GÖTEBORGS UNIVERSITET

HDK - VALAND
ACADEMY OF ART AND DESIGN

ENAMELLED STEEL

SHIFTING A MATERIAL FROM FUNCTIONALISM TO CONTEMPORARY SCULPTURE

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ABSTRACT

This exam project is about a material that developed with the rise of the industrial revolution, became almost obsolete in recent decades, and that I now use in the field of applied art, craft, and design.

Enamelled steel is a material mostly known for its use in domestic kitchenware and colourful road and advertising signs. A compound material, where a thin coat of glass gets fused onto a metallic base material.

Through extensive historical research, I learned about makers and scientists across 19th century Europe, who addressed public health issues, like lead-poisoning through improper cooking utensils. Their inventiveness and approach, to solve problems with scientific thoroughness and high-quality craft, informed and inspired me to develop my work further. This project and its physical artwork pay tribute to the early inventors and their experimental methods, as well as to the mass-production manufacturers later, who were able to distribute safe and affordable cooking utensils to the general public.

Slightly interrupted by the outbreak of a global pandemic, this project has a contemporary approach to craft, in combination with digital tools and modern manufacturing processes, but not losing sight of the value of carefully crafted, handmade work.

KEYWORDS

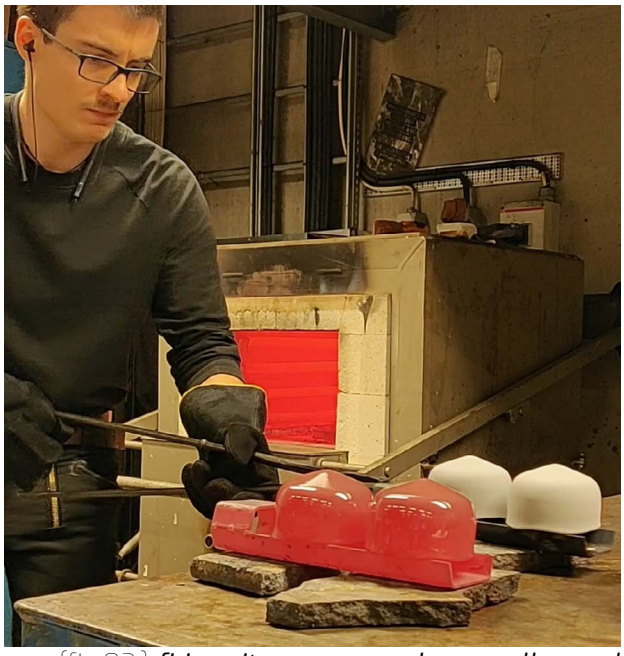
Enamelled Steel, Glass on Metal
Enamel, Emaille, Emalj
Enamelware, Kitchenware,
Householdware, Hollowware
Public health, Lead-poisoning
Industrial Revolution, Design, Functionalism
Gestaltung, Gestaltning
Contemporary Sculpture, Applied craft, Object art
CAD, CNC water-jet cutting, Augmented reality

TABLE OF CONTENT

1. BACKGROUND

Since one year the main material I work with is enamelled steel in the concept of vessel objects and sculpture.
Vitreous enamel is a glass coat fused onto a metallic base material, via application as powder or paste and firing around 800°C.
On copper and other precious metals, jewellery enamel is used since 3000 years and longer - but only since about 180 years it became possible to apply a stable, lead-free glass coat onto steel, as a surface protection layer. With the industrial revolution enamelled steel became widely used for all kinds of applications, and until the rise of stainless steel and plastic, it was the dominant material for kitchen and household ware.

(fig.01.) *Classic enamel kithenware* by **RIESS**, Austria



(fig.02.) *firing vitreous enamel on small vessel objects*

COLOUR

Throughout my craft career, as a trained blacksmith and metalworker, I was always ambivalent about the use of colour on metalwork. I was never a big fan of covering beautiful metal surfaces under plastic paint layers. With vitreous enamel I found a material suitable for high quality craft work. It is an equal counterpart to the steel and way more than just colouring metal.

(fig.03.) *Turquoise set N°1*, June 2019

FUNCTION

The material I work with, enamelled steel, carries that information of enamel kitchenware – and although I'm working within the context of vessels and containers, I try to separate my work from functional household objects. Either through their form or the partial or structured enamel coat.

One essential form feature is the cone base, which stuck to my work since I started experiments with deep-drawing sheet metal into vessel shapes.
I used the cone base as some kind of dogma "so I don't end up making flat bottom pots and pans". But I also played with the idea of function in the past, for example on older pieces like Turquoise set N°1, where I used spouts to have more variation in form as well as breaking the symmetry of the cylindrical shapes.

Enamelled steel, sometimes also called industrial enamel, is a nowadays mostly outdated material that was very present in everyday life of previous generations, either at home as all kinds of household ware or outdoors as coloured road and shop signs.

What I find interesting and exciting is the distortion from a smooth and stable protection layer to an expressive surface suitable for artistic work. Here we can draw a parallel to glazing and the field of ceramic art, where this shift already happened several decades ago, as seen on "orange crackle ware vase" by **Doyle Lane**. The African-American ceramist not only made pots and vases, but also large scale clay paintings and mosaics.

(fig.04.) **Doyle Lane**, *orange crackle ware vase*, ca. 1950

Vitreous enamel in modern and contemporary art is mostly found in the fields of jewellery and two dimensional enamel painting.

A contemporary artist working three dimensionally with enamelled steel is **Helen Carnac** from the UK. In her work Each Other she is using the enamel surface of the steel bowls to draw repetitive patterns by hand. By scratching and marking the enamel before firing she creates flaws in the coating of the steel, which she then exposes to natural oxidisation.

(fig.05.) **Helen Carnac**, *Each Other*

(fig.06.) **Myra Mimlitsch-Gray,** *Red and White Pitscher*, 2014

Another contemporary artist is the US metalsmith **Myra Mimlitsch-Gray**. In her series Studies in enamelware, she is exploring themes of utilitarian value and referencing traditional enamelware forms like the typical rolled lip.

> *"...it's sort of like a forced commonality that I'm interested in bringing to the work. So we see that I'm not that motivated by the preciousness conversation right now."*
>
> (*Interview transcript*, Archives of American Art)

(fig.07.) **Myra Mimlitsch-Gray,** *Patched Vessels*, 2010-2014

DO WHAT CERAMICS CAN'T DO

In both worlds, glazing ceramics and enamelling steel, there is one overall restricting parameter when it comes to size: the firing kiln.

I enjoy working on smaller vessel objects for experimentation, both in form and enamel surface. But there is always this very obvious connection to ceramics, so at some point I asked myself the question what can steel what ceramics can't.
The most obvious advantage of steel is probably that it is relatively easy to build bigger structures that are thin-walled, as well as rigid and shock-resistant. With forward-looking planning it is possible to build transparent constructions from individual parts that could even be taken apart when needed.

During the last semester and especially with my latest pieces, I tried to move further away from functionality as well as use my materials very own properties. After making Sonderling, a double layered vessel held together by an inner construction, I wanted to take a step towards bigger and more sculptural objects.

(fig.08.) *Sonderling*, Oct. 2019

(fig.09.) *Sonderling*, detail, Oct. 2019

(fig.10.) *Ignoramus Alpha*, Jan. 2020

Ignoramus Alpha is a sculptural vessel object intruding the space by resting seemingly accidental on its cone base.
Its name indicates that we hardly know anything about it, except that it might be the first or the main part of several unknown objects.
It consists of fabricated steel which outer surface is coated with randomly structured vitreous enamel.

2. PURPOSE

With this exam project I want to raise the relevance of the material enamelled steel in the field of contemporary object and sculptural art, as well as blur the lines of art, craft and design.

During the project I want to learn more about the materials history and further explore the possibilities of fusing vitreous enamel on steel, by applying it in the environment of vessel objects and sculpture.

