Coral

Eva van der Born
Master student Indutrial Design
at Eindhoven University of Technoloy
Eindhoven, The Netherlands
e.j.v.d.born@student.tue.nl

Jori van der Kolk
Master student Indutrial Design
at Eindhoven University of Technoloy
Eindhoven, The Netherlands
j.m.l.v.d.kolk@student.tue.nl

Rachelle Kraal
Master student Indutrial Design
at Eindhoven University of Technoloy
Eindhoven, The Netherlands
r.e.kraal@student.tue.nl

ABSTRACT
The methods and materials used for the production of clothing have been nearly the same for a long period of time, wherein the innovation in fashion emphasized the improvement of existing materials and methods. By looking at new unconventional materials with regards to fashion, Coral aims to explore other future possibilities. Experimenting with bioplastics in combination with procedural design, resulted in a new perspective on a future aesthetic language inspired by organic growth, and on the materials and manufacturing techniques used in the fashion industry through embracing the unpredictable qualities of the material. The garment that is created out of this process, shows the potential of this material as first step towards an alternative future. When working with yet undeveloped materials, value can be found in the dialogue that emerges between the designer and the material. Through this dialogue new values can be found that would never emerge were the designer is fully in control.

Authors Keywords
Bioplastics, Biodegradable materials, Future fashion, Procedural design, Exploratory making, Computational design, Grown structures

CSS Concepts
Media Arts

INTRODUCTION
Coral is a design exploration into the use of biomaterials in future fashion and takes a first step when it comes to a new aesthetic that comes from the use of this new material. The fashion industry is one of the most polluting industries in the world with many of the steps in the process having a large impact on the environment. It is for this reason, a lot of research is conducted to reduce pollution in one of those steps. *Apple-based material,* a project by Daniëlle Ooms, shows the potential to make a natural material that looks and behaves very similar to leather but without the harmful impact on the environment. The material is purely made out of apples without any additives, which makes the material and products fully biodegradable [7].

Coral explores the use of a bioplastic to create a demonstrator of what sustainable fashion could look like in the future. Initial explorations with the bioplastic were inspired by natural growing processes and resulted in a newfound aesthetic language that was realized through embracing the unpredictable qualities of the material and manufacturing techniques. The unpredictability of the material and its aesthetic, sparked a curiosity to see whether it was possible to design with this aesthetic in procedural design software. The addition of procedural design software in the design process opened up more possibilities in terms of personalization, control and creative freedom when creating complex, grown structures. This project explores the first step of procedural design and bioplastic in fashion by experimenting with the combination of these elements, both of which are not yet ready to be deployed on a large scale, but can, with practice and persistence, be used to create a unique aesthetic language and show a new take on the fashion design process.

CONTEXT

Crafting Everyday Soft Things squad

This design exploration took place in the Crafting Everyday Soft Things squad at the department of Industrial Design, at the Eindhoven University of Technology. The aim of the squad is to design through explorative and iterative making on the cutting edge of contemporary fashion practices and new emerging technologies and digital manufacturing techniques, to create future everyday soft things that will enrich our engagement with ourselves and our environment [2].

Exploring a first step towards a possible future

Initial directions for this project were drawn from speculations about possible futures for fashion. As we live in a time of the polluting and rapid changing fast fashion industry, designers have the ability to question the status quo and provide alternatives. Since fast fashion is somewhere in the top ten of polluting industries when it comes to carbon emissions, sustainability is currently the most talked about, controversial topic within this field [10].

Rather than providing a short term, effective and environmental solution for this area, our aim is to envision and realize a first step towards a possible alternative future regarding sustainability. This feature was deliberately not explicitly defined at the start of the project, because we believe it will continuously shape itself during the exploration. This first step has the potential to inspire other makers and creators by opening up new possibilities for reflection, intervention and further research.

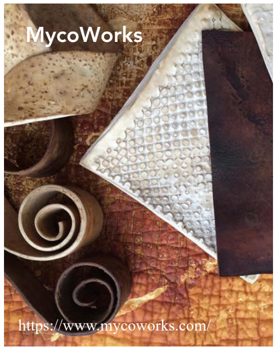
Recently the Dutch Design Week 2019 in Eindhoven, showed a vast trend in design wherein designers explored and experimented on the intersection of new materials and bio-design. In Coral, we have further build upon this intersection while working with an experimental and exploratory design approach.

During the process three major themes in our project came to the foreground: (1) *Designing with organic matter* (2) *Exploring the balance between randomness, control* and (3) *Organic Growth: a new aesthetic language*. We will further elaborated on these themes and explain how they relate to each other and how they have been shaped in the design process.

Designing with *organic matter*

In Coral, a special interest was taken in biodegradable plastics as a design material. They can be easily made from home and allow for simple modification. Rather than improving the material qualities of the biodegradable plastics for optimal usage, we are deeply interested in using the material as a creative tool during the design process, because of its unpredictable qualities such as its interaction with the environment and decay process, which both require unconventional manufacturing techniques and a new take on a design process.

The current state of the implementation of biodegradable plastics in fashion particularly leans towards DIY experiments and explorations done by art schools, makers and non profit institutes, who are also actively sharing step by step approaches on platforms to help you with creating your own biodegradable material [6]. Various design projects have recently been showcased that explored new biodegradable materials and manufacturing techniques in a fashion design process. A good example is *MycoWorks* [4], a company that creates mycelium based material that has the properties of leather. *Mestic* [4], a project by Jalila Essaidi, transforms animal manure into biotextiles, bioplastic and paper.



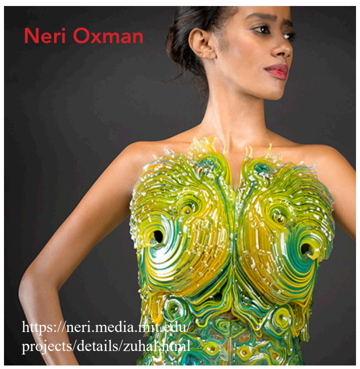
Agar agar, the main ingredient of our biodegradable plastic, is a powdered form of the jelly-like substance that is extracted from the cell walls of certain species of red algae. It is released on boiling and often used in the kitchen as a binder. Biodegradable plastics made from agar are extremely sensitive to the environment. Therefore these plastics tend to react with the environment and results in materials behaviour such as deformation, changing shape and decay. An example of a project that researches the use of agar agar as a design material is *Agar Plasticity*, an ongoing material research project at AMAM studio in Tokyo, explores how agar can be used as sustainable packaging material [4].

