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Lohmann, Julia

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Phytofictions and Phytofication

Julia Lohmann

Abstract

In ‘Phytofictions and Phytofication’, designer, researcher and educator Julia Lohmann introduces her practice-led research into seaweed as a material for making. In her work, macro-algae are material, method and muse in one. Lohmann makes a case for speculative and co-speculative design approaches to biomaterial development with an empathic mindset towards regenerative practices. She advocates a shift in the role of designers from individual authors to enablers of communities of practice that envision less harmful multi-species relations, set against the backdrop of the climate crisis. The ‘Department of Seaweed’, a community of practice Lohmann founded at the Victoria & Albert Museum London, demonstrates how museums can expand their role as repositories of artefacts into becoming spaces for multisensory material engagements and learning. Lohmann explains how ‘phytofication’ – actively embracing the material agency of macroalgae and treating it as a co-designer – enabled the development of biomaterials and objects that communicate the potential of seaweed to diverse publics. These in turn sparked ‘phytofictions’: conversations on how we might use algae and other biomaterials in the future. Julia Lohmann believes that working with algae, through phytofictions and phytofication, can help us shift our mindset from extraction towards regeneration – if we, as a species, learn from algae.

Keywords

design – regenerative practices – biomaterials – macroalgae – co-speculative design – material value systems – design ethics – museums – community of practice – ocean literacy

...

You are mystical multitudes, supple and strong, thriving whilst generously supporting other beings. You are umami, the fifth taste that deepens the other four and completes the experience. Our silent saviour in times of malnutrition and war, of crisis and collapse:

Kelp, may we humbly ask you to help us again in this moment of collective despair?



1 Introduction

Since my first conscious encounter with Japanese kelp on the fish market in Sapporo, Japan in 2007 I have been exploring kelp as a sustainable material for making. In this text I am introducing seaweedness, the inherent properties of macroalgae and describe how it guides the creative process. I describe how we co-imagined seaweed futures (phytofiction) with diverse publics through hands-on seaweed encounters in the Victoria and Albert Museum. I ponder how relating to the algae's marine origin and its agency in its eco-system helps us reflect and understand our own human agenda and mindset. In the process of working with kelp we aspire to become more like kelp. We are becoming phytofied. Can working with algae transform our actions and reflections towards a less destructive, perhaps even regenerative practice?

In 2007 I was a designer in residence at the Sapporo Artist in Residence Centre (S-AIR) in Hokkaido, Japan. I was investigating our human relationships with the sea. On the local fish market, I came across Japanese kelp and was enthralled by its materiality. I immediately saw its leather-like material qualities and imagined it as a potential leather substitute that did not involve the death of an animal, nor the chemicals, time and labour necessary to transform its hide. In this moment I thought that Japanese culture, deeply connected with kelp and known for its outstanding handicrafts, must bear extensive knowledge on kelp craft that I was simply unaware of. I imagined there might be book covers, wall hangings, scrolls, shoji screens, slippers, lamps, vessels, armchairs and dresses made from kelp, and I asked my Japanese friends what they make from seaweed. 'We eat it!' was the answer. 'And?' I probed. 'And ...? that's it. We eat it.' They replied. I realised that the kelp craft I had imagined did not exist yet, it was a fiction, a phytofiction. I decided to try and bring it into existence.

This encounter with kelp revealed to me that cultural framing can define the usage of organisms like algae and their applications as strongly as their inherent material properties. If, for generations, a material is known as food, it is difficult to realise that it might also have other uses and applications. Our cultural framing limits the scope of our imagination. Or was it simply that



FIGURE 12.1 Early kelp experiments during the exhibition *Panta rei*, Galleria Nilufar, Milan, Italy, 2008

PHOTO: GERO GRUNDMANN

people had tried to work with kelp and found that it was not possible to utilize it. I took some dried kelp (*Saccharina japonica*) back to Europe with me and began to explore working with it.

In parallel I set out to research the impact and role of brown kelp species on their eco-systems, historical uses for kelp and harvesting and farming techniques. I found a few examples from native cultures, most remarkably the model of a bull kelp water carrier made by Australian Aboriginals.

In Japan, the only non-food related references to kelp as a material for making I could find was the use of kelp to slow down the drying time in traditional lime plastering techniques. These early crafts had not yet developed into contemporary material applications and my initial tests showed promising results.

I began working based on the assumption that most of the things we will have made of kelp in the future simply do not exist yet. What might we make? Who might hold the knowledge needed to develop materials for making? If we succeeded in finding new applications for kelp, what would this increase in harvest / production mean for our marine ecosystems? I shifted



FIGURE 12.2 Model of a water-vessel made of bull kelp, Aboriginal Australian, ca. 1850
PHOTO: © THE TRUSTEES OF THE BRITISH MUSEUM, LONDON, UK



FIGURE 12.3 Seaweed experiments, Stanley Picker Research Fellowship, Kingston-upon-Thames, UK, 2009

my thoughts about seaweed from the past to the future, from imagined and discovered histories to speculative futures: What might a world in which kelp is an established making material look like? How would we need to shift our own mindset, to make this future not just possible, but sustainable and desirable? When MoMA design curator Paola Antonelli asked me about the future of design I said 'algae' but I did not envision that I would still be working with macroalgae 15 years later.

