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I thought I'd start this report by introducing myself. I am a stickler for magical, story driven experiences. I like art, movies and games that transport the viewer into another world. In design work, I specialise in sketching and visualisation. During this project I hoped to gain experience in creating digital prototypes and movies, as well as doing a complete project alone. And, right now I hope you will enjoy reading this report.
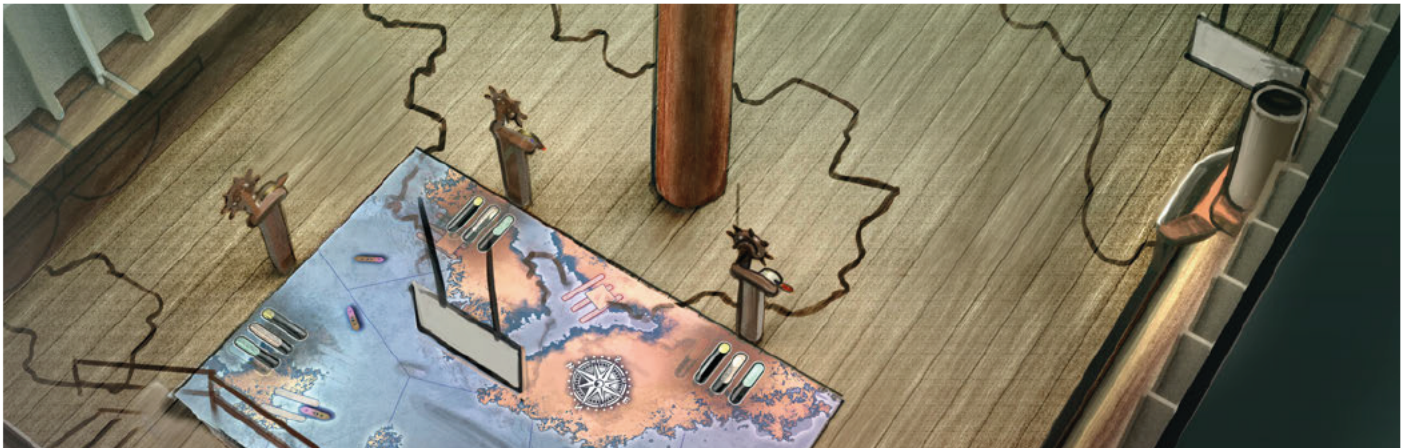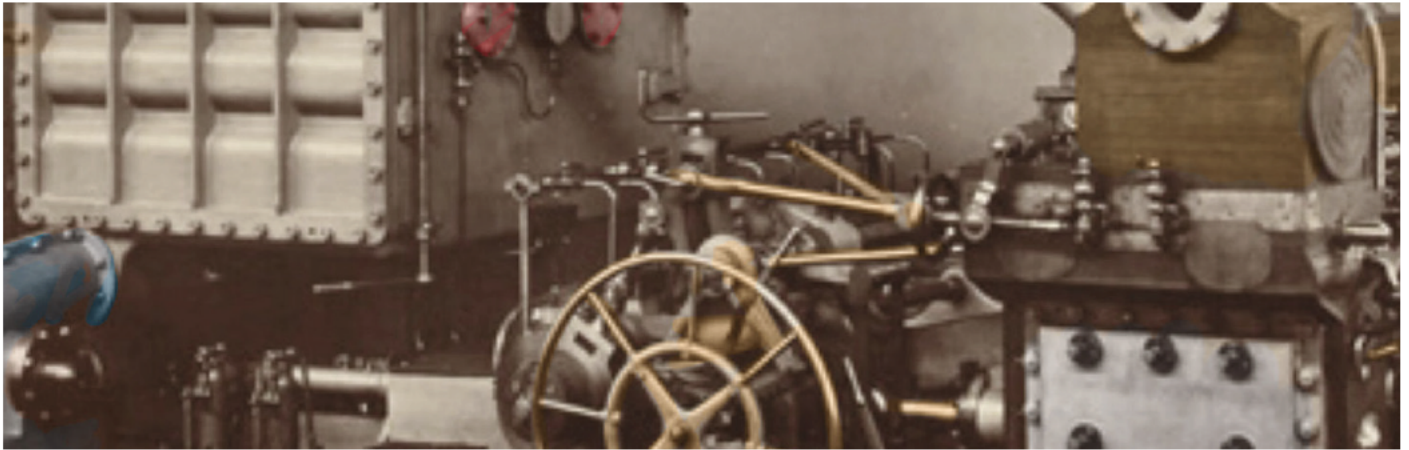
Marijn van Bekkum

Abstract

In this report you will read about the design of the Codex Bonaire, an engine room experience design of the Bonaire.
The Bonaire is a steam powered sailing ship being renovated in Den Helder to be a museum. This project is focused on creating an experience in the engine room that visualises the engine room without building it physically.
The design is meant for school groups of 12 14 years old, 14 students each. The Codex Bonaire comprises mostly of four interactive installations that tackle the different pieces of information that are essential for the Bonaire's heritage. The different installations also cater to different visitor's interests: Physical activity, competition, creation and visual beauty among others. The installations have a coherent embodiment styling, as well as a coherent digital interface and similar interaction throughout.
The rest of the room also contains other elements that increase the immersive ness of the whole experience, like stickers that simulate looking outside the ship, and an authentic telegraph that visitors can try getting orders from.

I don't know about you, but I often get lost in reports, espe cially when I don't want to read them entirely front to back and/or in linear order. This footer will tell you where you are in the report, and on what pages the other sections start.

Evaporation

Steam

Water

Fire

Heat transfer to water

Hot gases go into

FAST   MEDIUM   SLOW
FORWARD
BACKWARD   SLOW

Executive Summary

In this report the design process of an ex hibit for the Zr. Ms. Bonaire is described. The Bonaire is a steam frigate, a sailing ship with three masts and steam propul sion   a hybrid. Due to the renovation of the rest of the ship, the commission is looking for a way to show the steam technology to visitors while keeping the engine room empty and open for rent.

The commission has several goals. First, they want to convey the beauty and historical value of this old ship, and its unique technology. Secondly, they want to create interest in steam technology in younger generations, so that the heritage is not lost. Because of this last reason, it was decided that the design would be targeted at school groups of ages 12 14, as those are the ages that these children have to choose a profile and courses. To make the design more specific, it was also decided to make it for VMBO students, as they respond much better to visual and practical communication, while HAVO and VWO do not have such a strong preference.

The design brief was specified to creating an immersive experience for the visitors, using new technology to show the old steam technology. The goal was to teach, and to create interest. The interaction vision that also partly led the design was that the whole design had to be support ive to the visitor, easy to understand, and give visitors the feeling that the interac tion is tailored to them, and that all details are flawless.

The design, Codex Bonaire, is an ex hibit consisting of four main interactive installations, and a series of supporting el ements. The information that the exhibit conveys has a leading role; each instal lation has a main piece of information, and together they form a complete story. The four pieces of information are about the steam technology, the crew's work, the layout of the original room, and the bigger context of naval steam propulsion. The supporting elements are described in detail on page 30, but in short, they are:

- Two stickers on the wall provide visitors a look outside as if the ship was in water, and shows how high the water level used to be.
- A telegraph and speaking horn connect ed to a similar set on deck show visitors what these instruments were used for.
- Machine outlines show visitors the original scale of the machines, and give details about what parts were what.
- In many places there are information plates, in case visitors would like more information.
- The floor is covered with lines like a map, to tie the whole room together and give a more naval impression.
- The outlines and outside views, as well as a general surround system, will pro vide sound to heighten the atmosphere.
- For schools, an educational package could be provided to get the students in volved at an earlier stage, and keep them potentially interested afterwards.

The four installations are called Navigat ing the World, The Crew's Work, The Engine Room, and Design for Steam. They are interesting on their own and without context, but also connect to each other digitally. When a visitor interacts with one installation and then another, the first installation collects some rele vant data from their interaction, and the second installation feeds this data back to them. This should give visitors the feeling that the exhibit is being tailored to them specifically.

The first installation, Navigating the World, is a projected map of the Carib bean sea on the floor with four console around it. On the map are four ships that can be steered and powered by the consoles. There is also land, harbors and pirate ships on the map. Visitors get some goals in the interaction, to sail to a specific harbor or shoot down a certain amount of pirate ships. They also get several

resources to manage; coal, to power the engine, ship health in case they get shot at, and food, for staying away from ports for a long time. This installation teaches visitors about the context of seafaring with steam propulsion, and about where the Bonaire was sent out to. It is potential ly competitive or collaborative, for visitors that are looking for that.

The second installation, Design for Steam, is a touchscreen on which visitors can build a boiler or a steam engine. They do this by choosing parts to con struct from a menu, and dragging them together. The parts, if they are connected in a way that works, snap together and animate their functionality. This can help visitors figure out how the final result should fit together, but also teaches them how the technology worked. They can get more information about the machines as well. This installation is a calm, easy inter action that provides some pleasant visual feedback, for visitors that are looking for that.
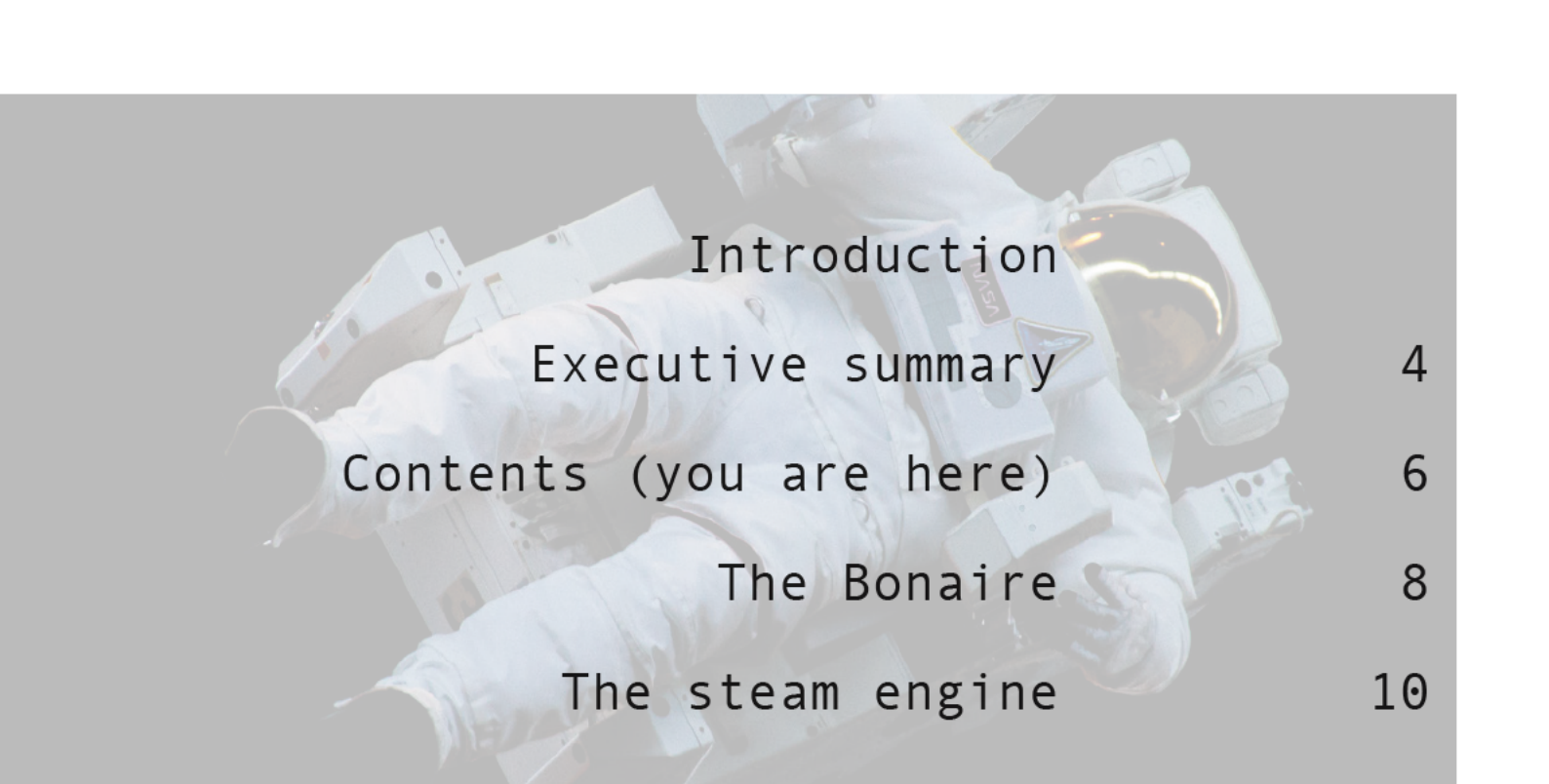
The third installation, The Crew's Work, is a console with an opening. Visitors can shovel coal into the opening from a reservoir beside it. On the console is also a water valve. Somewhere else in the room is a steam valve, with a pressure whistle. The interaction consists of visi tors shovelling coal and letting in water, which shows on the screen on top of the console how those would enter the system (in a schematic view.) sound and heat (in the case of coal) also plays. Visitors can also get warning screens about emergency situations that could really happen, and they can solve those by shovelling more or less coal or managing the water and steam valves. This installation involves physical activity, for visitors that are looking for that

The final installation, The Engine Room, is a table with an embedded screen show ing an empty top down engine room. Visitors can place 3d printed miniature machines, representing the authentic

machines that used to be in the room, on the screen. A camera detection system sees the machines and feeds this back to the screen, which in turn shows a halo around the machine, a name and some information, and crew walking into the room to work on the machine. Visitors are challenged to use the machines to create an efficient layout.

This last installation was tested with a prototype at two different schools. Reac tions were primarily positive, yet there are also things to improve. The version used in the test was not clear in some aspects, and participants in the test did not always know what to do.
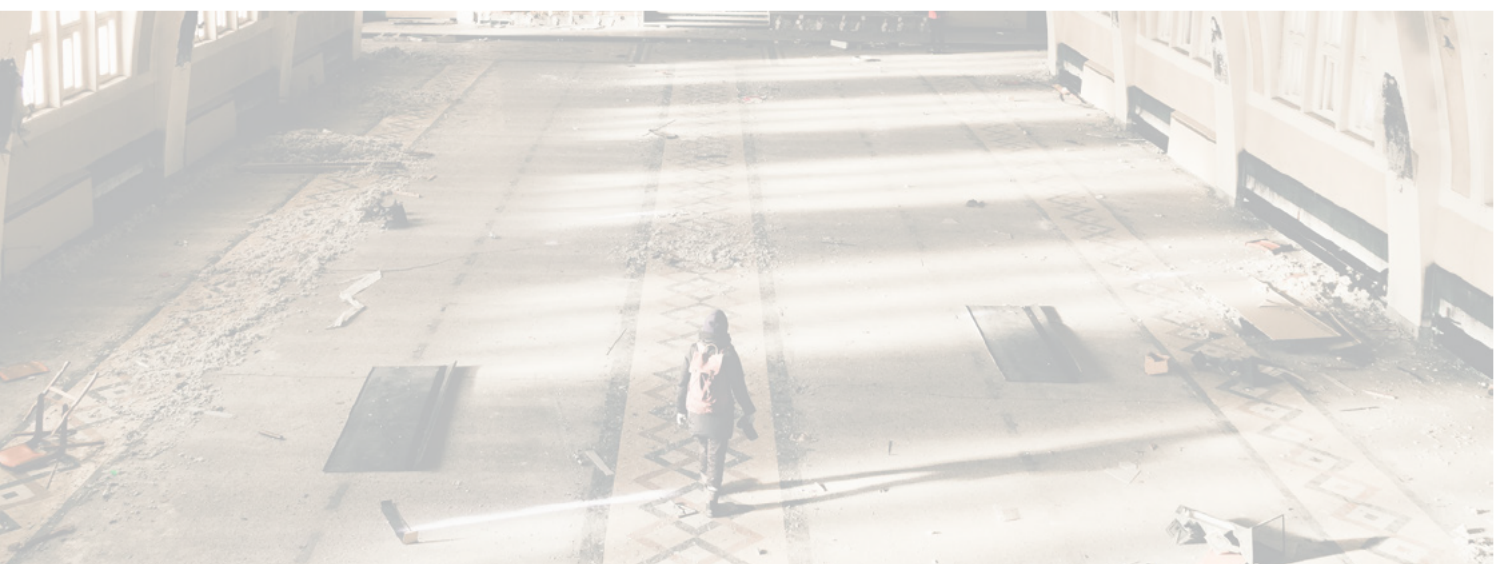
The total price of further development of this design has been estimated to be around €110.000, . This is divided in general costs and costs for each individual installation, and further into digital and physical embodiment.

The Bonaire

Introduction

The Zr. Ms. (Zijner Majesteits) Bonaire is a Dutch marine ship built in 1876. (fig. 1) It is one of the seven remaining steam powered sailing vessels in the world, and is currently being revitalised in the drydock in Den Helder, the Netherlands. This project focuses on the steam engine room, but a short introduction of the whole ship is useful to get some context.

History

The Bonaire was built in 1876, as a frigate (a vessel used for war) with a barquentine rig (meaning it has three or more masts. In this case, three). It was launched in 1877. During the next 25 years, it made several trips to the shores of Colombia and Venezuela to combat pirate problems
In 1924, the vessel was positioned in Delfzijl, functioning as living quarters and training ship for the Dutch Nautical College. During WWII, the Bonaire was hidden in Hellevoetsluis, so as to stay safe and intact.

Fig. 1: Illustration of the Bonaire

Fig. 2: Sunken Bonaire

Fig. 3: Current position of the Bonaire in the Den Helder drydock
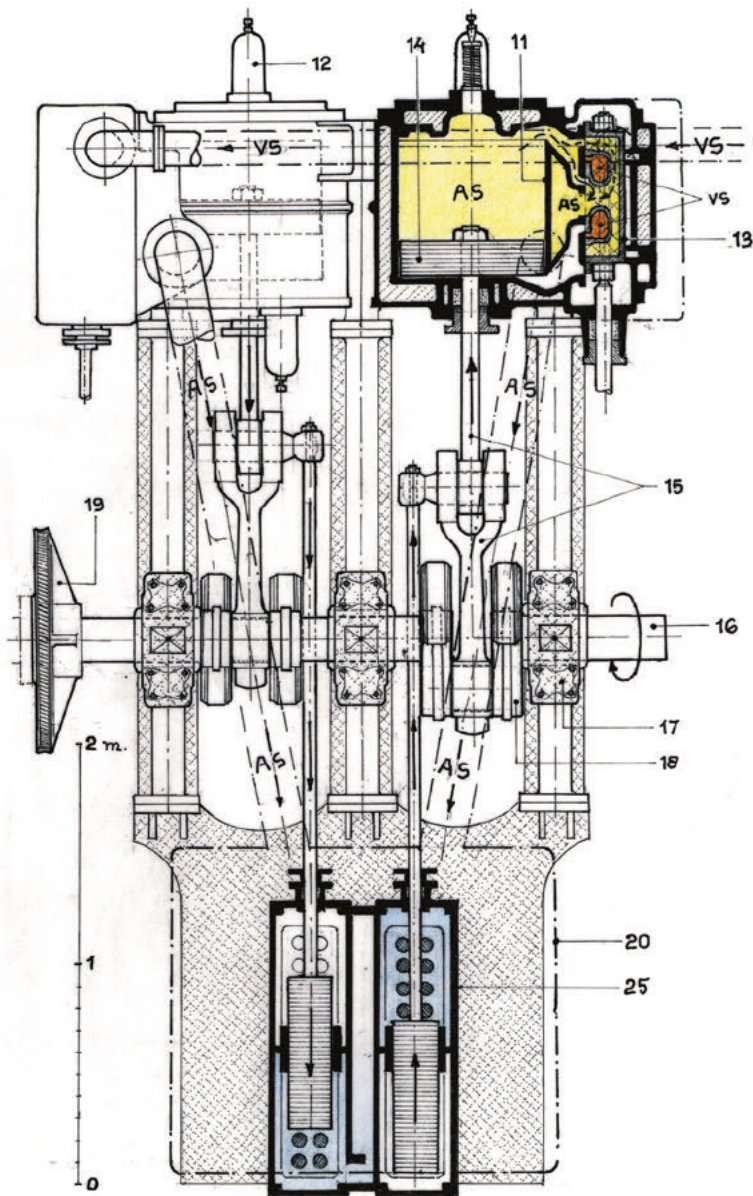
In 2004 (fig 2), the ship sunk in the harbor of Den Helder, and had to be retreived. Most of the ship had been irreparably damaged, and since then it has been in the Den Helder drydock, undergoing maintenance to restore it to resemble its original glory. (fig. 4)

Specifications
The Bonaire has three masts with sails, which it can use as propulsion when there is enough wind. If there isn't, the screw can be lowered onto the 'claw connection' of the main axle, which runs along the lower part of the ship and is powered by a two piston steam engine (fig. 4, 5). The screw is not lowered when the sails are in use, because it would produce a lot of traction. The claw connection is a simple system that allows for simply lowering the screw onto the axle.

Conclusion
The Bonaire is a ship built for war, but has mainly been used for education and heritage. Right now it is being rebuilt into a museum. The machinery is interesting, however, and you will read more about that in the next section.
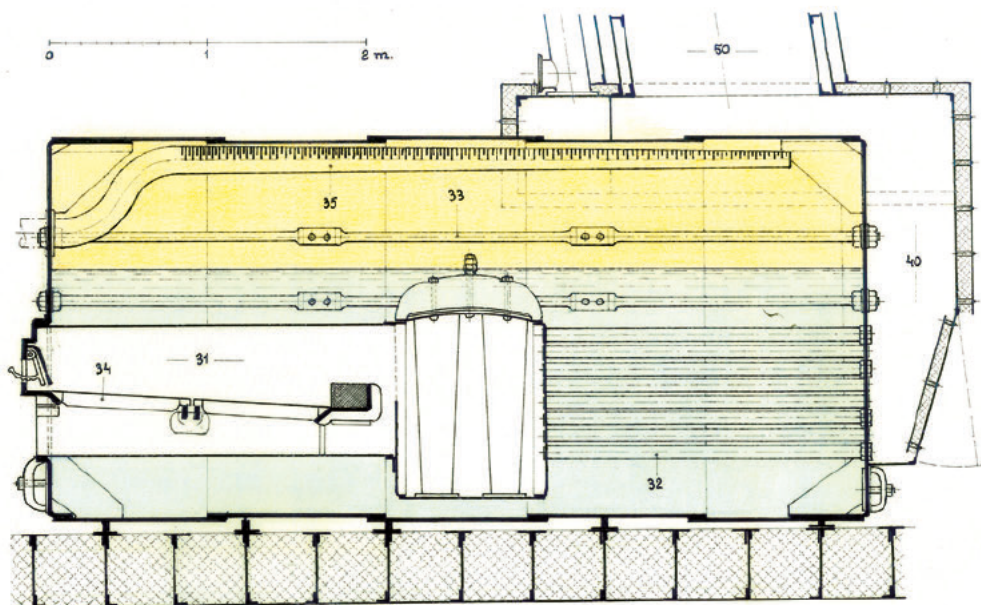
Fig. 4: (top) Top section of steam engine

Fig. 5: (bottom) Side section of steam boiler

The steam engine

Introduction

The Bonaire is powered by 2 boilers, which in turn powers a 2 cylinder piston engine (fig. 6). In this section, you will read a brief explanation of how the boiler and piston engine work.

Boiler

The steam for the engine is produced by two boilers with two compartments each, in which a fire is fueled with coal. The hot gases are led through the water via an array of thin tubes (fig 7), which have a large surface area and thus are efficient at heating up the water. The water heats up until its boiling point, evaporates, and is funneled through a pipe. The steam is then led to the engine.

The combustion gases from the fire in the boiler go into the chimney, where they are blown out into the air. (fig 8)

Fig. 6: Illustration of steam boiler layout in ship
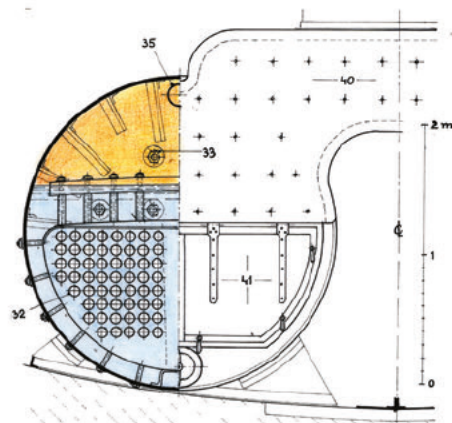
Fig. 7: Section view of the steam boiler, showing the amount of heat transfer tubes.

Fig. 8: Illustration of steam boiler working principle

Steam to engine

Hot gases into chimney

Evaporation

Heat transfer to water

Steam

Water

Fire

Hot gases go into small tubes

Water

Axle

Connecting Rod & Crank

Piston

Air is led back to boiler

Condensor

Air is cooled

Axle is actuated by piston through connecting rods

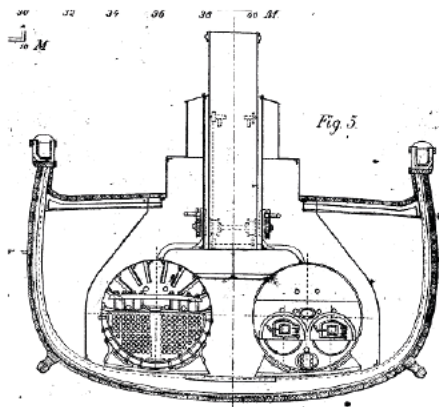Alternating steam flow

Smaller piston powers condensor

Piston moves up and down
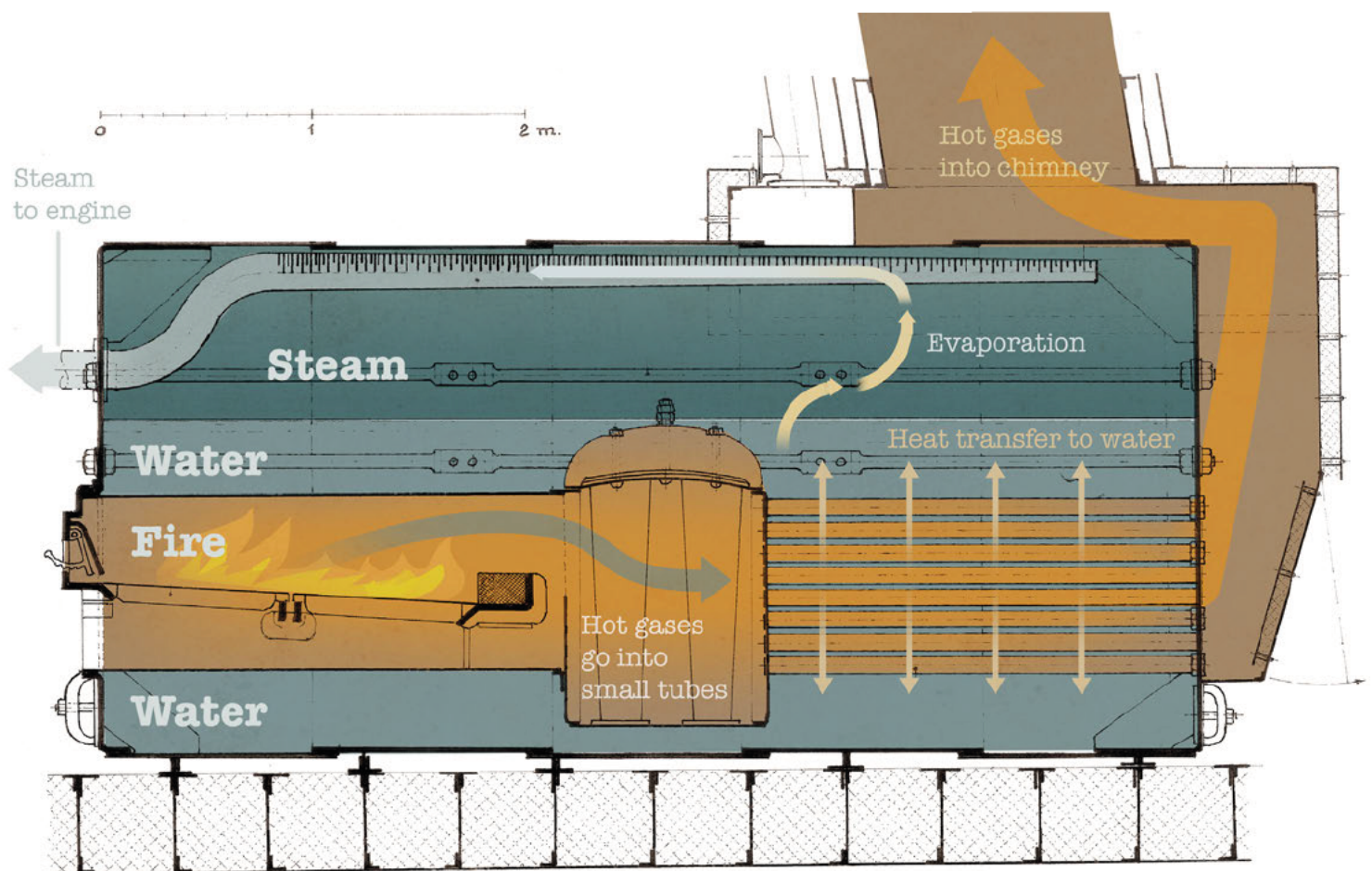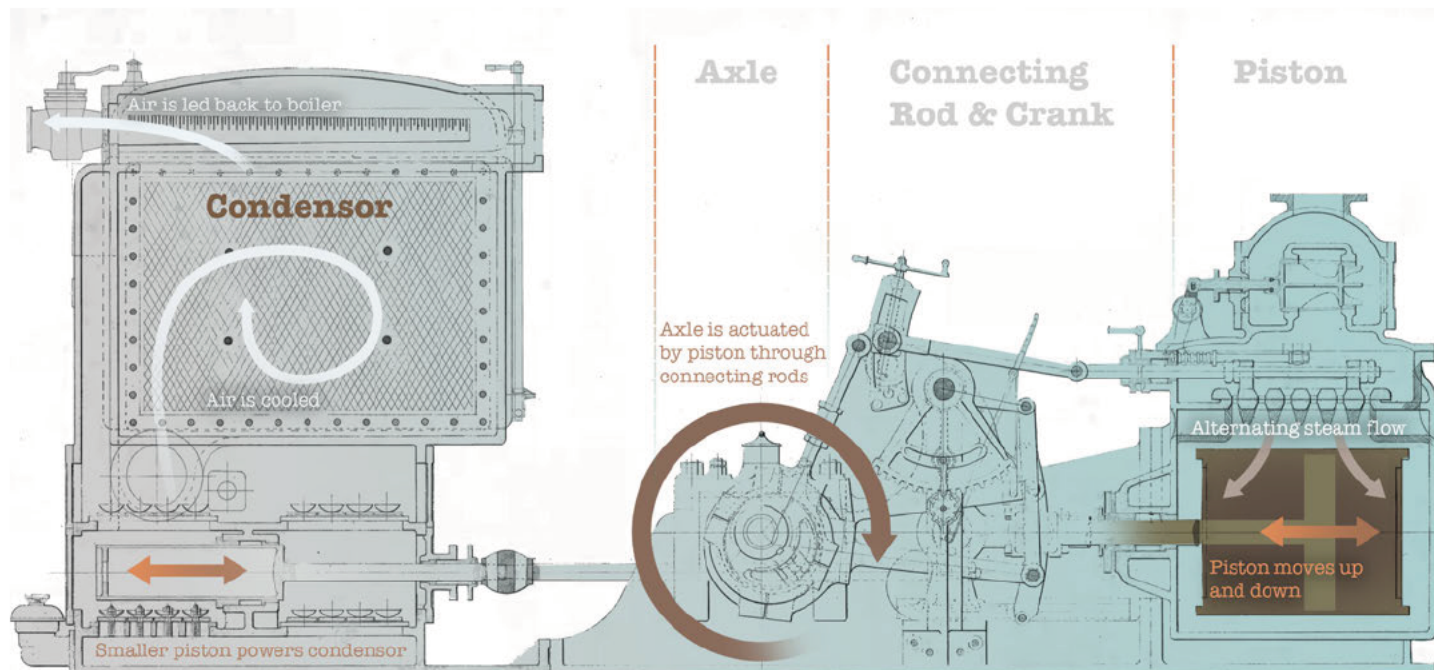
Fig. 9: Illustration of piston engine working principle.

Fig.10: Illustration of Bonaire interior, showing position of the steam engine and boiler

Piston engine
The engine works similar to a trunk en gine. Two horizontal pistons are powered by the steam, which in turn uses connect ing rods and cranks to power the main axle (fig. 9).
The steam then goes through a con densor, which cools the steam back to seawater temperature   and turns it back into water   after which it is led back to the boiler. The condensor is powered by a smaller piston connected to the main axle.

What's special
There are several things interesting about the Bonaire compared to other ships built at the time: [1] The machinery of the Bonaire was specially designed to be small, in order to be fully below water level (fig. 10). [2] Most ships built in this time had multiple machines to cool down the steam. The Bonaire does it all in the condensor, eliminating the need for extra machines. [3] The Bonaire's machinery is built in the last period where the relevant technology was in use.
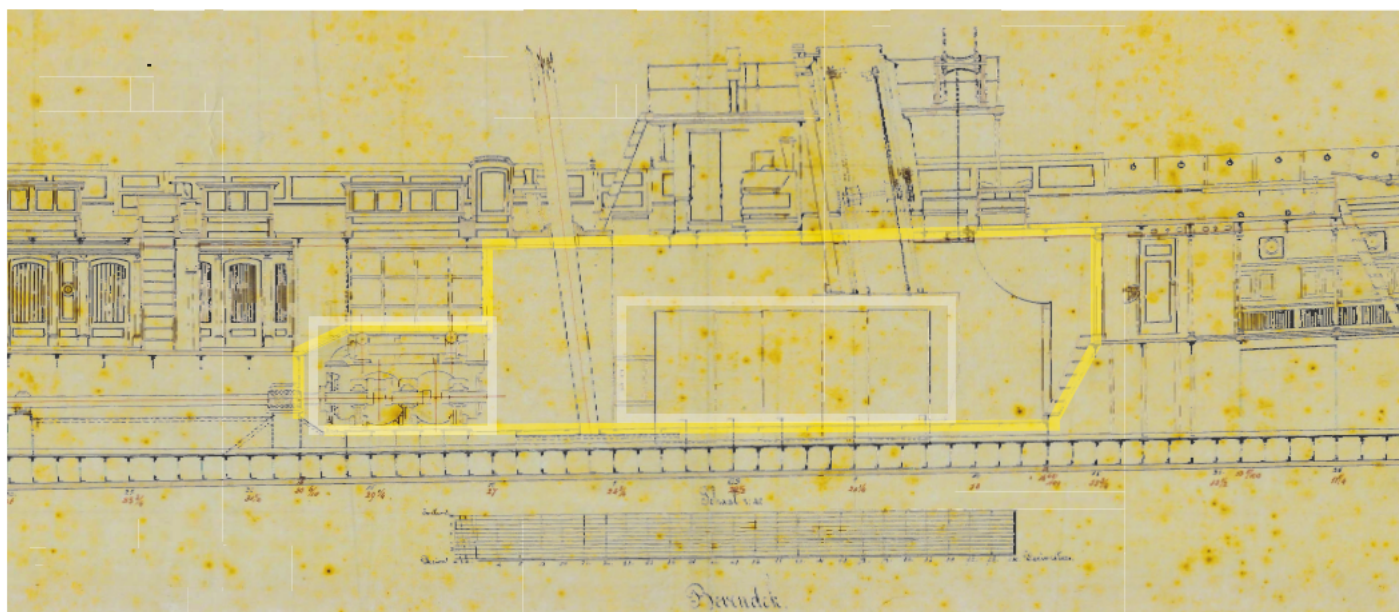
Design Brief

Introduction

In this project, an exhibit will be designed for 14 16 year old students from VMBO level schools, that go to the Bonaire on a school trip. The exhibit should engage these students in the emotional and practical aspects of the steam engine, and provide opportunity to delve deeper into more abstract subjects.