Exploring the balance between *randomness and control*

What these material projects have in common, is that they all work with materials that have their own unpredictable behaviour. Embracing these material qualities raises questions whether to take interventions to reduce this due to the free behaviour of the material, and when not in order to let material flourish and leave the path open for an uncharted design space. The organic shapes and behaviour of biomaterials is a result of an algorithmic process that is naturally found in organisms and nature [5]. The beauty that is found in the organic nature of these algorithms have been an inspiration for designers, architects and artists for a long time. Taking possible interventions to control material behaviour could also lead to a broadening of the beauty that is found in the organic algorithmic structures behind it. This report shows that the exploration finally opened up a search for balance between randomness (material) and control (methods in a fashion design process), and how that slowly shaped an aesthetic language that is initially inspired by algorithmic structures in nature. .

***Organic growth*: A new aestethic language**

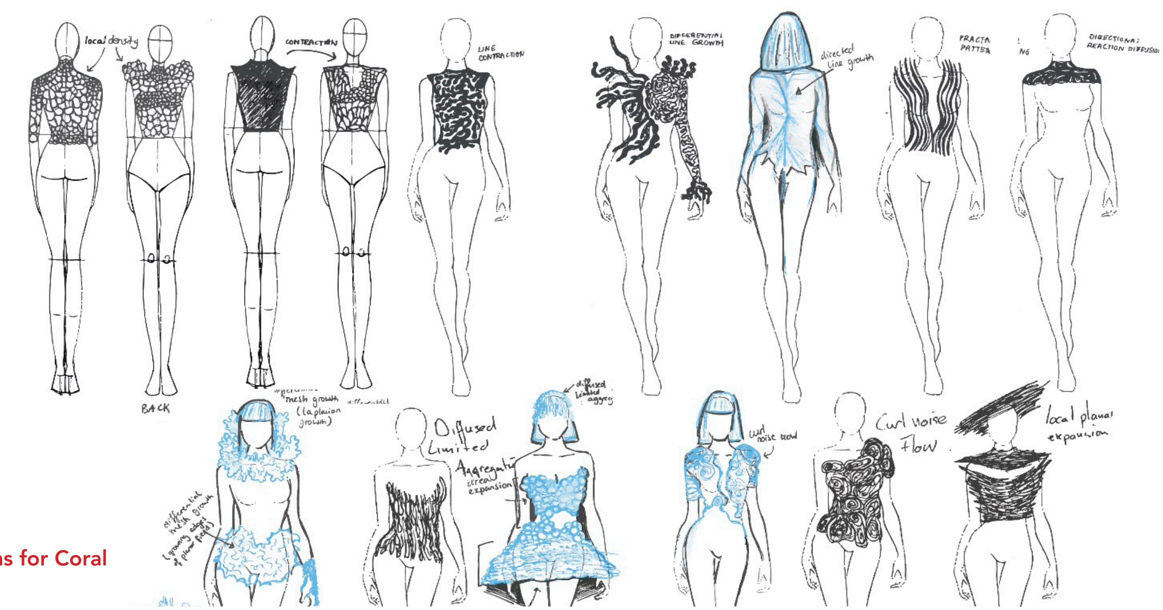
Organic growth is more often used as an aesthetic language and design inspiration. Iris van Herpen, for example, created her own unique aesthetic vision by fusing new technology such as 3D printing of unfamiliar forms and the use of radical garments in traditional Couture Craftsmanship [1].



Neri Oxman also used her design principles inspired and engineered by nature, and implementing them in the invention or novel design technologies.
In addition to her main application in architectural design, she showed that fashion design also lends itself to computational design and digital fabrication.
With Oxman's Wanderers project from 2014, she created wearables with 3D printed multi-materials based on the behavior of the bodies natural systems [8]. These examples have shown the beauty of the complex shapes and growing algorithms found in nature. In nature we see those smart and evolved forms such as kelp, coral and red algae. Voronoi algorithms found in animal skin, erosion of the earth and cellular networks have been used in clothing patterns to combine computational approaches and aesthetics in clothing. Growth line algorithms can be found in nature such as in the close relatives of corals, sea anemones and grow without intersection around surfaces. Also, fractal structures, found in plant geometries, find great similarities with the aesthetics of sea plants. These examples also highlight how 21 century design manufacturing techniques and computation help to mimic these structures and how they open up more creative possibilities.

DESIGN PROCESS: THE EXPLORATION OF CORAL

The aim of the project was to combine biomaterials i.e. bioplastic with procedural design, in order to create a piece of clothing that had the aesthetic that it was organically grown. The goal for the aesthetic was to resemble the structure and form of the red algae, the base material of the bioplastic. Such a shape can be created digitally using procedural design software, mimicking, in a way, underwater structures like coral. The result is a top that refers to the natural fractal growth process of the algae and necklace made from bioplastic that demonstrate this aesthetic.

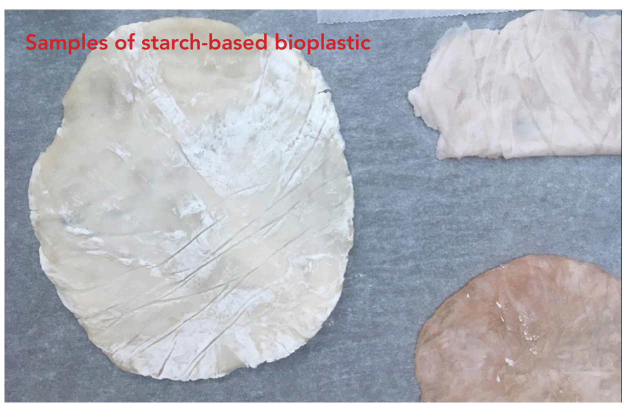


Visions for Coral

BIOPLASTICS

The Bioplastic Cookbook by FAB-TEXTILES [3] and Research Book Bioplastic by Juliette Pepin [9] and provided a lot of insight into bioplastics as well as several recipes. Several of these recipes were tested and rated based on the simplicity of the cooking process and the quality of the resulting bioplastic. Next to bioplastic, some tests were conducted with the making of fruit leather from peaches, but this material was discarded as it was very similar to the apple leather from the project of Danielle Ooms. Agar Agar based bioplastic was finally selected as the material to work with, due to its leather like qualities when pigment was added and when the material was waxed.

Bioplastics are relatively simple to make. The necessary ingredients are mixed in a saucepan and heated until the mixture starts to boil. The mixture can then be poured into a form to create the desired shape. In this first exploratory phase, two types of bioplastics named agar-agar based bioplastic and starch-based bioplastic, were cooked several times with variations in the quantity of the ingredients. The resulting plastics were graded and tested against each other to see which one was most suitable to be used as a material to work with. The desired qualities in the materials were: flexibility, durability, feel, and workability.: *flexibility, durability, feel, and workability.*



Samples of starch-based bioplastic

to draped around the body and to provide freedom of movement for the wearer of the garment.