A parallel focus is the investigation into sculptural form and structure, and its effect on the human body and perception, as well as on the surrounding space.

3. OBJECTIVE

My goal is to create sculptural objects, which celebrate the nowadays mostly outdated material enamelled steel but also shift it from functionalism to contemporary sculpture.

The outcome should show an uncertainty of classification, in terms of the always discussed categorization and thereby division of art, design and craft. So to say be a materialisation of my identity as a metal gestalter.

> *The German term Gestaltung (or Swedish Gestaltning) stands for a creative process, where through the work of the Gestalter, something gets changed. This can be a physical object, a process, a situation or an idea.*

4. QUESTION FORMULATION

- How can I raise the relevance of enamelled steel in the field of applied art, craft and design?
- How could a deeper focus on the history of enamelling metals as well as contemporary use influence my process and outcome?
- Where are the interferences in my work, regarding art, design and craft? And how can I use them to merge these categories to one *gestalt*?

gestalt | gəˈʃtɑːlt | noun (plural gestalten, gestalts)

Psychology: An organized whole that is perceived as more than the sum of its parts.

Origin: 1920s from German Gestalt. Literally 'form, shape'

(lexico.com)

5. APPROACH

I will approach the exam project by working simultaneously on three paths: research, sketching and experimentation. Sketching and experimentation will lead into a manufacturing period of one or more final pieces.

My research will focus on historic jewellery enamel work and industrial enamel products and applications, as well as contemporary artists working with the material.

My sketch process will mostly happen directly in CAD, because of the size and complexity of my current work, but also to easily outsource manufacturing steps to the local CNC water jet cutting company. This will save time during the project but also opens new possibilities in terms of precision and complexity.

(fig.11.) **Gareth Neal,** *SiO_2*, sand, 2019

When it comes to implementing digital manufacturing techniques to craft I want to reference the London furniture maker **Gareth Neal**. With his latest vessel series SIO2 , which he 3D-printed from sand, he is testing the limits of craft and design.

> *Gareth believes the machine to be an extension of the human hand, and that the eradication of the chisel does not deduct from the craftsmanship deeply rooted within every stage of the production of these vessels.*
>
> (garethneal.co.uk, 2019)

The experimental part of my exam project will mainly be more investigations into application and manipulation of the vitreous enamel coating.

6. RESULT OF PROCESS

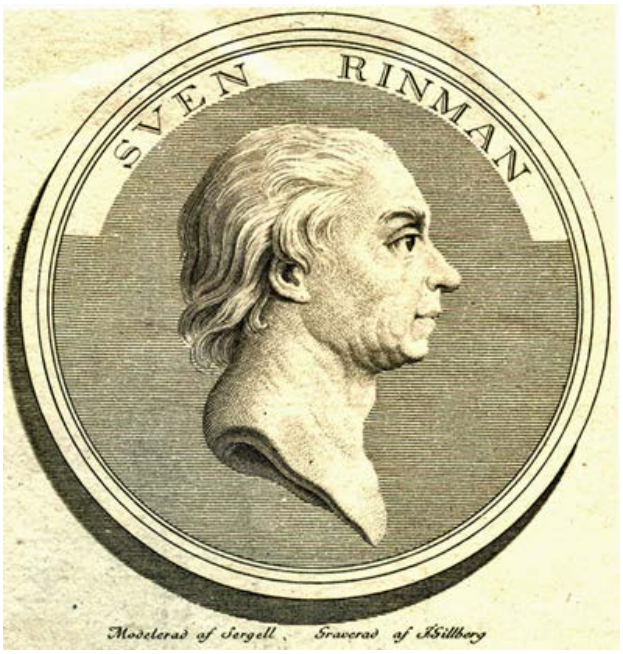
6.1 HISTORICAL RESEARCH

I'm focusing my historical research on the emergence of enamelware in Europe, during the end of the 18th century, and its rise throughout the 19th century with the industrial revolution. I tried to be as accurate as possible, but I'm not a historian, so the following isn't claiming to be exhaustive. Instead, I want to create a picture of personalities whose actions I find inspiring. The focus should lie on doctors addressing public health issues and craftspeople developing their products not only because of personal economic reasons, but also to improve the lives of others. Also about scientists and inventors sharing their knowledge in a manner that we today may call *open source*.
Of course the story of enamelware also involves legal disputes over patents and even hateful accusations about imported ware from other nations, but that's not what I'm after.

In the year 1779, the *Société libre d'Emulation* in Paris proposed an award of 900 livre for the inventor who *"discovers a composition fit for making kitchen utensils which should be free from the disadvantages attending copper, lead, tinned vessels, glazed earthen-ware, etc."* This French society of cultural elites was searching for a material *"which should be as strong as possible; less costly than the vessels used at present; and which should be able to bear the highest degree of kitchen fire, and the most sudden changes from heat to cold."* (Rinman, 1795)

The Swedish chemist and mineralogist **Sven Rinman** published a paper around 1795, titled "Experiments on the Means of improving the Vessels used in Cooking". Rinman points out that the use of improper material not only can affect taste and colour of the food cooked with them, but also be seriously harmful to the health of the consumer, and therefore should be carefully thought after. Beyond that he wants vessels to be durable as well as cheap, or in his words *"capable of being sold at a prize that all ranks of people can afford to pay"*.

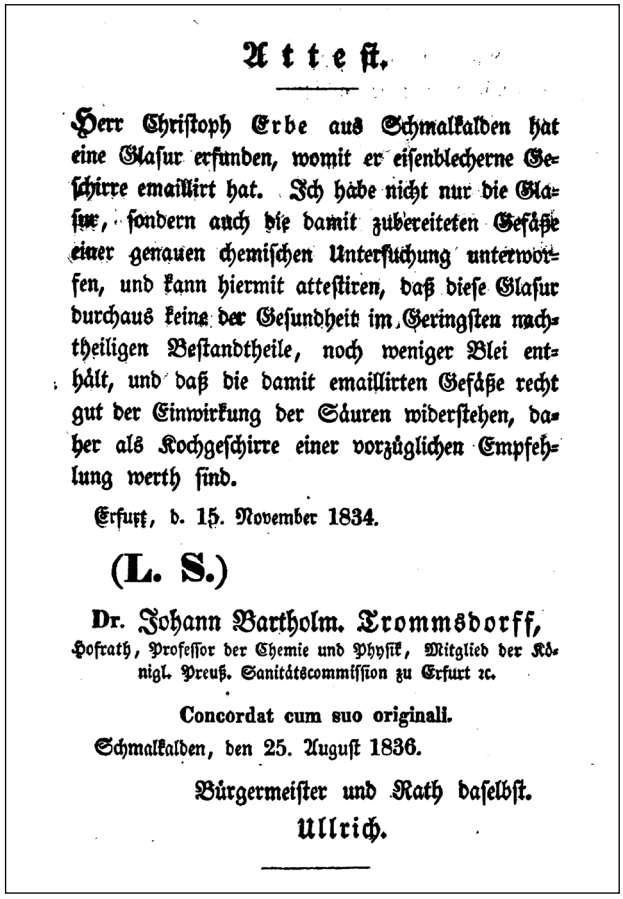
On the proposal of the French society of emulation, he commented that it requires too many conditions to be answered satisfactorily, and that he hasn't any intention of winning the award. In his opinion the solution may not lie in a totally new material but in the further development or combination of the already used materials in kitchenware: stone, glass, earth or metal.
In the paper, addressed to his colleagues of the Royal Academy of Stockholm, Sven Rinman mentions the art of enamelled jewellery and further describes several experiments where he coats small vessels of copper and hammered iron with enamel. He hoped to contribute something to reach the common goal, or at least "engage some more experienced philosophers to carry this useful subject to its great perfection".



(fig.12.) *Portrait of* **Sven Rinman**
copperplate engraving by J. Gillberg

Around forty years later, a German called **Christoph Erbe** wrote about household ware, made from cast or forged iron and coated with enamel, that got sold as "health-ware" (German: "Gesundheitsgeschirre"). But in his opinion not every enamelled piece deserved that title, because many of them might contain lead that could dissolve into the food and therefor seriously affect the consumer's health.

