wave energy.[18] The use of coral as building material has appeared in the ancient city of Cartagena de las Indas in Colombia.[19] This precedent shows the history of such thinking.[20] In addition coral reef restoration has been reported in the 1800s attaching corals to wooden stakes, and was known to Darwin.[21]

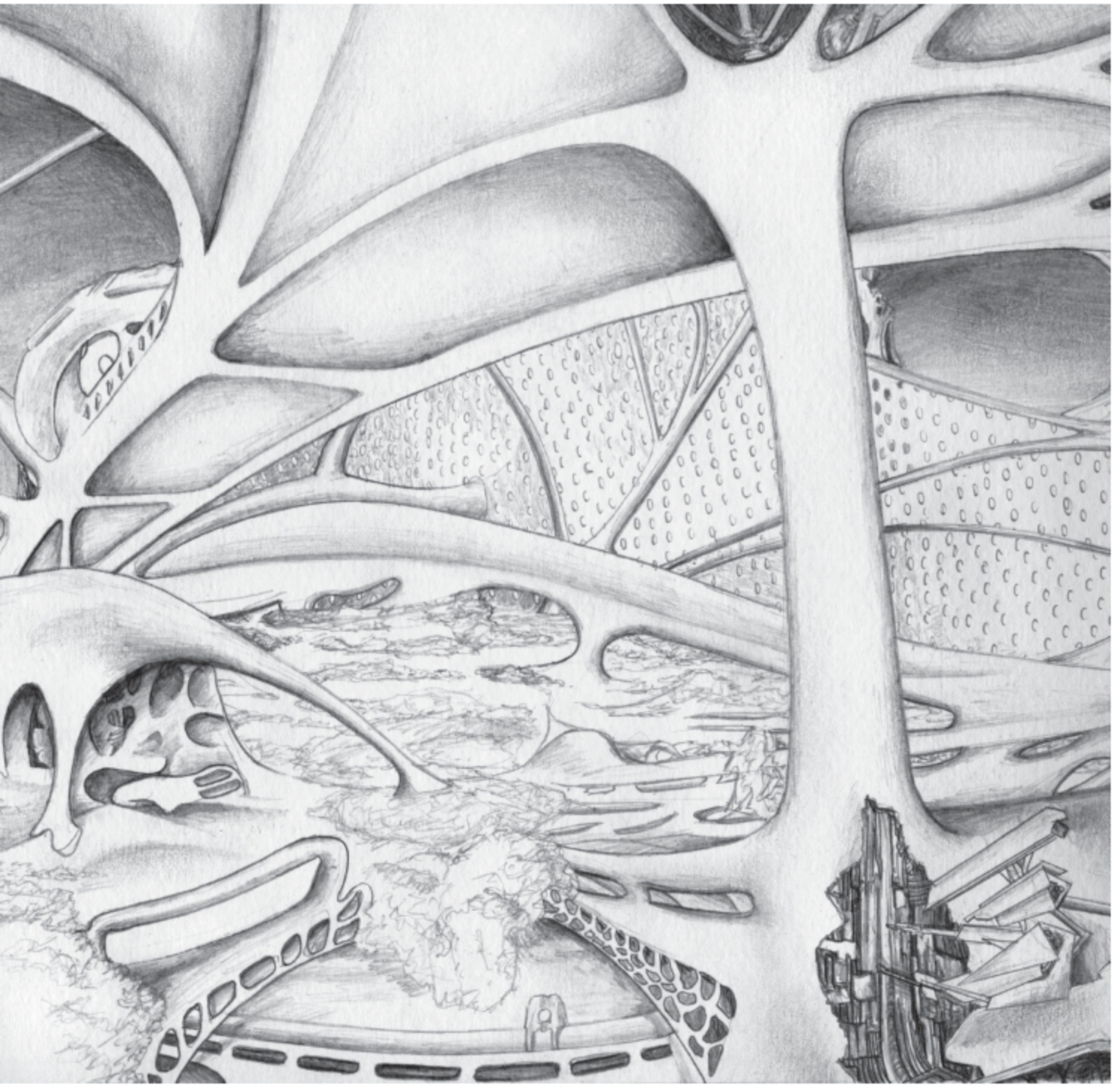
The arks have significant economic benefits to tourism apropos particular areas which have undergone extensive damage due to storms become snorkelling and dive spots. This creates networks of stakeholders all of which work together to monitor and sustain the arks. Other artificial reefs such as old cars, sunken ships or concrete modules coral take longer to take root and establish due to the pollutants that they excrete[22] - "thus do not produce genuine coral reef communities".[23] Additional benefits include the construction costs- wire, electricity and labour being the only outlay. Testing has taken place in Saya De Mahla banks,[24] NE Indian Ocean, a shallow marine ecosystem (and essential stepping stone for shallow water species). Hilbertz and Collective searched for suitable research sites examining the geography and bathymetry when he came upon Seamount Ampere,[25] east of Gibraltar and Skerki Bank near Sicily, though Saya de Malha Banks was deemed the most suitable. Additional builds have taken place in more than a dozen countries such as Pemuteran, Karang Lestari, Bali, Gili Trawangan, Lombok, Indonesia, Ihura Island, Maldives and Arno Atoll - The Republic of the Marshall Islands.

