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Project Usability and User eXperience Assessment in Design

ID4256-17

Phase 2

BluePrint Automation (BPA) industrial case packing and dashboard

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INTRODUCTION

Imagine the website you always have to use for your daily tasks, and now imagine it being completely different. Navigation is unclear, difficult technical terms are being thrown in your face and the information you so desperately need is hidden and very difficult to retrieve. This would make your day a lot less effective and would give you a lot of additional stress during your already stressful workday. This was the challenge for our Usability and User eXperience Assessment in Design (UXAD) project.

The challenge in the automated case packing industry is the sub-optimal human-machine interaction (HMI) that can lead to decreased machine effectiveness. Our task is to redesign the dashboard interface for BPA operators, streamlining the process of extracting relevant information to maximize its value.

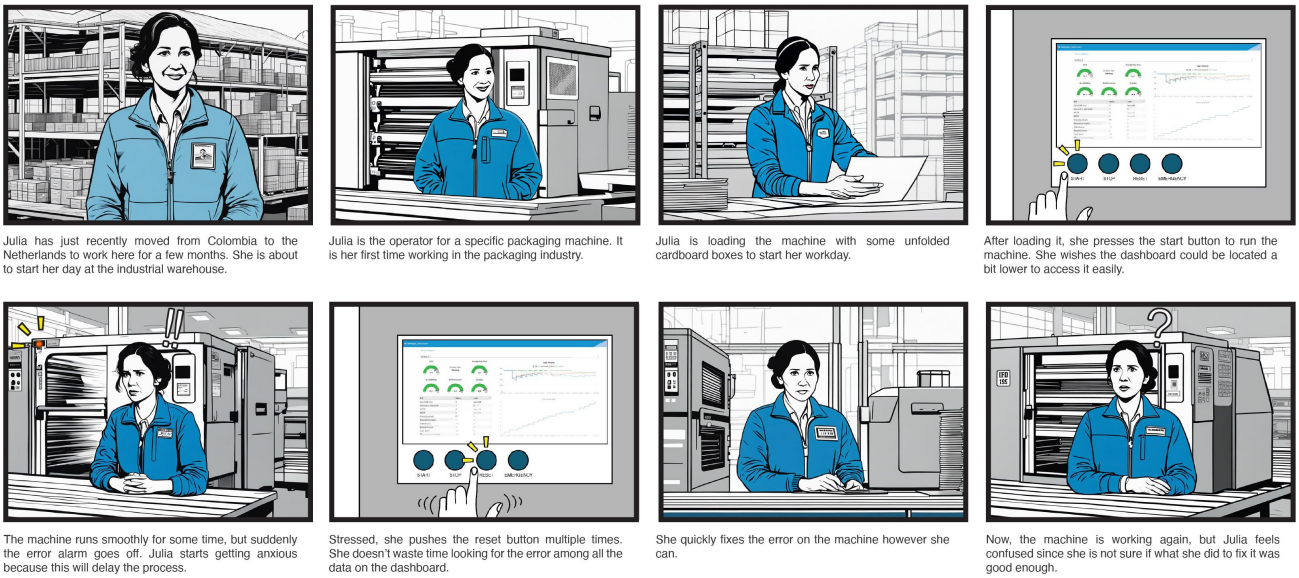
As the saying goes, "*Good design is obvious, great design is transparent*." Therefore, in this report, we share our thoughts, outline our ideation process and concept directions, as well as our evaluation of redesign concepts that led us to our initial proposal. This report builds on our analysis of the current BPA dashboard in Report Phase 1.

1 Design brief

This chapter shows the current interaction with the dashboard and how we intend to redesign it. The design criteria and testable targets show how we will evaluate our concept directions.

Current interaction

The use scenario (Figure 1) shows Julia, one of the persona's we used in phase 1, who is using the current dashboard of the BPA packaging machine. It shows how she has troubles reaching the dashboard, the anxiety she has when an error occurs and the confusion after the error has gone.



Julia has just recently moved from Colombia to the Netherlands to work here for a few months. She is about to start her day at the industrial warehouse.

Julia is the operator for a specific packaging machine. It is her first time working in the packaging industry.

Julia is loading the machine with some unfolded cardboard boxes to start her workday.

After loading it, she presses the start button to run the machine. She wishes the dashboard could be located a bit lower to access it easily.

The machine runs smoothly for some time, but suddenly the error alarm goes off. Julia starts getting anxious because this will delay the process.

Stressed, she pushes the reset button multiple times. She doesn't waste time looking for the error among all the data on the dashboard.

She quickly fixes the error on the machine however she can.

Now, the machine is working again, but Julia feels confused since she is not sure if what she did to fix it was good enough.

Figure 1: Julia's use scenario

Problem definition

The storyboard of the current interaction gives examples of the problems we want to address in the redesign of the dashboard. We identified two main problems that operators face while monitoring production and identifying errors in a BPA packaging machine.

1. Operators **fail to find and understand the information** given on the interface, and use the information to **identify issues** and fix them in the machines.
2. Operators experience a **lack of confidence**, as they feel **frustration** and **confusion**, not knowing how to solve the error or knowing whether they actually fixed it.

These problems occur because of several reasons:

- Lack of visual hierarchy for users to locate the most important information.
- Excessively technical use of language resulting in less understandable information.
- Insufficient fluency and logic of current user flow for users to perform tasks within the two pages of the dashboard.

Design goal

The following design goal was created to guide us in the ideation and exploration of solutions:

Our design goal is for **operators** to feel **confident** in managing the machines, **empowering** them to swiftly **identify and solve errors**. Through an **intuitive** dashboard interface, we aim to provide operators with **easy access** to relevant data for monitoring.

Interaction Vision

We created an interaction vision to present how we envision the experience of operators in the redesign. From the metaphor of playing games on an iPad as a child, we defined the characteristics of the experience we want to create.

The interaction with the redesigned dashboard should make the operators feel **empowered** and in control, so they can make informed decisions while operating the machine. The redesigned dashboard should be **accessible** and navigable. It should be **intuitive**, so it will enable them to work independently and with confidence. Lastly, the users should be able to **efficiently** perform tasks and access information through the dashboard interface without unnecessary delays or complications.

Design criteria

These design criteria and testable targets were created in the last phase. The design criteria were used to evaluate elements of our concept directions.

Design Criteria

1. Users should feel **confident** in operating the machines.
2. Users should feel **empowered** to identify errors correctly.
3. Users should be able to **navigate** the interface **efficiently** to find the right information.
4. Users should be able to **understand** the information on the interface.
5. The interface should be **inclusive** to all kinds of users.

Reflection

Our design goal and criteria haven't changed since the last phase. However, we did put more emphasis on creating motivation with the operators, next to confidence and empowerment. We heard that motivation is an issue with a large group of operators and although we can only make assumptions for the reasons why, we ideated for it.

In the last phase we set testable targets to use for testing whether we reached our design goal and criteria. For phase 2 these targets were too specific to evaluate our concept directions with. We expect to use the testable targets in the next phase to test our final concept.

2 Body of ideas

The next step after specifying our design requirements, design goal and interaction vision was to begin the ideation process. Our goal was to ideate in relation to our solution space and make sure that we included all our design criteria in our design directions.

Methods

Initially, we decided which methods would be most beneficial for us to develop our creativity. From all the possible methods available, we believed that the ones that could help us best to ideate as a team were brainstorming and braindrawing. (Van Boeijen, Daalhuizen and Zijlstra, 2020)

We went back to our solution space (Figure 2) and decided to develop these methods in regards to them, initially focusing on the primary solution space. The result for this brainstorming can be seen in Figure 3.

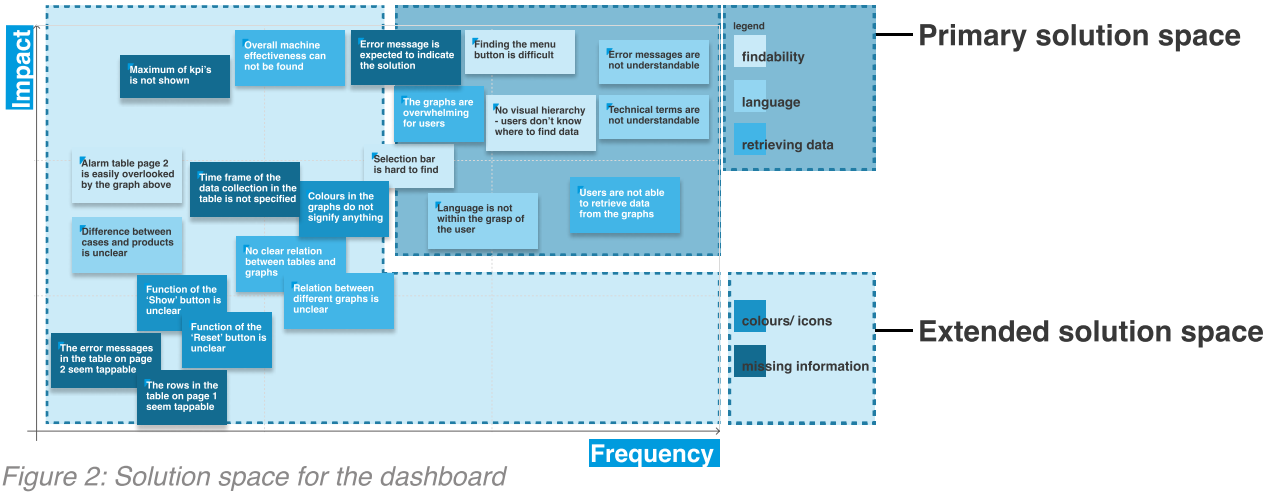


Figure 2: Solution space for the dashboard

Figure 3: Solution space brainstorming

Results

Once we finished ideating, we clustered the different ideas, digitalized them for better understanding and braindrew on how the ideas could look (Figure 4).

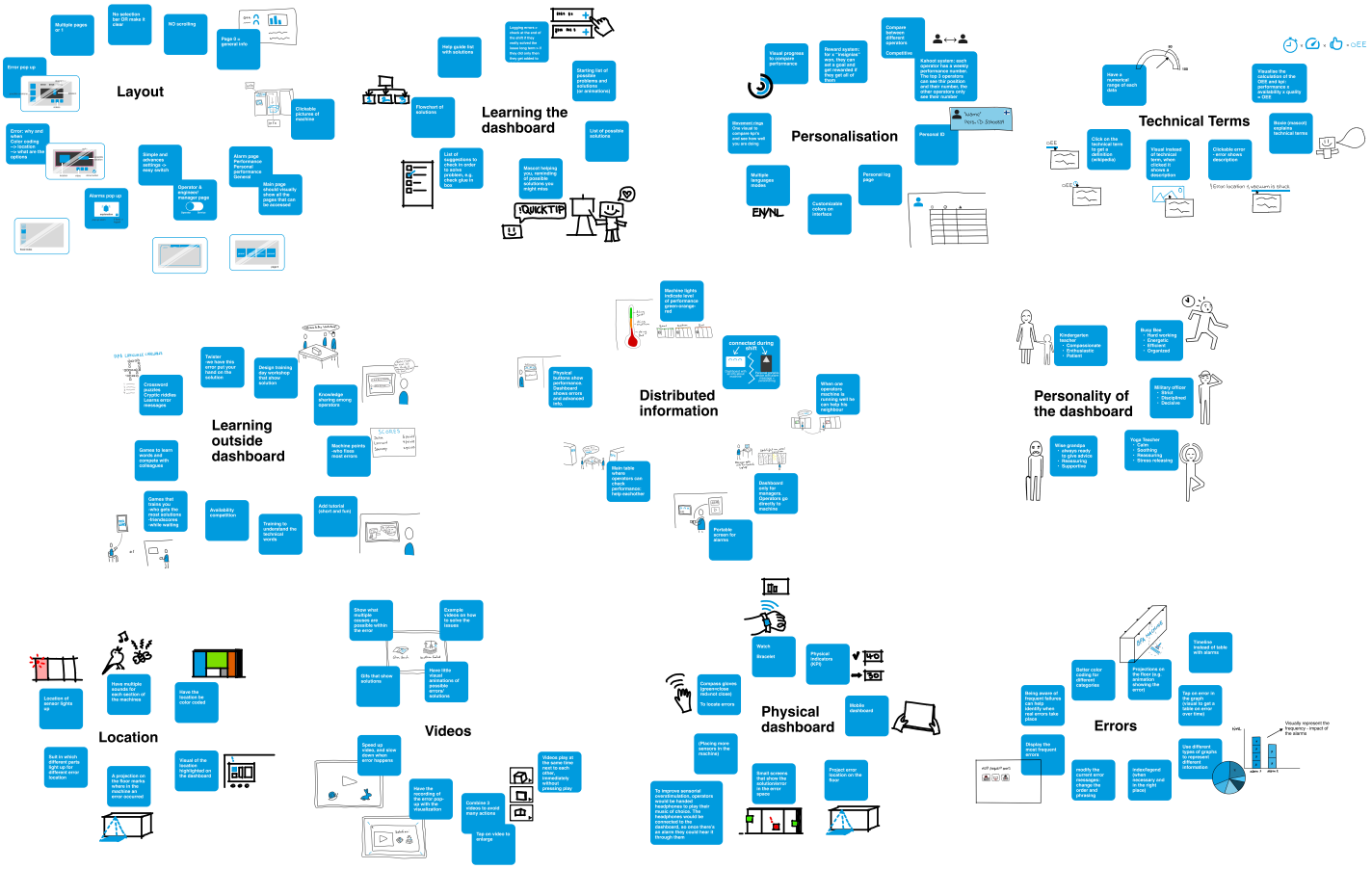


Figure 4: Clustered and visualized brainstorming

The ideas generated tackle many different aspects related to the dashboard and its use. We also included radical ideas such as: what would happen if there was no dashboard at all? We didn't want to restrict our creativity in any way. Most of the ideas are related to improving the aspects that were most detrimental in our user test: findability, language, and retrieving data.

For more comfortable reading, check Appendix 1.

Brainstorming and design goal

After analyzing our clustered ideas, we noticed that we focused a lot on the details and were missing concrete design directions that the dashboard could have. We decided to brainstorm again, and in this case we asked ourselves: what do we want the dashboard to transmit to its users?

From our design goal and interaction vision, we wanted the operators to feel more **confident** and **empowered** by making the dashboard more **intuitive** and **accessible**. We knew that motivation is a big issue that really hinders the operator's learning and progress, and without this aspect it would be more difficult to help them feel confident and empowered. For this reason, we brainstormed on elements and ideas that could help the operators feel more motivated, and at the same time help them act confidently and correctly (Figure 5).

The methods used were brainstorming and How To. (Van Boeijen, Daalhuizen and Zijlstra, 2020) BPA explained that motivation issues are also very related to the physical context in which the operators work: lack of natural lighting and sensory overload (noise) are part of it. We also wanted to tackle these issues even though they are not in our scope.

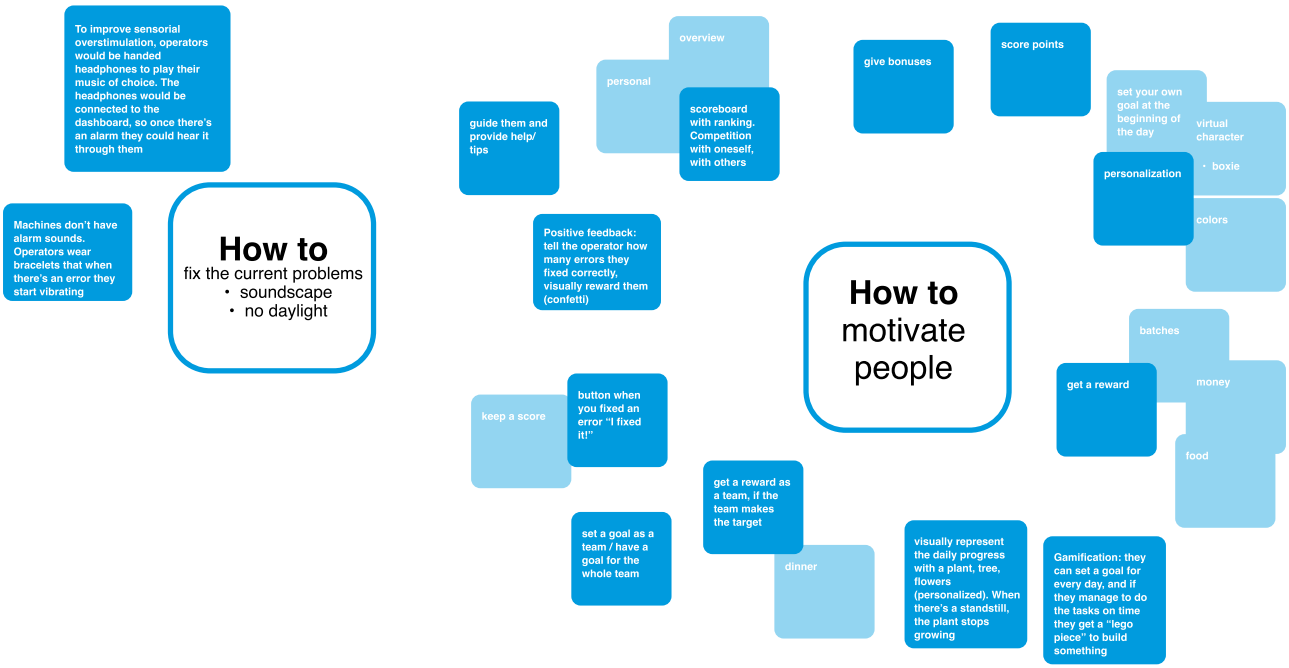


Figure 5: Brainstorming on motivation

This ideation process brought many interesting design directions. Some ideas include gamification aspects, competition, a reward system, being able to personalize the interface, and provide guidance and positive feedback. We will further develop this directions in the next chapters.

Reflection

Once we finished the initial ideation, we noticed that all the ideas generated really helped us form different design directions including different elements from all the brainstormings. Initially, we wanted to use the following methods for the ideations:

- Brainstorming
- Braindrawing
- Morphological charts

Before developing the How To Motivate brainstorming, with the ideas that we already had we built a morphological chart (Van Boeijen, Daalhuizen and Zijlstra, 2020) (Figure 6), hoping to create design concepts from it. However, building the table made us realize that from those ideas we couldn't create concepts because they were lacking a direction. This failed chart helped us comprehend that we needed to ideate on a broader sense. We also noticed that some of the categories in the morphological chart would be hard to mix, such as the most radical no-dashboard concepts, and all the categories directly related to the use of the dashboard.