Durability: The material needed to be durable fur the desired time period. This mostly meant that it should be strong enough not to tear or break while being worn.

Feel: How a material feels on the body is very important for it to be worn comfortably, therefore, the material needed to have a nice feel on the body of the wearer.

Workability: In order to turn the raw material into a garment, the material must allow to be sown, stitched or otherwise attached to itself while still retaining the other qualities.

The ingredients for the tested bioplastics based on starch were as follows:

- Corn starch/Tapioca starch
- Water
- Vinegar
- Glycerine

The ingredients for the tested bioplastics based on agar were as follows:

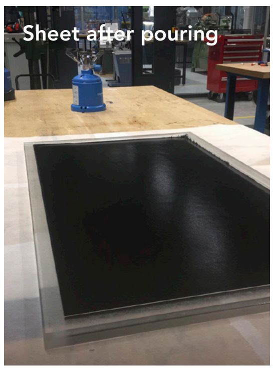
- Agar agar
- Water
- Glycerine

For both recipes, several different ratios between the different ingredients were tested to get a better understanding of what properties the material could get. The cornstarch bioplastics all got very stiff, broke easily and felt and looked rather nasty. Due to the added vinegar they had an unpleasant smell. The Agar Agar based bioplastic in contrast was clear, flexible, odorless and fairly strong, making it a far superior material to be used as a garment. Several pigments and additives were tested with the Agar Agar bioplastic. Several of the additives resulted in very nice and useful properties of the material e.g. by adding activated carbon to the material it became fully opaque and got a leather like feel. Other additives that were tested were: coffee grounds, marble powder and natural red pigment. When cooling down the material seemed to lose some of its water content resulting in a slight shrinkage of the material. After waxing with beeswax, the bioplastic became stronger and could easily be worked with a sewing or locking machine.

Sewing & locking

Scaling up the process of making agar bioplastics

To make a garment out of the bioplastic, it was necessary to create large sheets that could be used to make patterns. For this, frames were made with a dimension of 70 by 40 cm that could be used for the pouring of such large sheets. To make a basic shirt, approximately five of these sheets would be needed. The process of making one sheet was relatively simple. The necessary amount of ingredients were mixed in a pan and heated while being stirred continuously. After a while, the material starts to become syrupy which means it can be poured into the frame. This was probably the hardest step in the process. Due to the heat of the liquid, the underlayer of the frame, a 12 mm thick acrylic sheet, started to bulge, making the liquid run to the sides of the frame, even when holding it down with force.


Sheet after pouring


Cooking bioplastic

While making these large sheets, the material behaved more unexpectedly compared to the process of creating small samples. When drying, the material underwent significant shrinkage, resulting in the sheets tearing into several smaller crumpled up pieces. A possible explanation for this is the influence of environmental factors on the material, such as the dry air and a high room temperature. We assume that this was due to an accelerated reaction between the material and its environment, losing its moisture too quickly which resulted in cracks in the material. Also, we assume that the drying could be accelerated by the cardboard that was used as a drying

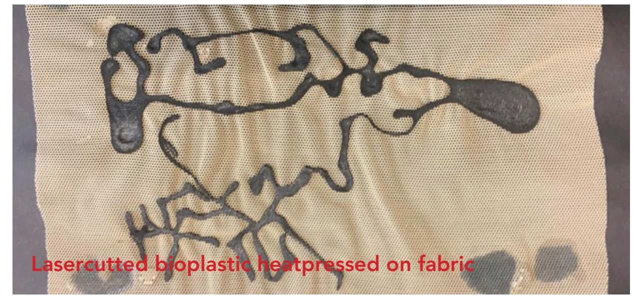

Sheets after drying for 2 days

surface. This was the first moment wherein the friction between the material and the intention of the designers, came to the foreground. When the sheets did survive, they had about one fourth of their original size and due to slight differences in material thickness were almost bowl shaped with the edges being significantly stiffer and thicker than the middle.


A sheet of bioplastic after ironing

Post-processing the materials

The surviving bowl-shaped sheets could be saved by cutting the thick edges off leaving only the thinner middle part of the sheet. By ironing between two layers of baking paper, it was possible to make flat even sheets of bioplastic. There sheets were a lot smaller than the anticipated 70 by 40 cm, but they show it is indeed possible to create usable pieces of bioplastic. The processed sheets could be modified in several ways. The material was easy to work with traditional sewing equipment like a sewing or locking machine proving the material could be used in a similar way to traditional materials. Next to sewing, it was also possible to cut patterns and shapes out of the sheets using a laser cutter. The cut made by the laser was very clean and there were no signs of burning making the material very suitable for this type of operation.


Lasercutted bioplastic heatpressed on fabric

Draping

Embracing these shrinking and tearing behaviour of the material opened up a possibilty of draping the pieces around a mannequin. A top slowly emerged with an aesthetic which refered to the structures of the fractals of the agar. The draping made it easier to bring the top to a whole, embrace the shape of the material instead of seeing it as a failure. Here the material could be seen as a co-designer in the design process of the top with an equal to the end result as the designers. When presented, the top received praise for exactly this quality.


Draping pieces

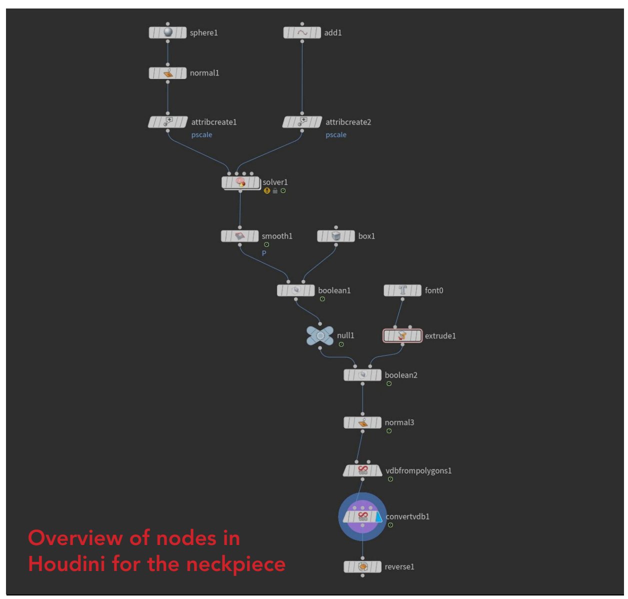
PROCEDURAL DESIGN

Procedural design software allows for the creation of shapes through the use of expressions. The advantage of this is that every parameter used in the design of an object can be changed later on in the process without complications for the rest of the design. In traditions design software, CAD, changing a parameter used in the beginning of the process can be impossible or lead to a lot of complications for all parameters depending on the changed parameter. Since procedural design works as a form of programming, it is possible to create expressions that result in the growing of shapes.