Living coral, light and PH sensitive, evolving, but also disappearing is an icon for our current climate – "the most vulnerable ecosystems to rising temperatures, sea levels, soil erosion, and to excess nutrients from sewage and fertilizers."[26] A major issue is coral bleaching possibly caused by 'hot spots', extended periods of warm sea temperatures above one Celsius caused by global warming.[27] The rate of acidification



in the sea due to an uptake in carbon dioxide in the atmosphere effects and is one trigger alongside rising sea temperatures for coral bleaching. The PH drop also affects fish species causing reproductive issues.[28]

Coral is perhaps the prime example of a living mega structure, of marine landscaping in which to locate our building methods - something that grows from itself anew. This heuristic method provides a vision of a synergistic 'constant state of becoming',[29] of architecture always in transition.[30] As 'Seascape architecture' the mission is one of conservation and



*Seaport Interior, After Newton Fallis (1970), 2010, Pencil, 21.5 * 31cm.*

restoration of the marine ecosystem and as Goreau and Hilbertz state,

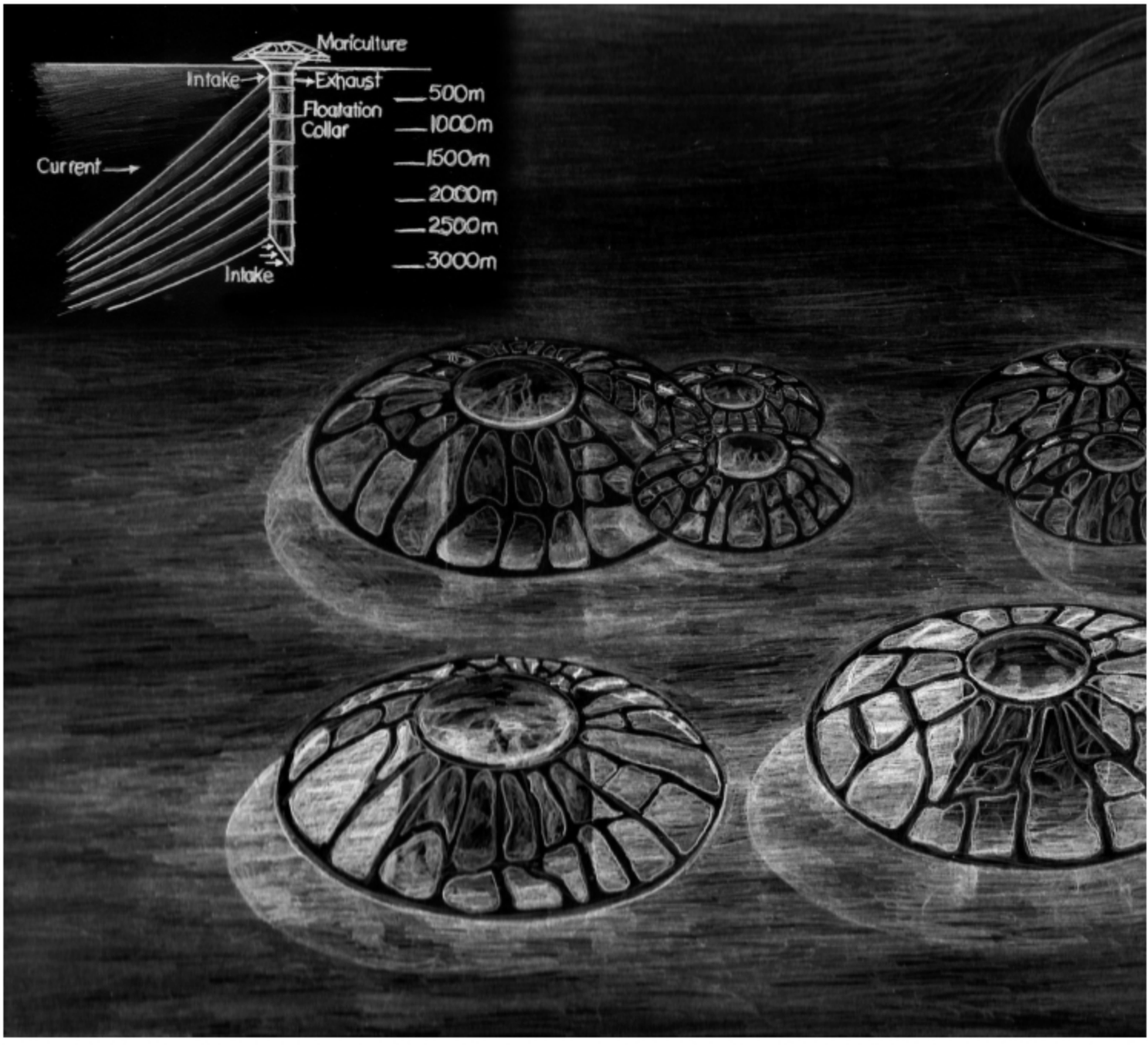
> Like its counterpart landscape architecture, it also focuses on designed ensembles and ecologies of flora and fauna that are self sustaining with human help... while producing aesthetically and artistically satisfying habitats... the professional mission embodies the same philosophy and ethical code inspiring the counterpart landscaper.[31]

