

Bachelor assignment

Design of a transparent interface

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Summary

PANalytical is a company that is specialized in creating analytical devices for all kinds of customers. They aim to be customer focused and innovative compared to their competition. One of the device PANalytical produces is the Zetium. The Zetium is a device that analyses material compositions using X-ray fluorescence technology. The software of the Zetium is controlled on a separate computer. PANalytical wants to combine the software on the Zetium into one device by placing an transparent interactive display technology on the transparent cover of the Zetium. There are other solution to combine the software and the Zetium, but placing it on the transparent cover appears to be the best option. If the Zetium is compared to the concurrent of PANalytical it turns out that the concurrent already combined the software with the device, but not with the innovative idea to use the transparent cover.

There are different kinds of transparent display technologies. LCD, OLED and projection. LCD is not suitable to use on the cover. Projection has a lot of flaws but is possible immediately but it will not be interactive. The most promising option is OLED, but the problem is that it is not really far developed and still very expensive. There are many kinds of input methods. The most promising at this moment is projected capacitive. In the future it would be attractive to use gesture input. In order to use non-interactive projection immediately some adjustments has to be made to the Zetium, so that a digiboard projector will fit into it.

By making sketches on the cover of the Zetium it turned out that blue and orange were the best colors to use in the new interface. Red must be used for warning signals. Out of all kinds of sketches four concepts appear to be most promising. One round design, one skeuomorphic design, one diagonal design and a clean design. Eventually the clean design seems to be the best concept to use as a final design with influences of the other concepts. This concept is eventually developed to a final design with all elements in it, that are needed to do an analysis of a material.

This design is unfortunately not suitable for the near future, because this interface will only be projected so it will not be interactive. It is also not extensive enough for the far future, because than more elements will be possible. That is why some scratches are made for this different time eras and these time eras are set out in a roadmap with associated technology and human interaction.

When the design is tested it turns out to be a promising design, with not that many flaws. It looks 'cool' and 'high-tech' on the cover of the Zetium. Unfortunately it also turns out that doing a large number of analysis on the cover is not very convenient because of the uncomfortable posture the user has to have while doing the analysis. Also typing vertically is not ideal. In the future something must be devised in order to solve these problems.

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Introduction

Ever saw the movie minority report? Tom Cruise controls several displays from a distance with just some movements of his hands. But these are not just ordinary displays, no these displays look like big windows. This is because the displays he uses are big transparent displays. Everything behind it is visible, but the display is still ready to work with. Imagine to have these transparent displays in real life and use them during your daily tasks or play with them during your workday. This would make your (work)day a lot more interesting wouldn't it?

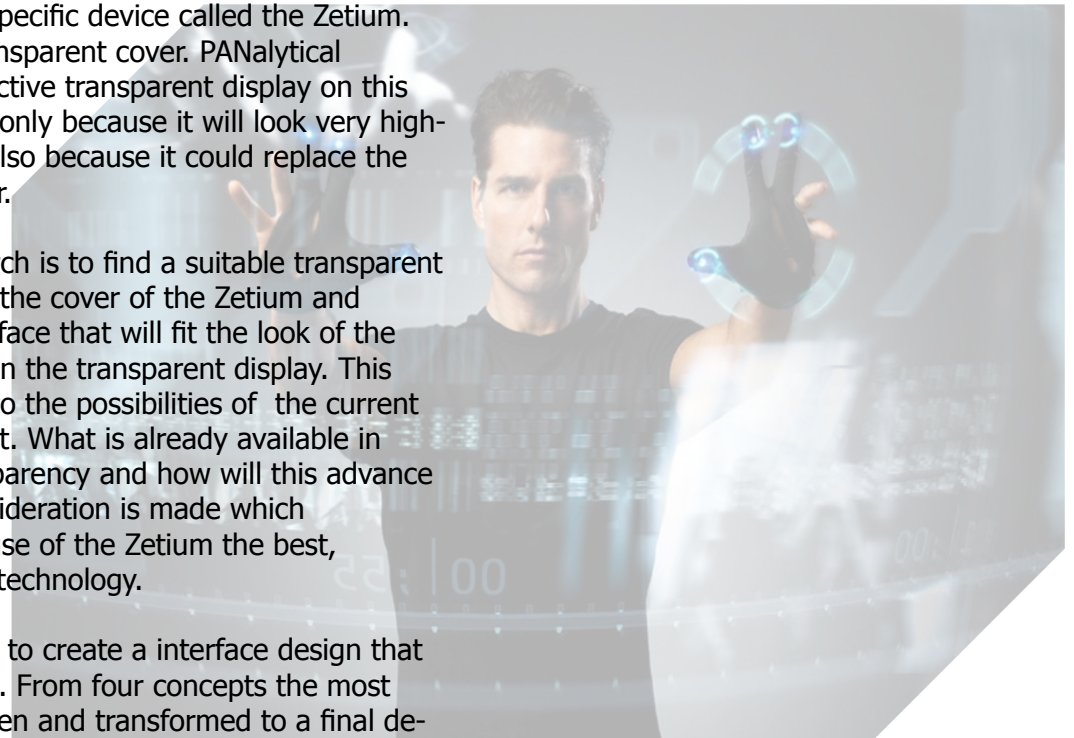
This is exactly what the company PANalytical thought when they came with the idea to use transparent displays on some of their devices. A specific device called the Zetium. This device contains a transparent cover. PANalytical wishes to have an interactive transparent display on this cover. They want this not only because it will look very high-tech and refreshing, but also because it could replace the use of an extern computer.

The purpose of the research is to find a suitable transparent display method to use on the cover of the Zetium and eventually design an interface that will fit the look of the Zetium and can be used on the transparent display. This is done by doing a study to the possibilities of the current transparent display market. What is already available in terms of interactive transparency and how will this advance itself in the future. A consideration is made which technology would fit the use of the Zetium the best, including a suitable input technology.

Eventually the intention is to create a interface design that fits the look of the Zetium. From four concepts the most promising concept is chosen and transformed to a final design. This is tested by experienced as well as inexperienced users. Also a comparison is made between the existing software and the new design.

But it turns out that the most suitable display solution is not currently available yet. That is why a roadmap is made. In this roadmap the different display and input solutions are expanded over the years. To every technology era, a design segment is linked.

To find out which displays the transparent display market has to offer and which design will make the cut, read the report.



Analysis

1.1 PANalytical

1.1.1 About

PANalytical is a company which creates analytical devices for a wide range of customers. It wants to create the possibility for people to get valuable insight into their materials and processes. It is the world leader in X-ray analysis systems with the an extensive product range. Elemental and structural information on their materials is obtained by using the combination of PANalytical's software and instrumentation, based on X-ray diffraction (XRD), X-ray fluorescence (XRF), near-infrared (NIR) and optical emissions spectroscopy (OES) and pulsed fast thermal neutron activation (PFTNA). In this report only XRF will be further explained, because only this method is important here. This is applied in scientific research and industrial process and quality control. The process of harnessing science to real world needs is central to PANalytical's activities and is achieved by working closely together with scientists and professionals in research and industrial laboratories.

PANalytical employs over 1.000 people worldwide. The company's headquarters are in Almelo (see Figure 1). Fully equipped application laboratories are established in Japan, China, the US, Brazil and the Netherlands. The research for PANalytical is done in Almelo and on the campus of the University of Sussex in Brighton. Supply and competence centers are divided all over the worlds as follows : Almelo (X-ray instruments and Eindhoven (X-ray tubes), in Nottingham (XRF applications and standards), in Quebec (fusion sample preparation) and Boulder CO (near-infrared instruments) (Panalytical, z.d.).



Figure 1

1.1.2 Values

The people at PANalytical keep in mind five values when working on different projects. These values are absolute integrity, empowerment, customer focus, restless innovation and high performance (see Figure 2). PANalytical's mission is to improve customers processes by delivering added value in analytical solutions (Panalytical, z.d.).

These values are the reason why PANalytical wants a transparent display on the Zetium. With their restless innovation it is inevitable that it wants to use the newest solutions available. With the upcoming use of transparent interfaces, PANalytical wants to be the first to use it on their devices, to stay up front with their competitors.

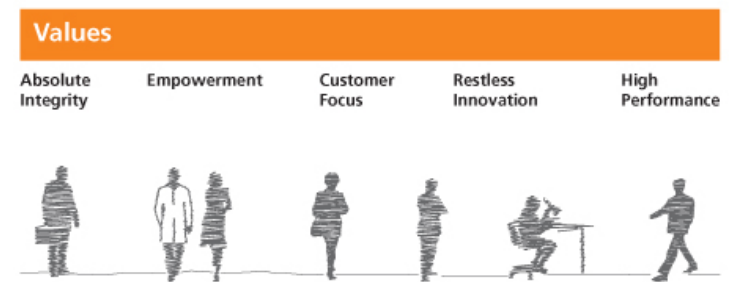


Figure 2

1.1.3 Customers

PANalytical's customers can be found in virtually every industry segment, from building materials, like cement industry, to pharmaceuticals and from metals and mining to nanomaterials. Customers can also be found in research practices, like laboratory and universities. Anywhere material processes are running. The customers use the products of PANalytical for example to set a maximum tolerance of a certain material or to get the highest yield as possible. Customers are not automatically the users of the Zetium. More on this in Chapter 1.2.



Figure 3

Analysis

1.2 Zetium

1.1.4 Products

PANalytical creates many kinds of analytical products. In this report this products will not be fully explained. A collage is shown in Figure 4 to get an idea of the appearance of the different products. Only the Zetium will be further explained in the next Chapter.

1.2.1 What it is

The Zetium is a device, produced by PANalytical, that analyses material compositions for companies. It can analyze all kind of materials from cement to polymers. After such an analysis companies get to know the composition of their materials. By knowing the composition of its materials companies can work more time and cost effective (Panalytical, z.d).

PANalytical sells an average of 300 - 350 Zetiums a year with a sales price of 100.000 - 160.000 each.

Zeto: to search
ium: element

1.2.2 Industry editions

The Zetium serves different kind of industries when it comes to analyzing materials. For these industries Zetium has different editions brought out. These industries are cement, metals, minerals, petro, polymers and ultimate. The Ultimate edition configuration meets the most demanding requirements regardless of industry (Panalytical, z.d.).

1.2.3 Elemental technology

Every aspect of the Zetium platform has been designed and engineered to deliver unrivalled analytical and operational performance, making it a true asset in environments that rely on accurate and dependable XRF analysis.



Figure 4

Analysis

The Zetium platform features PANalytical's new ultra-fast sample changer, allowing rapid batch analysis and seamless integration into automated environments. It also has a priority sample position, with sample presence detection, that allows the user to schedule urgent samples as 'next in line' in an active batch measurement. Some of the Zetium devices contain a barcode reader that allows rapid error-free manual input of a sample (Panalytical, z.d.).

1.2.4 How it works

The operation of the Zetium is based on X-ray fluorescence spectrometry (XRF). It is a non destructive technique used to identify and determine the concentrations of elements present in solid, powdered or liquid samples. The difference between XRF and XRD is that XRF determines the composition, so which elements does the material consist of and XRD determines the structure, so how are the different atoms arranged in the solid.

When sample atoms are irradiated with high-energy primary x-ray photons, electrons are ejected in the form of photoelectrons. This creates electron holes in one or more orbitals, converting the atoms into ions, which are unstable. Orbitals are the different layers in an atom. To restore the atoms to a more stable state, the holes in the inner orbitals are filled by electrons from outer orbitals. Such transition may be accompanied by an energy emission in the form of secondary X-ray photon, also known as fluorescence.

The various electron orbitals are called K, L, M etc. Each corresponds to a different energy level (see Figure 5). The energy of emitted fluorescent photons is determined by the difference in energies between the initial and final orbitals for the individual transitions. Wavelengths are inversely proportional to the energies and are characteristic for each element. In addition, the intensity of emission, with other words, the number of photons is proportional to the concentration of the responsible element in a sample.

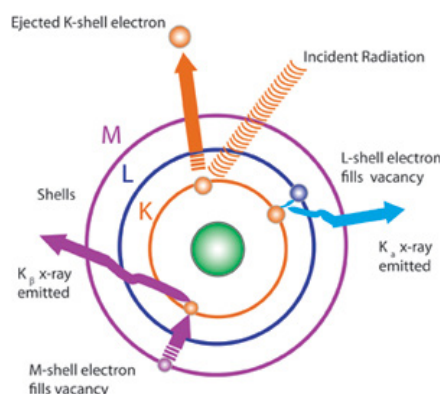


Figure 5

The detection system is a set of collimators, a crystal changer and a detector (see Figure 6). The x-rays coming from the sample fall on the crystal and the crystal reflects the x-ray with different wavelengths (energies) in different angles. By placing the detector at a certain angle, the intensity of the x-rays with a certain wavelength can be measured.

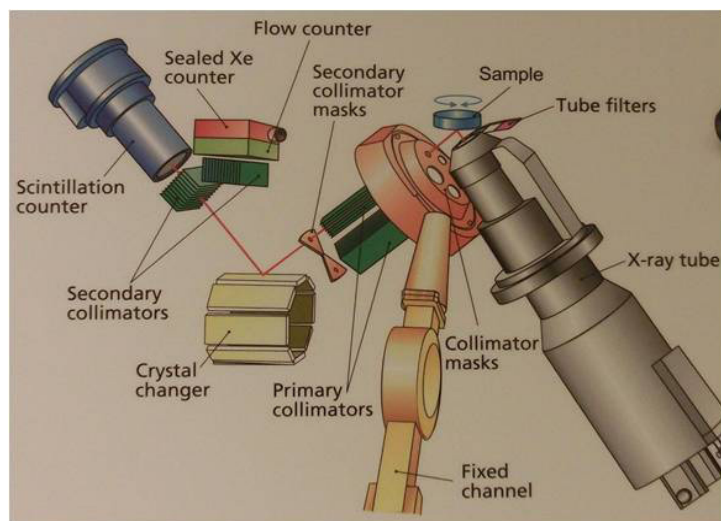


Figure 6

Analysis

1.2.5 Appearance

The appearance of the Zetium is shown in Figure 7. The Zetium has a fresh and clean look. All the vertical edges are rounded. The hood is made of transparent plastic. This plastic is PMMA, because this plastic is not very expensive and more scratch resistant than other plastics. The hood is a little bit blue. This is done because it fits the design and it provides the clean and bright look. PANalytical want to keep it this colour if it is possible.



Figure 7

1.2.6 Useful dimensions

The dimensions of the total transparent hood in front view are 85 x 54 cm. When the rounded corners and recesses in the hood are left out, only a flat space remains with the dimensions of proximally 69 x 42 cm. (So diagonal this is $422+692=6525$ $\sqrt{6525}=80,8$ cm = about 32 inch). On this space the transparent interface will probably be placed in the future. See orange square in Figure 8.

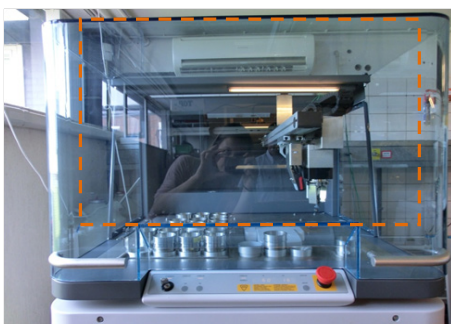


Figure 8

1.2.7 Analysis

The analysis is controlled by using special software on a separate computer. When a material is analyzed, first a sample has to be prepared. This is done by another machine and most of the time by another person than the one using the Zetium (more on this under 'User'). When the sample is prepared the user can put it in a special sample cup and into the Zetium. These cups are placed on a tray which can carry these cups, so the user can easily carry them to another place in one time. When the cups are placed in the machine the cover has to be closed, otherwise the Zetium cannot start an analysis. When this is closed the user chooses a measure application (see blue square in Figure 9).

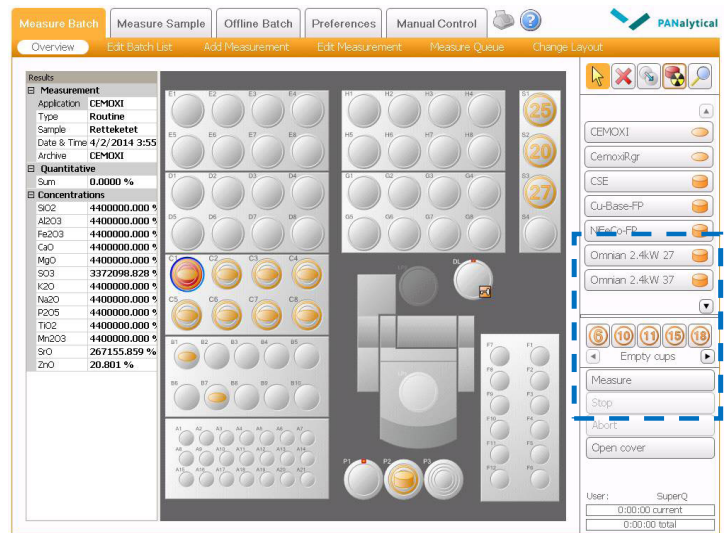


Figure 9

After this the samples can be notified, which means that the user chooses the right circle, so the circle where the sample is placed in the Zetium, on the software by clicking on it, now the system knows there is a sample on this particular place. Click on the specific circle and a new window appears (see Figure 10). In this window the name of the sample has to be filled in. Another value that often has to be entered is the weight or the concentration of the element. This is determined beforehand when the sample was being prepared. First the initial weight is important, so the weight of the test sample, also the flux weight, so the weight of substances added to prepare the sample and the total weight of the sample. This weight/concentration is important because most of the time at the sample preparation wax or glue is added to the sample.

Analysis

The machine also measures these additions so if it is not mentioned the measurement will give false results.

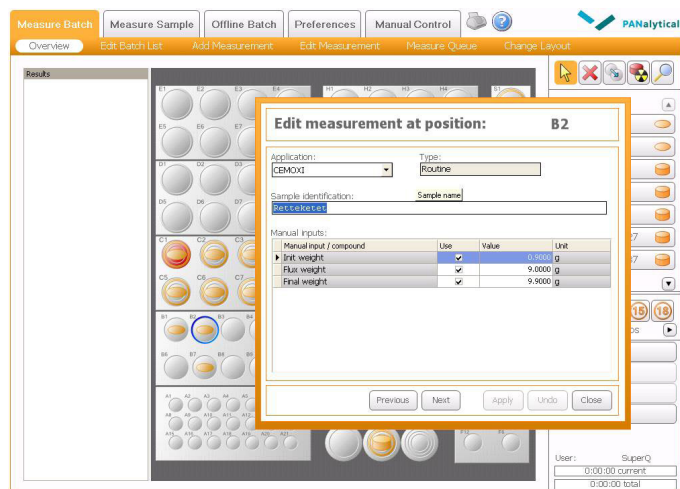


Figure 10

It is also possible that the sample includes a barcode. On the Zetium grabber a barcode scanner is sometimes included. If the sample contains a barcode the operator does not have to fill in anything because this barcode provides all information needed for an analysis. He only has to place the sample, enter in the software where it is placed in the machine and press start. Right now the measurement can begin, so measure must be pressed (see blue square Figure 11). Two loading bars appear, one for the remaining time of the current sample and one for the remaining time of the whole measurement (see orange square Figure 11).

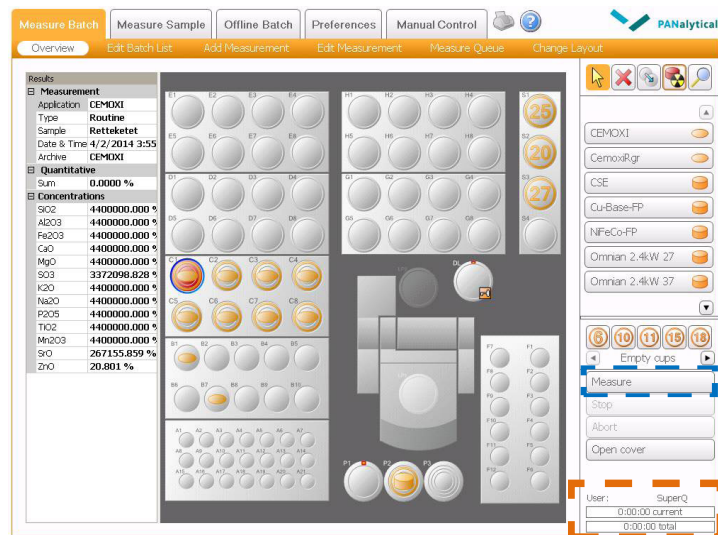


Figure 11

Now it is a matter of waiting until the Zetium is done analyzing, this analyzing time is different for every sample and depends on the kind of material and composition. During this analysis interim test results can be displayed on the screen shown in a graph as well as a table. In Figure 12 an example of the table is shown. This list of test results is also the outcome of the analysis, together with a qualitative analyses and calibration.

Results	
Measurement	
Application	CEMOXI
Type	Routine
Sample	Retteketet
Date & Time	4/2/2014 3:55:4
Archive	CEMOXI
Quantitative	
Sum	0.0000 %
Concentrations	
SiO2	4400000.000 %
Al2O3	4400000.000 %
Fe2O3	4400000.000 %
CaO	4400000.000 %
MgO	4400000.000 %
SO3	3372098.828 %
K2O	4400000.000 %
Na2O	4400000.000 %
P2O5	4400000.000 %
TiO2	4400000.000 %
Mn2O3	4400000.000 %
SrO	267155.859 %
ZnO	20.801 %

Figure 12

In appendix A this process is pictured in several steps.

1.2.8 Specialties

Maximum value

It is possible to set a minimum and/or maximum value for the concentration of a certain element. When the Zetium measures a value outside these boundaries, it will give a warning signal. This warning signal looks the same as the error message shown in Figure 14 on the next page. This function is not used by the operator of the machine, but is done by the lab manager. Because this project focuses on the use of the Zetium itself, the question of how setting these boundaries is done is not important for this analysis.

Analysis

Zoom

On screen a cut out can be made of the most important samples inside the Zetium. See Figure 13. The letter/digit combination of the sample indicates its location in the Zetium. So for example A1. In this way its more clear where which sample is placed. Only in this zoom image the names of the samples are displayed.