The design should reassure these students with the feeling that they are taken care of, and that the content is relevant and tailored to them.

Reasons to take this group are that the practical/sensory side of the steam engine mixes well with their interests, and other students will also be interested in a practical design, while that does not work the other way around (these students will not be as interested in text based exhibits)

Currently, the space where the engine room of the Bonaire used to be is empty. It is used for meetings, presentations and receptions, but visitors cannot see the steam technology behind the naval vessel. This technology is important for the technical maritime history in the Netherlands, and is a vital part of the Bonaire's 'vehicle platform'. It is also a relatively rare type of technology that is worth showing.

However, the engine room cannot be rebuilt physically. There is no budget for a full replica, and the practical functionality of the room is to be maintained. Thus, this project looks for a way to visualise the steam engine configuration and functionality, as well as the resulting life on board the vessel and in the chamber. In this chapter, the entire design brief will be discussed, as well as the target group and interaction vision.

Design goal

The design goal in this project is to design an exhibit concept for the Bonaire's engine room. In this exhibit, visitors will be able to learn and experience how the Bonaire's engine room worked and what had to be done to keep it running. The aim of the design is to utilise 'new' technology to improve the experience, keep up with modern museum trends and provide contrast with the 'old' steam technology.

Learning objectives

When visiting this exhibit, high school students should learn:
- That the Bonaire was a ship (partly) powered by an engine
- That this engine ran on steam
- That the entire engine room was dedi cated to making this engine work
- That the engine consisted of two boilers and an engine, and how these roughly looked and how big they were
- That there was a coal fueled fire in the boilers, which boiled water and created steam
- That this steam was then led to the pistons of the engine, who moved from side to side, and that this motion was then converted to rotation with a crank system
- That the engine and operational crew were entirely under water level
- That the crew had to shovel coal, manage valves, and listen to orders from upstairs through a telegraph and speaking tube
- That there was a lot of noise and heat in the engine room at all times

Special emergencies
- That there could be the following emer gencies, and how the crew could solve them:
  - The boiler could overheat
  - The boiler could run out of water
  - The system could build up too much

pressure at some point
  - There could be leaks of water or steam
  - The engine generates a lot of power, and could damage itself

Context
- That the Bonaire travelled to the waters near Venezuela and Colombia to combat pirates
- That steam was used to go faster than just by sailing, and to not be helpless in a battle without wind
- That the Bonaire was a warship with cannons

List of requirements

- The design should fit in the current space available in the engine room.
- The current space is slightly humid and salty, and will be heated.
- The design should be compact or removable or otherwise give the opportunity to make the room available for rent.
- The design should remain usable for 10 years, assuming it is cleaned regularly and repaired when necessary.
- The design should work for groups of 14 students, but should also be entertaining for bigger groups of people.
- The room has two exits, both of which should be accesible. The exhibit should work if visitors are coming from either exit.
- As the design will not be finished at the end of this project, all materials should be delivered in an understandable way, so that a next party can pick it up easily.
- The design should teach visitors the information listed in the learning objectives.
- The design should employ modern technology that contrasts with the old steam technology.
- The design should be catered towards high school students of age 12 14, but also be informative and/or enjoyable for other potential visitors.
- The high school students come in groups of 14, and the exhibit should fluently handle all of them at the same

time.
- The high school students have wildly varying interests (activity, competition, aesthetics, etc), and the exhibit should be capable of providing a fun and educational experience fitting to most of those interests
- The high school students are from VMBO, and the information should therefore be communicated in a visual, practical manner (as described on page 19)
- The design should be front loaded with information, so that it communicates most of its content within the first minute of interaction (per separate interaction).
- The design should, at the end of this project, have a clear route towards realisation, and it should be transparent how much it might cost.
- The design will be cleanable by sweeping once every other day or so, and doing more rigorous cleaning once every other week and/or whenever acutely necessary.
- The design's electronics should be stable, and if they break digitally or physically it should be accessible and there should be a manual for how to fix the common problems.
- The design should fit together as a coherent whole, and conform to the styling collage, both in colors, materials and forms.
- The design is a one off, and should be produced with relevant methods
- The design should not cause the engine room to become noisy, much warmer or colder than room temperature, or smell strongly like anything.
- The design should be functional for visitors with only a basic understanding of buttons and touchscreens.
- The design should be functional for visitors with bad eyesight, color blindness, and/or impaired hearing.

Interaction vision

The interaction vision shows how the experience should feel. This only means that the same emotional associations will be targeted, not that the focus of the project will be to make this design like the vision in all possible ways. There are some keywords below the interaction vision that indicate qualities and design features associated with this interaction, all peer reviewed with fellow designers. The pictures on the opposite page give some extra visual support that will serve as inspiration.

I believe the experience in the engine room should feel like "choosing a suit in a fancy clothes store, for a performance". It should feel like the visitor is treating himself and is really working towards something; not only towards getting a beautiful and well fitting suit but also towards heightening the performance. For me choosing clothes is fun and active, because you're always discovering and trying out new options, it is a very explorative process. Listed below are some qualities of the interaction with corresponding design features that can be used as a tool for designing the experience later on.

Interaction qualities	*Design features*
Supportive	Employee has attention for your goals
Tailored	Clear customizable measurements and options
Easy	Everything is built around giving you time to appreciate the clothes
Impeccable	All details are in place

Fig. 11: Illustrations used to inspire the design interaction vision

Target group

Introduction
At the start of this process, no target group had been specified. It is very useful to have a target group though, because it gives the opportunity to base design decisions on the characteristics of this group. In this section, you will read about the specification of the target group, and the consequences that will have for the design.

The target group
According to a citymarketing report for Den Helder (Citymarketing Den Helder, 2018) three already big touristic target groups are:
• Elderlies
• couples aged 25 35 with a medium income and education
• Families with parents aged 35 50 and kids aged 10 20, with a lower level of education and medium income

However, early on in the process it was decided that the design should target young people, with the intent on getting younger generations interested in technological heritage and technology in general. Neither of these three groups is especially fitting in this regard, so instead schools are taken as target group.

School trips are generally educational and not specifically touristic in nature. However, they can provide a lot of visitors to a museum. Some kids have parents that take them to museums, but almost all kids are in a school that takes them to a museum at some point (according to interviews in appendix IV)

The classes 1 to 3 generally correspond to ages 12 to 14, which is the point that most students have to choose some kind of education profile. If the design is to impact people, it would be best to do so early, before they make important choices like this.

Fig. 12: A bustling museum with a varied array of visitors. Used to illustrate the feeling of dealing with a wide variety of school students.

Finally, the country of the Netherlands categorises middle schools based on the balance of theory vs. practice. Roughly; VMBO is mostly practical, VWO is mostly theoretical, and HAVO is in the middle. These are then divided further into subcategories.

According to an interview in appendix IV, the difference between VWO, HAVO and VMBO level students is substantial. VWO students are (very generally) able and used to engaging with more abstract concepts, as well as a more text based presentation of subject matter. VMBO students on

the other hand are (again, generally) not as good at patiently observing text, and prefer to look at images or do activities in order to learn. Additionally, VWO students generally have parents with higher levels of education that take them to museums with family more often, while VMBO students go to museums mainly with school.

The choice has been made to design for VMBO level, as this would entail designing visual and practical elements. VWO and HAVO students could still engage with this material and learn from it (according to several interviews with

Fig. 13: Collage illustrating some of the aspects of the target group.

teachers (appendix IV)), while the other way around would be less successful.

'Getting a taste'

The educational goal of schools for their students, when they send them to museums, is often primarily letting students get a taste of the subject matter. It is not expected that the students will engage with paintings like seasoned art lovers, nor with cultural heritage as interested history scholars. Their attention span is generally very short, and thus it is considered a victory if the students have actually considered the subject matter in any capacity. To a certain extent it is unimportant how shallow this thought process is.

Groups of 14

Because the choice has been made to design for VMBO students, it is safe to assume that the target group will mainly come to the museum with school. From interviews with teachers (appendix IV), it can be concluded that schools like to divide classes of 20 28 students in half.

This group size is more manageable for the teachers as well as for potential guides. It has been decided, therefore, that the design will focus on working with groups of 14 students at a time, while the rest of the class goes around the rest of the ship.

Varied groups

Because these groups are big, compared to other common visitor types like families or couples, it is more relevant that there is quite a lot of variation within a group, personality wise. There are kids that like to be active, passive, competitive, collaborative, that just want to look at beautiful or funny things, or to interact with their peers. In interviews, several teachers point out that they mainly categorise their students by gender and by the Kolb personality types (do ers,thinkers, dreamers and decision makers)

Prep at school

Schools want to educate their students, and therefore it is common for students to get a preparatory class about the

museum's subject matter. The material for this is sometimes prepared by the teacher, but also oftentimes provided by the museum.

Autonomy - rebellion
Children in their early teens are just hitting adolescence, and that generally includes a search for their place in the world. They are trying out new ways of interacting with people and objects, and discovering new things about themselves along the way. This can often be characterised as rebellion when viewed from a parenting perspective, because the kids are suddenly behaving differently and some of the behaviour does need to be reigned in   possibly prompting hostile responses. However, the exploratory behaviour can for this design be taken as a given. When expedited in the right manner, it might be possible to really cater to these visitors.

Fig. 15: Illustration of an entire school group arriving at the Bonaire.They will split into two groups and go separate ways after this.

Total Design

Main design   Important Decisions   Supporting Elements   Styling   Interaction

Main design

Introduction
The design will be presented in this chap
ter. Or at least, mostly. As you will read,
there are four sub designs that will be
discussed in later chapters.

The design
The design of the exhibit consists of
several elements. First and foremost, four
interactive installations will be the main
attraction, and cover the four pieces of
information discussed earlier. Why the
exhibit uses four installations will be ex
plained later in this chapter.
Second, a bunch of non interactive mate
rials will fill the rest of the room, provide
extra context or support the interactive
installations.
The layout of the room can be seen in
fig. 16. The annotations in bold are the
interactive installations, and as you might
notice there are four chapters later in this
report devoted to each one individually.

Design decisions

In this section you will read about several
important decisions that were made
during the design process

Information
For further choices about the design, it
was important to define the subjects of
information that the exhibit has to convey
or portray.
In communication with the client it
became clear that the information was
all present elsewhere on the ship, and
this exhibit's main goal is to give visitors
a strong impression. The museum has
two main focus areas, as indicated by the
representatives consulted in this project:

• The steam engine's functionality and
technical background
• The work the crew does to keep the
engine running

These will be used as the main subject

Fig. 16 (right): Overview of
the engine room exhibit
Codex Bonaire.

Fig. 17 (left): Illustration of
the four sets of information
this exhibit conveys.

Crew jobs

Steam Tech

Steam Seafaring

Room Layout
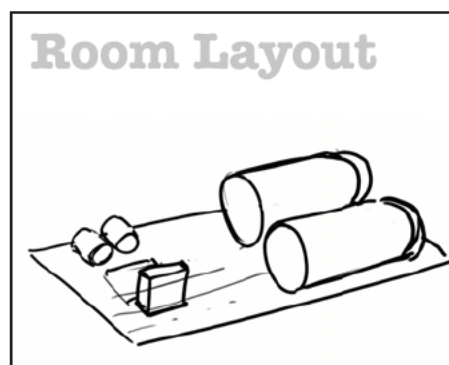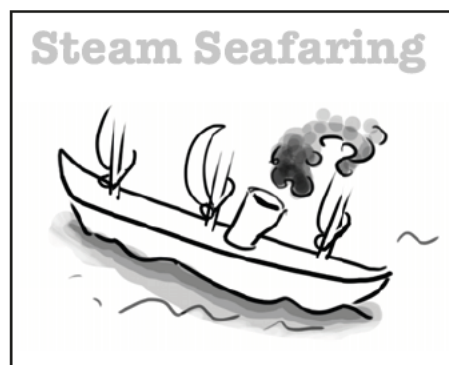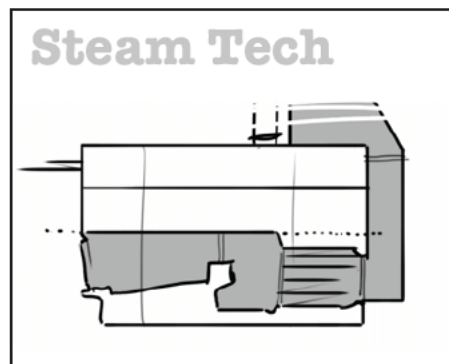
Side outline of boiler

Top outline of boiler

Calm outside view

communication tools

Battle outside view

Side outline of engine

Sailing the World

The Engine Room

The Crew's work

Design for Steam

matters in this exhibit. Furthermore, to paint a more complete picture and fill in the 'why?' and 'how?' questions, two additional minor subjects are decided upon:

• The layout of the room and connections between the machines
• The relevance of steam technology in seafaring

The layout allows visitors a chance to see how the crew could interact with the machines and where. Seafaring context takes visitors outside of the engine room to mentally get a chance to understand why the steam engine was there.
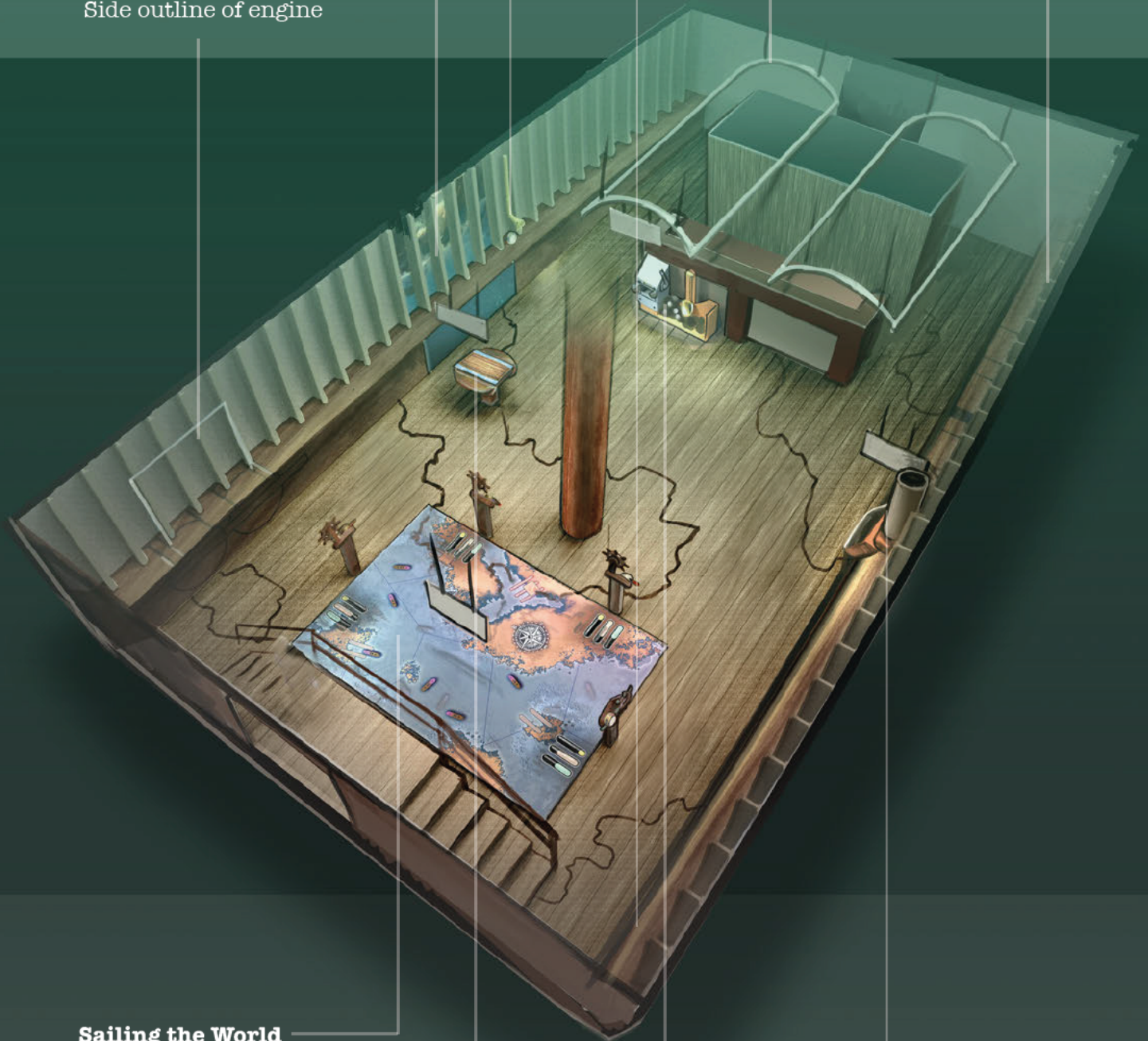The merit of using several subjects is that collections of information that can be linked to each other are more easily remembered. This could in turn incite visitors to be more interested in the rest of the ship.

Exhibit divided into several parts
The decision has also been made that the exhibit should be a collection of smaller elements that visitors can go through in an order they choose, instead of one big interactive setup. There are several

reasons for this.
• Having several smaller set ups allows larger groups to split up and go through the experience smoothly, while still being able to provide enough depth for single visitors.
• It also allows the exhibit to tailor to different types of people, by having separate things that are active, passive, competitive, cooperative, funny, beautiful, etc.
• Lastly, it allows for the presentation of multifacetted information while keeping individual info focused.

Connecting story element
With the concept of a collection of separate elements, the exhibit still needs to come off as one whole, to utilise the immersion generated by that. This immersion will minimise the mental effort visitors have to make to connect and absorb the presented information.
As discovered in appendix I, a story would help people connect to an exhibit like they can not do in a traditional museum. And as we need a connecting element for the separate pieces of the exhibit, a practical choice is to create an overarching story. One of the important differences with

Fig. 18: Illustration of the tailored interaction
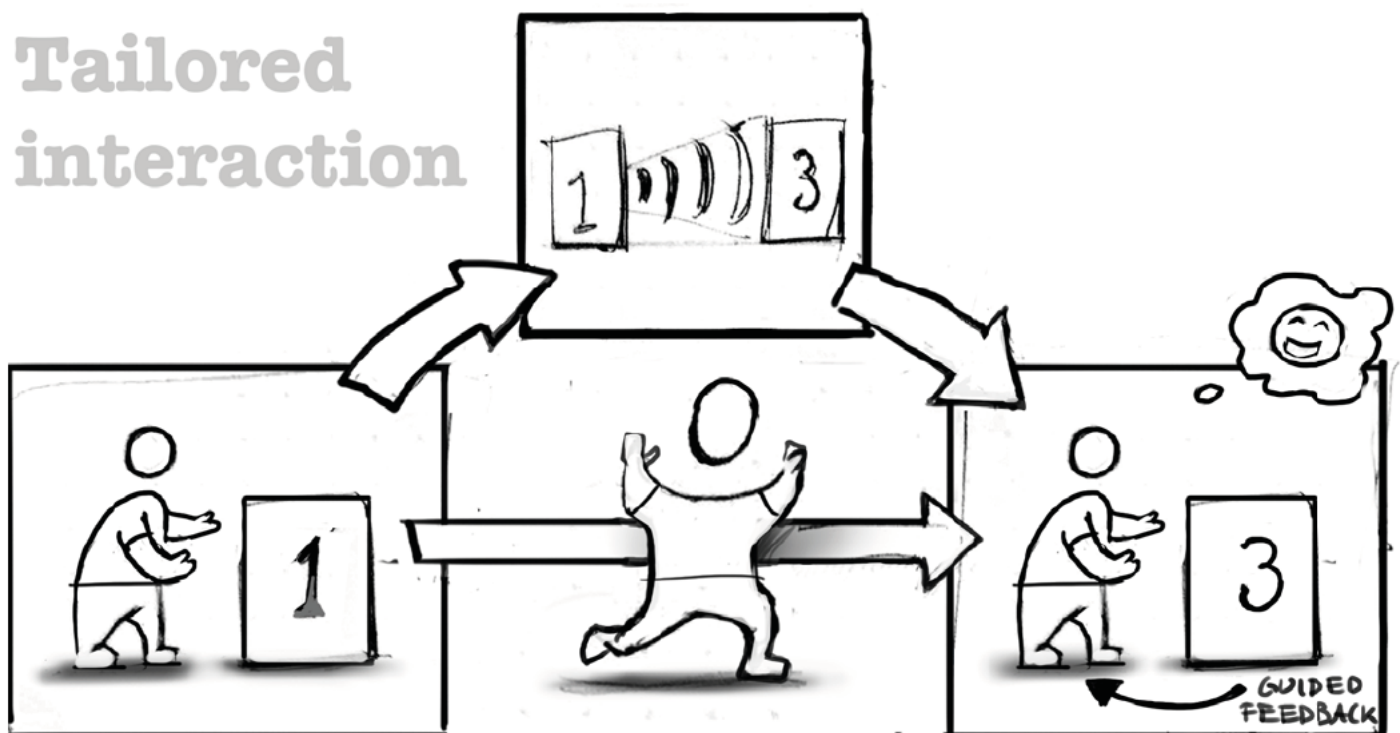

Tailored interaction

Fig. 19: Ticket scanner.

traditional storytelling in this case is that visitors can choose when to go where, so it is impossible to create a pre composed story that will be applicable to every visitor.

Short, highly focused activities
In an interview with designers at Kiss the Frog, they mention that focused set ups are usually the most succesful at engaging visitors, and communicating information. In other interviews, teachers point out that high school students generally have a very short attention span, and therefore should be given short, clear activities.

Tailoring
Allowing visitors to choose an order makes it more complex to design a system that tailors to specific visitors. In order to fit with the interaction vision in this way, and to make visitors feel supported, the (inter)active elements of the exhibit could communicate with each other, so as to alter their functionality based on a visitor's previous endeavors in the engine room.
This will require each separate interactive element of the exhibit to have a specified effect on every other element. The reason

for this is that visitors can choose their own path through the exhibit.

Barcodes
The visitors will all get a personal barcode on their ticket, which they can scan at the interactive installations. This is necessary to make the tailoring work. There will be a set of 100 bar codes that the system has to recognise, which only needs to be expanded when the expected amount of visitors per day exceeds this number. At the end of the exhibit should be a box for collecting the tickets, so that if they are in a good state, they can be reused. Some visitors might still want to keep their ticket, so there also has to be the option of printing extras on a regular basis.
The barcode scanners will have a recognisable design, that will be the same throughout the exhibit (fig. 19). It follows the styling guidelines on page 32, in materials. The dark gap where visitors hold the ticket is lined with a brass plate inlaid with the text 'scan ticket' (which is fine in Dutch and English). It is assumed that visitors have a certain level of experience with this kind of technology.

General Inventory

Design for Steam

Interests
- Building/creative process
- Simple interaction
- Engaging visuals

Connections to
- Design/architecture
- Steam technology
- Steam technology history

Learning points
- The boiler turned water into steam using a coal fueled fire
- The engine used pistons to turn steam into motion, and cranks to turn lateral into rotary motion
- Both the engine and the boiler were made up out of several parts, that all have a distinct function

The Crew's Work

Interests
- Physical activity
- Multisensory immersive experience
- Hands on information

Connections to
- Crew
- Steam engine
- Steam technology

Learning points
- The boiler turned water into steam using a coal fueled fire
- The crew had to shovel this coal in themselves
- The crew also had to monitor all kinds of other parameters, like the steam pres sure and water level in the boiler, and utilise valves etc to manage these

Navigating the World

Interests
- Small physical visuals
- Tactile machines
- Discovery and wonder

Connections to
- Architecture
- Steam engines
- Crew

Learning points
- The engine room used to be full with giant machines
- The crew worked every day to keep the machines running
- There were many conditions that the placement of the machines had to adhere to
- The machines are connected in a specific way to make the 'steam loop' work
- How the machines looked is accurately displayed in the miniatures

The Engine Room

Interests
- Small scale physical interaction
- Large, interesting visuals
- Teamwork & competition

Connections to
- Geography
- Maritime history
- Bonaire history

Learning points
- Relevance of steam for maritime history
- Coal was a resource
- The bonaire was a warship with can nons
- The Bonaire was sent out to the region Colombia/Venezuela
- That the telegraph was used as a way to control the steam engine from upstairs

The four installations each cover certain types of activities, interests and learning goals. This was the original reason to choose for a setup with multiple instal lations (page 26). In the table on the opposite page you can see which types of interactions each installation covers, as well as the types of information it is con nected to. There is also a list of specific learning goals, taken from the total list on page 14 15.

Some topics, namely crew and technology, are linked to more than one installation. This repetition will make them stand out more, and thus feature more prominently.

Conclusion

Okay, so far we have a system with four interactive installations that visitors can visit in any order, that create a story tailored to the visitor when they identify themselves with their ticket, and that con veys four cornerstones of information to the visitors as well as a series of learning goals. But, before explaining the specific installations, there are still some support ive elements to cover, as well as a styling guide and an interaction scenario.

Supporting elements

Introduction

Beside the four interactive installations, the exhibit will benefit from a number of support elements. You will read about those here.

Outside views

The Bonaire museum will not be floating on water. However, in the days when it did, the water would reach over half the height of the machine room. The crew was working under sea level. To really make use of the space on board, as well as give visitors the opportunity to empathise with the ship crew, two spots on the wall in the room will depict a view of the outside. These stickers will span the entire height of the room, and show where the water line was in addition to what is under and above it. The two scenes will differ vastly, to show two sides of marine life. One will depict a battle going on above sea, with debris sinking into the depths below the water surface. The other will depict clear waters, with colorful sea life underwater and an idyllic tropical setting above it.

Telegraph and speaking tube

Next to the outside view of the sea battle, and near the installation 'the Crew's Work' are a telegraph and a speaking tube. The telegraph pointer can move with a servo motor, and the speaking tube has a speaker in it. Above deck, a similar set of telegraph and speaking tube is in stalled, but this time with an angle sensor and a microphone   this set is for input. When someone upstairs moves the telegraph and/or says something in the speaking tube, it will be played back periodically by the downstairs speaking tube and the telegraph will move to that position. This shows visitors how the com munication worked on the ship, and is at the same time an interesting interaction. The speaking tube will also periodically play back other recordings that were made in advance, simulating the stress of the battle shown in the outside view next to it. These messages concern 'the Crew's Work' as well.

Machine outlines

The technical elements of the machines are already in part being communicated
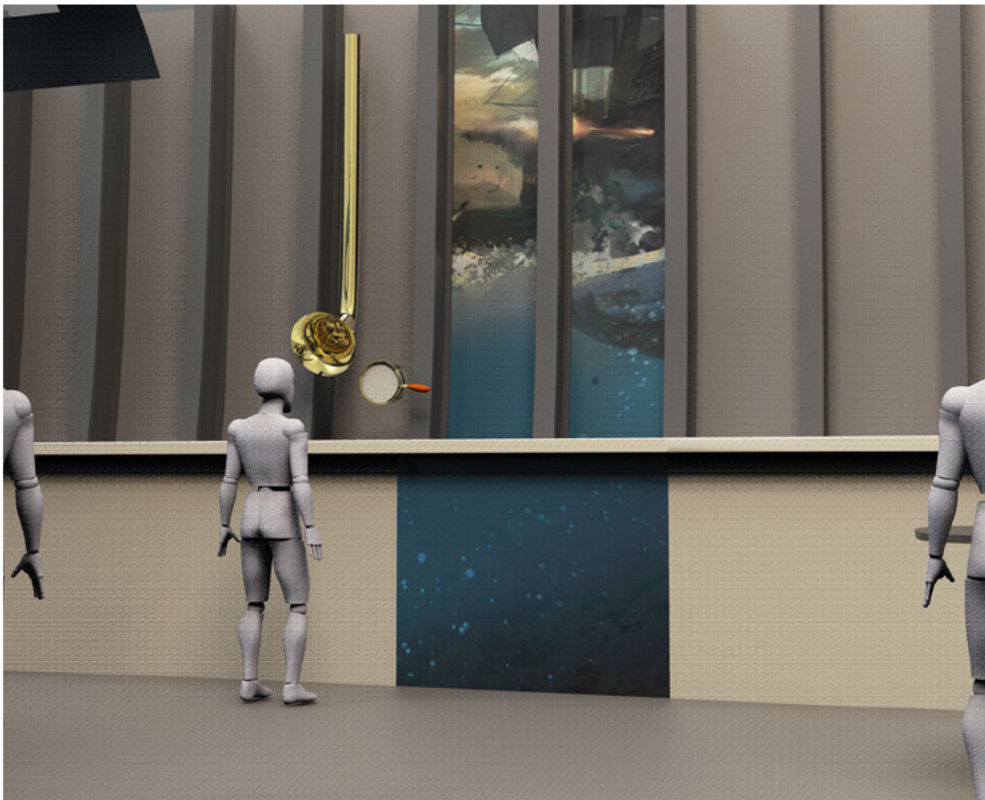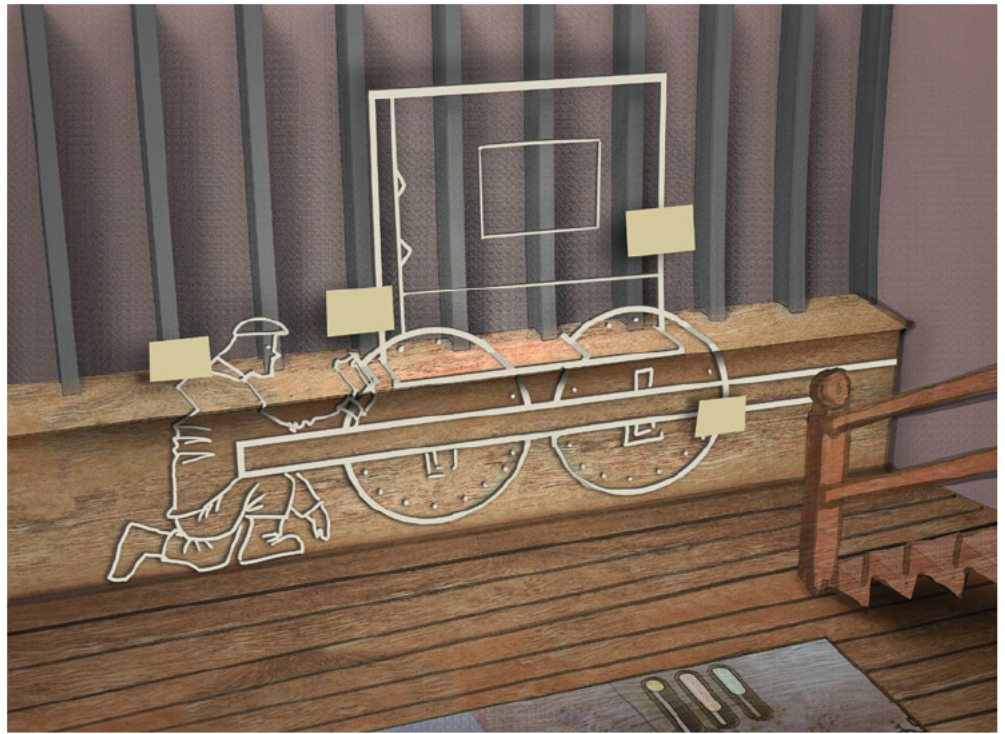
by several of the interactive installations, but the scale off the machines is hard to show without using 1:1 material. There fore the room will feature several 'out lines': one for the engine, against the right wall, and two for the boilers, one against the left wall and one above the bar.

Information plates

Of course there are a multitude of target groups to adress, not just students. Many visitors will want to get detailed informa tion. While the visual quality of the inter active installations has educational value as well, they will be complemented with information plates. These more 'tradition al' museum elements hold text and images that can go much deeper into the subject for those that are interested.

Map floor

As you will be able to read later, part of the floor is covered in a mat with a projected sea map. However, to visually tie the rest of the room together, the rest of the floor will also be marked with a simplified continuation of this map. This will make the room feel more like a whole, and also tie the 'Sailing the World' instal lation to the rest of the room.

Soundscape

Like the original engine room, there should be sounds in this room to give a strong impression. Besides any sounds that installations make, there should be sporadic moments of sound, so once ev ery five minutes the engine room becomes filled with the sound of distant hissing engines and clanking metal. Additionally, the outlines and outside views could have button activated speakers that give a little extra context by making machine or sea noise respectively.

Educational package

The interviews also point out that an educational package provided by the museum would be a great addition to the design. This would make it easier for teachers to prepare their students for the trip, and would tailor better to the contents of the museum than what the teachers could make themselves. Additionally, it provides the museum the chance to engage with the students before they have even arrived, possibly negating some of the negative preconceived notions of the trip.

Styling

It's important that the whole engine room looks like a coherent whole. In this section, you will read about the styling plan for the exhibition elements.

The visual identity of the exhibit is important, because it makes visitors feel like all details are in place, like the interaction vision says. Additionally, it can be a great addition to the interaction if the space conveys a certain set of 'memes', or cultural indicators.

The collage in fig. 23 displays the shapes and materials of these memes. They were chosen as a combination of the wood of the ship and the brass parts of the engine room. The interesting thing about the ship's wood is that most of it is bent or rounded in some way; this is necessary for the shell. The brass parts in the engine room of the Brunings (scheepvaartmuseum Amsterdam) are only in some spots, and visually only make up a minority of the design. This is reflected in the collage, and will also be reflected in the designs of the separate elements.

Digital interfaces
The digital interfaces of the installations also need a coherent style. This style can be seen in fig. 24. It uses a lot of brown, to fit with the wood of the physical elements, but also bright blue and pink to make certain things stand out. Blue is the main contrast color, as it is complementary to the orange hue of the brown. Pink is a good color for UI elements, as it is not a color that is logical to use for steam technology elements, and it is a pleasant middle ground between blue and orange. All colors mentioned here are not fully saturated, which makes them blend together better. It should be noted that the orange is quite distinct, and only used in the part for the fire. In this way fire, water and steam should have distinct colors, so that the process becomes easier to follow and more consistent.