Such a project, philosophy and emerging discipline is owed in great part to some of the early stage visualisations for the project and projections of the possibility of the material. It was a convergence of experimentation and creativity and collaboration between the architecture and engineering studios which developed the visualizations which then delivered a heuristic based method. Essentially a pedagogic mode delivering basic skill sets, interdisciplinary approaches to problem solving, design processes, environmental awareness all leading as Doehne states, for the architecture students' to "flee from the beaten path and explore his[/her] particular interests."[32]

Visualisation of a Micro-nation

"Not form, but forming, not form as final appearance, but form in the process of becoming, as genesis." Paul Klee

It is appropriate that from the illustration by Newton Fallis, who worked with Hilbertz, this particular vision can be spectated from a tower of *Autopia Ampere,* a drawing that depicts the development of the mineral accretion technological coral

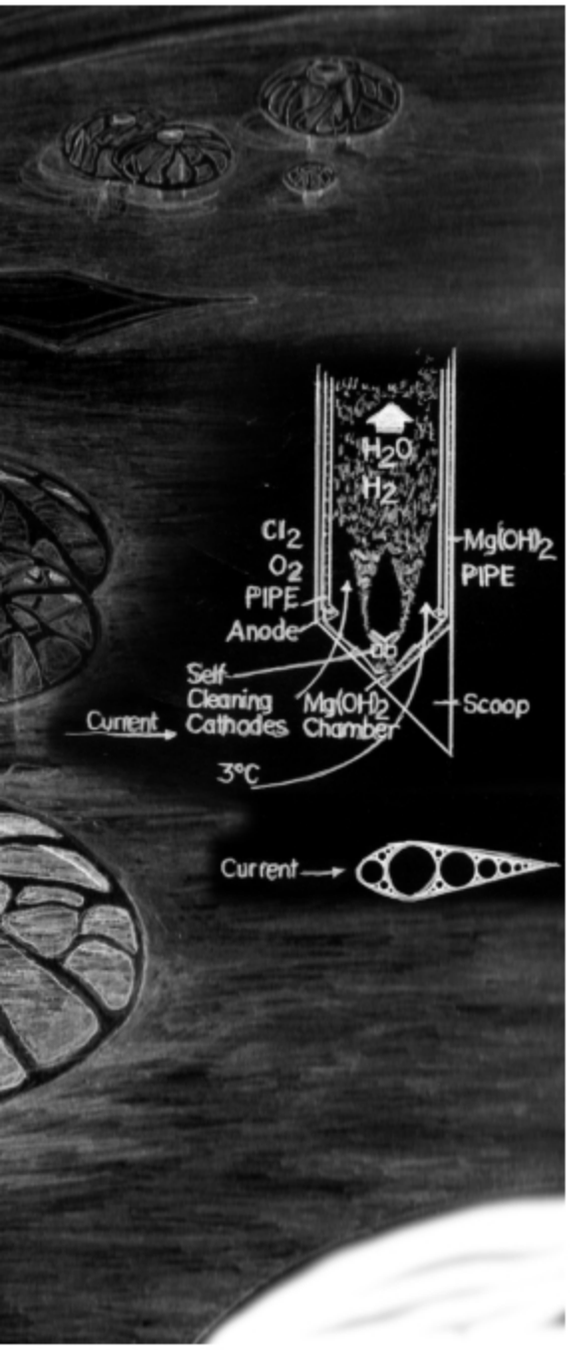


Structures 'Grow Out of the Ocean' (OTEC Plants), After unknown, from Wolf Hilbertz et al 'Electrodeposition of Minerals in Sea Water: Experiments and Applications', IEEE, Journal of Oceanic Engineering, Vol. 4, No. 3, July, (1979), pp94-113. 2011, Pencil, 17cm 26cm.*

(Biorock®) possibilities in the form of a city and oceanographic research institute. The composite produced was a means for the author to understand the elements of its design, not for the purpose of slavish representation but for the purpose of gauging its complex ideological positioning and ecologically demonstrative activity. As Dee maintains, adopting a critical method of dialogic drawing "provides the researcher with a more concrete critical position (through lived experience) with which to examine visual conventions that these studies differ from written critiques of images and their use."[33] It is to adopt a mode of enquiry of a Klee'esque (Moses) genesis, the stages of a work and its "coming into being"[34] a desire for the recreation of expression and a will to manifest itself. Or to recount Heidegger "let us go to the actual work and ask what and how it is".[35]