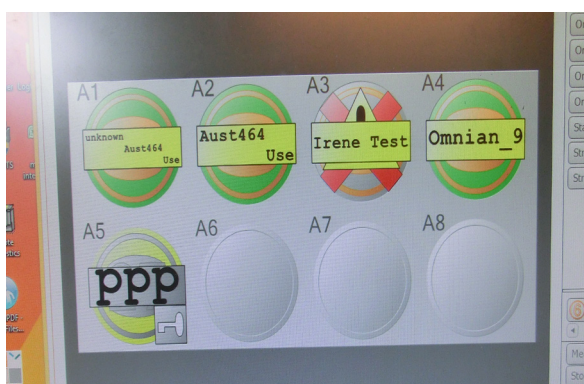


Figure 13

Error messages

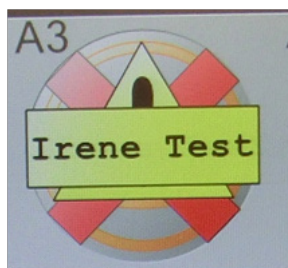


Figure 14

When something is wrong an error appears. In Figure 14 an example is shown of what this error looks like. This error message appears for example when the Zetium misses a sample when grabbing it, because the sample is placed wrong or something like that. An error

message also appears when the maximum value of a sample is exceeded like mentioned in paragraph 1.2.8. The message will always be displayed with a red cross. When the mouse hovers over the cross, more information about the problem will appear.

Open cover

In the software there is one button called "open cover". This button will blink when the hood of the Zetium is open. If this is the case the analysis will not start. Another possible way to use the button is by clicking on it when the hood is closed. Then the grabber will move to its origin of the Zetium so that the user can easily reach the different samples.

Priority position

Samples can be put in the priority position. This is done when the user wants to measure a certain sample, before all other samples. This are the three places in the front of the Zetium (see orange square Figure 15). When this is the case a pop up will appear in the software (see Figure 16).



Figure 15

Now the name and weight or concentration has to be entered just like doing a normal analysis. This position is also used to Park a sample when it is not needed for a moment. This is done by the grabber itself.

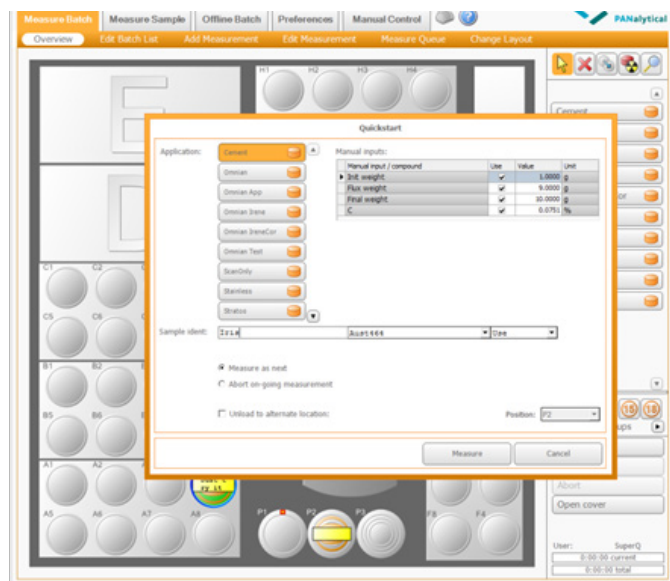


Figure 16

Analysis

Measurement options

The user has to choose a measurement application to fill in the weight or concentration. The type of measurement applications are different for every company. The customer can set and program these options itself. So the number of options also varies and with that the size of the bars where the text is in. These are scalable.

More possibilities

The software has a lot more options and possibilities but in this analysis only the most important functions are needed, to go further in the project.

Trays

There are 4 kinds of trays. One with 8 samples, one with 10 sample positions, one with 12 samples and one with 21 sample positions. The type of tray can also be chosen on the screen. The user can arrange the screen himself in this way.

Buttons

The five buttons shown in Figure 17 all have their own function. From left to right:

1. Use arrow to select things
2. Remove sample
3. Move sample to other position keeping all the information
4. Measure sample immediately keeping information. (A sample that is already measured)
5. Zoom



Figure 17

When using touchscreen, option 1 and 5 are no longer needed, because it can be solved in a different way. More on this later in the Final Design.

1.2.9 User

The user of the Zetium is an employee of the earlier mentioned customer companies. The user gets the samples already prepared from a different department. He only has to put the samples in the machine and sign them in on the right place. The user is experienced with the software and knows what he has to fill in and how. This is a reason that the software does not have to be extremely intuitive. The users work with it every day so gets to know the software very quickly. The user gets all the information about what he has to enter into the software on paper. He does not know anything about the material and its composition, because he did not prepare the sample. The user just has to fill in the name and the weights/concentrations of the sample. Only in some research situation the user also prepares the samples, but most of the time this is not the case.

The Zetium will stand in a safe environment so the user does not have to wear big gloves. It is possible that he will wear latex gloves or thin fabric gloves. The operator most of the time is not in the room where the machine is doing its job. He will now and then check how far the process is with running the analysis. So it will be convenient when the loading bar is clearly shown on the machine and visible from a distance so that the operator does not have to go all the way to the computer. Another solution will be that the operator gets a message somewhere when the machine is done. This way he does not have to check at all.

1.2.10 Transparent interface

Now the question is, why does PANalytical desires a transparent interface on some of their devices and especially on the Zetium. The first simple answer PANalytical gave to this question was, "Just because it is possible". Transparent displays are upcoming and the Zetium already has a transparent cover, so why not? PANalytical really wants to replace the computer screen by a more effective way to use the software and wants to give a possibility to put it all together in one device. This will probably be more time and work efficient. In the next paragraph some other options to replace the computer are listed to see if a transparent interface really is the best solution for PANalytical.

Analysis

1.3 Other solutions

1.3.1 Introduction

When you take a look at the use of the Zetium, using a transparent display on the cover is not the only possible solution to replace the computer. In this paragraph some other options for replacing the use of the computer are highlighted.

1.3.2 Tablet

An option to replace the use of the computer is using a tablet. On this tablet the same kind of software is used as on the computer (see Figure 18). Some adjustments must be done to this software, because this software will cause some problems when it is used on a tablet, like for example too little space for the use of touch screen and unreadable lettering. The tablet can be brought everywhere, so that the user can control and keep an eye on the Zetium from a distance and even from another room. It is very easily manageable and the operator can use it in every position and take it everywhere with him. See figure 18 for an example.

Advantages:

- It is portable.
- The operator can follow the process from a distance and even from another room.
- It is maneuverable and easy to take with you.
- Easy to use, most people know how to use a tablet.

Disadvantages:

- It is very easy to lose. Especially in a busy work environment. Purchase a new tablet every time it gets lost is very expensive.
- The screen is very small compared to a computer screen. Therefore the readability can be poor.
- Adjusted software must be made. This is very expensive.
- Tablets are often not very energy efficient. This means that the operator has to charge it probably a few times a day.



Figure 18

1.3.3 Screen integrated with the Zetium

This idea is kind of a copy of the competitor Bruker (see Chapter 1.4). The idea is a small screen attached to the Zetium. This can be for example be attached to the panel on the Zetium (see Figure 19). This way the user does not have to switch between two devices but can do everything on one machine. The screen is probably a little bit small, because otherwise it will get in the way with the actual use of the Zetium itself, like changing the samples. This smallness results in the fact that the user cannot follow the process from a distance. He has to go to the device to check if it is going well. The smallness also results in a bad readability, so the software has to be adjusted to this new screen size.

Advantages:

- The user cannot lose it because it is attached to the Zetium.
- Software use is integrated with the use of the Zetium.
- One device required for almost everything
- Touch screen is easy to use.

Analysis

Disadvantages:

- No freedom in positioning. The screen has a fixed position relative to the Zetium
- Small and difficult to read
- Complicated system has to be built in the Zetium instead of using the software on existing systems, this will probably be very expensive.
- It can be in the way when using the Zetium (for example when opening the cover)
- The user has to walk all the way to the device to check its status.



Figure 19

1.3.4 Projected on the wall behind the Zetium

In this idea the interactive screen will be projected on a wall or other surface close to the Zetium. In this way the screen can be projected in any size. So if the user is near by it can be small and if the user is far away he can project it big so he can read the status of the analysis from a distance. If the projector is turned out, the wall is empty again. See Figure 20 to get an idea of this option.

Advantages:

- Lots of screen sizes possible. This depends on the size of the projected surface.
- Users can see the process of the analysis from a large distance.
- Probably not tried by similar companies before.
- No adjustments to the Zetium have to be done.

Disadvantages:

- Limited situation possibilities. Only possible when the Zetium stands for a plain empty wall.
- Not very easy to use.
- The position the user when handling the software is not very convenient.
- The idea is a bit devious when focusing on solving the problem.
- Software must be adjusted to work on the projection.
- Additional component needed, the projector.



Figure 20

Analysis

1.3.5 Making one side of the Zetium opaque

By making one side of the transparent cover of the Zetium opaque the software can be displayed here (see Figure 21). This way the display is integrated with the Zetium without occupying any extra space. The display will be readable very well, because it is opaque and has the same size as a computer screen. When the cover is open, the screen cannot be used, so the cover always has to be closed. It will not be beneficial for the design of the Zetium. One side of the cover will not be transparent anymore, it will look less clear and the user can only look into the device from two sides.

Advantages:

- The user cannot lose it because it is attached to the Zetium.
- Not causing extra space, so it will not get in the way.
- Interface close to the machine.
- Readable size of the screen.
- Touch screen is easy to use.
- Use one device.

Disadvantages:

- Only useful when cover is closed.
- Not suitable with the look of the Zetium.
- Reduced sight into the device.
- Too small and strange angle to see status from a distance
- Adjustments to the Zetium have to be done.
- When cover is open, no interaction possible



Figure 21

1.3.6 Transparent interface

Using a transparent interface is the most innovative way to replace the use of the computer. The software will be displayed on the transparent cover of the Zetium (see Figure 22). This software has to be adjusted to work on and fit the look of the Zetium. This option will not cause any extra space because it will be imbedded in the device. There is a change that the readability will be poor because transparency can result in low contrast. It will be a difficult task to find a display option that works on the cover of the Zetium.



Figure 22

Advantages:

- The user cannot lose it because it is attached to the Zetium.
- Innovative (suits value of PANalytical)
- Most certainly not tried by similar companies before.
- Not causing extra space, so it will not get in the way.
- Beneficial for the look of the Zetium.
- Status of analysis visible from a distance.
- Touch screen is easy to use.
- Use one device

Disadvantage:

- When cover is open, no interaction possible
- Readability can be poor caused by transparency and low contrast.
- Software must be adjusted to fit the look of the Zetium and to work on a transparent screen.
- Adjustments must be made to the Zetium itself.

Analysis

1.4 Concurrent

1.3.7 Conclusion

Looking at the advantages compared to the disadvantages it is obvious why trying a transparent interface on the Zetium is a very good idea. Mainly because being innovative and advanced compared to other companies is very important for PANalytical, but also for other reasons like saving space and following the process of the analysis from a distance. The disadvantages are less important compared to the advantages, especially since most disadvantages also occur in the other ideas and some advantages do not. It will be a challenge to find a transparent display that will work on the cover of the Zetium. This will be further examined in this report. In Chapter 1.4 is told what can be learned from the concurrent of PANalytical.

1.4.1 Introduction

In this paragraph a concurrent of PANalytical is researched. Their products are compared to the Zetium and a conclusion is made about striking things.

1.4.2 Bruker

One of the competitors of PANalytical is Bruker. This company covers a broad spectrum of applications in all fields of research and development. Its systems are used in all kinds of industrial production processes focused on ensuring quality and process reliability. Being one of the world's leading analytical instrumentation companies, Bruker wants to meet its customer's needs and develop innovative solutions for today's analytical questions. Bruker is the first company that offers touch control on analytical instrumentation. One big advantage of touch control is how easy and quick it is for the daily operator to use the instrumentation (Bruker, z.d).

1.4.3 Products comparable to the Zetium

Two products of Bruker that resemble the Zetium are the S8 Tiger and the S2 Ranger.

S2 Ranger

The S2 Ranger performs multi-element analysis from Carbon to Uranium in solids, liquids and powders, with little or no sample preparation. It is an all in one solution for elemental analysis. Plug and play technology, everything is in the S2 ranger. X-ray tube, vacuum pump, the computer and it even prints out the results of the analysis with a small printer (see Figure 23).



Figure 23

Analysis

It is very low cost. Low cost of ownership, low cost of maintenance and low cost of running. Because of little moving parts in the device, little maintenance is required. It has a very intuitive touch screen panel, integrated with the machine. The software comes in different languages and is very easy to learn (Bruker, z.d).

S8 Tiger

The flexibility of the tiger provides with one instrument you can measure every element from Boron up to Uranium. A multiple sample changer allows the user to put different samples in different positions. The reliability of the Tiger is very high because of many safety solutions. The S8 tiger has a small touch screen panel at the side of the device. The software is very intuitive. Put the sample into the instrument, choose the application, type in sample ID and press measure (see Figure 24) (Bruker, z.d.).



Figure 24

1.4.4 Differences in use

The first very noticeable difference between the Zetium and Bruker's products, is that in Bruker's products the display is integrated in the machine. In the Ranger even a little printer is included. This means that the products of Bruker are more all in one devices, no extra hardware is necessary when using it. With the use of the Zetium, the operator always needs an extra computer, no matter what the task implies. The advantage of Bruker is that the operator does not have to switch between two devices, a disadvantage is that the displays are relatively small. Especially on the S8 Tiger. This means that the software will be displayed small and this may have a negative effect on the readability and the ease of use of the software.

In Figure 25 is shown what the main screen of Bruker's software looks like. Bruker also works with little rounds that represent the different samples. Other than some design details like color and use of signals the software is quite similar to the software used with the Zetium. When the name or weight has to be entered, a keyboard appears on the touch screen panel.

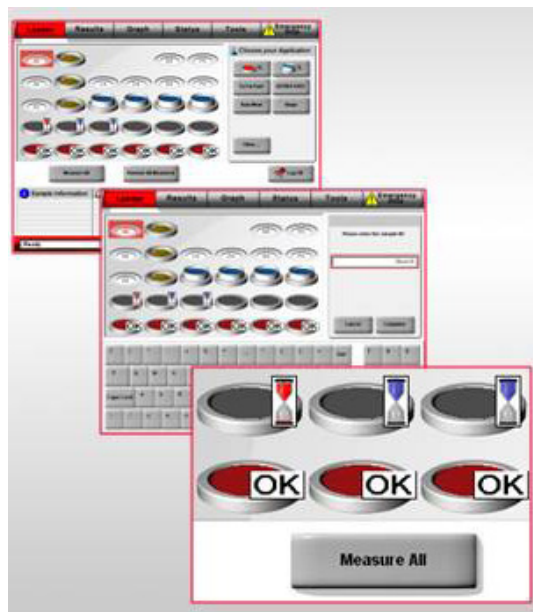


Figure 25

It is remarkable that also Bruker did not choose for a removable tablet, but kept the display stuck to the device. PANalytical indicated that using a tablet is not convenient, because loose tablets quickly get lost in the workplace. It is likely that Bruker has the same reason to keep the displays attached to the machine.

1.4.5 Conclusion

So looking at Bruker it is noticeable that it is convenient to combine the machine and the display, so that the user does not have two switch between to devices. Bruker also did not choose to use removable tablets, this confirms to question the use of this method and if this will work on a daily basis.

What needs to be taken into account is the fact that an integrated display has to stay readable. So it is not a very good idea to just project the current software on the Zetium. Because of the transparency the readability will decline. A new software should be developed that will match the machine and does not suffer from the transparency of the screen.

Analysis

1.5 Scenarios

Now that the best replacement option is specified, some scenarios are made to highlight the advance of a transparent interface in the future. In appendix B two scenarios are pictured comparing the situation as it is right now, and the situation how it should be when using a transparent interface on the cover of the Zetium. One scenario is about error messages and one is about the going back and forth between the Zetium and the computer.

When looking at the warning signal scenario it is obvious that placing the warning signal big on the cover will improve the response time of the user. When the warning signal is giving on the computer the Zetium stands still for a long time and this is a waste of time.

The conclusion that can be made when looking at the back and forth scenario, is that switching between the computer and the Zetium is almost the same for both when the user has to do advanced settings. It will be convenient in the future when all the settings can be done on the Zetium, so that a whole analysis can be done here. Only then it will be an advantage to place the interface on the cover.

1.6 Technologies

1.6.1 Introduction

In this chapter all kinds of technologies when it comes to transparent displays are discussed. This way more insight into the possibilities of transparent use of the Zetium is highlighted. In Chapter 3.3 these findings are represented in a roadmap. That is why it is important that all methods for creating the perfect transparent interactive display on the cover of the Zetium are researched.

First three kinds of display technologies are discussed; LCD, OLED and projection. After this a few concrete examples of existing transparent displays are listed. Finally several touch and gesture input technologies are discussed to show what are the possibilities when it comes to controlling the interface.

1.6.1 Display technologies

To get an understanding of the principles of the several transparent solutions, the different technologies are explained. Eventually more information is given, about what each technology means for transparency.

LCD

What it is

A liquid crystal display is a flat panel with low energy consumption. It is a "transmissive" display, meaning it is not its own light source but instead relies on a separate light source and lets light pass through the display into the watchers eye.

How it works

LCD panels use a very thin lamp called "back light", which is placed directly behind the LCD panel. This light passes through a polarizing filter, this is a filter that aligns the light waves in a single direction. Then the polarized light passes through the actual LCD panel itself. The liquid crystal portion of the panel either allows the light to pass through or blocks the light from passing through, depending on how the liquid crystals are aligned at the time the light tries to pass through (see Figure 26). The panel is split up into tiny individual cells that are each controlled by a tiny transistor to supply current. Three cells side by side each represent one pixel of the image. The three cells have three colors, red, green and blue. These three colors can, when combining them, create all other colors.

Analysis

The three cells per pixel work in conjunction to produce the right color. For example, when a pixel needs to be white, each transistor that controls the three color cells in the pixel would remain off, so allowing red, green and blue to pass through completely. Your eyes see the combination of the three as white. When the light has to be purple the transistor for the green cell would turn on, thus allowing only red and blue to pass through in that pixel (Wikipedia, z.d.).

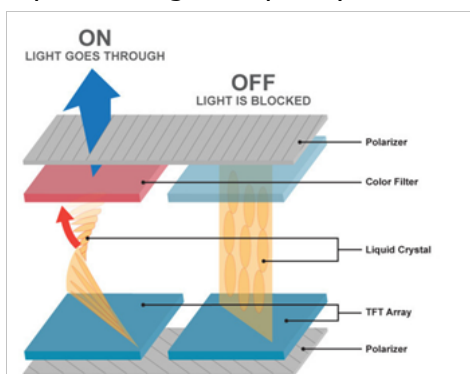


Figure 26

TLCD

Normally, LCD displays are incapable of being see-through because of their thickness and inability to emit their own light. However some LCD screens use natural lighting like the sun instead of electrical back-lighting. The lack of backlight allows the screens to be thinner as well as see-through. LCD screens are made of silicon and absorb most lighting. LCD displays need a polarizer, but when this is used the permeability decreases. See-through LCD screens are cheaper than OLEDs, but their use is more restricted because of the natural lighting.

When it comes to the use of color on a transparent display every color is possible, except for white. With a LCD screen the color white means that all the light passes through, because all colors together make white. With a transparent display when all the light passes through, this means total transparency, so instead of white you will see only blank transparency, like a normal window. Black means that no light passes through, so when all the transistors are turned on. So the color black is possible.

OLED

What it is

Organic Light-Emitting Diodes are solid-state devices composed of thin films of organic molecules that create light using electricity. OLEDs can provide brighter, crisper displays on electronic devices and use less power than conventional LEDs or LCDs. It does not have to be backlit, because it creates its own light.

How it works

An OLED is a solid-state semiconductor device that is 100 to 500 nanometers thick. OLEDs have two layers of organic material. An OLED consists of 5 parts (see Figure 27). First the substrate which supports the OLED, then there is the anode. This part removes electrons, so it creates an electric "hole", when a current flows through the device. On top of this the two organic layers are placed, a conducting layer and an emissive layer. These layers are made of organic molecules or polymers. The conducting layer is made of organic plastic molecules that transport the "holes" from the anode. The emissive layer is made of other organic plastic molecules that transport electrons from the cathode. This is where the light is made. At last the Cathode, this part injects electrons when a current flows through the device.

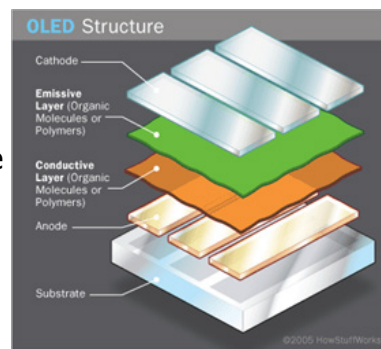


Figure 27

OLED emits light through a process called electrophosphorescence. First an electrical current flows from cathode to anode, through the organic layers, giving electrons to the emissive layer and taking electrons from the conductive layer, leaving holes in the conductive layer that need to be filled with the electron from the emissive layer. As the electrons drop into the holes, they release their extra energy as light. The color of the light depends on the type of molecule in the emissive layer. Manufacturers place several types of organic film on the same OLED to make color displays. The intensity of the light depends on the amount of electrical current applied, the more current the brighter the screen (Freudenrich, z.d.).

Analysis

TOLED

Transparent OLEDs only have transparent components. When turned on this transparent components are up to 85% as transparent as their substrate. When a transparent OLED display is turned on, it allows light to pass in both directions (see Figure 28). When it comes to the use of color, all colors are possible except for black. The color black means no light, because black light does not exist. But when an OLED pixel is turned off, so no light is created the screen will be blank transparent instead of black, caused by the transparent components. The color white can be created when using all the colors of light.