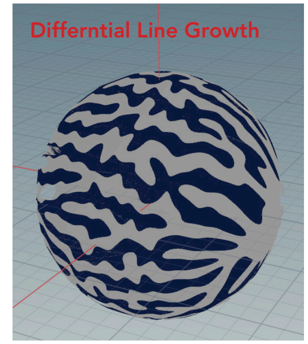
To gain some valuable insight on several topics related to the project experts were contacted on several occasions during the design process. The team visited the Precious Plastics workspace in the center of Eindhoven, met with experts, both at the university and externally, about mould making, and Abnormal was brought on as a project partner. Abnormal is a small London based design agency that specializes in procedural design for art, design and engineering as well as speculative design. They advised the project with regards to procedural design, what software to use and they helped solve some technical problems. Next to this, they took on a more advisory roll about the vision and direction of the project, drawing from their experience with speculative design projects. The team visited Abnormal at their office in London for an extensive work session on invitation from the company.

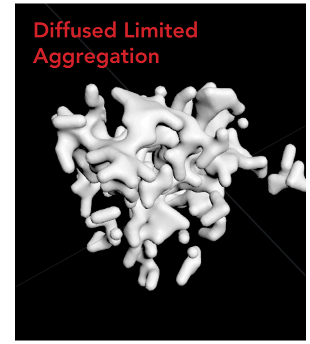

Brainstorm session at Abnormal in London

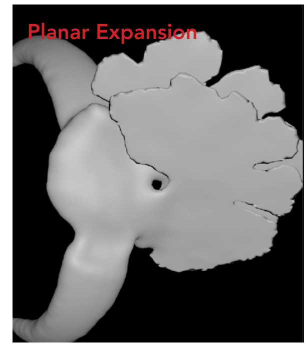
The first design package that comes to mind when thinking about procedural design is Grasshopper, a plugin for Rhinoceros by Robert McNeel & Associates. Although technically not a procedural but parametric design software package, its node-based programming interface allows for easy control over all variables. With the use of several plugins and the Python programming language, it is possible to grow shapes in grasshopper. Our project partner Abnormal recommended the use of Houdini, a visual effects program widely used in the film industry. Although not meant as a design tool, it has many features built in that grasshopper does not. The procedures that are setup to simulate growth are run multiple times. The output of one cycle is the input for the next. This is rather difficult to achieve in Grasshopper while being a standard function in Houdini. Houdini, like Grasshopper, has a node-based interface where the procedures as setup. In Houdini this interface is very advanced and has multiple layers, increasing the possibilities but also the learning curve. To have the most chance of success in growing organic structures the choice was made to use Houdini instead of Grasshopper.

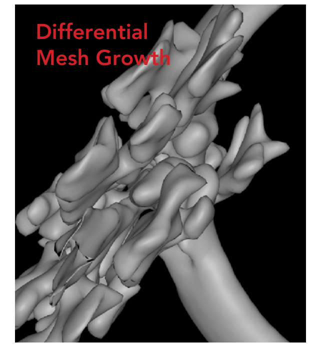


Overview of nodes in Houdini for the neckpiece


Differntial Line Growth


Diffused Limited Aggregation


Planar Expansion


Differential Mesh Growth

To get an understanding of the growing algorithms that are possible to create through Houdini, several tutorials by Entagma were followed. There tutorials provided a base to start from and were adapted to achieve the desired growing behaviour. Some of the growing algorithms that were tested were: *Differential Mesh Growth, Differential Line Growth, Planar Expansion, and Aggregate Growth* as well as several others. All of these algorithms, except Aggregate Growth, work by deforming and growing out of a base mesh, the resulting shape depends on the input mesh, as well as several parameters that can be controlled by the designer. Although it is possible to exert some control over the final outcome, most of the growing is organic or random, i.e. the algorithm follows a random path and there is no conventional way to determine what the final result will look like. This process is a negotiation between desires of the designer and the unpredictability of the algorithm.

PROCEDURAL BIOPLASTICS

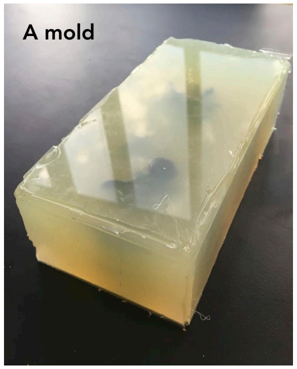
In Houdini several coral and leaf like structures were generated that fulfilled the desired aesthetic. Since the goal was to create these shapes out of bioplastic, several options were explored to turn the virtual models into tangible ones. The option that eventually seemed most promising was 3D printing the models using PLA. From the 3D printed model a mould would be created out of silicone that could later be filled with bioplastic.

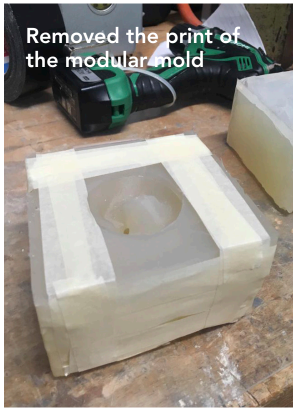
3D printed samples made in Houdini

Turning a virtual model on a computer into a tangible model can be done in many ways. The most accessible and maybe most obvious is 3D printing. Other techniques include CNC milling and casting. The option of making filament, for use in a 3D printer, was looked into, but the lack of hard data about the material made this process very difficult as there were too many variables to just go and try. Another option was that of casting. A 2D or 3D model could be 3D printed using conventional materials that would then be turned into a mould for the bioplastic. After careful consideration this method was chosen as it had the highest chance of working successfully.

After creating the desired shapes in Houdini, the models were sliced in manageable pieces and 3D printed on a Prusa i3 in regular PLA. Each of the 3D prints was then turned into a silicone mould. This was a tedious and labor intensive process as the silicone moulds had to be cut open by hand to remove the printed parts. This was done by hand due to the complexity of the shapes and to make sure the mould would release properly once the bioplastic was poured. After pouring, the bioplastic had to dry overnight before it could be very carefully removed from the mould. Here the same shrinkage occurred as with the sheets but without breaking the models. Over time, the bioplastic models would go from their original moulded size to about one fourth while drying. With help from Chet Bangaru, the moulding process was successful and possibly the only way to create the desired shapes out of bioplastic given the timespan of the project. It was however very labour intensive and far from ideal. In the future another more suitable method should be found to create the same shapes out of bioplastic.