Autopia is an economic, material trading, with *Cybertecture* (CYBERnetics and architecture), an autonomous city with radical socio-cultural-political implications in our relationship with the ocean that also exemplifies an evolutionary environmental system.[36] Based on a shallow sea floor, the construction method would allow the creation of free form internal space more akin to biology than architecture, built for the comfort of its occupants making furniture nearly obsolete.[37] Vaulted open floor plans would be developed avoiding compartmentalisation, designing and growing the space and location to the wishes of the inhabitants using the three sub-systems that Hilbertz theorised. Such form would be similar to air form and free form thin concrete shell structures.[38]

The space would contain entertainment complexes, hydroponic gardens, parklands and recreational space. It would cultivate seaweeds and hold fish pens. Conduit running circuitry and services would be grown in and function as the arteries of the structure, which could be extended with incisions in the structure, these incisions then being re-grown. These activities would



be enacted by robots controlled by a super-computer neural network monitoring and evolving the city, responding to its inhabitants from humidity control to food production. A part of the Autopia structure involves a proposal from Hilbertz for Ocean Thermal Energy Conservation (OTEC) plants converting thermal energy into electricity.[39] The plants would involve deep shafts formed of accreted material. Again, any damage occurring could easily be repaired and the plants could be re-anchored to shift with prevailing currents. The plants could also produce refractory magnesium, the raw material for magnesium production. Possibilities other than OTECs, discussed as the project has developed as technological possibilities materialise from the original conception, include tidal turbines and wave generators.

Magnesium could also be used as the base metal for mineral accretion. Autopia would be autonomous, being free from political coercion (at least for a while) as the oceans are free from such territorial claims,[40] working as both a creator of aquaculture and building components, all of which are exportable resources. Such possibilities were amalgamated into Marshall T.Savage's *The Millennial Project: Colonizing the Galaxy in Eight Easy Steps* as the title suggests under the first practical step, colonizing the oceans through 'Aquarius' and its sister colonies.

Having studied architecture in Berlin, Hilbertz began teaching at Southern University in Baton Rouge, Louisiana in 1965 where he founded the 'Responsive Environment Laboratory'. He worked on the notion of Cybertecture before moving to the School of Architecture, University of Texas, Austin and then founded the 'Symbiotic Process Lab' in 1970 working on non-traditional building materials.