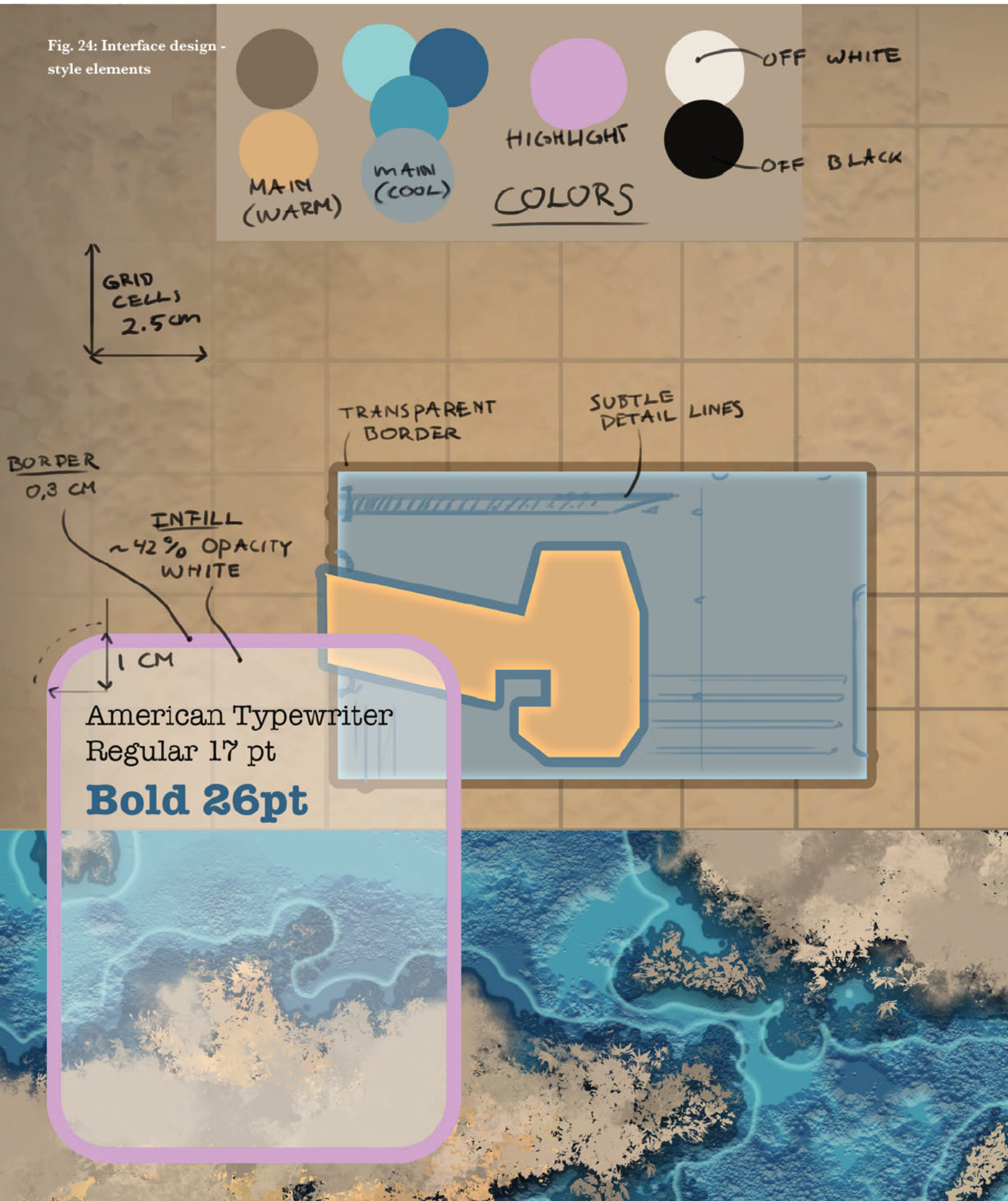Fig. 22: Part of the interior of the Brunings, showing the copper influences to the styling collage

Fig. 23: Embodiment styling - memetic collage

**Fig. 24: Interface design -
style elements**

OFF WHITE

HIGHLIGHT

OFF BLACK

MAIN
(WARM)

MAIN
(COOL)

COLORS

GRID
CELLS
2.5cm

TRANSPARENT
BORDER

SUBTLE
DETAIL LINES

BORDER
0,3 CM

INFILL
~42% OPACITY
WHITE

1 CM

American Typewriter
Regular 17 pt

Bold 26pt

Interaction

In order to create cohesion in the exhibit, a general interaction scenario depicted in fig. 25 defines the interaction that each interactive installation provides the visitor. As you can see, when the visitor arrives, but before they have identified themselves, the installation should make clear to the visitors what they can do there. When they have identified themselves, it should give an explanation of how to perform the interaction (however simple that may be). Then the specific interaction for that installation takes place. At the end, the visitors get a results screen which displays what they did, and what meaning their actions might have had in the real ship. In cases where it is relevant ('the Engine Room' and 'Design for Steam'), they also get to see a video showing the original layout or design of the engine room or machines. It also shows where they can go next to do more things in the exhibit. This helps create the feeling of continuity and cohesion. A step by step plan like this keeps the interaction clear and easier to understand for visitors.

This sequence will, in three of the installations, be accompanied by a physical knob (fig. 26). This knob has four settings: Intro, Explanation, Go! and Outro. Visitors can rotate the knob to progress in the installation. The installation that does not have this knob is a touchscreen, where this function can be added digitally.

Arrive

Introduction

- Short preview of the inter-
action

Ontwerp de
Machinekamer!

Start

Enter ticket

TICKET HERE

- Explanation of how the
interaction works

Explanation

Installation-
specific
interaction

Zie verbanden

Behaal de
doelen

DONE

WELL
DONE

Efficientie

Ergonomie

Voortgang

En nu?

- Results of the interaction

- Extra information about
the context

- Suggestions on where to go
next

Results
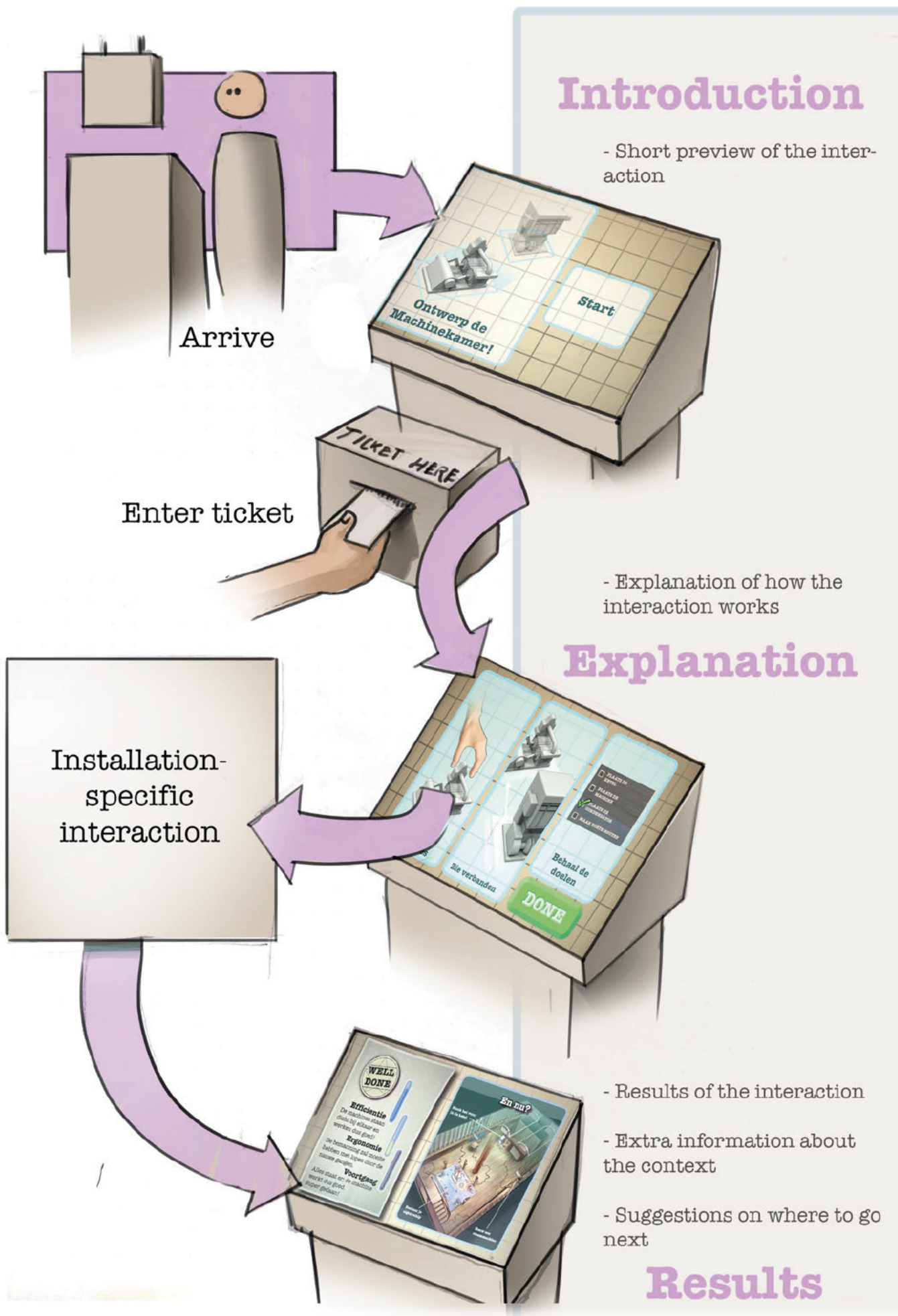
Individual Installations

'Sailing the world'

Introduction

The first installation discussed here is called 'Sailing the world'. In it, visitors can use a console with a ship's steering wheel and a telegraph to manoeuvre a ship across the sea. They can learn about the relevance of steam technology here, as well as experience a simplified sea battle.

Where?

From the entrance, Sailing the World can be found straight onwards, in front of the stairway (fig. 29). However, the map continues on onto the rest of the floor to create visual coherence.

The installation

Sailing the World consists of a big mat on the floor, with a projector projecting a map onto it. On this map, there are two red ships, two blue ships, and two black ships. These correspond to two player teams and a non player computer con trolled team respectively. On the map are also islands, with 5 harbors in total, and a user interface (UI) area for each player.

Around the map are four consoles, pillars with on top of them a ship's steering wheel, a telegraph, a button and a ticket identifier. Visitors start the interaction by scanning their ticket, and after a short explanation they can use the other three controls to commandeer their ship. The steering wheel is for going left or right, the telegraph for determining forwards or backwards and speed, and the button fires the cannons.
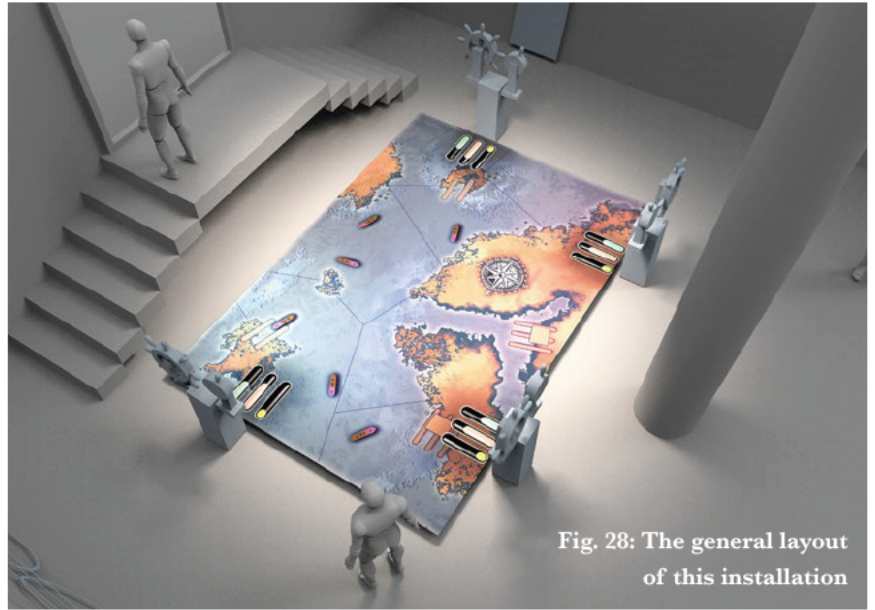
Fig. 28: The general layout of this installation
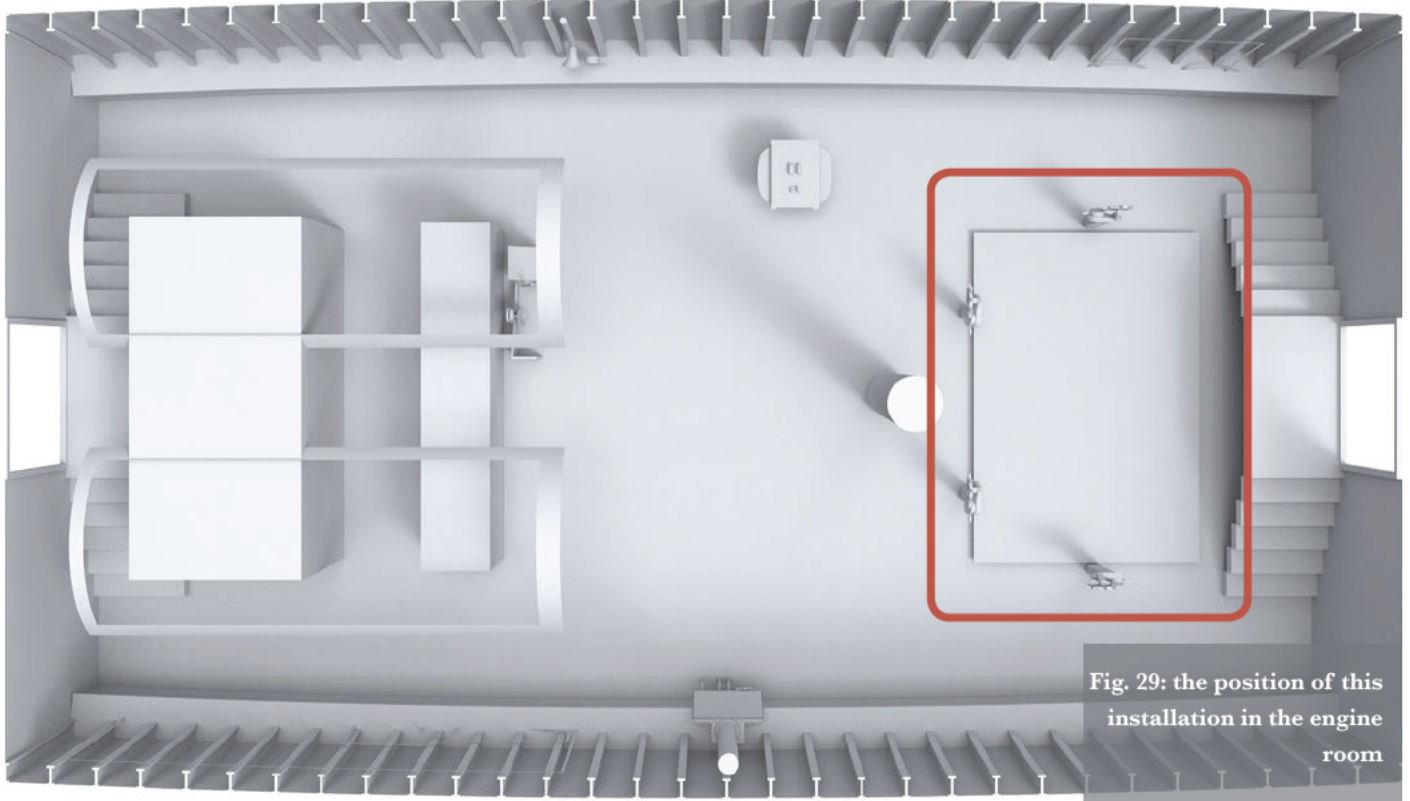
Fig. 29: the position of this installation in the engine room

Steering wheel
Telegraph
Identifier
UI area for this console
Console number
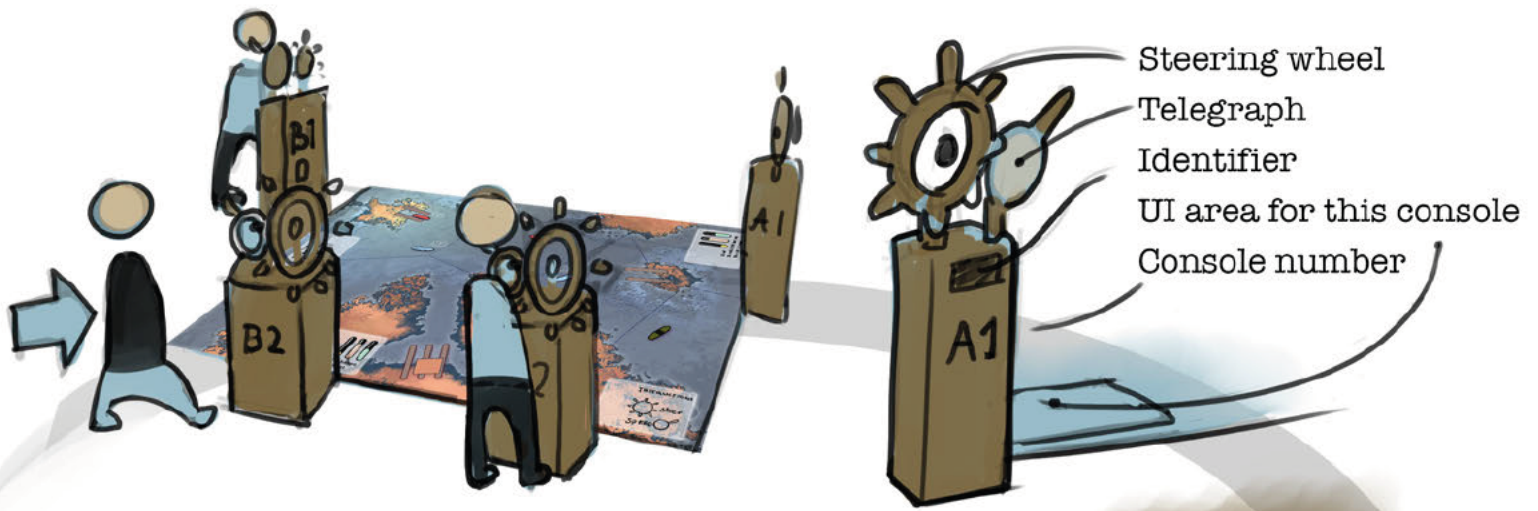
Matching ship number

Team color

A1

Welcome!

Explanation

UI Area

A1

Goals
O Reach x harbor
O Sink 2 pirate ships
O Sink 1 blue ship

Food Coal Health

Move

BOOOOM!

Shoot ships or obstacles
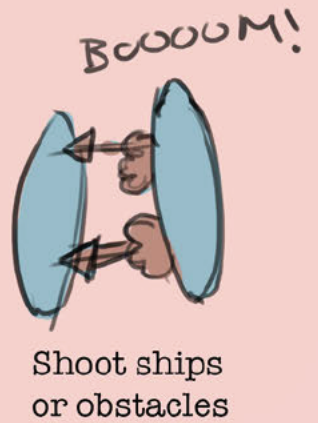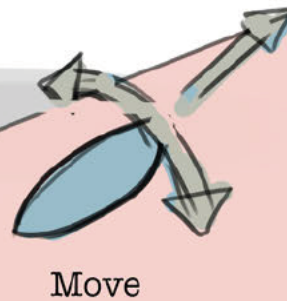
Emptied resources reset your position to a harbor

Sailing reduces coal.
Time reduces food.
Harbors replenish all resources

Cannonballs & obstacles cause damage
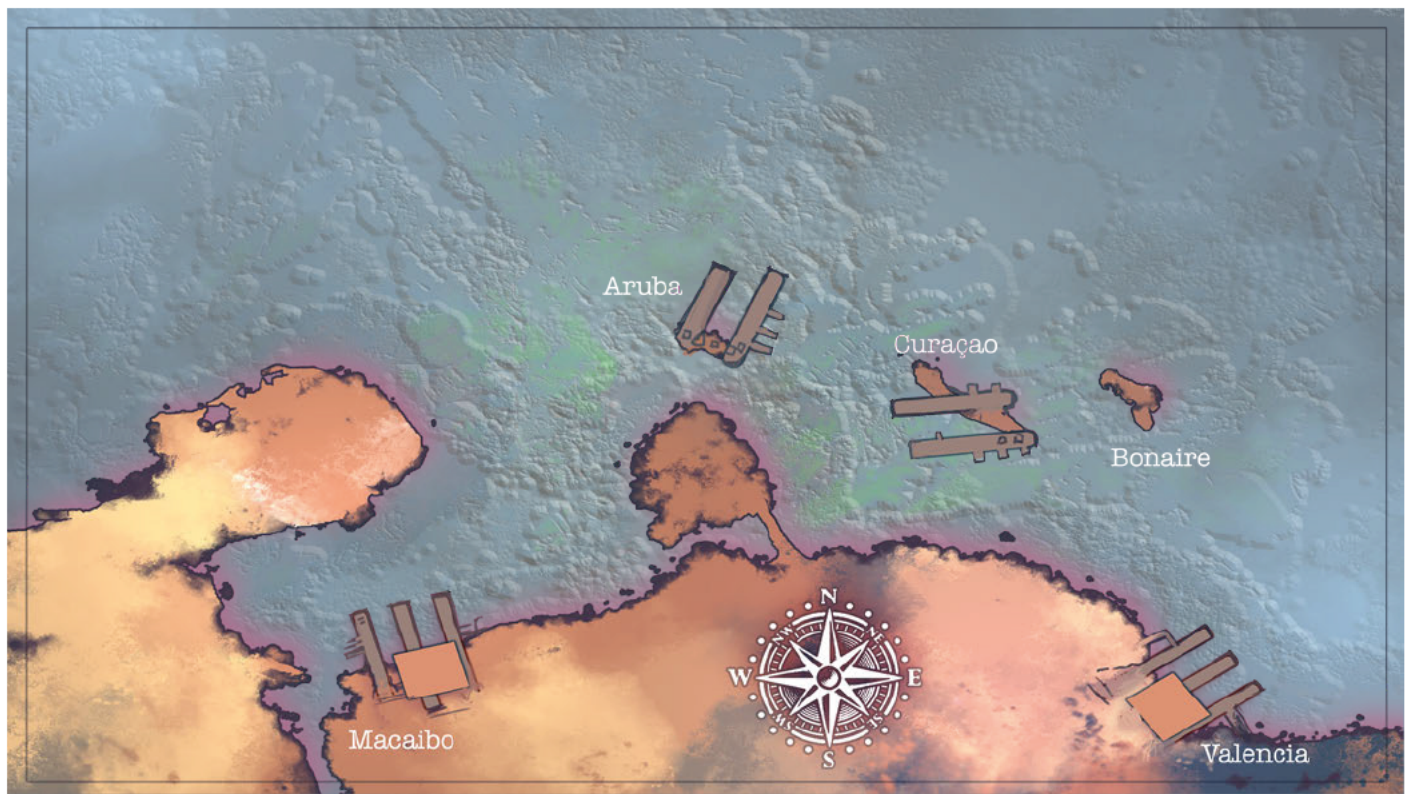
The interaction

The installation is always moving; When there is no one interacting with it, all of the ships are controlled by the computer to sail from harbor to harbor.

When a visitor arrives and sees an empty console, they can move to it. Consoles have a number, linking them to one of the ships on the map. the UI area for an unused console is not yet visible.

All this is so that when a visitor scans their ticket in the identifier, the UI will pop up, which is more noticeable than if it had been there before. On the popped up UI, the user gets a short (no more than 10 second) explanation on how to control the interaction. While this happens, their ship 'teleports' to the harbor near their console.

Then, the main part of the interaction starts. The UI area shows three full bars labeled 'Food', 'Coal' and 'Health' and a series of goals. The goals include sailing to a specific harbor, and sinking a specified amount of pirate ships.

When a visitor causes their ship to bump into land or another ship, their health goes down. When another ship shoots them, their health also drops.

When their health is depleted, their ship 'teleports' back to harbor.

Food is a measure of time. It will steadily run out, and give a sense of urgency. When food is depleted, the ship teleports back to harbor

Coal consumption is determined by the telegraph. The Bonaire is a sailing ship, so it will work without the engine, but generally slower. The telegraph has options for base speed, or several stages of faster movement. The faster options consume increasing amounts of coal. When coal runs out, the ship is not teleported back to harbor.
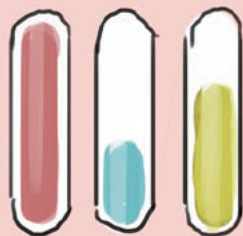
When a ship reaches harbor, either through depleted resources or just by sailing there themselves, all their resources are replenished.

Embodiment

The mat on the floor is about 3 by 4 meters, so the resolution of the projector is relevant. In this case, a 4k projector with the appropriate throw distance could produce an image where every pixel is a square millimeter. This is plenty, for both the visual aspects and the text.
The mat itself should be made of a sturdy

Fig. 30 (top): The map of the Colombia and Venezuela area that this installation takes place in.

Fig. 31 (opposite page): The embodiment design of the steering consoles.

The interaction   **Embodiment**

material that wears well, so that it will stay functional for a long time. It is important that the surface is very matte, and a light grey color. The reason for this is that a glossy surface will produce a lot of reflections that make it hard to see the projection, a dark surface makes the light parts of the image too dark, and a white (or at least, too light) surface restricts the darkest shade that can be used in the projection to the color of the projection surface.

The consoles (fig.32) are primarily constructed out of wood. They consist of a hollow pillar, through which cables for power and communication can run, and a top section, with the controls.
The controls are mounted on a smoothly curved plate. The steering wheel sit on a protruding stand and is entirely made of wood, the telegraph is mounted directly on the plate and is made of brass or brass covered material for the case, wood for the handle, and printed paper with a transparent plexiglass cover for the face. The handles of the steering wheel and

telegraph are painted a lighter color to indicate and/or confirm that they are the usable parts of this mechanism.
The telegraph uses a vble the wheel turning more than 180 degrees to either side. The button sits under the steering wheel. It has a brass covered ring around it and is itself glossy red, to stand out.
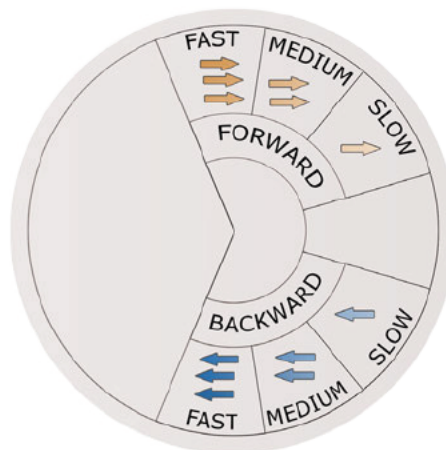
Fig. 32 (opposite page): More about the console's embodiment design.

Steering wheel

Button

Telegraph

Barcode scanner

Pillar

Potentiometer

Cabling
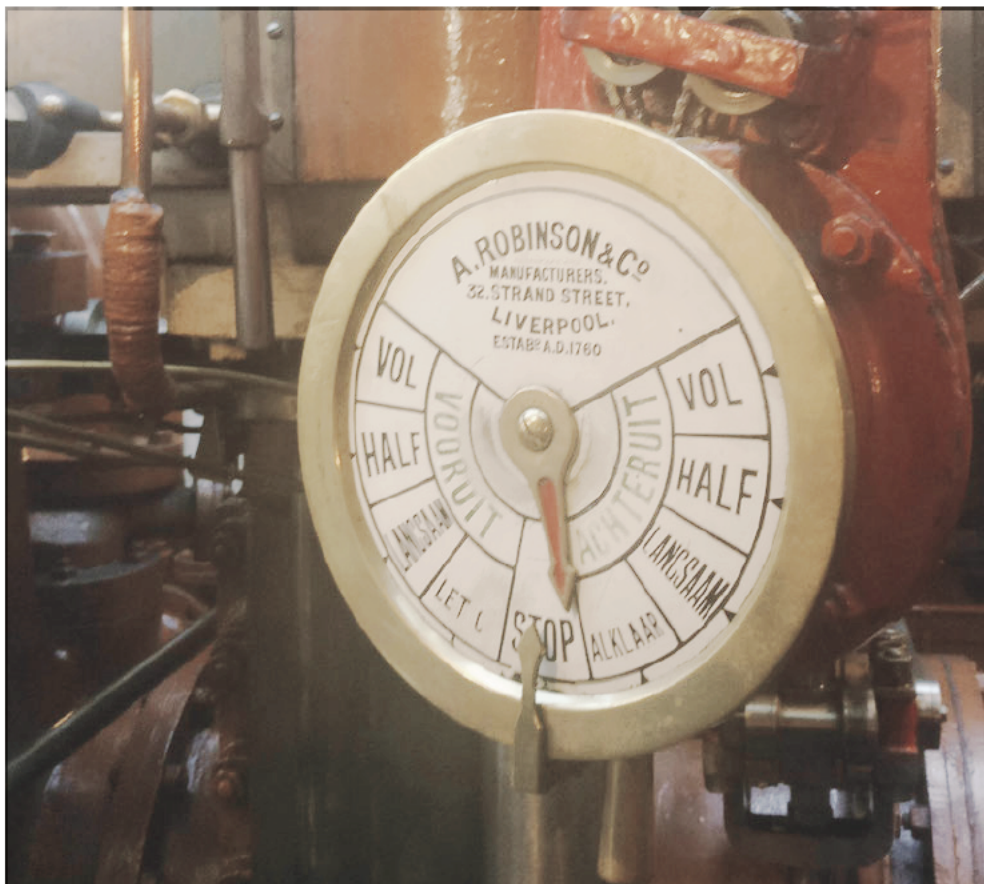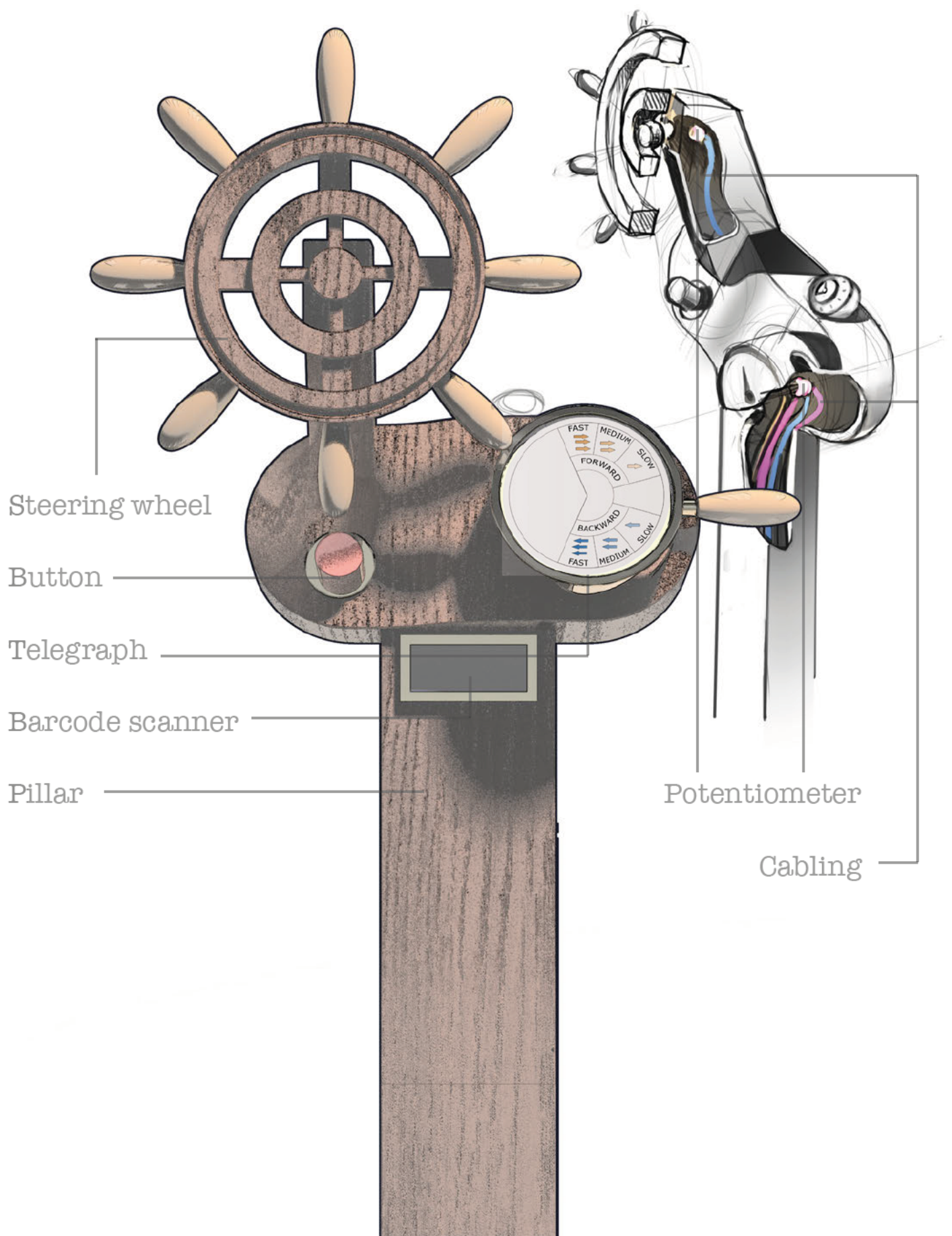
'Design for Steam'

Introduction

The second installation is called 'De
sign for Steam'. In it, visitors can use a
touchscreen to build a steam engine and a
boiler. A schematic 2D style allows visitors
to see what each component in the system
does, and thus learn about the functional
ity of the steam technology.

Where?

From the entrance, Design for Steam can
be placed in the middle of the left wall.
(figure 36)

The installation

The installation comprises of a touch
screen, mounted against the wall. The
screen has a barcode scanner under it,
and sits in a wooden casing.

The interaction

When a visitor arrives at Design for
Steam, the screen displays an invite: "start
 steam ship design". It also displays a
preview of what might be made by the
visitor at this screen. When a visitor scans
their ticket, they get a short animated

explanation about how the steam process
works   fire makes water boil, which pro
duces steam and drives the pistons, which
in turn powers the ship's main axle. They
get a short indication of how to operate
the touchscreen, i.e. how the onscreen
buttons work.

Then the main interaction starts. Visitors
are first prompted to build a boiler or
a steam engine. They can push the top
button of the three to open a menu with
components: The fire chamber, chimney,
water tank, water inlet and steam outlet
for the boiler, or pistons, steam inlet,
crank arms, axle and condensor for the
engine. When they drag these compo
nents into the 'build area', they snap onto
a grid. When two components are placed
close to each other, the system checks
if they can connect, and connects them
together if possible. It then makes sound
and shows an animation of fire, water,
steam, movement or smoke (whatever is
relevant, based on the components) to
indicate that the two components work.
The visitor can continue this process until
all the components have been placed. He
or she can also move components after
they have been placed to make room for

Touchscreen

Welcome!

+ steam process
explanation

Explanation

Barcode
scanner

Build!

Components

More Info

Done

Click

Process
explanation

Done!

Extra
Info

Great work!