With the publication of a manual and recipe for a lead-free and affordable enamel coating process, Christoph Erbe directly addressed manufacturers that used lead, and even kept a secret around their formula. To reassure the safety of his own enamel, the publication includes a certificate of a member of the royal Prussian sanitary committee, who chemically tested his "glaze" and the vessels he applied it on.



Attest.

Herr Christoph Erbe aus Schmalkalden hat eine Glasur erfunden, womit er eisenblecherne Geschirre emaillirt hat. Ich habe nicht nur die Glasur, sondern auch die damit zubereiteten Gefäße einer genauen chemischen Untersuchung unterworfen, und kann hiermit attestiren, daß diese Glasur durchaus keine der Gesundheit im Geringsten nachtheiligen Bestandtheile, noch weniger Blei enthält, und daß die damit emaillirten Gefäße recht gut der Einwirkung der Säuren widerstehen, daher als Kochgeschirre einer vorzüglichen Empfehlung werth sind.

Erfurt, d. 15. November 1834.

(L. S.)

Dr. Johann Bartholm. Trommsdorff,
Hofrath, Professor der Chemie und Physik, Mitglied der Königl. Preuß. Sanitätscommission zu Erfurt ꝛc.

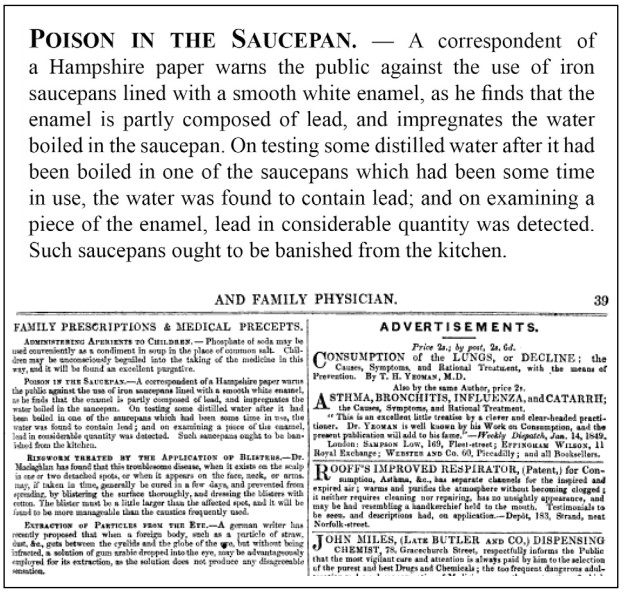
Concordat cum suo originali.
Schmalkalden, den 25. August 1836.

Bürgermeister und Rath daselbst.
Ullrich.

(fig.13.) Safety certificate; **Christoph Erbe**, *"Gründliche Anweisung zum Emaillieren und Verzinnen der gegossenen und geschlagenen Kochgeschirre"*, Thuringia 1837

With the headline "Mors est in olla" (Latin; *death is in the pot*) a Professor for chemistry called **Adolf Pleischl**, warned the public about the dangers of lead-containing tin and copperware in the Viennese newspaper "Wiener Zeitung" in 1845. (Wiskoczill, 1854)
Three years later, he published an extensive scientific study, titled „About lead-glaze used on common pottery and its harmful impact on the human organism".
Pleischl described toxication reports that were connected with lead-glazed pottery, as well as inspections together with market authorities. One of them came to the conclusion that only 10 out of 52 chemically tested vessels were lead-free. He continued with reasons why lead-glazes are so common in pottery, and the problems that can occur while firing. Pleischl further described all kinds of chemical experiments he performed, to prove that the lead oxides in the glaze can dissolve into the food. Because critics were arguing that the used acids and the laboratory conditions aren't reflecting a real household situation, he repeated all experiments with common acidic foods like pickled vegetables, curdled milk, sauerkraut and fruits. In his publication, he also criticised the situation that the poor are most likely to suffer from lead-poisoning because of the combination of cheap low-quality ware and their diet.
But Adolf Pleischl wasn't only addressing lead-poisoning and the threat to public health, he later also developed his own lead-free enamel coating for metals and established a factory to produce enamelware that equipped kitchens of public institutions, like hospitals and prisons, throughout the Austrian-Hungarian empire.

Also in London, lead-poisoning through kitchenware was an issue, as the bulletin "Poison in the Saucepan" shows, which was published in *The People's Medical Journal* from 1850.



POISON IN THE SAUCEPAN. — A correspondent of a Hampshire paper warns the public against the use of iron saucepans lined with a smooth white enamel, as he finds that the enamel is partly composed of lead, and impregnates the water boiled in the saucepan. On testing some distilled water after it had been boiled in one of the saucepans which had been some time in use, the water was found to contain lead; and on examining a piece of the enamel, lead in considerable quantity was detected. Such saucepans ought to be banished from the kitchen.

AND FAMILY PHYSICIAN. 39

FAMILY PRESCRIPTIONS & MEDICAL PRECEPTS.

ADVERTISEMENTS.

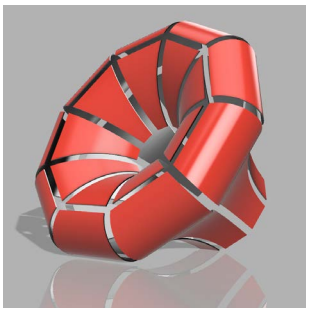
(fig.14.) *The Peoples Medical Journal*, **Thomas Harrison Yeoman,** London 1850

In the *Journal of the Franklin Institute of the State of Pennsylvania* (John F. Frazer, 1852), a Dr. Kennedy is mentioning French enamelware, that was elaborately ornamented, and also "that the business of enamelling iron was fast assuming importance on the continent". Kennedy continues that signs made of enamelled iron are frequently seen on European railroads and corners of streets, "perfectly indestructible by ordinary wear and tear".

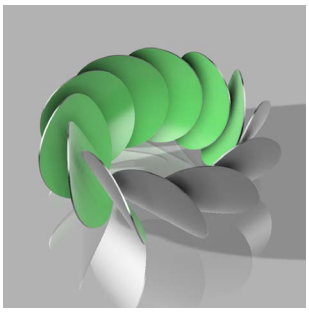
Interesting enough, this was the earliest source I could find, that meantions the use of enamelled iron not only for household ware, but also for signs.

6.1 SKETCH PROCESS

When I started my sketch process in CAD, I quickly discovered boundaries I wanted to work within, but also some I had to stick to. Because it was clear for me that I wanted to continue working with enamelled sheet metal, I always started with constructing flat sheet parts that I then bent, either more or less sharp, or with a curve over the whole part. This one rather simple sheet part got then positioned and multiplied around a centre axis as a circular pattern, to create some sort of korpus, or vessel shape with an inside and outside. To get rather quick sketch results and to get out several ideas, I decided to leave out any logic or thoughts on connections for that moment, so the single parts in my early sketches are just floating in space.



(fig.15.)



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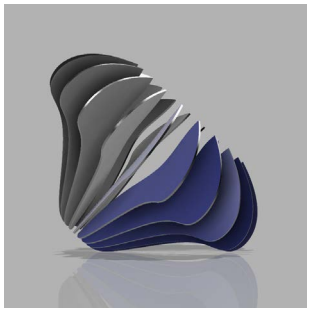

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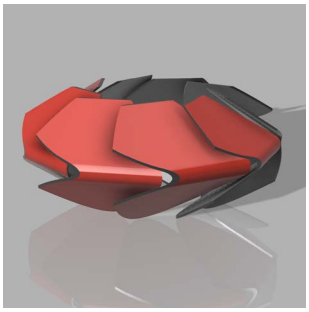
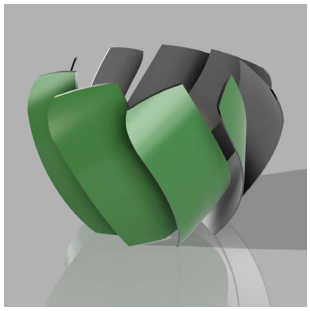
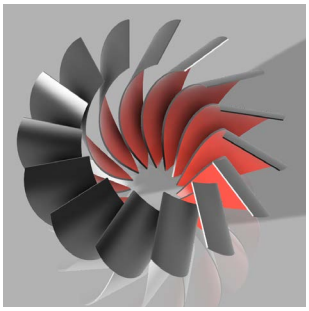


(fig.18.)