Fallis worked on a number of drawings as a student of Hilbertz, alongside Forrest Higgs and the engineering school during the fall semester of 1970. Hilbertz asked the students to explore many technologies that were in their infancy such as zero-gravity based robotic constructions for use in space and oceans, and land-based recyclable surface materials. One can only speculate on the energy and excitement present in what took place there. The original Autopia drawing, using the golden mean by Fallis, was produced in large format which 'grew'; a drawing grappling with complex ideas of philosophical purpose, sociological use, natural material imitation and technological-function. Such thought processes and visualization are demonstrated by Fallis when recounting drafting Autopia,

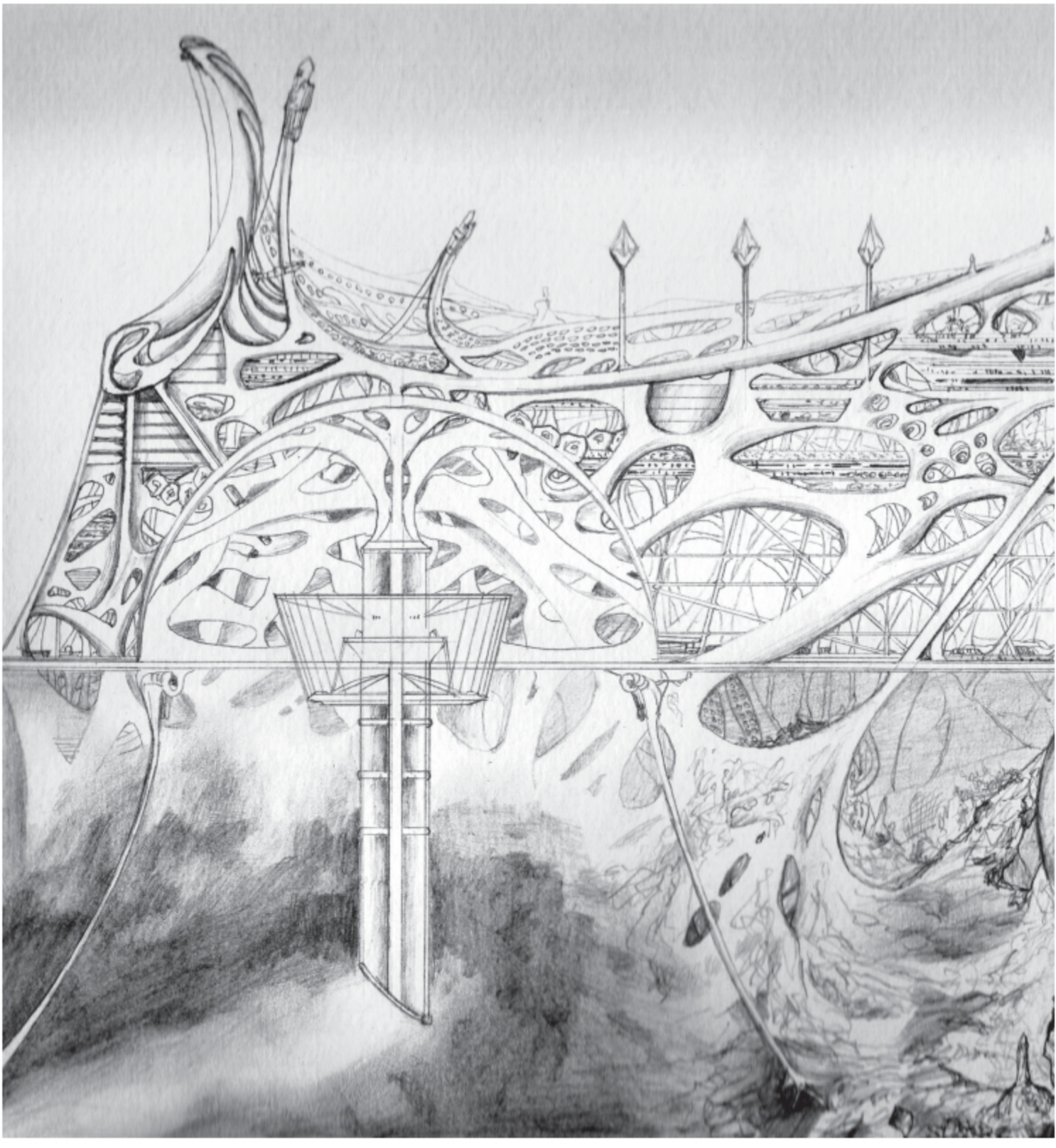
> Farming and waste recycling would be engaged, but how could they be integrated in pleasing meaningful ways? Hydraulic, wind and solar systems would be early components, but would not be remote from the inhabitants. It really seemed inhabitants could be surrounded by the ecological processes that made their life there possible and enjoyable, if they were handled correctly. Manufacturing and hydrogen collection seemed 'natural' to maintain at the expanding parameter. As such the act of drawing was a very freeing, evolutionary exercise.[41]