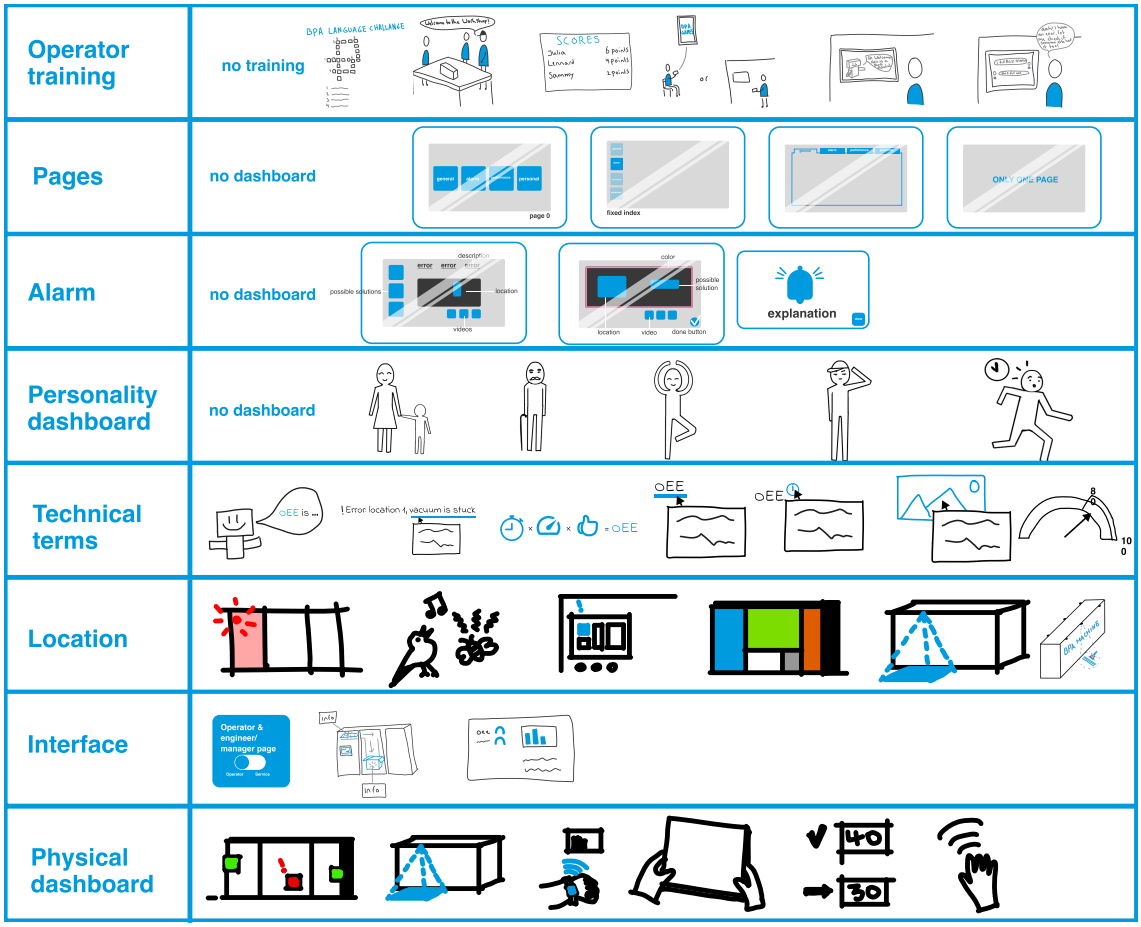


Figure 6: Morphological chart

In the end, it was good for us that this chart failed, since it pushed us to brainstorm on the overall goal of our redesign rather than just focusing on the small details. It also still helped us in building the design directions since it was easier to visualize the different elements.

Overall, the methods used were helpful for us and they allowed us to structure our ideation process. The results obtained are diverse, interesting, and broad, which allow for more creativity.

Conclusion

This process helped us build different design directions and we also started tackling the elements that need to be improved in the dashboard to provide a better interaction between the user and the machine. An important decision that we made during this ideation process was creating a division in the content that will be shown in the screen. For this, we will design different pages focused on different users and content:

- An overview (main page), designed for the operator. This page will only include the most necessary information such as the most important KPIs to know how the machine is performing.
- A more detailed page designed for managers/engineers with the complete overview of the KPIs, including graphs.
- An alarm (error) page with the information of previous alarm messages.
- A personal page for the operator which will allow for personalization.

The exact content of each of these pages is still to be decided.

3 Interaction concepts

After exploring our solution space with brainstorms and clustering our ideas, we converged these fragments into several solid directions on which we built our interaction concepts. With the goal of motivating operators to rise efficiency, we sketched out our ideas on the interface and polished them for further evaluation.

Dashboard personalities

From the clusters of ideas we concluded from the brainstorm session, we chose the personalities as the starting point to go from ideas to concepts. Since our design goal is situated in emotional attributes of users, it's a quick way to build such emotional connections through the behavioural qualities of the dashboard, through its personalities.

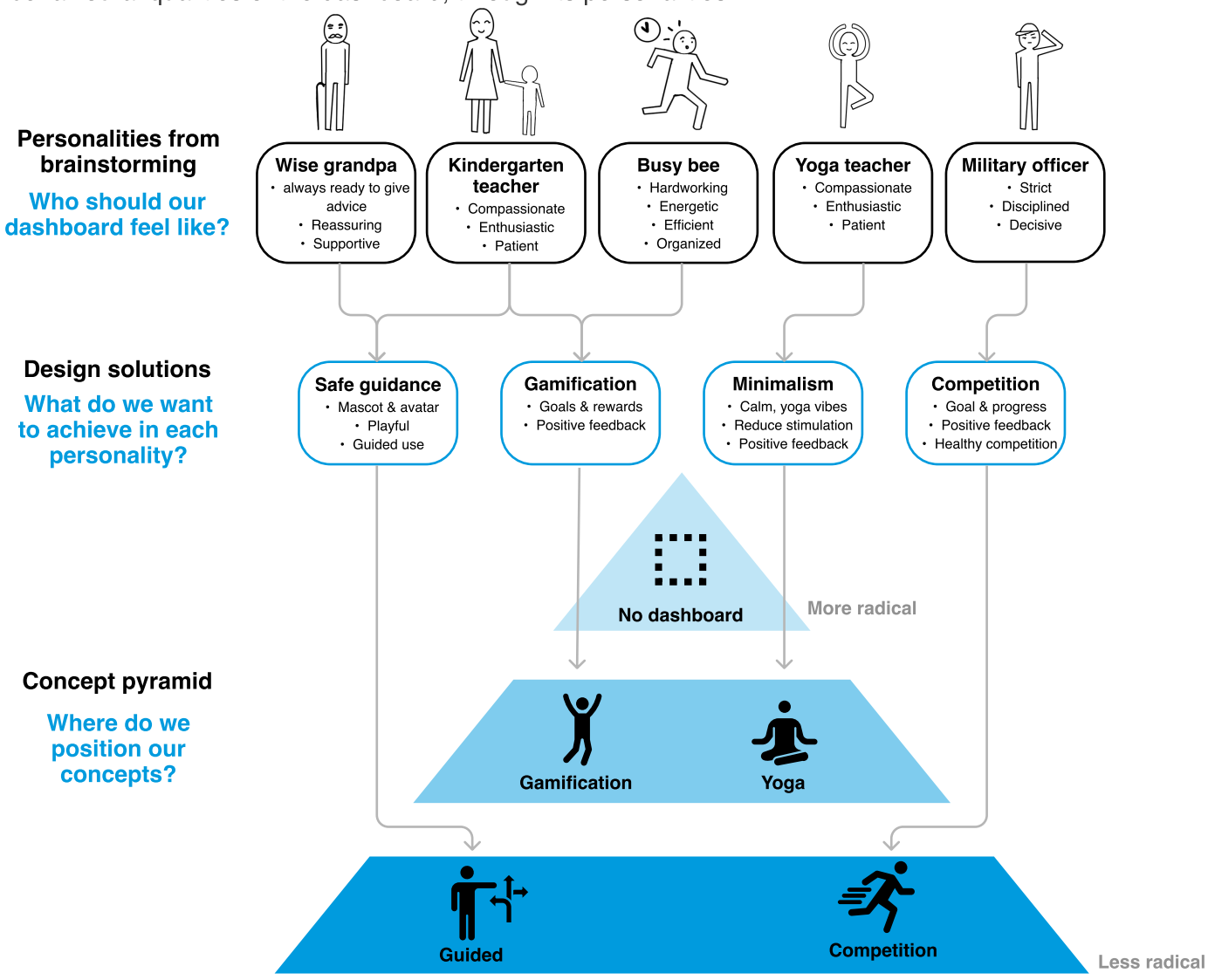


Figure 7: Building the concepts

From the five personalities, we concluded four design solutions that can serve as directions for our concepts. We then ranked them based on radicalness and mapped them into a pyramid graph (Figure 7). We also took into account the concept where there's no dashboard and modifications are done physically. Through this pyramid, we are able to compare between conservative and 'out of the box' solutions and have an overall control over our concepts. When evaluating ideas in later stages, we can have a grasp on the priorities of each solution with this scale.

Interface sketches

Based on our 4 main directions, we ideated on the layout and details of the dashboard interface, and sketched them out (Figure 8). In this way, we could see how each concept varies in their experience through UI elements and intended interaction.

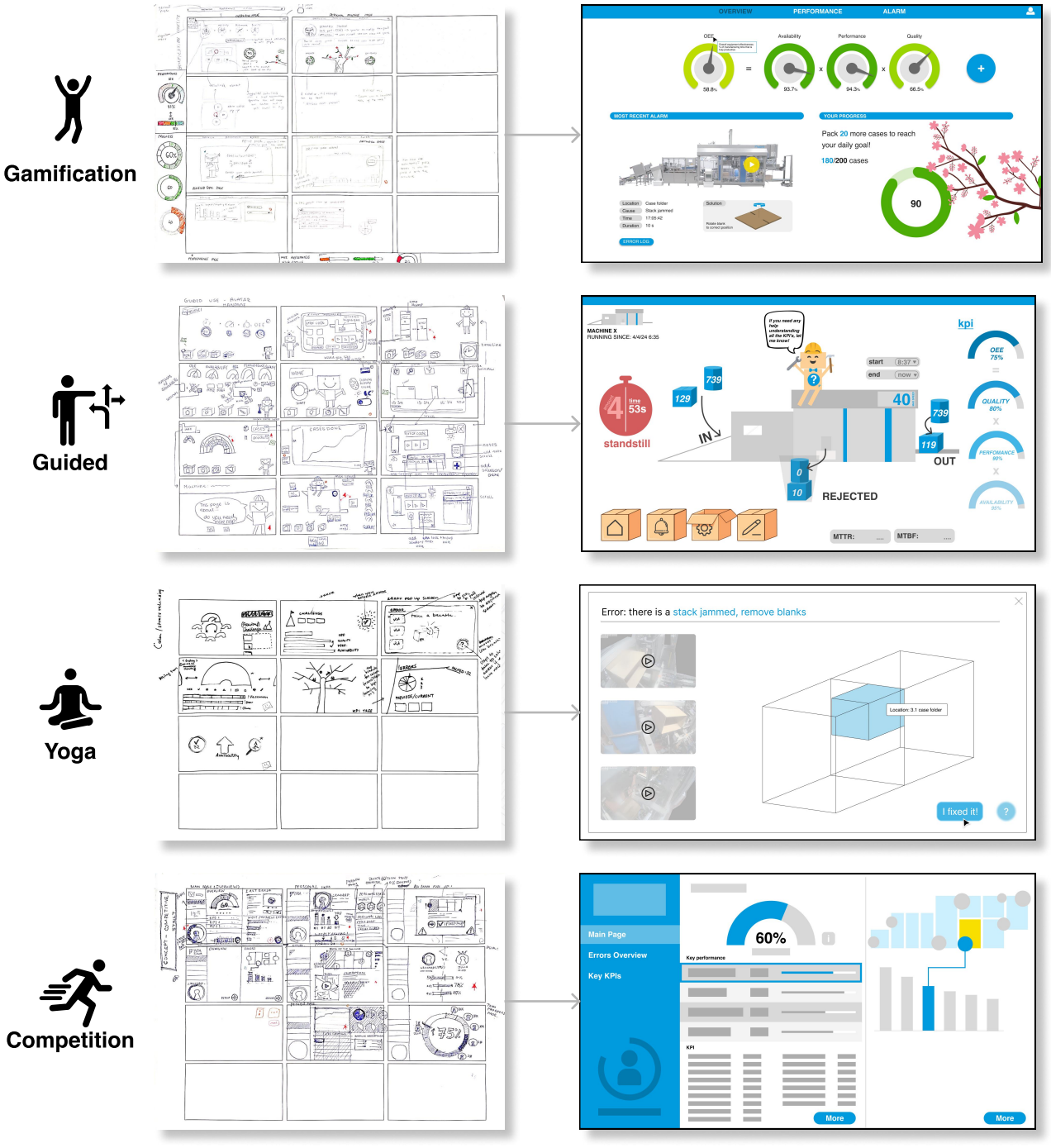


Figure 8: Sketches of our concepts and detailed interfaces

Detailed interface

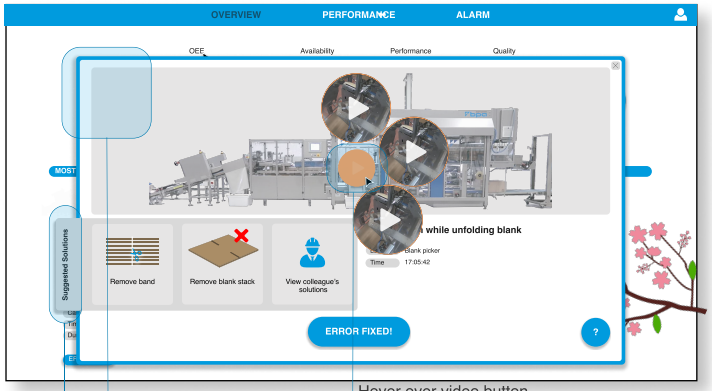
To better demonstrate our ideas and evaluate them, we developed our sketches further into digital forms for each concept (Figure 8). We chose the most representative and unique pages for each concept as well as general and universal pages like overview or error pop-up.

Gamification

This concept revolves around the idea of gamifying the experience to motivate operators and turning monotonous daily work into a puzzle game that gradually builds as operators finish their daily goals (Figure 9). Visual styles are also designed to be vivid and engaging. The pages featured a blossoming tree which grows as operators reach towards their daily goal, and withers when there is an error.

How to motivate users		Games & playful feedback
Visual style	Strict	Vivid
Complexity	Simple	Complex
Playfulness	No	Yes

Error pop up page

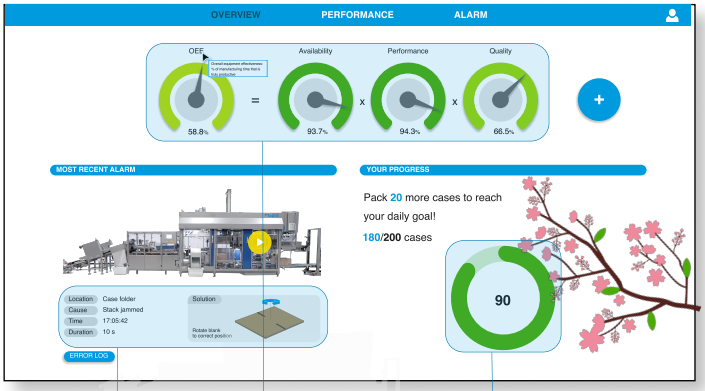


Pop up when error occurs

Show suggestions to solve error related to error message

Hover over video button to show the video recordings. Video button is located on the machine in the location of the error.

Overview page

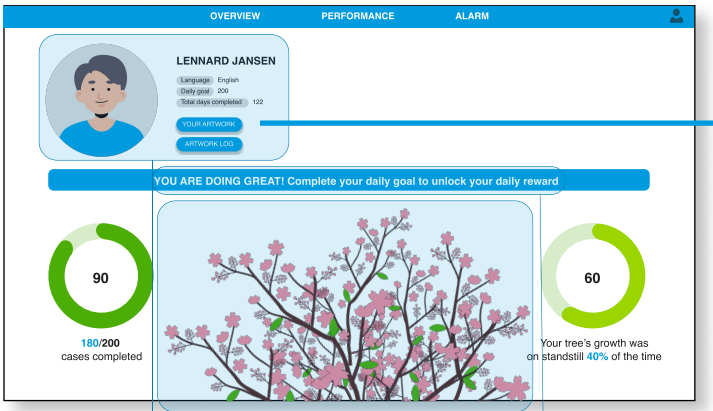


Visual explanation of OEE

Information of last alarm and how it was solved

Visualisation of personal progress to motivate the operator

Personal page

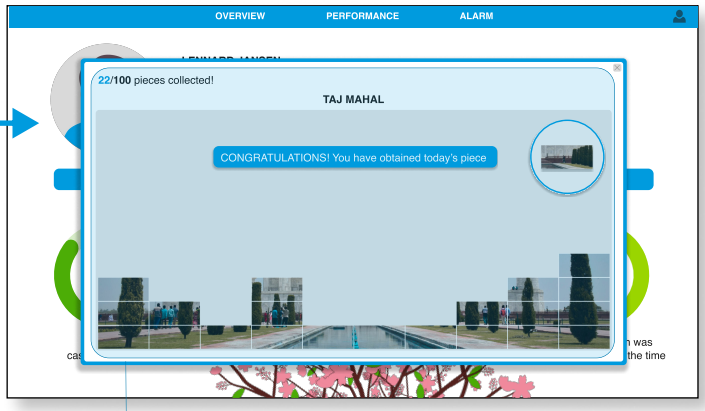


Personal ID

Tree which grows based on progress during the day. The progress is constructed from multiple variables like standstill time and cases completed

Motivational messages

Artwork pop up



Personal artwork which is built up by collecting a piece each day when daily goal is achieved.

Figure 9: Digital interface concept - Gamification

Competition

The competition concept aims at motivating operators with healthy competition between colleagues (Figure 10). Operators are able to see their progress in a weekly ranking, and earn badges for their performance. The overall visual language is strict and controlled, with more abstract and simple shapes, while data is presented more in detail.