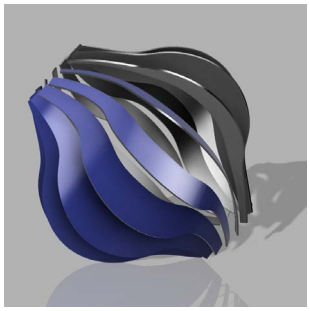
To get started I made a sketch where I took a form of a smaller deep drawing experiment and built it up like my latest big piece "Ignoramus Alpha" (fig. 15). In further sketches I continued by trying to twist the parts, in relation to the centre, to play with overlaps and layer effects. In combination with a one sided enamel coating, which I just quickly simulated by applying a plain colour to some faces, I got some interesting results where the single parts lighten the transition between inside and outside. These forms also appear to be more transparent, and not so much voluminous.



(fig.19.)



(fig.20.)

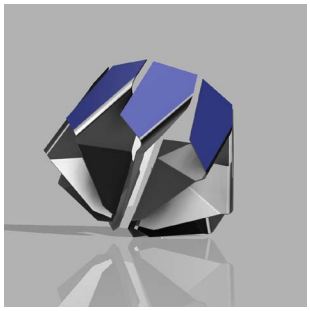


(fig.21.)

(fig.22.)

But I was ambivalent about the ones I found most interesting, because they also reminded me very much of turbines, of technical rotating parts that deal with moving liquids or gases. (fig. 19, 20, 21)

To find a balance between volume and transparency, I continued with sketches where I tried to construct the parts, in a way, that they twist from a flat outside surface layer into an inner "turbine" (fig. 23). But I wasn't too satisfied with it, so I took a break from CAD sketching, and switched to hand colouring print outs from the CAD sketches. There I basically tried to break up the unrealistic and sterile perfectness of the digital objects, and in a way gave them a more organic feel, like a structured enamel coat would do. (fig. 24)



(fig.23.)

(fig.24.)

VOLUME

I would describe a voluminous form in general as a body, where an inside is pressing against the more or less flexible shell. The keyword here is surface tension. The inside matter can be gaseous, like in a hot-air balloon, liquid, like in a single drop of water, or more solid like a bag of coffee beans.

But for vessels the surface tension appears to be somehow frozen in time. The hollow emptiness is not actually stretching the solid and inflexible shell, but there is still a strong interplay of pressure between the in- and outside.
In many cases, throughout all crafts that deal with vessels, this interplay of pressure petrified in the form, derives from the making process. Blown air that pushes the hot glass into a mould, hands that form the clay on a wheel, or hand or machine tools that form and press flat metal sheet into voluminous shapes.

(fig.25.) **Jokinen Konu,** *multi*, glass blowing mold, 2019

(fig.26.) **Florian Gadsby,** *making a bowl on the potter's wheel*, 2020

(fig.27.) **Adi Toch,** *working on silver piece*, 2019

Just before this exam project I worked on a series of smaller vessels that emerged from my ongoing tool making experiments I use for deep drawing. The pieces within this body of work, called "Bodenlose Frechheit", consist all of two joined halves. While the bottom halves are all the same, the form of the top varies on all pieces.

But for me, the most interesting form in this series is the one that is simply mirrored, where top and bottom are the same. With its narrow openings, and its wide circumference this seems to be the most voluminous form I created so far. Even though it's fabricated from two halves, one can still feel the interplay of pressure between tooling from the in- and outside.

(fig.28.) *"Bodenlose Frechheit"*, Feb. 2020

TRANSPARENCY

With metalwork, the only way of creating transparency to a certain degree is through the use of gaps and negative space in the construction. In that sense transparency is not a material quality, like it is for glass, liquids or gases, but a form quality.

Here I would like to compare the work of two artists who both work with vessels that are at the same time voluminous and transparent.

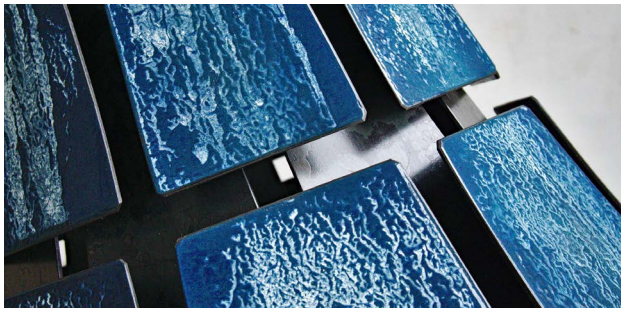
The Japanese sculptor and glass artist Ōki Izumi uses her materials transparent quality to create mysterious architectural shapes and vases. Instead of using precious clear crystal and bright colours with classic glass art techniques, like hot blowing and kiln forming, she builds her work up from layers of industrial glass.

(fig.29.) **Ōki Izumi**, *Air vase,* 2014

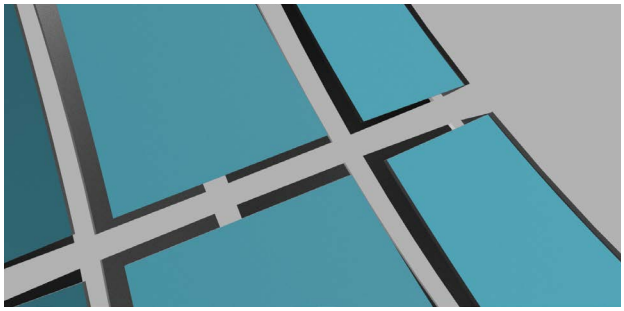
(fig.30.) **Kim Cridler**, *Jar with Oak*, 2016

A more traditional approach to craft is seen in the work of US metalsmith Kim Cridler. By using relatively thin wire for her work, she is able to create vessels from metal that show both form qualities: volume and transparency.
But when compared to my work, they are lacking bigger material surfaces, something that is vital for my enamelled steel pieces.

Looking back at my latest and first bigger piece made from several enamelled parts, "Ignoramus Alpha", I really enjoy the light and shadow play within the gaps and between the outer panels and the inner construction. But due to the fact that the inner construction is mostly made from big panels, like the outer shell, it is blocking most of the gaps. Looking at the CAD model without the inner construction, the piece would be much more transparent.



(fig.31.) *Ignoramus Alpha,* detail, Jan. 2020



(fig.32.) *CAD model, without inner construction,* Nov. 2019

Although there are enamels that are transparent in itself, this significant material quality of glass is lost, when fused to a base metal. What remains are reflective qualities, especially interesting when the enamel surface has some sort of structure, or when several surfaces are positioned at an angle to each other.

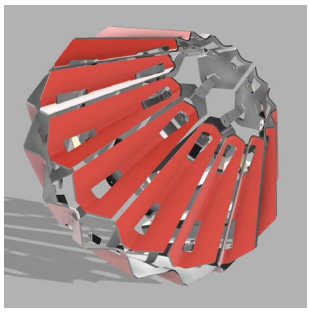
So back to my sketch process I wanted to basically find a balance between three things: volume, transparency and actual surface for enamel application.