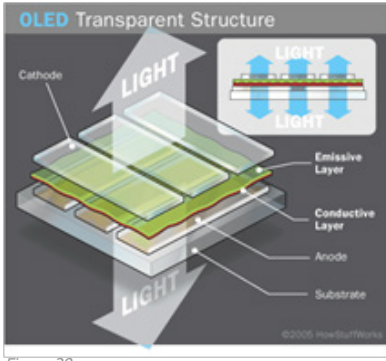


Figure 28

possible except for black. The color black means no light, because black light does not exist. But when an OLED pixel is turned off, so no light is created the screen will be blank transparent instead of black, caused by the transparent components. The color white can be created when using all the colors of light.

Projection

What it is

Projection is a way to display an image on a specific surface with the use of light.

How it works

To understand how a projector works, it is best to start at the beginning with a beam of light and end on the projected surface (see Figure 29). So first a powerful light source emits a beam of intense white light. Secondly the beam of white light bounces off a group of mirrors that includes two dichromatic mirrors, which are coated in a special film that reflects only a specified wavelength of light. The same principle as with a prism applies here, only every dichromatic mirror breaks off a single specified wavelength. So when the white light hits the mirrors, those each reflect a colored beam of light, one red, one blue and one green. These beams pass through three different liquid crystal displays composed of thousands of tiny pixels. These LCD screens allow the light to go through or blocks it. All three of the LCD screens display the same image, only in gray scale. When the colored light passes through these three LCD screens, they relay three versions of the same scene, one tinted red, one tinted green and one tinted blue.

Inside the projector the three tinted versions of this scene recombine in a dichromatic prism to form a single image composed of millions of colors. At last the light of this vibrant, colorful version passes through a projector lens and on to the screen (Lamb, z.d.).

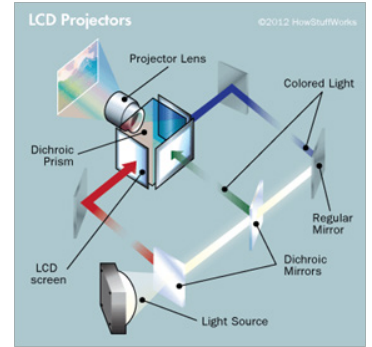


Figure 29

Transparent projection

To project on a transparent screen a holographic rear projection film is needed. This film is specifically designed to be projected on from backside of the viewing surface. The projection will then be mirrored. The composition of the film allows it to capture the majority of projected light and making the most of the projector brightness providing bright, crisp HD digital images right on the existing glass.

When it comes to the use of colors on a transparent projection, all colors are possible except for black. A projector cannot project black, because black light simply does not exist. So when you use black on a transparent projection this will give a blank transparent result. White can be used, because all colors together create white.

1.6.2 Transparent display examples

In this section the different findings of existing transparent display solutions are listed. In appendix C a total overview of all the found displays can be found. Three existing solutions are further explained in this section. One OLED example, one LCD example and one projection example.

Projection - Vislogix EZtouch Window

EZ touch is an interactive projection on glass or other transparent surfaces. It allows real time multi-touch interactivity directly to the glass with any mouse-driven content (see Figure 30). It consists of a special laminate that contains both the holographic optical rear projection foil and the interactive through-glass touch film which is a mutual capacitive multi-touch screen that senses a users touch up to 0.75" through existing glass.

Analysis

The laminate is applied to the back of the glass with a special oil Vislogix provides so no adhesives are necessary.



Figure 30

The projector is always placed behind the display. Vislogix manufactures the holographic projection foil to accept the projected light from one of 3 possible angles depending on spatial restrictions. The light is then refracted much like a prism to the viewer, while any opposing light is disregarded by the screen. As a result the screen can be used in virtually any sort of illuminated situation. The projector needs to be connected to the source that is used. If the screen will be interactive it must be connected to a computer. The technology does work on PMMA but the touch is not as conductive through plastic as it is through glass so it should be avoided if possible and if not possible, keep to a maximum of 1/4" thickness. The holographic projection foil is Vislogix' proprietary technology. The integrated touch is a third party product (Vislogix, z.d.).

The cost for a transparent 32" screen will be \$7,602 for 2-Touch and \$8,444 for a 20-touch screen. A non-interactive one will cost \$3,728.

LCD - MMT Hypebox

The MMT Hypebox is a display box that uses a transparent interactive LCD panel. The panel consists of three layers. From outside in a multi-touch unit, safety glass and the transparent LCD (see Figure 31).

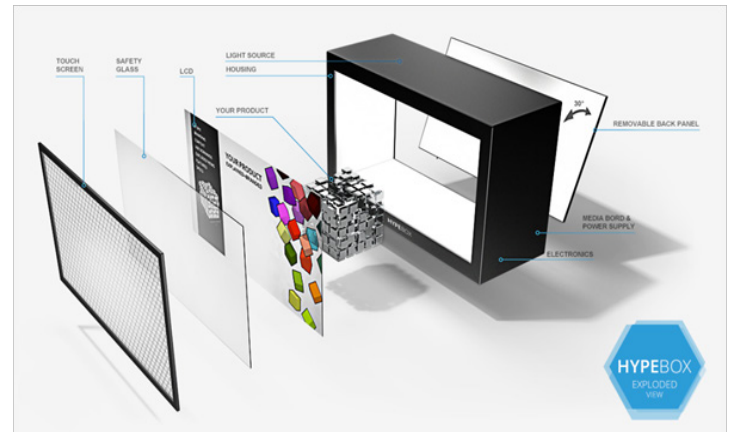


Figure 31

The panel is usually delivered together with the display box. This is because LCD technology requires a very strong backlight in order to correctly display images on the panel. The Hypebox has optimized internal illumination. It is possible to use only the panel, without the box, but there is a great change that the display will not be completely transparent when it is not properly backlit (see Figure 32). Without a proper backlight the screen will be dark, products behind the panel will look dark and images on the screen will look dark as well with bad color and low quality. Too much light means that images will be "burned" by it, with too much bright colors and undefined borders. In Figure 32 also is visible that there will always be a frame around the panel. This is both for protection as well as to use the touch screen panel (MMT, z.d.).

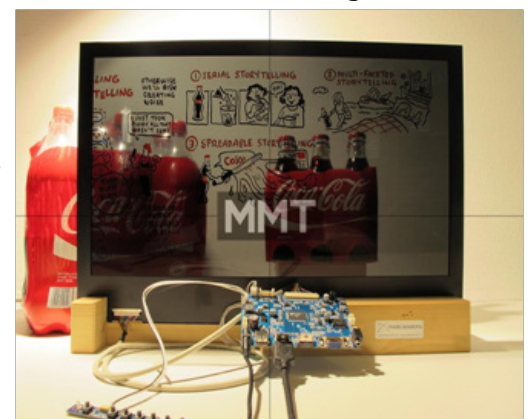


Figure 32

The color white does not exist on this display. The color white will be transparent, while black and most other colors will be strongly visible. The capacitive touch screen is very advanced with a resolution of 32768 x 32768, ultra precise touch recognition and up

Analysis

The costs of only the panel are €1350 for a single 32" panel. As the quantity increases the price will drop to €539 for a quantity of 100-199. The LCD panel has a weight of 15 kg so it is very heavy.

OLED - PLANAR

Each pixel in the transparent OLED display includes red, green and blue sub-pixels and open or clear area which enables transparency. The off-state of the screen looks like smoke glass or tinted windows. The user can place a light behind the screen, to light up the physical objects behind the screen, but this has no effect on the overall color or brightness of the display. Content of transparent OLED works oppositely of how it does on LCD panels. When the transparent OLED display lights up, it blocks the view of the items behind the display. White or bright content like the car in Figure 33, will be opaque and will shine from the screen and appear in the foreground. When it is turned off the display is clear. Black or dark content will be see-through.

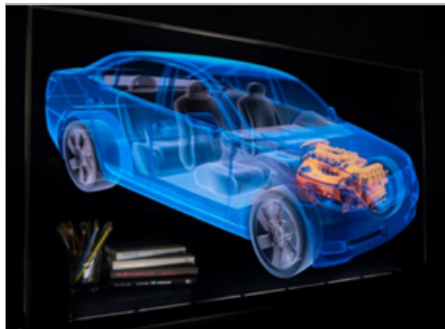


Figure 33

Figure 34 shows that the pencils are visible and the titles of the books can still be read clearly, even though the display is on. Objects dozen of meters behind the display are viewable. This opens up possibilities for room dividers and other applications.



Figure 34

As shown in Figure 35 text on the front of the screen, appears reversed on the back. Objects or scenes behind the display (in this case, the flower arrangement) is reflected on the back surface of the display, but does not fully obscure the content image (the lipstick).



Figure 35

OLED is still a very expensive solution because it is new and not yet highly developed. There is no cheap process for creating the transparent OLEDs yet.

In appendix D an overview of the advantages and disadvantages of these three examples can be found (Planar, z.d.).

Conclusion

When the information, the examples and advantages and disadvantages are compared a conclusion can be made about the fact which technology will work best on the Zetium.

Projection is a technology that is very easy to apply. It can be used everywhere. Just a holographic layer is needed to project the image on, because it is not possible to just project something on the glass. Also the interactive thru-glass touch film to make it interactive. The problem is that making this film is very expensive and taken this in account it will not stand up against the disadvantages projection has, like a hazy image. It is also the question where to place the beamer, because when it is placed in the back of the Zetium, the grabber will constantly move in front of the lens and this will interrupt the projection. Concluding this is a good options when the screen does not have to be interactive and a place is found for the large beamer.

LCD is attractive because it is relatively cheap and the technology is proven, including touch screen possibility. However, the screen needs to be backlit properly otherwise the screen will be dark, it will always have a frame around which is undesired and maybe most important, it is very heavy, so the cover will be heavy when it is attached. LCD is not a suitable solution for the cover. OLED is probably the best solution, however, it is not very far in progress. It is very promising, because it is light, frameless and easy to apply because it is very thin. It has its own light so this will not be a problem either. It is now very expensive, but this is also because there is not found a efficient way to produce it. OLED is still in upcoming, but when this technology is more elaborated and cheaper it will be a perfect solution to use on the cover.

Analysis

1.6.3 Input methods

When it comes to technologies for the future use of the transparent cover as a display, choosing an input method is also very important. There are several kinds of input possible when it comes to touch and gesture, and they all have their advantages and disadvantages. To get an understanding of the several touch screen methods, some methods are described in short. Eventually the pros and cons of the several methods are listed in a overview, which can be found in appendix E.

Resistive

This technology is used in a wide range of small to mid-sized devices, including smartphones, mobile phones, PDAs, car navigation systems and Nintendo DS. With this method the changes in pressure will be detected at the position the screen is pressed. As shown in Figure 36 the monitor exists of a simple internal structure. There is a layer of glass screen and a film screen separated by a narrow gap, each with a transparent electrode film attached. When the surface is pressed, the screen will press the electrodes in the film and the glass to come into contact, resulting in the flow of electrical current. The point of this contact is identified by detecting the change in voltage (Eizo, z.d.).

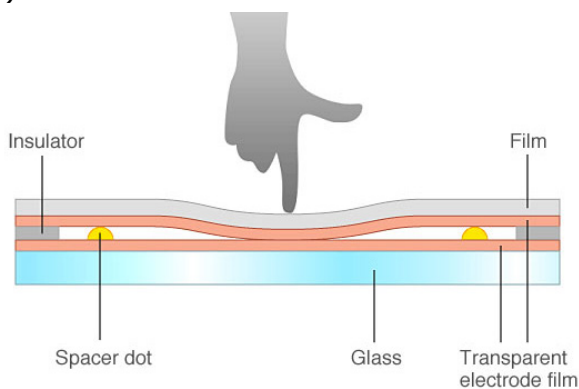


Figure 36

Capacitive

Capacitive touch screen panels represent the second most used sensing method after resistive panels. Aside from standalone LCD monitors, this capacitive method is often used in the same devices as resistive panels, like smartphones and mobile phones. With this method, the point at which the touch occurs is identified using sensors that sense little changes in electrical current generated by contact with a finger or changes in electrostatic capacity (load). There are two types of capacitive touch panels, surface capacitive and projective capacitive touch panels (Eizo, z.d.).

Surface Capacitive

These are often used in relatively large panels. Inside these panels, a transparent electrode film is placed on top of a glass substrate, covered by a protective cover. Electric voltage is applied to electrodes positioned in the four corners of the glass substrate, generating a uniform low-voltage electrical field across the entire panel. The coordinates of the position at which the finger touches the screen are identified by measuring the resulting changes in electrostatic capacity at the four corners of the panel (see Figure 37). This type of capacitive touch panel has a simpler structure than a projected panel and is therefore also cheaper. But because of this it is also difficult to detect contact at two or more points at the same time, so multi-touch is less easily possible (Eizo, z.d.).

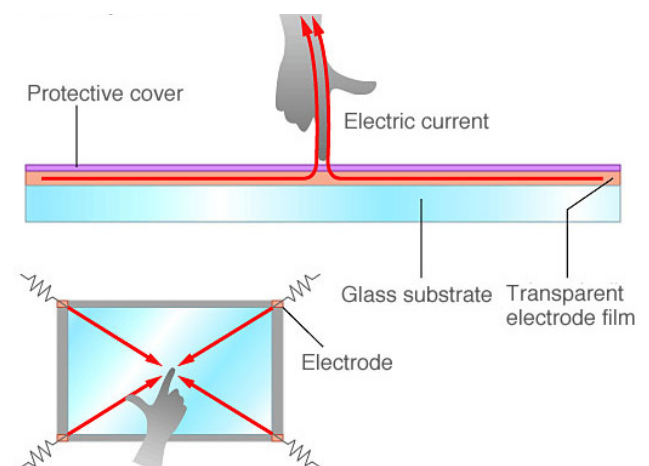


Figure 37

Analysis

Projected Capacitive

Projected capacitive touch panels are often used for smaller screen sizes. The Apple devices all use this method to achieve high-precision multi-touch functionality and high response speed. The internal structure of these touch panels consists of a substrate incorporating an IC chip for processing calculation. A layer of numerous transparent electrodes is positioned over this in specific patterns. The surface is covered with an insulating glass or plastic cover. When a finger approaches the surface, electrostatic capacity among multiple electrodes changes simultaneously. In this way the position where the contact occurs can be identified precisely by measuring the ratios between these electrical currents (see Figure 38).

An unique characteristic of a projected capacitive touch panel is the fact that the large number of electrodes enables accurate detection of contact at multiple points. So it is very suitable for multi-touch. However these panels, using indium-tin-oxide (ITO) are poorly suited for use in large screens, since increased screen size results in increased resistance (Eizo, z.d.).

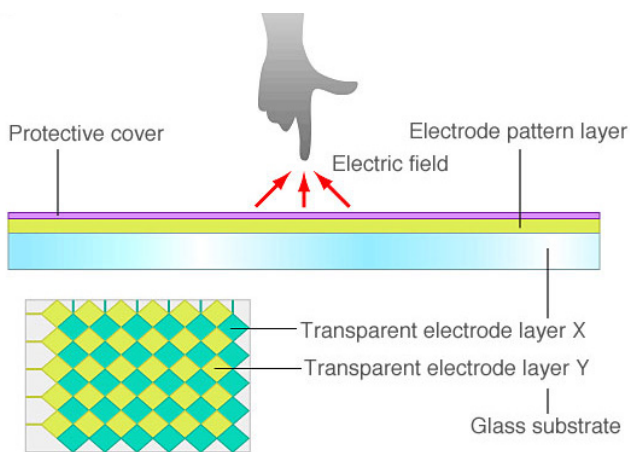


Figure 38

Optical (Infrared)

Optical touch panels include multiple sensing methods. The number of products employing infrared optical imaging touch panels based on infrared image sensors to sense position through triangulation has grown in recent years, especially among larger panels.

Optical touch panels use one infrared LED each at the left and right ends of the top of the panel, along with an image sensor (camera). Retro reflective tape that reflects incident light along the axis of incidence is affixed along the remaining left, right, and bottom sides. When a finger or other object touches the screen, the image sensor captures the shadows formed when the infrared light is blocked. The coordinates of the location of contact are derived by triangulation (see Figure 39) (Eizo, z.d.).

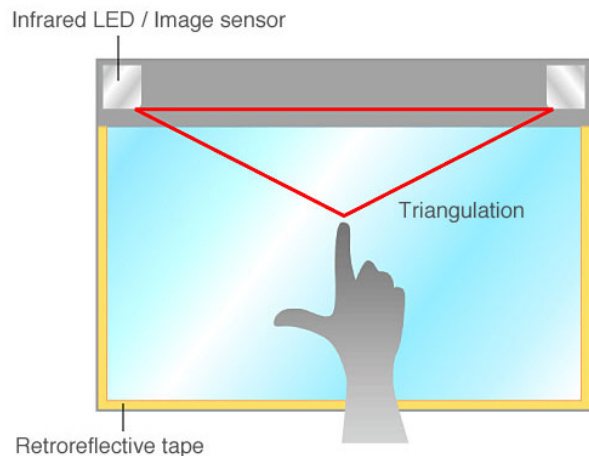


Figure 39

Acoustic

Surface acoustic wave (SAW) touch panels, also called surface wave or acoustic wave touch panels, are widely used in public spaces, in devices like point-of-sale terminals, ATMs and electronic kiosk. These panels detect the position on the screen where the contact with a finger or other objects occurs, using the attenuation in ultrasound elastic waves on the surface. The internal structure of these panels is designed in a way which enables multiple piezoelectric transducers that are arranged in the corners of a glass substrate to transmit ultrasound surface elastic waves as vibrations in the panel surface. Transducers that are installed opposite of the transmitting ones receive these elastic waves.

Analysis

When the screen is touched, ultrasound waves are absorbed and attenuated by the finger or other object. The location is identified by detecting these changes (see Figure 40). The user does not feel these vibrations. These panels offer high ease of use (Eizo, z.d.).

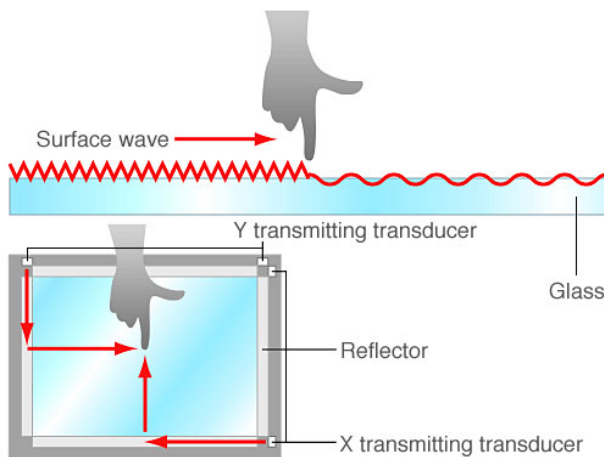


Figure 40

Gesture input

With gesture input the user can control the display from a distance. It often works with two or more cameras and infrared light. These two work together to detect the movements of the arms and hands of the user and translate those to the screen. This option is not further explained because it is not something that is suitable for the Zetium in the near future, but it is mentioned because it could be a possibility for use in the late future. An example of the use of gesture input is the Leap Motion Controller shown in Figure 41. This is a device that is connected to the laptop or computer. It copies the movements of the hand of the user and only works when the hand is above the device (Leap Motion, z.d.).



Figure 41

Conclusion

When a touch screen method is used on the Zetium, resistive is not a suitable option. Mainly because it has less light transmittance and this will reduce the transparency of the cover. Another reason to not use the resistive option is that it is less shock resistant. The cover will constantly be opened and closed and this could damage the touch panel.

Capacitive touch is very suitable for use of the Zetium, the Projected Capacitive variant. The Surface method is less suitable, because it does not handle multi-touch well, but it is cheaper and easier for bigger screen sizes. Projected capacitive is suitable, because it is very reliable and can be used as a multi-touch screen. But when you want to make it suitable for bigger screens it is less appropriate for mass production. This is not a problem because there are produced only 300-350 Zetiums a year.

In the future the Optical method is very interesting, mainly because it is often used in bigger screens. Another big advantage for use of the Zetium is that there is only a border on one side of the panel, unlike capacitive panels which have a border all around (see MMT example). It is a technology that is still in development and probably will be improved in the next few years. It is currently very expensive, but maybe this will drop in the next few years.

Gesture input is very attractive for the future because then the user can control the Zetium from a distance and does not have to walk all the way to the device. The current solution for gesture input, the Leap Motion Controller, does not solve this problem, because this device is still near by the displayed content. Maybe there will be bigger and better solutions for gesture input in the future and then it will be a outcome for use of the Zetium from a distance.

Analysis

1.7 Projection solution

1.7.1 Introduction

The projection technology is a solution which can be used in the near future. The design of the near future does not have to be interactive, so projecting it on a holographic layer will be sufficient.

But now the question is, where the projector must be placed. It cannot be placed in the back of the device, because the grabber will constantly move and this will constantly interrupt the image when it goes in front of the projector.

In this chapter three solutions are explained to integrate a projector with the Zetium.

1.7.2 Projection from front

The first idea is to attach a beamer on the cover of the Zetium as shown in Figure 48. This way it will move together with the cover when it is opened. To be able to work with this projector Zetium combination, the Zetium must be made higher or be placed on a pedestal, because otherwise it will get in the way of the user and the other way around, the user will get in the way of the projected image. Another problem that you must project from the back of the holographic layer otherwise the image will not be sharp. So this is a possibility but not a very good one.



Figure 48

1.7.2 Projection from above

The ceiling of the Zetium also is transparent. So a way to project on the backside of the cover, but from the outside of the Zetium, is through the transparent ceiling. See Figure 49 for a rough sketch of the idea.

A problem that arises when using this way of projecting the interface, the light will break caused by the transparent ceiling. As a result of this the image will be projected very small on the cover. Part of the light also be reflected to the ceiling of the room so the light intensity gets lost. Some settings can be done on the projector to adjust these mistakes, but it will never be totally recovered, so the image stays a bit small with a low intensity.