Now, in 2022, the interest and research into the use of algae has grown rapidly and reaches across the whole spectrum of material production, from bioplastics to cosmetics, from food supplements to fuel, from chemical compounds to bathing experiences. The parties engaged in it range from individual entrepreneurs to large international research consortia, from the oil industry to activists with venture capital. Some aspects of the futures we imagined in our encounters with algae are becoming probable as we gather more of the expertise required to realise them. However, at the heart of all these new applications for algae also lies the threat of overexploitation and further stress on the marine ecosystem. If we are to use seaweed, it is essential that we explore any cultivation and harvesting activities in a considered, science-led manner that is location-, case- and species-specific. It depends on what type of seaweed is grown with which technique in which specific location. When I presented the initial idea of developing materials for making from kelp to Prof. Juliet Brodie, the phycologist of the Natural History Museum, she said: "Oh." When I asked her whether or not she thought we could make objects from seaweed she made a statement that has guided my project ever since:

Brown algae already suffer from warming oceans, habitat-loss, acidification and other anthropogenic changes and impacts on the environment. I am worried that, with all these new human uses emerging for it, we will mess up these algae and the ecosystems they support even more, just as we have impacted on so many of the organisms that we focussed our human interest on.¹

We urgently need biomaterial alternatives that are healthy for us and the environment; materials with a global impact so that we can turn away from unsustainable fossil-derived materials. Algae can be grown in ways that do not

1 Personal conversation with Prof. Juliet Brodie in 2010, more detailed insights on seaweed harvesting by Prof Brodie can be found in this testimony to Scottish Parliament about the harvesting of wild kelp: <https://macroalgalresearchgroup.com/2019/07/05/reflections-on-the-mechanical-harvesting-of-kelp-science-environmental-change-wider-thoughts-and-a-way-forward/>.

harm, but benefit the marine ecosystem, capture carbon and reduce eutrophication (nutrient overload) that otherwise leads to systemic imbalances. These benefits can be lost or enhanced through the decisions we make. Our material transformation has to bring forth a shift in our mindset: When we scale algae-production we need to be aware of and scale the environmental benefits without scaling the negative impacts. We need a regenerative mindset that supports the eco-systemic health of the locality we engage in. By employing a bio-inclusive ethical frame² that considers the needs of the non-human stakeholders we affect through our actions we can grow algae in a way that supports its agency and benefits ocean health.

2 Seaweedness

In ‘Vibrant Matter’ Jane Bennett speaks about a ‘thing-power’ when she refers to objects as actants that are able to influence situations through their materiality.³ I describe this vibrancy of seaweed, its inherent character and the agency that I aim to support through my creative processes as seaweedness.

The algae I encountered in Japan, *Saccharina japonica*, became the central species for my algae experiments, since I was able to import it as a food ingredient and because there was an established harvesting, drying and classification protocol that guaranteed that my experiments could be repeated and that I was able to reliably source materials. Later, I expanded my practice to European species of brown kelp such as *Saccharina latissima*, *Laminaria digitata* and *Laminaria hyperborea*.

All of these types of kelp continue to possess seaweedness, a dynamic material agency, long after they have been harvested and dried. As a material, kelp by no means feel dead. Taken out of water, it will dry, becoming hard and brittle, at times, depending on the humidity conditions of the room and type of algae it develops a fine white patina of mannitol sugars, fatty acids and salts dispersing from inside the blade. It remains highly sensitive to moisture and humidity and will become soft and supple again if the water content of the air increases. The Victorians knew about this and used fronds of seaweed as a tactile tool to forecast the weather. Touching the seaweed creates a sensory connection between our body and the macroalgae, through our touch we get a deeper understanding of the environmental factors we are surrounded by

2 Veselova, E., & Gaziulusoy, I. (2019). Implications of the Bioinclusive Ethic on Collaborative and Participatory Design. *The Design Journal*, 22(sup 1), 1571–1586. <https://doi.org/10.1080/14606925.2019.1594992>.

3 Bennett, Jane *Vibrant Matter*. Durham: Duke University Press, 2010.



FIGURE 12.4 Humorous Victorian postcard referencing the algae's weather-forecasting qualities. Late 19th century

and even an instinctive glimpse of conditions to come. We cannot feel such connectedness when we touch the glass tube of a thermometer or other, more predictable materials derived from land.

When we are working with seaweed, we engage with it in a kind of dialogue, or correspondence as Tim Ingold calls it.⁴ “Making”, writes Ingold (2013, p. 31),

4 Ingold, T. (2013): *Making: Anthropology, Archaeology, Art and Architecture*. Routledge, London.

is a process of correspondence: not the imposition of preconceived form on raw material substance, but the drawing out or bringing forth of potentials immanent in a world of becoming. In the phenomenal world, every material is such a becoming, one path or trajectory through a maze of trajectories.