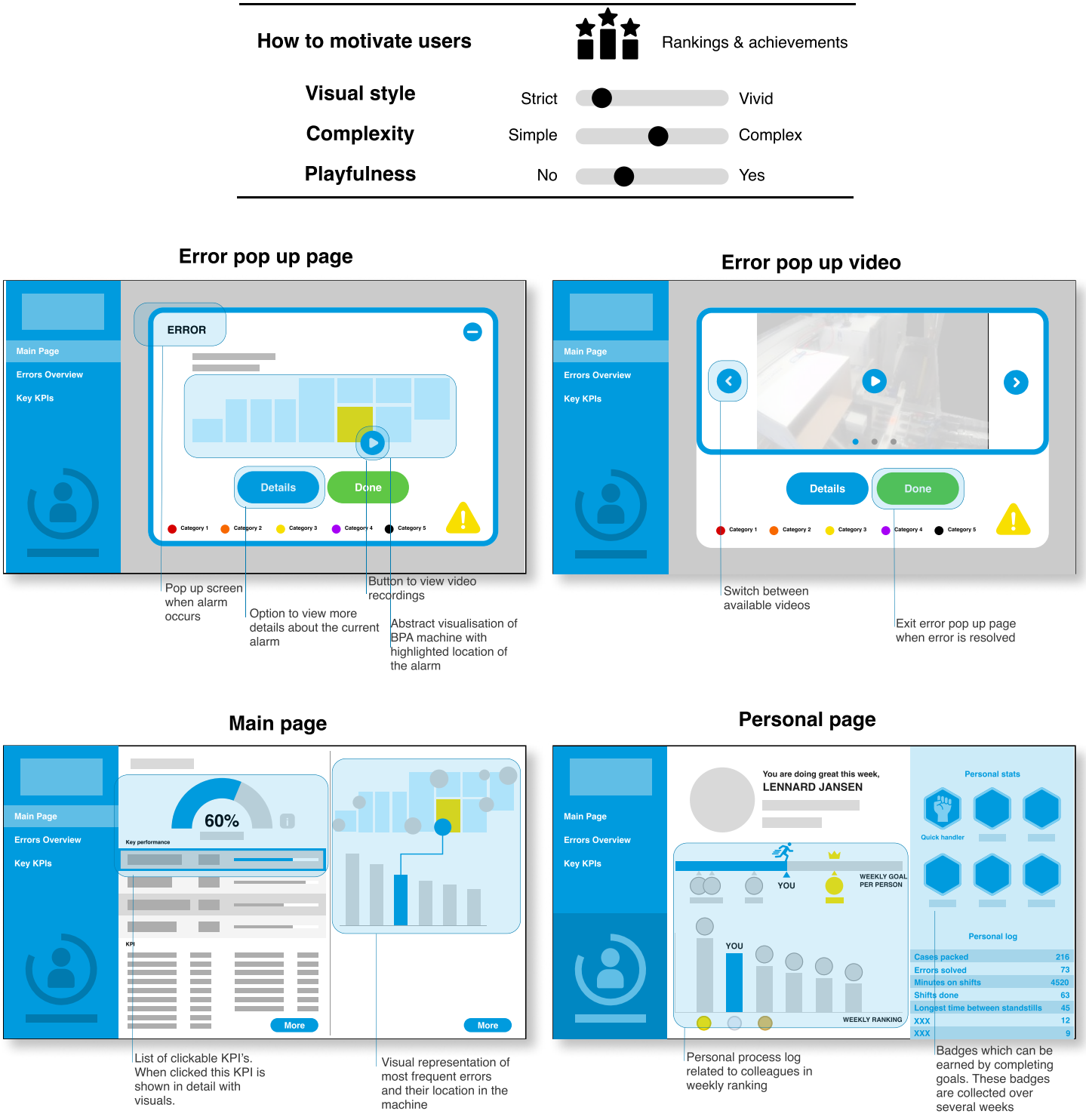


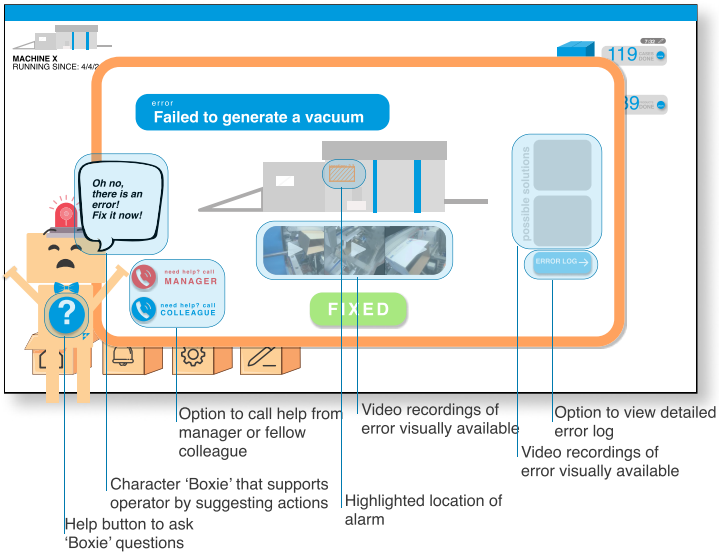
Figure 10: Digital interface concept - Competition

Guided

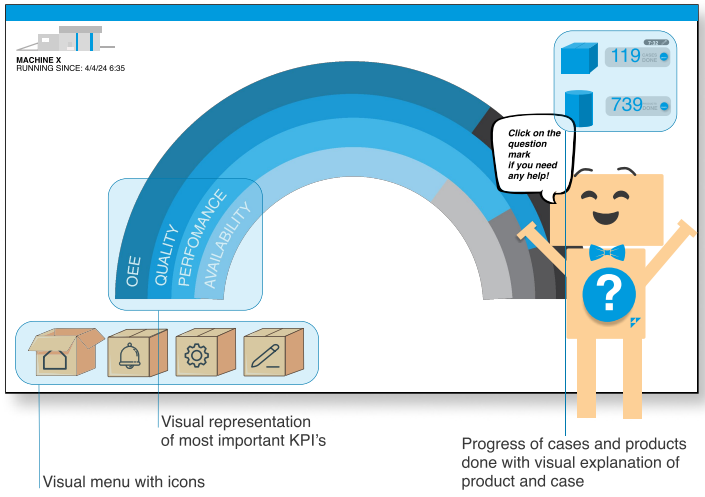
The guided concept is centered around the character Boxie who guides the operator through the dashboard (Figure 11). The style of this dashboard is playful and vibrant, providing easy access to guidance and explanation. Technical terms and data are shown in visual representations to minimize the barrier of comprehension.

How to motivate users		Playful, friendly guidance
Visual style	Strict	Vivid
Complexity	Simple	Complex
Playfulness	No	Yes

Error pop up video



Main page



Performance page

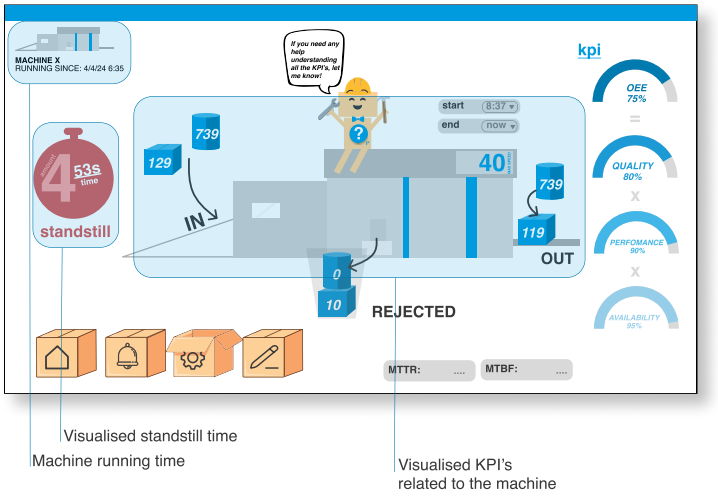
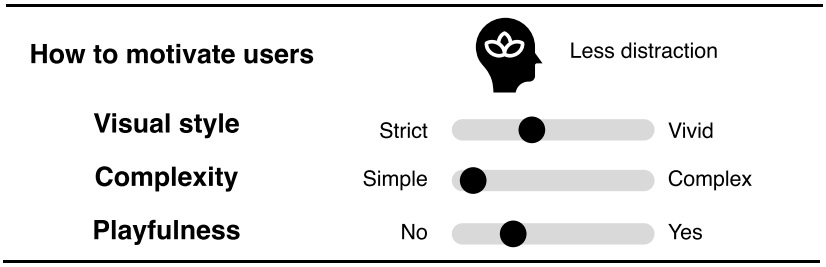
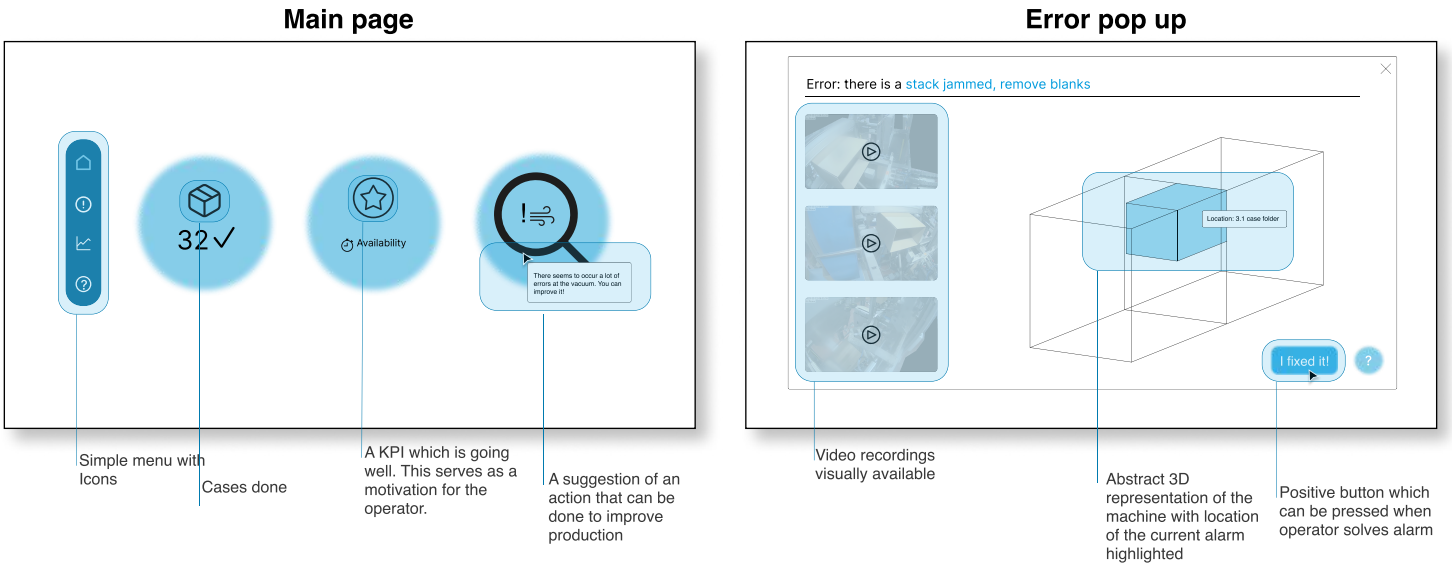


Figure 11: Digital interface concept - Guided

Yoga

This concept reduces elements shown on the dashboard to lower cognitive load, contributing to a calm and reassuring flow of use (Figure 12). By simplifying the menu page and using minimalist style in visuals, operators can have a clear focus when dealing with errors in an overstimulated factory setting. The concept also featured a 3D representation of the error location different from other concepts.





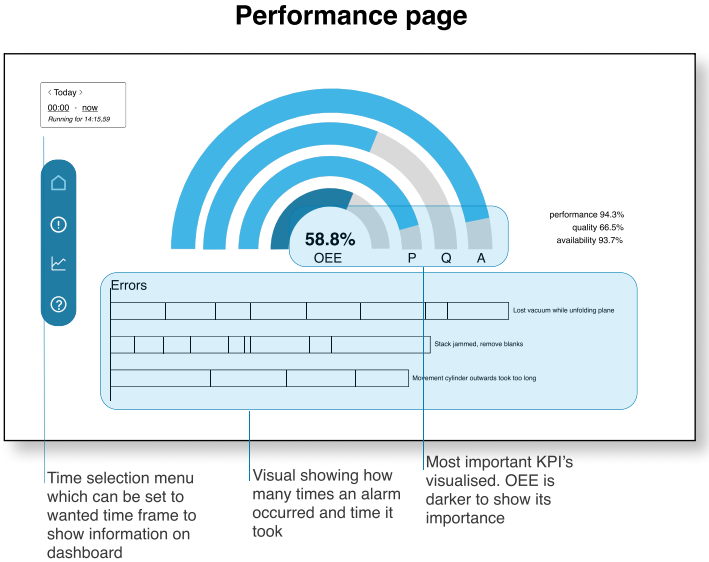


Figure 12: Digital interface concept - Yoga

Reflection

When brainstorming on possible approaches to redesign the dashboard, we were not intentionally considering the actual implementation of these solutions. Such way of ideating set us free from the burden of improving the original dashboard and avoided design fixation, but it also created obstacles when we enter the concept generation phase.

After noticing the difficulty of putting together our ideas to make concepts, we quickly decided to use personalities as a starting point and sketch our ideas out on paper. This approach really helped to move the project forward when we started to define the varying attributes and focuses of these concepts. Also, the way our concepts varied reflected our different approach towards our design goal, which aimed at improving confidence and motivating operators.

The process of moving our ideas from paper to screen encouraged us to think of how we present all the information and data and decide on the overall appearance. Different aesthetics and mindsets among our team members contributed to 4 concepts unique in visual and use.

Conclusion

At the end of this stage, we had 4 different interaction concepts for the dashboard, varying in visual style, complexity and playfulness, directing in different approaches to motivating users. Next, we are going to evaluate certain elements in our design and reflect on our current directions with quantitative and qualitative methods. Based on our findings through testing, we will create an initial redesign proposal that guides our final design.

4 Concepts evaluation

After designing four different design concept directions that were based on the varying personalities, we needed to evaluate them thoroughly, to make well-founded decisions for our final design proposal. This chapter contains the evaluation of our concept directions, which methods were used, how they were evaluated and what results were retrieved from it.

Evaluation method

In order to facilitate comparison between the different design elements/concept directions, we used an adapted Likert-Scale. (Van Boeijen, Daalhuizen and Zijlstra, 2020). Participants were interviewed and asked to rate individual design ideas on a scale of 1-5, with each element's scale based on one or more design criteria, which were confidence, empowering, efficient navigation, understanding and inclusive (Chapter 1). Participants were also asked to explain their ratings. Using this reasoning, we conducted a Plus-Minus-Interesting (PMI) analysis. (Van Boeijen, Daalhuizen and Zijlstra, 2020)

Test set up

To ensure a clear understanding of the design ideas, we conducted in-person interviews with part of the participants. The other part of the participants received the evaluation via email and answered in their own time. To avoid any bias, the isolated design elements were converted to greyscale. One interviewer asked the questions to maintain consistency. Before showing the design concept directions, we first asked participants to rate the grayscale design elements to prevent favoritism and ensure unbiased feedback.

For a comprehensive evaluation, we sought input from students and BPA employees. This allowed us to get a well-rounded opinion and include the voice of our client. two of the BPA employees conducted the evaluation via email.

Figure 13 shows the format of the evaluation pages. We evaluated elements that were based on navigation, error messages, KPI understanding, motivation, and confidence when starting the job.

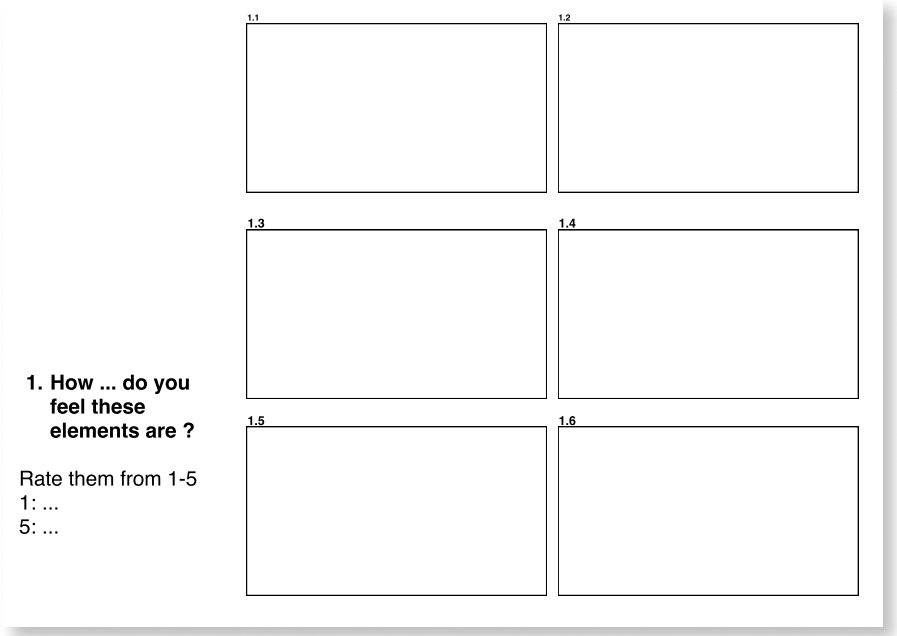


Figure 13: Format evaluation pages

Evaluation results

We visualized the results of each design elements in a graph (Figure 15) that compared all the different design elements from one evaluation page. We took the average to get a immediate impression on which scored the highest. The participants consisted of four students (P0, P1, P2, P3: light blue) and three BPA employees (BPA1, BPA2, BPA3: dark blue), which are shown differently in the graph. BPA2 and BPA3 conducted their test via email. All the comments that the participants gave to explain the reasoning of their rating are being evaluated in a PMI analysis which can be found in Appendix 2.

1. Dashboard Navigation

To improve easy navigation (Design Criteria 3), we focused on displaying the menu. The participants had to rate them on a scale of intuitiveness. Figure 14 shows the evaluation page of the different elements and Figure 15 shows the corresponding results. The conclusion that we drew from the results can be found in Chapter 5.