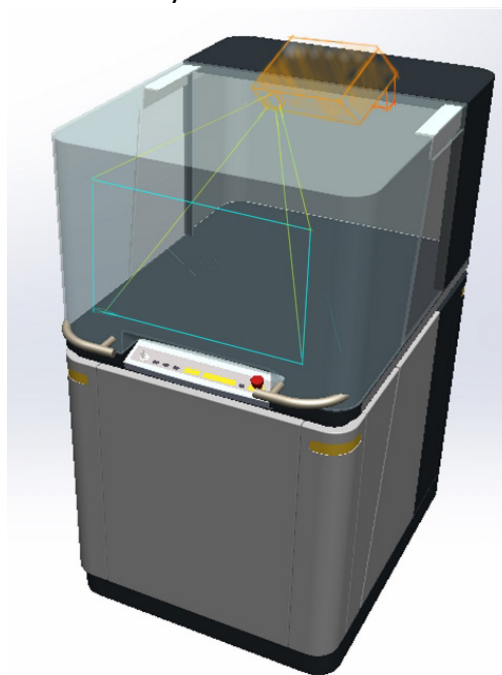


Figure 49

1.7.3 Projection from the inside

The final and best option is to use a digiboard projector, like the HITACHI CP-AX2504 shown in Figure 50. This projector projects in a sharp corner so it can be placed close to the front of the transparent cover. This way the grabber will not get in front of the lens and interrupt the screen. The sizes of the projector are shown in Figure 51.

Analysis



Figure 50

The platform of the Zetium is very full it has only 130mm x 195mm free space to place the beamer and then it will not even be straight in front of it. See Figure 52. The beamers needs a space of 463 mm in width and 377 mm in lenght (website). So when PANalytical wants to use this projection method it has to create some extra space in the Zetium. Another problem that accurs then is that the beamer will project 66" and the cover has a size of 32". This means the image will be to big (Touchscreen Digiborden, z.d.). But there can be probably done some settings on the beamer that will reduce the size of the projection or the projection self has to be adjusted.

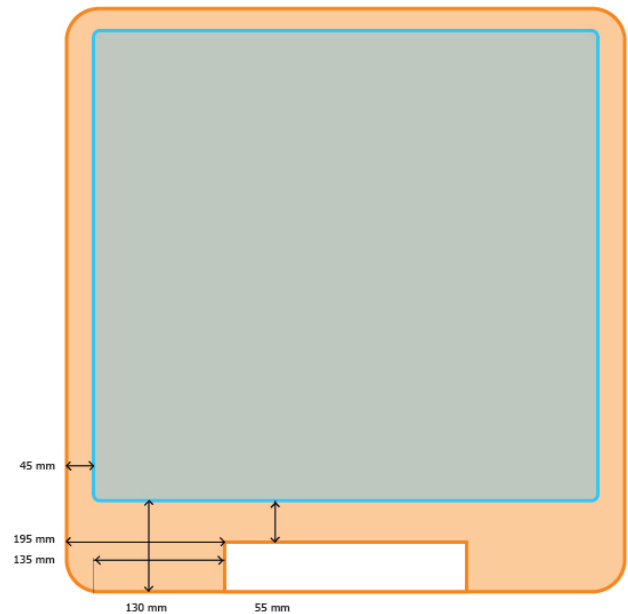
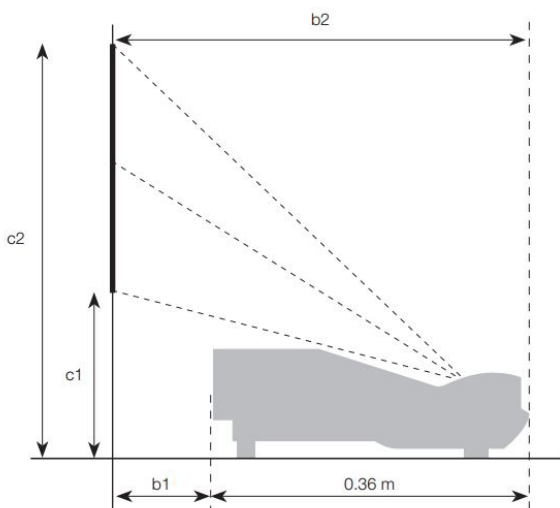


Figure 52

1.7.4 Conclusion

All these solution are still not ready to use. Adjustments have to be done to the Zetium. If PANalytical really wants to use the projection method the projection form inside is most recommended. This method is most promising and the only adjustment that has to be done here is make room for the projector. This can probably be done by removing some trays or something. The image of this projection will be the clearest and sharpest by far because it is directly projected at the back of the holographic layer like it should.



4:3				
Screen size (diagonal)	Projection distance (m)		Screen height (m)	
	b1	b2	c1	c2
60" (1.5m)	0.103	0.463	0.222	1.122
70" (1.8m)	0.169	0.529	0.246	1.326
80" (2.0m)	0.236	0.596	0.269	1.469
90" (2.3m)	0.303	0.663	0.292	1.672
100" (2.5m)	0.369	0.729	0.315	1.815

Figure 51

Analysis

1.8 Interface design rules

1.8.1 Introduction

In this paragraph some basic principles when it comes to designing an interface are listed in three separated lists. One is the theory of Christoffer Wickens (jaartal), one is prepared by Jakob Nielsen (jaartal) and the last one is devised by Ben Shneiderman (jaartal). Also 5 gestalt principles are mentioned. Eventually the similarities are discussed. These principles can be taken into account when it comes to the design for the Zetium interface.

1.8.2 Christoffer Wickens

Perceptual principles

1. Readability. Make sure the display is readable.
2. Avoid absolute judgments. (e.g. light red is a little bit less danger than dark red)
3. Top-down processing. People receive and interpret signals according to what they expect based on experience. (e.g. don't use a warning signal for something good)
4. Redundancy gain: Leave out redundant information, give information in multiple physical ways. (e.g. color and position of a green traffic light)
5. Discriminability: Signals that are similar to each other easily confuse the user, so highlight differences and use distinctive signals.

Mental model principles

6. Principle of pictorial realism: Visual orientation should correspondent to the environment in which it is presented. (e.g. high temperature, vertically high displayed)
7. Principle of the moving part: moving parts of a display has to move in a spatial pattern and direction that's compatible with the users' mental model or how the represented element actually moves in the physical system. (e.g. speedometer up, when speed increases)

Principles based on attention

8. Minimize information access costs: spatial proximity, minimize eye movements, smaller displays.
9. Proximity compatibility principle: spatial proximity, improve integration, divided attention on two information sources. When two elements together provide an action, place them closely together.
10. Principle of multiple resources: if a lot of information is transferred it is convenient to use visual recourses as well as auditory resources (e.g. an ambulance uses flashing lights and a siren).

Memory principles

11. Replace memory with visual information: knowledge in the world. Be careful with too much information cluttering. Alternate between top-down and bottom-up processing.
12. Principle of predictive aiding: displays that can predict stuff are very effective in supporting human performances.
13. Principle of consistency: Be consistent to avoid a lot of confusion. (e.g. a red signal always means the same thing in different situations)
(Wickens, Lee, Liu & Becker, 2004)

1.8.3 Jakob Nielsen

1. Visibility of system status- System should always keep users informed about what is going in, through appropriate feedback within reasonable time
2. Match between system and real world - The system should speak the users' language, so use words, phrases and concepts that are familiar to the user.
3. User control and freedom - Support undo and redo. A user often makes mistakes, when it does it needs a clearly marked "emergency exit" in order to leave the unwanted state without having to go through an extended dialogue.
4. Consistency and standards - User should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
5. Error prevention - Even better than good error message is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit an action.
6. Recognition rather than recall - Minimize the user's memory load by making objects, actions and options visible. Instructions for use of the system should be visible or easily retrievable.
7. Flexibility and efficiency of use - Make use possible for both experienced and inexperienced users by making the interface for example adjustable.
8. Aesthetic and minimalist design- Dialogues should not contain information which is irrelevant or rarely needed. It causes clutter and makes important information relatively less visible.

Analysis

9. Help users recognize, diagnose and recover from errors - error messages should be expressed in plain language, precisely indicate the problem and constructively suggest a solution.

10. Help and documentation - Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. List concrete steps to be carried out (Nielsen, 1995).

1.8.4 Ben Shneiderman

1. Strive for consistency - Identical terminology should be used in prompts, menus, help screens etc.

2. Cater to universal usability - Make interface suitable for novice to expert difference, age ranges, disabilities etc. Adding features for novice inexperienced user, such as explanations and features for expert, such as shortcuts.

3. Offer information feedback - For every user action, there should be system feedback. (Modest for frequent actions and more substantial for major infrequent actions)

4. Design dialogs to yield closure

5. Prevent errors - Design the system such that users cannot make serious errors. (e.g. an "Are you sure" window when something is done that can cause a big error)

6. Permit easy reversal of actions - Every action should be reversible, for example like ctrl+z. This will relieve the anxiety, since the user knows the error can be undone.

7. Support internal locus of control

8. Reduce short-term memory load - Avoid interfaces in which users must remember information from one screen and then use that information on another screen (Schneiderman & Plaisant, 2010).

1.8.5 Gestalt principles

1. Similarity - Occurs when objects look similar to one another

2. Continuation - Occurs when the eye is led from one object to another object

3. Closure - Occurs when an object is incomplete or a space is not completely enclosed. People fill in the missing information

4. Proximity - Occurs when objects are placed close together

(Graphic Design, z.d.)

1.8.6 Conclusion

It is obvious that there are a lot of design principles when it comes to interface design. A lot of different designers carry their own vision on which principles are (most) important. Yet there are many similarities between the different lists. For example the principle of consistency is reflected in every list. Error prevention is also a very important principle, if the faults are prevented the user its stress level will be a lot lower. Another recurring principle is to reduce the short-term memory load, so the interface must help the user to remember the previous information. A last frequent principle is the principle that the interface has to match the real world in many ways.

Analysis

1.9 Collages

Figure 42 and Figure 43 show two collages of modern interfaces. This will provide some inspiration when it comes to designing the interface for the Zetium. The collage in Figure 43 views some total interfaces of nowadays. Some inspiration can be achieved from this collage about how present interfaces look like and what these interfaces use to control it. Figure 42 shows all kind of non-existing interface parts. This collage will help to get a design that is more out of the box. In Chapter 2 some of these elements are reflected in the different concept designs.

1.10 Design considerations

1.10.1 Introduction

Designing for a transparent display differs from designing a regular interface. There are many aspects the designer has to consider. In this paragraph some of these considerations are listed.

1.10.2 Considerations

1. Contrast - On a transparent interface the contrast between different colors of different shades of one can be much lower. Especially with projected interfaces. So do not use colors that are not very contrasting.
2. Size - The size of the screen is inversely proportional to the transparency, so do not make it too big.
3. Speed - It is possible that a transparent interface will act slower because it has more trouble detecting the touch input
4. Design possibilities - Some displays, like the sun-innovations EPD screen, lack some possibilities. The sun-innovation screen can for example only project lines. Also the use of black and white is limited, take a look at paragraph 1.6.1.
5. Touch input - Not every screen has (automatically) touch input. Sometimes in can be added by using another transparent touch layer.

Analysis



Figure 42

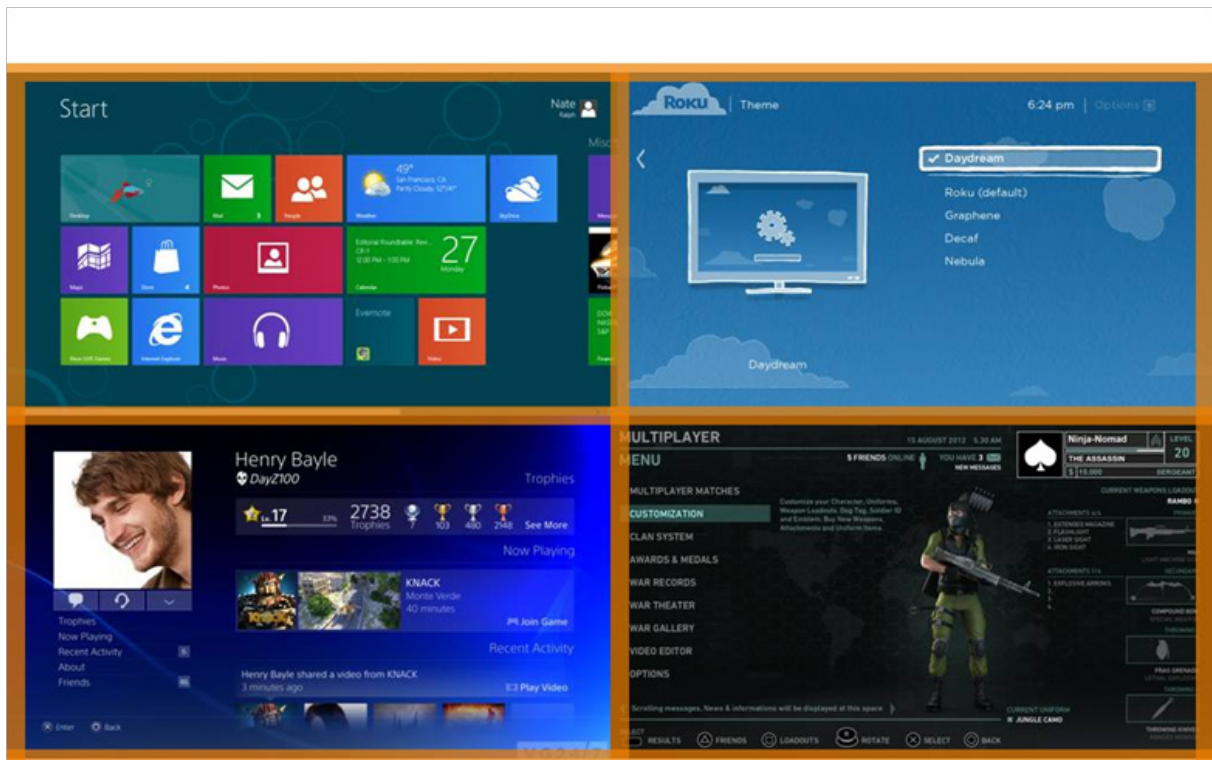


Figure 43

Analysis

1.11 Program of requirements

1.11.1 Introduction

In this chapter a program of requirements is set up. First some requirements for the display itself are drafted. These requirements say something about the display method that is chosen to use on the cover. These requirements are based on the analysis of the different technologies of Chapter 1.6. After this requirements of the interface are drafted, these requirements say something about the interface design. These requirements are based on the existing software and on the different principles of Chapter 1.7.

The requirements are ranked from most important to least important. In Chapter 3.3 a roadmap is set up. The requirements that are only important for the interactive design are colored blue.

1.11.2 Requirements

About the screen

Display...

- ... size lays between 22" and 32", so it fits on the cover of the Zetium
- ... can be attached to the Zetium, when it is an external screen
- ... has at least a transparency of 15%, based on the minimal transparency of the technologies (LCD has a transparency of 15%)
- ... has at least a contrast of 500:1, otherwise the screen will be too vague
- ... is suitable for daily use
- ... uses OLED, LCD or projection technology
- ... **is interactive**
- ... is frameless, with exception of one side

About the interface

Interface...

- ... is suitable for a transparent display
- ... meets the design principles
- ... its appearance matches the look of the Zetium
- ... can be used by experienced users
- ... can display the information the operator needs
- ... contains feedback about the system progress
 - > Feedback can be seen from a distance of 5 meter
- ... can give warning signals
 - > Warning signals can be detected from a distance of 5 meter
- ... contains a reference to the sample locations
- ... indicates which sample is placed at which location
- ... indicates which sample is in progress
- ... **contains the possibility to choose different measurement applications**
- ... use can be learned in one day
- ... makes use of different colors
- ... has high contrasting colors
- ... **uses swipe**
- ... **can switch between different "sheets"**
- ... **contains an ability to enter characters**
- ... **a whole analysis can be done by only using the Zetium**
- ... **contains an option to send the end results to known addresses**

Concepts

2.1 Sketching Phase

2.1.1 Introduction

In the sketching phase sketches are used to see which elements, colors and sizes are most fitted on the cover of the Zetium.

2.1.2 Research on Zetium

At first a research is done on the cover of the Zetium. In this research the use of color, the size and the thickness of the lines used in the design are tested. What is the best color to fit the Zetium and which color can be detected best from a distance. Etcetera. This is done by using a transparent film on the cover of the Zetium. On this film lines and text is drawn with different colored markers. The results can be found in Appendix F.

Conclusion

Looking at the images in Appendix F first the conclusion can be made, that it is not a very reliable test. The drawings are very unclear and obscure. But one thing that stands out is that the color red is the most visible and the color blue fits the cover the best. Also the color orange is very visible. So warning signals must be red, because then it will stand out the most. The other two colors that should be used in the design are blue and orange. When a close look is taken at the readability text it stands out that small words are more readable than very big words. This has probably to do with the proximity principle and the reflection of the cover.

2.1.3 Part solution

This paragraph shows some part solutions that are made. This means concept ideas for part of the complete design, for example the design of the progress-bar. Eventually these part solutions are merged in different formats. See Appendix G for the different parts.

2.1.3 Formats

In this paragraph the part solutions of the previous paragraph are merged into different screen formats. This way it becomes clear which part solutions fit with each other. The result are shown in Appendix H.



Figure 44

2.1.4 Final sketches

Eventually the formats are worked out in neater computer sketches. See Appendix I. Here color is used to get a better picture of which design fits the best. The sketches are tested by putting a picture of a Zetium behind it like shown in Figure 44.

Conclusion

The combination of blue and orange works because blue fits the color of the cover and orange really stands out. So it is obvious the best thing is to make the important components orange and the less important parts blue. Now four directions must be chosen to work out. These directions must differ from each other a lot so a clear decision can be made.

2.1.3 Conclusion

The four directions that are chosen to work out are shown in Figure 45. These directions are chosen because they fit the Zetium the best and stand out the most. They also differ from each other a lot so more different options are highlighted.

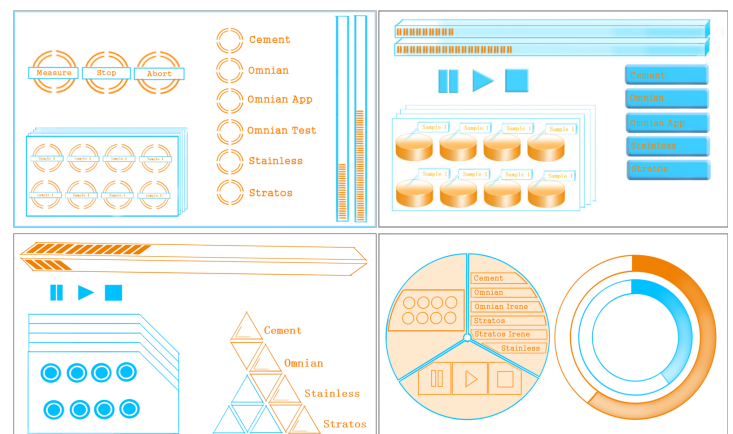


Figure 45

Concepts

2.2 Final concepts

2.2.1 Introduction

Eventually four directions are chosen to work out. It is developed in four images of each concept. One home screen image, one overview, one zoom and one expression of the results. These concepts are only based on look, so a lot of buttons are left out. These will be worked out in the final design with the look that is chosen. In this chapter all concepts get a brief explanation.