The kelp I work with has been removed from this natural, eco-systemic context into the human-made world. However, it has not yet settled into its final framing, form or function. It is on the brink of the change that occurs in the shift from one system to another, a transformative process that changes its value, agency and meaning. The multi-sensorial presence of this biological 'actor' pulls the discourse back to its marine origin, which is in turn embedded in people's lived experiences with nature.

As part of my PhD at the Royal College of Art I had the chance to run a six-month residency at the Victoria and Albert Museum in London (V&A). Together with a group of other practitioners I founded the 'Department of Seaweed', an open collective of people wanting to transform algae into a sustainable material for making. We worked together in the V&A and would welcome museum visitors into our workshop, sharing with them the processes, tools, samples and prototypes we were working with. The smell of algae was wafting through the building and the residency space became a multi-sensorial experience both for the museum visitors, for staff and for our collective. These public encounters with seaweed became the context in which we co-imagined phytofictions – scenarios for future uses of algae and their potential benefits and pitfalls.

Most of the visitors to the Department of Seaweed at the Victoria and Albert Museum during our residency in 2013 had prior algae-encounters at the sea-shore and were reminded of these experiences by its scent. Our conversations often started with these very personal anecdotes and the physical presence of algae enabled a holistic engagement.

The strength of the seaweed lies in its ever-changing and ephemeral nature. To work with it and realise its potential as a material, we must let go of ideas of permanence and uniformity. We need to question prevalent industrial concepts of repeatability and perfection. No two things made of seaweed will be the same. Each frond of kelp has its own characteristics and qualities, its own reactivity to the environment – just as we do – and these qualities change over time. This can be illustrated by the colours of kelp. Its lush greens fade into a translucent parchment-like colour as the chlorophyll is gradually degraded by light, while the fucoxanthin that gives the brown kelps its distinctive colour, remains. This process can take weeks or a few months, depending on species. The artefacts made show the seaweed's characteristics so that encounters with them equally become encounters with seaweedness.



FIGURE 12.5 Julia Lohmann working in the *Department of Seaweed* studio in the Victoria and Albert Museum, 2013
 PHOTO: PETR KREJCI

Translucency, shrinkage in drying, natural changes of colour, organic forms, the width and length of the seaweed's blade and the awe for life we feel in experiences of nature were the guiding factors in the creative processes at the Department of Seaweed. Vague in function and legible or rather experienceable in its materiality and form, we created the sculpture *Oki Naganode*, made of kelp blades stretched onto rattan frames.

Oki is the Japanese word for 'big' and can also be used as a first name, *Naga* refers *Naga-kombu*, the type of Japanese kelp the sculpture is made of and *node* is both synonym of knot and a Japanese syllable ending a family name. Consequently, the *Oki Naganode* is both the 'big *Naga* kelp knot' and could also be read as a Japanese name, much like that of a co-designer – which reflects the way I view kelp.

The *Oki Naganode* was followed in 2020 by two other large structures. The first was *Hidaka Ohmu* (2020), a seaweed pavilion that I named after the *Hidaka kombu* used, and the similarly shaped '*Ohmu*' creatures from the post-apocalyptic, environmentally themed Japanese anime film '*Nausicaä of the Valley of the Wind*'. This was then joined by the *Kombu Ahtola* (2020), a hanging sculpture I made in Helsinki, Finland. It takes its name from the



FIGURE 12.6 The *Oki Naganode* seaweed and rattan sculpture, built in the Victoria and Albert Museum during the *Department of Seaweed* residency in 2013
PHOTO: PETR KREJCI



FIGURE 12.7 The sunlight-bleached *Oki Naganode* seaweed and rattan sculpture, shown in the exhibition *Earth Matters* at Artipelag, Stockholm, Sweden, in 2015
PHOTO: JEAN-BAPTISTE BÉRANGER



FIGURE 12.8 *Hidaka Ohmu*, seaweed and rattan pavilion, *Partnering With Nature* exhibition, 50th World Economic Forum Davos-Klosters, 2020
PHOTO: WORLD ECONOMIC FORUM

‘Ahtola’, the underwater residence of the sea gods and marine beings of Finnish mythology.

To some extent, these sculptures design themselves. Considering the attributes of seaweedness, I am proposing their form and they complete it. The kelp I am gluing onto the three-dimensional rattan frames of the sculptures is treated to remain supple, and I attach it while it is wet. It twists and manipulates the rattan rods as it dries, deforming straight lines into concave curves. The seaweed skin stretches taut, into the smallest surface area possible within the framework. This form-finding and shaping correspondence between the two materials makes some of the material’s physical attributes legible in the final sculptures. I am embracing and am accommodating this shape-shifting process with rattan frames that are rigid enough to hold the seaweed and weak enough to be shaped by the kelp.

The outcome is an organic-looking, tensile structure that is responsive to light and humidity. In this way, I have shifted the kelp’s weather forecasting



FIGURE 12.9 *Kombu Ahtola*, seaweed and rattan sculpture, Annantalo, Helsinki, Finland, 2020

qualities to the inside of buildings, giving an indication of how healthy and habitable interiors are for humans. If the humidity in a space is within normal parameters, the seaweed is supple and strong. If it is too low, often caused by ventilation and air conditioning systems seeking to prevent the spread of mold and other microbes, the seaweed will tense up until it eventually rips. If we realise that the kelp mirrors our own physical responses to such a space, it becomes clear that we too will dehydrate and the ecosystems that are our bodies will degrade if we remain in such an unhealthy manmade environment. Being with kelp raises the question why we should value architectural permanence over human wellbeing.