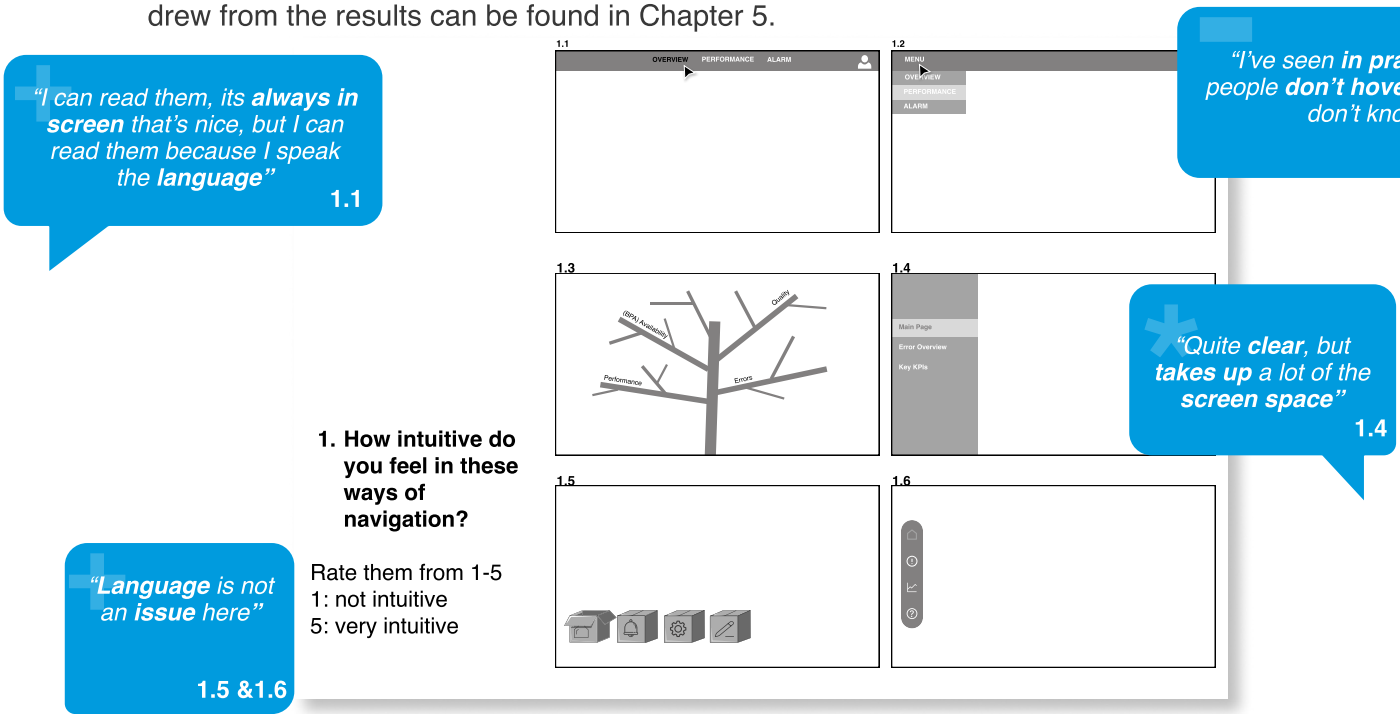


Figure 14: Dashboard Navigation Evaluation Page

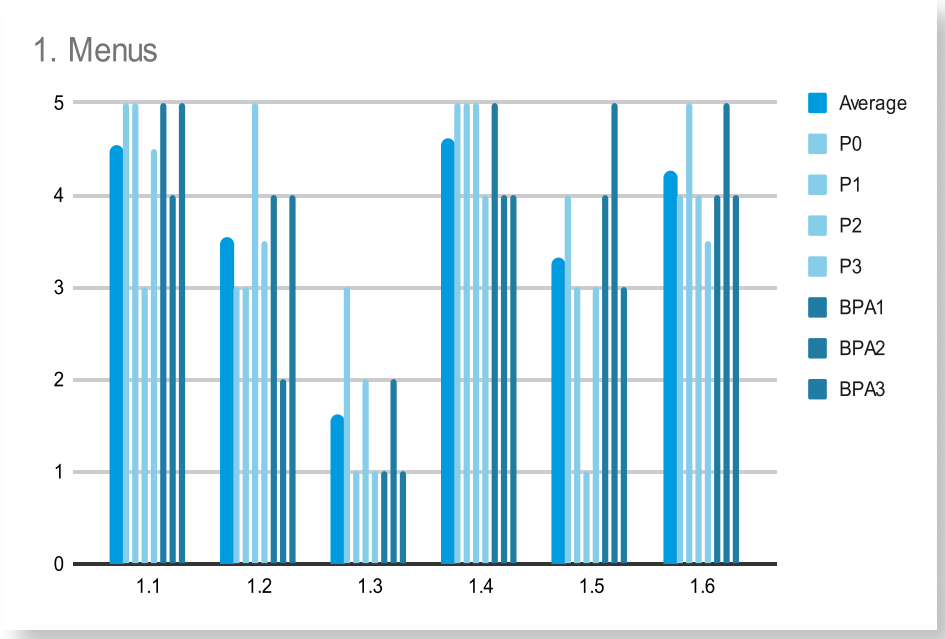


Figure 15: Dashboard Navigation Evaluation Results

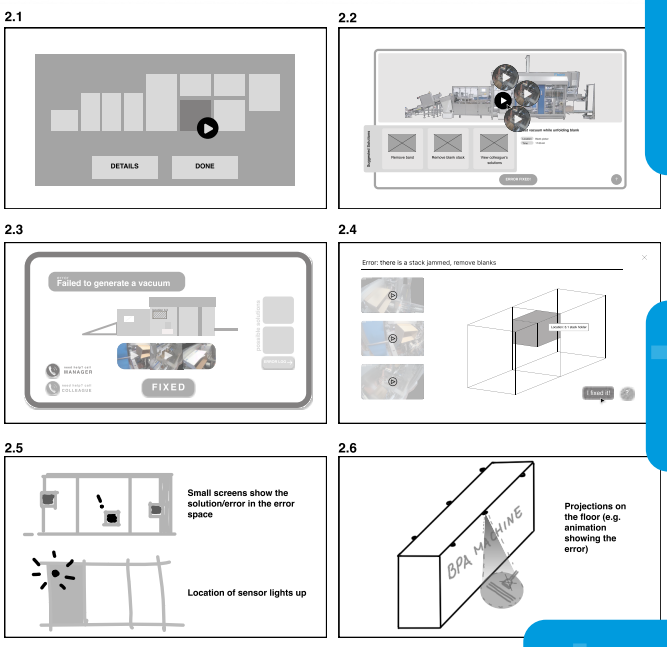
2. Error Messages

To rise the feeling of empowerment and confidence in error solving (Design Criteria 1 & 2), we focused on how the error should be visualized on the display. The participants had to rate them on a scale of intuitiveness, confidence and control (Figure 16). The first 4 elements (2.1-2.4) redesigns for the current use of a digital dashboard. The last two (2.5-2.6) show possible ideas that are based on a redesign without using a dashboard. Figure 17 shows the results for the error messages.

*"This makes me **feel more** in **control**, and there is an **error log**"*
2.3

2. How intuitive, confident and in control do you feel in these representations of error messages?

Rate them from 1-5
1: not intuitive
5: very intuitive



*"Calling the manager is also a **possible solution**, I **don't** think **managers would be happy** with this button though"*
2.3

*"Nice that it is **3D**, good orientation"*
2.4

*"Error log: it is **important** to see if a **error happened a lot before**, if you make changes you can see the difference, whether it has improved"*
general

*"A **red light lighting up** in the machine area with an error would be nice. **Screens** all over the machine probably **less**. Most people like to be able to see everything from **one central place**."*
2.5

Figure 16: Error Messages Evaluation Page

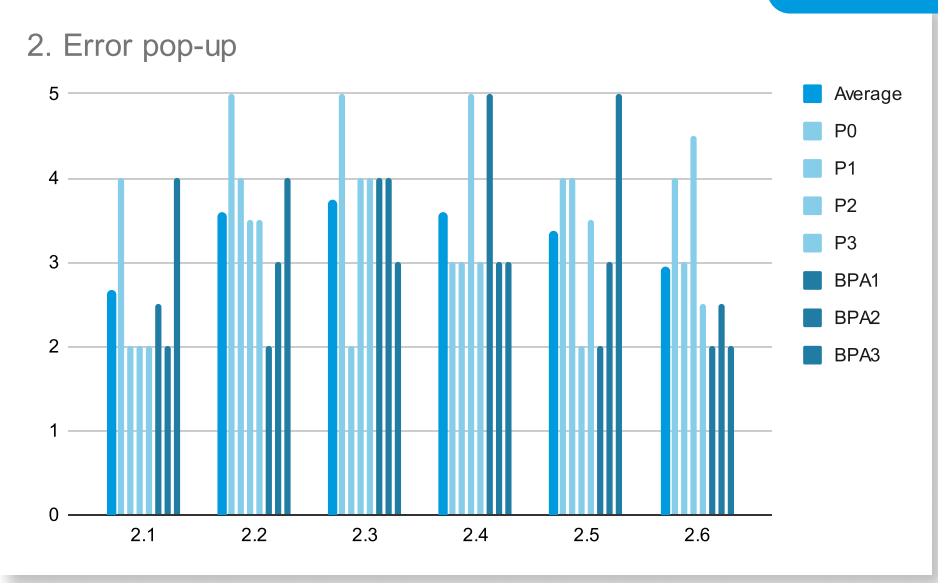
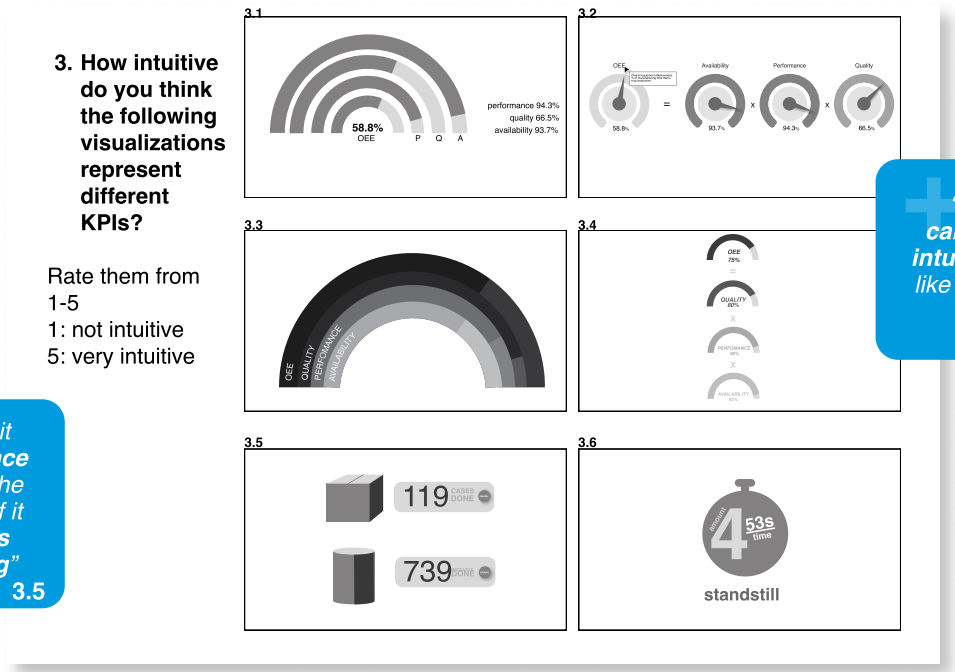


Figure 17: Error Messages Evaluation Results

3. KPI Visualization

In order to improve the understanding of the KPI's (Design Criteria 3 & 4), we compared different ways of visualizing different KPI's (Figure 18). The first four elements (3.1-3.4) are representing the same KPI's in a different way. The last two are visualizations of different KPI's, this was done to discover whether people would find it intuitive to see it in a visual way. The results for the KPI visualization can be found in figure 19.



"Nice visuals, maybe it would take **a lot of space** but its **very intuitive**, the **circular thing** is nice if it would be the **same as what you are packing**" 3.5

"Pretty **clear** with the **calculations**, this is most **intuitive** only flip it around, I like it to be round instead of half circles" 3.2

Figure 18: KPI Visualization Evaluation Page

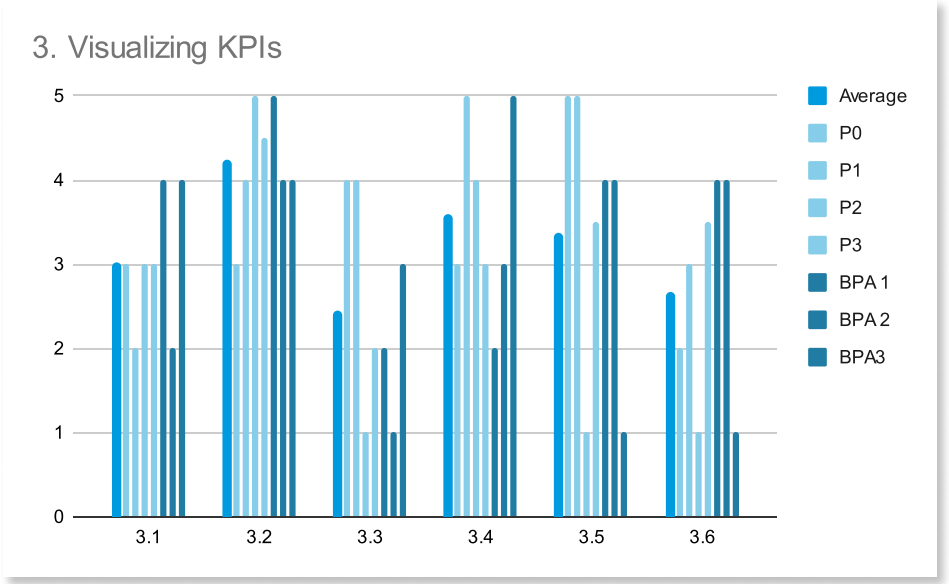


Figure 19: KPI Visualization Evaluation Results

4. KPI Findability

For the redesign of the understandability of the information shown (Design Criteria 3 &4), we evaluated elements that show the overview of different KPI's (Figure 20). Some are small elements that represent an idea (4.1) and some show the overview, where KPI's are shown together (4.2-4.4). In figure 21, the results can be found.

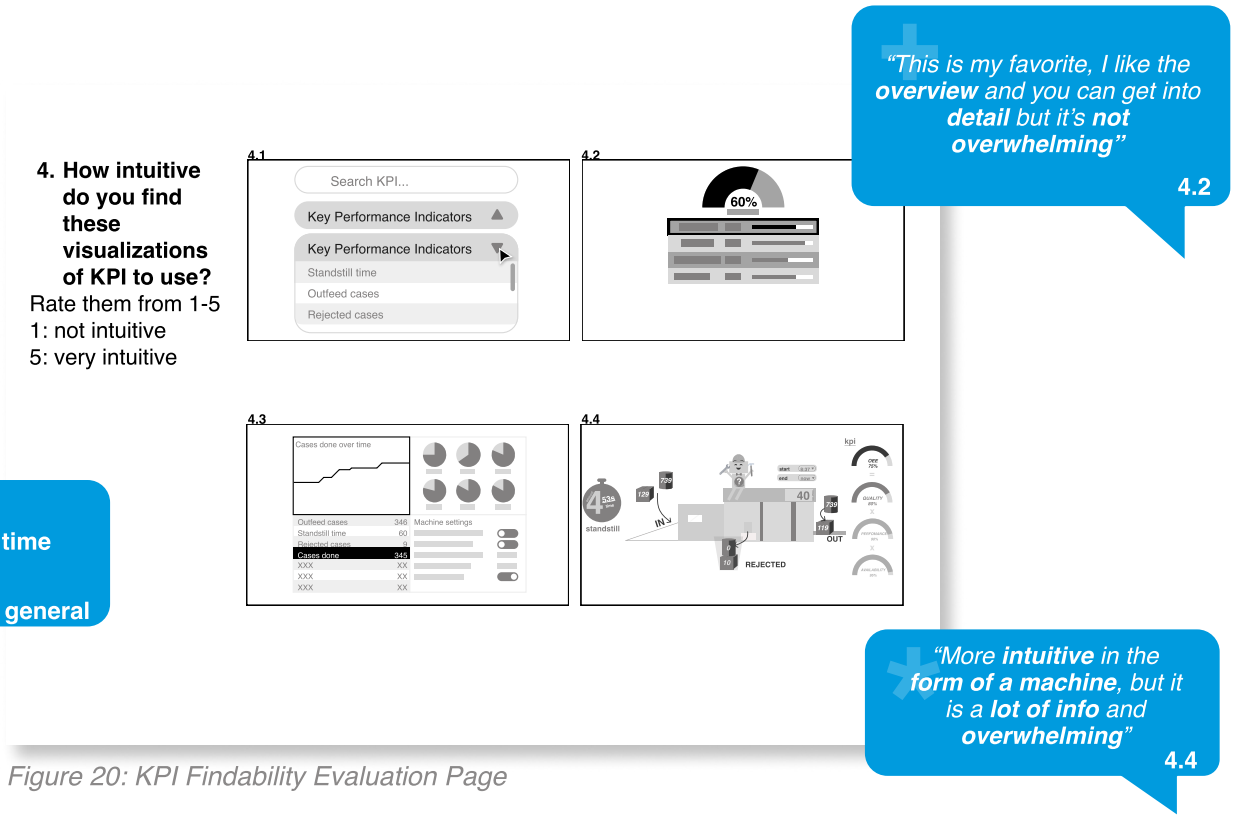


Figure 20: KPI Findability Evaluation Page

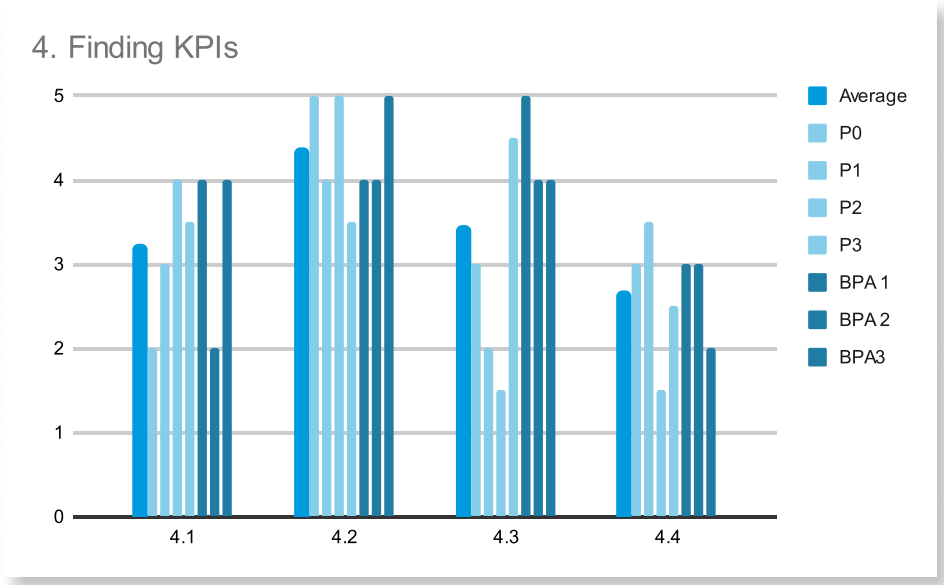


Figure 21: KPI Findability Evaluation Results

5. Motivation

Based on the design goal, we wanted to include the motivation of the machine operators as an important aspect for the redesign. Figures 22, 23 show the different elements from the concept directions that are designed to help operators feel more motivated at work. In Figure 24, the results can be found.