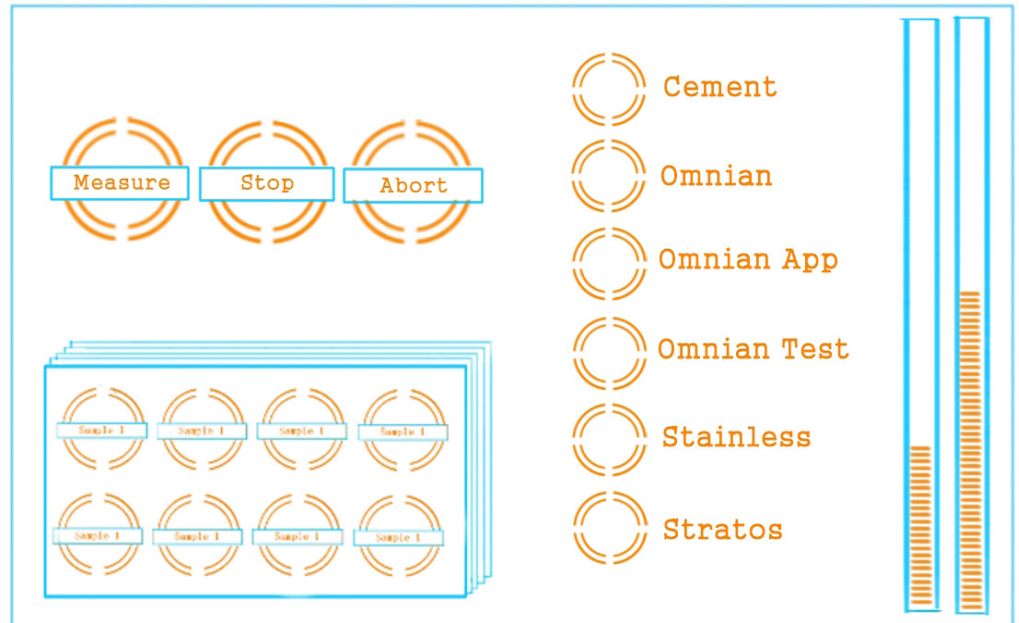


Figure 46

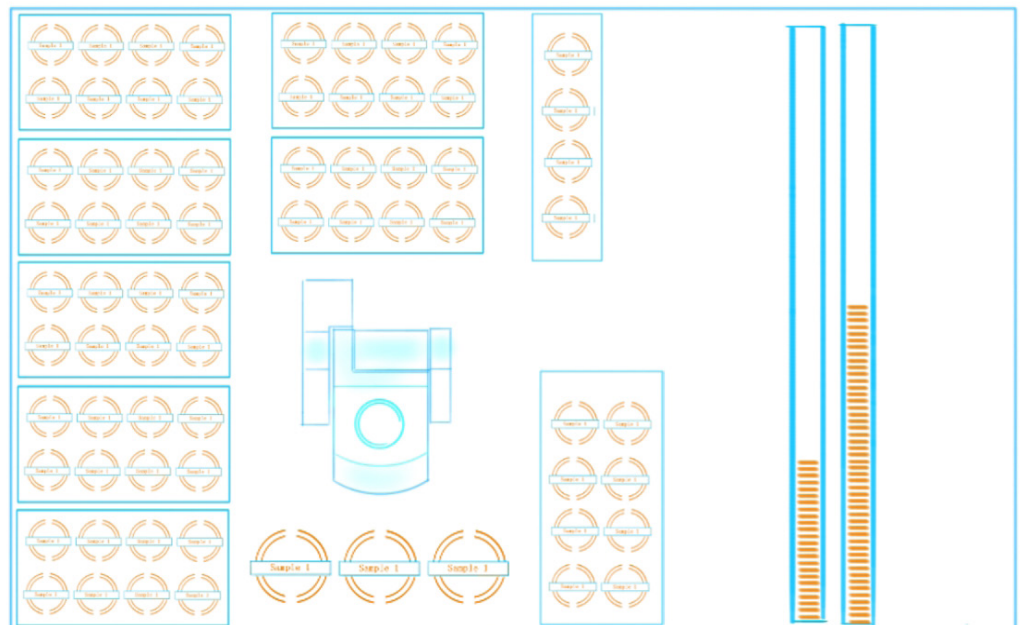


Figure 47

Concepts

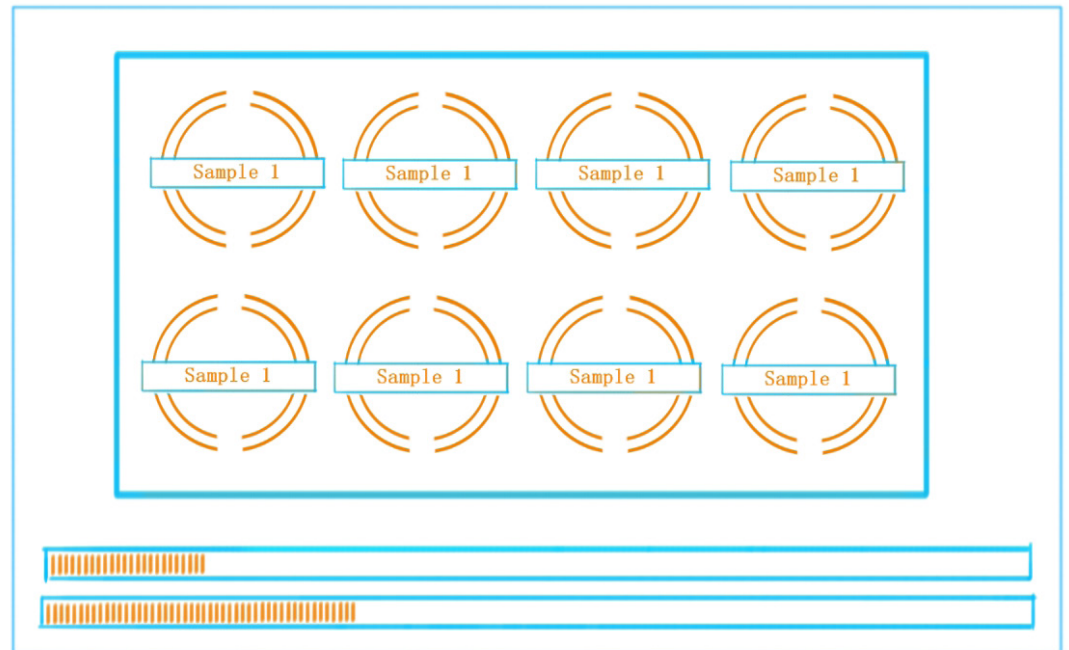


Figure 48

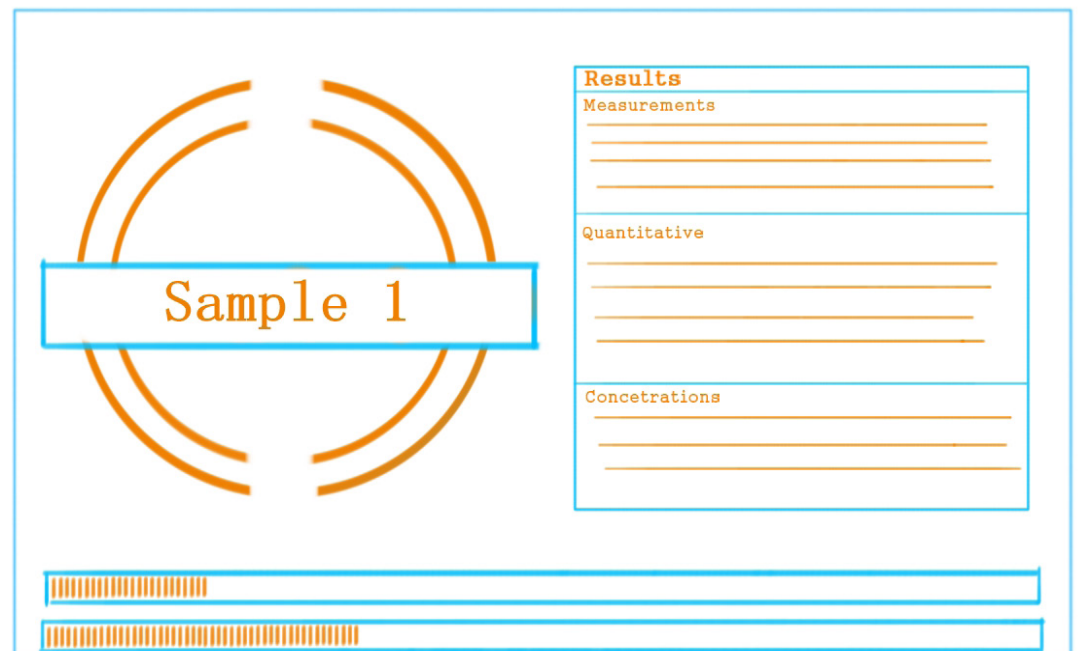


Figure 49

2.2.2 Concept 1

Concept 1 is based on the rounded shape of the Zetium (see Figure 46-49). In the home screen all the elements are round except for the progress bar. This element is not round because otherwise it would not fit on the cover and in this way it is very clear where the end point of the progress bar is placed.

Overall it is just a very simple design without distractions. Just to the point.

Concepts

2.2.3 Concept 2

In this concept all aspects are designed to be skeuomorphic, in other words realistic (see Figure 50-53). It is done by making everything 3D, by giving the elements shadows and highlights. This way the user gets the feeling he is actually pushing buttons. According to PANalytical the competition also uses realistic shapes in their designs.

What stands out the most are the samples which are pictured as flat cylinders. This shape gives a realistic reproduction of reality. The buttons look like they can be pressed.

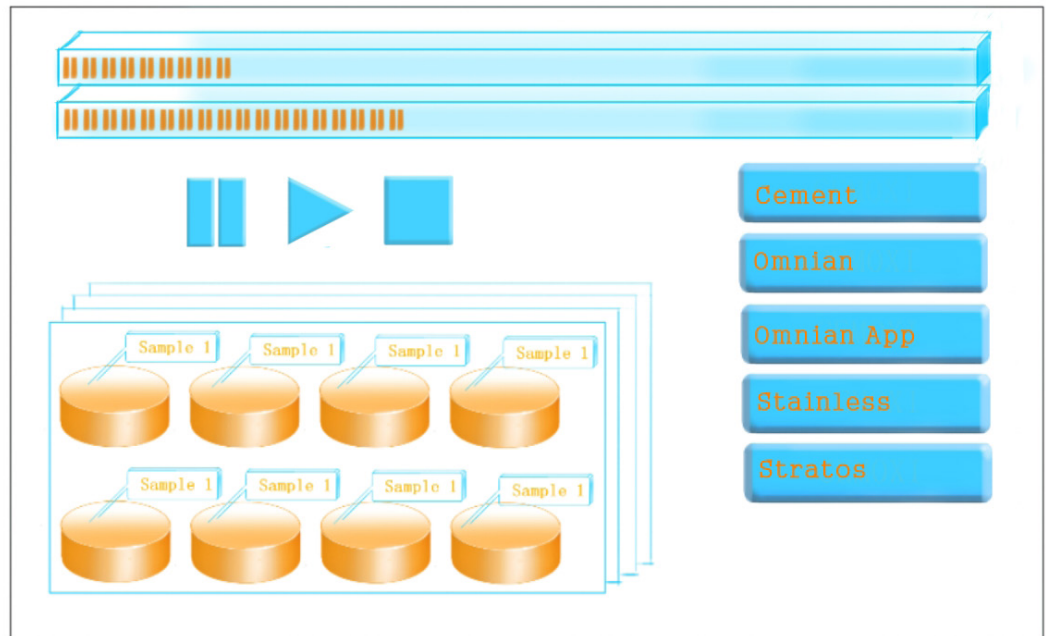


Figure 50



Figure 51

Concepts

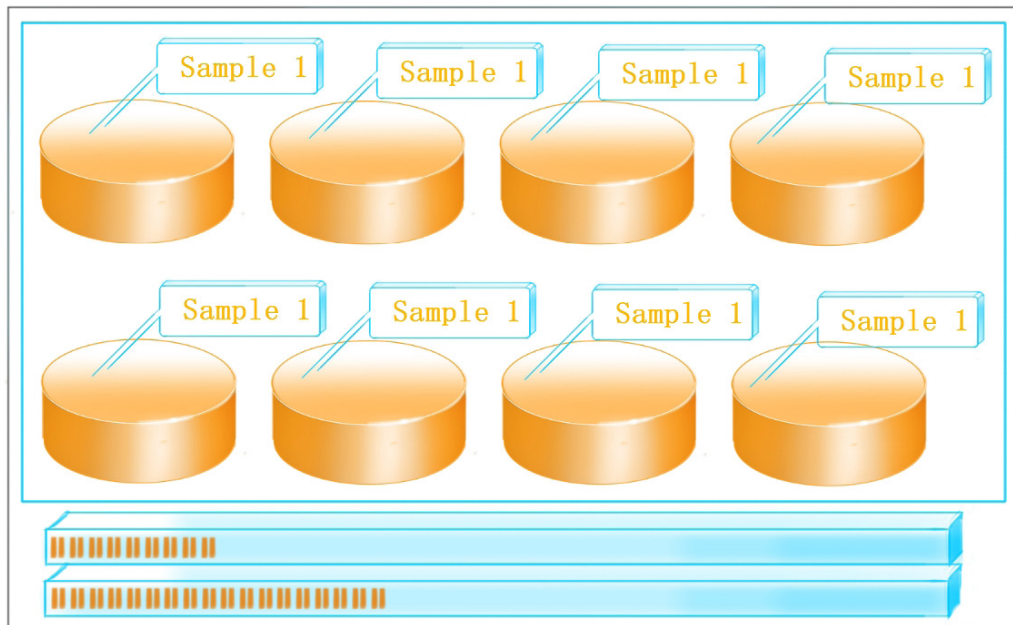


Figure 52

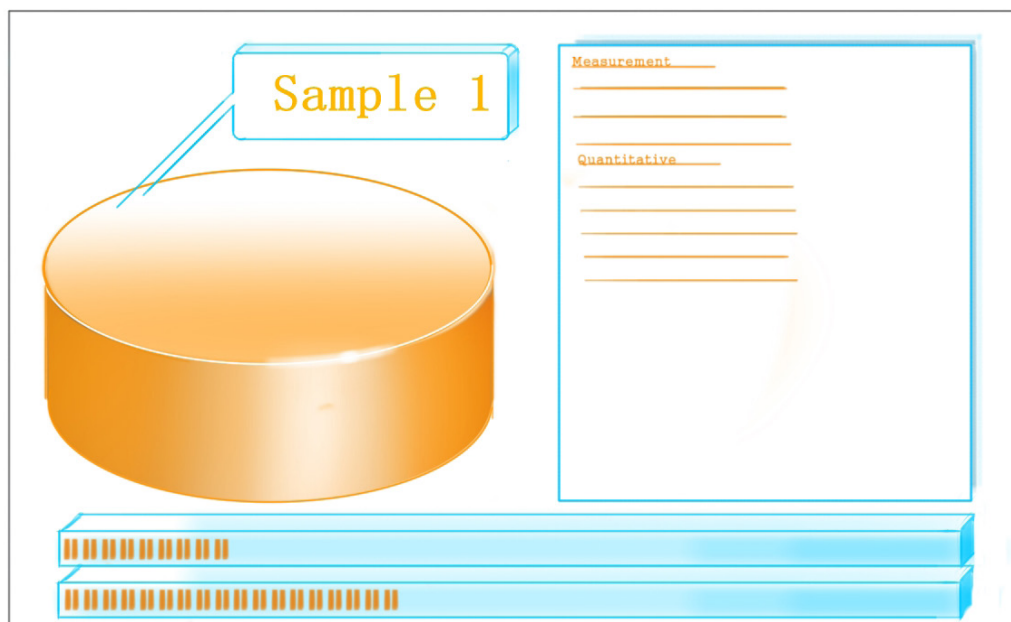


Figure 53

Concepts

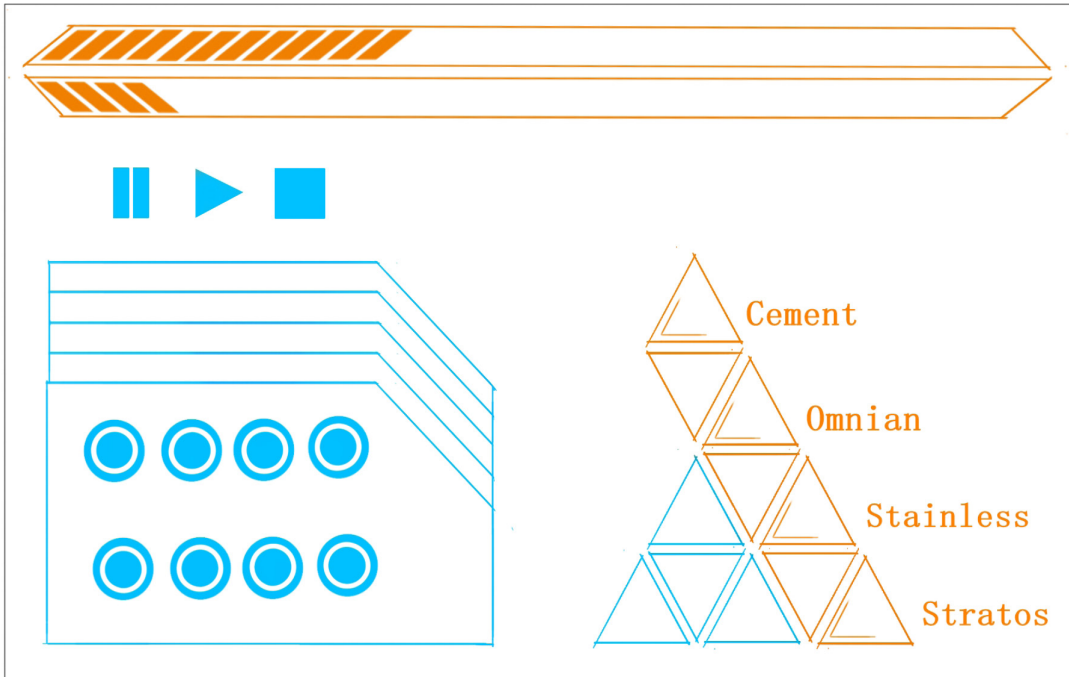


Figure 54

2.2.4 Concept 3

Concept 3 is a concept that is more out of the box (see Figure 54-57). In the first instance it seems like it does not fit the look of the Zetium because of its hard and diagonal shapes, but when you take a closer look to the Zetium, it strikes that the Zetium does have diagonal shapes on the side of the casing.

The sample references are round, because this will link it to the samples. If they were shaped otherwise the user might misinterpret these shapes and confuse them with something else.

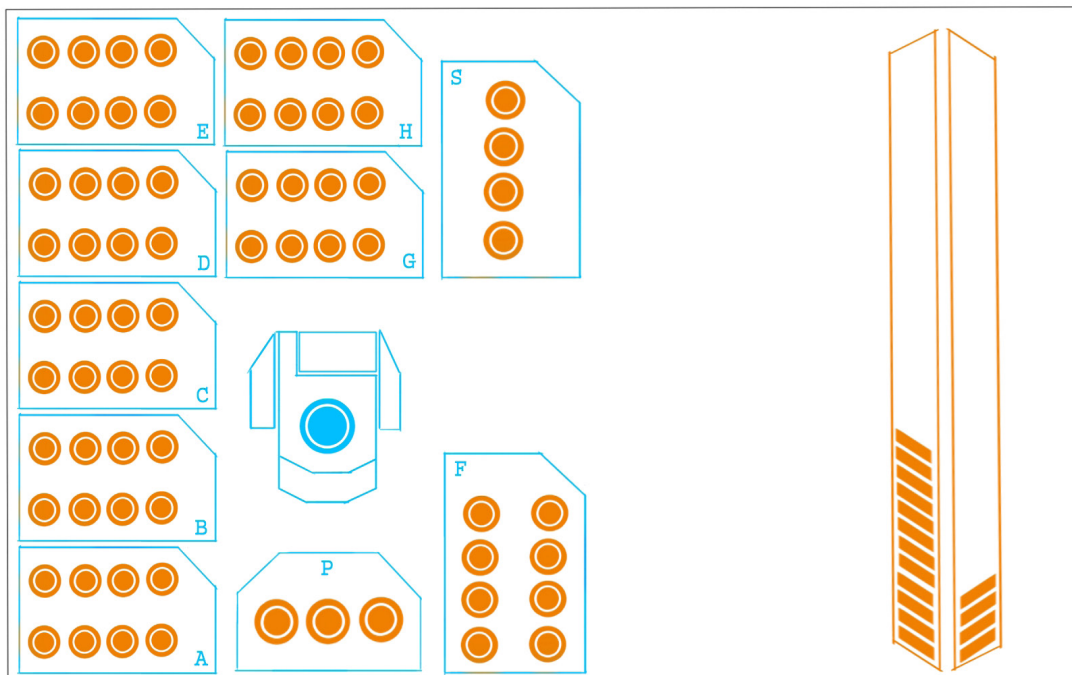


Figure 55

Concepts

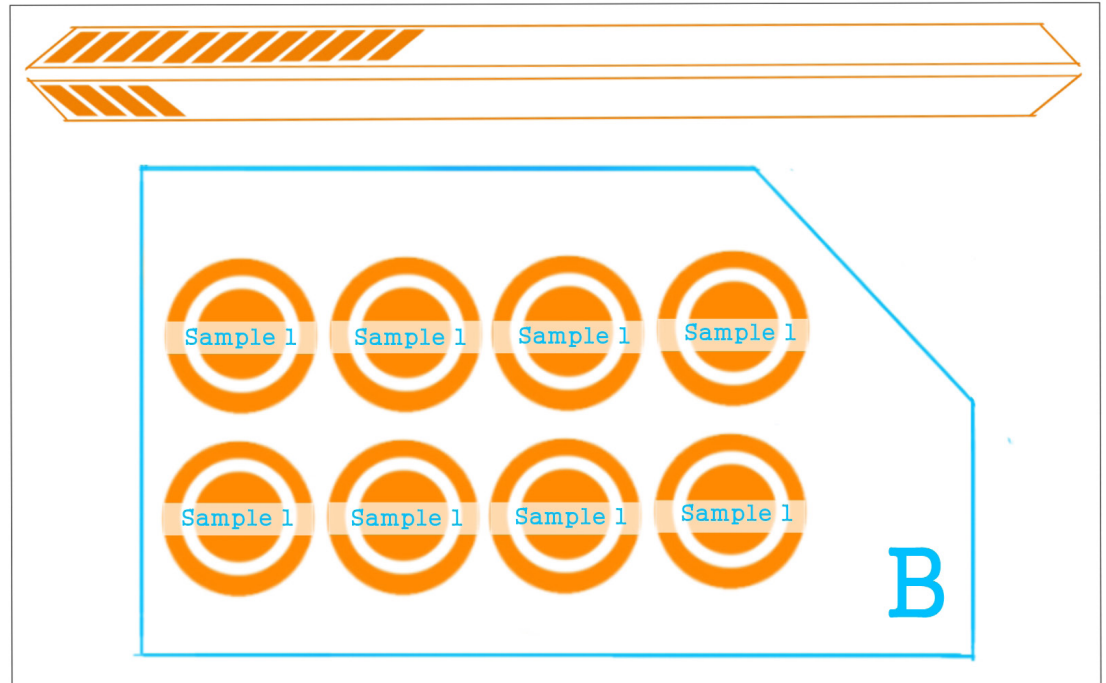


Figure 56

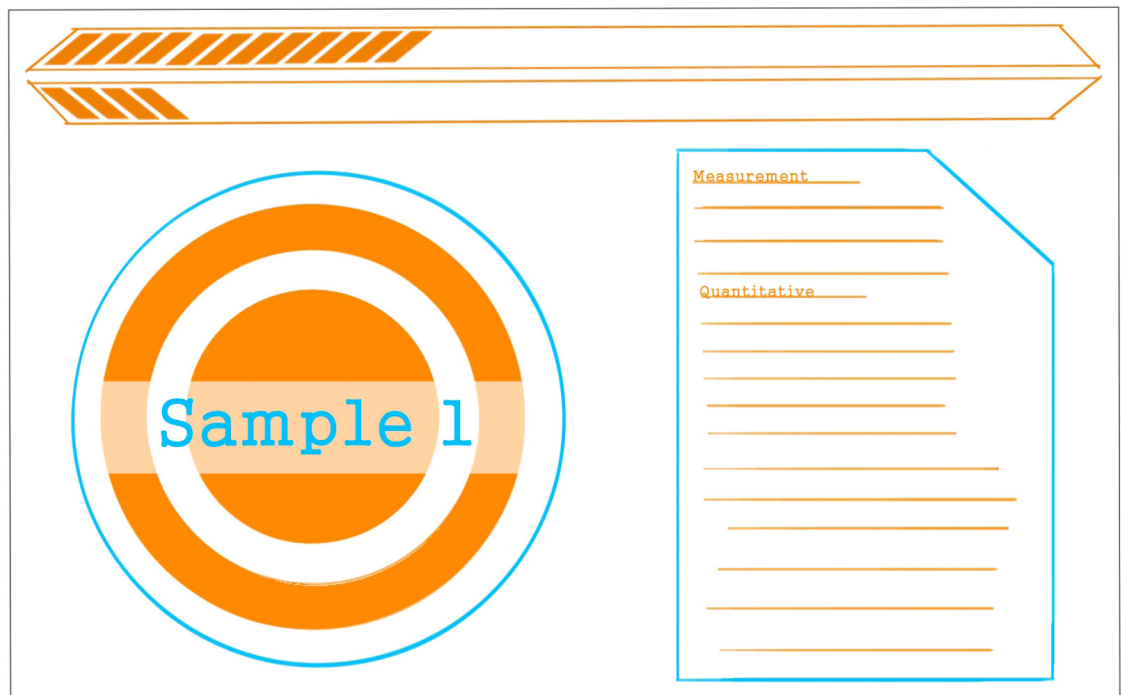


Figure 57

The solution for the measure applications is very creative. This solution will maintain the diagonal image of the design together with the progress bar. In this design the names of the samples are left out in the overview. They will only be visible in the Zoom image. This will also be the case with concept 4.