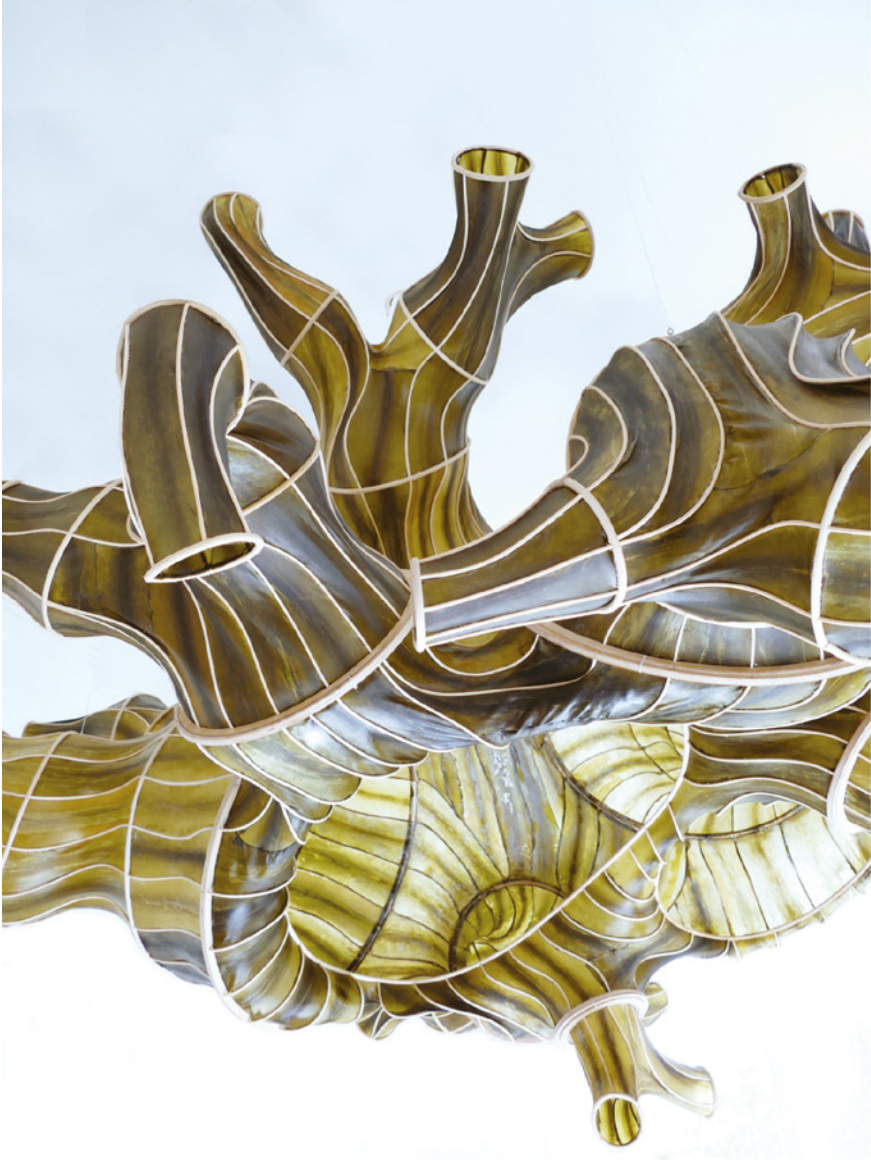


FIGURE 12.10 Interior view of the *Kombu Ahtola* seaweed and rattan sculpture and its skin on frame structure. The hanging sculpture opens up at the bottom, so that viewers can experience it from the inside and outside.

3 **Phytofictions**

In the Department of Seaweed, we invited the public of the museum into the process of working with algae. The visitors came into the studio and encountered the seaweed's evocative, multi-sensorial presence within the context of an ongoing design process, not just an exposition of finished artifacts. Neither still in its ecosystem, nor yet fixed into a defined human sphere of reference, sharing process allowed our thoughts to travel along its trajectory of transition both into its multiple potential futures and into its ecological past. The agency and appearance of aliveness in algae also reminds us of their vastly greater agency in the ocean, an ecosystem that we as humans cannot inhabit but depend on for our survival, as do countless other species. Safeguarding the ability of algae to fulfil their habitat-forming, oxygen-producing, nutrient, pollutant and carbon-capturing role – and if possible, expanding it – should be at the core of any algae-related work.