Results | Further visit
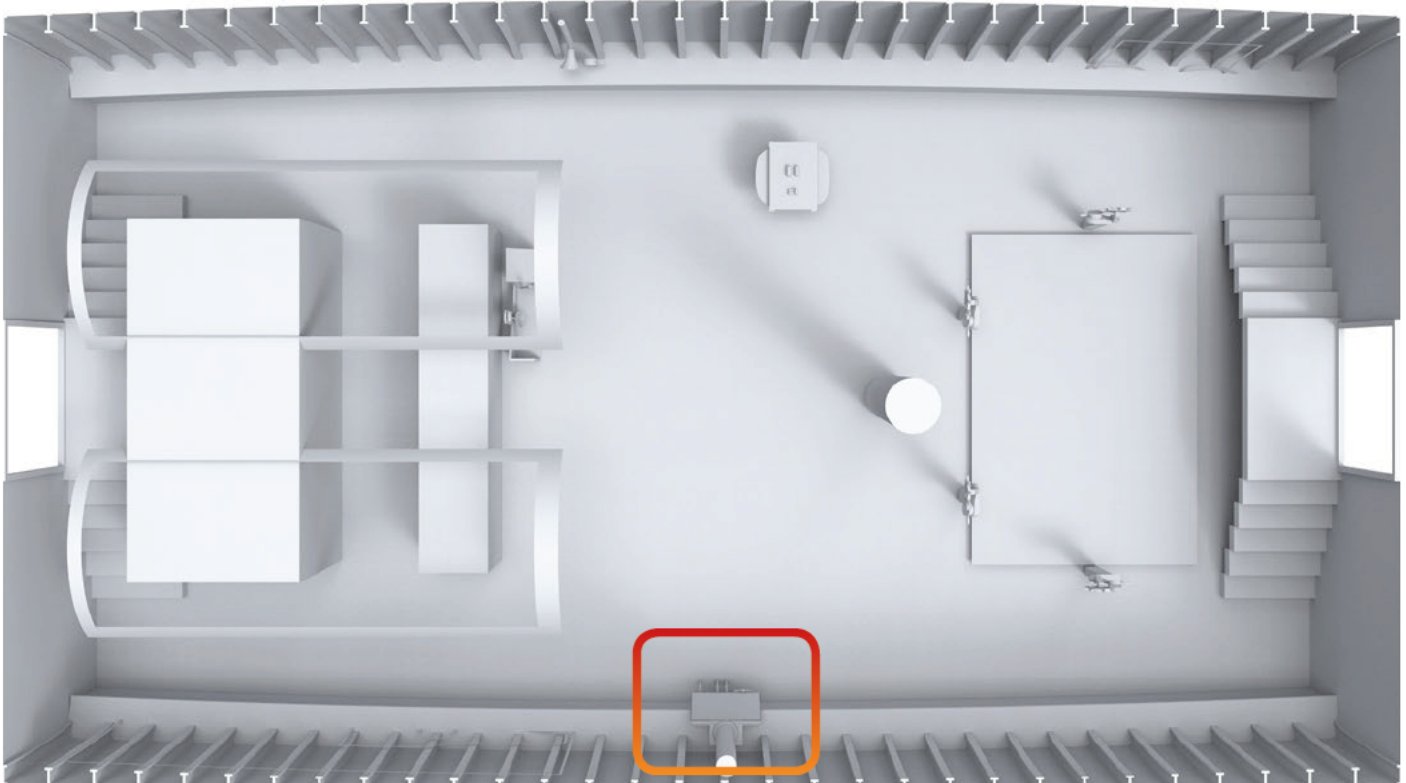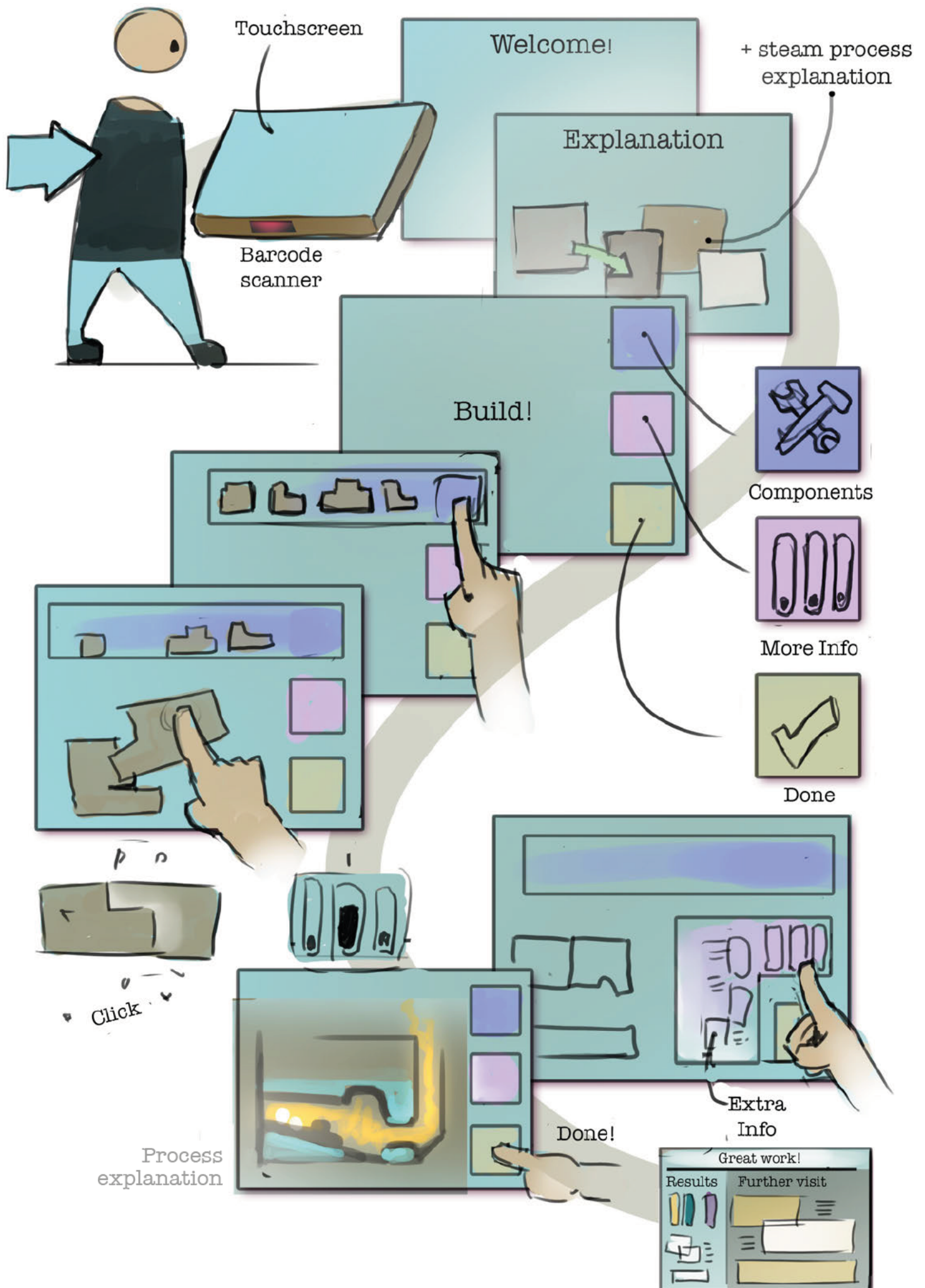
others. When they press the second but
ton, a menu opens that shows some extra
info about the boiler or engine. When the
visitor deems their creation finished, they
can press the third button. This will lead
them to a final screen, which shows the
results of their interaction, as well as what
else they can do in the engine room.

Embodiment & styling
This installation is only a touchscreen,
and thus would not need much embod

iment to function. However, it is still an
opportunity to create visual coherence
with the rest of the room (fig 39). Addi
tionally, since the installation is positioned
partly into the wall and does not take up a
lot of room, it should be able to stay when
there are meetings. As you can see in
figure 40, behind the screen is a comput
er, which sits freely in the container with
lots of extra empty space. The computer
links to the barcode scanner and screen,
and controls the visitor interaction. It

START!

STEAM SHIP DESIGN

Non-functional

Screen

Computer

Access hatch

Fig. 40 (opposite page): Embodiment details about Design for Steam

Fig. 41 (right): This explanation shows a clear explanation of the steam process happening in the boiler and engine
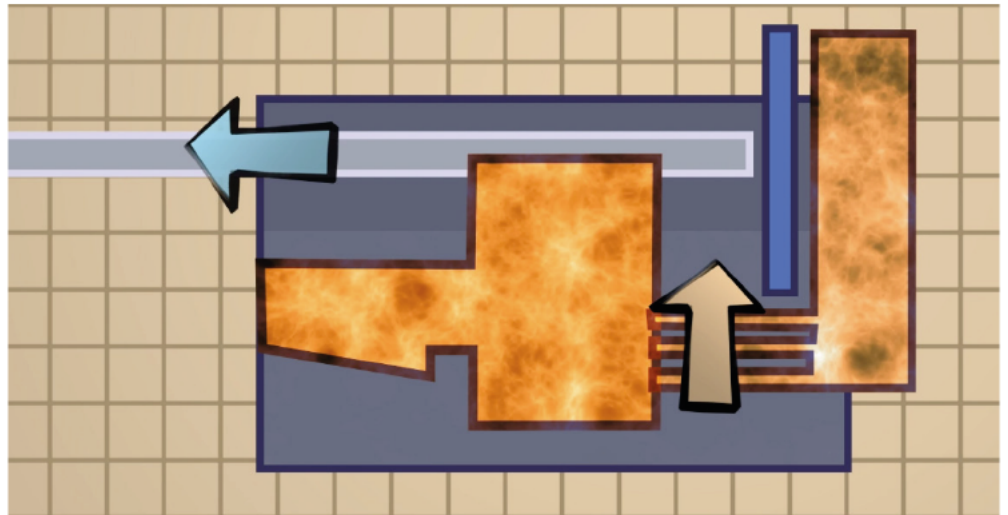
also connects to the main system via the wall. An access hatch allows some simple maintenance, but the entire thing should also be removable in case a component needs thorough maintenance or even replacement.

Interface
The installation's interface styling is mainly based on the styling guide on page 32. Notable is the fact that there should be a clear color indication for separate elements: fire, steam and water should be easily recognisable. This has not been set in stone yet, as can be seen in figures 38 and 41, and will have to be decided still.

'the Crew's Work'

Introduction

The third installation is called 'the Crew's Work'. In it, visitors can use a shovel to throw faux coals into a hole, simulating engine crew shoveling coal, and they can let water into the boiler. They get multi sensory feedback on their input, so that they can fully experience what it was like to work there.

Where?

The Crew's Work can be found against the right side of the bar, close to the out side view and a telegraph/speaking horn combination.

The installation

The Crew's work consists of a console with a screen on top of it and an opening in the front. A shovel hangs to the side of the console, and it has a lever on the other side. Next to the pillar is a container with faux coal blocks.

The interaction

The Crew's work simulates some of the jobs that the crew had to perform when operating the machines in the engine room. After arriving, and scanning their ticket, visitors get an explanation about how the boiler heats up water with a coal fire, and how the steam generated there makes the pistons of the steam engine os cillate. Visitors can then use the shovel to shovel the coal blocks into the opening. If they do so, the sound of fire will play from speakers inside the opening, and some heat will come out through a radiator. Additionally, the screen will display coals entering the boiler, a fire starting, and the flow of hot gases, heat transfer to the water, and the steam exiting.

Visitors can also pull the lever, which is labeled with a blue ring. When they do so, the sound of flowing water plays, and the screen shows the boiler filling up. After a short while, the visitor gets a warning message, telling them to solve a problem related to the boiler: The water is running low, the fire is going out, there is too much pressure or heat, whichever is most relevant based on the amount of water and coal they added up to this point. After a short period (something like 5 seconds) a hint appears that helps them solve the warning, in case they did not

Intro

Explanation

Start

Lever

Screen

Barcode Scanner

Shovel

Faux Coal

Hole

Sound

Heat

Coals enter the screen

WARNING! TOO LITTLE WATER

Water rises

DONE

Great work!

Results   Further visit
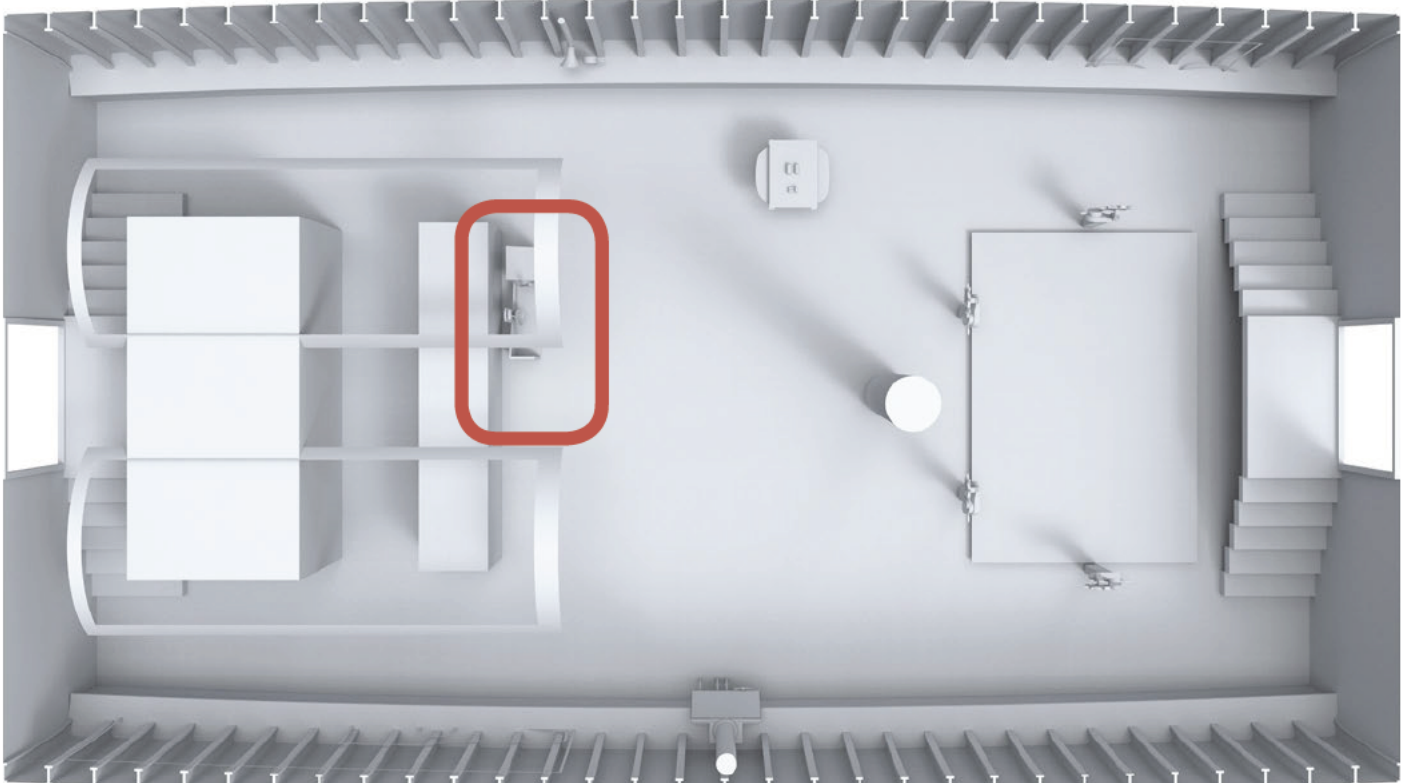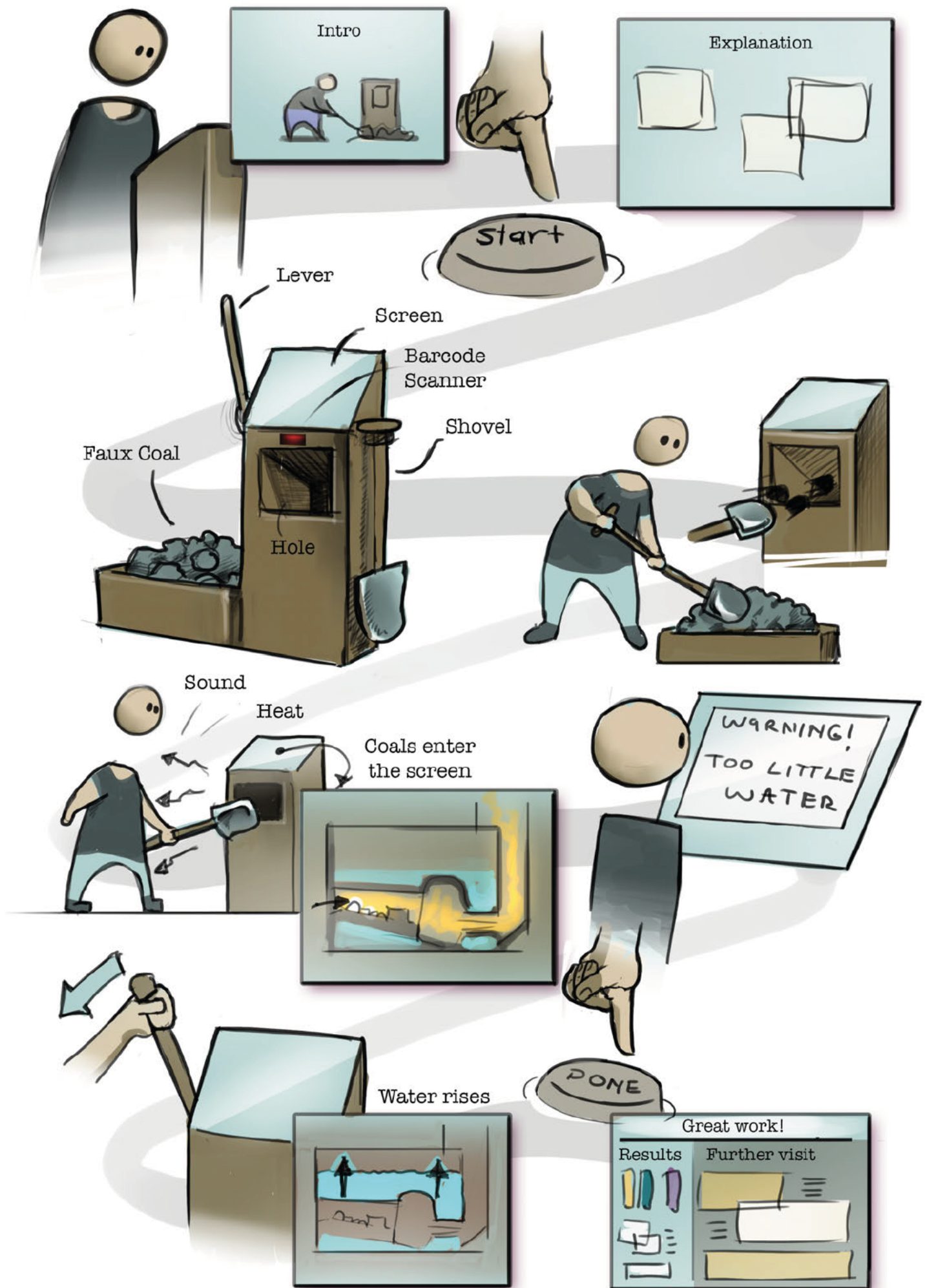
understand how to do so.
When visitors solve these problems, they get some positive feedback and can continue.

A bar will track 'progress' during the in teraction, filling up a little while shovelling or adding water, and a lot when solving a warning message. The interaction does not end when the bar is full, it is just an incentive to stop.

When the visitor is done they scan their ticket again to end the interaction, which brings them to the results screen.

Styling

The installation will be placed under one of the large overhead boiler outlines described on page 30. As you can see in figure 45, the installation continues the round line in both the console and the wooden container beside it, so that from a distance the giant cylinder of the boiler is more visible. The design of the console is based on the design of the boiler in the Brunings, a ship that is a little younger but still in generally the same age range (fig. 46). The visually iconic hatch weights and matte metal are very different from the rest of the design, and therefore will stand out considerably. To tie the installation to the rest of the room, the shovel and coal container are both modeled in more co herent fashion with the other installations.

Embodiment

The installation will be built out of wood and metal. The shovel can be a normal shovel, although it is important that the end is concave in order to shovel the coals efficiently. The screen in the console is flush with the surface. The console itself has the opening, which leads directly back to the coal reserve. There is a light sensor that detects the passage of coal. This setup will not allow for the detection of how much coal passes, but it will man age to count how many times it passes. Shovelling performance is thus measured by the 'shovels per minute' and not 'coals per minute'. A consideration would be to make the shovel small, so it becomes more logical to shovel small amounts anyway. The lever to the side of the console is mounted in a purely decorative way. Its

Fig. 44: Sketch of a visitor interacting with The Crew's Work

Fig. 45 (above): Embodiment
sketch for the Crew's Work.

Fig. 46 (right): Reference
from the engine room in the
Brunings, for the embodi-
ment of the Crew's Work.

functionality is mainly comprised of a po
tentiometer and a spring damper mecha
nism. The potentiometer can feel how far
the lever is turned, and thus how fast the
water should flow into the system. The
mechanism stops the lever after a certain
turn angle, and calmly pulls it back to its
starting position after the user releases it.

The coal blocks will be made of black
or dark grey foam. A rigid polyurethane
foam is a good choice.
The material should be bought either
in sheets of ±5 cm thick, or in scraps
that have a type of natural shape. The

latter only need to be cut to manageable
size (maximum around 7x7x7 cm). The
former need to be cut in a semi random
way, to represent the natural shapes of the
coals.
The choice for foam spans from several
considerations. First, it is likely that the
blocks will experience being stepped
on accidentally of purposefully, and
the springiness should ensure that they
are reusable afterwards. Second, in the
event that the blocks are lost or destroyed
anyway, it would cost minimal effort to
replace them. (in fact, it might be a good
idea to have a reserve.) Lastly, cleaning is

Fig. 47: Series of visualisa-
tions showing the embodi-
ment of The Crew's Work

Valve

Shovel

Screen

Coal opening

Coal reserve

Spring & damper

Computer

Sequence knob

Coal chute

Coal detection
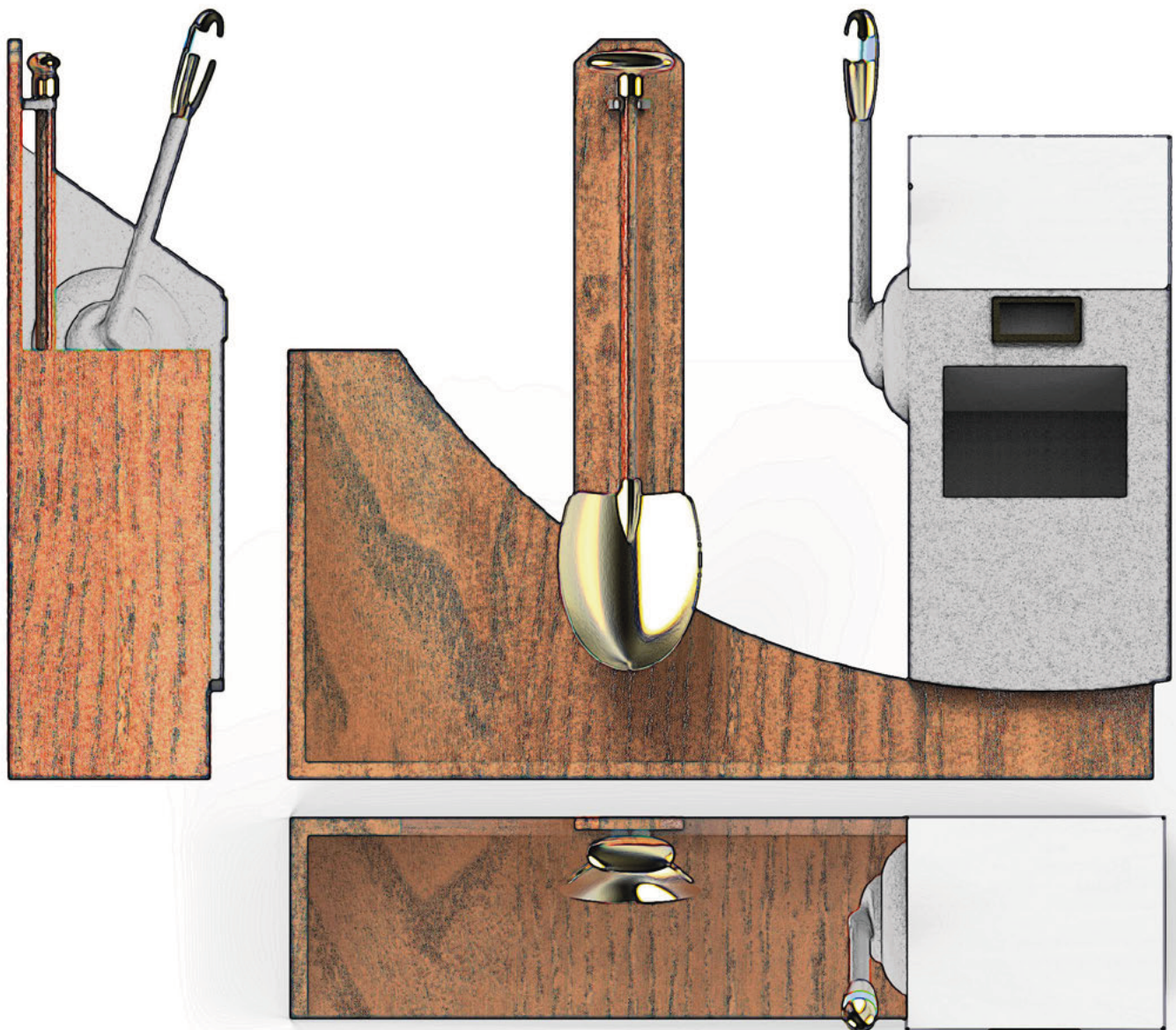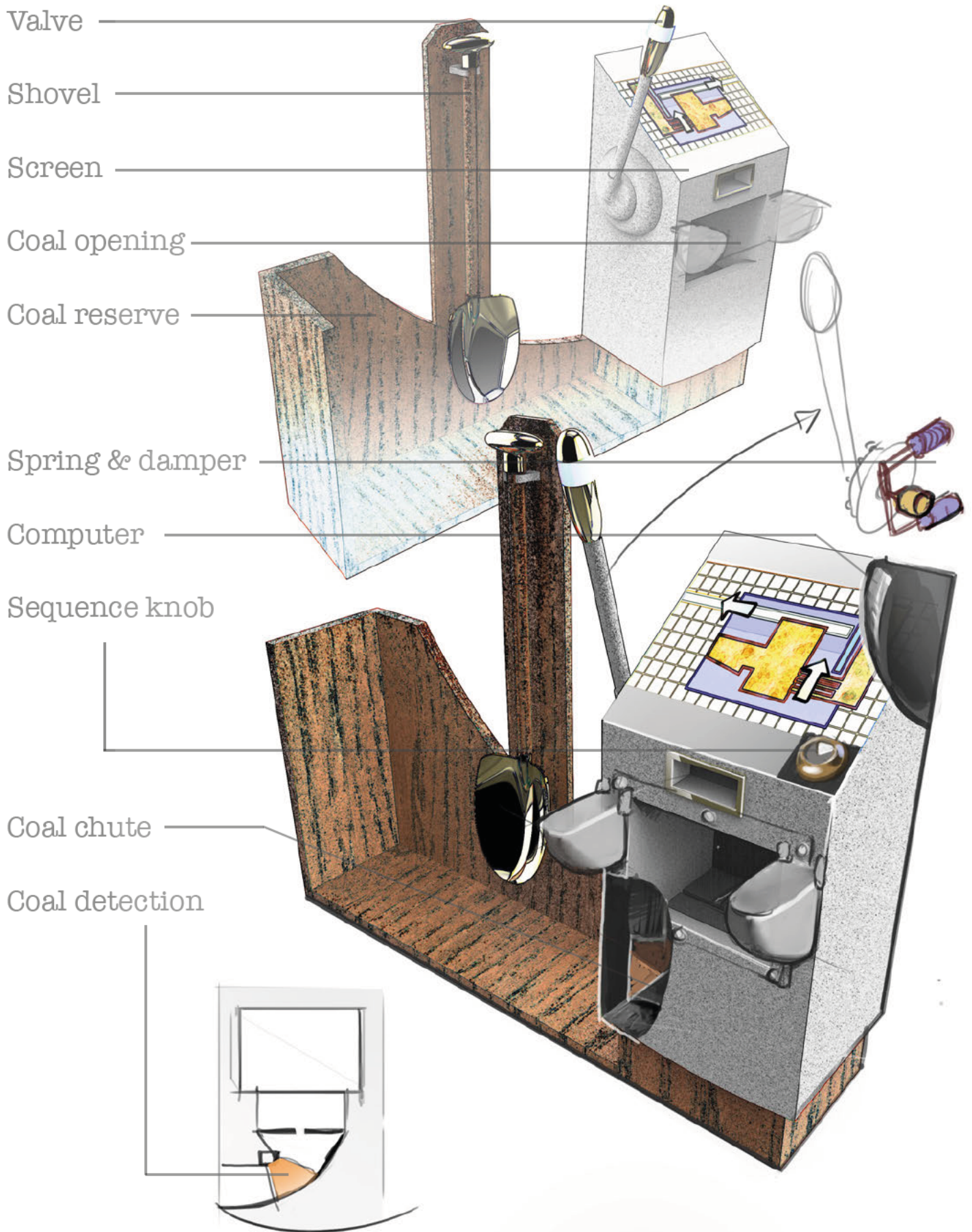
an important consideration. It is possi ble that because the coals are obviously cheap, light and not fastened to anything, they will be used in non intended ways like being thrown around occasionally. The extremely low weight and soft mate rial of the blocks will minimise the risk of anything else breaking because of this.

Related to this, there should be no blocks that are really small so they do not get into any small cavities, and there should be a regular session where all the blocks are sweeped back into their container. The semblance to actual coal is minimal on a functional level. The blocks are soft, slightly glossy, not dusty, make next to no sound when shoveled, and probably have slightly different types of shapes than real coal. It would therefore be a nice addition
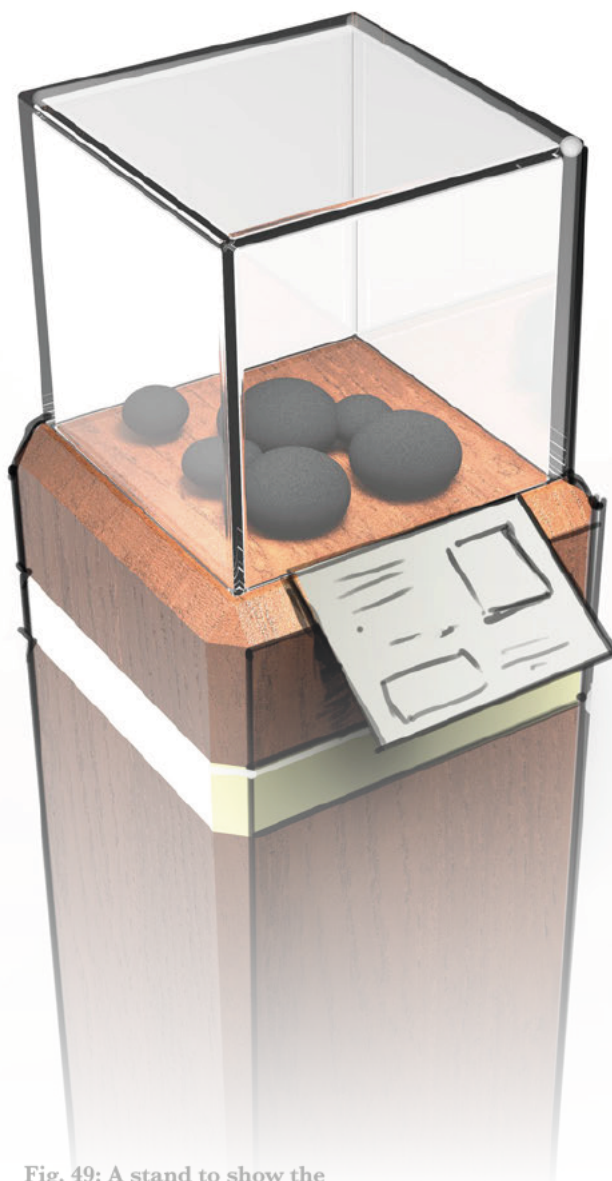
! WARNING !

STEAM PRESSURE OVERLOAD

Fig. 51: Sketch of the steam valve that should be some-where else in the room

to the exhibit to place a pedestal with some actual coals behind a glass cover next to the installation.

Steam pressure trouble
There is a steam valve (stoomafsluiter) in this installation as well. This steam valve could be a solution to some of the emergency situations posed to visitors during the interaction. To accompany emergency warnings about steam pressure overload, a steam whistle could blow near this valve. This is a high pitched noise that authentically informed the ship crew of pressure problems. So whenever the whistle blows, visitors need to turn the valve, blowing off some steam and solving the situation.

Spreading the elements
It was noted in a meeting that the different controls of this installation don't necessarily need to be in the same location. Spreading them out, even slightly, creates some more activity in this installation, and allows for more teamwork. It also allows the controls to be in their authentic locations. The downside of putting the controls elsewhere instead of all on the same device is that more/longer connections between them have to be made, which can increase material costs and/or input latency depending on the method. As it was introduced late in the process, it is not officially included in the design, but definiely something to explore further.

'The engine room'

Introduction
The final installation is called 'the Engine Room'. In it, visitors can put miniature versions of steam machines on a screen showing a top down view of the engine room and learn about the machine's functionality and connections.

Where?
The Crew's Work can be found in the right half of the room, accross from 'Steam Design'.

The installation
'the Engine Room' is a table with a 42' screen in it and a plexiglass cover. On the long sides of the table are two plateaus. On the plateaus, and connected to them with metal core cord, are five machines that used to belong in the engine room: Two boilers, an engine, a condensor, and a warm water reserve.

The interaction
Visitors can, after getting an introduction, place the miniature machines on the screen. A camera above the installation detects the location and orientation of the machines, which allows the screen to display a halo with information near them. When several machines are on the screen, the screen also displays connections between them (e.g. the boiler provides steam to the engine, or the condensor leads warm water to the warm water reserve). Once the visitor has placed two machines, a small area of the screen shows some goals that the visitor can achieve: placing all machines, and creating an efficient room layout. An efficient layout is something that will have to be examined further, as it is not clear at the time of finishing this project what would be a good end goal in terms of both authentic and educational value. If it had to be defined right now, short walking routes for the crew and short pipes between the installations would be a considerable option. In any case, the system should give some sort of feedback when visitors are placing these routes; e.g. a number or star rating when they place the machines. This way they already have an idea of what they have to do to meet the goal, and they will not have to try things out randomly until they find the solution.

Fig. 52: Scenario for visitors interacting with 'the engine room'.