This is what drawing sometimes allows, a testing of vision for optimal solutions, (Videre, Latin. *to see, to look forward*) a pilot of pilots: *Autopia Ampere* whilst an aesthetic of the sci-fi, is resistant to and filters such fiction in its applicability and possibility of lived space. This species of drawing, of which there are many types (just as Euclid offered a definition of a species of line[42]), imply wider social, political re-creations than 'form fit' architecture or architecturally similar land reclamations with sometimes problematic un-foreseen oceanographic consequences.

Drawing, like coral, has a quality of 'becoming', as Robin Evans (1944 – 1993) would state in *Translations from Drawing to Building*, drawing has sometimes a generative role in its dual projective qualities: an 'over-determined' surface equivalence and the propelling of the myth of pictorial space to provide a visual language of communication. Ultimately, Evans would argue for the reverse directionality of drawing "the subject matter (the building or space) will exist after the drawing not before it"[43] (though not all architecture can be formed in this medium). A contemporary paradox of 'pilot' hand drawing has opened up between obsessive practitioners and those who have displaced the method in contemporary architecture & landscape architecture. Whilst drawing has a futurological ability it also functions as part of the history of ideas, and moreover can visualize intention and perhaps as Stuart Cohen has argued, can *influence*.[44] This *influence* is hard to quantify but could be located in an attempt to understand and communicate the design choices and possible context. As Tuan remarks part of the process,

> To see and to think are closely related process. In English 'I see' means 'I understand'. Seeing, it has long been recognized, is not the simple recording of light stimuli; it is a selective and creative process in which environmental stimuli are organised into flowing structures that provide signs meaningful to the purposive organism.[45]

Thus applied, drawing's ability to speculate, to 'see' think and see forward, mediating the conceptual and practical combined



*Autopia Ampere Section with OTEC Plants, 2011, Pencil, 26cm * 26.5cm.*

with an arguable influence, has proven its value as a tool of information design in which architectural history is rife with examples. Fallis demonstrated this role, when interviewed on the Autopia piece, he

> Found that as your hand is filling in some forms your mind is able to ponder the vastness of the city's implications and attempt to generate new form and technological solutions to problems – Ecology was always at the forefront.[46]

Contemporary visual focus is more weighted towards the virtual object; resisting current simplified arguments positioning the hand crafted against the virtual, as this simplifies a complex inter-relationship of visual method. William Gibson articulates in *Virtual Light* , that within computational design when concentrating upon the object, (in the 'Republic of Desire' using the 'Dream Walls' software) beyond it "… you get this funny sense that you were leaning out, over the edge of the world, and the space beyond that sort of fell away, forever."[47] This 'beyond' space described by Gibson, unfulfilled – has both similarly

visible and invisible axioms to drawing in its cultural layering and points of departure. Though the digital, whilst bringing new fractals and detailing advances, as Alberto Pérez-Gòmez & Louise Pelletier suggest in *Architectural Representation and the Perspective Hinge*, the drawing needs to provide a promise in the interrupting of its objectivity and information reduction: a disruption of its application & standardization of architectural production.[48]