Silicon mold making

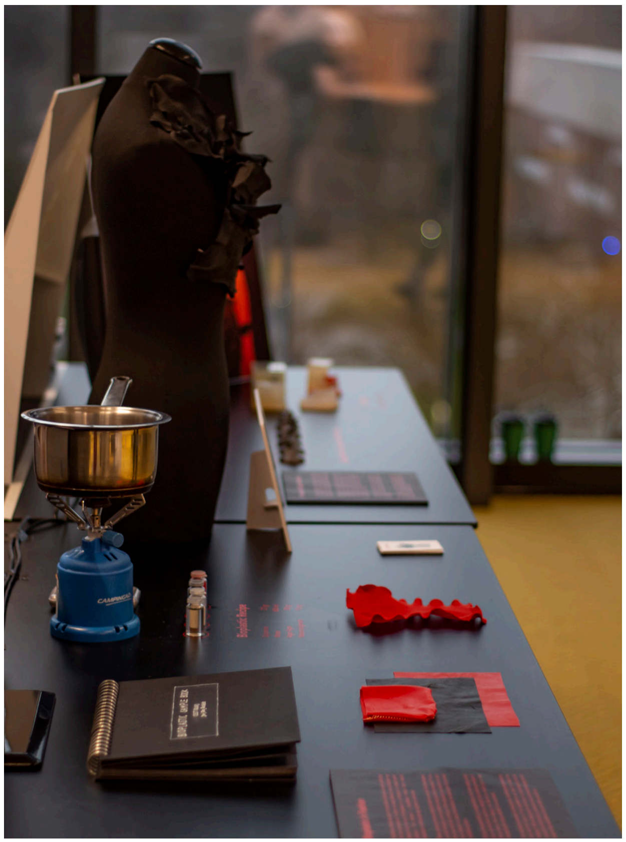

A mold


Removed the print of the modular mold


Pouring bioplastic into the mold

To create the final demonstrator, the top was combined with a necklace that was made from cast bioplastic. Several coral structures were attached to a thin strip of bioplastic to create the necklace. The top and necklace together demonstrated the possibilities of the material as well as the tension between control and randomness that occurred throughout the design process. During Demo Day it sparked numerous discussions about how much control designers should try to excerpt on the materials they work with and how randomness and uncertainty can be seen as a strength instead of a nuisance.

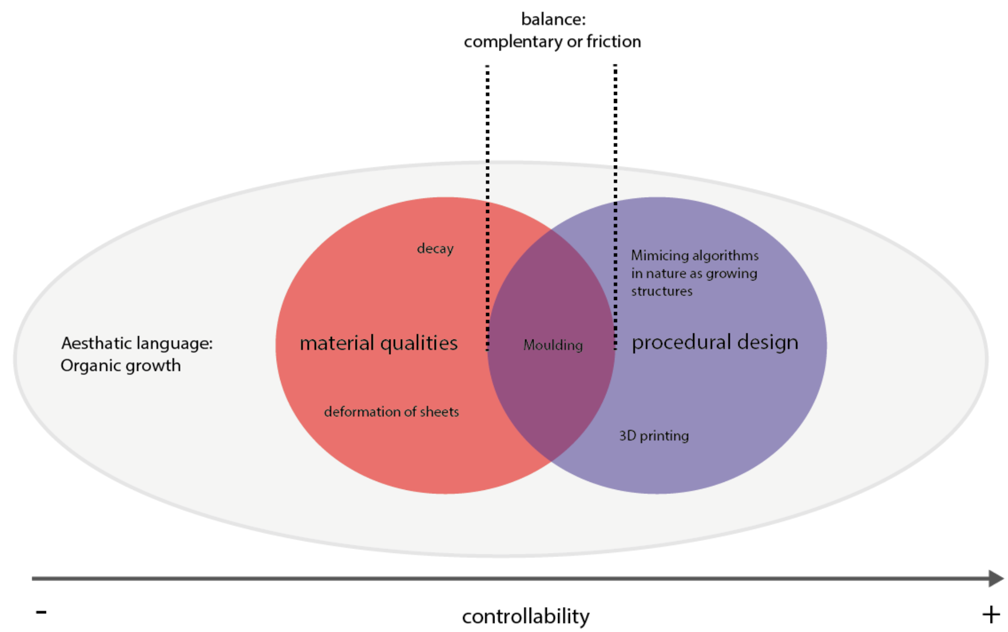

Final Demonstrator presented at the Demo Day of ID at the TU/e



DEMO DAY
Coral was presented at the Demo Day of Industrial Design at the Eindhoven University of Technology. High-quality photos of a model wearing our final garment, were made to demonstrate narrative in context. Also two videos presented the process behind the creation of the bioplastics and the procedual design shapes. Afterwards, Mick from Abnormal provided us with insightful feedback which can be found in appendix 4.

DISCUSSION

The main finding of this study is the value that is found when embracing the uncertainty seen in the bioplastic and the procedural design processes. Designing with this uncertainty is a continuous dialogue between the designer and the material, both the physical bioplastic as well as the virtual procedural design. When the will of the material is seen as undesirable and something that needs to be controlled friction occurs in the process. When the uncertainty is embraced, the materials and designer can complement one another. Here the material becomes a sort of co-designer in the process. This requires a new take on a new unconventional take on a new design process. We have taken the first step towards an alternative future and sketched out a first diagram that captures our exploration in terms of relations that shaped the aesthetic language we were aiming for.



In the Context, we showed how designing with an organic, biomaterial requires an unconventional design process, wherein control never fully lies with the designer. The material qualities are influenced by the environment causing deformation and decay. On the other hand, more control can be assigned to the designer with procedural design.

In the middle of those two elements there is an overlap where both complementation and friction can be found. Moulding the biomaterial gives more control to the grown structures made in Houdini and therefore a predictable aesthetic language can be perceived. This is just a grasp of the possibilities to let go of and retake control over the desired aesthetic. The design process of Coral has been a constant negotiation between us, the designers, and the material.

This same tension also exists between the different materials that were used during the project. Both the bioplastic and procedural design have a certain level of randomness. The uncertainty of the procedural design disappears when the artifacts are translated into physical objects. When moulding the bioplastic, uncertainty is reintroduced as the bioplastic shrinks and deforms when cooling down. The intersection between the quality of the bioplastic and the procedural design is shown in figure X In the overlap between the two, complementation and friction can be found. Molding the biomaterial gives more control to the grown structures made in Houdini and therefore a predictable aesthetic language can be perceived. At the same time, the shrinking properties of the material make it hard to predict the outcome of the final shape.