Fig.53: Position of 'the engine room' in the exhibit.
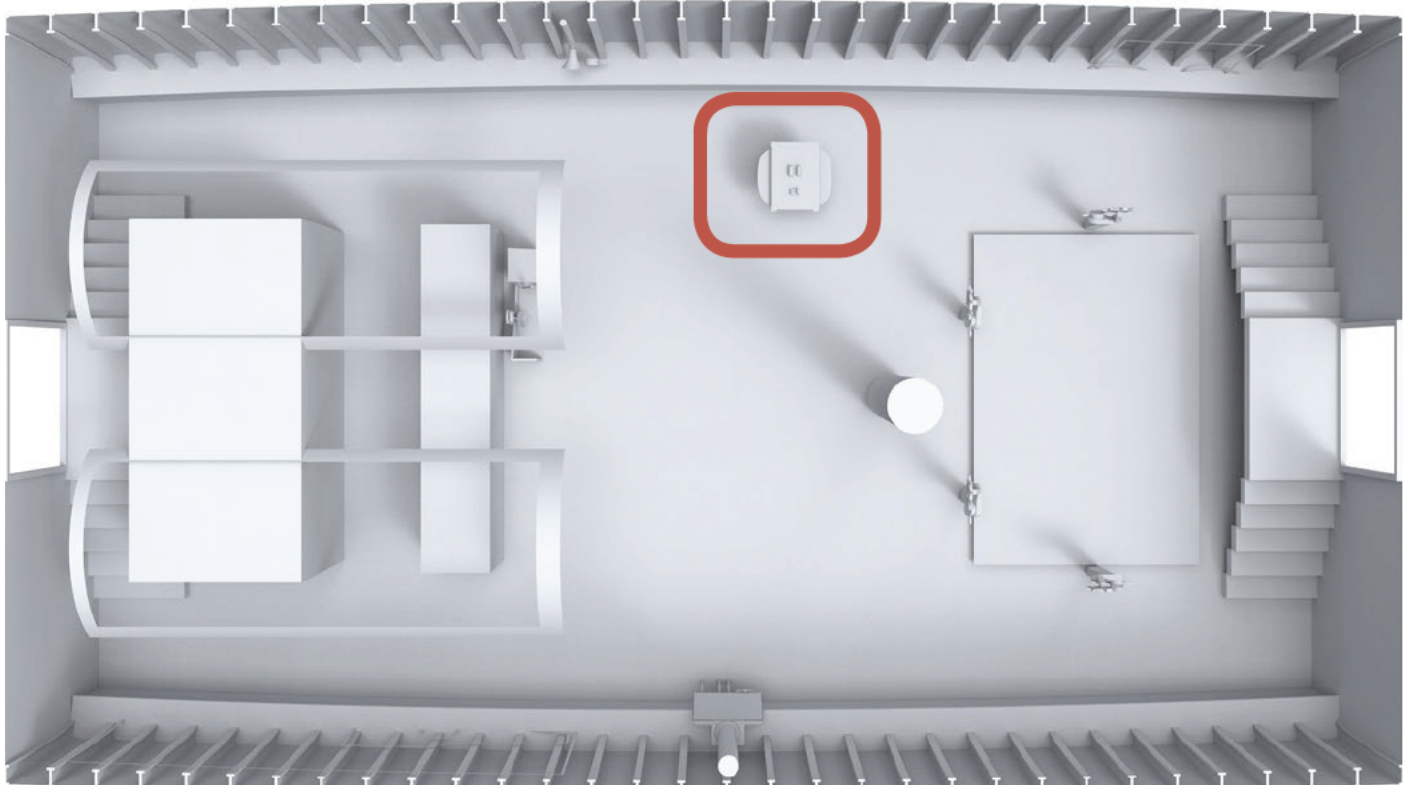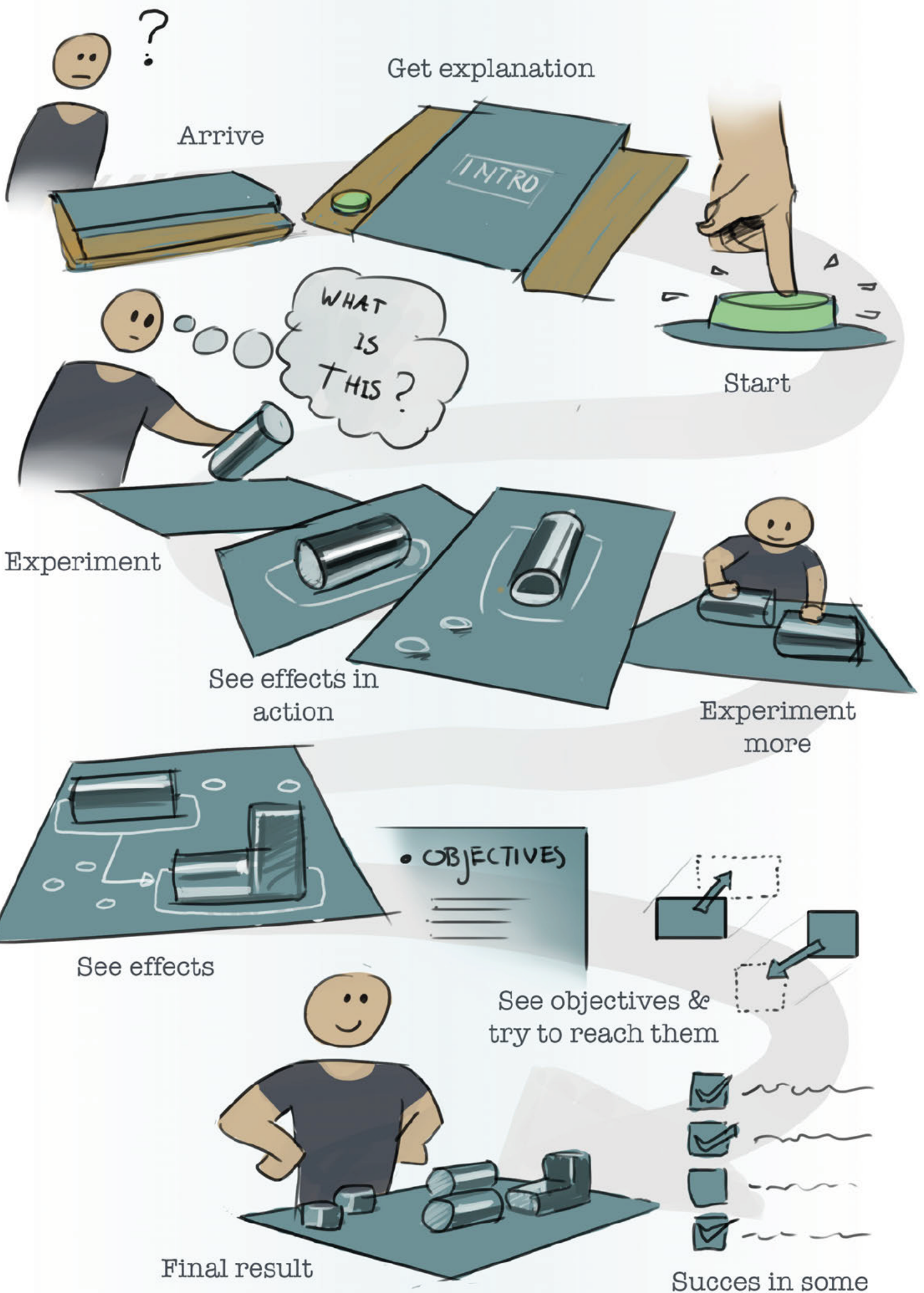
Arrive

Get explanation

Start

Experiment

See effects in action

Experiment more

See effects

See objectives & try to reach them

Final result

Succes in some

Detection

The object detection for this installation will be done with a camera vision system. The proposed medium is openCV, an open source library for several coding languages. OpenCV is used in all kinds of applications, including facial and object recognition, tracking of object and camera movement, and many other features. The algorithm can learn what the machines look like from the top, the more distinctive the shape the better. Then it can track the position of the objects live and feed that to the system. The algorithm can, to an extent, also take into account hands covering the machines, allowing for a certain accuracy even in suboptimal conditions.

Miniature machine embodiment

The miniature machines will be 3D printed. The models for this should be made taking into account the schematic drawings of the original machines, but apply a 1 mm radius fillet to every corner that might hurt a visitor, and ignore any details that stick out far and are very thin. The models should also include a ground plate, which at the top has a ring to connect a cord to.

3D printing does not traditionally allow for a wide range of materials, but it has the distinct advantage that it is very easy to make accurately shaped models in low batch sizes, without extra labor past the first model (since the CAD file can be re used). Reproducability is useful in case the machines are ever damaged go missing. To prevent theft, since the machines will be a loose part, they will be fastened to the installation's pillar using plastic coated steel wire.

Table embodiment

The table is comprised of a half semi cylinder, with two thick beams forming the main visual 'ribs'. The side tables have roughly the same shape as the body, only thinner. The screen is inlaid with a plexi glass cover which is flush with the top of the wood beams.

The plexiglass cover is there to provide structural support to the screen. Both for placing the miniature machines and for general mishap prevention, it is good if the vulnerable screen is covered and not easily damaged.

The whole structure sits on a beam that connects to the ground via a system of ba jonetcatches, like in this system: https://www.groundlevel.nl/275 ferox wegne embaar.html. The pillar can be easily removed with a key, by turning the pillar to open the locket catches. It is simple and not heavy, but also impossible without the key, so visitors can not cause any harm.
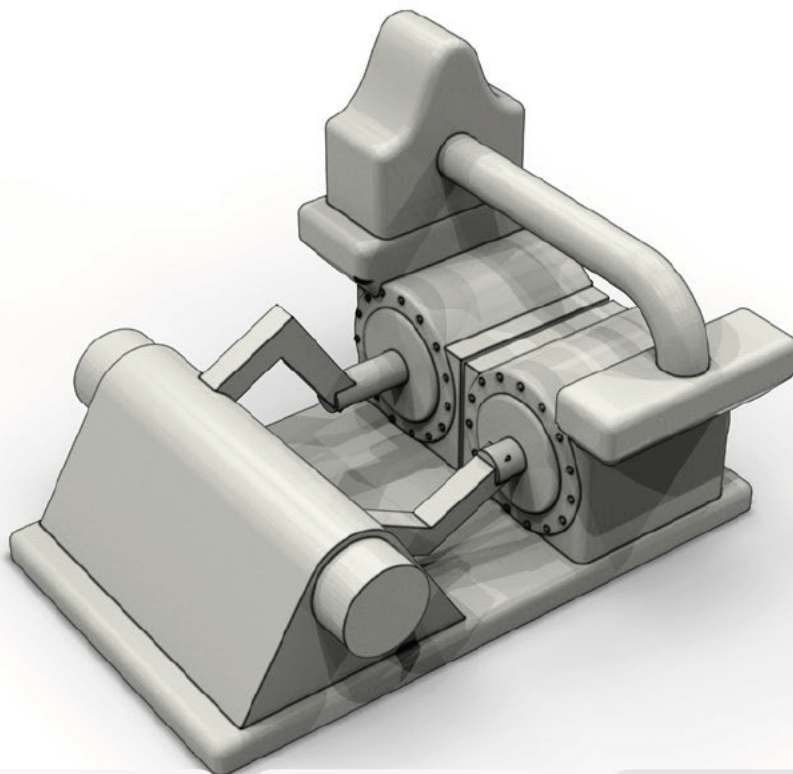
Fig. 57: Series of visualisa-
tions showing the embodi-
ment of The Engine Room
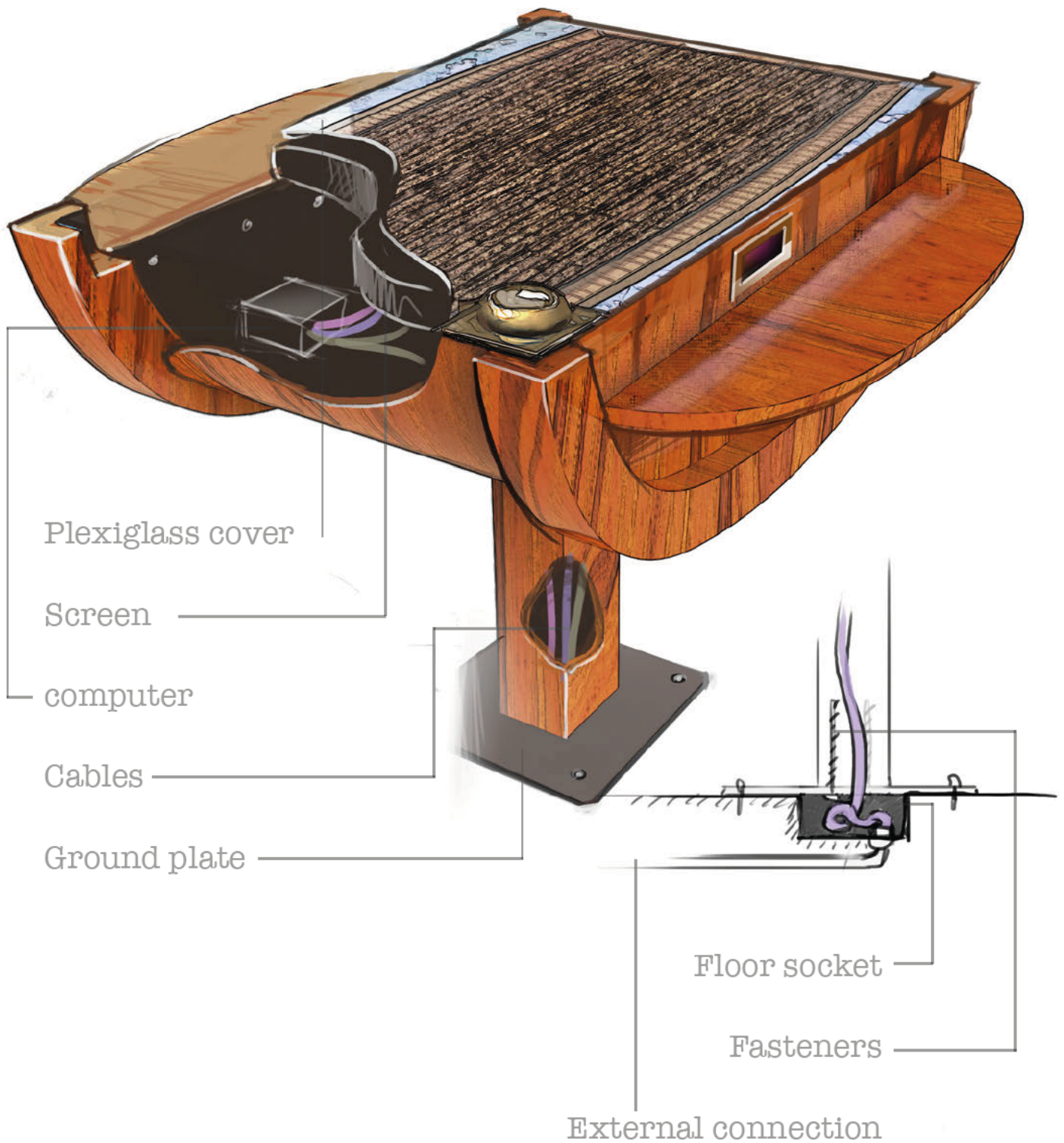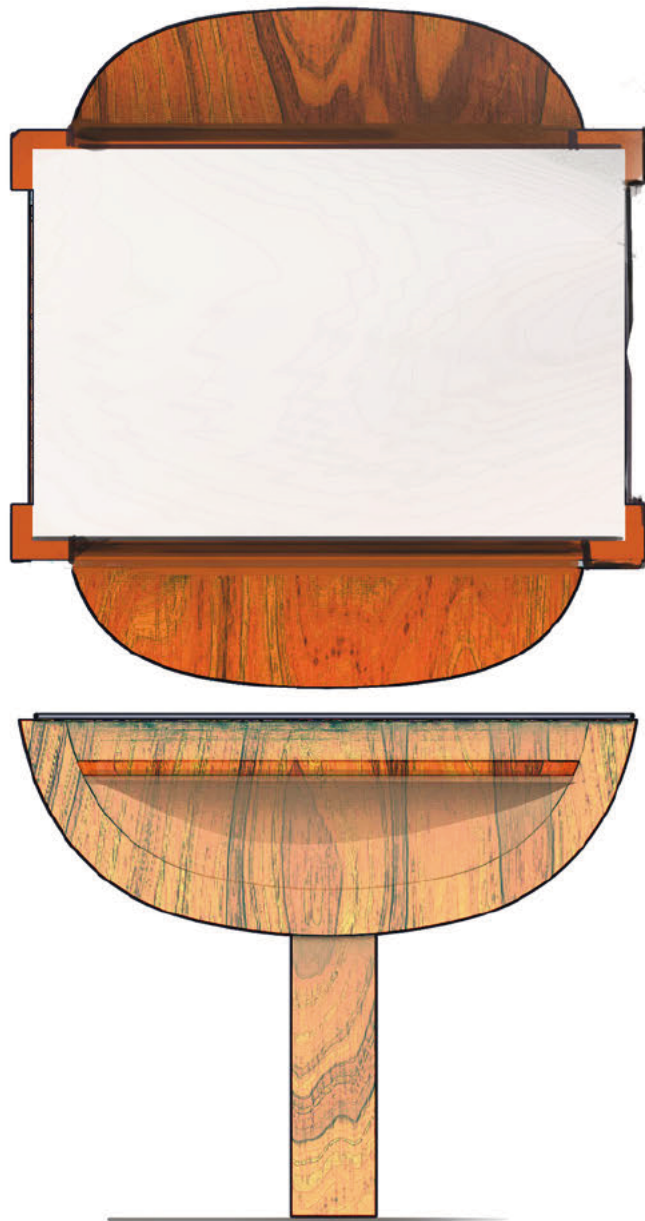
Plexiglass cover

Screen

computer

Cables

Ground plate

Floor socket

Fasteners

External connection

Camera

1M
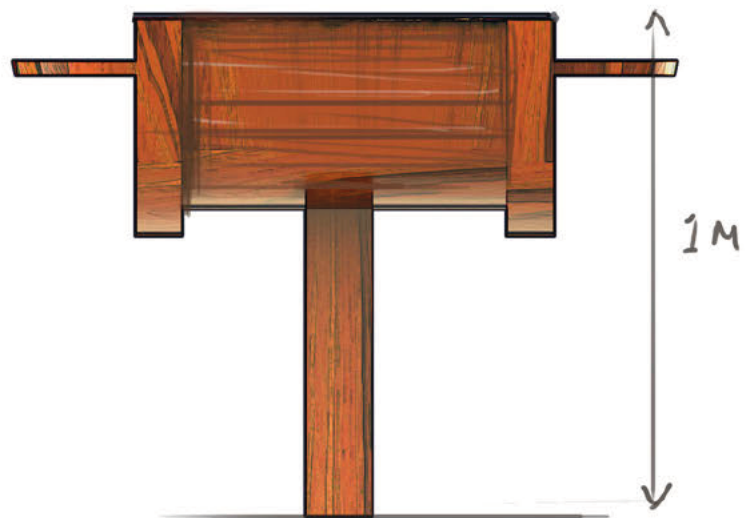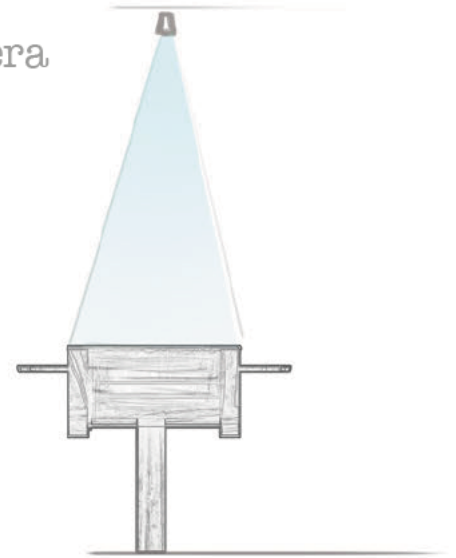
Wrapping up

Validation

Intro

At the end of the design process, it will be useful to know whether the design will be liked by the target group, and what they will learn and experience from it. In this research the installation 'The Engine Room' will be tested.

Setup

This setup is used for a test with three participants. There is one researcher, and one assistant researcher.

As you can see in fig. 58, the whole setup is on one table. Three chairs with subjects are positioned around the prototype. The prototype consists of an aesthetic part, made out of wood and copper pipes, and a functional part, consisting of a Cintiq 13' HD screen.

Next to the participants is the assistant researcher, using a laptop to control the screen interface. Next to the assistant researcher is also a pile of already com pleted questionaires. On the opposite corner of the table is the researcher, with in front of him the two introductory pic tures, questionnaires for after the test with

several pens, and a notebook.

The space should be dimly lit, so that participants can see the screen well.

The screen is controlled using a program called Resolume Arena 6. It allows the as sistant researcher to toggle user interface elements and drag them around accord ing to the actions of the participants, without the participants being able to see the mouse cursor.

Subjects

The available participants are middle schoolers of ages 11 13, from two differ ent classes. They are taking a class and will be sent to the research set up one by one until the lesson's time is up.

Since the exhibit is designed for groups, it is likely that the installations will be used by multiple students at the same time. Therefore the subjects are also called in groups for the most part. Two partici pants will be alone in the test, because the installation also has to be fun when you're alone. After those two, three participants will be used per test.

The tests were done at two different schools. The first is a primary school in
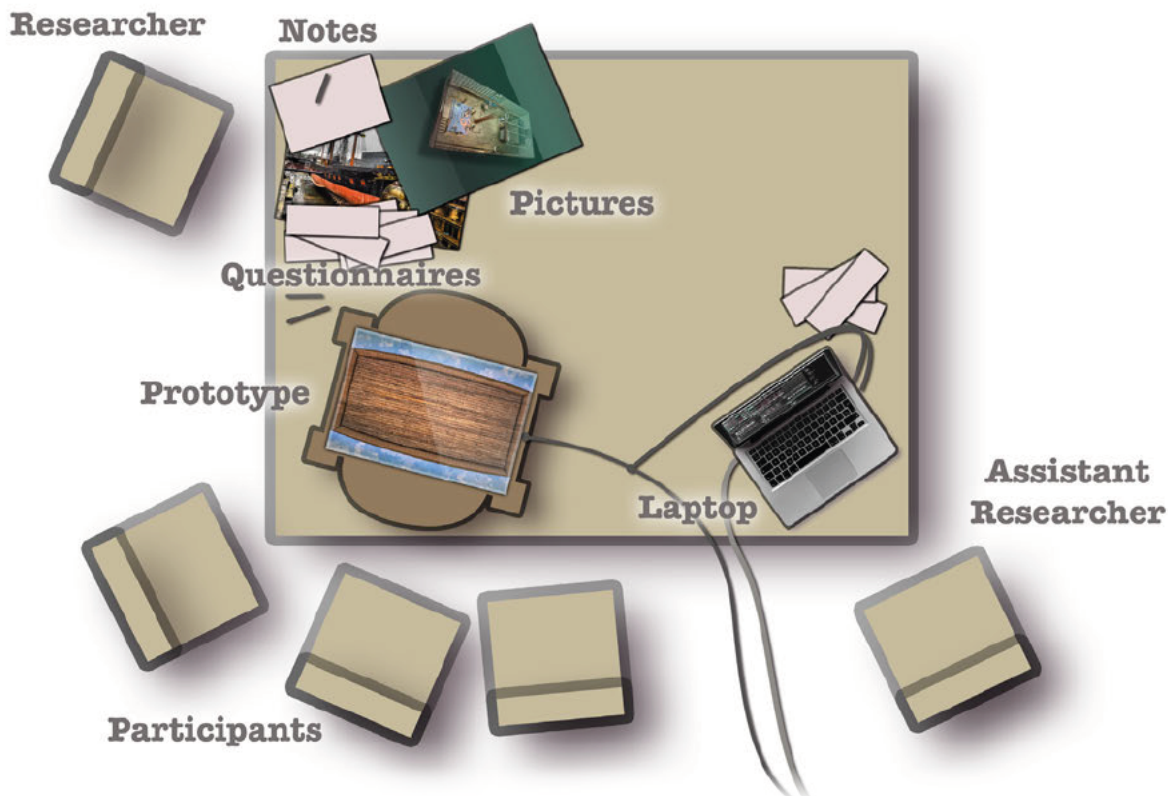
Fig. 58: Test setup

Ontwerp de Machinekamer!

Start
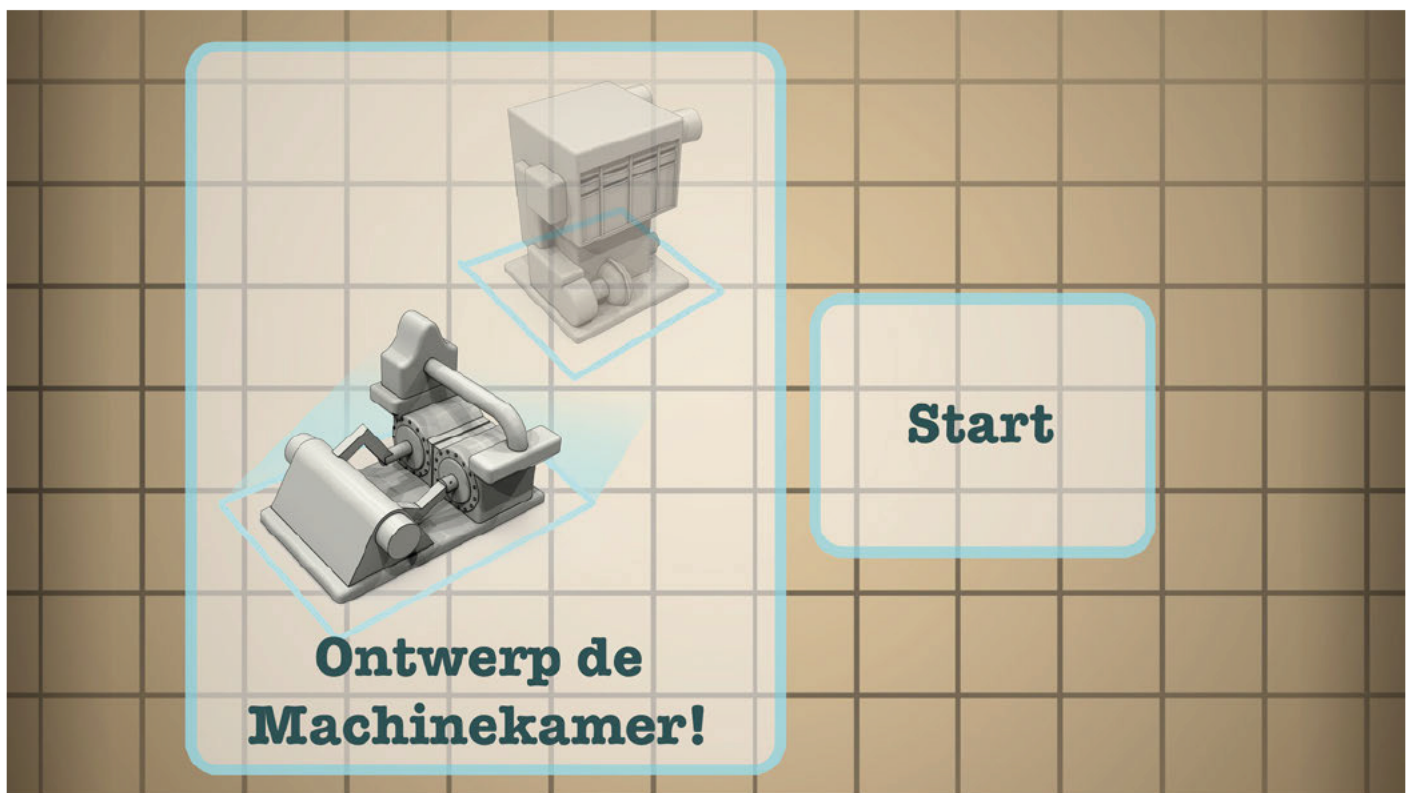
the Hague, where the subjects were from the 7th year, aged around 11 year old. The second is a VMBO in the vicinity of Den Helder, where the subjects were from the 1st and 2nd year, around 12 13 years old.

Method

The test will go like this:

- The researchers introduce themselves. The subject is asked to think aloud, phrasing anything they think outside of answering the specific questions the researcher asks.
- The subject is shown an image of the Bonaire from the outside and of the engine room with installations on the inside. The subject is then told that for this test, they should try to imagine that they are on a school trip here and going down into the ship.
- The subject is introduced to the prototype. They are asked to ignore the Wizard of Oz, and instead imagine that the prototype did the detection by itself. They are, however, asked to do their interaction somewhat calmly, because that will make it easier to give them an accurate experience with the Resolume

software.

- The subject is asked to try interacting with the prototype. The prototype will show an opening screen with an introduction to the interaction, and a button that looks like it can be pressed as a touchscreen. When the button is pressed, the screen will change into a visual explanation of how the interaction works with another button. When this button is pressed, the screen starts to show a top down engine room.
- When the subject places a machine on the screen (which will hopefully be understood as the intended interaction by now) the screen shows a halo around it, a piece of text with its name, and some crew come in to work on the machine, represented by a cloud of animated meandering dots.
- When more machines are placed they also get a halo and name, but the dots just wander in between the machines. A UI appears as soon as the second machine is placed, challenging the subject(s) to place the third machine and to optimise the layout.
- Once the third machine is in place, a button appears that when pressed, takes

Plaats machines

Zie verbanden

condensator

PLAATS DE KETEL
PLAATS DE MACHINE
PLAATS DE CONDENSATOR
MAAK KORTE ROUTES

Behaal de doelen

DONE
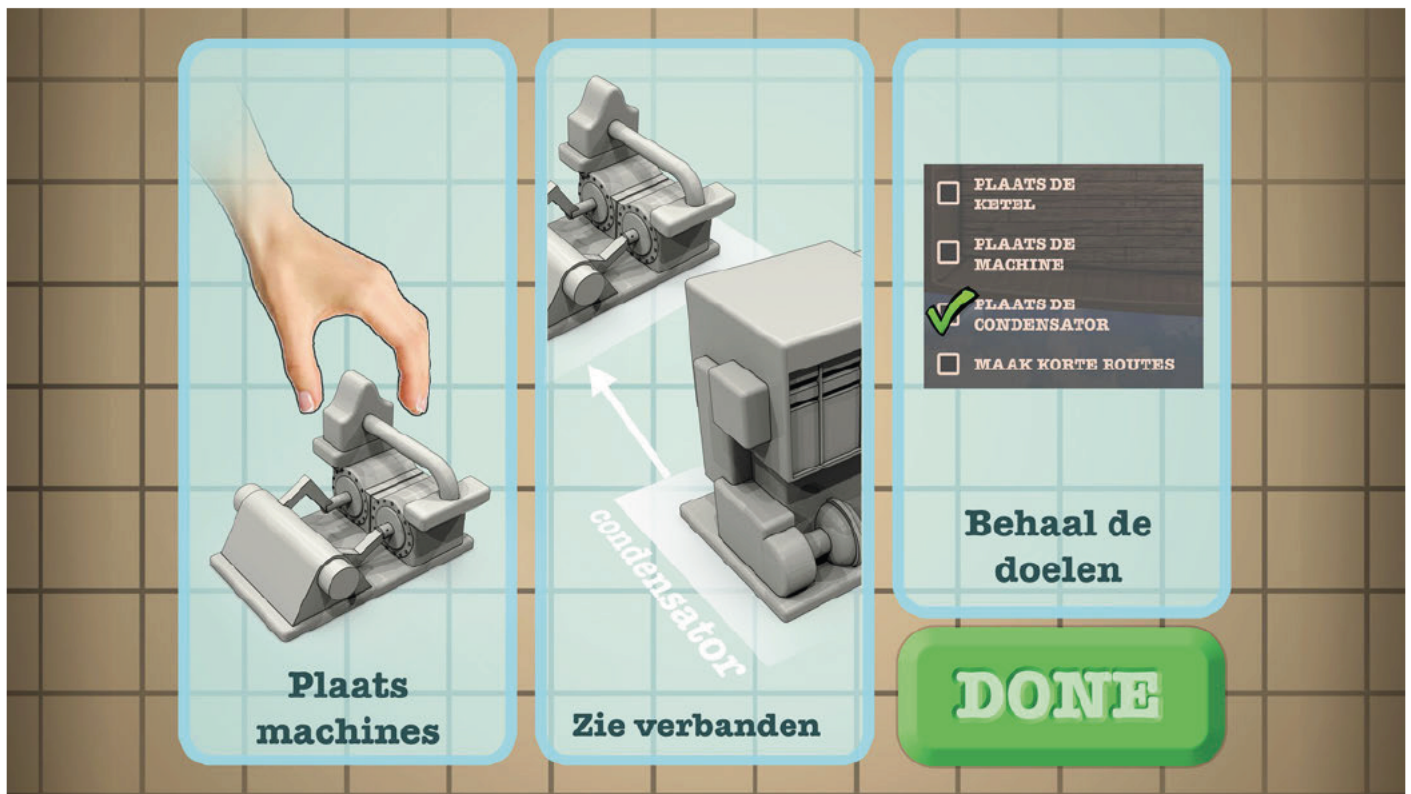
the subject to the final screen, which shows their performance, some information, and directs them to other installations (that aren't present here)

• The subject will be asked about their experience with this prototype according to a questionnaire. This questionnaire consists of three scales. The first asks participants how educative they found the prototype to be, the second question asks how easy it was to understand, and the third asks how fulfilling the whole experience was. Throughout all three questions, the researcher asks participants to elaborate on their answers, and records all comments. Participants also have the option to write their own extra comments in the space below the scales

Fig. 60 (above): The explanation screen of the digital interface

Fig. 61 (below): The prototype with miniature machines on it
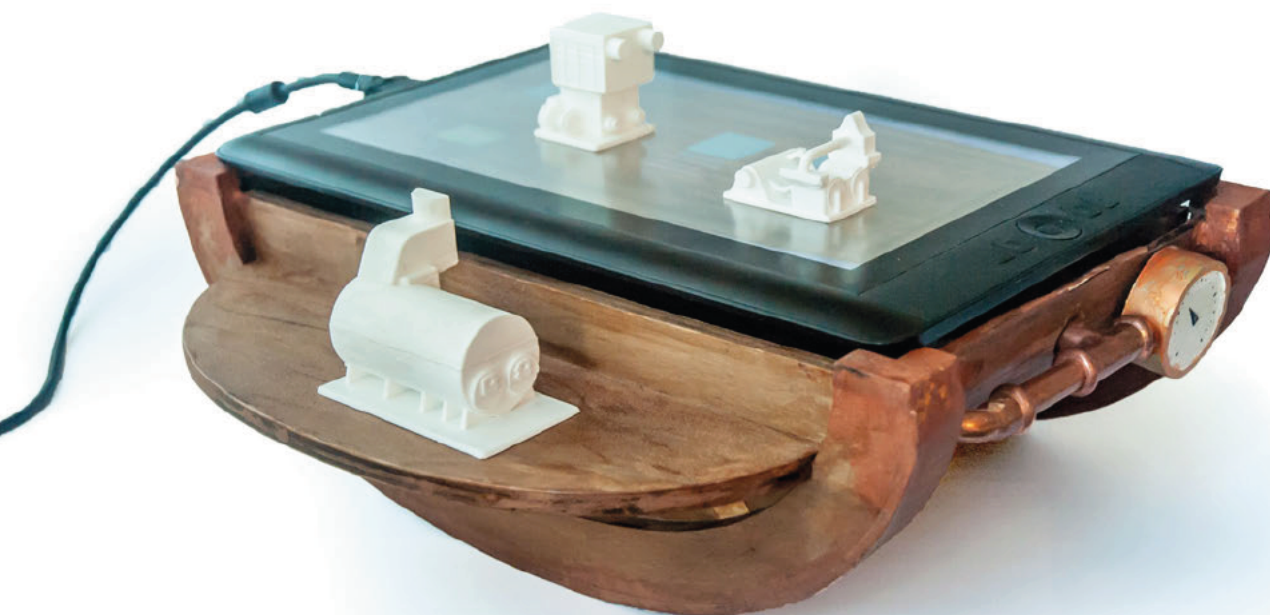
Fig. 62 (above): The results screen of the digital interface.

Fig. 63: The prorotype displaying the intro screen

Fig. 64-65: Test participants from the Hague interacting with the prototype.

Results

The results from the first test, at the Nutsschool Hoogvliet in the Hague, were as follows:

Did you think this was....
Educative?
Totally not — Totally
(2, 9)

Did you think this was....
Easy?
Totally not — Totally
(2, 4, 1, 4)

Do you feel....
Fulfilled?
Totally not — Totally
(1, 5, 5)

Vond je dit....
Leerzaam?
Helemaal niet — Heel leerzaam

Vond je dit....
Makkelijk?
Helemaal niet — Heel makkelijk

Ben je nu....
Tevreden?
Helemaal niet — Heel tevreden

Heb je nog opmerkingen?

Comments from the discussion afterwards and observations were more helpful:

• One participant thought that the inter action might be too hard for younger children, but yet another was adamant that it was meant for younger children (groep 4, roughly 8 year olds), because he already knew roughly what steam engines did.

• Several participants mentioned that they did not experience it as 'super' educa tive, but that it was nice to learn how the ship is propelled.