From a maker's perspective, the properties of macroalgae suggest cultural references and material analogies that reach from wood to leather, plastic, lacquer, glass, paper, textile, to the more exotic snake- or dragon-skin, rubber, latex, resin. None of these analogies completely match the material properties, agency and applications of kelp. Still, comparing and contrasting kelp with established materials opens up opportunities to experiment with crafts and processes linked to matter that is alike. We can build on often extensive bodies of knowledge and a wealth of cultural points of reference, past and present. For instance, if we wanted to develop the leather-like qualities of kelp, we could look into tannery, the furrier's trade, leather crafts, surgery, skin-on-frame kayak building, as well as museum conservation techniques, to name but a few fields. On the other hand, studying the differences between kelp and other materials hints at what may be qualities unique to algae and potentially rich in experiences, knowledge and applications.

Unlike for example leather or wood, algae are not yet established as materials for making in a design context. There is no formal algae aesthetic and clearly defined contexts of use for algae beyond the food industry and less visible uses of algal chemical compounds. Even though research into kelp has increased in the past decade, kelp's trajectories into future human contexts are still open to speculation, experimentation and rich in possibilities. These conditions enable us to imagine freely and with few constraints of established applications we are already familiar with. Many of the uses of algae that already exist, apart from foodstuffs, focus on compounds derived from the organisms and do not aim to retain the physical integrity of the algae. They are largely based on the same mindset that humans have used to extract other types of matter from

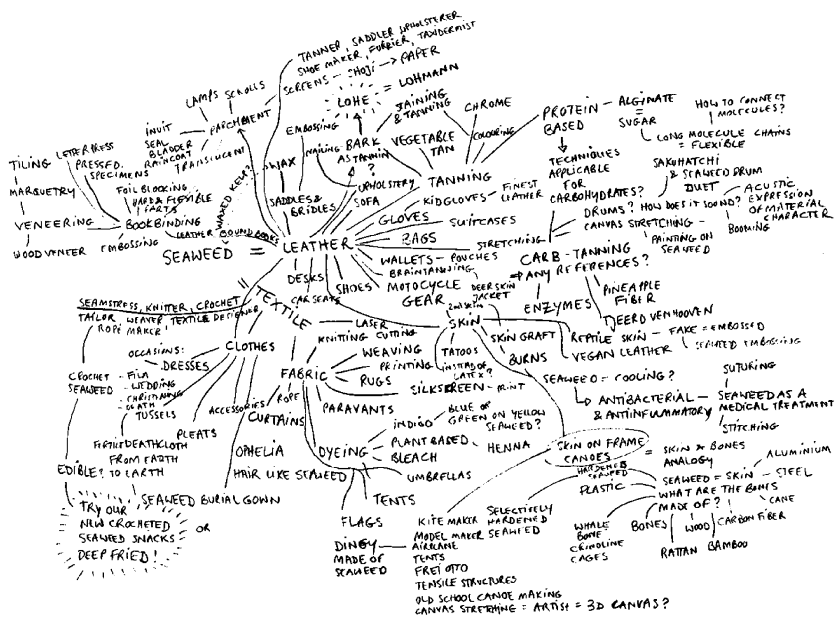


FIGURE 12.11 Mindmap of material analogies of seaweed and leather, craft, cultural heritage and applications that may aid the development of algae as a leather-like material. Algae do not equal leather, but material analogies inspire processes and applications to test with algae, and material differences suggest unique algal qualities and agencies.

the Earth, classifying them as ‘natural resources’ rather than ‘co-inhabitants’. In the Department of Seaweed, we engage with algae by establishing a physical relationship with the organisms, body to body, by letting seaweedness guide our way of working. This type of engagement with algae is sensually rich, evocative through touch and smell and taste as well as visually. The matter itself is versatile and changeable, hyper-reactive to the conditions it is placed in, changing dramatically in its interactions with light, moisture and the treatments applied.

Which phytofictions algae stimulate in people depends equally on how they encounter the material and on their own viewpoint, interest and cultural frame. In the context of food, for instance Japanese dashi soup stock, this ability of algae to enhance the flavour of other ingredients is called *umami*. Within the assemblage of the Department of Seaweed I observed similar *umami*-like behaviours of kelp: It enabled us to imagine through hands-on exploration. Kelp in a material context is highly evocative and relational, meaning that it stimulates the imagination of most people who encounter it and it inspires them to relate it to their own frames of reference. Its vibrancy helps us to see



FIGURES 12.12 (LEFT) AND 12.13 (RIGHT) The appearance of a collar made from brown kelp in changing light conditions
PHOTOS: PETR KREJCI, 2013

our own lives in relation to it and to imagine futures that relate to our own lived experiences. With our visitors we discussed a broad spectrum of potential future algae applications and the dialogues proved to be multi-faceted, tying together personal, poetic and scientific questions. In discussing them critically together, we also explored which pathways were merely probable and which might actually lead to meaningful, preferable futures. These collective encounters with the material generated many more ideas, pathways and aspects of possible futures than I could ever have imagined myself. They helped us in articulating our own values, understanding our own biases and helped us to seek and establish a community of practice to achieve our aims. The algae taught us an important lesson: alone we achieve very little, in multitudes we thrive. If we all start at square one with inventing a new material and do not share the knowledge we gain in an open-source way, we will simply repeat these first steps time and again.