CONSTRUCTION

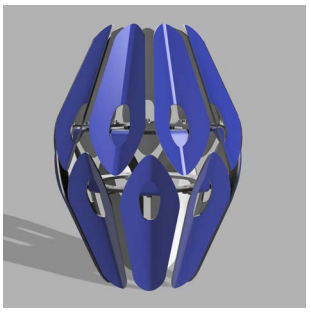
Up until this point the physical scale of my sketches didn't really matter to me, because I left it open if I'm going to make one bigger piece (around the size of "Ignoramus Alpha") or several smaller ones. But around week 11 I started to tend towards the idea of several smaller objects. So I sketched more with scale in mind, and focused on medium sized vessel objects (diameter 600mm; fig. 33) and smaller ones (diameter 300-400mm; fig. 34, 35).

The simplicity of the voluminous mirrored vessel, from the "Bodenlose Frechheit" series, became more and more appealing to me. Therefore I started to build up cone shapes from panels that could become whole voluminous objects with a simple mirroring command.

I gave the panels an angled bend lengthwise, to enhance the direction and division of the form, but also to make use of reflective effects of the later enamelled surfaces. Giving the two mirrored halves the right twist to each other, enabled the panels to interlace, what resulted in a more cohesive appearance. (fig. 34)



(fig.33.)



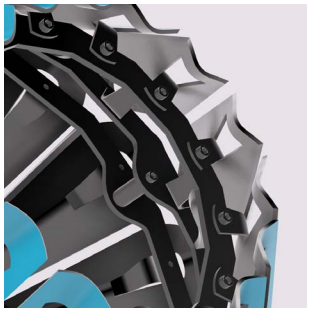
(fig.34.)

Another aspect I really enjoy about these forms is their possibility to exist in two different stages. On the one hand they can stand upright, in this steady, more classic position.
On the other hand they can also lie on their side, in this leaning, tumbled down position, similar to all my previous work with cone bases.

To achieve more transparency in my work, I decided that the inner construction of my pieces should be more like a skeleton. It shouldn't block the gaps between the outer panels too much as a second shell construction might do. I made a sketch with two layers of panels (fig. 35), but then decided against it because it felt to overloaded.

In my practice I want to use the full potential of the materials and techniques I have available. Because I decided very early in this project that I want to outsource operations to the local water-jet cutting company, I didn't want to just get simple parts cut, that I also could do by myself.

(fig.35.)



(fig.36.)

One great advantage is the possibility of rather complex inside cuts. This possibility gave me the idea to make the connection between the panels and the inner construction via "attachment ears" that form directly out of the panel's surface. This feature also increases the piece's transparency, while obtaining the overall completeness of the form.

With this decision made, to make the connections so visible and present, transparency became also a methodical quality, of not trying to hide anything and being totally honest about how the piece is constructed. Based on this idea I decided to use cylinder head screws, to attach the panels to the inner construction, which subsequently became an ornamental feature as well as a technical. (fig. 36)
Because of their circular layout, they are easily associated with rivets, like on a steam engine, which connects well with my historical research and the rise of the industrial revolution.

In the end I concretized a bigger piece based on a 15 sided polygon (fig. 37), and a smaller one based on a 9 sided polygon (fig. 38).
The construction and their panels' sizes and forms are similar, what makes the pieces related to each other, although their circumferences and angles are very different.

While the panels will be made from 3mm thick mild steel, I planned the inner construction to be made from 6mm thick parts. This is to give the skeleton enough stability, but also to have enough thickness to tap M6 threaded holes into it, for attaching the panels.

(fig.37.) *based on 15 sided polygon*

(fig.38.) *based on 9 sided polygon*

After preparing the .dxf files for the panels and all the different parts of the inner construction, I placed an order for water-jet cutting one set of parts for the bigger piece, and two sets of parts for the smaller one.

NOTHING IS AS IT WAS

In March 2020 the Covid-19 pandemic reached Europe. Four weeks into this exam project, the University of Gothenburg switched to remote studies and all students of HDK-Valand lost access to workshops and facilities, to help contain the spread of the coronavirus. Hopes that this might be sat out in a week or two were quickly abandoned, when governments around the world were closing borders and imposing lockdowns.

The advice for exam students was to continue their projects as good as possible in a theoretical and digital way from home. The exam presentation, which usually takes place at Steneby's Konsthallen in front of an audience will be held via video conference, and the date got moved two weeks back to give everyone more time to adapt to this new situation. The exam show in Gothenburg got cancelled, an online platform might happen instead.

Accompanied by this massive collective uncertainty I moved my desk working space from the workshop to my bedroom. In the beginning it didn't affect this project to much. I was still busy getting the CAD models ready, and after placing the order I continued with historical research and writing this report.

According to my time plan I should have also started with enamel sampling and experiments, while waiting for the water-jet cut parts to be manufactured.

AUGMENTED REALITY

With exhibitions, events and art fairs cancelled, and museums and galleries all over the world closed, the art world is now even more dependent on technology, digital tools and social media.
During the world wide covid-19 pandemic one could monitor an increase of online exhibitions, live studio tours, Q & A's and other online art events and possibilities.

In early April 2020, the New York City based artist and designer **Sebastian Errazuriz** launched an online tool for augmented reality exhibitions. On this platform, **ALLworld.io**, everyone can self-publish their own work as AR.

VR (virtual reality) describes the state were you are fully immersed into a digital world, while blending out your real surroundings. AR (augmented reality), on the contrary, equips and extends your real surroundings with digital features, with the help of your mobile device.

(fig.39.) *experiencing my CAD model via AR in the surroundings of Dals Långed*

This initiative of providing a free tool to help artists set foot in this new technology sparked my interest, and with CAD models of my work ready and no workshop access, I decided to give it a go.
Because everything is still in its infancy, it took me about two days to get something to work.

Though I still had problems with the right scale - my AR model appears way oversized - I would call it a success.

For the sake of completeness I will describe the path that worked for me, to get from my CAD design to a decent functioning AR experience. Hopefully this technology will develop quickly and become more user-friendly.

> *For my general CAD modelling I use the free program* **Fusion360**. *Because my object consists of many individual pieces, I started by joining them to one contiguous body that I then exported as a* **.stl** *file. This simplified the 3D model, which basically consists of triangles describing the surface, I then imported into* **Blender**, *an open source 3D animation program. From Blender it is possible to export a* **.glb** *file, which is the AR standard for* **Android** *devices. For* **iOS** *devices it is necessary to have an* **.usdz** *file. I got this by first exporting a* **.fbx** *file from* **Blender**, *which I then converted via an online converter, called* **scapic.com**, *to an* **.usdz** *file.*

Because of the importance of materiality in my work, I don't think it would make sense to focus more on faking materiality during the stage of sketching and constructing. For my practice, AR could be a useful tool to visualize sketches for site specific work, or to give a client a better understanding of scale and proportions of models.

An application for AR dealing with already finished work, could be the reverse way: scanning and taking the finished crafted object or product back into AR. This AR model could then easily be used in addition to the normal photos of the piece, in a portfolio or online shop, to address curators and customers.

Experience my AR model, placed in your surroundings through your phone or tablet, directly via this link:

http://allworld.io/WEqCil04nsuLb6RNoizy

6.3 MANUFACTURING PROCESS

After 26 days without workshop access, we exam students got the possibility to use some of the University facilities to continue our exam projects and finish our education. This now happens in strictly separated and scheduled groups and with improved hygienic rules, to help contain the spread of covid-19.

Although my order for the water-jet cut parts was also a little delayed due to the pandemic situation, I'm extremely lucky that the workshop shutdown fit almost perfectly into my projects schedule. The day after we could continue our projects in the workshop, I was able to pick up my order at the local fabrication shop.

With now 50% workshop access I tried to plan my work days as good as possible, to use the time as clever as possible. Again luckily, my project at that stage was ideal for doing that. The whole construction of the pieces was already planned in CAD, the water-jet cut parts were perfectly precise, so it was great fun to quickly build up and see things come together, after weeks sitting at the desk.