• It was mentioned by one participant that it was not entirely clear how the ma chines had to be placed on the screen.

• It was mentioned several times by sev eral participants that the 'explanation' screen was not clearly defined as an explanation screen

• The explanation screen was also men tioned by several participants to be on screen for too little time.

• Many of the participants tried to use the three columns on the explanation screen as touchscreen buttons

• After the interaction, there was confu

sion in several participants about wheth er they should remove the machines from the screen when the results popped up.

• It was mentioned several times by participants that they would like more information with the machines, or about the rest of the ship, e.g. year of construc tion or captain in command.

• It was mentioned by one participant that they would have wanted more time to adjust the positioning of the machines, resulting from a situation where one participant already pushed the 'done' button before the other felt like they were done.

• There was confusion about how to start several times

• Several of the groups of participants had a lot of discussion about what to do, and how to accomplish things in this interaction, and what the different

things mean.

- Almost all of the participants tried to connect the parts of the machines like they were lego, trying to find connecting elements that neatly fit together.

The results from high school Wiringher lant in Wieringerwerf, at the first year of 'techniek' (mechanics), were as follows:

Did you think this was....
Educative?
3 1 8
Totally not   Totally

Did you think this was....
Easy?
6 4 2
Totally not   Totally

Do you feel....
Fulfilled?
8 4
Totally not   Totally

These following are comments from the participants during and after the tests, as well as observations:

- One of the groups tried stacking the machines on top of the condensor, which has a flat top
- One of the participants mentioned that they were interested in the topic because it concerned boats
- Many of the participants mentioned that the interaction was difficult. This was twofold. First, some groups had trouble figuring out how the interac tion worked, or were afraid to try stuff (even though they were told that there are no wrong answers). Secondly, some of the participants mentioned that the information about the machines as well as about the purpose of their activities was sparse, and that this hindered their understanding of the interaction and

thus made it harder.
- Some of the participants mentioned that the interaction could be longer
- One of the participant mentioned that it might be nice to include difficulty levels in the interaction, so that visitors could choose how difficult the interaction should be.
- One of the groups used the fact that the information appeared when the machines hovered over the screen by holding the machines airborne and reading the text, before trying to come up with a layout.
- The explanation screen caused trouble for some participants, because they did not understand what to do there

Understanding the results
The number of participants was quite low. The eleven total from the Hague was formed out of two individual participants, and three groups of three. The twelve from Wieringerwerf were four groups of three. The low number of participants makes the quantitative data not much more than an indicator.

It is interesting to see that the primary school students rated the interaction as much easier than the high school students. This might have something to do with the fear of trying things that was observed, the primary school students in general seemed more spontaneous and less afraid that they would do something wrong. However, this fear was substantially more in the group that didn't seem to be friends than in the groups that did. Sadly this was not confirmed with them during the test. One of the things that kept coming back in feedback was the flow of the UI. The screens should be clearer about what they are, and what they are trying to commu nicate, and about what the user can do at that moment. The explanation screen in this test was none of those things, and it ended up confusing a lot of participants. The user should have enough time to read everything, so perhaps manual control of the UI flow is desirable.
Many participants also said they would

have liked to get more information. About the goal of their interaction, about the machines, et cetera. Of course it is possible to give more information, and it is good to hear that participants want it. However going forward its import ant to consider exactly how much, and specifically what information is given, to make the interaction interesting as well as educative.

Although it was in no way a direct goal of this project, it is good to see that the ex hibit can also be entertaining for younger children. Later on it could be tested exact ly what the potential target groups are, to have a better idea of who might enjoy this exhibit and who might not.

Discussion
There were several things that might muddy the results of this test.
First and foremost, the prototype was manually handled, and although par ticipants were told that it was manually handled and that they should try to be patient, there was still confusion and frus tration that arose from the interaction. Secondly, the information given about the test and also at the results screen was not fully complete. Participants were tasked to build short routes, but not told why, and the results screen told all participants the same results, regardless of the layout they actually built. Participants did not know this and no one said anything about it, so presumable nobody noticed, but there is still a chance that it felt unnatural.
Third, the 3D prints used as miniature machines were not designed, just built straight from the technical drawings with some rounded edges. Many participants tried to find physical connections to them like Lego. This is not necessarily a bad thing, but it is something that was not considered beforehand and could be a point of attention going forward.

Fig. 67: Participants at the Wiringherlant interacting with the prototype

Costs

Introduction

In this section you will read about the cost estimates associated with the different parts of the design. The software and concept development costs have been dis cussed with Ronald Theunissen, project manager at Kiss the Frog. The costs of specific hardware were estimated on the high end of prices available online. The rest was roughly estimated and dou ble checked with Annenies Keur, exhibit organiser at Archeon.

It is still useful to have these estimates, in order to make informed choices in later development. Roughly knowing what one installation will cost might help deciding to postpone or cancel the construction of that installation, if budget related problems arise. It is important to recon sider the estimates later on in the process though.

The concept and software costs are based on what it would cost to develop the software and design at Kiss the Frog, an experienced design agency in the muse um field. The price range for these sums indicates the level of meticulousness with which the design is executed.

General costs

The following table shows costs for everything but the installations. The con cept&software part represents the costs of making all the interactive installations connected. If, later on, the choice is made to leave this connection out, this is the only part of the total price that is saved.

General	Price Estimate
Concept + software Development	5000 8000
Construction	7500
Lighting	5000
Tickets	300
Unforeseen	2500
Total	**20300-23300**

Installation costs

Below, you can find the cost estimates for the installations.

Navigating the World	Price Estimate
Concept + software Development	15000 20000
barcode scanner	75
4k projector	2000
internal electronics	750
computer	1500
Construction & Installation	4500
Unforeseen	2500
Total	**26325-31325**

Steam Design	Price Estimate
Concept + software Development	6000 10000
Barcode scanner	75
42 inch touchscreen	2000
Internal electronics	400
Computer	1500
Construction & Installation	1500
Unforeseen	2500
Total	**13975-17975**

The Crew's Work	Price Estimate
Concept + software Development	6000 8000
Barcode scanner	75
Screen	1500
Internal electronics	750
Computer	1500
Construction & Installation	3000
Unforeseen	2500
Total	**15325-17325**

The Engine Room	Price Estimate
Concept + software Development	8000 15000
Barcode scanner	75
Screen	1500
Internal electronics	750
Computer	1500
Construction & Installation	3000
Unforeseen	2500
Total	**17325-24325**

Exploitation costs

The design will also cost a certain amount to keep running once it is built. This can be divided into several elements. The Codex Bonaire does not need guides, but there needs to be someone on the ship that sells tickets and watches the premises. The installations need to be turned on before the visitors come in, and turned off at the shift end. The room also needs to be cleaned regularly, which requires some people and cleaning products.

When the room has to be used for a reception, it has to be switched around, which requires some people to take off the installations that are in the way, get them out of the room, make small adjustments and possibly clean.

Tickets can be reused, but still likely need to be reprinted on a regular basis, in case visitors take them home.

The coal in The Crew's Work should be replaced once in a while. It is hard to tell at this point how often.

The shovel in The Crew's Work, as well as the machines in The Engine Room, are separate pieces that run relatively high risk of being damaged. They need to be replaced if necessary. Furthermore, any of the hardware might break, and soft ware needs some upkeep as well, once an installation starts malfunctioning. It would be good to find companies that can do 'expected' fixes before they are necessary, so they can be called easily when the need arises.

As far as ticket price goes in terms of making profit: The assumption is that the exhibit will last for 10 years. In this time, if a school group (28 students and two teachers) comes to the room every two weeks, plus an average of 20 other visitors per week, there will be 1820 visitors per year, or 18200 visitors in the total running time of this exhibit. Assuming a rela tively high final investment of €120.000, tickets for all those visitors have to make around €6,50 profit to break even in the end. Larger amounts of visitors or higher profit margins will result in breaking even earlier, and the other way around. The Reddingsmuseum in Den Helder, one of the more prominent museums that is quite close to the Bonaire, got 14.306 visitors in 2016, while the Marinemuseum got 85.000 in the same year. While it is not likely that a small museum like the Bonaire will attract that many visitors, it does give the impression that higher visitor counts are not unthinkable.

Further steps towards Realisation

There are two things that need to be done, or at least considered, before continuing. The first is that the Stichting Bonaire needs subsidies to build anything in the engine room, and this report might help finding them. The second is that parts of the design could be either post poned until later, or scrapped altogether. The cost estimates will hopefully help find a balance in these initial monetary festivities.

Relatively easy ways to save money:
• Leave out the software connecting the installations, described in the gener al tab. The installations still function without it, and since it only concerns software, it could be added later on without system downtime.
• Leave out any one installation, depend ing on which is deemed less essential. The installations are self contained experiences, and not dependant on each other.
• Have the entire project developed by students (as described in the next para graph)

After sorting this out, the actual construction is comprised of several elements. The software, electronics, graphic design and embodiment styling, and the non electronic construction. There are two obvious routes to go here. One is to formulate a series of educational briefs for HBO students. An IPO student could handle the construction, integration of electronics and embodiment styling. A graphic design student could create a coherent visual style. An IT student could perform the coding for the installations.

The other way is to depend entirely on professionals instead. As mentioned before, the graphic design, software and coding could be done by Kiss the Frog. A construction company like Echo (http://www.echo id.nl/contact echo.html) could provide both the construction of the embodiment and the electronics, or this task could be further divided up to specialised companies. At this point, it would be better to discuss with those companies.

The choice for students or professionals is hard, but relevant. Student work is probably cheaper than the price estimates presented earlier, but results may vary quite a bit. It might also be difficult to find students from specific disciplines if those educational institutions are far away from Den Helder. Additionally, students might be limited by external factors, such as maximum project length or the lack of access to certain tool, or a lack of experience in interdisciplinary communication. Professionals are more expensive, represented in the estimates. They are, however, more reliable at producing desired results.

Recommendations
Since this design still has a way to go before it can be built, here are some recommendations.
- In general, the installations should all be tested like *the Engine Room* was tested, to find out what the possible hurdles still

are. Furthermore, the installations still have to be developed further to finetune the interactions and embodiment. The current versions are roughly defined, and have room for improvement.
- Navigating the World: There are several authenticity related things that still could be added here. First, the Bonaire was mainly a sailing ship, with the engine as a backup when wind was low during dangerous times. This is not highlighted in the installation yet, but it could be. Secondly, the Carribean area was treacherous, full of shallow water, too shallow to traverse with a large ship like the Bonaire. Third, it still remains to be tested, but it is possible that the steering poses problems. The boat can be coming towards the console, causing it to go right when the visitor steers left. Whether this is a problem still remains to be determined.
- This project was focused on creating an experience down in the engine room, but it might be interesting to consider building something above deck as well. Navigating the World is a promising candidate for this in terms of the interaction, because steering was always done out in the open. However the current embodiment would not allow that, as projectors don't work well in a light environment.
- The Engine Room: In this project it is not defined yet what the efficiency of the engine room entails, just that it is nice to have something of that order in the installation's goals. Before it can be realised, this should be considered and solved.
- The Crew's Work: Right now this installation is a self contained unit in a single place. It might be interesting to see if the steam valve or water inlet can be placed elsewhere in the room, possibly in their authentic positions. Secondly, the way to let water into the boiler was not clear during this project, but with authenticity in mind it would be good to do research into that and change the installation accordingly

Reflection on Design

Now is the moment to look back at the goals that were set at the start of this project:

   "The design goal in this project is to de sign an exhibit concept for the Bonaire's engine room. In this exhibit, visitors will be able to learn and experience how the Bonaire's engine room worked and what had to be done to keep it running. The aim of the design is to utilise 'new' technology to improve the experience, keep up with modern museum trends and provide contrast with the 'old' steam technology."

The exhibit concept presented in this report does allow visitors to experience how the room worked and what the crew had to do. The information is perhaps not as deep as originally envisioned, although that would probably be possible to intro duce later. However the information is presented in a very exciting, practical way, so that many kinds of people could enjoy it and learn from it.

The exhibit also uses new technology, al though the use of touchscreens, and even live camera tracking, is rapidly becoming less unique. New but widely available technology is rarely a unique selling point, and will go out of style at some point. The draw for this exhibit therefore is not only in the technology, but how it is used to create a fun learning experience. All of the installations have been designed from the experience, only thinking about how it could be done later. This approach is somewhat scary, because you don't know if maybe there is no feasible solution for a problem you're facing, but it also helps ensure that no technology is used just because it is shiny and new.

The interaction qualities that the design tried for were impeccable, easy, supportive and tailored.
I think the design really is quite easy and supportive. It is very visual and inviting, and the installations are simple to start up and guide the user through the process. They would have to be tested to make this work to the fullest extent, because the one test with The Engine Room already brought many issues with the UI flow to light where some visitors would not un derstand what to do. Testing during devel opment will be crucial to make this vision true in the end. I think the design as it is now is not yet impeccable. I've tried hard to infuse it in all the details that I worked on, but in the end it will still come down to the construction. It is likely that there will be numerous things that only become visible once they are built in the room, and some creative individual will have to solve them right then and there.

So in hindsight, at the end of this grad uation project the design goal has been mostly fulfilled, and the interaction vision still needs a little bit extra to truly work.

I think the design fits the target group very well, as seen in the validation test, but I do not know if it can be enjoyed by other audiences as well. There are spots with simple, dry information on sheets next to images, and the installations also offer some depth if you take the time to look for it, but in general the exhibit has a chance of losing an audience of seniors by repelling them with the feeling that 'this is for kids'. This could be improved by making the graphic design fun for kids but not overly kid like, in later develop ment, but it would also need to be tested.

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22. Brunings interior, photo taken by author, october 2018
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60.   Original work
61.   Original work (picture)
62.   Original work
63.   Original work (picture)
64.   picture at school
65.   picture at school
66.   Original work
67.   picture at school

Graduation Appendix

Marijn van Bekkum

I. Exhibit design

Since this project is about designing an exhibit, the first discipline to turn to is exhibit design. This is not a huge field, but it is substantial. Quite a lot of research has been done into different types of museums and their educative value and different visitors. This report will categorise the different findings of museum research into education, engagement and cognitive load.

Effective museum design

Intro

To design an exhibit which is effective at teaching people, giving them a pleasurable experience and enriching their day, there are several factors that need to be kept in mind. First, it is important that the museum actually presents the information that it wants to teach in an effective way. Secondly, to provide the stimulus to go to the museum and stay there, the museum needs to engage (potential) visitors. Third, it is important to keep in mind the cognitive load visitors are under, in order for them to not become disinterested halfway through.

Visitor expectations

Visitors generally go to museums with their mind set on 'educative leisure. (Hanquinet and Savage, 2012) However, a different study by Stylianou-Lambert(2009) indicates that there are eight types of filters for experiencing museums: professional, art-loving, self-exploration, cultural tourism, social visitation, romantic, rejection, and indifference. Relating these filter types to visitation frequency, the study concludes that, for people, 'the way in which museums are perceived is just as meaningful as the choice of visiting or not visiting."

Education

General

The main goal of the Bonaire maritime museum is to teach visitors. There is a broad range of topics to teach, and in the engine room the focus will be on life on board the ship and in the engine room, as well as the technical details of the engine room.

Designing for educational activities comes with certain considerations. (Bitgood, 2011) notes that many studies test retention of information with text-based questions, while many exhibits are for a large part visual. My assumption is that an educative exhibit design balances the types of information that are being conveyed, e.g. some text, images, objects and movies together is more effective than

Fig. 12: eight different perception filters that visitors can have

mostly text and a few images.

Lock (2006) gives a list of things that educators can do to teach high school students how to study. Many of these points relate to giving students a positive attitude ("Remind students to have a positive attitude as they begin to study by replacing negative(e.g., "I can't do this.") with positive self- talk") or making tasks more manageable ("Instruct students to begin long-term projects as soon as they are assigned."). This could indicate that high school students sometimes have trouble learning not because they are cognitively incapable of doing so, but because they do not believe in themselves or the project, give up too easily or shoot themselves in the foot by managing their time ineffectively. Of course there is no direct translation from school studying to museums, but this is still a worthwile consideration when identifying the target group.
The list also indicates that it helps students to follow up their study time with a critical attitude. Asking themselves what the relevance of their material is, or preparing questions for class the next day for example. Stimulating a healthy critical attitude might be difficult but equally rewarding.

Immersion

Different time & place

All part of coherent whole

Focus shift

Content

Participatory form

More fiting to expectations of 'entertainment'

Drama

Museum

Persona's

Empathy

Narrative

Clear reward

Competition

Movies

Games

Exhibit design
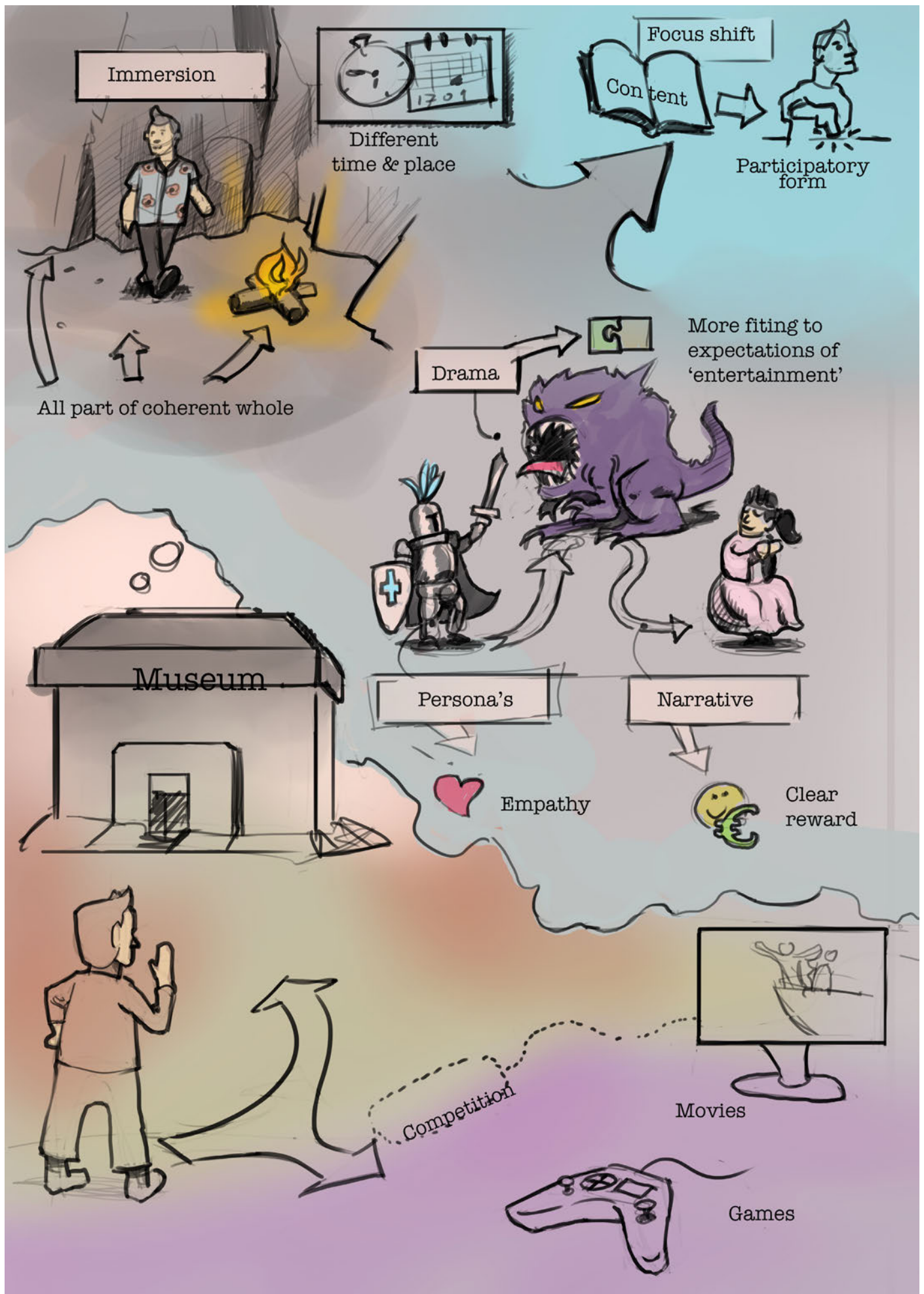
Engagement
Museums are usually regarded as a
leisure activity by casual visitors, and as
such have to compete with other leisure
activities like movies, video games, sports,
et cetera. (Keene, 2006) identifies that
museums have to evolve to meet expecta-
tions. Strategies to engage visitors in the
design of the exhibition could be to make
it about a certain clash or drama within
the context of the museum, use personas
that visitors would be able to empathize
with, and create a narrative flow that, if
followed, promises a clear structure and
reward. ("author 72", Museumfutureslab)
Immersion is a specific type of engage-
ment that lets people imagine themselves
in a different time and/or place. This
requires people to have some measure of
imagination, and can be more effective
when visitors are focused on the partici-
patory form instead of the contents of the
exhibit. For immersion to work well, it is
important that the presented, imagined
world is coherent, and thus all elements
must be presented as part of a whole as
much as possible. This improves visitor's
suspension of disbelief, which is their
capacity to stop critisising something
unreal, and momentarily accept it as
something that is actually happening.

Cognitive overload

Short visits

Low atttention

Bad design

Object satiation

Distractions

Other factors

Standardise

CLOCKWISE = MORE

Adhering to cultural standards

Same layouts everywhere

Increase comfort

Good lighting

Seating

Reducing ambient noise

Solution

Simplify

Formfit to known concepts

LOOK

Limit available options

Employ mystery Watching & waiting

Exhibit design

Cognitive load

Museums are centers for learning, traditionally inciting visitors to use their brain. In many cases, this is still true, and it can be mentally straining for visitors to be in a museum for long. Especially guardians with children are under duress, because they have to look at an exhibit, interpret its implications and simultaneously communicate it to the children (Allen, 2004). After reaching a certain limit, visitors will generally start 'browsing' the rest of a museum, looking for a few immediately interesting spots before leaving. (Bitgood, 2009) This phenomenon is called 'museum fatigue'.

Museum fatigue can in part be prevented by making things in an exhibit as 'immediately apprehensible' as possible (Allen S., 2004). This means that visitors can immediately recognise the information, purpose and controls contained in every individual part of the exhibit. Considerations when designing for immediate apprehensibility are using standardisation throughout the exhibit (e.g. controls are always in the same spot near the info plate) and coherent with social or cultural standards (e.g. turning a dial clockwise increases the amount of whatever it is controlling). Limiting the amount of things visitors can see and thus interact with is also a simple way to prevent cognitive overload. More complex subject matters can be simplified by showing them as part of something that is easily recognisable (e.g. showing the functionality of pistons by letting visitors actuate a cyclist's leg with color-coded pistons, or introducing a 'race' with wooden disks of asymmetrical weight to show the effects of weight distribution). If a subject matter is discoverable by waiting and watching for a while, the mystery can engage visitors without requiring a big cognitive investment.

Finally, comfort levels are very important for reducing cognitive load. Good lighting, low amounts of ambient noise, and seating spaces are effective ways of giving visitors a calm experience that doesn't strain the brain.

II. Multisensing

Technology is advancing steadily, and many things are now possible that were not, only 5 years ago. Multiple senses can be influenced at the same time, greatly increasing the immersion that an experience can have. This section is divided into different senses, and showcases technologies that are new and/or relevant in that category. This will serve as a benchmark to see what might be possible in a design later on.

Visual

Virtual Reality
Virtual reality is a technology that is contained in a set of goggles, as seen in figure 14. The goggles project images on high resolution screens through special lenses into your eyes, which makes it look as if the images are real and you as the user are suddenly in a different place. The goggles also have motion sensors tracking rotation of the head, so the virtual world can move with the head of the user, making the simulation more believable. There are a lot of technologies in development for interacting with virtual reality, like special devices for 'gripping' virtual objects or a threadmill-like device to make it possible to walk without going anywhere physically.

Augmented Reality
Augmented reality is the overlaying of digital enhancements over the real world. There are several types of AR: phone/tablet apps, projections and goggles. AR is set in the real world and thus requires input through a camera to accurately overlay information. The two main types of information intake are markerbased and markerless. Marker-based AR uses predefined markers (e.g. QR codes, but could be anything as long as it is easily recognisable by the camera) to calculate the distance between them and in that way place extra objects in the correct perspective (fig. 15). Markerless tracking uses the environment that is there to determine the perspective, based on information that it already had or by tracking recognisable points like letters or rivets.

Phone/tablet apps
Phones and tablets have good motion sensors and camera, and developers can use these to build AR. Many apps have you point the camera at a predefined marker, for example a grid that the app gives you to print out, and then place a virtual object on that marker in the correct perspective.

Projections
AR can also easily be achieved by pre-scanning any object's surface, digitally mapping additions over it and projecting those back onto it. This has been in use for a long time, as in 1969 Disneyland opened

a haunted mansion ride with singing busts; stone busts with singing faces projected onto them. Since then it has been done a lot on the sides of buildings due to easy upscalability, (fig. 16) but on small scale it is still a feasible technique.

Goggles
There have been dreams of wearable AR for a long time, and there are already some instances of it on the market. The microsoft hololens is the prime example; Goggles you can wear that digitally project extra information into your workspace. However, it was critisized for its small field of view and the price is not yet in range of most consumers.

Mixed reality
Mixed reality is a combination of AR and VR, where digital and physical objects are in the same space and interact in real time. The definition is still somewhat vague.

Display technology
It is good to note some of the things that are possible with display technologies

nowadays.

Moving displays
Due to advancements in compactness of
the display, as well as a decreasing amount
of necessary wires, it is possible to move
displays around quite a bit, even rotating
them (fig. 17).

High detail
Displays can, for a price, be very de-
tailed, up to a point where it is hard for
the human eye to even identify the use
of individual pixels. This is mostly done
on screens that will be used close to the
eyes, like phones, as tv screens are usually
farther away and thus need a lower reso-
lution to still be detailed enough.

Transparency
The use of OLED and subsequent tech-
nologies allows screens to be transparent
(fig. 18). This is not very widely used for
consumer applications because it makes
the contents of the screen harder to see,
but it is not specifically hard or expensive
and can be quite potent in creating visual-
isations (e.g. floating jellyfish, augmented
data, etc)

3-dimensionality
Special glasses can be used to make
2D-images seem 3D. The downside to
this is that the images will then not be
very legible without glasses (fig. 20). It is
also possible to create a 3D-effect with-
out glasses through 'autostereoscopy', but
these technologies are either confined to a
small screen (as on the Nintendo 3DS, see
fig. 19)) or to crude visualisations requir-
ing a lot of resources.

Multisensing

Fig. 22: (on the right) sculpting a digital dragon in VR.

Tactility, balance and proprioception

Tactility, balance senses and proprioception will be discussed here. They are grouped like this because they are all physical, and often a device or technology will influence more at the same time. Proprioception is our ability to know where our limbs are. You can experience it by stretching out your arm, pointing your finger out, closing your eyes and touching your nose. Most people will get this on the first try, or at least close. This is possible because of proprioception, because it tells the brain where the arm is pointing and how to move it to get to the nose. Balance sense is influenced by several things, it tells the brain what 'up' is. It is the main contributor to travel sickness in planes and cars.

Touch screens

Screens can have touch functionality (fig. 21), and this is getting increasingly more common. Many people might expect screens in an exhibition to have touch functionality as well, possibly leading to disappointment if they don't.

Haptics
A wide range of devices is on the market or being developed that allow users to experience a tactile sensation without being real. These can be linked to VR gear to let users draw or sculpt in VR, or grab virtual objects and have those objects seem like they have a solid surface (fig. 22-24). There are also VR setups that include an omnidirectional threadmill, so users can walk around in a virtual world and have it provide feedback that 'feels' right, as well as keeping them from walking into walls in the real world.

Fig. 23: Haptic glove with pressure points and force feedback

Fig.24: VR omnidirectional threadmill
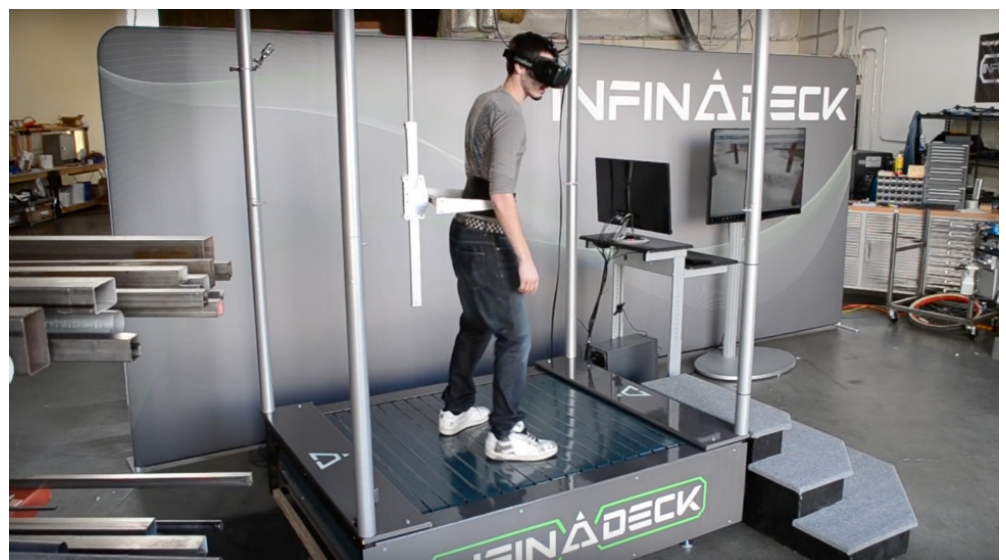
Motion sensing

Live motion tracking is a technique that computers can use to track physical movement from a distance. The simplest way to do this is with markers, like the ones present on many motion capture suits (fig. 27). There are also markerless solutions, like the Kinect (fig. 25), a plug-in for the xbox game console that tracks the silhouette of the human body.

Motion sensing is a useful technique because it does not require users to push buttons, the system can just automatically activate without it feeling random. In the case of marker-based tracking, this is used in many AR applications and can be powerful and quite accurate (fig. 26).
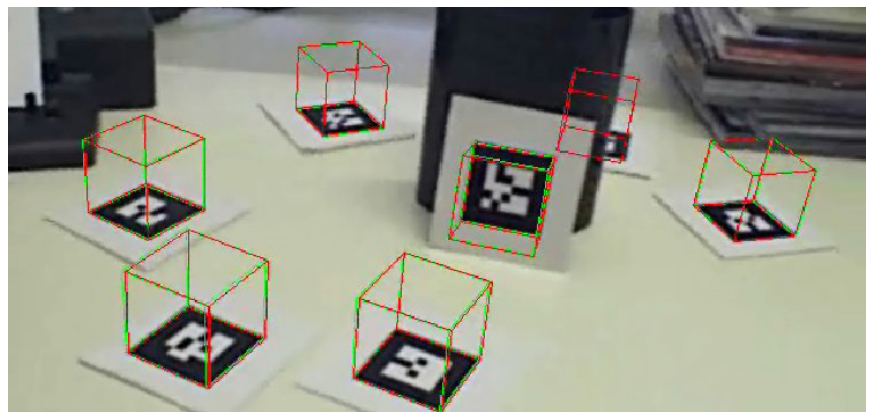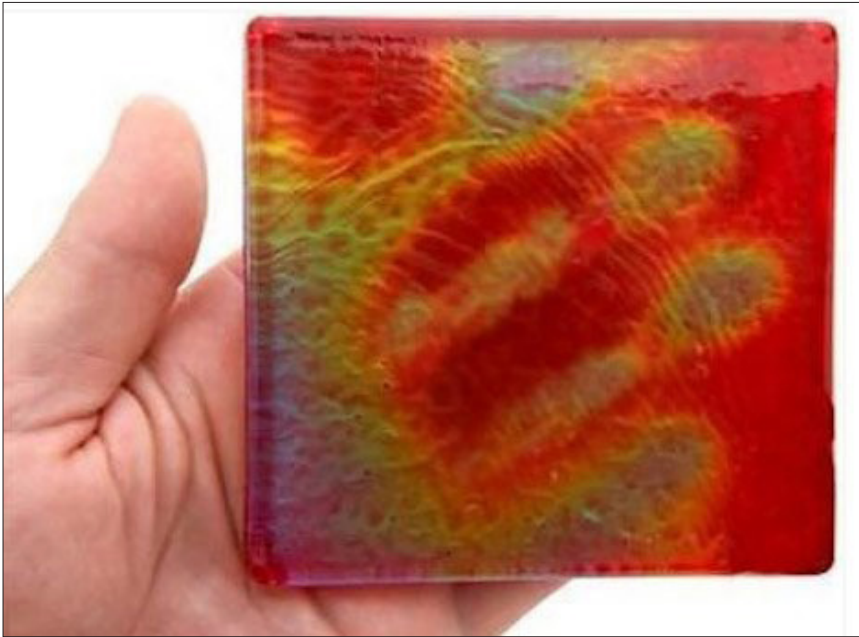
Heat

Radiator
The simplest way to influence the feeling of hot and cold is with actual temperature change. Traditionally this might be with fire or warm water (fig. 30), but electric radiators are also simple and effective (fig. 31).

Temperature-based color changing materials
Certain types of plastic will change color when heated up to a certain degree. This is not really influencing the human temperature sense, but can still be a nice visualisation (fig. 28, 29).

Sound

Speakers
Sound is often produced by speakers. The technology for these is already quite advanced, and high-end speakers can produce a wide range of pitches and volumes. Speakers can be of several different types. 'Normal' speakers produce sound that can be heard anywhere in the same room (fig. 32). Directional speakers are a more uncommon type of speaker that project sound over a much more narrow path, allowing for creative use of sound projection and blocking. Speakers can also be arranged in such a way that they produce surround sound, which gives listeners the impression that it is coming from all directions.

Headphones and earbuds
If sound is just meant for one person, direct transmission are ideal. With headphones and earbuds, sound is produced right next to the ears, so it does not have to be loud to be experienced fully (fig. 34). On the flip side, it is relatively easy to make sound that is too loud, hurting the user's ears.

Bone conduction
Bone conduction (fig. 33) is a technique where vibrations are passed through the skull via a set of headphones, instead of producing actual sound through vibrating air. It can be used to help people with a hearing impairment hear better, but also by 'normal' users. The technique can also be used to hear in environments where that would normally be hard, like underwater, or on construction sites.

Fig. 32: (top) surround sound system

Fig. 33: (middle) placement of bone conduction headphones, near the temples

Fig. 34: (bottom) different types of headphones

Smell

Digital scent technlogies
Several different technologies have been developed over the years to produce smells together with digital visualisations. Devices generally function by releasing the smell and sometimes propelling it with a very soft air current. It has been used in cinema (fig. 36), with desktop devices, and with VR goggles (fig. 35). There are still hurdles to take before it can be used widespread without risk, mainly around the unknown health effects of digital scents, but also the current lack of knowledge about human olfactory (smell) experience.

Fig. 35: Ohrama, recent VR scent technology

Fig. 36: Charlie and the chocolate factory, presented in Smell-o-vision, the first digital scent technology used in cinema.

III. Cultural landscape

By going to museums, films, playing games, and experiencing all kinds of different leisure activities, people build an idea of what these experiences are like. In the film industry, vfx are becoming ever more advanced and realistic, in games processing power allows higher detail, more interactivity and more beautiful environments. This allows them to create complex stories and emotions. Although often played up beyond realism, this is a great inspiration on what type of emotions are experienced as important to the players of these games and the viewers of these movies.

Museums also develop their design and strategy constantly, and it is valuable to take a look at how other museums are evolving.