The deformation of the bioplastic is hard to predict and is a cause of uncertainty. The decay of the material is an unpredictable process that depends on factors such as light, moisture, and time. Our hypothesis is that the humidity of the air has an effect on the deformation of the bioplastic. During the drying process, the bioplastic takes what seems to be a parabolic shape. With this behavior, the material mimics the aesthetic of underwater plants.

Procedural design, on the other hand, provides the ability to adjust the parameters that form the basis of the structures. It has a higher degree of controllability. The mimicking of natural algorithms refers back to organic growth. The structures are simulated by making a digital analysis of the mathematical logic and properties of artifacts found in nature. Through procedural design, it is possible to influence and predict the structure for the generated shapes so they simulate the aesthetic of water plants that formed the inspiration for the design of the garment.

Since the value of embracing uncertainty and unpredictability was only discovered near the end of the project, we were unable to do an in-depth exploration and analysis of this value. Therefore we cannot make any claims about the precise implications of this. Future work should be to explore the value that is created by embracing uncertainty with the goal to develop a set of tools for designers to use this in their own process. Emphasis should be on creating the tools in such a way that designers can embrace uncertainty without losing grip on their process and the envisioned outcome.

This report demonstrates that the narrative around Coral needs substantiation.This made it hard to make concrete statements about our findings, which is in line with the feedback we received from Abnormal. More exploratory design work and exposure on other exhibitions will be helpful to shape this narrative further.

We hope Coral can continue to spark interesting conversations and discussions in the same way it did during demo day. From the 19th of January till the 14th of March Coral will be on display at the Innovative Fashion and Smart Textile Expositie in Museum de Kantfabriek in Horst, curated by Marina Toeters. We hope to be featured on more expositions like this and at the Dutch Design Week in October 2020.

CONCLUSION

Coral shows the potential of embracing randomness and uncertainty in the design process instead of trying to resist it and what the resulting artifacts could look like in a fashion design context. Seeing the material as a co-designer in the design process and allowing it to express itself brings enormous value both for the designer and the outcome of the process.

The aesthetic of Coral is a direct result of this co-design process and the mediation that took place between the will of the material and the designers. The unforeseen properties and behaviour of the bioplastic resulted in an aesthetic of organic growth within the created garment that was later embraced and explored through the use of parametric design software. The accompanying necklace shows the connection between the organic and the virtual and how randomness, complexity and different levels of control can be found and used in both design spaces.

We were not able to make a strong claim about a general method to embrace uncertainty in a design process and how to combine this randomness in the material and virtual worlds. In order for other designers and teams to embrace this approach they need to be able to give up control without the fear of losing grip on their process and remain confident about the outcome. To fully realize the potential of embracing uncertainty, a design methodology or framework should be developed that provides designers with the necessary tools.

ACKNOWLEDGEMENTS

We are grateful for everybody that helped us through this project. We especially like to thank:

• All the coaches from the CEST squad, for all the interesting discussions we had, the feedback and the inspiration.
• Mick Geerits, for sharing your expertise, enthusiasm and having us at Abnormal in London.
• Chet Bangaru, for your devoted support to the project. The molds would not have existed without you.
• Our fellow students from the CEST squad, for their support, feedback and sharing a positive atmosphere.

REFERENCES

[1] About | Iris van Herpen, Iris van Herpen from https://www.irisvanherpen.com/about.

[2] Crafting Everyday Soft Things. Tue.nl, 2020 from https://www.tue.nl/universiteit/faculteiten/industrial-design/innoveren/collaboration/squad-projects/crafting-everyday-soft-things/..

[3] FAB-TEXTILES. Bioplastic Cookbook from https://issuu.com/nat_arc/docs/bioplastic_cook_book_3

[4] Franklin, K. and Till, C. Radical Matter: Rethinking materials for a sustainable future. Thames and Hudson Ltd, London, 2019.

[5] Harari, Y. Homo Deus: A Brief History of Tomorrow. Vintage, London, 2015.

[6] Materiom.org. from http://www.materiom.org/search.

[7] Ooms, D. Apple-based material. Danielleooms.nl, 2019. https://www.danielleooms.nl/apple-based-material.

[8] Oxman, N. Mushtari, Jupiter's Wanderer | by Neri Oxman. Neri.media.mit.edu, 2014. https://neri.media.mit.edu/projects/details/mushtari.html.

[9] Pepin, J. Research Book Bioplastic. 201. from https://issuu.com/juliettepepin/docs/bookletbioplastic

[10] Wicker, A. PLEASE Stop Saying Fashion is the 2nd Most Polluting Industry After Oil - Ecocult. Ecocult, 2017. https://ecocult.com/now-know-fashion-5th-polluting-industry-equal-livestock/.

APPENDIX 1 - INDUVIDUAL REFLECTION EVA

I began the project Crafting Everyday Soft Things with a fresh perspective and a strong motivation. I had not been studying for a semester mainly to give myself a little rest after my Bachelor, but also to explore other possible design directions, such as UX/UI design. During that period I missed having a proper creative outlet and I missed the freedom I had at ID. I decided to continue my path as a designer and to pursue a Master in Industrial Design at the TU/e.

I was particularly drawn to this project because of its freedom and explorative nature. This explorative nature is something that I found very difficult during my B2.1 project in UPTSS. I have often found myself stuck in a circle of ideation, conceptualization and validation. I had put the standard for myself really high and therefore had to validate every insight. Since two years ago, I have been setting myself the goal to have a more open approach to break this cycle through means of pragmatic interventions, such as rapid prototyping and small user test. Still, I can easily fall back into these old habits and therefore a more substantial shift in my design process was required. Thus, I decided to join the squad for a second time, but now with a different attitude: I would embrace the explorative approach and would search for a way to make it truly my own.

The previous projects I did evolved around the question: how can we create a more sustainable and harmonized relationship with emerging technologies in the everyday? This was often done through a speculative design approach wherein I questioned the status quo and explored with alternative futures. Contentwise, this project felt like little departure from my usual design space that is often focus upon technology in the (future) everyday. Therefore, I learned a lot of new practical skills through all the explorations such as working with organic materials, 3D printing on fabric, vinyl cutting, draping, the basics of Grasshopper and most important, the VFX software Houdini. The aesthetics of computation, which can be seen for example in my FBP, has always been a significant inspiration for me. Therefore, I had a vast interest in the possibilities generative design and this project offered the me the possibility to finally learn this. Although going full in depth with mathematics proved to be really hard, though this project I learned to get an understanding of the underlying processes. Applying this knowledge through procedural design, resulted in the aesthetic language that I always wanted to learn to create. For example, learned to develop a mathematical understanding of different growing algorithms such as Diffused Limited Aggregation and Differential Line Growth by means of Entagma Tutorials, and learned to apply them in order to create the organic shapes and animations.