Concepts

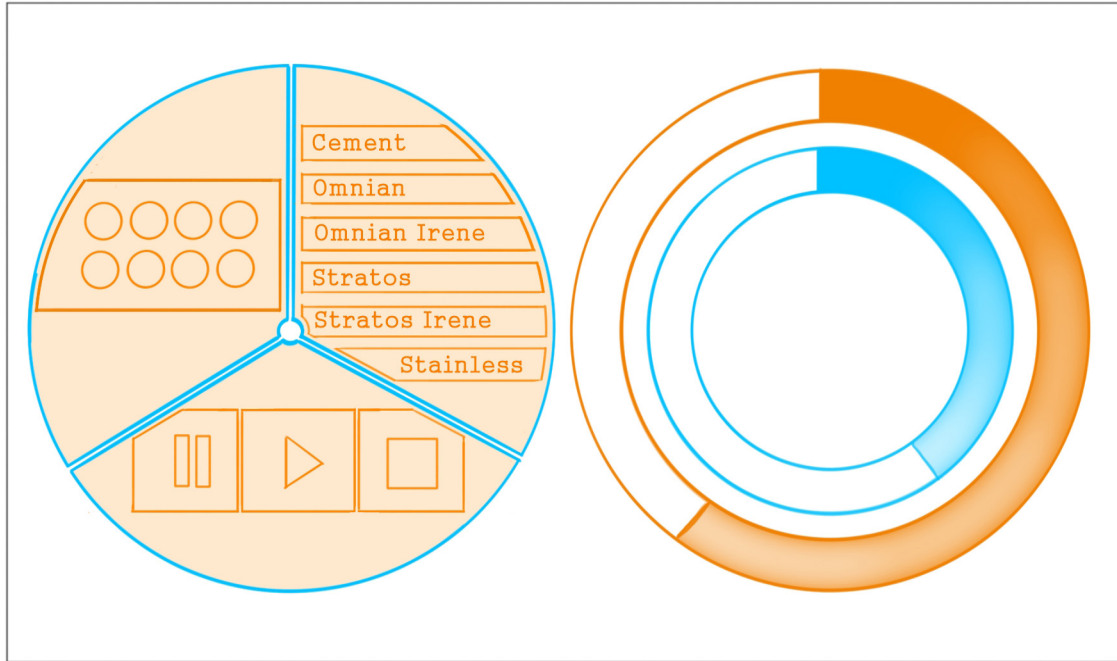


Figure 58

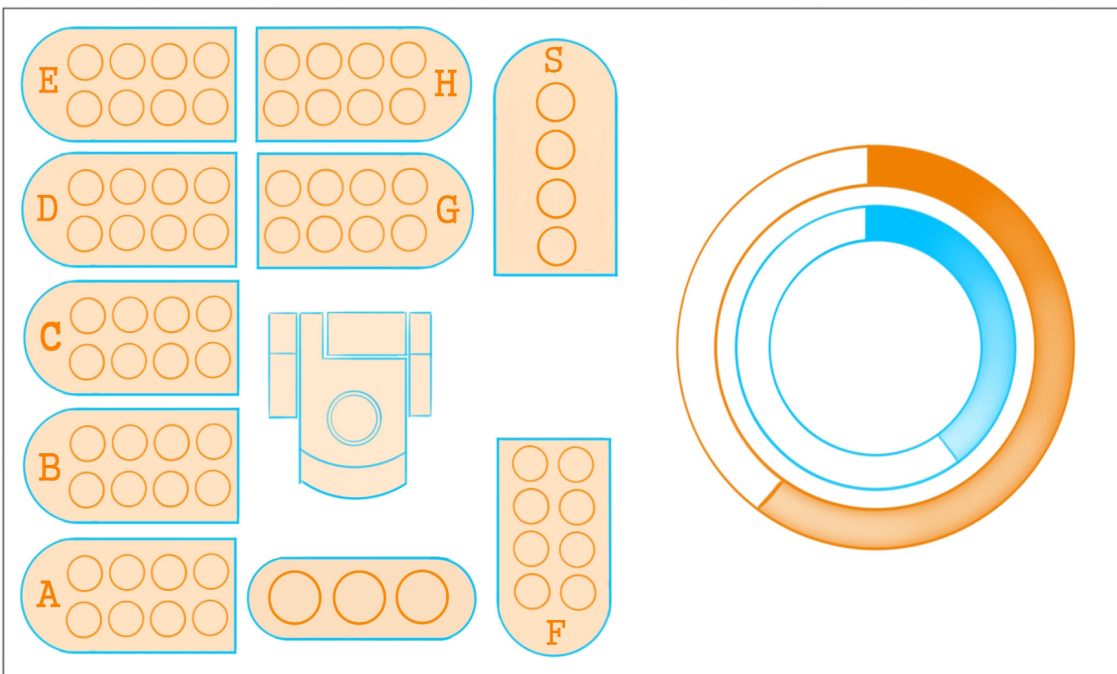


Figure 59

2.2.5 Concept 4

This concept is another out of the box design (see Figure 58-61).

The homescreen just exists of two big circles. One circle represents the progress bar and the other circle contains the rest of the buttons needed on the home screen.

The styling in the rest of the design is, like concept 1, based on the rounded corners of the Zetium. The samples are just represented as empty circles. Another difference between concept 3 and 4 and concept 1 and 2 is that in concept 3 and 4 the letters of the trays are displayed. This gives a more clear image of which tray is placed where in the Zetium.

Concepts

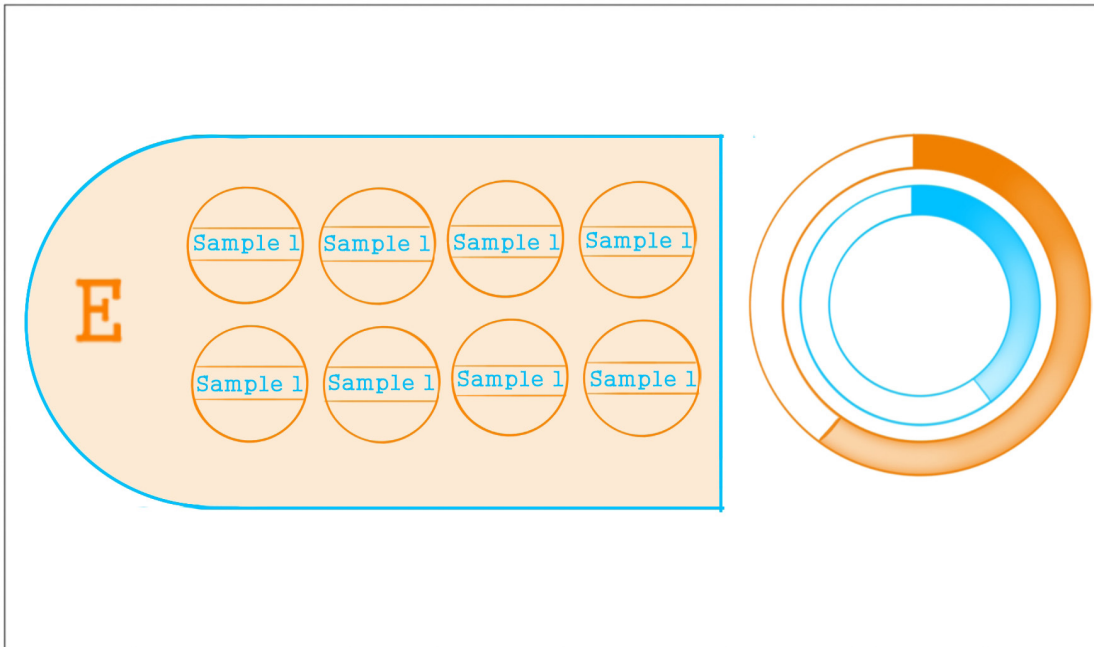


Figure 60

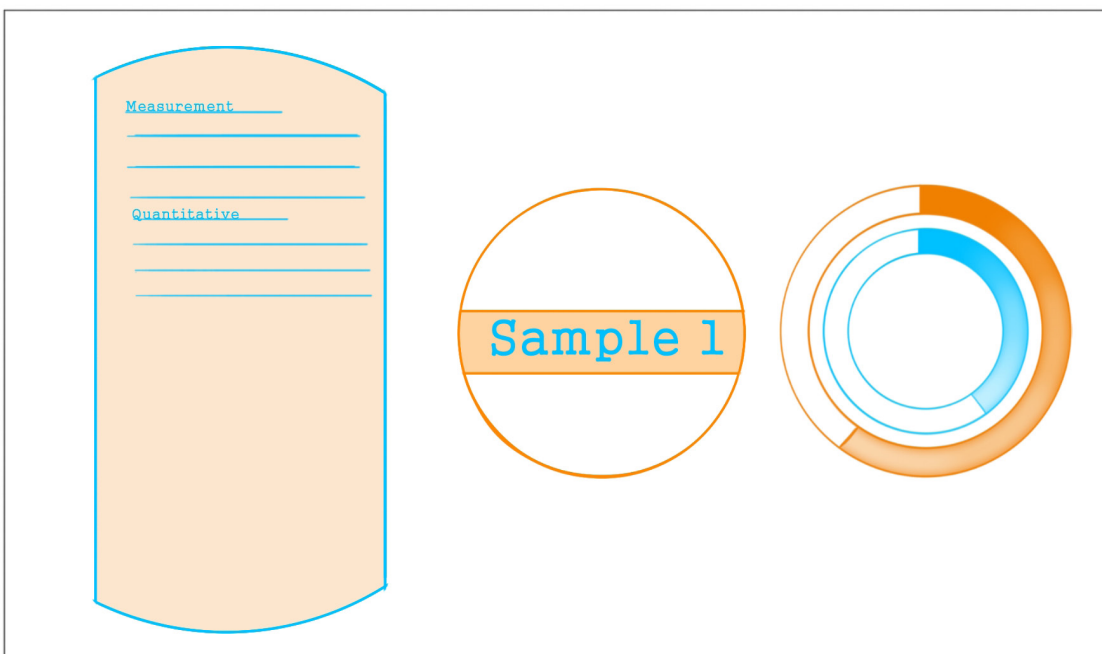


Figure 61

2.2.6 Conclusion
All concepts have their advantages and disadvantages. To give a well-founded opinion about the concepts and make the right choice between the concepts, a small test has to be done. In the next chapter this test is explained and a choice will be made.

Concepts

2.3 Concept choice

2.3.1 Introduction

The 4 concepts are rated by 3 different reviewers. One reviewer was the designer of the concept, one was a mentor from Benchmark and one was a specialist of the Zetium. Before the test the four different concepts were printed on transparent film (see Figure 62). In the test the transparent concepts are attached to the Zetium. In this way the reviewers can get a idea of how it will look on the cover in the future and give a more reliable opinion about for example the contrast and the use of color. The main goal of the test is to choose one of the concepts which design will be used as final concept.

2.3.2 Approach

All the concepts were marked from 1-5. Grade 5 means it really meets the requirements and 1 means it does not meet them at all. After this the reviewers added some comments to give a more founded opinion or explanation about their grading. The requirements are ranked from most important too least important. The most important requirements count more in final verdict. The concepts are mainly chosen on design, so how it really works is not included in this test.

When it comes to importance of the requirements the conspicuousness of the progress bar is the most important, because this is a important improvement of the software, namely read the progress from a distance (see Chapter 1.10). The intuitiveness of the interface is not that important because the user of the Zetium is one operator that continuously performs the same task, so gets to know the interface very quick. The readability is not important in this test only, because in every concept the same font is used. So it is not very revealing in this test. This ranking is based on sight and overall knowledge of the design and the Zetium which is obtained in the analysis.

In appendix J the questionnaire that is used in the test can be found. The results of the test can be found in appendix K.

2.3.4 Conclusion

First the total amount of points is summed up to get a global view of the liking of the different concepts. Later the scores are discussed into detail.

Concept 1: $30 + 28 + 24 = 82$

Concept 2: $20 + 34 + 20 = 74$

Concept 3: $28 + 26 + 23 = 77$

Concept 4: $31 + 30 + 30 = 91$

Concept 4 scores the best when you look at the overall points. But this is for itself not a very reliable result, because some requirements are more important than other. When you look at the most important requirement, the conspicuousness of the progress bar, concept 4 scores the best with all three reviewers. It also gets a high score for fitting the look of the Zetium. It does not score very high when it comes to fitting the background, but with some adjustments this can probably be solved.

Eventually concept 4 seems to be the most promising design. However a lot has to be adjusted to the design to be perfectly suitable as end result. For example the two circles in the beginning are not a good representation of the use. Especially because the circles are too close together and provoke the idea that the two belong together. Use the whole space of the Zetium more to provide this problem and use distinctive shapes to avoid confusion. So do not use the two circles but do keep the home screen as simple and empty as possible to avoid clutter. Another important point of attention is leave out unnecessary lines and details, only display what is important.

It is also an attractive option to use the strong points of the other designs to build a perfect final design.

From concept 2 the skeuomorphic elements can be used in lesser extent in the final design. The representation of the samples of concept 3 were very popular so these shapes can also be used. The diagonal shape in concept 3 was also a point of attention. The reviewers noticed that this diagonal shape was reflect at the side of the Zetium.

So eventually the final design is largely based on concept 4 with influences of concepts 2 and 3.

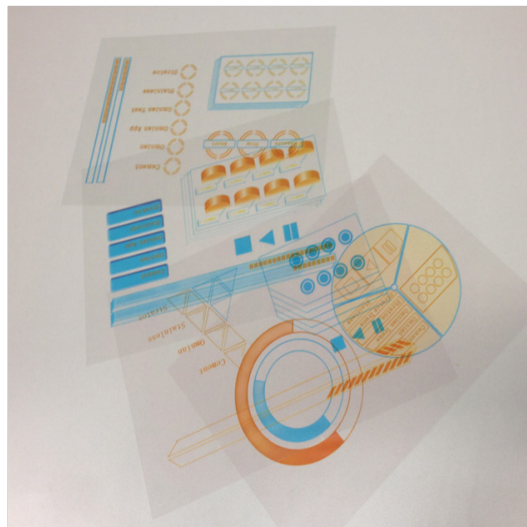


Figure 62

Final Design

3.1 Final design

3.1.1 Introduction

Based on the 4 concepts, including the comments, a final design is made. In this final design the design rules of chapter 1.7 are incorporated. In the next paragraphs these final design is further explained.

3.1.2 Home screen

The home screen is kept very simple, to avoid clutter. This way all the information that is important in this screen will stand out and no irrelevant information will distract the user from doing his task. That is why on the home screen only the measure application options, the button to go to the overview, the progress bar and the start, pause, stop and go to origin buttons are displayed (see Figure 63).

On this screen the user first chooses a measure application. When a measure application is selected the orange element turns blue (see Figure 64). After the user chose a measure application he can go to the overview to choose a sample on a certain position where he wants to use this measure application with.



Figure 63



Figure 64

The elements that work together to provide an action like the measurement application options and the button to open the overview are put close together to 'minimize information access costs' and meet the 'proximity compatibility principle'.

When reading this report you may wonder why the home screen even exists because all the settings can be done in the overview. However on the home screen the progress bar is displayed very big so the user can see from a distance how far the system has progressed with measuring the samples, without the distraction of any other element.

By clicking on the big orange button the overview is opened.

Final Design

3.1.3 Overview

When the user has pressed the overview button the overview screen appears (see Figure 65).

In the overview all trays with its samples are displayed. Just like with the current software a 'match between the system and the real world'. On the right all buttons that are necessary on this screen are displayed. The buttons that have a similar functions are placed close together in the same row. The measure application can also be adjusted on this screen so that the user does not have to go back to the home screen and start at the beginning. It can be changed by using the arrows to scroll between the different application options.

The other buttons approximately match the buttons of the existing software so to know what these features do read paragraph 1.2.8.

If the measure application is selected and a sample is pressed the measure menu will open.

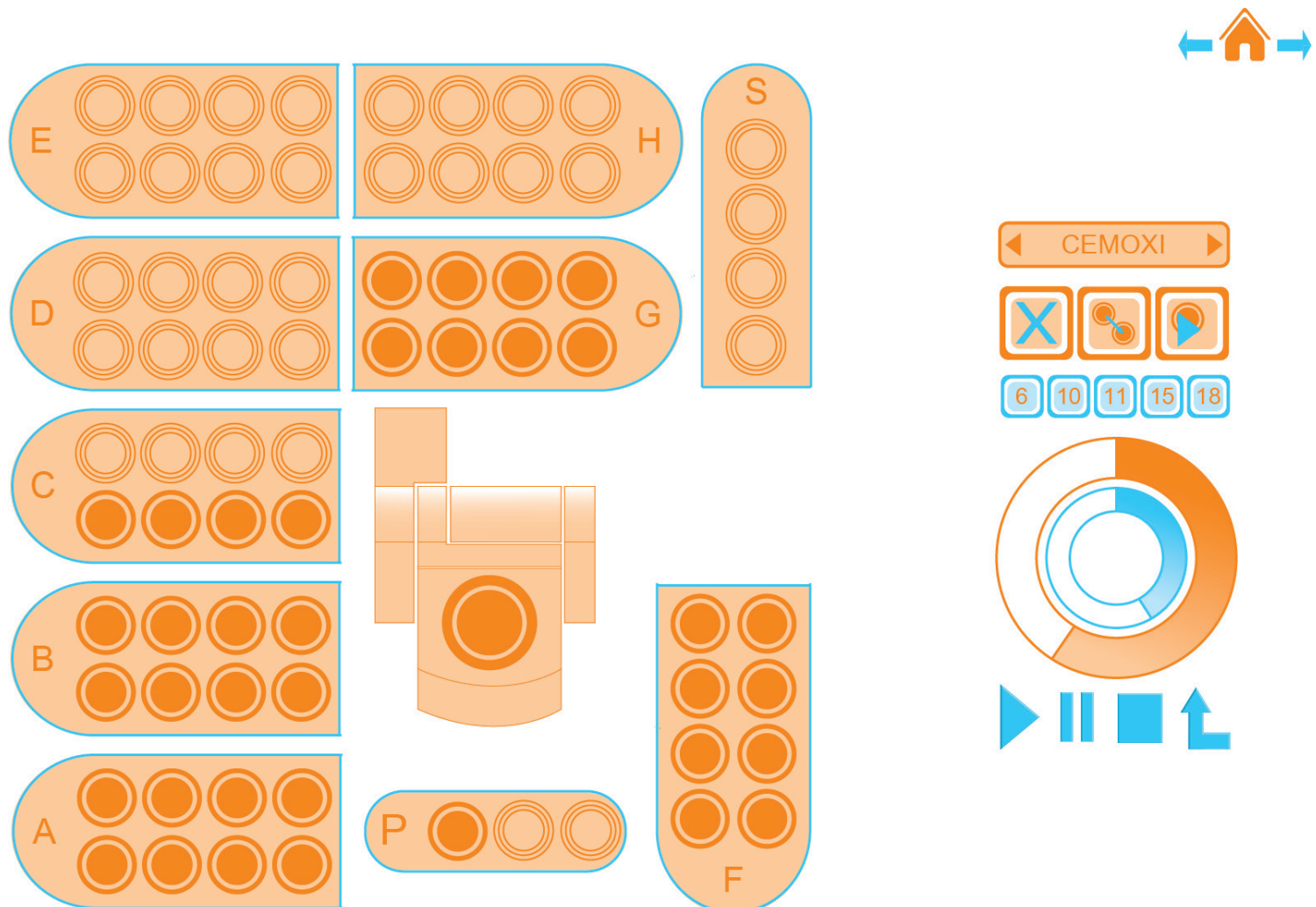


Figure 65

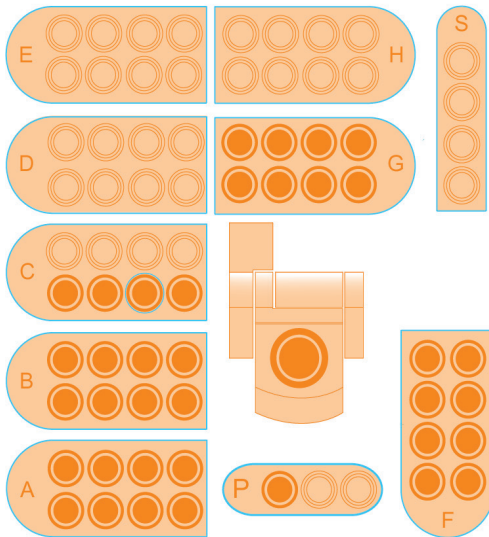
Final Design



3.1.4 Measure menu

In the measure menu all the data can be entered. This menu actually works the same as the measure menu of the existing menu so it speaks for itself. The menu will open next to the sample overview (see Figure 66). When the user presses on the bar to fill in a identification a keyboard will appear underneath the measure menu (see Figure 67). The name of the sample can be entered now. On this keyboard the checkmark means to close the keyboard keeping the characters, the cross means interrupt the action, so the typed characters will be deleted. This is the 'emergency exit', so when the user does something wrong he can always stop what he is doing. The user can switch between the characters and numbers with the '123' and 'abc' button (see Figure 67).