I became conscious of the fact that what I had actually been doing at the V&A was to craft multisensorial encounters that enable collective dialogues and expressions of imagination. On this basis, I developed methods for co-speculative design in my PhD.⁵

5 Lohmann, Julia, 2018, Thesis, *The Department of Seaweed: co-speculative design in a museum residency* PhD thesis, Royal College of Art. <https://researchonline.rca.ac.uk/3704/>.

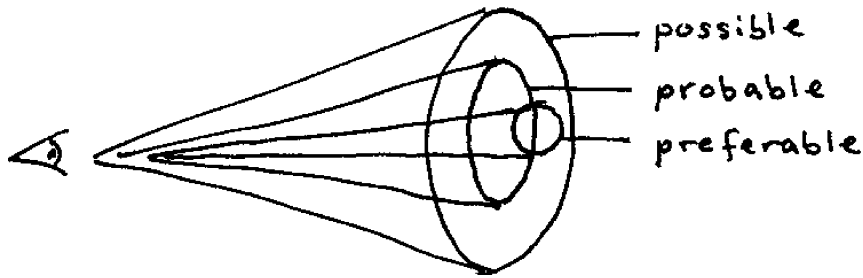


FIGURE 12.14 A *future cone* diagram, used to explain probing possible, probable and preferable future applications for kelp

Co-speculation proposes a shift in roles and mindset from individually authored practices and scenarios to the facilitation of communities of practice that engage in collective speculation and practice-led research centered around a shared concern – in my case seaweed. A ‘future cone’ diagram consisting of nested or intersecting cones emanating from a point of origin is often used to represent speculative visions. From the centre towards its edges, it may feature cones representing possible, plausible, probable and preferable futures.

However, a single cone only stands for a single perspective, or author. Co-speculative practices generate a multitude of future cones, a field of visions, resulting in a much wider, more diverse scope of speculation around a given concern. This shift from ‘Me’ to ‘We’ is also an opportunity to examine which values the community of practice shares and use these to focus on meaningful, preferable futures.

Gradually in the process of working with kelp, our Department of Seaweed community of practice has come to understand the importance of ‘listening’ to our material. We yield to the macroalgae we work with and relegate the authorship and control over some elements of form-giving to the seaweedness. We learn from kelp, come to anticipate the kelp’s reactions and attune ourselves to its material properties. Our maker-and-material relationship becomes reciprocal, the kelp serves us, and we serve it in return; it expands its role from being our material to gradually also becoming our method and our muse. In *Conversations on Plant Sensing*, Natasha Myers discusses the ‘affective and kinesthetic entanglements’ of plants and the plant scientists who grow and observe them in their research. She asks: “Is it possible that practitioners’ sensoria get ‘vegetalized’ over the long duration of their experimental inquiry?”⁶ Even though the algae we work with is not a living organism any more, we feel connected to what it once was and what it can do in its ecosystem and – through

6 N. Myers, *Conversations on Plant Sensing*.

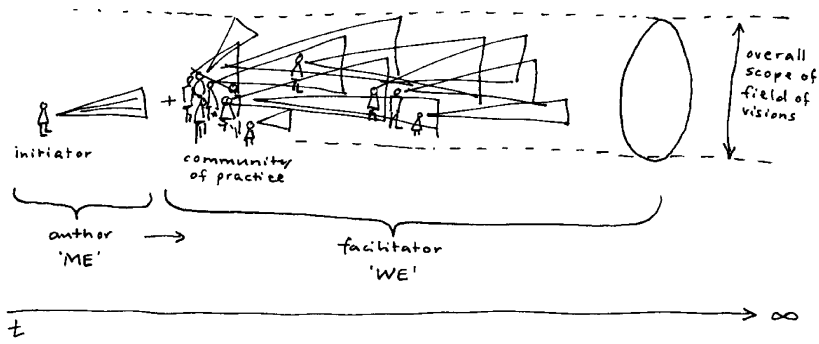


FIGURE 12.15 The open-ended process of *Co-speculative Design*, with its shift from *me* to *we*, from an individually authored vision to the co-speculative field of visions generated by a community of practice

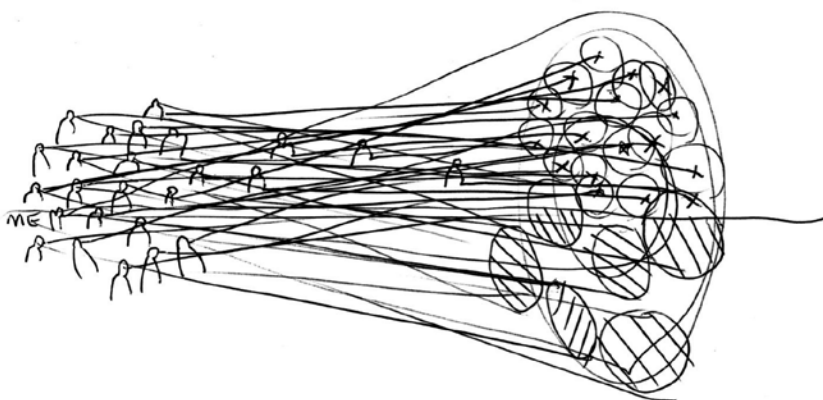


FIGURE 12.16 A *Co-speculative future cone*: the diverse positions from which we imagine our phytofictions enriches the scope of ideas articulated. Shared values enable us to discuss not just possible and probable futures, but also to probe which ones are desirable and undesirable

its evocative material properties – also within the framing of material culture. As practitioners we are humbled by what we learn about, from and with algae. We are starting to aspire to be like seaweed, we are being phytified.