Hand drawing involves the body, is resistant to spaces of alienation and in this sense defies becoming a pure visuality as Tim Ingold writes; hand drawing embodies its history on a single sheet.[49] As the draughtsman Oliver Regan states (pre-empting the contemporary resurgence and interest in haptics) in *Pencil Points: Journal of the Draughting Room* (Vol 1, 1920)[50] it is desirable to acquire "an acute sense of the feel of his pen or pencil on the paper, a delicacy of touch that is not unlike that of the skilled surgeon who is said to be able to almost 'see' with his fingertips.". As long as the suggested ability maintains a connection with the phenomenology of our environment, this potentially, can constitute the material connector to lived space, and be resistant to detachment, vacuous formal representation and the privileging of the image (though historically drawing has been just as susceptible to literal perspective transcription and Cartesian projection). Wider implications for design can be found in Henri Lefebvre's *The Production of Space* where he warns "...we produce only the reproducible, and hence we only produce only by reproducing or imitating past production...because reproducibility is what ensures the renewal (or reproduction) of existing social relations".[51] These social relations can in part reflect back, in a reversibility of design, the ideology of production, the ideology of representation which cannot be reductive, but needs to be consciously reductive in its choices - a form of 'speculative editing' over mimetic endeavours. As James Corner suggests in *Recovering Landscape,* we need to enable forms of representational technique with eidetic operations – specific ideational techniques for construing (imagining) and constructing (projecting) new landscapes.[52] Drawing should not be privileged in this respect but revitalized in the role that it plays with other methods of visualization, for projection is at stake and so are its qualities of becoming:

> [it] evokes temporality and boundaries. Defining the space between light and darkness, between the beginning and the beyond, it illuminates the space of culture, of our individual and collective existence.[53]

This is moving from Lefébvre's question of "What exists, between the shadows and the light, between the conceived (abstraction) and the perceived (the readable/visible). Between the real and the unreal [?]."[54] Pérez-Gòmez & Pelletier, thus call and mark out, like Lefebvre, the transitive role of projection, geometry and its abstractness, an abstractness which can enrich architectural production. Autopia marks a movement, and invites in its viewing moving beyond the image itself, to where further imagining can take place, construing a mental image of the evolution of the city and its complex inter-relationships and functions – Seascape Architecture.