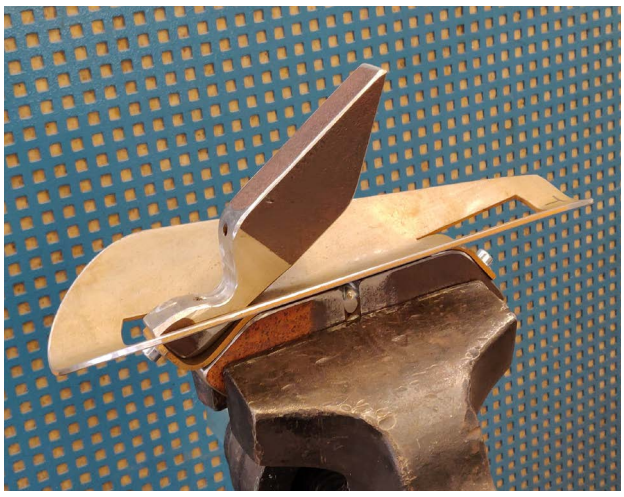
I decided to focus first on the bigger piece, and put the two smaller ones aside, to make sure that I can finish at least one piece that could also stand alone for this project. During projects in general, and especially when working on a single piece for a longer time, I often give my pieces working titles to identify them when in conversation with friends and colleagues, but also to name files and organize sketches and notes. These working titles are sometimes based on specific features of the piece, but sometimes also on funny associations like in the case of the bigger piece: working title "coffee filter death star", short CFDS.

In the first two days I was able to build up the whole inner construction of CFDS. This included grinding all sharp edges of 31 parts, drilling and tapping 70 threaded holes, as well as mill 10 special features.

Before welding, I fired all the parts of the inner construction in the electric kiln, like I would fire enamelled parts, to match up the oxidation colour and scale pattern of inner construction and outer panels.

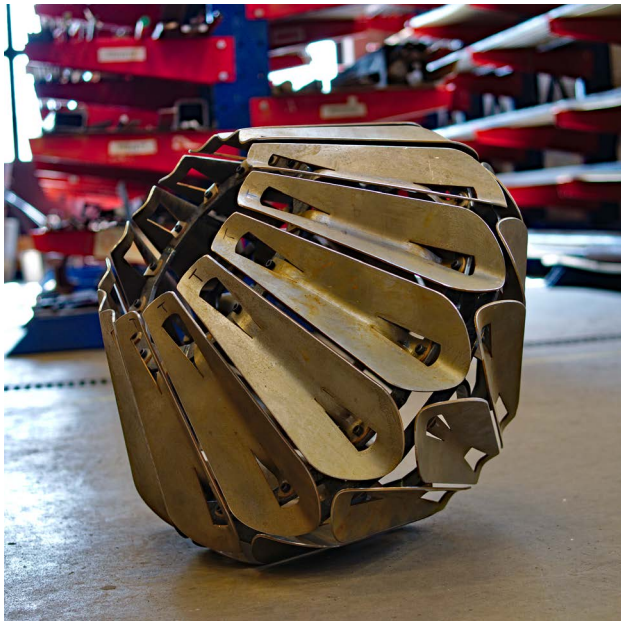
(fig.40.) *inner construction of CFDS with panel before and after bending*

It took me another two days to figure out how, and to actually bend all 30 panels. For the main longitudinal bend I was able to use a tool I made for "Ignoramus Alpha", which allows to make angled bends on the press-brake with a bigger radius than usual. The trickier part was the three small bends that form the "attachment ears". For these I had to build a special bending jig to repeatedly bend accurate angles at the right position.



(fig.41.) *special jig to bend the attachment ears*

It was a great moment to dry assemble the whole piece, after only four days in the workshop. After seeing it so long in CAD and playing around with it in AR, it confirmed for me the significance of making and experiencing the real thing.

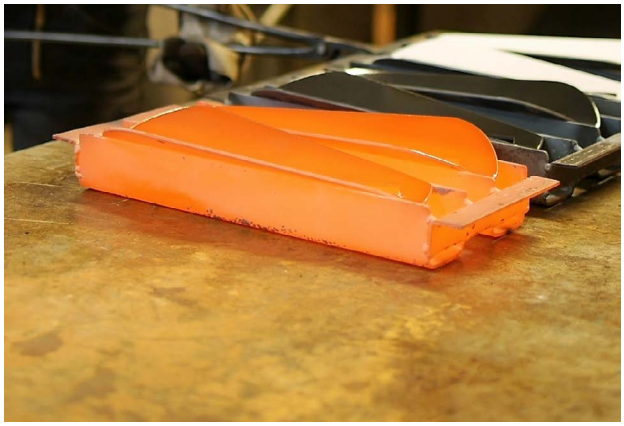


(fig.42.) *CFDS, dry assembled*

ENAMELLING

Since finalizing the sketches of the pieces, I thought of possible colours and structures for the enamel coating. Because the big piece always felt like the main object of this project and the two smaller ones more like an additional pair, I felt like white enamel would be the right choice. The possibility that I might only manage to finish the bigger one, confirmed my tendency towards the use of white. Also the historical research of this project is informing this piece a lot, and most early enamelware was black, grey and white.

Before the enamel sampling process I quickly built firing trays, which can hold two panels each, or several sample pieces. These make loading and unloading the kiln quickly and safe, and prevent that I damage the enamel coat or bend the hot glowing parts when handling them with tongs.
I also use a simple foot pedal to open the kiln door, so I have both hands to hold the tongs, and loose less heat.



(fig.43.) *firing the ground coat onto the panels*

Since I started working with enamel over a year ago, I'm using products from WG Ball, an English enamel manufacturer. The enamel gets delivered as powder that I mix with water to a paste. Unlike jewellery enamel that can be fired directly onto non-ferrous metals, industrial enamel needs a special ground coat to fuse onto the base material steel. Compared to the coloured top coats, this dark grey ground coat contains cobalt- and nickel-oxides, so it can adhere to steel.

To have a better understanding on how the enamelled surface will perform on the piece itself, I prepared test pieces with the same bend as the panels. Because I knew that I want a solid ground coat on all panels, no matter what kind of structure I'll apply later, I worked parallel on experimenting on samples and applying and firing the ground coat on all thirty panels.

(fig.44.) *flat and bent sample pieces*

While I applied a solid ground coat with the spray gun onto samples as well as panels, I took different approaches with the white top coat. I experimented with applying the enamel in different ways, like with brushes, spatulas or dusting on the powder. But I also tried to manipulate sprayed on coats, with different tools or water.

Where the white enamel coat gets thin, or even removed, the dark ground coat comes through. But I also made experiments where I applied black enamel on top of a fired as well as unfired white coat. Contaminating the paste is something I also tried, with things like steel wool, rust and grinding dust. But also with organic things that burn out during firing, like wood shavings and coffee powder.

(fig.45.) *flat and bent sample pieces*

This is a very playful experimental process, where one result leads to the next idea very quickly and intuitive. Unlike applying the ground coat to all 30 panels, which is very repetitive. First all holes need to be taped shut, to keep the attachment ears free from enamel. After spraying on and letting the enamel paste dry, the masking tape gets removed and all edges cleaned from enamel carefully. The inside edges with a brush and the outside edges with a piece of cloth. This is necessary because when an enamel coat melts over a sharp edge, it is very likely that it chips off as a sharp shard. This can happen directly after firing, when the piece cools down, but also even days or weeks after.

(fig.46.) *removing the excess enamel from the edge*

Whenever dealing with enamel powder, spraying the paste or manipulating dried coats, it is necessary to wear the appropriate protective equipment. Gloves prevent the skin from drying-out, and a respirator hinders fine enamel dust from entering airways and lung.