Because the measure menu stays visible at the same time as the overview, settings can be done for a lot of samples in a row, even when these samples are not positioned close together. Just by pressing the sample you want to change. When a sample is selected there is a blue circle around it. For the samples close together the arrows on the measure menu can be used to go through the different samples next to each other.



Edit measurement at position: C7

Information

Application: CEMOXI Type: Routine

Sample identification: Sample 1

Manual input / compound	Use	Value	Unit
Init weight	<input checked="" type="checkbox"/>	0.9000	g
Flux weight	<input checked="" type="checkbox"/>	9.0000	g
Final weight	<input checked="" type="checkbox"/>	9.9000	g

Navigation icons: left arrow, right arrow, checkmark, backspace, and X.

Figure 66

Edit measurement at position: C7

Information

Application: CEMOXI Type: Routine

Sample identification: Samp

Manual input / compound	Use	Value	Unit
Init weight	<input checked="" type="checkbox"/>	0.9000	g
Flux weight	<input checked="" type="checkbox"/>	9.0000	g
Final weight	<input checked="" type="checkbox"/>	9.9000	g

Navigation icons: left arrow, right arrow, checkmark, backspace, and X.

Keyboard layout (Figure 67):

Top row: Q W E R T Y U I O P

Second row: A S D F G H J K L 123

Third row: Z X C V B N M I ←

Bottom row: ↑ [] ← ✓ X

Top row: 1 2 3 4 5 6 7 8 9 0

Second row: : ; ! ? () [] - abc

Third row: + = \ / & ^ % # ←

Bottom row: ↑ [] ← ✓ X

Figure 67

Final Design

3.1.5 Quick start

The Quick start menu works the same as mentioned in paragraph 1.2.8. In Figure 68 is shown what this Quick start menu will look like in the final design.

Manual input / compound	Use	Value	Unit
▶ Init weight	<input checked="" type="checkbox"/>	0.9000	g
Flux weight	<input checked="" type="checkbox"/>	9.0000	g
Final weight	<input checked="" type="checkbox"/>	9.9000	g

Figure 68

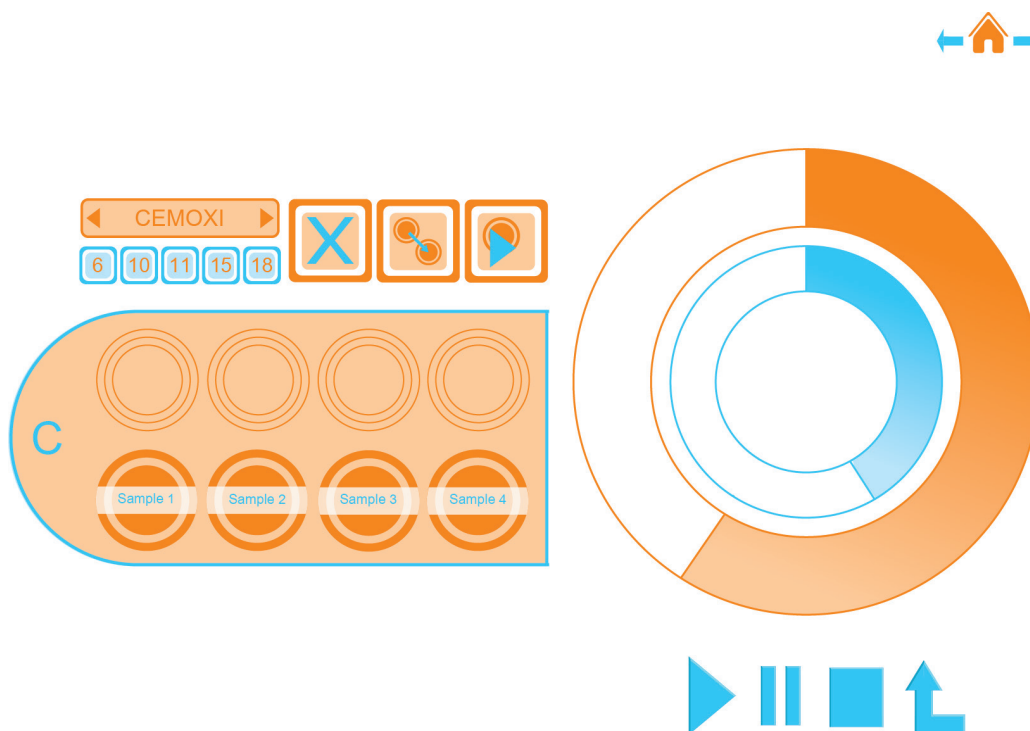


Figure 69

3.1.6 Zoom

The zoom is opened when the user moves his fingers over a tray like shown in Figure 70. When the screen opens one tray is displayed bigger (see Figure 69). Now the names of the different samples can be read. It is comparable with the zoom explained in paragraph 1.2.8. The buttons will stay the same as in the overview only placed on a different position. So the same actions can be done.



Figure 70

Final Design

3.1.7 Result screen

The resultscreen can be opened by moving the fingers over a certain sample, where the user wants to see the results of, like shown in Figure 70. There are two types of result screens. The first result screen is given in a table (see Figure 71). The other result is given in a graphic (see Figure 72). The user can switch between the two types of result screens by using the buttons on the right.



Results	
Measurement	
Application	CEMOXI
Type	Routine
Sample	Sample 1
Date & Time	4/2/2015 14:55
Archive	CEMOXI
Quantitative	
Sum	0.0000 %
Concentrations	
SiO2	4400000.000 %
Al2O3	4400000.000 %
Fe2O3	4400000.000 %
CaO	4400000.000 %
MgO	4400000.000 %
SO3	3372098.828 %
K2O	4400000.000 %
Na2O	4400000.000 %
P2O5	4400000.000 %
TiO2	4400000.000 %
Mn2O3	4400000.000 %
SrO	267155.859 %
ZnO	20.801 %

Figure 71

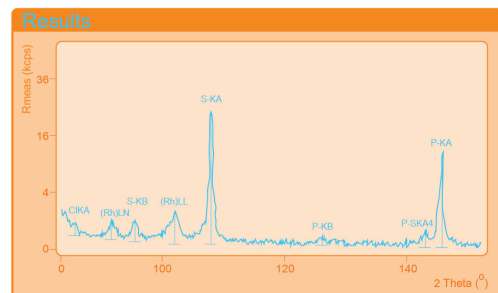


Figure 72



Figure 73

3.1.8 Button selection

When a button is selected it always gets a frame (see Figure 73). When the delete button is selected or the measure application button they both get a blue frame. This means the design really meets the 'principle of consistency' because a frame always means the same thing, namely that a button is selected.

Final Design



3.1.9 Loading sample

When a sample is busy measuring, this will be displayed on the screen (see Figure 74). So the user is always informed which sample the system is measuring. The user always has a 'visibility of the system status'. In Figure 75 an implication is giving of what the movement of this feedback will look like.

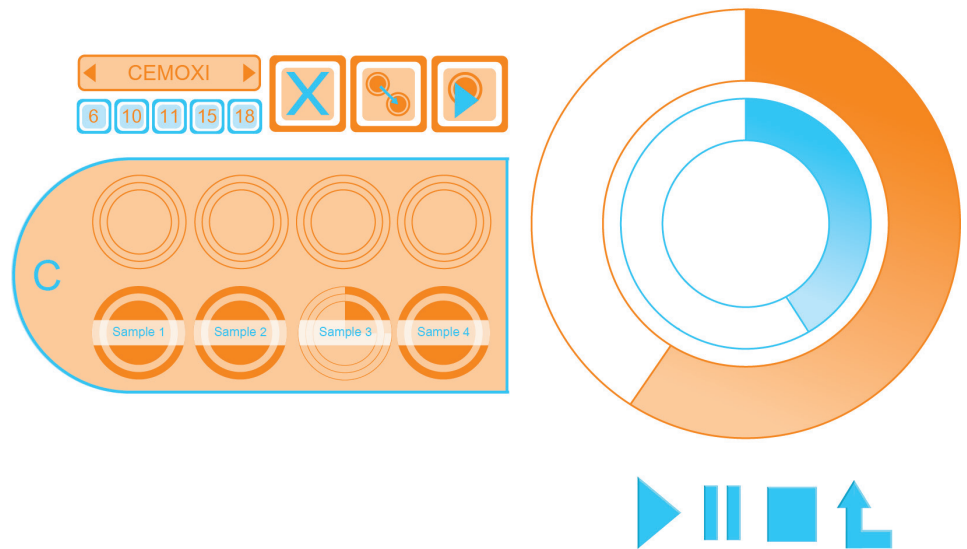


Figure 74



Figure 75

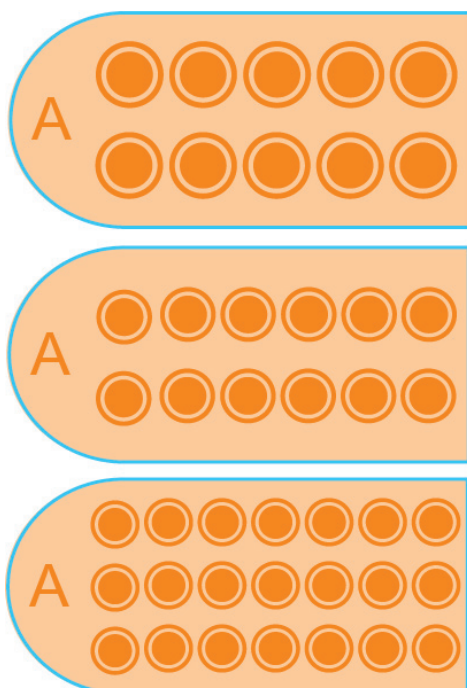


Figure 76

3.1.11 Different trays

As explained in chapter 1.2 there are different sample trays. One with 8 samples, one with 10 sample positions, one with 12 samples and one with 21 sample positions (see Figure 76). The user organizes the layout of the different trays himself.

In this design the user can switch between the different trays by swiping from left to right.

Final Design

3.1.10 Error message

When there is something wrong with the measurement an error message appears (see Figure 77). This error message will flash, to get even more attention. At the screens that show the different trays, the sample where the error is occurring will get a red cross. The error message is 'expressed in plain language', it 'precisely indicates the problem' and it 'suggests a solution' or even two in the case of the example.

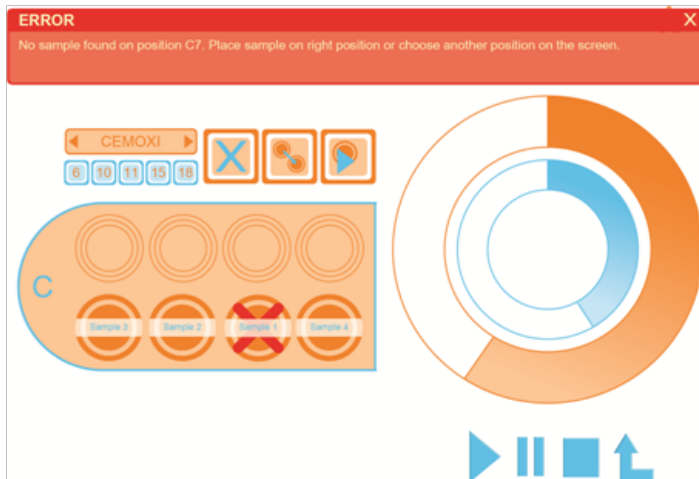


Figure 77

3.1.12 Remaining

Progress bar

The progress bar exists of two circles. The small blue circle implicates the progress of the current sample and the big orange circle represents the total progress time. This circle is bigger because this is more important feedback for the user when he is checking from a distance if the system is almost done measuring.

Home button

The home button provides the possibility for the user to always go back to the home screen (see Figure 78). With the arrows the user can go back and forth between the current screen and the last screen he has been. This means that the user has a lot of 'control and freedom'.



Figure 78

Play, pause, stop and origin buttons

These buttons shown in Figure 79 represent the 'measure', 'stop', 'abort' and 'open cover' buttons of the original software. In the current software stop means pause the system, leaving the sample that is in the measuring tube at it is. Stop means the current measurement will be closed, and this sample will brought back to its first position.



Figure 79

Final Design

3.2 Future designs

3.2.1 Introduction

The final design cannot immediately be used on the cover of the Zetium. The technology is simply not that far. In this research no suitable solution is found for an interactive transparent display on the cover of the Zetium. It will take a few years before the technologies are developed enough to use the final design. Before this, so in the near future, a non-interactive interface could be used by just projecting it on the cover. When the technology permits the final design can be used. When you go further into the future a more extensive design can be used, and even further in the future a futuristic design could be made using laser projection into the Zetium. This chapter gives an impression of what these other designs will look like. They are not developed extensively but it gives an idea of what it could be.

In chapter 3.3 all these design segments will be divided over the years, with the matching technologies, in a roadmap.

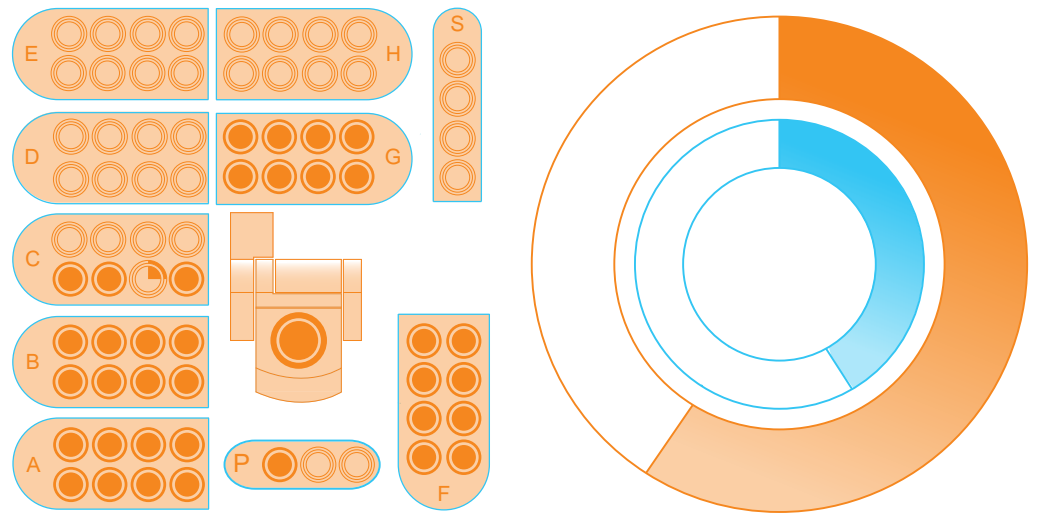


Figure 80

ERROR

No sample found on position C7. Place sample on right position or choose another circle on the screen.

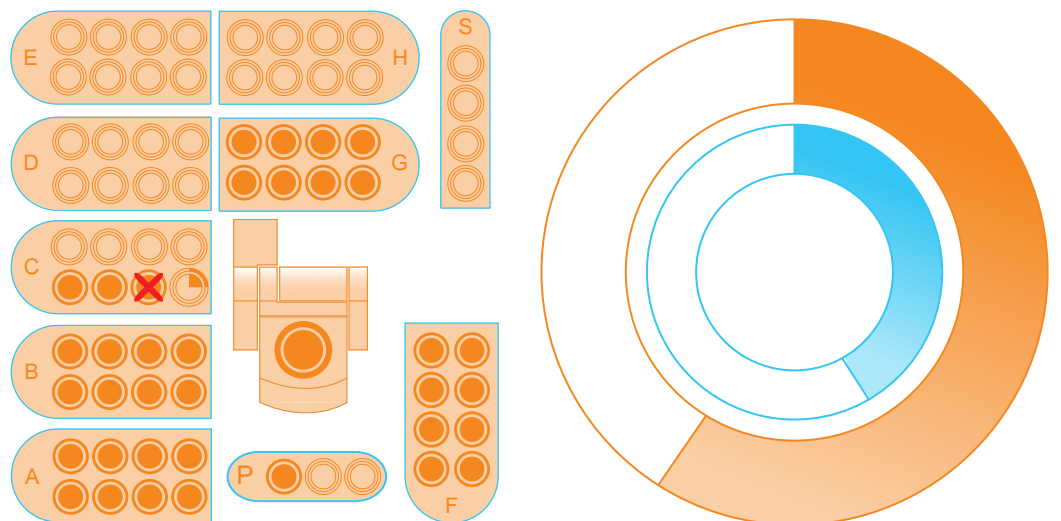


Figure 81

Final Design

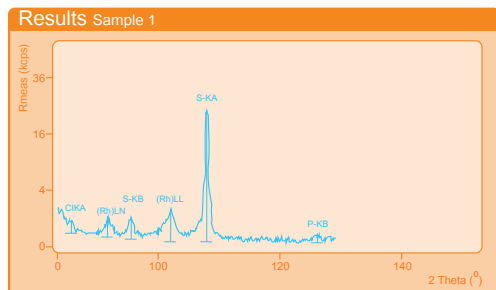


Figure 82

Results	
Measurement	
Application	CEMOXI
Type	Routine
Sample	Sample 1
Date & Time	4/2/2015 14:55
Archive	CEMOXI
Quantitative	
Sum	0.0000 %
Concentrations	
SiO ₂	4400000.000 %
Al ₂ O ₃	4400000.000 %
Fe ₂ O ₃	4400000.000 %
CaO	4400000.000 %
MgO	4400000.000 %
SO ₃	3372098.828 %
K ₂ O	4400000.000 %
Na ₂ O	4400000.000 %
P ₂ O ₅	4400000.000 %
TiO ₂	4400000.000 %
Mn ₂ O ₃	4400000.000 %
SrO	267155.859 %
ZnO	20.801 %



Figure 83

3.2.2 Non-interactive design
The non-interactive design is something that can be used in the near future. It exists of four elements. First the progress bar. This is displayed very big so that the user can keep track of the progress from a distance. Next to this the total overview of the trays is displayed. Now the user can see from a small distance which sample is busy analyzing (see Figure 80). Secondly the error message. This error message is the same as the one in the final design (see Figure 81). As a third the results table and result graphic. These are displayed next to the progress bar. The user can see the results as time passes (see Figure 82 and 83).

At last a new feature. This feature is a list of all the data that has to be filled in on the computer. Normally the user gets this data on a piece of paper, but by projecting it on the cover, the user can just take over this data from the cover and an extra step will be beaten, namely the printing and delivering of the paper. It will also reduce the printing costs. The data list will be send to the projector from a computer (see Figure 84).

Information list					02-11-2015
Sample Number	Identification	Application	Init Weight (g)	Flux Weight (g)	Final Weight (g)
440338	Sample 1	CEMOXI	0.9000	9.0000	9.0000
440343	Sample 2	CEMOXI	0.9000	9.0000	9.0000
440354	Sample 3	Cement	0.9000	9.0000	9.0000
440363	Sample 4	Omnian	0.9000	9.0000	9.0000
440375	Sample 5	Cement	0.9000	9.0000	9.0000
440384	Sample 6	CEMOXI	0.9000	9.0000	9.0000
440398	Sample 7	CEMOXI	0.9000	9.0000	9.0000
440401	Sample 8	Omnian	0.9000	9.0000	9.0000
440413	Sample 9	Cement	0.9000	9.0000	9.0000
440424	Sample 10	CEMOXI	0.9000	9.0000	9.0000
440431	Sample 11	CEMOXI	0.9000	9.0000	9.0000
440444	Sample 12	Cement	0.9000	9.0000	9.0000
440456	Sample 13	Cement	0.9000	9.0000	9.0000
440459	Sample 14	Omnian	0.9000	9.0000	9.0000
440462	Sample 15	CEMOXI	0.9000	9.0000	9.0000
440468	Sample 16	Cement	0.9000	9.0000	9.0000
440477	Sample 17	CEMOXI	0.9000	9.0000	9.0000
440478	Sample 18	CEMOXI	0.9000	9.0000	9.0000
440481	Sample 19	Cement	0.9000	9.0000	9.0000

Figure 84

Final Design

3.2.3 Complete software design

In this design all settings are possible. It has the same features as the current software. The computer is no longer needed. This complete design will exist further into the future because a lot of changes must be done to the Zetium in order to make this software work on the cover. It will take some time to make these changes happen. In Figure 85 is shown what the home screen will look like when it has tabs for all features.

The tab menu can be minimized when it is unnecessary. When it is minimized it turns into a small square in the left corner of the screen (see Figure 86). When this square is pressed the tab menu will appear again.