I am really grateful for the help Abnormal provided me with learning the basics of this design tool, because it is quite a niche market. Their knowledge is rarely found at an ordinary design studio. Furthermore, visiting their design studio in London, filled with computational model explorations, was an eye-opening moment for me. It showed me that you can make a business out of design that is more speculative and directed towards art practices. Since, I have visited them, I am considering more to pursue a career at such a studio. This also requires a more entrepreneurial attitude as speculative designer. Therefore I have decided to start searching for a medium-sized, strategic design studio for a collaboration during my FMP, wherein I can apply my speculative design vision in a more commercial context.

Looking back at the project in relation on how made me grow as a designer, there are some key takeaways. Although this project did not evolve around the topic of speculating on emerging technologies, my major learning point is that I learnt how to make a speculative future more real by means of a lot of prototyping and explorations. All the material and manufacturing explorations resulted in alternative future that somehow becomes very real. The philosophy behind Coral, which is described in the context of the report, is to me also far more important than the final outcome (the garment) of our project. I also learned to become more confident when doing these explorations, because I now have experienced that they hugely contribute and enrich the speculation, in ways that cannot be achieved through brainstorming. Therefore I can I now know how to avoid getting stuck in an endless cycle of ideation, conceptualization, and validation. This is a new major skill I will further apply in my M1.2 showroom research, and also in my FMP.

This project was the first project that I did in a team since one and a half years, thus it required some readjusting. When doing a project on your own, you can fully implement your ideas and vision into the project and make design decisions based upon that. On the other side, working in a team can also make the project flourish, wherein group members build upon each to find a new common ground. This is just impossible without each other.

Due to our different design backgrounds, our team started off with an open-minded and broad perspective. This really complemented the beginning of the design project and resulted in a big variety of early bio-design explorations. However, when big decisions needed to be made, for example on how we wanted to present our narrative at the demo day, flaws in our communication became visible. Everyone had their own strong and vast convictions towards design, which is different compared to the Bachelor wherein most people have not developed a strong vision on design yet. Since none of us was a natural leader in the group, things were sometimes excessively discussed but no action was taken. The friction that came out of these strong opinions that were not followed by concrete actions, or put into other proposals, and this started to really bother me at the end of the project. I often found myself picking up the pieces during times of deadlines. Although, I haven't had much previous experience with the role of a group leader, I slowly started to grow into this role and learned how to feel more comfortable in that position. Furthermore, I learned how to step up my game by reaching out to the right people for help in order to find a compromise. This kind of leadership is still very new to me, and I know there is still a lot to learn in this area. I am very motivated to continue working on this skill in my upcoming electives because I believe that it is significantly valuable not only for now, but also after University ends. Ultimately, we learned how to compromise by questioning ourselves how strongly we wanted to hold onto own beliefs and opinions. For a next group project, I learned now that it is essential to explicitly make each individual role, within the group clear, and stick to these roles. Chances are high that I take on my next project as the group leader from the very beginning and that I use my mediating skills to create a motivated and positive atmosphere in the group. It is good to look back at the collaboration with a critical point of view, I also highly value the feeling of the positive, motivated and complementary atmosphere that we shared 85% of the time.

APPENDIX 2 - INDUVIDUAL REFLECTION
RACHELLE

Starting off in September 2019 on my first design project at the TU/e made me intuitively choose to work in the Crafting Everyday Soft Things for multiple reasons.
I felt my bachelor studies Creative Technology has brought a good basis in the expertise areas Creativity and Aesthetics and User and Society. Many electives, a graphic design study abroad in Barcelona and my bachelor thesis in interactive visuals effects contributed to a motivation to work in a squad where aesthetics is on the foreground. In the early brainstorms my aim to work on this design project was to create societal impact which suited the trend in the squad to work with sustainable materials. Together with Eva van der Born and Jori van der Kolk we found common ground to start of the design project. We wanted to work with a new material to create awareness how the fast fashion industry influences consumer behavior or how these traditional production processes could be changed with new manufacturing techniques. Mentioning this last shared interest, the others expertise Technology and Realization fitted in the collaboration to start off the semester.
One of the learning goals of the semester was to become more confident in speaking up in the group. I found a way to stronger communicate during this project not to hesitate with telling my whole ideation, but rather present it in a visual way like a mood board and sketches. These tools made it possible for me to shape the first directions of how I thought the final prototype would look. In order to be at the same page with my team communication is key and I wanted to work on this during this semester.

In line with the ideology of the CEST squad I want to make weekly explorations regarding materials and craftsmanship. During my last bachelor thesis, I got stuck in a cycle of thoughts instead of starting with early samples. We still brainstormed about the vision of the project frequently during the whole process, but this approach pushed the project too a level where curiosity to the possibilities of the material won from the many explorations that went ´wrong´. Finally we ironed, laser cutted, molded, sew, draped a new material.

A third learning goal which grew during this semester was broadening my network. Although it contains a small part of my reflection, for me as person and as a designer the social contacts became extremely valuable. The easy accessibility of all the coaches in the squad says a lot about the open atmosphere of sharing ideas and thoughts. With working in this squad we used the advice of many experts which opened up many new perspectives. It probably also says something about the mature attitude of being a master student at the TU/e. We contacted many parties, which I have credit my team members for sharing their network in Eindhoven, such as Precious plastic, Bureau Moeilijke dingen, Labelledby, and of course Abnormal. In addition to the openness of the people I met here and the proactive attitude you should have as master student, I am thankful for my project group which supported me in finding my place her at TU/e.

Based on individual goals the division of tasks within the group went well. We shared curiosity in learning about biodegradable materials, new manufacturing tools such as 3D printing with biofilament and later learning how to work with generative design. I focused on cooking with bioplastics since I wanted to improve my hands on approach. I could put this into practice by creating many bioplastic samples, but also use this material as a creative tool to explore in laser cutting, heat-pressing and sewing techniques. I wanted to get a grip of what was possible with using nature inspired algorithms in generative design to improve my overall competence as a designer is 3D modeling, since I worked with another node based VFX builder engines before during my bachelor's thesis. I finally could explore in early samples by 3D printed grown structures derived from procedural design in Houdini.

Working on a speculative design is a method that fits in with the domains used in my previous bachelor in Creative Technology, such as societal impact and showroom elements. Although we have only taken a first direction in making a speculative design, I think we have achieved a nice result to sketch the future of future clothing piece. Reflecting on the explorative approach I think it was effective to come out of conceptualizing and is something I would also use in future speculative designs.