In this section you will read about games and films with simulation or mixed reality elements and how they are relevant, and then you will read about several museums in the Netherlands and the good and bad elements of their exhibits.

Mixed reality in other media

Introduction

In this section, a selection of movies and video games are analysed. All of these subject matters contain an element of simulation, immersion, augmented or virtual reality or similar phenomena. Most of the subject matter is sci-fi themed, as it is interesting to see what the continuation of today's technologies will be in the creator's view.

In the analysis a short description of each subject will be given, and one or two relevant points will be discussed.

With this analysis I hope to obtain a list of guidelines or conclusions that can be used to improve the design of the engine room experience.

Assassin's Creed - Animus

Content

The Animus in Assassins Creed is a 'genetic time travel' device, allowing into transfer 'genetic memories' of a subject and project them around the user, essentially taking them into the time and place of whoever's DNA is being read. This creates the main story mechanic of the Assassin's Creed games; time traveling to distant cities in long-past times to explore the environment and carry out missions.

Relevance

Interestingly the core of the game takes place entirely in the past, implying that

tian environment

Fig. 39: Initialisation of the Animus simulation

the time traveller actually physically is there, as he/she experiences everything as if it was real. However, the activation of the Animus shows visuals that seem to imply a digital hologram instead of a physical environment. Additionally, online documentation (source) indicates the working principle is projecting on screens. This dichotomy in the games is a storytelling device, and provides an interesting mystery. Implying there is more than just 'real' and 'not real' could be an interesting vantage point.
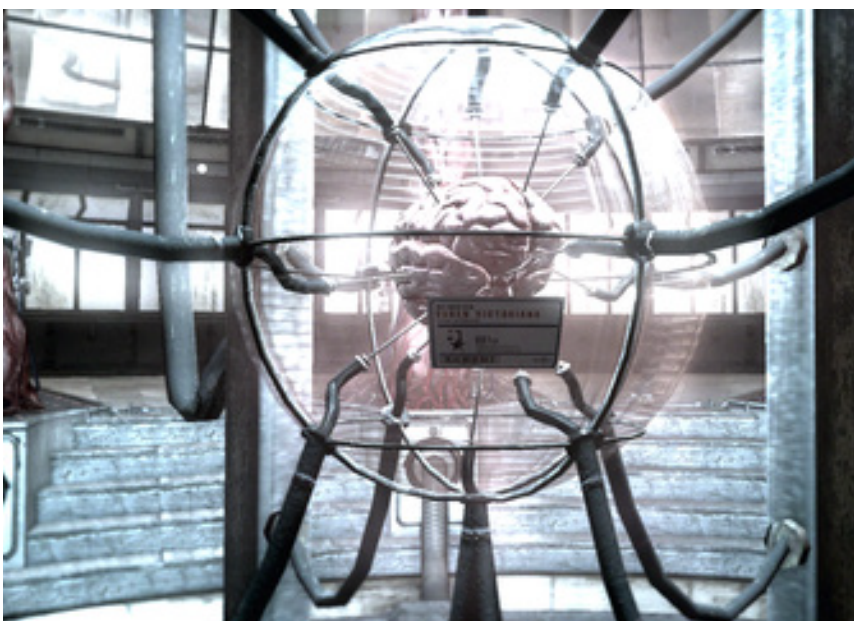
The Evil Within - STEM
Content

The Evil within is a series of psychological horror games. STEM is a computer-like device that drives the main narrative of these games. It connects to people through 'ports', knocks them out and projects their image in a world inside the computer. The core of the computer itself is also a human consciousness, and through connecting more people to it it gains strength. The company behind it, MOBIUS, wants to connect the whole world to it and become the overlord of the human race.

The evil within is a horror franchise, and STEM is portrayed in ways that make it seem creepy and painful. People are connected into it by lieing in bathtubs and sticking wires into their skin, and in later games the machine can target people wirelessly and knock them out that way. The world inside the machine is otherworldly and deadly, in the games the protagonist experiences many forms of horror while wandering the environment.

Relevance

Of course technology like this does not even resemble what we are able to accomplish today, but in general what STEM teaches us is that 'realness' is not specifically something to chase after, as it is not intrinsically positive. The images inside STEM are terrifyingly real, and can make subjects go crazy. This also indicates that subjects are much more vulnerable but also much more susceptible on an emotional level.

Inception - Dreams
Content

In Inception, technology has been developed that allows people to be conscious in their dream world, or even join others

in their dreams. They can then influence that world as they see fit, similar to the real-world concept of lucid dreaming (source?). In a dream, people can go to sleep as well, and with the same technology enter a dream within the dream. In the movie this technology is used by a team of dream-travel experts to enter the dream of a businessman, go several dreams deep, and implant an idea there that influences him to make an important business decision in the real world.

Relevance
Whether an experience like this happens in a dream or a simulation, it is important to realise that the new environment is more malleable than reality, and it could be interesting to let visitors have some freedom in this. Additionally, another angle for teaching ideas is to implant metaphors and/or support ideas with experiences. The movie suggests, not unbelievably, that this approach speaks more directly to the visitor on an emotional level.

Ready player one - OASIS
Content
In Ready Player One there is a gigantic worldwide VR platform called OASIS. Here almost the entire world population can flee from the dilapidated reality into a magical world where they can be whoever they want and do whatever they like. There is an economy, you can make friends, it is in many aspects similar to many online open-world games available

today, only on a much bigger scale. In reality however, the people playing are shown as vulnerable, unaware of their surroundings, and they are portrayed unflatteringly in general.

This brings up the point of selfconsciousness of the real self. Will visitors fully engage with a completely digital world if they know other people might see them? Is it a responsible decision to bring visitors into this vulnerable state at all?
On the other hand, taking inspiration from gaming aspects is an interesting viewpoint to take, for both this movie and a museum exhibit. The movie also shows the great extent to which people can engage with a rich, unending experience.

While not desirable in this form in a museum, it might be interesting to consider the implications for exhibit design.

Sword Art Online
Content
In the japanese animated series Sword Art Online, the characters enter a VR world with a medieval fantasy theme which functions like a game. However, the game designer traps the players in this world, and their inert bodies are left to starve if they don't beat the final boss of his virtual world quickly enough.

Relevance
Possibly the best learning point from this plot is that it is important to give people in a virtual experience the idea that they

Fig. 44: The world inside OASIS is vast and rich

Fig. 45: However, the world outside it is cramped and decrepit.

can get out at any time they want. Especially in a position where visitors might be leaving their physical more exposed than normal (in whatever way) it is good for them to have knowledge of this freedom.

Minority Report - Halo
Content
Minority report features, among several other futuristic technologies, the Halo. This is a headband that puts the wearer in a coma-like state, giving them visions as if they were still living on. It is used as punishment for people that were about to commit crime, as predicted by the precognition technology also present in the movie.

Relevance
It is important to create a clear distinction between the real world and any simulations, to make the visitor feel sure of their situation. As of today there are still discussions about the end of the movie, because there is no indication of whether the happy end is actually reality or coma-induced visions. This ambiguity could be scary and unpleasant, and should be avoided in real designs.

Star Trek - holodeck
Content
The star trek holodeck is a space on a spaceship where a virtual world is projected. For people in the projection, the world seems real and physical when they interact with it, and in this way they can experience life on distant planets, long-past times or play out scenarios as a test before executing them in real life.

Relevance

Fig. 46: The players in Sword Art Online are portrayed immobile and physically helpless

Fig. 47: However, the world inside the game is rich

Fig. 48: Subjects of the Halo are depicted floating naked in a glass tube, like lab rats.

The holodeck is a vision of how simulation technology can provide for a wide range of experiences that are also malleable, totally in control of the viewer. In the show it stimulates the scientific mindset, and allows viewers to explore the countless possibilities of the universe without having the resources to go to all those places and do all those things.

Discussion

Cultural landscape

This has been a layout of future or alternative views on immersion and simulation. This serves as a guideline for how the creators of these stories see a possible development of the technology. Despite the fact that they are mainly used for dramatic effect, the technologies bare resemblance to reality, or what reality might develop at some point, and the potential challenges and opportunities that arise with it. From a different perspective, this is the cultural baggage that many people will enter the exhibit with. Media like film and games are inherently unrestricted by technological development in reality, and as such technology can do whatever the story needs. Visitors might not be impressed as much by a decently lit 3D model and some particle effects because they have seen it a thousand times in blockbuster cinema since the release of Jurassic Park in 1993. In a way, this analysis is also benchmarking the possible expectations of going into an immersive exhibit.

Fig. 49: the holodeck is just a simple room when not turned on.
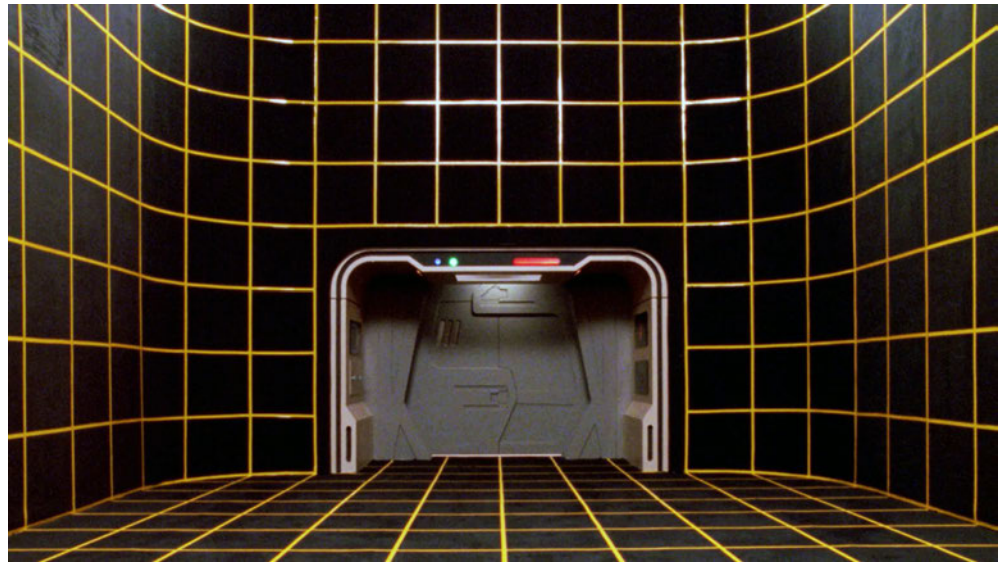
Fig. 50: But when on, it creates a perfect multisensory simulation of anything imaginable.

Conclusion

This is a list of things that should be kept in mind for the design of the immersive exhibit, based on the content presented in this section: (see also fig. 51)

- Emphasize that there is more than real and not real, have the two modes interact and create the MR. However, also be very clear about what is real and what is not real. In general, give visitors as much control over their situation as realistically possible.
- Take care of visitors emotionally. They are vulnerable when they take an open stance towards an immersive experience, and it will be important to be trustworthy and caring.
- Physically the visitors might also be vulnerable if they explore a virtual experience. Making sure they know how not to hurt themselves (e.g. by bonking into things on their way) might make visitors feel comfortable.
- Simulated experiences can be rich, endlessly varied and rewarding. Utilising these aspects by making it seem like there are a lot of options might be a good way to stimulate a sense of wonder and an explorative mindset. Allowing visitors to influence the simulation, or otherwise showing that it is more malleable than reality, might be a cool way of showing that things are not real without losing the wonder and excitement.
- Because the virtual world is able to show 'impossible' things, there is an opportunity to support a teaching agenda with metaphorical or conceptual support.
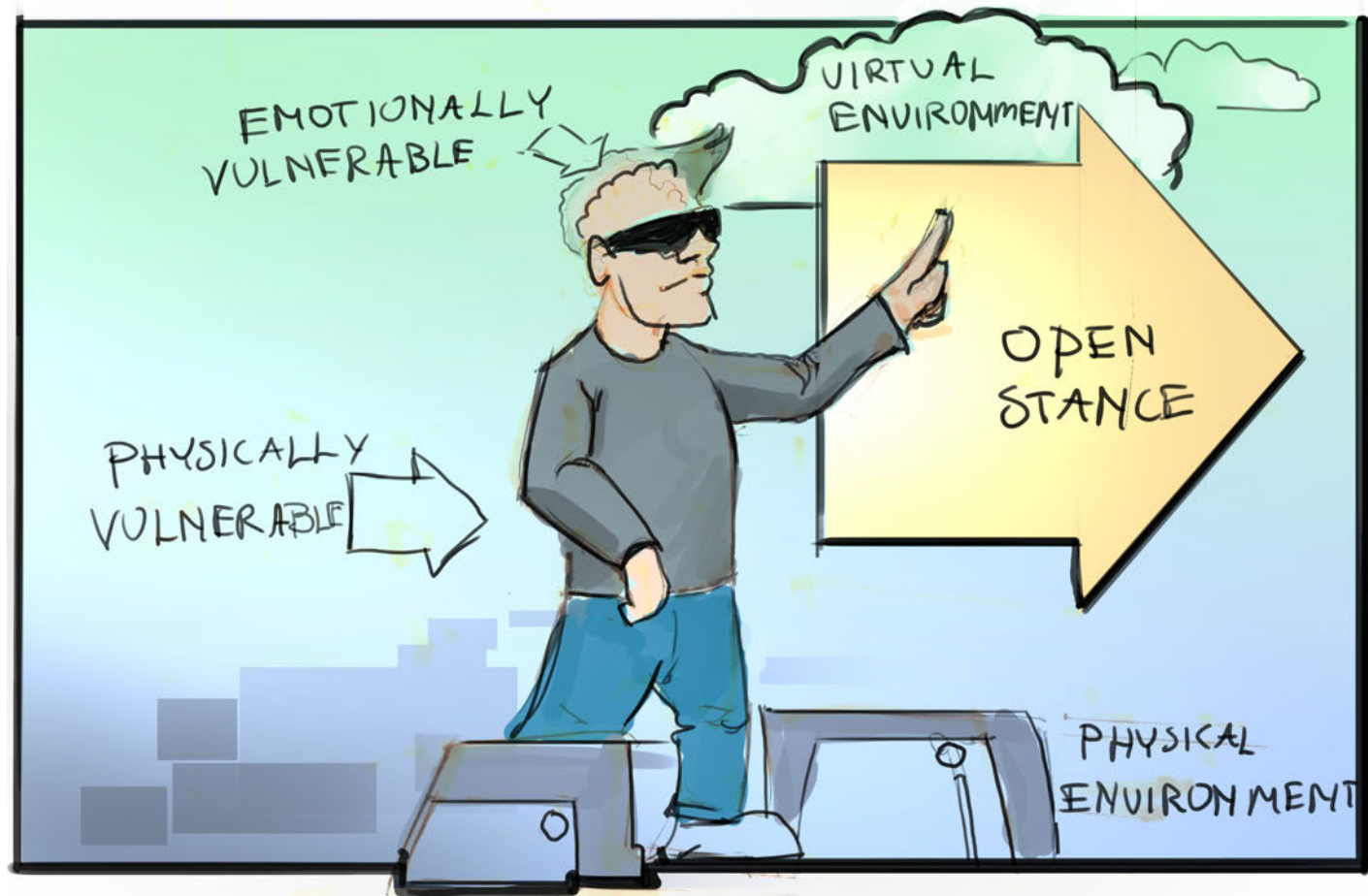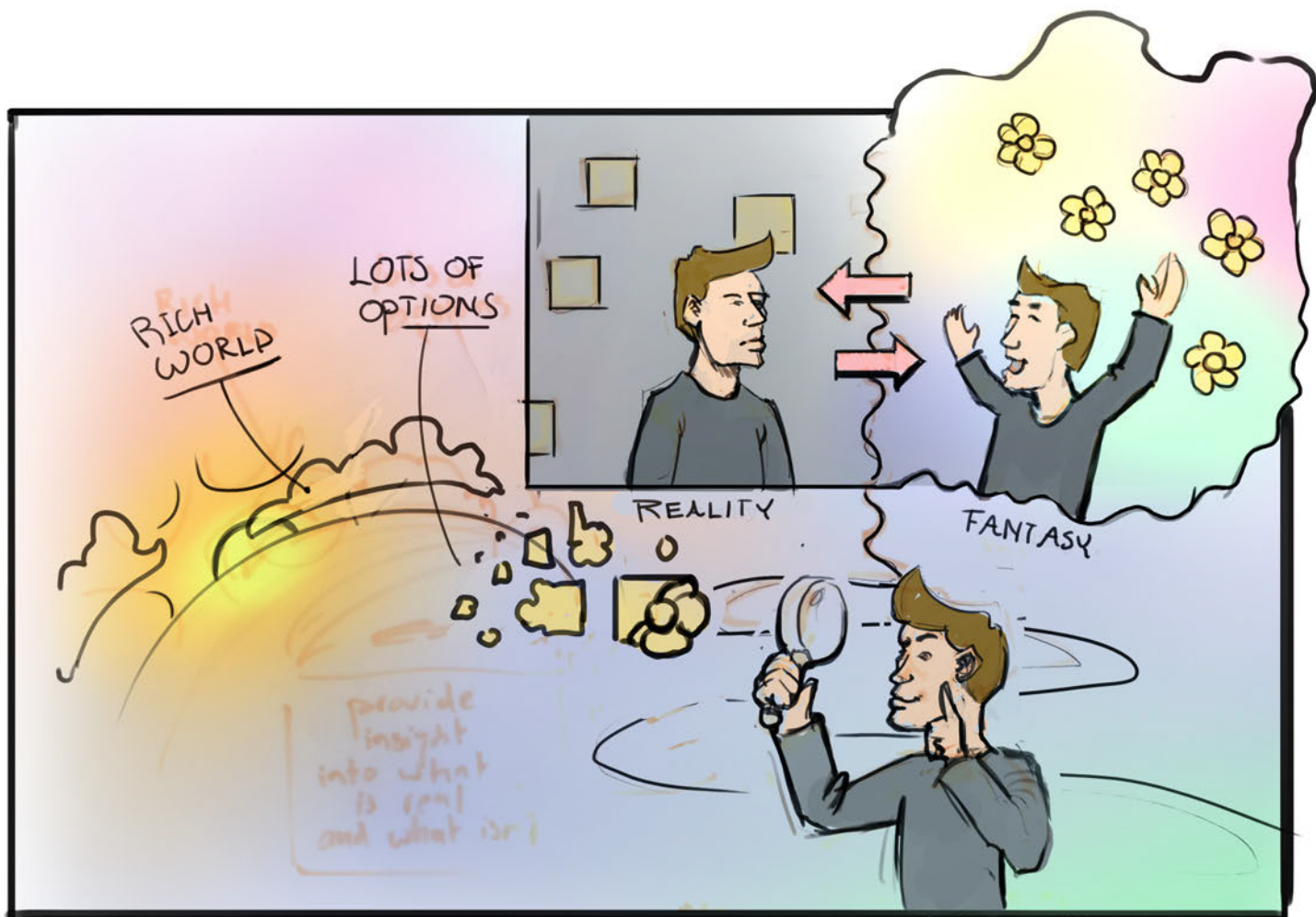
Museum Inspiration

Introduction

When designing for museums, it is of great value to take a look at what is out there. On one hand it is a great source of inspiration, as many museums employ different and interesting design features. On the other hand, it serves as a bench-marking analysis. Visitors walk into a museum with certain expectations, and if those are not met it might have negative consequences for their enjoyment of the experience. These expectations are in part formed by having been to other museums.

The analysis in each museum will be structured differently, as the visits were partially recreational (partly to simulate how it would be as a normal visitor, but also because I just like going to museums) The writing in this chapter will therefore take a more journalistic approach. At the end, all of the relevant conclusions will be summarised.
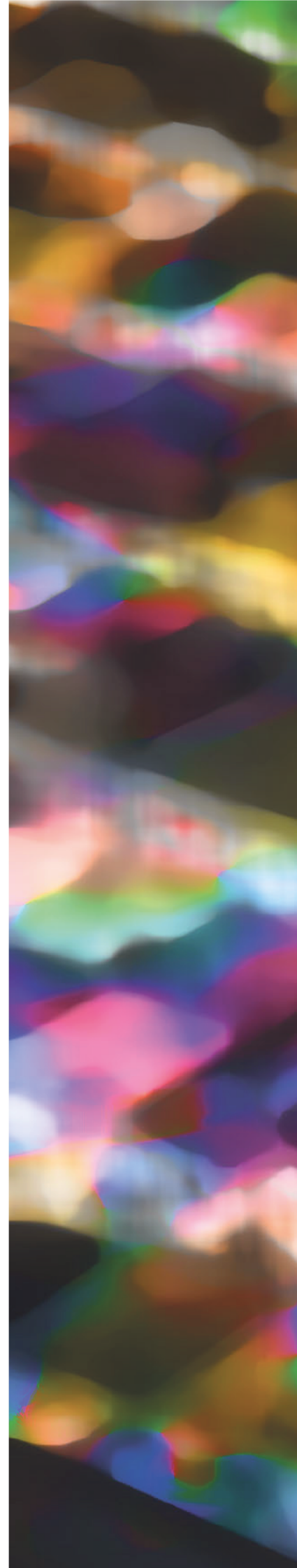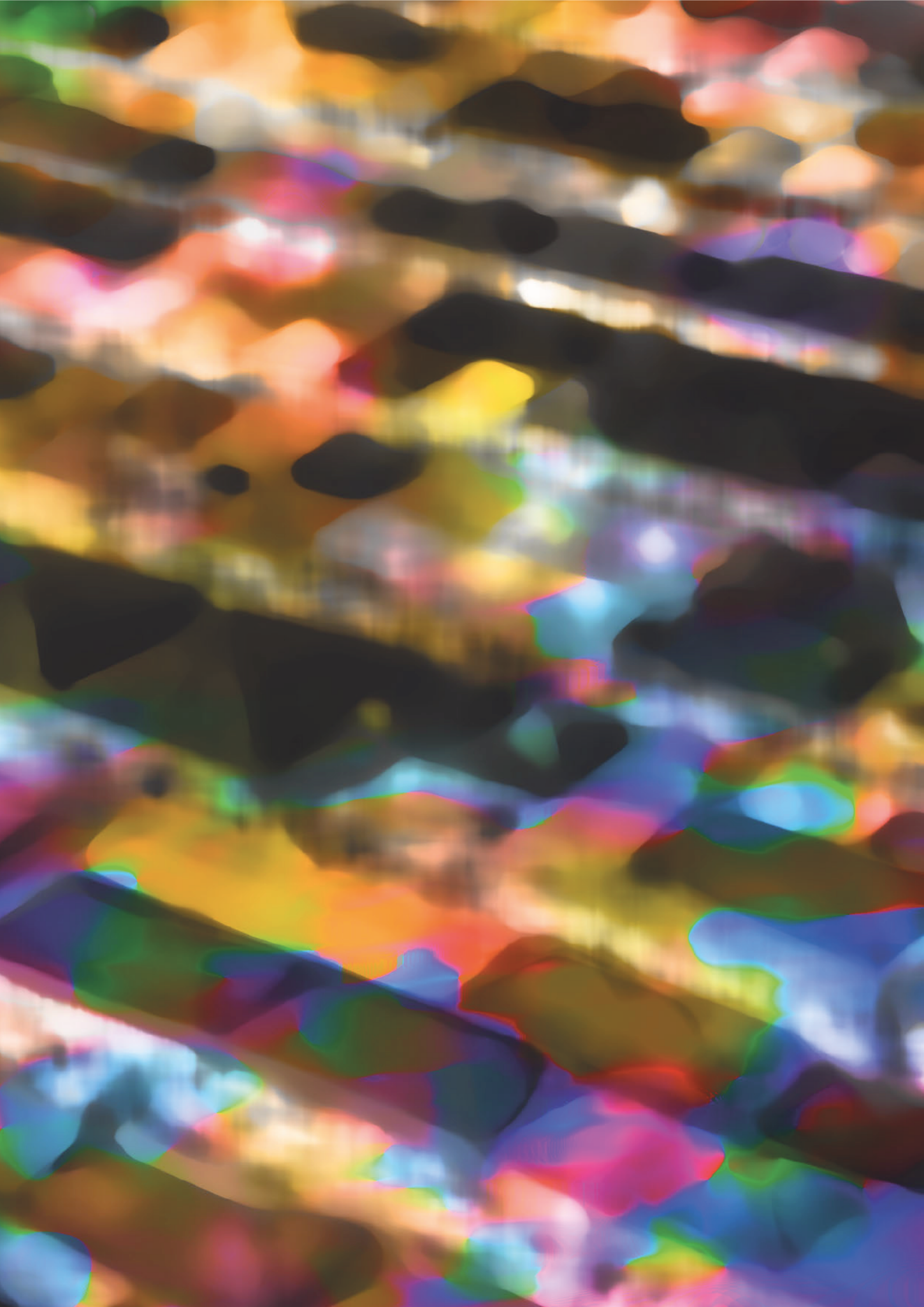
Steam museum Medemblik

The steam engineering museum in Medemblik holds a collection of small and large steam engines, tries to preserve the heritage and explain the working of this machinery to visitors. It is situated in the north of the Netherlands in Medemblik, a port town to the wadden sea. The entrance to the museum is a small country road, and the building itself is adorned with a large chimney that towers above the rest of the landscape. The environment is very green, and several buildings and some steam machinery are scattered throughout the landscape.

The museum gives a relieving feeling, as it looks grander than on the photos online. It is also well kept, and leading up to the entrance it is possible to already get a glance of the smithy and the machinery park in the back.

The exhibit itself was elaborate and impressive, but seemingly less well organised. Most of the space was filled with large, still functional steam engines and complementary info cards. There was one with visible sections of the pistons, and also some miniature versions on display, showing different aspects of how the machines were used. An interactive part of the exhibit allowed visitors to buy a block of miniature fuel and power their own miniature steam boiler, powering a single-piston miniature steam engine (brand?). This takes somewhat long, as the boiler needed around 8 minutes to produce a serviceable amount of steam, but the engine interactivity is great - it is possible to feel if the pressure is right with a whistle, turn the valve, then give the flywheel a push and the machine starts running itself.

The museum is run entirely by volunteers; steam engine enthusiasts mostly, who know how to run the engines and can tell visitors about them. These are enthusiastic, driven people who want nothing more than to help the museum carry out its message. However, they are also hard to guide. They know how to handle the machines, but there is little in the museum that the staff can use to welcome and help the visitors. The potential of their enthusiasm is wasted, in this regard.

Me getting the little steam engine to work almost immediately grabbed the attention of one of the other visitors in the room, an 8 year old boy who also wanted to try this. He came up to me and asked how I did this and how it worked. He seemed genuinely eager to learn. Great feedback, I'd say, and I think I would experience the same; the small engines were a clear, interesting and generally wonderful part of the exhibit.

Cultural landscape

Fig. 52 the little steam engines to try out were very interactive

Fig.53 The entry lane of the Steam museum gives a great impression.

Fig. 54 (left) the hallway of the museum is stuffed with all kinds of machinery

Fig. 55: (right) There is work being done live on the machinery, making the experience more authentic
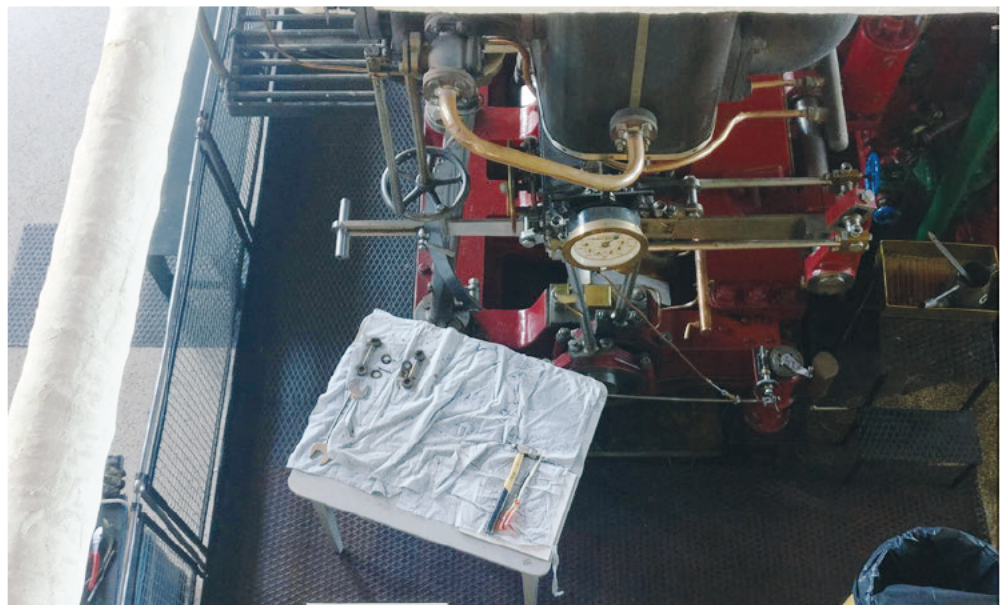
Castle Radboud

Medemblik also is home to Castle Radboud. This is an exhibit in a castle built under Floris V, intending to show the life in castles in the late middle ages. The exhibition is still undergoing renovations, and summer 2018 was the first time that objects were on display.

The objects on display were poorly lit and the accompanying text was relatively long and not easy to read. The interiors were not following a consistent theme; a lot of the furniture was 20th or 21th century design, and many of the hearths were used as a place to put paintings or furniture without clear reason. The audioguide produced shrill, loud noises when listened

Perhaps because of this reason, this exhibit shows several things that should be avoided in museum design. At the start all visitors are offered an audio guide, but it seems like the voiceover for it was solely aimed at younger visitors. There was also a quest for children, and the relatively small store is focused almost entirely on children. It certainly seems like the museum targets children, but does not indicate this in their online marketing or at the counter.

The overall quality of the exhibit was poor.

to with earbuds. The routing through the museum was also unclearly defined. Following the main route, visitors are not only led through the main exhibit but also through a room where children's parties are held. I'd say; no fun for anyone involved.

Fig. 57: misrepresentation of history, like these chairs in the hearth, is undesirable

Fig. 58: a very small, low to
the ground maquette

Fig. 59: A very shoddily presented ar-
mor, missing a glove

Fig. 60: the main hallway
was dressed, but was not
guiding visitors well

Maritime museum rotterdam

In the maritime museum in rotterdam are a range of exhibits. The museum is aimed at three main target groups; children, their parents and their grandparents (website). There is an exhibit displaying early maritime history, with scale models of large ships from the 1700s and paintings from around that time as well. This exhibit is 'traditional' and does not contain a lot of stimuli besides the artifacts and a small description plate besides it. Possibly, this is aimed at the grandparents in the target group.

There's a few exhibits that go a little bit more overboard with new ways of display and exhibit design. An extension of the maritime history exhibit details ship design and maintenance, both in current times and in history. It shows some objects accompanied by large amounts of text, but there's also some video material. Content-wise it's interesting that the new information is linked to how it was done in ancient times, but in many cases the links were somewhat far-fetched.

 (e.g. linking the approval of schematic drawings by a modern mechanical engineering agency to an old calculator-type machine. Not bad, but not particularly exciting either).

This exhibit also seemed to suffer from a lack of clear focus, as there were mentions of environmental problems, species spreading through maritime travel, design, informational systems, and on-board maintenance.

An exhibit , called 'Knappe Koppen', that seemed to be more focused on children was interesting from a design perspective. Featuring some texts from Andre kuipers as well as a collection of stories about 'clever people' in history, it had an interesting mix of engaging activities, tasteful set dressing and historical artifacts. Tying the whole exhibit together was a quest (presumably for children, considering the colorful design, simple language and height of most of the related activities) for finding letters, and for each letter the questing visitor has to do a small task related to a part of the exhibit. For example, there's a box that makes the sound of insects flying around, making you think it is full of creepy crawlies, and a plate telling to push the button inside the box to reveal a clue. It was situated near other objects and descriptions about an accomplished bug researcher, so as to lead visitors from the activity into the content.

Good set dressing was also placed in some of the exhibit. Notably, a part about a historical anthropologist was decorated with life-size cutouts of illustrated tribespeople. They were clearly fake and thus not scary (as I expect they might have been, had they been realistic), but still provided the otherwise perhaps dull books with atmosphere, letting you as a visitor get into the environment and feel like you're experiencing what the anthropologist experienced during research.
The final exhibit visited in this museum was the "Offshore experience". This came closest to what would be called an immersive experience, and featured the

Fig. 61: The cardboard cutouts of indigenous people provided great set dressing

most advanced technological equipment in the museum. It started with a video of an offshore platform safety officer briefing the viewer on safety protocol. Visitors are then suggested to wear a yellow safety helmet and vest, and invited to go upstairs. The next room has walls displaying a video of the sea, the walkways are metal grating with railings to the side, all to give visitors an idea of how it is to be on a platform. There are some games to play here, a.o. using a pair of physical red 'bats' to perform instruction signs and help land a digital helicopter, overlaid on the screen displaying the sea. Visitors can attain scores in these games that are later compiled to show on a certificate with their name and photo. A lift brings visitors to 'the bottom of the sea' (which in reality is one floor down, near the start of the exhibit) which turns out to be a dark room with construction pipes, fluorescent jellyfish displayed on transparent OLED screens to seem as if they are swimming in between the ocean floor weeds (phys-

ical plastic plants). The room is dimly lit with a 'rippling water' effect and a muffled underwater soundtrack is played, giving quite a good impression of being under-water.

Fig. 62: A game where a visitor is using two red bats to guide a digital helicopter to a landing platform
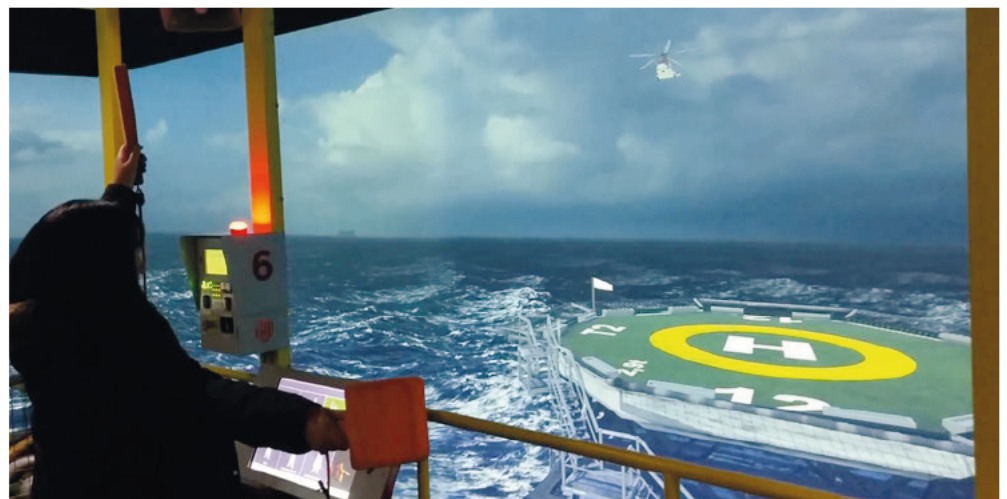

Fig. 63: The first, somewhat traditional, exhibit

Scheepvaartmuseum (Maritime Museum) Amsterdam

The Maritime Museum in Amsterdam has several exhibits that are interesting from a design perspective. First and foremost, the VR experience in the Amsterdam.

The Amsterdam is an 18th-century ship in the harbor of the maritime museum. Visitors can enter aboard and explore the space. The VR experience is a big contrast to the rest of the interior. It has a futuristic design, and there are VR goggles hanging from the ceiling above swivel chairs. Museum staff makes sure there are no more than 20 people in the room, closes the door, and gives a spoken introduction while visitors take a seat and get comfortable.