4 **Phytofication**

In Phytofiction I focused on the material’s trajectory into kelp as a part of human material cultures. In this section I will describe how we can and why

we should take a biomaterial's organismic past into account when designing and thinking with it. Both directions of thought on the trajectory from the organism kelp to the materials and artefacts we make from it invite a deep engagement, fuel curiosity and entangle us through haptic, conceptual, olfactory and intellectual engagement.

Algae are marine organisms that thrive in an eco-system that we humans cannot inhabit. The living past of the algae is mystical, alien, enthralling and full of unknowns, even more so when marine biologists, who have studied the ocean for years, contribute to our dialogues. Our understanding becomes less sure-footed, our knowledge patchy; after all, so much of the oceans is still unexplored, 95% of it is still unknown.⁷ The bodily encounters we have with algae in its own eco-system when swimming, diving, rock-pooling can be unsettling, often experienced as a loss of control, unwanted touches, an immersion into an unknown world, putting into perspective our perceived superiority as a species, the frames of reference we often unthinkingly apply when we are in our own eco-system.

When I research the marine past of my biomaterials, I encounter our human impact as a major force destabilizing the marine eco-system. Even the natural kelp beds around Hokkaido, Japan, that have been harvested sustainably for generations are now declining rapidly because of warming oceans.⁸ Our human impact on the ocean is immense, whilst the ocean's 'eco-system services' buffer and mask the dramatic shifts we are setting in motion. If we disrupt the ocean's ameliorating action any further, the Earth's ecosystems will suffer catastrophically.

Kelp is ideal to illustrate how we need to reframe our thinking from an extractive towards a regenerative mindset because growing it can improve the health of the local marine ecosystem.⁹ From an extractive perspective, we might see kelp as another natural resource to be consumed, a foodstuff, a material. We know that it grows afresh in two-year cycles and can be harvested time and again. We may even communicate that it is 'sustainable' or 'regenerative' and tout it as the 'green gold' of the 'blue economy' of the ocean. However, the danger of this lens lies in humans thinking and asking – to paraphrase the US president John F. Kennedy – what kelp can do for them, rather than

7 <https://www.marine-ed.org/ocean-literacy/principle-7>, accessed on October 10th 2021.

8 <https://english.kyodonews.net/news/2020/03/fba75aa19a61-feature-global-warming-wreaks-havoc-on-japanese-edible-kelp.html>.

9 <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/seaweed-farming>.

what they can do for kelp. An extractive mindset that reduces the immense complexity and agency of the ocean down to human economic principles is an eco-systemic insult. At the level of kelp, taking it out of its natural context and perceiving it in isolation means intentionally or unintentionally disregarding the role it plays in the sea. Within this mindset we would only explore what can be done with kelp, rather than considering what kelp does and is. Whilst extraction is appropriate in some cases, in others we might deplete yet another swathe of species and as a consequence also those that depend on them, their dependants, and so on. Instead of these negative cascades of intervention, our designs must be focused on supporting the agency of algae and ensure their continued existence. We could grow algae in areas that otherwise support very little life, over sandy sea bottoms or hanging above deeper waters to create neopelagic ecosystems that give shelter to fish and offers zones of protection. Of course, for this kind of algae farm to be beneficial to the other organisms we would have to consider their needs and the systemic interactions in our decision-making processes. Their needs would have to be considered when defining where the farm should preferably be located (Marine Spatial Planning), when and how harvesting takes place and which species to grow so that our human impacts on the environment can be alleviated.

Micro- and macroalgae are valuable indicators of marine eco-systemic imbalances. They may be either disappearing from their established habitats or appearing in new ones due to changing climatic conditions or human interference. Algal blooms or beach-cast biomass are other tell-tale signs of off-kilter systems. At the same time kelp forests are some of the most biodiverse places in the ocean and offer shelter and food for a multitude of other species. Kelp is vital to ocean food webs. It shelters fish, becomes a nursery for their eggs and young, as well as habitat and food source for a multitude of other organisms. It grows by removing nutrients from the water, often excess nutrients that impact the ocean because of human activities such as fertilisers and fish farm faeces. Kelp thereby contributes to improving water quality and at the same time it produces oxygen through photosynthesis. At the end of its lifespan, wild kelp sinks to the seabed, taking with it the CO_2 it has captured. If it washes up on land, it can be used as fertilizer and feed for livestock, with recent studies showing it may significantly reduce the methane excretion of cattle. Depending on which type of algae we utilise, the role of the species in its eco-system should direct our methodology.