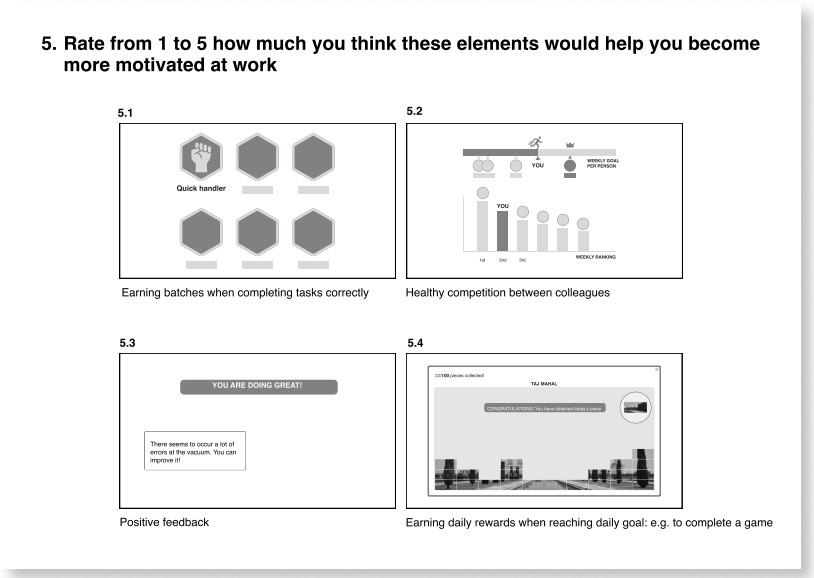


Figure 22: Motivation Evaluation Page 1

*"I like it, it **motivates** people, however it is **very hard** within this **machine.** If the operator fixed 10 errors, this is not good, it means that the machine had many errors. Really **nice** but **hard** to **implement**"* **5.1**

*"**Demotivating.** If you are very much behind I would just give up, if I am first. I would **not help** the second one. "* **5.2**

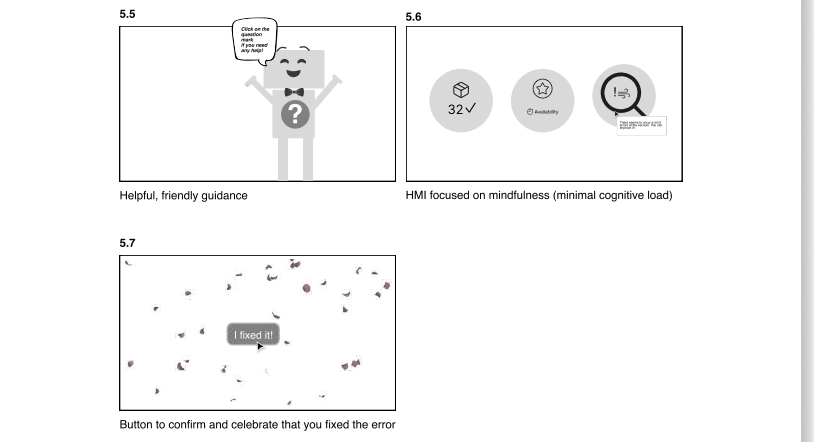


Figure 23: Motivation Evaluation Page 2

*"I like that you do this **over days**, I would feel that every day I am **contributing** and **building up**"* **5.4**

*"**False hope don't** really know if you **fix the error**, that takes time. If you find a **standstill** and change something and then it is fixed **after a while**, then to get a **batch** would be very nice "* **5.7**

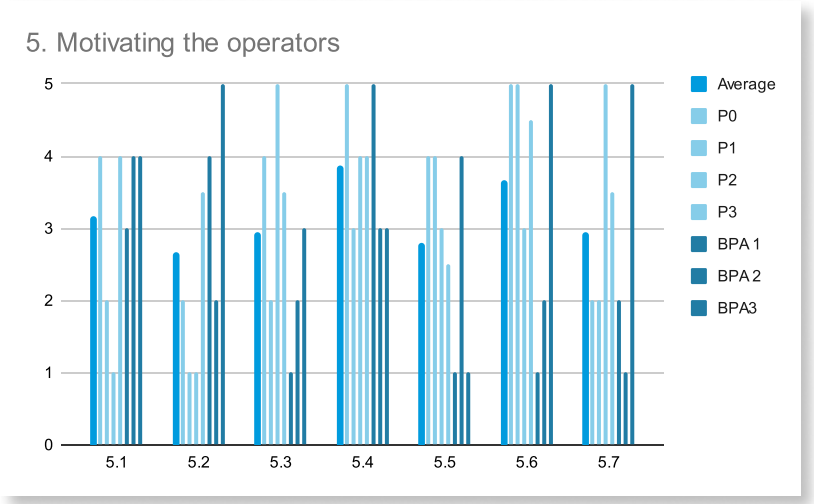


Figure 24: Motivation Evaluation Results

6. Learning the dashboard

To improve the confidence of the operators (Design Criteria 1) and to take a look beyond the digital dashboard, we wanted to evaluate elements that could be implemented into the bigger system which includes the training for a (new) operator (Figure 25). Figure 26 shows the results of the dashboard learning evaluation.

*With a workshop, I think I would **feel prepared**, in a workshop you **can't do anything wrong.***

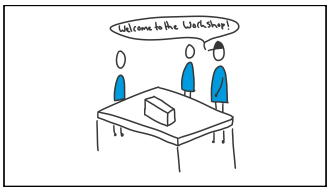
6.1

*I like it, but also feel like I am just **standing there**, maybe with really small videos and to **step by step** see everything*

6.2

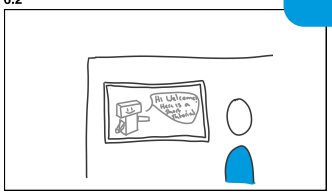
6. Rate from 1 to 5 how much you think these elements would help you become more confident at making decisions at work

6.1



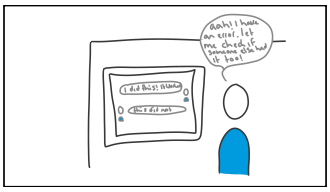
Provide an initial workshop on how to use the machine + HMI

6.2



Provide a guided tutorial on the dashboard

6.3



Check on the dashboard suggested solutions on how to fix errors (from the manufacturer and from other operators)

*Good for specific issues and help me **feel confident** because of the solutions from others.*

6.3

Figure 25: Dashboard Learning Evaluation Page

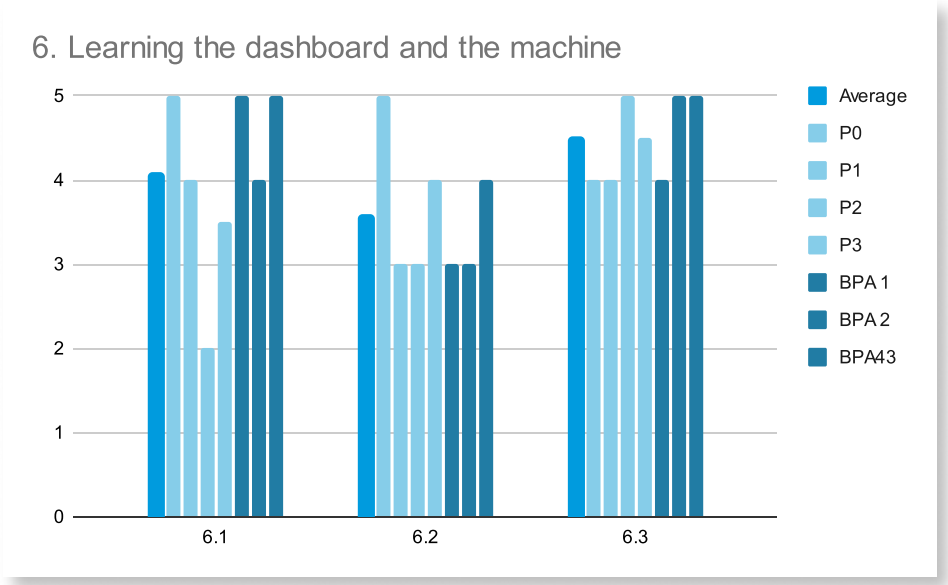


Figure 26: Dashboard learning Results

Reflection

When thinking about the ways we could evaluate the different elements we chose to use a Likert-Scale, because we wanted to be able to compare them. We thought about using a Harris Profile or weighted objects, but we felt that by using those methods, we would have been the ones deciding on importance. This didn't feel right, since we were also the ones designing them, so we would have been biased in a way. By using the Likert-Scale, we tried to have the participants have a neutral view about the different elements. By also including the PMI method, we tried not to only have quantitative data, but also some qualitative data.

Due to several reasons, two of the BPA employees evaluated the concepts in their own time via E-Mail, without having any additional information available for the elements/concept they have seen. This way, we cannot be sure, they fully understood the intention of the different concept directions/elements. Next time, we would include an annotated version, to make sure the intentions are well understood. With the other participants, we were present during the testing and guided them with explanation through the different elements. Because of this way of working, we could possibly have influenced them and make them feel that they could not be completely honest. Which they could have been if the test was anonymous. However, this way we really stimulated the participants to think aloud and explain their ratings, something we would not have control over if it was without us being present. Which ended up being very helpful concluding our evaluation.

Conclusion

At the end of the evaluation, there was a clear idea about what elements worked well, which had potential and which did not work. Based on these findings, we will draw conclusions that will be the foundation for the initial design proposal.

5 Initial redesign proposal

After evaluating the different categories, it was time to analyze the results and make decisions. In this chapter we will be going over the ideas that will be part of our final design. The details and formal aspects will be developed in phase 3.

Design proposal

From the evaluation, we reflected on the feedback provided by our participants, and for all the different categories we decided which elements and concepts will have potential to become part of our final design.

1. Navigation

The most liked menus for navigating the dashboard are the ones shown on Figure 27.

Figure 27: Top ranked navigation menus

1.4 was voted high, however it was noted that it might take too much space from the screen. From the comments, we decided on some characteristics for the menu:

- The menu should be seen at all times.
- For a more accessible use, the combination of words (1.1) and icons (1.6) would be the most intuitive. It would allow for people with language and reading restrictions to understand it thanks to the icons, and it would also provide text as an explanation.

A good outcome of this would be to redesign 1.1 adding icons next to the text for more accessibility.

2. Alarm message

The top ranked alarm messages are show on Figure 28.

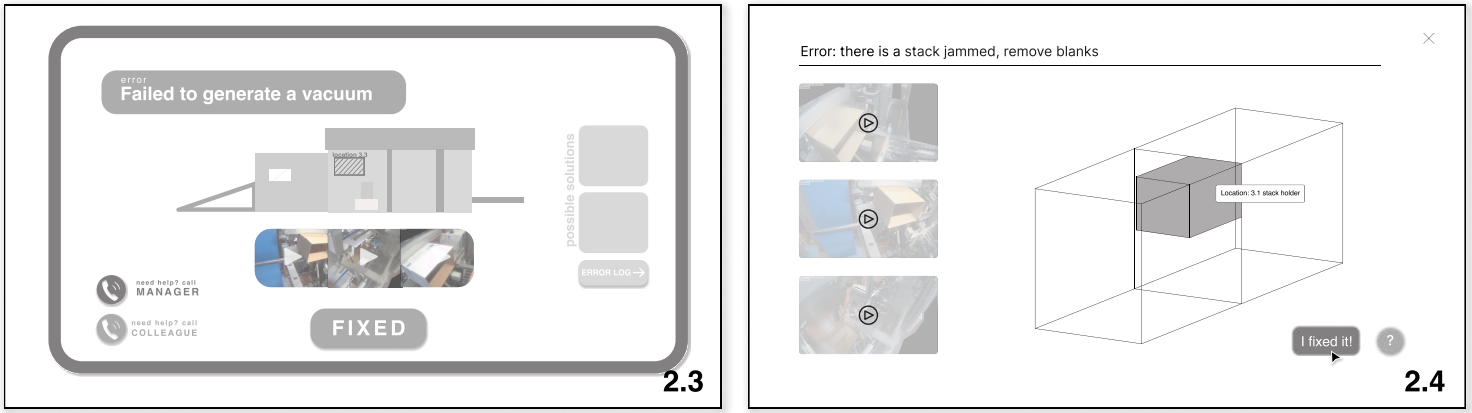


Figure 28: Top ranked alarm messages

From the evaluation, we concluded that the alarm message should mix both the concepts shown above. We also concluded that:

- It should be a pop-up menu that appears once the machine detects an error.
- A 3D representation might work best in showing the location of the error. We could use a simplified CAD model of the machine to achieve this (2.4).
- Being able to access the error log is important so that the person using the machine can check its past performance. (2.3)
- Having suggested solutions for the error could help the operator feel more confident. These suggested solutions could be provided by BPA, and also operators could enter in the log and write down their own suggestions (2.3).
- Videos should be easily accessed.
- The buttons asking for help are a very liked addition (2.3).

3. KPI visualizations

For visualizing different KPIs such as the OEE and products and cases, the following visualizations ranked the highest (Figure 29):

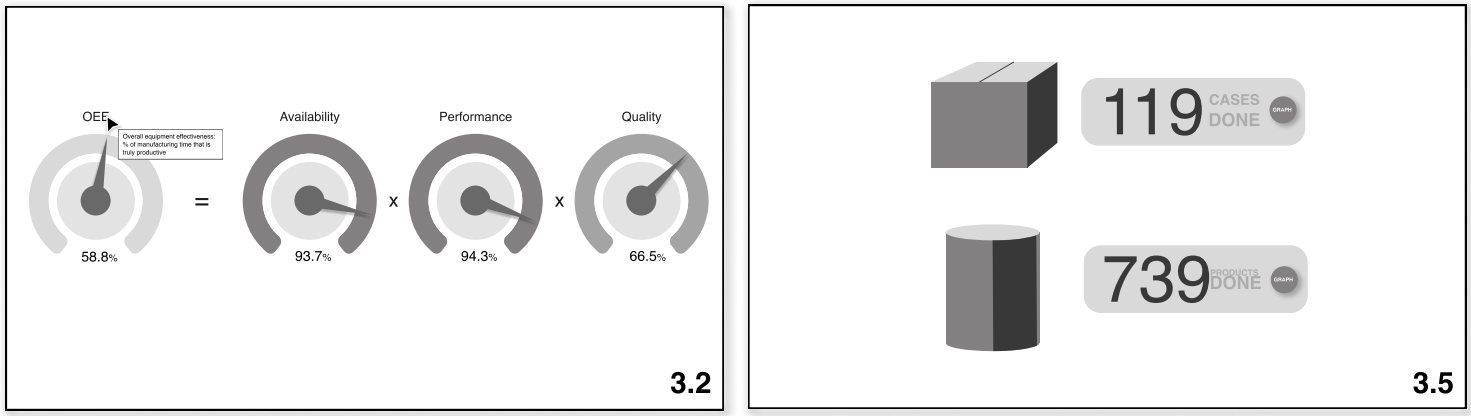


Figure 29: Top ranked KPI visualizations

Some conclusions in regards to the KPI visualizations are:

- Presenting the OEE as an equation in horizontal is very intuitive and clarifying. (3.2)
- The shape of the counters is not final. Could be simplified to match the aesthetic of the final design.
- Color coding the percentages (e.g. red for a poor OEE) is very intuitive.
- The cases/product distinction is intuitive. The product visual could be modified to show the actual product that is being packed (3.5).

4. KPI findability

From the different ways of visualizing all the different KPIs altogether, the highest ranked one was Figure 30:

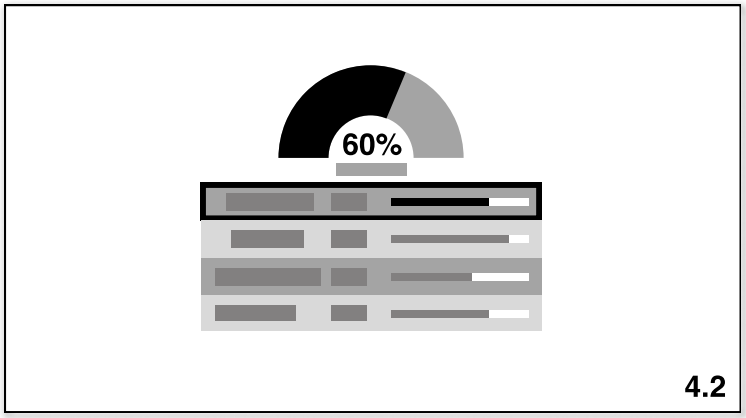


Figure 30: Top ranked KPI findability

Some of the conclusions were:

- Showing different visuals/graph for every KPI once its clicked is effective and makes the screen look less cluttered.
- A time selection menu should be added so users can retrieve the information for that KPI in that time frame.
- A search bar would still be a good addition in case users want to retrieve information from that specific KPI.
- A search bar overall in the design would be a nice addition for quick data finding.