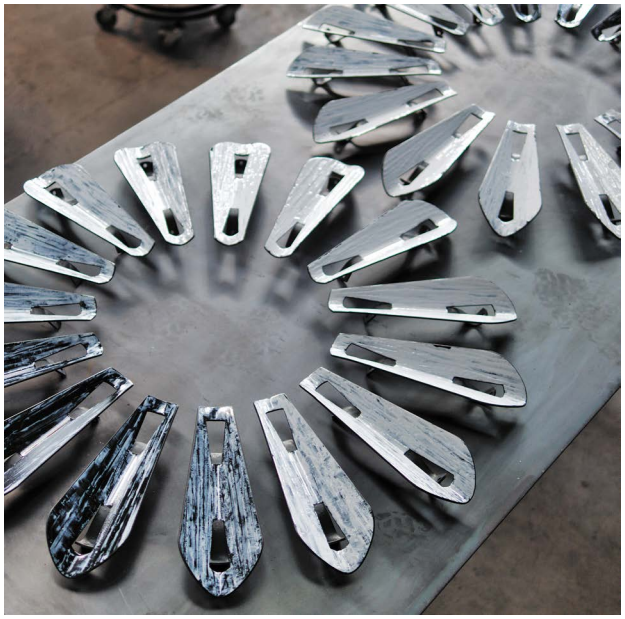
Since I started working bigger with enamelled steel, I had the idea of implementing a gradient within the enamel coating. Either from one colour to another or in the density of a structure.
The current piece CFDS is ideal to try this out, because it has so many panels around its circumference, which means that the gradient can be in steps from panel to panel. Getting a smooth gradient within one surface, and having it match up with the neighbouring ones would be way more difficult.

I took my favourite sample piece from the day before and made two more test pieces, to see if I can achieve a gradient using the amount of white enamel, while keeping the surface structure interesting.

(fig.47.) *favourite sample in the middle, with gradient tests left and right*

To have a better overview and to keep track of the gradient on CFDS, I laid out all thirty panels in two circles as they would come together on the piece. As on my chosen samples, I applied the white enamel paste by hand with a spatula, creating a heavy structure that is oriented lengthwise on the panels.

By making one by one, I was able to find the right spot for each panel in the gradient circle, and quickly learned how to apply the right amount of enamel paste to achieve a certain step.
After the paste dried on all thirty panels, I could clean all edges from excess enamel and fire them in pairs at 820°C for six minutes.



(fig.48.) *finished panels laid out in gradient circles, ready for final assembly*

I never completely cover pieces with enamel, always partially, with steel surfaces exposed. During firing, when heated above 800°C, these exposed metal surfaces oxidise, and develop a matt black scale in a random flaky pattern. I cleaned up the individual pieces by removing the loose scale particles with a wire brush and used fine steel wool on the edges next to the enamel, so I don't damage and scratch the shiny glass surfaces.

On bigger pieces like that, I use Owatrol as a finish for the steel surfaces, a commonly used rust protection oil based on linseed oil. I apply it generously with a brush, let it sit for some minutes, and then wipe off the excess with a piece of cloth. When the oil is halfway dry, I rub the enamel surfaces clean with spirit, to remove any oil that might have gotten on there before.

After ten long days in the workshop, spread out over two and a half weeks, I was able to assembly and finish the main piece of physical work for this project. Relieved to have a finished piece of work to back up this project during these weird times, and that everything went so well, I was now able to use my workshop days to continue on the smaller pieces with a way more relaxed working attitude.

(fig.49.) *the finished piece (back) and a dry assemblied smaller one*

Making of video "Mors est in olla"

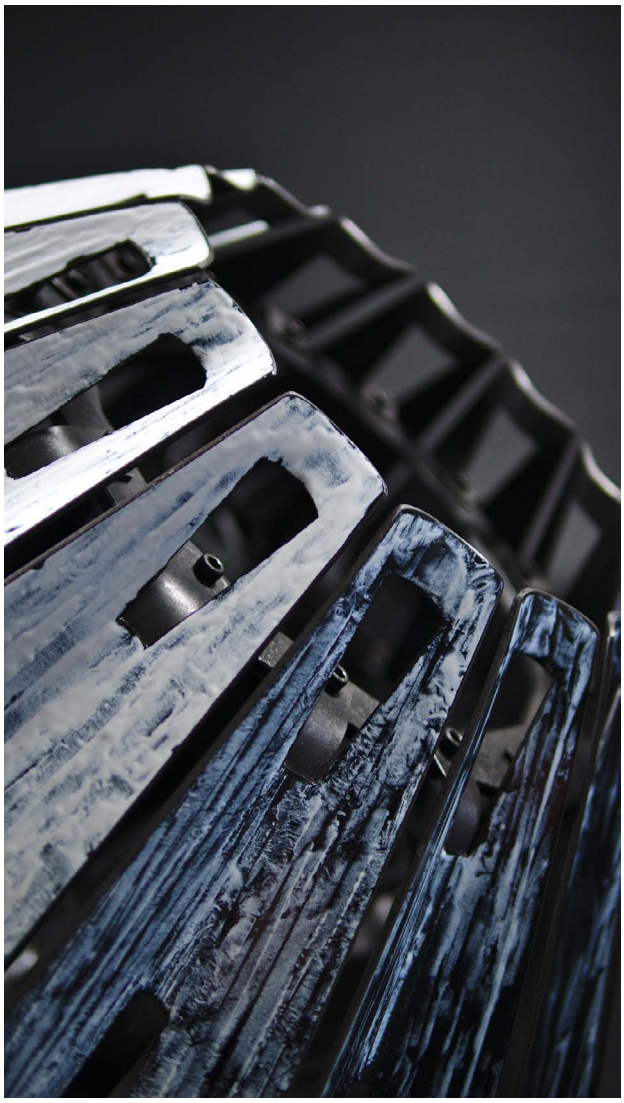
https://www.youtube.com/watch?v=pjrqYUb65ql&t=32s

(fig.50.) *Mors est in olla*, enamelled steel, May 2020

The main piece of my exam project, "Mors est in olla", is borrowing its title from a headline published in the Viennese newspaper "Wiener Zeitung" in 1845. Translated from Latin to "death is in the pot", a Professor for chemistry warned the public about the dangers of lead-containing tin and copperware. He later developed a lead-free enamel coating and started producing enamelware.

"Mors est in olla" is shifting enamelled steel from functionalism to contemporary sculpture. The domestic metal vessel is almost entirely eradicated, while the enamel coat switched from being a smooth surface protection layer to a structured artistic medium.

(fig.51.) *Mors est in olla*, detail



(fig.52.) *Mors est in olla*, detail

7. DISCUSSION AND REFLECTION

The examination presentation of this project, took place on May 28th 2020, via zoom video conference.

During the discussion with the opponents the relation between art, craft and design came up, with a question by Sebastian Schildt, if one can still call it craft, when the process is controlled by the machine?

For me the process of making and creating, is influenced by many things. Including the personal skills and experience, the material itself, the tools and much more. In my work, I see digital manufacturing as on tool of many. Since humankind started to use tools, we were always improving them, to make our lives easier, to reduce extensive manual labour and to improve the quality of the outcome. So in a way it feels natural for me to make use of the latest technology as one tool of many, as long as it benefits my work.

Of course there are undeniable qualities of handmade processes, and I sometimes find myself doing things by hand just for the sake and joy of making. But as mentioned earlier, on this topic I'm in complete agreement with Gareth Neal, the London based furniture maker.

> *Gareth believes the machine to be an extension of the human hand, and that the eradication of the chisel does not deduct from the craftsmanship deeply rooted within every stage of the production of these vessels.*
>
> (garethneal.co.uk, 2019)

In my case as a trained blacksmith, it would be more an "eradication of the hammer". Except some light taps with a rubber mallet to adjust a bend, there is actually no direct interaction between hammer and piece in my work, in the sense of the typical method of manipulating material, like forging or raising. Nevertheless I'm self-confident enough to claim that my work is executed on a high level of craft.

Another point for me, at least in my case and what I've seen so far in the craft field, is that the machine is not (yet) coming up with the idea, it is very dependent on the input from the maker.
But in semester five I wrote about coincidental decision-making.