There are species of algae that are in decline because of human activity and others that thrive and grow excessively, at the expense of the other members of their eco-system. For example, in my local context the Baltic Sea, the brown

algae *Fucus vesiculosus* is a keystone species in decline. A keystone species is a species that “relative to its abundance, has a disproportionately large effect on its environment. It plays a critical role in maintaining the organization and diversity of its ecological community, and changes in its abundance and distribution thereby affects many other organisms in the food web.”¹⁰

When working with a keystone species of any eco-system it is obvious that we cannot apply an extractive mindset that might deplete the keystone actor. If we harvest from the wild, the methods we apply need to follow strict sustainability guidelines and cannot exceed the regrowth pattern which needs to be monitored and re-evaluated constantly. In the case of *Fucus vesiculosus* this means that we should not promote any usage of wild stocks at all. At the same time an increase in *Fucus vesiculosus* could benefit the marine ecosystem. Could it be farmed in places where it might not thrive otherwise? Could it be farmed in ways that can nurture its agency as a keystone species as well as provide biomass for human uses? When farming brown kelp, we have to make sure not to negatively affect the wild stock and we should aim to develop practices that support the kelp's potential to benefit its local ecosystem. We need to grow the keystone's agency, not just its biomass.¹¹ We can achieve this by understanding the keystone species as a key stakeholder or the ‘client’ of our design process. When we engage with a client, we employ a service mindset that is led by the desire to encounter, come to know and understand their point of view. We begin by aligning ourselves with our client's position as closely as possible, with the aim to understand. Empathy, listening, connecting, research, immersion and supplementary knowledge are the ingredients of this phase of the design process. At the same time, we complement this aligned viewpoint with our own insights as an outsider, our ‘fresh eyes’. As such, we engage in stereo with a heightened sensibility for any discrepancies, design insights, in what we encounter. The questions we ask our client are those we ought to pose when we are working with a keystone species: *What is your role here? What do you need to thrive? Who might help me understand you? Who are your potential allies and competitors? How can I help you with my skill set, connections and point of view? Are there possibilities for expansion that I can help you unlock? How can we both benefit from collaborating? What is a sustainable long term strategy?* Expansion here is not to be understood as a tilting of the balance towards

10 https://stockholmresilience.org/download/18.416c425f13e06f977b14a55/BalticSTERN_State+of+the+Baltic+Sea.pdf.

11 Finnish startup company Origin by Ocean sustainably grows and harvests Baltic algae: <https://originbyocean.com/>, the Sea Farm in Sweden grows brown kelp *Saccharina latissima* on lines hanging in the ocean to study the environmental benefits of seaweed farming, <http://seafarm.se/>.

solely benefitting the keystone species, but as a way towards an increased carrying capacity of a biodiverse and thriving ecosystem.

There are also kelp species that only grow in the wild. When we discover properties in these types of algae we need to consider whether promoting them would lead to inevitable exploitation. Perhaps we should then refrain from proposing these types of kelp for use all together.

In the case of algae species that are growing excessively¹² or invasive species that endanger the balance of the local ecosystem,¹³ the key aim of the design process could be to utilise the biomass to reduce the environmental impact, ideally in a way that simultaneously addresses its cause and generates biomass that funds the continuous rebalancing efforts. A science-led, extractive mindset within a system-oriented regenerative framing might be an appropriate method for this type of engagement.

Algae-led design processes should be science-led, site specific inquiries. Are we for instance, making algae a viable material to help reduce over-abundant species and extract excess nutrients from the sea? Or are we developing kelp crafts to inspire empathy and engage a community in marine stewardship? Do our proposals have the possibility to benefit the local ecosystem?

The algae's role and agency in its ecosystem defines whether or not we should employ it as a material for making in our human made world, and if so, how. Questions that cannot be answered without a transdisciplinary understanding of the complexity of the matters we design with that includes the material's eco-systemic origins and its future in our material culture. A regenerative mindset involves a systems-level understanding of the situation. It is case- and site-specific and considers the role and impact of the algae in its local marine ecosystem. The designerly approach should be informed by bio-inclusive ethics¹⁴ and shaped by local environmental insights as much as by material affordances, constraints and potentials. It can include methods of empathy and connection as well as extractive practices, always with the aim to regain balance and stability in the socio-ecological system. It recognizes that kelp is more than matter to be shaped by humans – that it can be a marine ecosystem builder, a keystone species or a profiteer of human activities, a destabilizing force or an ecosystem service provider that could reduce our human impact on

12 For instance Sargassum: <https://climatecleanup.org/sargassum/>.

13 See for instance the case of *Caulerpa taxifolia* <https://plants.ifas.ufl.edu/plant-directory/caulerpa-taxifolia/>.

14 Veselova, E., & Gaziulusoy, I. (2019). Implications of the Bioinclusive Ethic on Collaborative and Participatory Design. *The Design Journal*, 22 (sup 1), 1571–1586. <https://doi.org/10.1080/14606925.2019.1594992>.

the sea. It is itself embedded in complex webs of life that we need to consider, to know how to engage in the situation.

Kelp helps us shift our mindset and define a regenerative designerly approach. It inspires us to become more empathic, opens possibilities for community-building dialogues and it raises our awareness of being just one of many species co-inhabiting this world.