5. Motivational elements

Opinions were diverse in this part of the evaluation, but the highest ranked options for this category were the daily reward system turned into a game, and the minimalist interface for less cognitive load (Figure 31):

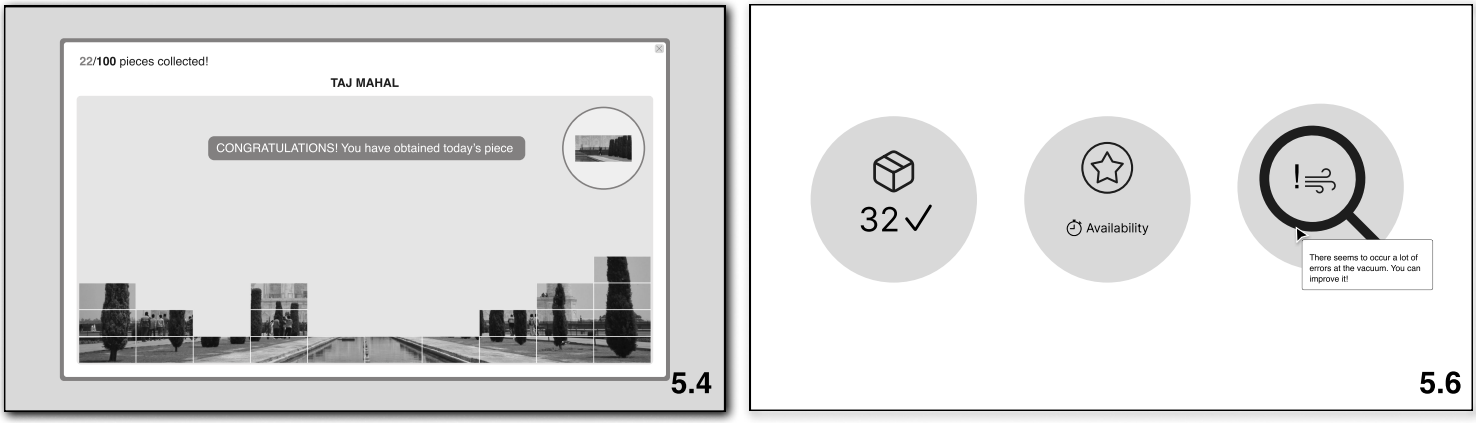


Figure 31: Top ranked motivational elements

Some of the conclusions were:

- The idea of including very minimal information to reduce cognitive load could be adapted in the dashboard as a general rule (5.6).
- The idea of earning daily rewards and building something over multiple days helps the user become more engaged and proactive. It can also help them feel recognized and rewarded for their hard work (5.4).
- The idea of the puzzle is not final. As long as the idea fulfills the previous point other elements could be used.
- Other motivational elements could still be included. These two helps us build a clearer design direction.

6. Learning the dashboard

In general, all ideas in this category were ranked quite high. However, the top ranked one was providing suggested solutions for error fixing, both from the manufacturer and also from other colleagues (Figure 32):

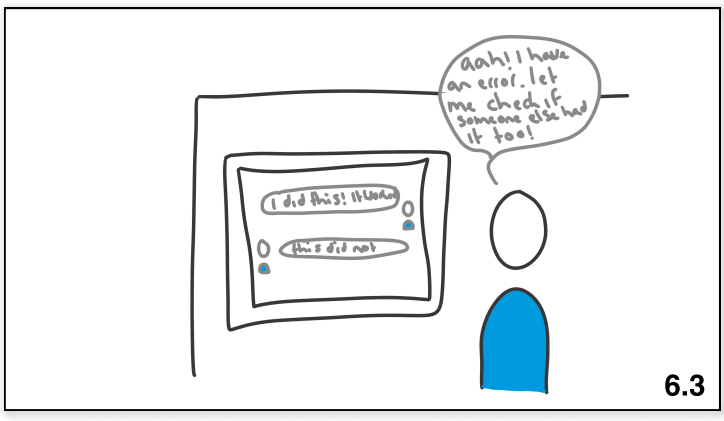


Figure 32: Top ranked learning element

We concluded that:

- Learning from experienced colleagues is very positive to build a sense of community and empathy. This could be included in many parts of the dashboard, such as suggesting solutions to solve an error that have been written by other colleagues.
- A tutorial in the dashboard would still be a nice addition for those who need that extra help.
- Organizing a workshop would be very valuable to better learn how the machine as a whole works, but it's not in our scope.

Conclusion

The evaluation has been helpful because:

- It has helped us create a concept direction, which will be mostly focused on the daily reward system and minimal cognitive load (specially for the pages dedicated to the operators).
- It has helped us have a more clear view on what element we want to include in our final design, and also how they could look.
- We have learned many insights from our participants, who were critical and pointed out which elements might not be the best to achieve our design goal.
- We focused the evaluation on proving the criteria from our interaction vision and design goal, such as intuitiveness, confidence, empowerment and motivation. Doing this will help us later on in making sure we include these criteria in our final design.
- It has helped us prioritize the elements in our design that are most important (e.g. interface navigation, concept direction, accessibility, finding data...), rather than focusing on smaller details (e.g. used colors, text, icons...).
- The higher ranked elements are not a final design, but more like elements that have helped us come up with a series of requirements that our final design will have. Some of them might stay the same while other might change.

Next steps

During the development of Phase 3, we will be focusing on developing further the higher ranked elements, making sure that our design goal and interaction vision are fulfilled. During the process of designing the formal elements and the content, we will also tackle our extended solution space by making sure that colors, icons and text are completely understandable, intuitive, and create a harmonious interface. We also keep in the back of our minds the possibility of modifying the physical dashboard, for example by making it removable from the machine so that operators can walk around while carrying it with themselves.

Once we have built a functional interface demo, we will organize a user test and we will make sure to use the testable targets established in Phase 1.

General

- Users should be able to indicate feeling confident while using the interface (in the feedback form after the test).
- Users should be able to score the interface as intuitive to use (in the feedback form after the test).
- Users are able to use the interface in an ergonomically comfortable position.

Managing Errors

- Users should be able to find information on the most recent error and how to solve it.
- Users should be able to understand what type of error occurred.

Current Effectiveness

- Users should be able to find information on the current effectiveness of the machine within 10 seconds.
- Users should be able to understand the current effectiveness of the machine.

Progress

- Users should be able to retrieve the right data to explain the progress of the machine over a specific period of time.
- Users should be able to find the location of the amount of rejected cases and products.

6 References

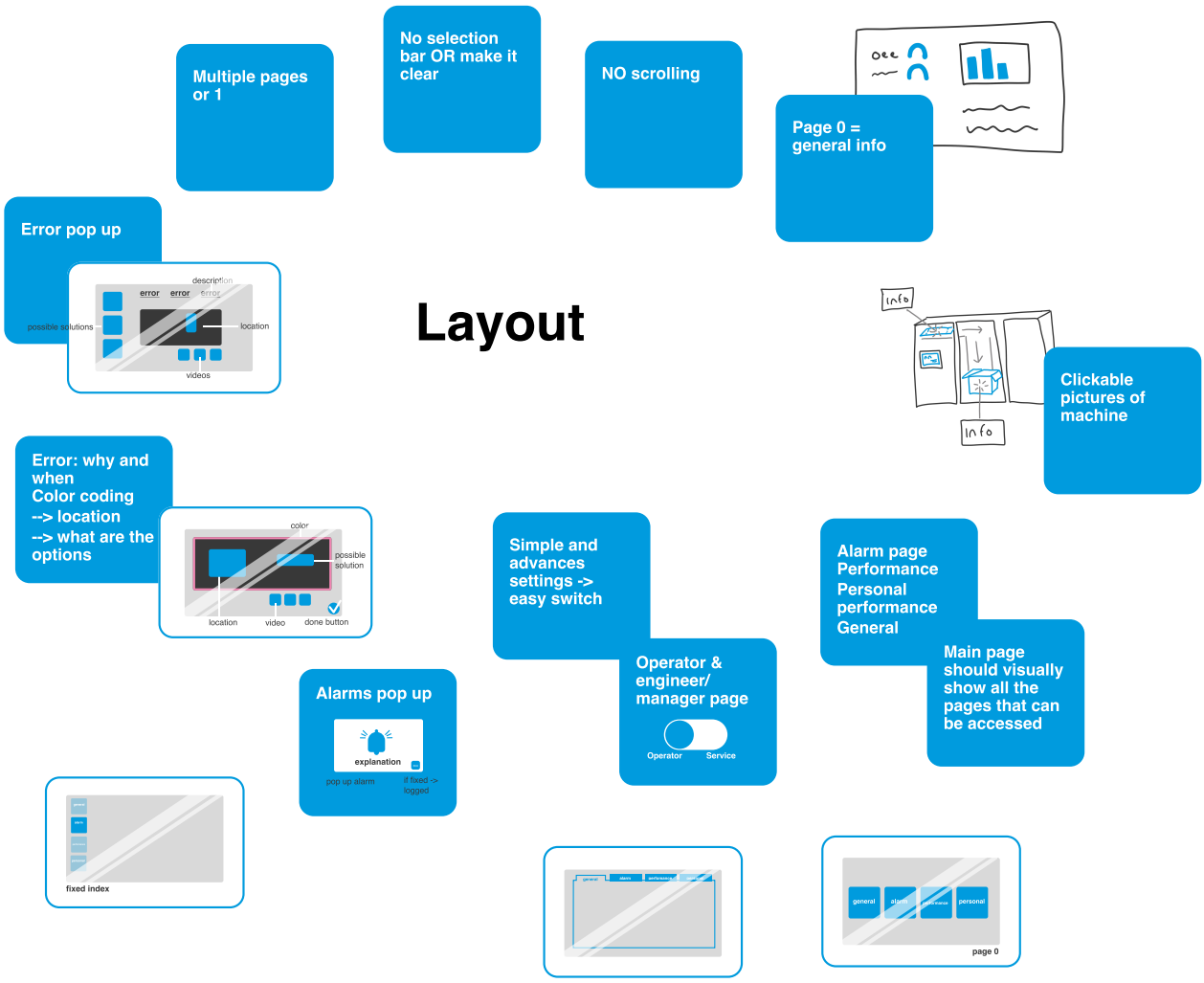
Van Boeijen, A., Daalhuizen, J. and Zijlstra, J. (2020) *Delft Design Guide : Perspectives - Models - Approaches - Methods.*

https://research.tudelft.nl/en/publications/delft-design-guide-perspectives-models-approaches-methods.

7 Appendix

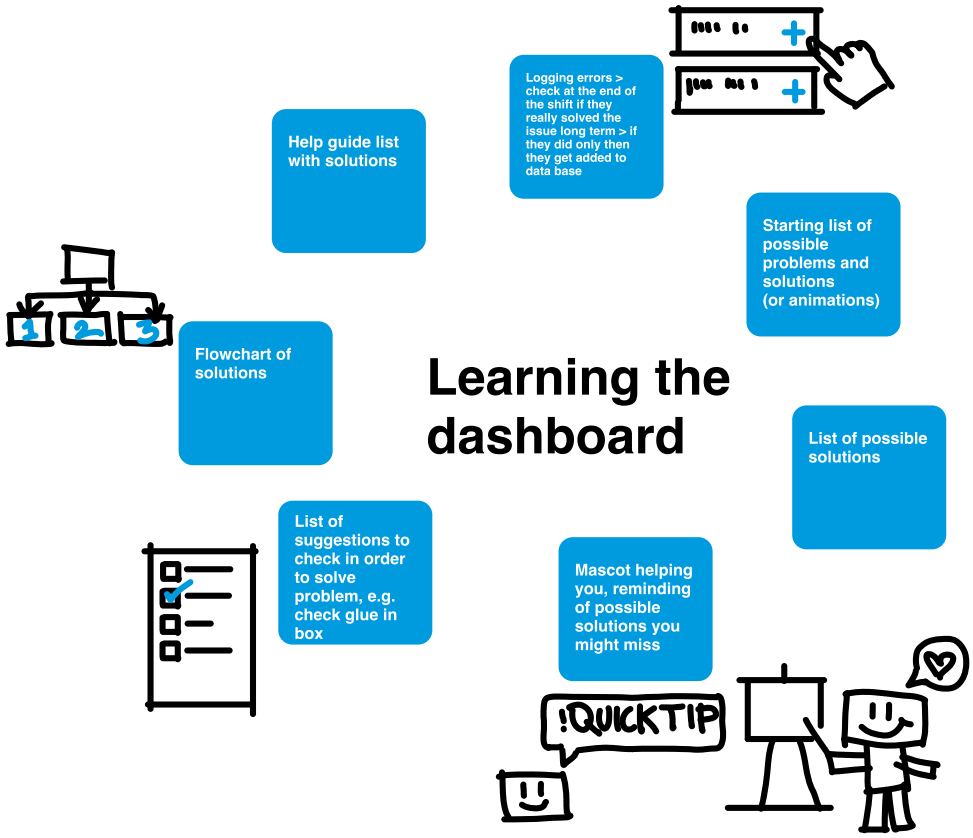
1.1: Brainstorm clusters

Ideas on the layout of the dashboard interface



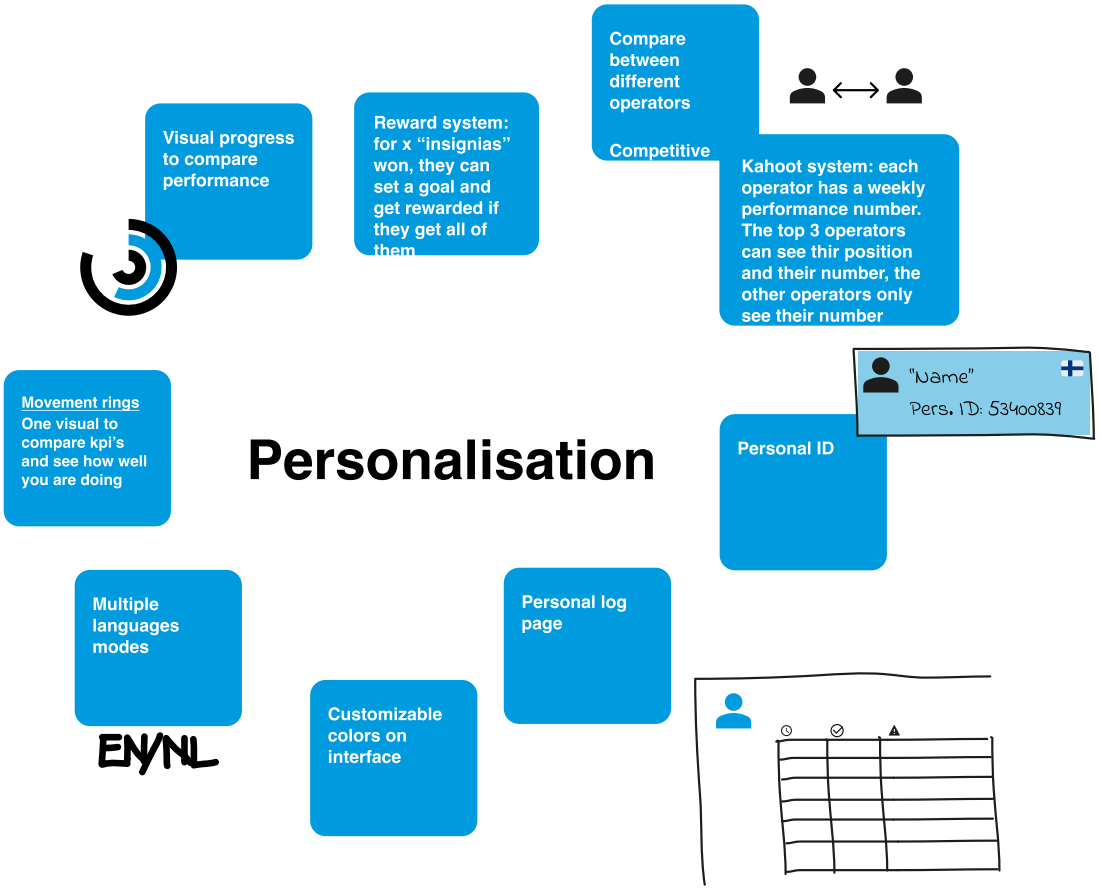
1.2: Brainstorm clusters

Ideas for learning how to use the dashboard inside the dashboard



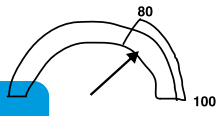
1.3: Brainstorm clusters

Ideas focussed on personalisation for the operator



1.4: Brainstorm clusters

Ideas focussed on the understanding of technical terms

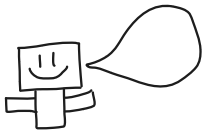


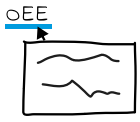
Have a numerical range of each data

Visualise the calculation of the OEE and kpi: performance x availability x quality = OEE

Technical Terms

Boxie (mascot) explains technical terms

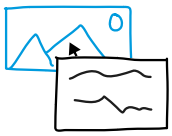


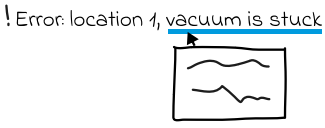


Click on the technical term to get a definition (wikipedia)

Visual instead of technical term, when clicked it shows a description

Clickable error - error shows description





1.5: Brainstorm clusters

Ideas for learning to use the dashboard outside of the dashboard

Crossword puzzles
Cryptic riddles
Learns error messages

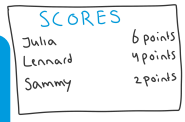
Twister
-we have this error put your hand on the solution