The experience itself starts off with the inside of a ship, some actors moving boxes, and a briefing on what you should do if you feel nauseous (a relatively common concern with VR). Then the camera flies upwards to the top of the ship and starts a trip through 18th-century Amsterdam harbor. 3D models of ships under construction, people working and living, and ships sailing on open water contribute to a rich and lively experience. The visualisation switches between 3D renders and a movie sequence at some point to show a scene of people saying goodbyes and getting on a ship.

The experience is visually impressive and gives a good impression of how things might have looked in 18th century amsterdam, but it is also very limited in depth and conveys little practical information. There is no text or explanatory voiceover, so the visitor is left guessing at what exactly is shown or why it is relevant. This would be an opportunity to implement the power of VR, showing more than just what reality would have been.

The maritime museum includes two other exhibits with notable experience design. The first is about the 17th century, the golden age of the Netherlands. The exhibit was tightly packed, with maps and ships and books. There were parts where actors were projected on a screen or wall, portraying 17th century people of various occupations. The tight placement makes the route of the exhibit very clear, so visitors

automatically end up facing the screens - clear routing design. The exhibit also contains several video games that show or explain a small part of the exhibit. For example, one of the games allows visitors to control a merchant's ship, sailing from port to port to buy and sell wares. Visitors are challenged to make as much money as they can within a set amount of weeks, which can be done by looking at the prices of goods at each port.

Another exhibit, this one about whale hunting, also features video games. These games are actually quite effective; they are simple and easy to learn, look good, and teach a small amount of information in an enjoyable way. The whale hunting exhibit has another interesting design feature. The exhibit contains large models of human whale hunters, as well as a large whale that is open on one side, allowing visitors to look through his eyes and even go up to his intestines to learn about the whale fat the hunters were looking for. Both the humans and the whale are not hyper realistic; the humans are spray painted white and the whale has a slightly comical design. The whole setup is, however, an intuitive way of immersing visitors in the exhibit, and creates wonder.

I immediately get the urge to calculate the optimal strategy of the video games, because it certainly seems like there is one. I am guessing that might be the reason there is no leaderboard.

Fig. 64: The VR room was designed like a futuristic space, with mirrors and lights everywhere

Fig. 66: projected figures (in the background) blend in well with the physical space

Fig. 65: The games and
interactive elements in the
exhibit were well designed
and felt contemporary

Fig. 67: The interior of the Amsterdam
was open to trying out for visitors.
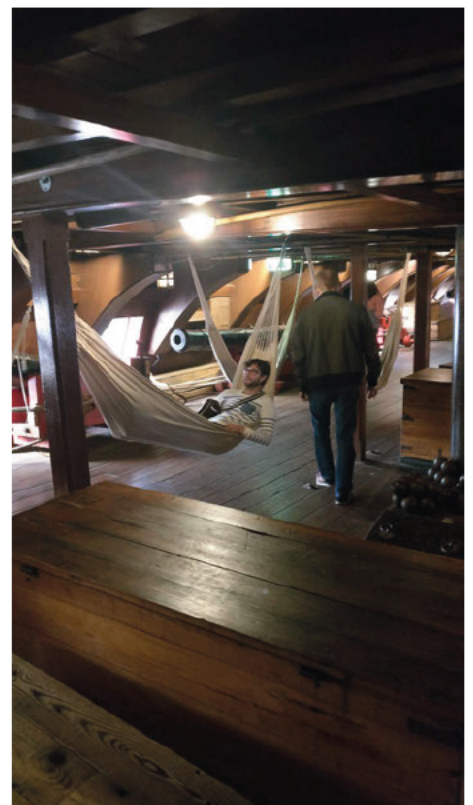
Conclusion

These museum visits provide several useful insights into museum design.

Employing the physical space (such as in the offshore experience) is an efficient way to immerse the visitors in the experience.

Having physical interactive elements (the little steam engines in Medemblik) is an 'easy entry' for visitors, as there is a very low bar for participating in such an activity, after which they then have a much easier time engaging with the learning aspect.

Making use of the inherent quality of old artifacts (the projected map and games in the maritime museum amsterdam) is a nice way of using the museum's 'strengths' to make it look contemporary without using expensive, advanced technology.

Visually impressive exhibits are effective on some level, like the steam museum in Medemblik or the entrance to the Amsterdam ship. This is, again, an 'easy entry' for visitors to become interested.

Good guidance is critical, as can be seen from the absence of it in castle Radboud. It can be done with several tools, including the architecture, signs, a physical map, and possibly more.

IV. Interviews

Jeroen Croes,
Director of De Werkplaats, in Bilthoven, notes: (translated dutch-english and paraphrased from notes for understandability)

De werkplaats has primary school and high school ranging from VMBO-t to Gymnasium

Life is a social process and that they want to stimulate living together with other people

Teaching is also raising

De werkplaats wants the development process to be fluid, with little actual classrooms. They also want kids to be owners of their own development

At lower/more practical levels of VMBO, kids relate heaviliy to the person conveying the information. A personal touch is influential. "Who are you?"

Museums are always better than the classroom, to kids. Classrooms are boring.

A relation to daily life is also helpful to relate to

School trips have to fit into the schedule and teaching program

For VMBO kids it is important to highlight that museum exhibit content isn't holy - they can like or dislike it the same as any other object

Many schools make two trips in a year with their students. Apart from that there are also separate trips for ckv students

Kids with higher education go to museums with their parents more often. When kids are with their parents, the parents often act as guides.

For VMBO, you have to present abstract concepts in a concrete and visual way.

In HAVO, the variance between students is higher. There are kids that are good abstract thinkers that do not work hard enough for VWO, and kids that are not very good abstract thinkers but work so hard that they surpass the VMBO level. This often causes clustering of similarly fated students.

The preconceived notions of boredom concern learning, not museums in general.

Michael van der Meer,
Director of the TU Delft science center, notes:
(translated dutch-english and paraphrased from notes for understandability)

The current exhibit has been designed with a team in 2009-2010.

The exhibit is only aimed at the TU, different from e.g. Nemo

Schools usually come to visit just for a workshop, which is also aimed specifically at schools

Not that many schools seem to have mechanics education (In Michaels experience)

VMBO is less frequent among the centers visitors, because they are less interested in the TU

There are, however a lot of interns from MBO and HBO, they can maintain and repair installations

Schools usually come on weekdays

Although it might seem like it, the exhibit is not aimed at young children

Doing activities gives a childish impression, in this case wrongly

In michaels experience, male visitors have less problems doing things that seem childish

The center does not pay attention to different types or 'leerstijlen'. They focus on a division between research, design and building

Building a relationship with a museum is difficult for visitors. Sometimes students do it while making their 'profielwerkstuk', but otherwise it is rare

Paulina Schulp,
Teacher in French and coordinator culture at De Werkplaats, Bilthoven, Notes:
(translated dutch-english and paraphrased from notes for understandability)

De Werkplaats is a culture profile school, of which there are about 50 in the Netherlands. This means they have connections with each other, and are more interested in promoting culture

Technology culture combination is a field that is being explored at this moment

Usually, the school goes to visit museums form a visual arts/history perspective

A museum visit is to get students in touch with the museums contents, not to go in depth

There has been a growing interest in new media - photo and film - for some time now

Assignments given to students in the museum vary according to the main goal of the visit

Exam-year students get a tour in the Rijksmuseum > more attention goes to higher classes in this case

The experience is sometimes all that's important

Art based learning is an educational vision that is becoming more popular

Boys and girls are both about equally interested in museums

Girls are usually more visually focused, boys are more practical

Gamification can help both genders discover

Learning styles have a lot of influence on how the information should be presented

Providing educational materials as a museum helps schools a great deal

It is important that experiences are not too long, and that students get to make their own choice autonomously

Project manager Ronald Theunissen and project director Remco Molenaar, Kiss the Frog, Delft, note:
(translated dutch-english and paraphrased from notes for understandability)

Kiss the Frog does design, programming and projec management.

Data is personalised, this allows us to record personal results

A lot can go wrong in an exhibit, it is important to give museums the possibility to perform some maintenance themselves

Kiss the Frog does a lot of digital work

Subdividing a group is easily done with multiple elements in an exhibit

It could be nice to create educational materials for before the school visit.

Handling large groups can be done by dividing roles within the group - through the tickets for example - and sending different people to different spots efficiently

Schools have around 45 minutes, or at least a relatively short, set amount of time

It is not a good idea to limit individual visitors too much with the school design

Lower levels of education are much earlier with their choice of profession than higher levels

Budgetwise, an interactive touchscreen can range from 5-10.000 euro, but anything with more interactivity, including hardware and set dressing etc, could range in the 30-40.000s.

Kiss the Frog sometimes handles a square meter-based price

It will be important to speak to the target group, and test with them if the design is going to work.

An installation is more effective when it concerns one simple principle, so that the visitor can focus

The engine room exhibit should be a balance, budget-wise, with the rest of the museum. If the masts were expensive, it is not weird to also spend money on this room

It will help to have clear visitor profiles

It will be important for the museum to also consider promotion costs and maintenance in later years

Maybe stories from passionate voluntary workers can add a lot of life to the exhibit.

Michiel Lucassen,
Culture coordinator X11, Utrecht, notes:
(translated dutch-english and paraphrased from notes for understandability)

The Beeld & Geluid museum uses a ring for identification

The design could take inspirction from Naturalis or the Spoorwegmuseum

It is important to take the learning capacity of the students seriously

Under the name 'sterk-techniek onderwijs' VMBO schools will in the following years get 400 million euro to improve their mechanics education

It is important to look for a dialogue and creativity

The 'fonds voor cultuurparticipatie-VMBO' exists

Interview with students at X11, Utrecht. The students note:
(translated dutch-english and paraphrased from notes for understandability)

Following a sort of story can be cool.

The consequenses of your actions in an installation could also be negative

They would want an explanation, through static or dynamic information

Their association with this design is that it seems like minigames or challenges, as in video games.

They would find 45 seconds a good length for an explanation video.

'Basisschool tv' is a good reference to them for how to do instructional videos right.

They would like to see some sort of score when they leave, and perhaps get a prize if they are the best?

They are worried young children will walk over the map projection and ruin the fun

In the touchscreen installation, they would be interested in choosing different motors and seeing the specifications.

Martin

16 = mbo jongste leeftijd

mbo   niv. 2/3/4
          basis   kader   theoredisch

geeft leeswerk
aanbieden
korte tekst
/ simpele hersenhelft

docent mechadronica/smart tech
          bovenbouw
  - hardware kant
  - constructie berekeningen / materialenleer
  veel groepswerk

aansluiten op belevingswereld
                    → plakt beter

smart tech : veel (10%) meisjes
ook veel op niv. 2
    1 op 20 is
meisjes pakken theorie op niv 4
iets makkelijker, theorie meer
discipline

KOLB doener   beslisser
          dromer   denker

---

coachig 7 groepjes
1 docent 1 assistent
super duidelijke structuur
  (△ geen onzekerheid)
    gamification: nog
    geen effect van gezien
ade mavo   9-vraag
                    quiz wedstrijd
start voor hbo kahoot
WB/NL hoog niveau
snappen door expansie

niveau 2   krijgt geen
zachte skills, kunnen
niet samen werken

ook afdeling art & design

uitjes naar beurzen
bedrijf
    nacht/merken/stages

selfie voor stand
1 of 2 interviews
gesprekken zijn eng

goeie opleidingskeus is
20-30% twijfelaars

onderwijs museum

Sfeer binnen klas word bepaald door docent

duidelijk & direct
leerrendement → soms even afblazen

Veilig leer klimaat

binnen klas kleine groepjes (4)

      ↳ meereizen
      → gezellig
      → zilfde school
      → etc...

  ↳ studenten zijn heeeeel eerlijk naar elkaar

the learning pit
     ↘ licht op berg
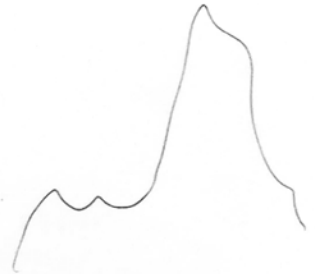
Jeroen Croes

vmbo = 4 niveaus

oude basis
nivo → theoretisch

+ basisschool
+ middel school vmbo t - gymnasium
          └→ ook veel gekleurdies

de werkplaats - kindergemeenschap

leren = sociaal proces → gezamenlijk met anderen
kinderen zij. werkers → werken aan ontwikkeling
          └→ "vel heel hoog in de idealen"
                                                            eigenaarssc
leren = ook opvoeden   over ontwikkel
weinig lokalen → veel fluïde

binding met lagere niveaus = persoon die het introduceert
                                    _____

                                    (is belangrijk)

→ rondleider is   persoonlijke touch helpt
   erg belangrijk
                            → "klaslokaal is saai" ish
                              eerst relatie dan museum
"wie ben JIJ?"
                        (ook dagelijks leven relatie
= interessante   └→ gem. grovere levenswijze
  vraag

[AM museum]
          └→ schoolreisjes moeten in het schoolprogramma
             passen
voor VMBO; stom of leuk — niet de heilig
snelle sfestjes zijn doelgroepgericht — zeker voor VMBa

Veel scholen zeggen: 2 voorstellingen in een jaar.
er zijn vaak ook dochten voor losse chv studenten

met ouders zijn de ouders rondleiders

hoger opgeleide ouders gaan sneller naar musea

Ronald (kiss the frog)

voor VMBO moet je abstracte concepten wel visueel,
concreter behandelen.

40% VMBO   60 % HAVO/VWO

↓
verschilt
per persoon
↓
minder homogeen
in het midden
↓
groepsvorming

vooroordelen zijn niet tegen musea, maar tegen leren

Steven Hanzer = Aardrijkskunde

Paulina Schulp — Frans & cultuurcoordinator

Bilthoven

Kees Boeke

X 11 leerlingen
& Michiel Lucassen

- wat ~~is jullie~~ denken jullie?

~~wat heb~~ ~~er~~ ~~beb~~

- wat vinden jullie van
  een ~~interactief~~ interactief verhaal?
- hoe zouden jullie hiermee iets
  kunnen leren over schepen bouwen
  /stoommachines
  /ontwerp?

terug naar holen
    scheppen
Minigames of challenges
45 sec.
    basischool schooltv
klein theater

VR bril
als je weggaat score
laten zien ro prijs

verhaal volgen
is cool

gevolgen
kunnen stam
zijn

bordje voor
uitleg
ro filmpje

voor beste?

jonge kinderen lopen over
projectie

meerdere motoren kiezen
~ verschillende specs

Interview Jeppe den Uyl

Ik wil graag:

= feedback over wat er niet/wel werkt aan mijn idee

- weten of ik een keer met scholieren kan houden testen

beeld & geluid
↳ vraag

naturalis / spoorwegmuseum

levend vermogen serieus nemen

VMBO - scholen hizyn homogener

700 miljoen euro voor verbetering techniek

(stich - technisch onderwijs)

Zodan naar die (oog /geahvskeit) fonds voor cultuuronderwijs cipnotral - VMBO
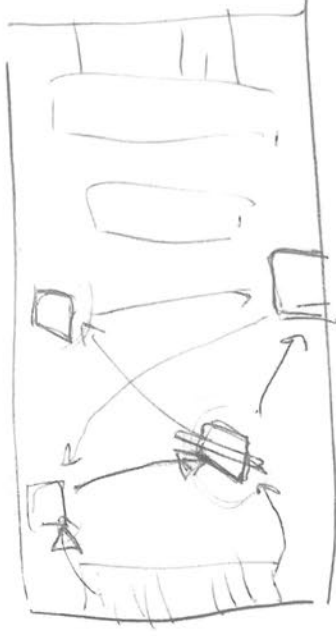
JMB noordran

underschool mahhlihh en bej)

NY haybor school → covenance island

ontwerp & programmeurs regulier management(engels)
data is gepersonaliseerd

persoonlijk regelband opnemen
veel dingen kunnen meegaan
→ museum mogelijkheid geven
om zelf onderhoud te plegen

veel digitaal werk
meerdere elementen een groep
op te delen
vooraf- lesstof bijna het
rollenverdeling → via haagtje
school wil binnen 75 min weer weg
indn bezoek heit hem je niet teveel
bepalen
lager niveaus tegen al veel ervaren
bezig met beroepskeus

---

budget → losse exhibit
touchscreen etc — software
= 5-600€

meer interactiviteit → 1000

makkelijk richting 30- 40 etc

vierkante meter PISS

echt naar doelgroep toe

stoom? rss?

1 simpel principe

marine museum → lassen
stoomhamer in budget moet in balans zijn
duidelijke bezoekers profielen
later budget → onderhoud en reclame
in houden jaren?

wat kunnen/weten ze?
verhalen van vrijwilligers kunnen interessant
zijn

interview intermezzo!

Michael vd Meur

directorm science centre TU Delft

- wat doe je precies?
- wat is de ~~most~~ meest recente verandering
  in het museum. en hoe is die ontworpen?
- wat is de doelgroep?
- komen er vaak scholen? welke niveaus?

- hoe bezoeken scholen het SC?

- jongens en meisjes?

tentoonstelling ontworpen
                    → met team   2009-2010

① inspiratie → alleen gericht op TU
                         anders dan Nemo

② onderzoek

③ ontwerp & bouw
   werkplaats etc.
        ↓
   ook workshops
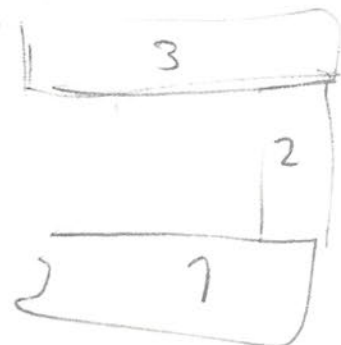
Scholen komen vooral door workshops

↓

specifiek op scholen gericht

↓
weinig scholen hebben techniek onderwijs

er komd wel soms VMBO maar is onder
het museum minder populair

veel MBO stagiairs

nieuwe robot armen

doordeweek zijn scholen het meest

↳ mbo/hbo techniek kan een rol
spelen in onderbouwd van een expo.

altijd iets doen vanuit TU

de kern is altijd
iets echts

ook zelf iets
doen

Het (I is een misvatting dat het enkel op
kinderen gericht is. ⇐

handelingen doen geeft een impressie
van hinderachtigheid

mannelijk publiek heeft minder probleem
met hinderachtig doen

geen aandacht voor verschillende
leerstijlen v leerlingen

    ↳ stukje - onderzoek
            - ontwerpen
            - bouwen

    brug bouwen :
ruimte voor verschillende insdap

Tanja Klop

                    → band opbouwen met
                      museum is lastig
                         ↓
jongens & meisjes   soms met profielwerkstuk
- niet specifiek - weinig verschilmaken
- jongens = race auto's   "techniek is techniek"
  & explosies   → focus op minder
meiden minder   race- of fabriekscontext
competitief → groepsdynamiek

Interview intermezzo!

- paulina schulp
  cultuur coordinator & docentfrans. de Werkplaats

• direct of indirecte kennis?

[mag ik recorden?] → stoommachine bouwen
of
moord oplossen door
iets te zoeken in de
machine hammer

• jongens - meisjes? → praktisch/theoredisch
competitief?
~~text~~

wat doe je als cultuur coordinator?
wanneer gaan studenten naar musea?
met welke focus worden musea gekozen?
Wat ~~zit~~ is focus waarmee studenten een
museum in worden gestuurd?

[sideways text left margin top]
wat doe (
wanneer
met welke
wat ~~zij~~
museum

jongens - n

[mag ik recorden?]

- paulina
  cultuurcoor

• direct of

[right column sideways]
beleidsplan cultuur
↓
doen

contacten
→ verenigi
wel bezig (cultuurp
met snijvlak ~ regio
tech - cultuur →
↓
niet b

→ naar museum
met beeldend/ges
(combi opdracht
↓
in aanwezig hom
↓
kunst

(artcadia)

Volksbuurt museum

[bottom sideways text]
BO - 8
naar NEMO

overspijzende
link

nieuwe media
(foto, film)

1 meer samenwerking
tussen cultuur
sikhar

leider

posde
geen
vakdocent

Florence?

Opdracht = afhankelijk van doel

examenkandidaten wijzen rondleiding
in Rijksmuseum lesopdrachts

Soms gewoon beleven
→ eentje kiezen die je het meest
pakt
→ verhalen
bedenken

Art based learning?

[Lesdidactiek]

Jongens & meisjes niet zo geïnteresseerd in
museum

meisjes meer visueel geïnteresseerd Jongens
meer praktisch
gamification → ontdekken, jongens en meisjes rebut?

direct of indirect hangt af van leerstijl
Hoe komen er ; multidisciplinair technisch -
voorbereidings activiteit

Esscher → lesplan (bruikbaar anders)
anders

Hogeschool vol kunsten
niet te lang
Eigen keuze maken
autonomie

→ ergens binnenkort door gaan
wat ik zou willen anders zou
niet meer maken

=

DESIGN FOR our future

TUDelft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

🛈 **USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT**
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME
Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 ! ⚠

family name	
initials	
student number	
street & no.	
zipcode & city	
country	
phone	
email	

Your master programme (only select the options that apply to you):

IDE master(s): **(O) IPD**   ( ) DfI   ( ) SPD

2nd non-IDE master: _____

individual programme: ____ - ____ - _____ (give date of approval)

honours programme: (Honours Programme Master)

specialisation / annotation: (Medisign)

(Tech. in Sustainable Design)

(Entrepeneurship)

SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	Arnold Vermeeren	dept. / section:	ID
** mentor	Peter Kraaijeveld	dept. / section:	DCC
2nd mentor	_____		_____
	organisation:	_____	
	city:	_____	country: _____

comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

🛈 Second mentor only applies in case the assignment is hosted by an external organisation.

🛈 Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair _Arnold Vermeeren_ date _17 - 9 - 2018_ signature _____

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _31_ EC

Of which, taking the conditional requirements
into account, can be part of the exam programme _31_ EC

List of electives obtained before the third
semester without approval of the BoE

⊗ YES   all 1st year master courses passed

◯ NO   missing 1st year master courses are:

name _____ date _21 - 9 - 18_ signature _CB_

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ✓ APPROVED   ◯ NOT APPROVED

Procedure: ✓ APPROVED   ◯ NOT APPROVED

comments

name _A Huwae_ date _2 - 10 - 2018_ signature _____

Initials & Name _____

Student number _____

Title of Project _____

_____ project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple.
Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date   17 - 09 - 2018   12 - 03 - 2018   end date

INTRODUCTION **
Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

The naval vessel Bonaire, one of the seven remaining combined steam-powered sail ships and built in 1876, is being revitalized in drydock in Den Helder. The steam driven propulsion power plant in the engine room was a unique representation of marine engineering innovation in the second half of the 19th Century. However, all the physical systems and components of this unique marine engineering heritage are lost in the last century. None of it can be physically replaced within practical and monetary constraints. On top of that, this space on board of the vessel is highly valuable for briefings, presentations, receptions and events on board of the ship and should keep this function.

This is where "Stichting Zijner Majesteits Bonaire", the coordinating organization of the renovation, sees an opportunity to implement new technology to visualise the steam engine configuration (possibly in action), in collaboration with the MuseumFutures lab in Delft.

During the project, information will be exchanged with the Rijksuniversiteit Leiden maritime history, as well as the "Vereniging van Oud-Officieren van de Technische Dienst der Koninklijke Marine". These institutions will provide necessary historical and technical background information, and benefit from a successful design and design process.

The Bonaire is located in Den Helder, and thus this will be the context to be considered. Among potential visitors are coast visitors and tourists, aspiring marines, interested groups related to maritime technology, schools and students. But what exactly the relevant target groups are will have to be determined during the project. The City of Den Helder and the NoordKop region of the Province Noord-Holland will benefit from a successful Bonaire project (as a whole) as well, because it could draw attention and thus visitors. On top of that, the project in Den Helder draws a lot of academic international attention.

space available for images / figures on next page

Initials & Name _____   Student number _____

Title of Project _____

introduction (continued): space for images

image / figure 1: _____

Initials & Name _____   Student number _____

Title of Project _____
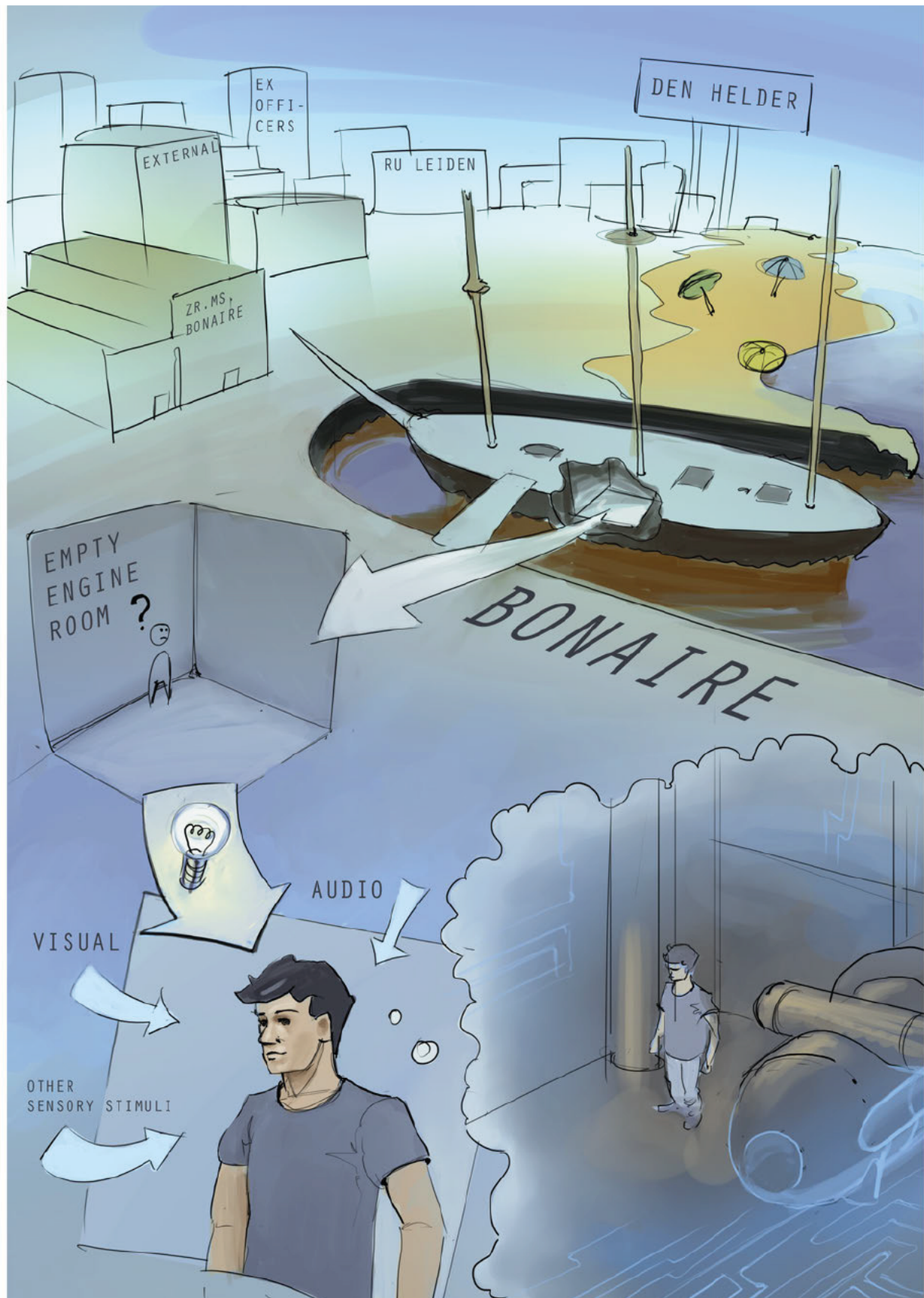
PROBLEM DEFINITION **
Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Currently, the space where the engine room of the Bonaire used to be is empty. It is used for meetings, presentations and receptions, but visitors cannot see the steam technology behind the naval vessel.
This technology is important for the technical maritime history in the Netherlands, and is a vital part of the Bonaire's 'vehicle platform'. It is also a relatively rare type of technology that is worth showing.
However, the engine room cannot be rebuilt physically. There is no budget for a full replica, and the practical functionality of the room is to be maintained. Thus, this project looks for a way to visualise the steam engine configuration and functionality, as well as the resulting life on board the vessel and in the chamber.

The bonaire, like any other modern day museum, has to find a balance between exciting and educational content. As tastes and available sources of entertainment change over the years, it is unrealistic to design experiences that are the optimal balance of exciting and education for all ages. Children, for example, require more up-front excitement to be interested in learning while older, experienced museum visitors might be interested in learning intrinsically, without extra stimulants. Solving this problem is important to ending up with a design that creates relevance and meaning for the Bonaire.

ASSIGNMENT **
State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Design an immersive steam engine room experience that raises visitors' interest for the technology as it was used in the Bonaire and gets them to learn about it, based on an analysis of technologies and interests that are relevant and appropriate for the target group.

Initials & Name _____   Student number _____
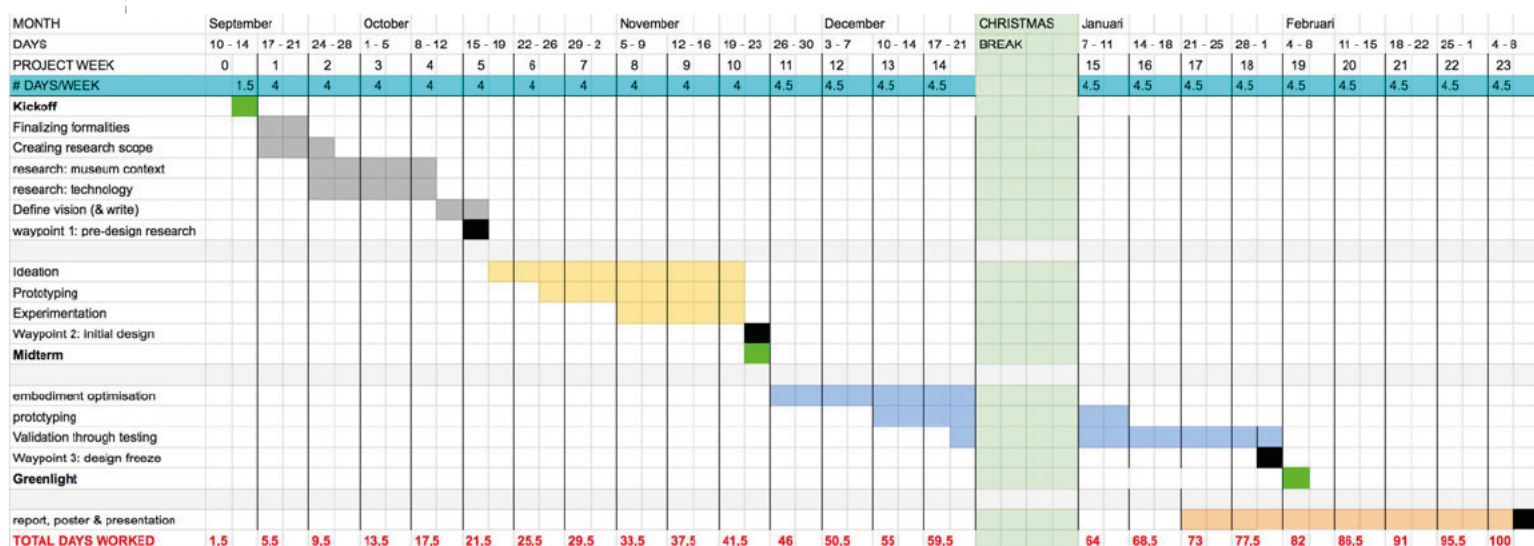
Title of Project _____

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 17 - 09 - 2018   12 - 03 - 2019 end date

MONTH	September			October				November				December				CHRISTMAS BREAK	Januari				Februari				
DAYS	10-14	17-21	24-28	1-5	8-12	15-19	22-26	29-2	5-9	12-16	19-23	26-30	3-7	10-14	17-21		7-11	14-18	21-25	28-1	4-8	11-15	18-22	25-1	4-8
PROJECT WEEK	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14		15	16	17	18	19	20	21	22	23
# DAYS/WEEK	1.5	4	4	4	4	4	4	4	4	4	4	4.5	4.5	4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5

Kickoff
Finalizing formalities
Creating research scope
research: museum context
research: technology
Define vision (& write)
waypoint 1: pre-design research

Ideation
Prototyping
Experimentation
Waypoint 2: initial design
Midterm

embodiment optimisation
prototyping
Validation through testing
Waypoint 3: design freeze
Greenlight

report, poster & presentation

| TOTAL DAYS WORKED | 1,5 | 5,5 | 9,5 | 13,5 | 17,5 | 21,5 | 25,5 | 29,5 | 33,5 | 37,5 | 41,5 | 46 | 50,5 | 55 | 59,5 | | 64 | 68,5 | 73 | 77,5 | 82 | 86,5 | 91 | 95,5 | 100 |

You will notice I planned more than 20 weeks, but note that the total adds up to 100 days in the end. This discrepancy is caused by working less than 5 days a week, due me having several teaching assistent jobs with the faculty.

The project will roughly be divided in a research stage, an ideation stage and a concept development stage.
During this project, a concept will be created for the new engine room experience that is exciting and educational. The balance between these will be decided when choosing a target group.

Exciting: Visitors should be engaged by the design, and become eager to explore and learn.
Educational: Visitors eager to do so should be able to learn something about steam propulsion specifically.

The initial research areas are identified as follows:
- Design considerations for museums
- Steam technology
- Benchmarking visualisation technologies and feelings of immersion
- Balance of educational values (e.g. info vs. fun) for target groups

In addition, a creative session will be organised at the start of the project to expand the research scope.

At the start of october, three target groups will be presented as choices for Ben Mooiman, the coordinator of the project. Together with him a main target group will be chosen at that moment, so that the rest of the research can be more focused.

The rest of the information generated will be used in ideation. During ideation, several iterations of ideas will be considered, also through testing with potential visitors, and finally end up at a final rough concept. This rough concept entails a clear idea of what the system would be like, including visuals and prototypes for any other vital parts of the system.

During the concept development stage, the rough concept will be refined through prototyping and testing with visitors, to finally end up with a finalised design. Additional goals are setting up the implementation of the design and collaborating with the stakeholders.

This project will not be responsible for realising the entire implementation of the design, just for the initial plans thereof. The design will be a representation project the final design, that allows testing whether the embodiment would allow the chosen target group to get the envisioned experience. The deliverables of this project should be the starting point for contracting the implementation. Additionally, this project will not go into full technical detail in regards to optimization of used technologies, unless that is deemed doable within the timeframe.

TUDelft

MOTIVATION AND PERSONAL AMBITIONS
Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

This project was set up with the following main learning goals in mind:
- Learning to effectively make digital visualisations: VR, AR and movie prototypes
- Designing spaces and environments
- Working for a 'small' client, but a lot of stakeholders

Competences I have from earlier in the IDE programme include sketching, visualisation, creative techniques, materials and production methods knowledge, system thinking, and many more large or small topics. Compared to fellow students, I am good at sketching, visualisation and creative techniques, and my skills with electronics are somewhat underdeveloped. I might be adressing that in this project, but I'm not including it in the main goals because it is not something I aspire to focus on as a designer.

I'm excited to be working with a museum for this project, and in the Museumfutures lab, as I am very interested in this field and think I would love a similar job in the future. Thus this project is also aimed at finding out more about this field.

Initials & Name _____   Student number _____

Title of Project _____