> *There we find happy accidents, when failures reveal new qualities, but also guided coincidences. That concept covers "letting the material do what it wants" and "leaving room for accidental flaws", but also the deliberate use of external influences like gravity.*

Before starting this exam project I was already playing with the idea, how a craft project in collaboration with an artificial intelligence could work.

> *For the start it will probably be enough to just implement digital generated randomness to a project, but I could imagine that outsourcing decision-making processes to algorithms and artificial intelligences could play a role in the future of our field.*

Since I have no experience in that field, I dismissed the idea for the ten week exam project, but I could imagine taking it up again at a later date, and revisit with a modified question: "can I call it craft, if I collaborate with the machine?"

Afterwards the discussion moved to functionalism of the material enamelled steel and functionality within my work.

Even though one of enamelled steel's main qualities is its functionality, a clear goal from the very beginning was to make non-functional objects. A quite naïve idea, so I could put all the "what is it for" and "what does it do" discussions aside, I thought.

But functionality also comes with the concept of vessels and hollowware in general, where a hollow form contains something else. In earlier work I introduced the concept of time to my work, in the sense that my pieces are not made to contain anything materialised in our three-dimensional world, but instead dealing with time as the fourth dimension. The vessels contain the time that I as a maker spent on their creation, as well as the time every viewer perceives them, and I think this notion is also relevant for the pieces made during this project.

If someone addresses me with an idea and a budget for an interesting functional project, based on my work, I would, of course, consider direct functionality. But then there is a clear job for the object from the very beginning of the project, and consequently a much bigger design approach. In a project like this, the artistic expression on the other hand, might have to develop in a much tighter framework.

Speaking of tight framework, my other opponent Emille de Blanche mentioned that the chaotic features in my work are wild within the borders. And that, with the subject of lead-poisoning and this toxicity within the early material, she imagined a more organic shaped outcome, while I took the opposing route with more industrial forms.

I'm totally with her that the little wild chaos in my work is confined inside an organised framework, and my plan for this project was to do more enamel experiments, but because of the restricted workshop access I had to decide for the safe route, of not going too crazy. This might be connected to the fact that the general situation at that time, and outside of the project was chaotic enough, with news of the pandemic changing every day. During that time I used my practice more as an anchor, to have something where I'm mostly in control about what happens.

On the other side experimental enamelling has constraints, which, once exceeded, result in a vast drop of stability and quality. And this is something I cannot tolerate within my work. I've experienced this myself on previous samples that I considered as a success after firing, only to discover a few days later that the enamel chipped of randomly as sharp glass shards.

Another subject that came up during the discussion was how I would like my work to be exhibited, and how I plan to communicate with the audience, and educate about the historical background of my project. Because not everybody can identify it as enamel, at first sight it might be mistaken as paint.

I don't expect the viewer of my work to instantly recognise the connection to enamelware. I hope my objects can spark curiosity, and make the viewer want to find out more about them. Maybe even with the question of functionality in mind, like "what is it for?".

Additional information through text, the process video or conversation with a gallerist or myself can hopefully educate about the materials history and my contemporary approach to it. This is something I will have to work on differently, depending on what exhibition setting is available.

(fig.53.) *untitled/green,* enamelled steel, May 2020

(fig.54.) *untitled/red,* enamelled steel, June 2020

After finishing "mors est in olla", I continued on the smaller pieces, and finished "untitled/green" just before the exam presentation. During my last days at Steneby, parallel to packing and moving out of the workshop, I managed to finish "untitled/red".

Because of the monochrome big piece, it was clear for me that the two smaller ones need to have a bright colour. Since I haven't done any work in green enamel, except a handful of samples, and with all the fresh greens of sprouting nature in May, it felt like the right choice. I spent a day experimenting, and ended up with three tones that I applied similar to the white on the last piece by hand with a spatula. Out of curiosity I kept the wider end of the panels' surfaces free from enamel, to see how oxidised steel on the outside affects the objects appearance.

With my time in Sweden running out I chose red for the second smaller piece, by taking the recipe and application technique from my series "Bodenlose Frechheit". The red enamel is applied through a combination of spraying and dabbing with a piece of cloth, as well as contaminated by coffee and rust powder.

Through the complementary colours, the two pieces became an unlike pair, sharing the same physical from and size, but are divers and at the same time connected.

"Mors est in olla" is definitely the main piece of this exam project and "untitled/green and -/red" an additional pair. A pair, which might be a little more detached from the historical research, and already halfway on the next step out of this project.

Nevertheless, these three pieces can be exhibited and exist as a group, as well as in pairs and on their own. In fact, I left "untitled/red" in Sweden, to be exhibited in Stockholm later this summer, and "mors est in olla" and "untitled/green" are with me back in Austria where they will be shown all summer at "Galerie für Gegenwartskunst Hofmarcher" in Scheibbs.

8. CONCLUSION AND RESULT

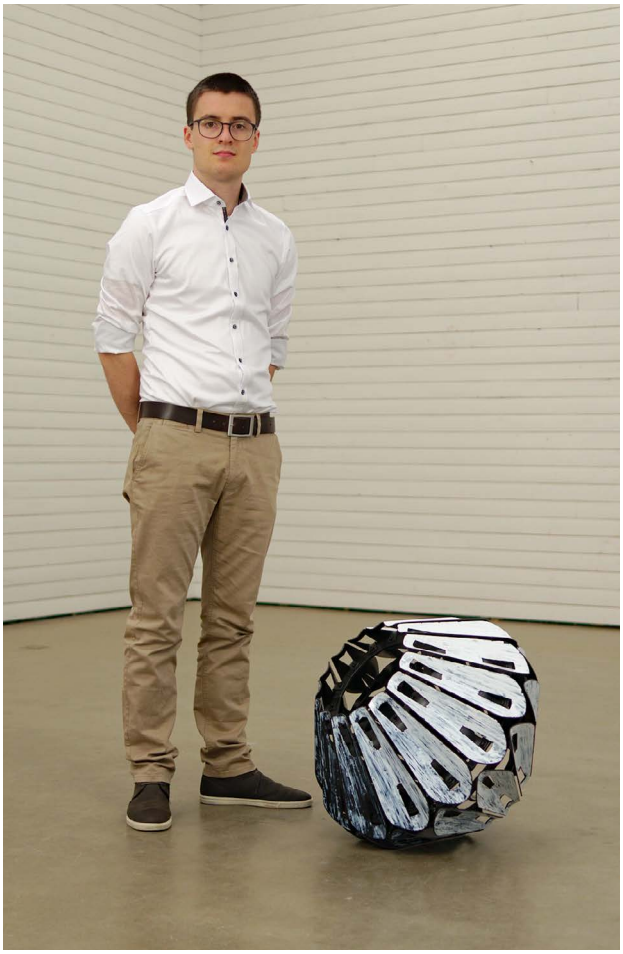
Despite the unpredictable interruption by the Covid-19 pandemic, I'm quite satisfied how this exam project turned out in the end. I was able to develop my work further, complete my three years at Steneby, as well as set a milestone for my future practice.

I did extensive historical research, which turned out to inform this project more than I expected, but I also implemented digital manufacturing into my craft, even with a short excursion into augmented reality.

Even though this exam project is now completed, and I already left Sweden behind, I'm not done with enamel yet. I think I found my niche, and going back to the question formulation at the beginning of this project, I asked myself "how can I raise the relevance of enamelled steel in our field". I guess the project itself, the objects that emerged out of it, and the upcoming exhibitions where they will be shown, is a good start, but I'm not yet at the end of the line.

Maybe it's not enough to just produce good work to raise the materials relevance. I might need to actively share my knowledge that I gained so far, maybe through video tutorials or workshops, as well as constantly educate myself further on the subject and develop my practice.

During this exam project, I definitely identified some interferences in my work, regarding art, design and craft. But merging them to an organized whole within my practice will probably be a lifelong endeavour.



(fig.55.) *Mors est in olla,* human for scale

Johannes Postlmayr
July 2020

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