Design training day workshop that show solution

Knowledge sharing among operators

Learning outside dashboard

Games to learn words and compete with colleagues



Machine points
-who fixes most errors

Games that trains you
-who gets the most solutions
-friendscores
-while waiting

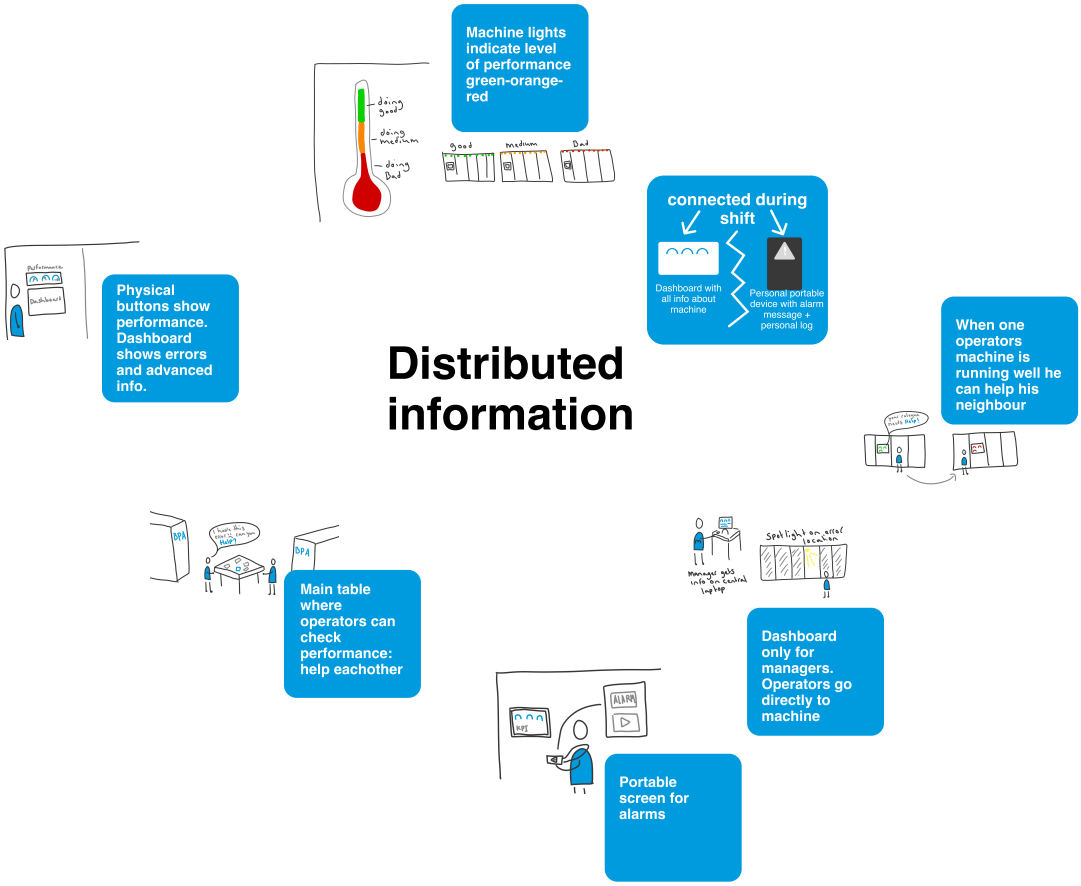
Availability competition

Training to understand the technical words

Add tutorial (short and fun)

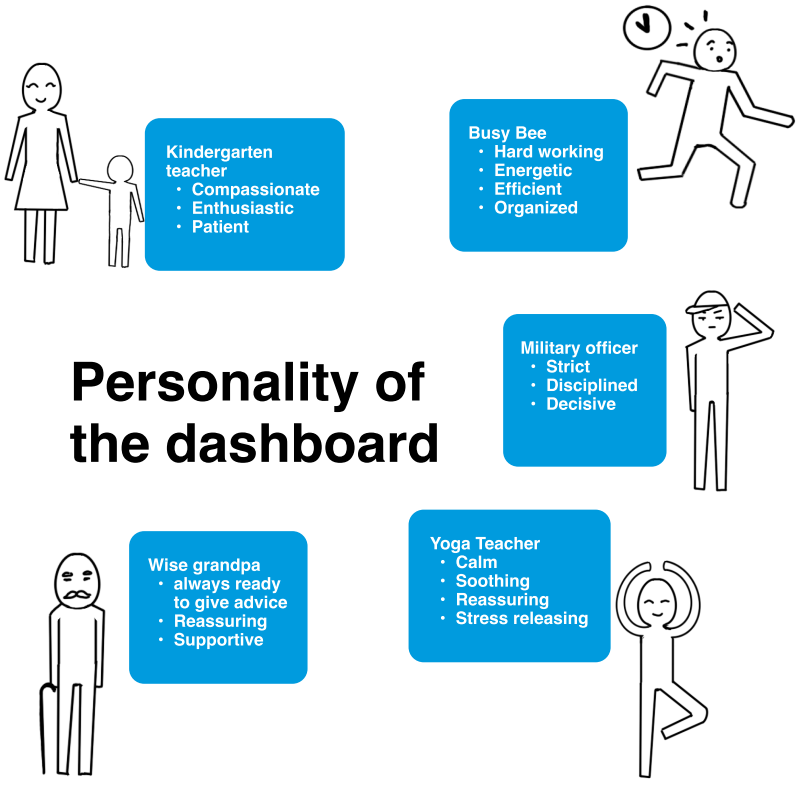
1.6: Brainstorm clusters

Ideas focussed on ways of distributing and displaying information



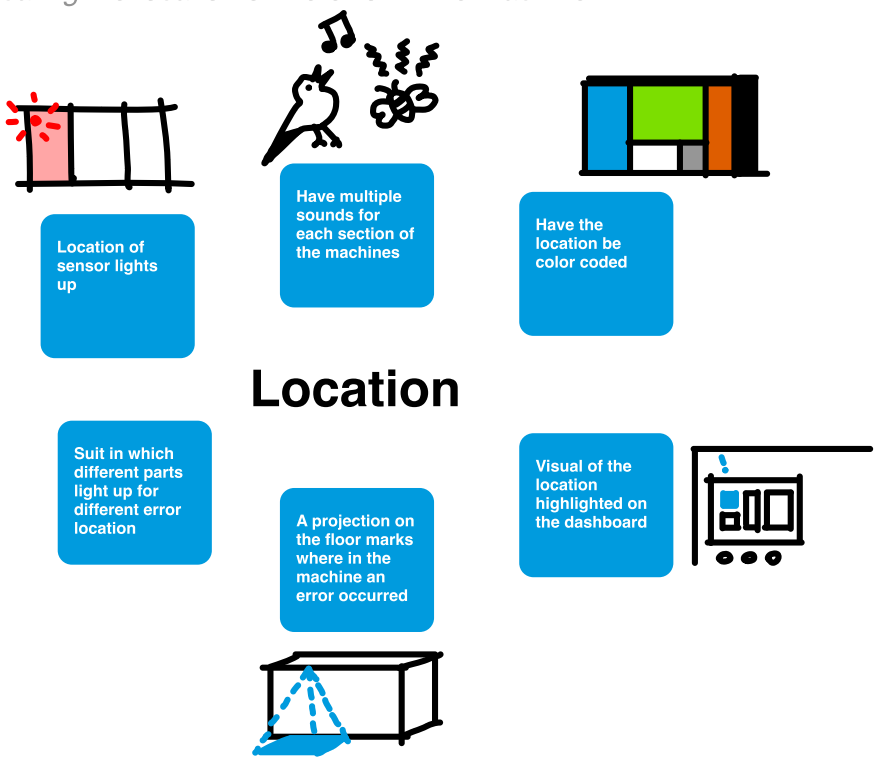
1.7: Brainstorm clusters

Ideas for personalities that could form the experience of using the dashboard



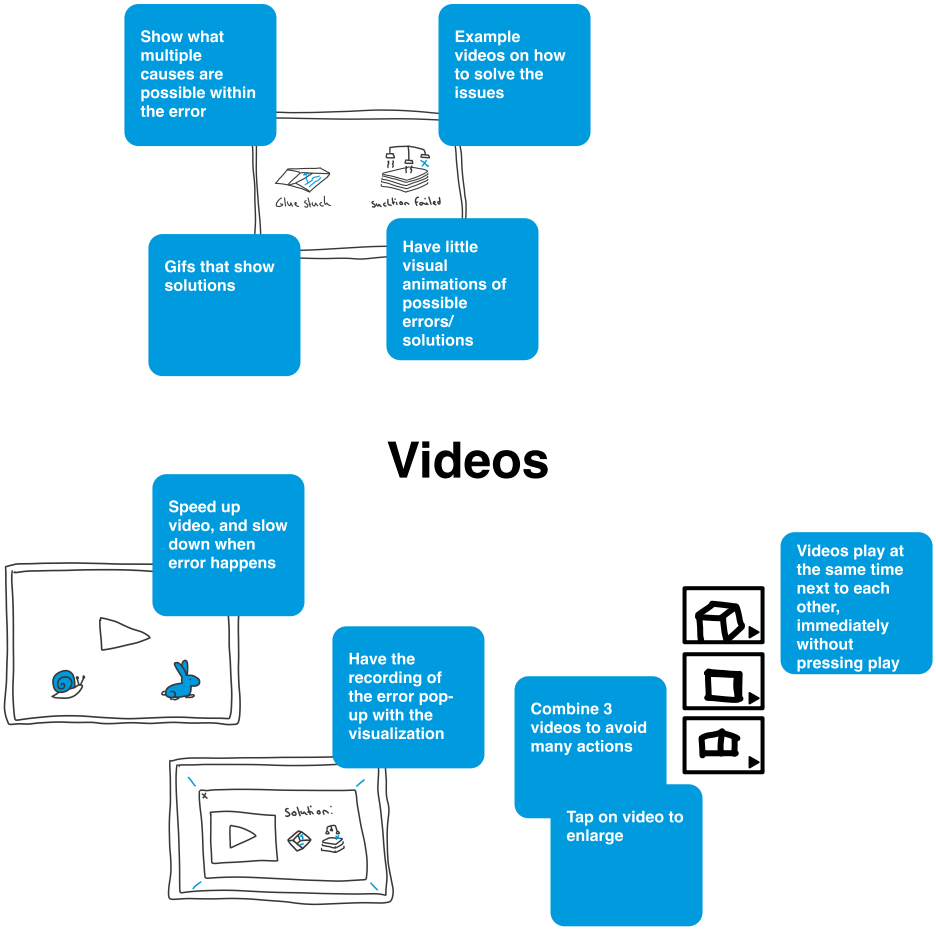
1.8: Brainstorm clusters

Ideas for indicating the location of the error in the machine



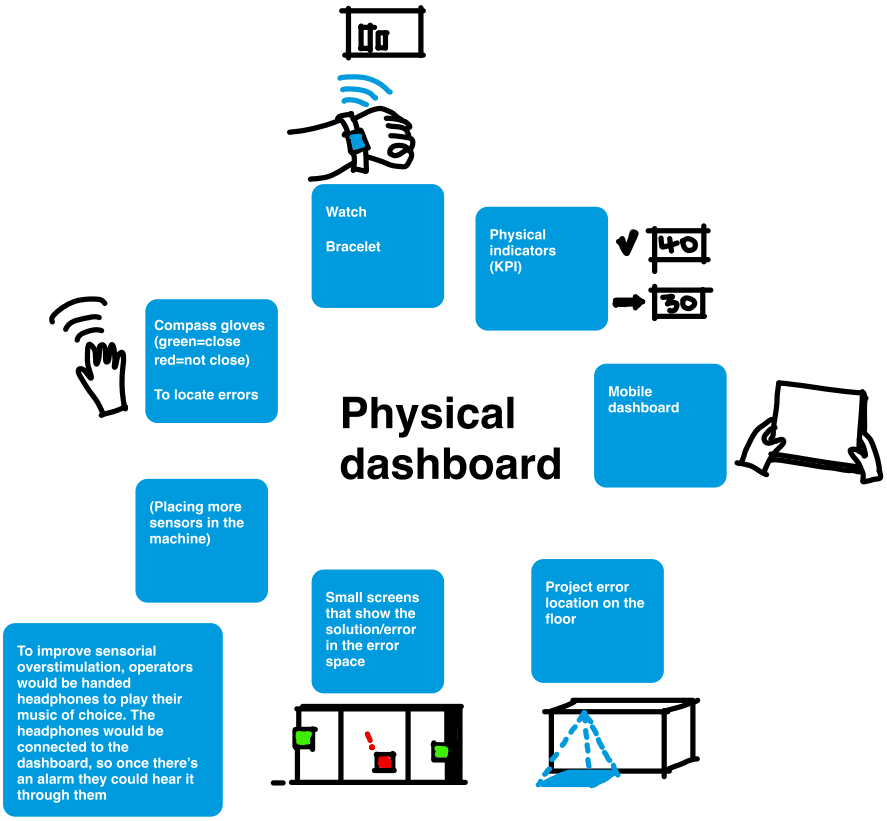
1.9: Brainstorm clusters

Ideas for improving the display of error video's



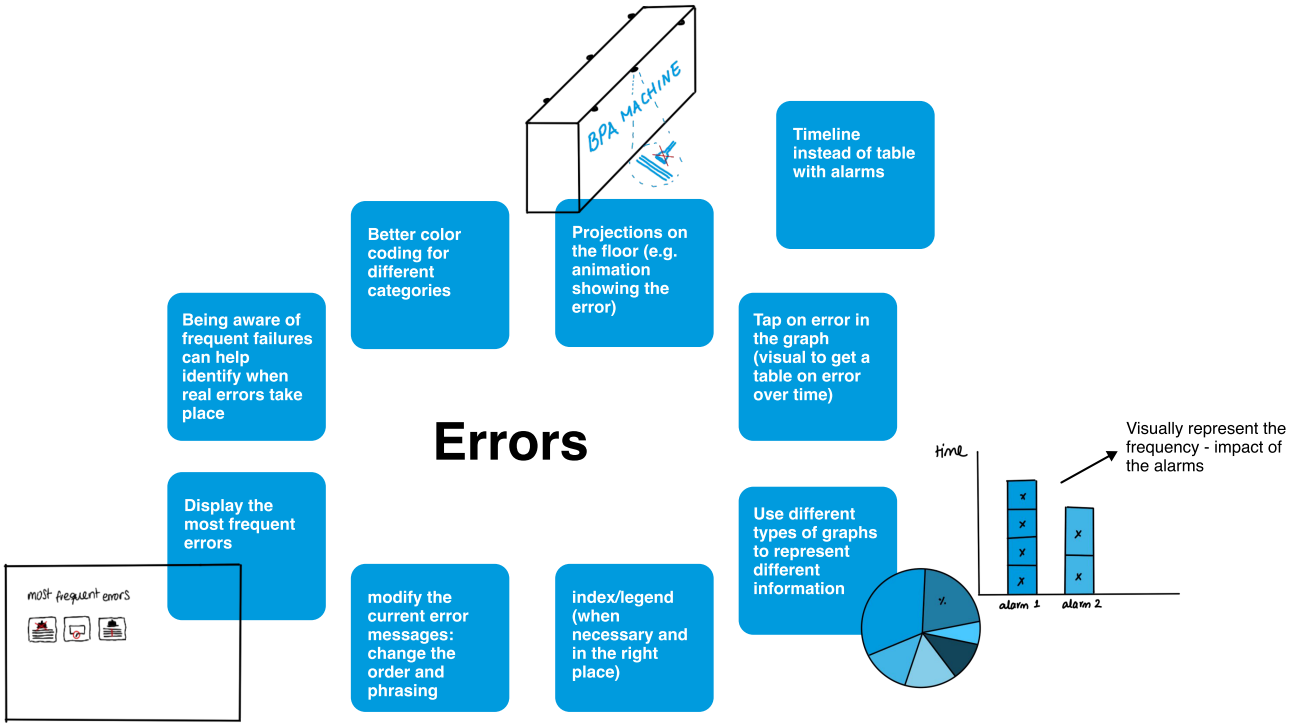
1.10: Brainstorm clusters

Ideas on the physical aspects of the dashboard



1.11: Brainstorm clusters

Ideas for learning to use the dashboard outside of the dashboard



2.1: PMI analysis of feedback

Feedback is divided into positive (plus), negative (minus) and interesting comments

1. How intuitive do you feel in these ways of navigation?

Rate them from 1-5
1: not intuitive
5: very intuitive

1.1

PLUS

*This is very **obvious***

*I can read them, its **always in screen** that's nice, but I can read them because I speak the **language***

Basic

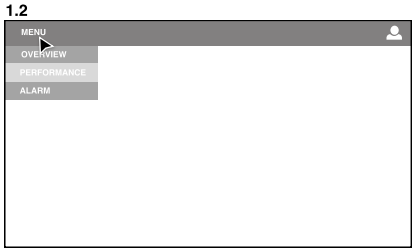
Web-site layout, very familiar

INTERESTING

*It's convenient that the **menu bar is fixed** on top.*

MINUS

1.2



PLUS

Most intuitive

Familiar, but only necessary if you have more options

INTERESTING

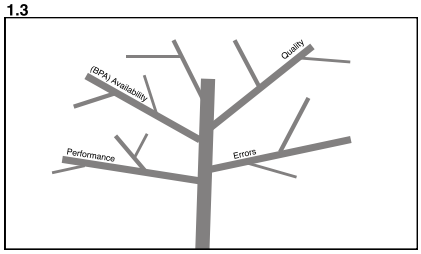
Pretty intuitive, not right away clear what the options are

MINUS

*I've seen in practice that **people don't hover** when they don't know*

Less intuitive

1.3



PLUS

I really like the tree

Too confusing, not easy on the eyes. Where do you click: branch? text?

INTERESTING

MINUS

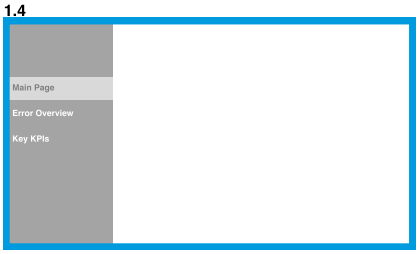
Feels messy, hard to navigate.

*I find it very **cluttered**, see **no relation** between them*

*A tree-type menu could be useful for menu's with lots of sub-options, **here it makes no sense***

***Messy**, not very regular*

1.4



PLUS

*Nice, **always present***

Also most intuitive

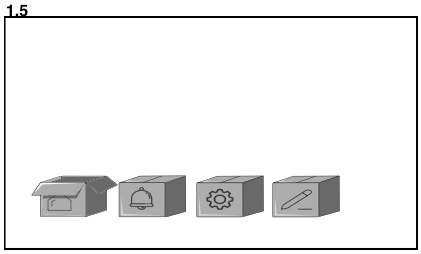
INTERESTING

Quite clear, but takes up a lot of the screen space

MINUS

Screen is almost squared so on the side is very expensive

1.5



PLUS

***Language** is not an option anymore*

INTERESTING

I dont know what the icons mean, if the icons are better it would be very clear

MINUS

It's not clear what the first box shows

Icons are not clear

*Looks cute, boxes **distracts** from the icon, not very intuitive, not speaking the language. Icons are pretty clear*

More of a 'looking pretty' than functional.