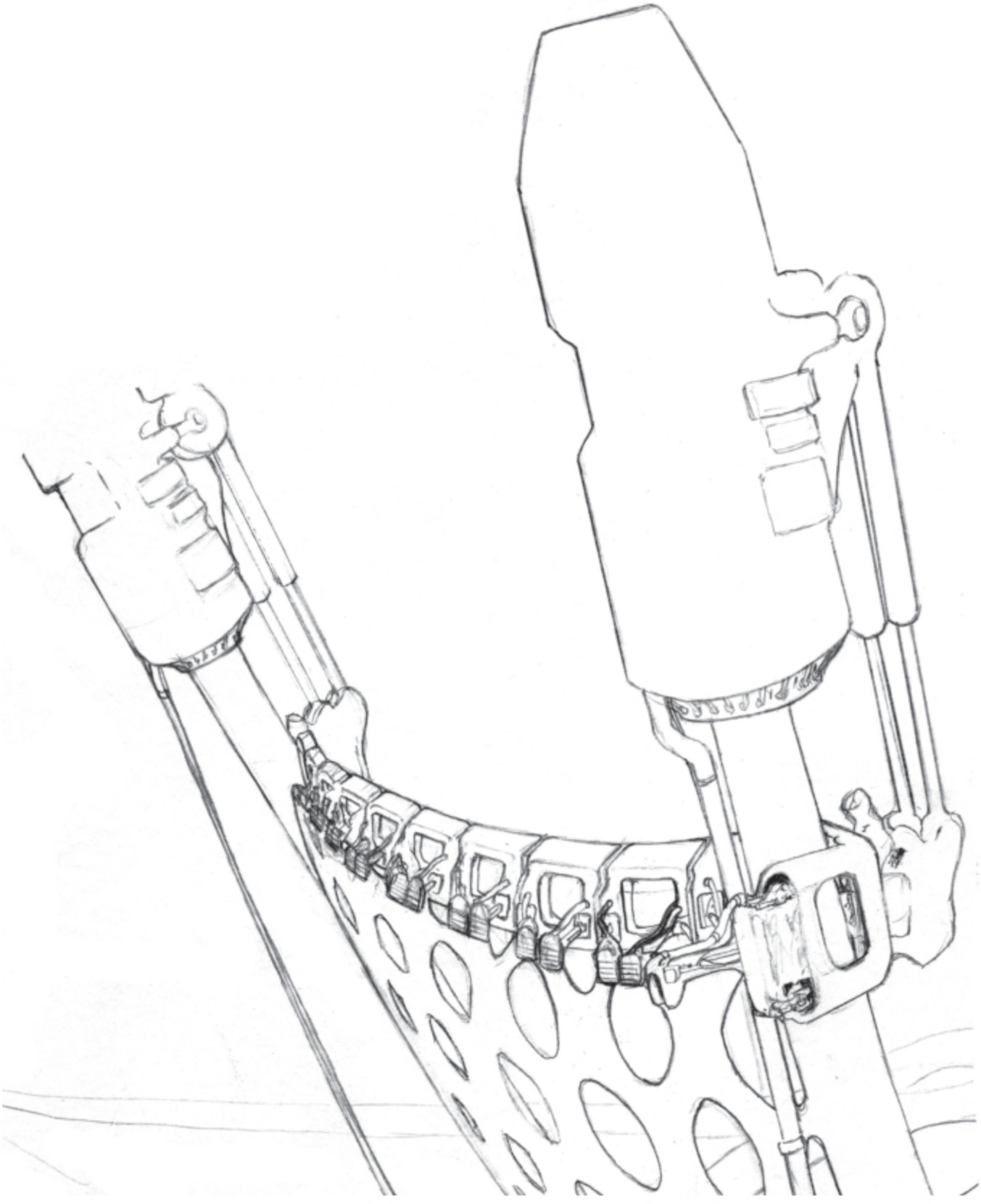
Summary

Coral bleaching and rising sea temperatures, as well as acidification and the recent devastating Tsunamis' combined with radioactive discharges, overfishing and lack of education in certain sea communities amongst many other factors make Hilbertz's endeavours highly provocative and challenging designs and plans to respond to. As Goreau states research into seascape architecture is needed as,

> protecting coral reefs for future generations may be the truest test of international commitments to sustainable development, because it places some of the most stringent constraints on doing the right thing for the environment.[55]

A small coral fragment grows anew, likewise the development drawings contained within Hilbertz and Goreau's scientific papers, and drawings produced in the 'Symbiotic Process Lab' on the accretion process, illuminate and move into the visionary- embodying an optimism borne out of collaboration and opportunity within the architectural studio to provide marine landscaping, countering the increasing degradation of the coral ecosystem promoting and educating on the importance of marine biodiversity. It requires a change of thinking for a whole system approach, involving reactive and proactive capabilities, within which humankind has a stake. Similar sentiment is found in Fuller,

> Humanity will be re-orientated
> From its one way entropic
> Me-first energy wastings
> To its syntropic circulatory
> Synergetical you-and-we
> Cosmic ecology regenerating
> functions[56]



*Brise soleil, Detail of Autopia Ampere, After Newton Fallis (1970) and Wolf Hilbertz (1978), 2009, Pencil, 18.5cm * 13.8cm.*

Such re-empowerment of communities through the use of Biorock restoring fragile ecosystems, allows local management of its resources, changing scales and relations towards a one and all activity – mitigating global warming, rising sea levels, diseases (in corals) and costal pollution.[57] It is through the vision of *Autopia Ampere*, which remain possible, and the work conducted thereafter perhaps, that we can touch, 'to see', amplify, critically evaluate and energize just one future vision. Thus provide or influence heuristically charged solutions to our changing climate. As Evans states, "Without the architect's faith that geometrically defined lines will engender something else more substantial yet discernable through the drawing, without faith in the genetic message inscribed on paper, there is no architecture".[58] Thus, the drawings contain a pressing philosophy to be developed and an end image of coral reefs restored and enacted, one small example counting towards an anti-homogeny and vision, a correctional synergistic activity for the biosphere – this is the time for drawing and working out... for spaces and structures then to become.

Special thanks to Dr Thomas Goreau, Newton Fallis, Forrest Higgs, Kai Hilbertz, Ursula Hilbertz & Derrick Hilbertz for their assistance in the writing of this piece.

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3 Dr Thomas Goreau tirelessly campaigns for the conservation of Coral Reefs, President of the Global Coral Reef Alliance (GCRA) and is the Coordinator of the United Nations Commission on Sustainable Development Partnership in New Technologies for Small Island Developing States.

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