I describe my role in the team, as a team worker. I felt I was supportive to my other team members on a conceptual as well executive level. Shifting between details of the project and the societal impact as seen in the aesthetic theme of Coral is something I found comfortable off discussing. Also on an executive level I found myself at ease when working together and ideate on how material explorations could make the next step to embodiment. However, what I found hard was to critically think of certain decision when they were strongly believed in by others. Although I started weak in decision-making abilities but rather searching for team cohesion and finding compromises in friction, this improved in the end of the semester. I tend to keep on improving raising my designer voice on decisions and opinions.

The most valuable learning point might be the lack of confidence to keep following your own design process as well as critically reflect on advises and decisions made. This has been hard partly due to the strong opinions in the group. We ended up in having two narratives for our design process. We have kept searching for a way to present our vision where everyone was comfortable in, but might not have found one which was leading. For next projects I take with me to critically look at what you want to present to the outside world and go for design processes and ways of communication I feel comfortable in.

APPENDIX 3 - INDUVIDUAL REFLECTION JORI

When looking at the results of this project, how it was presented on demo day and the positive responses we received I can only be happy and proud, but that is not the general feeling I have about the project. The results and demonstrators that were shown on the demo day are very good, but the process that they came out of and my own contribution to that process is not, in my opinion.

When I look back at other projects I am proud of, what I mostly think about is the time and dedication I put into that project and how that resulted in a good outcome. With this project, that has unfortunately not been the same. From the start, I found it difficult to dedicate time to the project and I did not have an idea of what I could do to bring the project forward. Most of the work shown was made by my group members who did all the work with the bioplastic. I have thought a lot about why this was the case, but I cannot really put my finger on it.

Something I can think of was the lack of a central vision or an idea of what we wanted to accomplish with the project. This can make it hard to know what to do and it can feel like you are just doing something for the sake of doing it, which was sometimes the case. We also had trouble defining a vision for the project. In the beginning, I think we tried to do the so-called ‘everything project’. We managed to find more focus but the project still had a lot of facets that did not always seem to come together nicely. This left the project rather broad and I think this might have been the reason why we did not go as deep as I would have liked.

During my final bachelor project, I did not experience this problem and I don’t think it is very likely to happen during the next project, which is individual, but I would really like to prevent it from happening again.

A very interesting result of the project only became apparent near the end. For the whole duration of the project we tried to fight the material, bioplastic, we were making. It behaved in ways we did not anticipate and that were definitely not desired. When drying, for example, the material would shrink a lot resulting in tears in the sheets we were trying to make.

The breakthrough came when working with these unexpected behaviors and outcomes instead of against them. The top we showed during demo day was the result of precisely that. Without the tearing of the sheets and the apparent disaster it caused, we would have never made a garment that worked so well. I would not have known how to create those organic shapes and the garment we would have made if the sheets came out as intended would have been wildly different and probably not as interesting.

This is also where the procedural design comes into play and how it adds value to the project. We started with procedural design purely out of interest, as a sort of fresh start for the project. It was when we embraced the uncertainty of the bioplastic that working with procedural design software made sense as it too has a lot to do with embracing and working with uncertainty.

The way I look at it, procedural design, at least in the way we used it, is in itself a mediation between control and randomness in the same way we experienced with the bioplastic. The algorithm that you make in the process holds numerous parameters that you can tweak and control. Despite this apparent control, the output of the algorithm is partly random and always will be. The control even seems a bit of an illusion sometimes. I think there is real power in embracing this behavior and trying to work with it instead of against it. Like I said before, I don’t think we would have made a garment that worked as well as this one if the bioplastic had precisely done what we wanted. The material in this sense almost became a co-designer in the process that had the same, if not more, input as we had, the same goes for the procedural design.

We only realized this quality of uncertainty near the end of the project and consequently did not really explored it further. It would have been very interesting if we would have explored the ins and outs of embracing randomness to a deeper level. Now, we cannot draw any general conclusions about this finding which we maybe could have otherwise. Something to keep in mind for next time.

A way to find something like this earlier on in the process would be to take a bit more of a step back every once in a while and look at all the aspects of the project without prejudice and leaving the current goal and status of the project out of it.

In general, I have some mixed feelings about the project. The result was very good I think, but the process lacked behind in a lot of ways which makes me wonder what the final result would have been had the process gone better. I find it a bit of a bummer that I have this mixed feeling about the first project in my masters, but maybe that is part of the problem, high expectations. I am looking forward to the other projects in my masters and I will take the lessons, small and big with me for the next one.

APPENDIX 4 - FEEDBACK ABNORMAL

Mick Geerits from Abnormal provided us with insightful feedback, after the Demo Day and will further be discussed in the Discussion section.

The Coral team reached out to me with in interest in learning more about generative design. Throughout their project they've developed a fundamental understanding of how computer generated graphics and processes from the VFX industry can apply to design. They then explored the application of such procedural design processes to the production of a garment.

The juxtaposition of computationally generated organic geometry and the natural deformation of the bioplastics creates an interesting tension within the piece and raises the right questions on what it means for a designer to give up control over the exact end result through both physical and digital processes. At this current stage I have limited insight in the level of critical reflection from the team around this topic. In the meeting I had with the team there was still a big division in the project between these two elements, the organic materiality and the computational geometry. I think the final piece reflects this as still being an open question -- how can one meaningfully integrate these processes? Although it's perfectly valid for the project to be a speculative piece that debates this, I would have liked to have seen them posit a bold answer to this question.

Overall I think the project produced a striking visual piece and was a platform for the team to get a grip on what the cutting edge of procedural and generative design looks like

APPENDIX 5 - FINAL BIOPLASTIC RECIPE

Recipe for one sheet of bioplastic (70 l x 40 b x 0.5 h in cm)

Ingredients

Glycerine	27	g.
Water	600	ml.
Agar Agar	30	g.
Pigment	3	tsp. Graphite pigment (black) or

Organic toluide (red) are used to create Coral Top

Appliances
Pan (plus possibility to heat in kitchen, gas burner)
Spatula
Plexiglas frame (70 l x 40 b x 0.5 h in cm)
Bottom plate (to prevent spilling)

Method
1. Gather the necessary ingredients and appliances.
2. Combine all the weighted ingredients and stir together.
3. Heat on medium-low for approximately 15 minutes until a glazed structure appears
4. Pour the mixture onto a smooth surface (plexiglas frame of mentioned size).
5. Leave the bioplastic to harden for at least two days on a flat surface