1.6

PLUS

Good, nice

The icons are clear

INTERESTING

***Language** is not an issue here*

MINUS

Same thing with icons

Icons are not clear

General comments:
1.5 and 1.6 are very difficult to realise, 1.1 and 1.4 is more easily

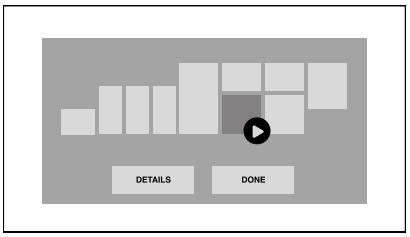
2.2: PMI analysis of feedback

Feedback is divided into positive (plus), negative (minus) and interesting comments

2. How intuitive, confident and in control do you feel in these representations of error messages?

Rate them from 1-5
1: not intuitive
5: very intuitive

2.1



PLUS

*Very **abstract**, but I like it*

*Displaying **where** an error is.*

Best of these, but might be a bit too minimalist

INTERESTING

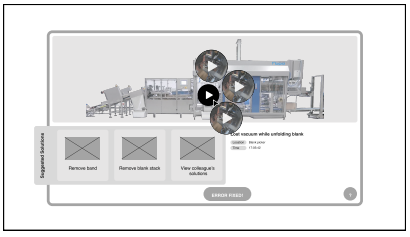
*Can't see **title**, **key information** is **missing***

***Too many images** of the machine, I can't really see any **depth**, still guessing. Done **button is not necessary**, because the machine will know*

MINUS

The error itself. Is there even an error here?

2.2



PLUS

*I like this one because it shows **more info***

Pretty nice

INTERESTING

*I am afraid that the solutions are **in my face**, I am **not in control** and it's **cluttered**, **location** is **not clear***

*Way **too busy,** too much happening on screen. **Information** and **suggested** solutions are **nice** though*

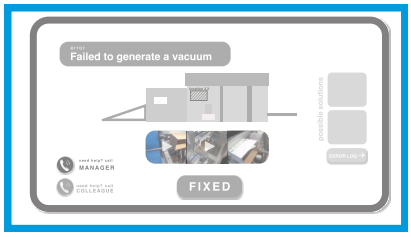
MINUS

***Too much** information and hard to find where to focus on, text is too small.*

Confused** by the **bubbles

Too many play buttons, bit overwhelming

2.3



PLUS

*The layout is nice, with a **clear title.***

*I like that the **error** is very **big**, and that I can **call** a manager, **fixed button** is nice*

*This makes me **feel more** in **control**, and there is an **error log***

*Error stated **clear***

INTERESTING

*Though I would add a **red flashy** bit in the **location** of the error in the machine. Red flashy squares are often easily **connected to errors** (and most of the time requires by our customers).*

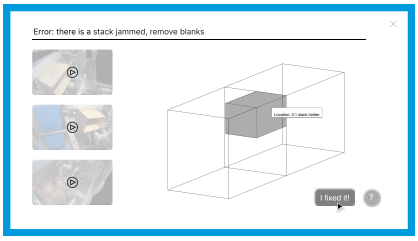
*Calling the manager is also a **possible solution**, I **don't** think **managers would be happy** with this button though. (also, the button on the bottom makes me think this error has been fixed. Is that the case?)*

MINUS

Not** very **clear

Not clear where the problem occurs

2.4



PLUS

No info** or **extra details** are there but the **videos is nice** and the **location is clear

*Error log: it is **important** to see if a **error happened a lot before**, if you make changes you can see the difference, whether it has improved*

Like the 3d, i fixed it button is nice and error stated is clear and that big

*Nice that it is **3d**, good orientation*

INTERESTING

*Again, make the box in the machine **red**, it's an **error**. If the **question** mark gives me some more **data** (like on 2.2), this is great.*

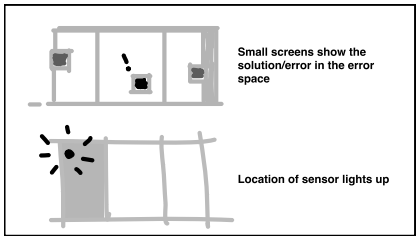
MINUS

*It is **less clear** because it is just a box, it doesnt show a lot*

Lacking context, eg where is front or rear?

*The layout is **too simple***

2.5



PLUS

*Like that the **location lights up**, feels intuitive*

*Light is nice, to know **exactly where** it it, screens are shitty*

Feels intuitive. and guiding can you see the lights?

INTERESTING

*A **red light lighting up** in the machine area with an error would be nice. **Screens** all over the machine probably **less**. Most people like to be able to see everything from **one central place**.*

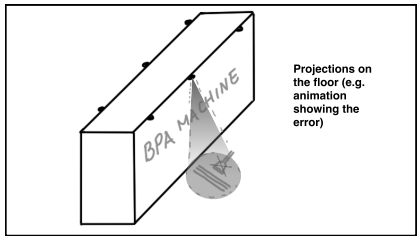
MINUS

*You see where but **not what***

*Could be **less efficient** to check different errors. Probably need a place to hold all error messages.*

***Zero control**, many screens would mean that I have to look at two places at the same time, every sensor should be equipped with a light, but they can break*

2.6



PLUS

*Nice that you are **not seeing the screen**, and that you **stand before it***

INTERESTING

*Cool, not very **clear***

*On it's own not intuitive, because it is only an icon. It is nice though, and could be a great **addition** to a comprehensive screen in the HMI (just like the red lights inside of the machine. Very **futuristic** as well, makes people **enthusiastic** :)*

MINUS

Not intuitive to use in factories

*Quite **intuitive**, but **no control***

*I would be afraid that it is **not** very **readable**, but like that the location is the same*

Feels very awkward

ERROR LOG
Go back to error log, time since last standstill, time since this unique error, how often it occurred, should we do anything to the machine

VISUALISE 3D
right, left, front and back is different from every direction, saves time if that is clear, pinpointing where the error is could be faster

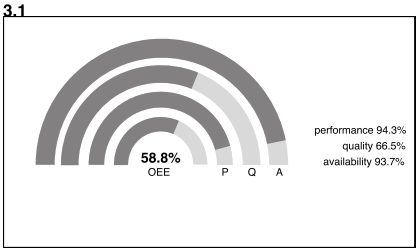
2.3: PMI analysis of feedback

Feedback is divided into positive (plus), negative (minus) and interesting comments

3. How intuitive do you think the following visualizations represent different KPIs?

Rate them from 1-5
1: not intuitive
5: very intuitive

3.1



PLUS

*Nicely **structured***

INTERESTING

*Because the circles are **different sizes**, maybe one is more important, **hierarchy** is important*

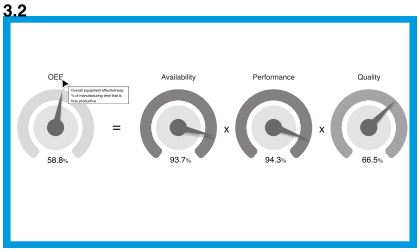
The most important (OEE) is the smallest circle?

MINUS

*The P,Q,A are **unclear**, and text on the right is **confusing**.*

*Very **cluttered***

3.2



PLUS

*Like it, looks like the **original** one, what a percentage means. I would like the **explanation** the be there **more obvious***

*Pretty **clear** with the **calculations**, this is most **intuitive** only flip it around, I like it to be round instead of half circles*

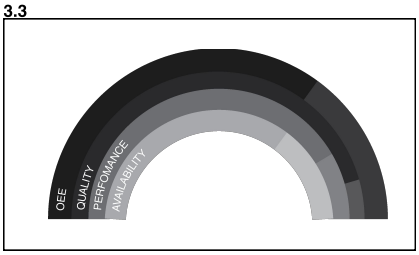
*Most **clear**, i like it*

INTERESTING

*Can be more **abstract**.*

MINUS

3.3



PLUS

INTERESTING

(4 for representation but very hard to see)

*More **clear** than the other one, **OEE** is the most **important** one.*

MINUS

*Can't see the **exact number***

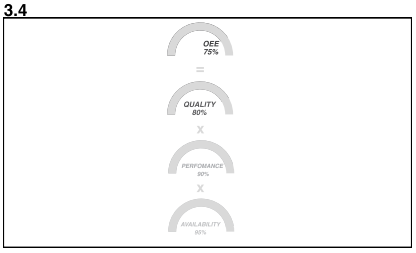
No numbers** so not very **clear

*Colors are **stacked***

*Very **cluttered** and **stacked***

Too close, needs space in between circles

3.4



PLUS

Good for a vertical screen

INTERESTING

*The same as 3.2 but **less intuitive***

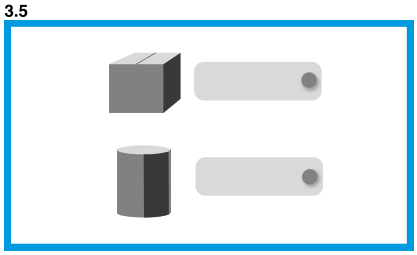
MINUS

*The **vertical layout** is **less readable** and the **color contrast** is **less clear**.*

*It **shades down**, it is **not as visible** as i would like*

***Lower opacity** makes it **hard to read**. Yes, maybe those are **less important,** but you should still be able to read it well if you want to know it*

3.5



PLUS

*It is very **clear** what everything is*

*NIce visuals, maybe it would take **a lot of space** but its **very intuitive**, the **circular thing** is nice if it would be the **same as what you are packing***

*Instantly **clear***

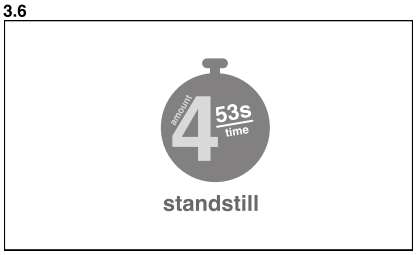
INTERESTING

*The **icons** seems **too abstract** and I don't know what they are.*

MINUS

I dont understand anything

3.6



PLUS

INTERESTING

*This is **too artistic** to me and **less understandable**.*

*Too many **crocked** words, I don't understand*

MINUS

I don't understand anything

Amount 4, 53 sec time? what does this mean?

2.4: PMI analysis of feedback

Feedback is divided into positive (plus), negative (minus) and interesting comments

4. How intuitive do you find these visualizations of KPI to use?

Rate them from 1-5
1: not intuitive
5: very intuitive

4.1

PLUS

*I like the **search bar***

***Intuitive yes**, **not** very **easy** to use*

INTERESTING

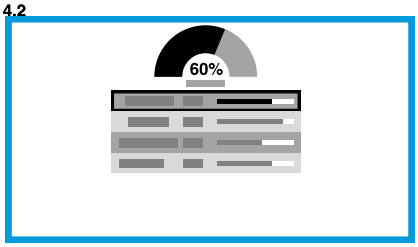
*Okay, **intuitive** but **not clear***

MINUS

*I would like them to **be all present***

***Not** very **intuitive**, because I have to know what i am looking for*

4.2



PLUS

*I like that when you **click** on it, it would **be bigger***

Nice

*Very good, shows me **not too much** info but gives **extra info***

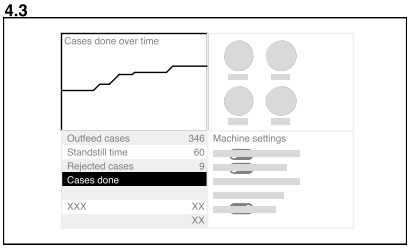
*Favorite, **overview** and you can get into **detail** but **not overwhelmed***

INTERESTING

MINUS

*I don't see anything **special***

4.3



PLUS

Very detailed and every information can be shown.

INTERESTING

*I **click** what I **want to see***

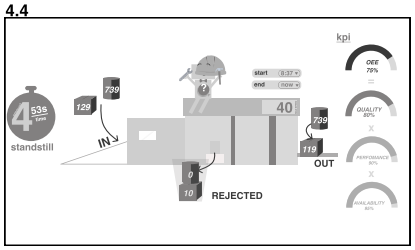
MINUS

*I like it **less**, because it is a **lot of information** all together*

***Too many** things going on*

Might not work for everyone

4.4



PLUS

INTERESTING

*It has **potential**, but it is **not** very **clear** at first sight, it does **explain** the **difference** but you **really need the time** to look at it.*

*More **intuitive** in the **form of a machine**, but it is a **lot of info***

*I **don't** feel I can **understand** this if I don't know **how the system works**.*

*Quite a **lot of information**, I like the way it is **visualized** (in and out) but very **cluttered***

MINUS

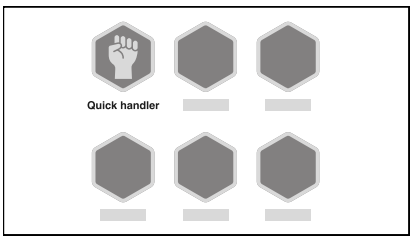
Very overwhelming, what needs my attention first?

2.5: PMI analysis of feedback

Feedback is divided into positive (plus), negative (minus) and interesting comments

5. Rate from 1 to 5 how much you think these elements would help you become more motivated at work

5.1



Earning batches when completing tasks correctly

PLUS

*I like **badges** and **collecting** stuff so this is good to me*

*I like this, it is **familiar**, because it is used in **games***

INTERESTING

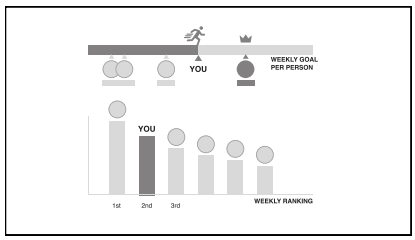
*I like it, it **motivates** people, however it is **very hard** within this **machine**,*
*ii it is fix 10 errors, this is not good. Really **nice** but **hard** to **implement***

*Badges is **nice**, but not wow*

MINUS

*It feels that the compagnie just **wants me to work more***

5.2



Healthy competition between colleagues

PLUS

INTERESTING

***Comparing** it to **personal previous weeks** would be nice*

MINUS

*If the machine would fail, then I would **feel bad about myself***

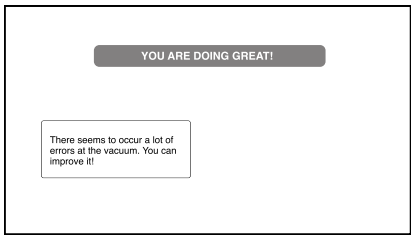
***Demotivating** if you are very much behind I would just give up, if I am first. I would **not help** the second one.*

I don't like this

***Not** very **motivating** if you are last*

*This might be **too stressful** and can have **contrary effects**.*

5.3



Positive feedback

PLUS

INTERESTING

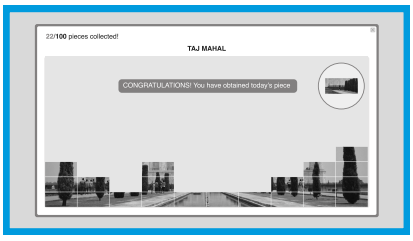
Okay, but yeah

*Yes I like this, it would make me **happy** but eventually I would **ignore** it*

MINUS

*This gives less **feeling** of **achievement** to me compared to others.*

5.4



Earning daily rewards when reaching daily goal: e.g. to complete a game

PLUS

*The **effects** might **differ between people**.*

*I like that you do this **over days**, I would feel that every day I am **contributing** and **building up***

*Puzzle is **cuter** and **adds** something nice*

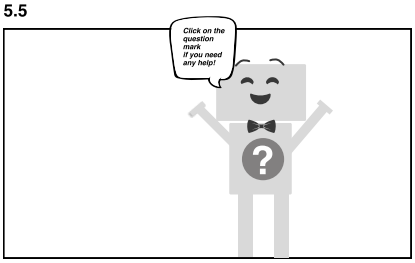
INTERESTING

*Like the idea of an **artwork***

*It **depends** on the **image**, but very **cute***

MINUS

5.5



Helpful, friendly guidance

PLUS

*Bot is nice, **better interaction** then a message*

*The fact that I can get **guidance** is very nice, no matter in what shape*

INTERESTING

*This would be nice, but **doesn't** really **help** me to get more **motivated***

*I like Boxie, I am afraid that it **wouldn't help** too much*

MINUS

*This feels **less effective** than others.*

5.6

HMI focused on mindfulness (minimal cognitive load)

PLUS

*The **least** input as possible, that's nice*

*I like the **calmness**, most of the time you cant really do much about it. As long as there is an **option to go into depth***

INTERESTING

***Not sure** what all the **icons** mean, but I like it for its **aesthetics**.*

*Nice, **not** very **motivating***

MINUS

Environment doesn't** really **fit

2.6: PMI analysis of feedback

Feedback is divided into positive (plus), negative (minus) and interesting comments

5.7

Button to confirm and celebrate that you fixed the error

PLUS

*I like the **celebration***

If you have good animations this could work

INTERESTING

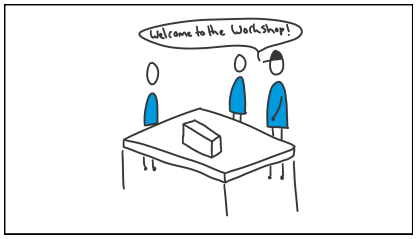
*I like it, but **after a while it wouldn't do anything**, but I like the button*

***False hope don't** really know if you **fix the error**, that takes time. If you find a **standstill** and change something and then it is **fixed after a while**, then to get a **batch** would be very nice*

MINUS

6. Rate from 1 to 5 how much you think these elements would help you become more confident at making decisions at work

6.1



Provide an initial workshop on how to use the machine + HMI

PLUS

*Because someone tells me what to do, would make me feel **confident***

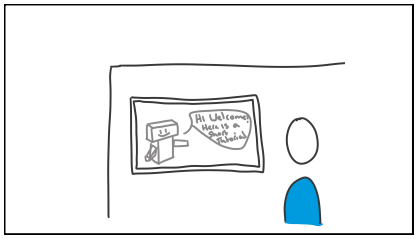
*With a workshop, I think I would **feel prepared**, in a workshop you **cant do anything wrong***

*Like this one most, usually if you are t**rained by someone with experience you get nice tips***

INTERESTING

MINUS

6.2



Provide a guided tutorial on the dashboard

PLUS

INTERESTING

*I like it, but also **feel** like I am just **standing there**, maybe with really small videos and to **step by step** see everything*

*There might **not** be **solutions** for **tricky** issues.*

MINUS

6.3

Check on the dashboard suggested solutions on how to fix errors (from the manufacturer and from other operators)

PLUS

*Good for specific issues and help me f**eel confident** because of the solutions from others.*

*If mine is the same as the suggested it would f**eel good.***

*I would like to have a **backup***

This is the nicest one

*Nice that it is also **from other operators***

INTERESTING

I don't know if many people would do this, but can be very helpful if available

MINUS