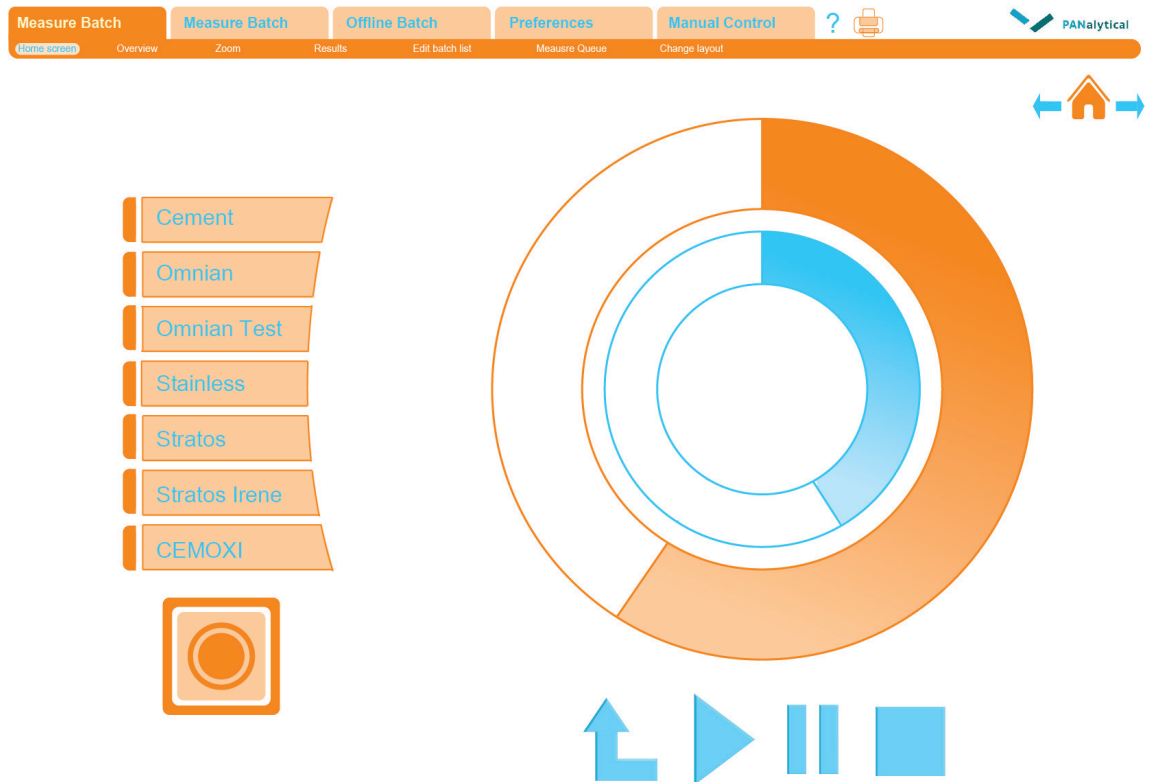


Figure 85

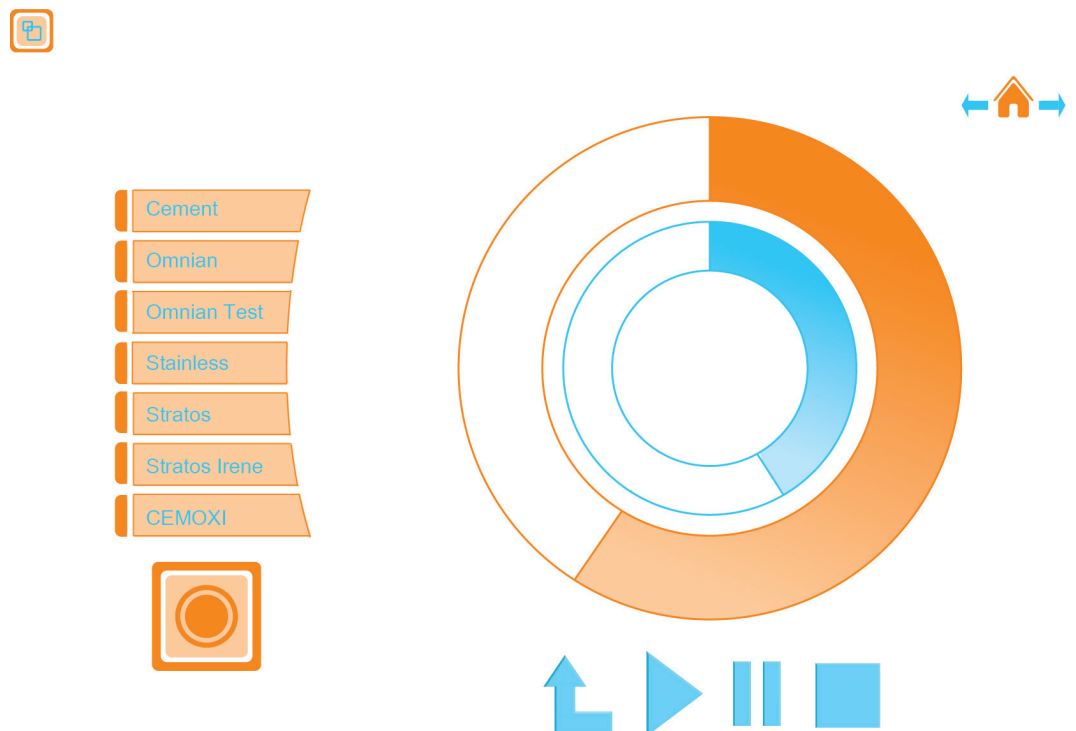


Figure 86

Final Design

3.2.4 Futuristic design

The futuristic design assembles the software and the Zetium more. It uses elements of the Zetium to project information on. Instead of copying the overview of the trays it uses the actual trays to give information about the name of the sample and which sample is busy analyzing (see Figure 88). This only shows the name of the sample and a busy sample but a lot more information could be projected like something on the measure tube or information about a sample next to it or the lettering of the trays etc. In Figure 87 is shown where the laser would be placed. In the future it must be able to move to avoid being interrupted by the grabber.

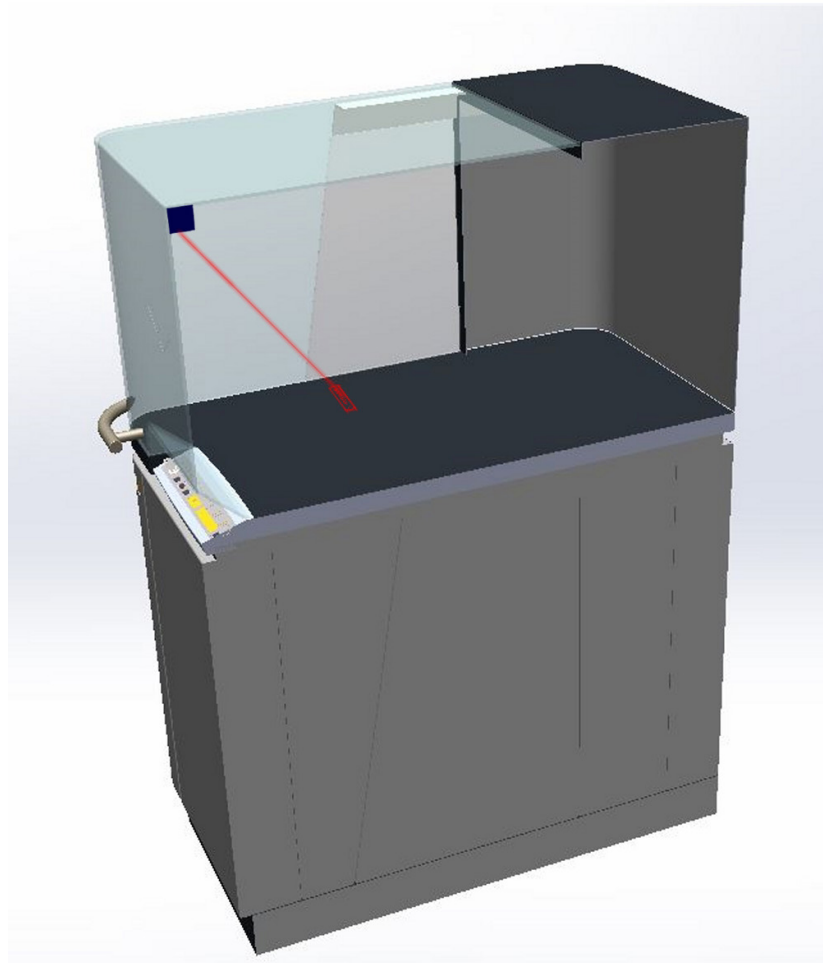


Figure 87



Figure 88

3.2.5 Conclusion

These are all scratches of future designs. If these designs will actually be used on the cover, these designs have to be developed a lot further to be suitable on the cover, but this is not part of this report. In the next chapter these designs will be divided over the years in a roadmap.

Final Design

3.3 Roadmap

3.3.1 Introduction

In this chapter all findings of the research in this report are arranged in a roadmap. This roadmap is shown in Figure 89. This roadmap is made because most technology and design options are not possible in the near future. For example, OLED is the most promising display technology, but it is not yet in an advanced stage. The expectation is that it will be more advanced and cheaper around 2020. In this roadmap an estimation is made about the use, technology and the design in the next ten years from now till 2026.

3.3.2 Use

First the use of the software is explained over the years. When you go further into the future the use of the software on the cover of the Zetium gets more and more advanced.

3.3.3 Technology

The different display and input technologies are divided over the years. Which technology is used when is indicated with a scoop on the right position. Also the use of the personal computer is mentioned. This use represents how often the user has to go back and forth between the computer and the Zetium. This decreases as you move further into the future.

3.3.4 Design

The different designs are also included in the roadmap. This way it gets clear which design will be used in which timeframe. The different designs are indicated by using the name which is also used in chapter 3.1 and 3.2 for the different design segments.

3.3.5 Limitations

There will be more changes as you move further into the future. For example the processor of the Zetium. In order to make the OLED screen or the touch screen work it has to be controlled by the Zetium. This will cause a lot of changes in the technology of the Zetium. However this is not included in this roadmap because it goes beyond this survey.

Final Design

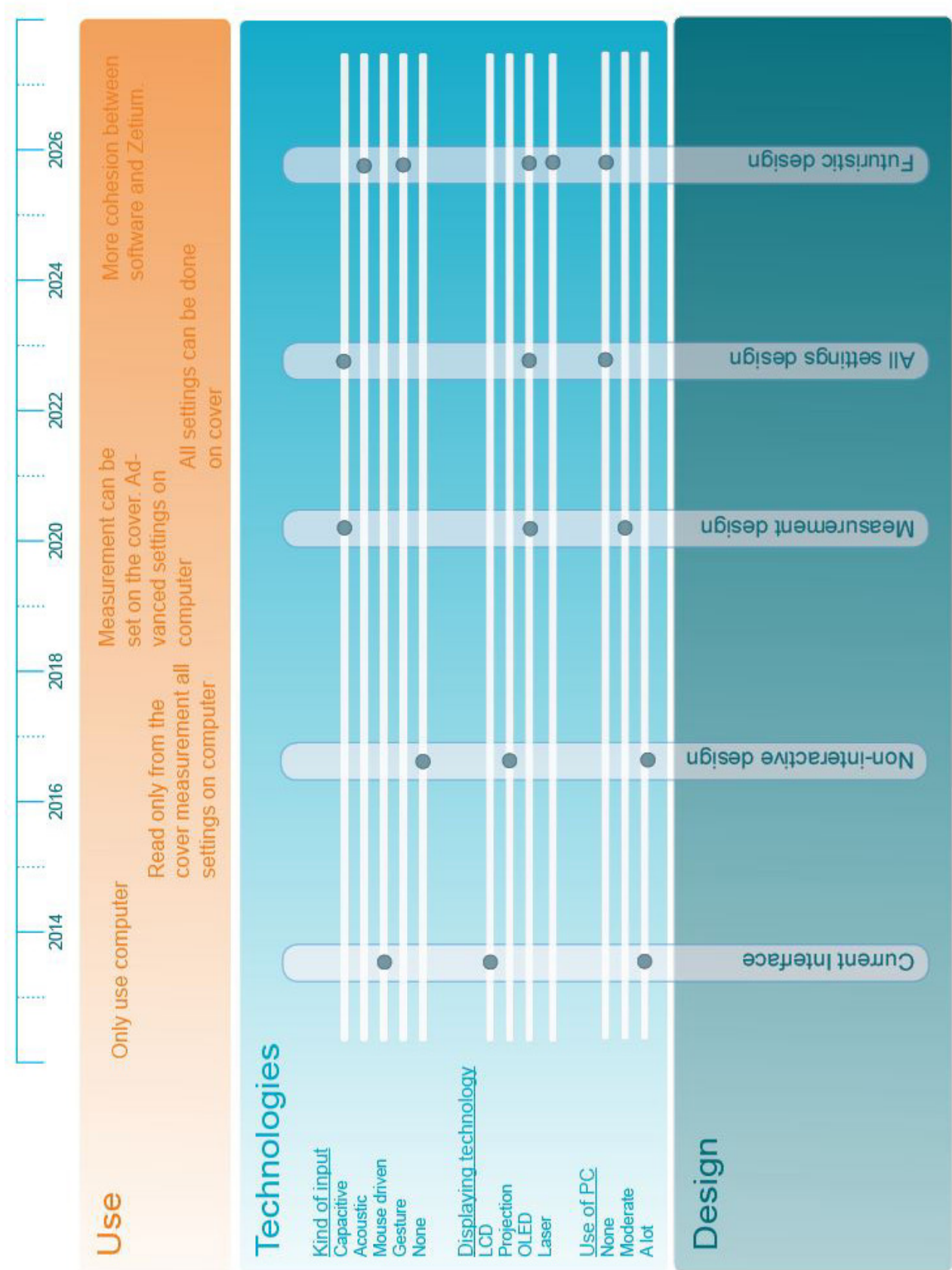


Figure 89

Final Design

3.5 Program of requirement test

3.5.1 Introduction

In order to test if the final design meets the program of requirements it must be compared to it. This is only done with the final design and not with the future designs, because these are just concept ideas. This means the design has to meet all the requirements because it is an interactive design.

First the program of requirements is repeated, after this something is said about every requirement.

3.5.2 Program of requirements

Interface design...

1. is suitable for a transparent display
2. meets the design principles
3. its appearance matches the look of the Zetium
4. can be used by experienced users
5. can display the information the operator needs
6. contains feedback about the system progress
--> Feedback can be seen from a distance of 5 meter
7. can give warning signals
--> Warning signals can be detected from a distance of 5 meter
8. contains a reference to the sample locations
9. indicates which sample is on which location
10. indicates which sample is in progress
11. contains the possibility to choose different measure applications
12. use can be learned in one day
13. makes use of different colors
14. has high contrasting colors
15. uses swipe
16. can switch between different "sheets"
17. contains an ability to enter characters
18. a whole analysis can be done by only using the Zetium
19. contains an option to send the end results to known addresses

1. ✓
2. ✓, most of them (mentioned in chapter 3.1)
3. ✓, rounded corners
4. ✓, resembles the existing software
5. ✓
6. ✓, distance has to be tested
7. ✓, distance has to be tested
8. ✓
9. ✓
10. ✓
11. ✓

12. ?, needs to be tested
13. ✓
14. ?, has to be tested on the cover
15. ✓
16. ✓/X, not directly
17. ✓
18. ✓
19. X

3.5.4 Conclusion

Most requirements are met, with exception of requirement 16 and 19. These two requirements were not taken into account when designing the interface. But the least important requirements are at the end of the list so these requirements are not as important as the ones before, which are met.

Some requirements must be further tested to know if these are met. For example the question if the requirements can be learned in one day can only be answered by doing a test with an inexperienced user.

Just based on this test is not enough. There has to be performed a User-Test. This will be described in the next chapter.



Figure 90

User-Test

4.1 User-Test

4.1.1 Introduction

Finally the design is tested. Only the final design is tested, the other future designs are left out.

The final design is tested by using a demo version of the interface. Four subjects did the test, two experienced users and two inexperienced users. This number should actually be higher, but their just was not a possibility to get more experienced users, so the inexperienced users is kept on the same number to be able to compare the two tests more reliable.

The test is conducted on the cover of the Zetium. This is done by projecting the interactive interface on a holographic layer on the cover. The subject performs the test on the cover of the Zetium. This cover is not interactive of course, so the interrogator must simulate the actions of the subject on a computer that is connected to the projector (see Figure 90). The set-up can be seen on Figure 91 and Figure 92. At the end of the User-Test the interface will be discussed with all the participants. Everything will be filmed so everything can be taken into account in the conclusion and recommendations.

Two things are tested by doing two different tests. In the first test the difference between an experienced and an inexperienced user is tested. This way a conclusion can be made if the interface is easy to understand when the subjects knows the old software and if the interface is intuitive enough. Eventhough intuitiveness is not extremely important (see Paragraph 1.2.9), it does has to be taken into account for users that will not use the software on a daily basis. Secondly the time difference between a measurement on the existing software and a measurement on the new software has to be tested. This is done by performing the same tasks on both interfaces. One on the computer and one on the cover. One experienced user has to perform the test 3 times to compare the time difference. One time on the cover with the new software, once on de computer with the current software and another time on the cover with the new software. It must be done three times, because when the user performs the tasks on the computer he already knows which tasks are going to come, so he will be quicker anyway. By doing it another time on the cover the user has the same knowledge at the beginning, so the comparison will be more reliable.

Both tests are needed to draw the right conclusion. The difference in time with the first test says something about the comprehensibility, but the difference in time in the second test says something about the handiness of the use of the software.

At the end an questionnaire is done. By this questionnaire more information about the subject its opinion can be obtained. This questionnaire can be found in Appendix L. After this questionnaire there has been a discussion that was caught on camera. This discussion is processed in the conclusion of chapter 4.2. Doel

4.1.2 Test procedure

Test 1

Goal:

Test comprehensibility of the interface for experienced and inexperienced users.

Sub goals:

- Readability
- Suitability
- Use speed
- Intuitiveness

Dependent variables:

- Task completion time
- Number of errors per task
- Type of error per task
- Users opinion

Independent variables:

- Knowledge of existing software
 - > User knows existing software
 - > User does not know the software at all

Evaluation methods:

- In-direct observation with a camera
 - > Note findings afterwards
- Interrogation
 - > Interview

Hypothesis:

- Users who knows the existing software will finish the tasks in less time and with less mistakes than the users who does not know the software at all

User-Test

Subjects:

- 2 employees of PANalytical who know the existing software
- 2 random persons that do not know the existing software (these people get a description about the Zetium and the possibilities of the software)

Tasks:

This are the actions the subjects have to do to see if they can deliver the established tasks. This way every part of the interface is addressed.

Begin at home screen (the user just placed a sample at position C7 and wants to sign it in)

1. Sign in sample at position C7 with measure application CEMOXI
2. Give sample the identification: Sample 1 (including a space)
3. Change the measure application of sample 2 placed on position C6 from CEMOXI to Omnian and press OK
4. Remove sample placed at A2
5. Start measurement
6. Enlarge tray C in order to read the names of the different samples
7. Move sample 2 from position C6 to C1
8. View measure results of sample 2
9. Switch to measure results of sample 1
10. Switch from results in a table to results in a graphic
11. Go back to home screen

Test set-up

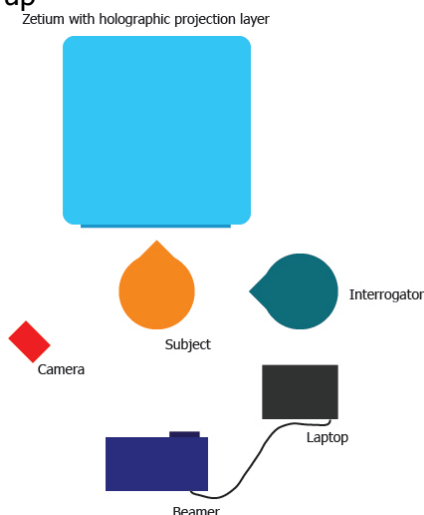


Figure 91

Test 2

Goal:

Test improvement of the new software on the cover of the Zetium, compared to the existing software on a computer.

Sub goals:

- Readability
- Use speed
- Comprehensibility
- Use of shortcuts

Dependent variables:

- Total completion time
- Users opinion

Independent variables:

- Software type
 - > Existing software
 - > New software

Evaluation methods:

- In-direct observation with a camera
 - > Note findings afterwards
- Interrogation
 - > Interview

Experiment form:

- Uitoeken als resultaten binnen zijn

Hypothesis:

- Total completion time of all the tasks is shorter when using the new software than using the existing software

Subjects:

- 1 employee of PANalytical who know the existing software

User-Test

Tasks:

The difference between this tasks and the ones in the first test is that in test 2 the switching between the Zetium and the computer is taken into account. This way the total time can be measured.

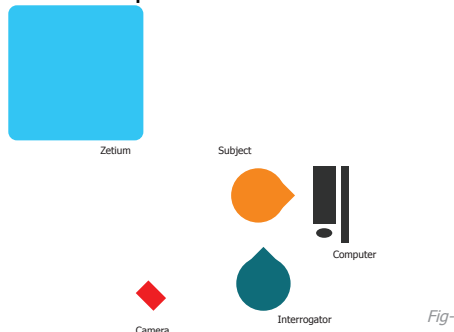
Begin at home screen

1. Put a sample cup at place C7 in the Zetium
2. Sign in sample at position C7 with measure application CEMOXI
3. Give sample the identification: Sample 1 (including a space)
4. Change the measure application of sample 2 placed on position C6 from CEMOXI to Omnian and press OK
5. Remove sample placed at A2
6. Start measurement
7. Enlarge tray C in order to read the names of the different samples
8. Move sample 2 from position C6 to C1
9. View measure results of sample 2
10. Switch to measure results of sample 1
11. Switch from results in a table to results in a graphic
12. Go back to home screen

Tray C is done analyzing

13. Pause the measurement and get tray C out
14. Resume measurement

Test set-up



4.1.3 Results

All results can be found in appendix M.

Time

The time results are summerized in table 1. The inexperienced users finish the tasks on average slower than experienced ones. But this difference is so small that you can say that the interface is quite intuitive for an inexperienced user.

Experienced	Inexperienced
n=2	n=2
avg = 123.5 s	avg = 191.5 s
SD=14,5	SD=24,5

Tabel 1

The test on the old software is performed a bit faster than the test on the new software. This is mainly caused by the fact that typing on the new software takes a lot of time. The extra tasks, so the tasks where switching between the two devices was necessary took less time on the current software.

Errors

The two most common errors are tasks 7 and 6. When the sample must be moved to another position the subject wants to drag it instead of using a button first. This is a very logical response that must be included in the software. To zoom a tray you have to swipe but the users want to use a zoom tool or double click the C to open it. This should also be possible so again a understandable mistake.

There was also some hesitation which button was meant for opening the total overview in task 1. But this will only be a one time hesitation in real life. After using the interface once, an user will know what to do.

Questionnaire

What really emerges when you take a look at the answers is the fact that performing a measurement standing is not an ideal position. The cover of the Zetium is quite low for an average sized male. The user has to bend a lot to be able to enter something. Another thing that almost all subjects mentioned is the fact that a vertical keyboard is not easy to type on. People are used to typing horizontally. All in one the position of working on the Zetium is not very desirable for many measurements.

Another thing that arises is that the interface is not always consistent. For example with all actions you have to use a button first, but not when you want to show the results. This is also weird because when you click on a sample in the total overview you will not see the result screen. But this is only the case in this demo version. In the real interface you can also see the results from the total overview by moving the fingers like Figure 70 on page 48.

Another thing that is said is that the colors look somewhat dark on the cover. This is mainly caused by the projection.

User-Test

4.2 Conclusion

This conclusion is not only based on the tested facts but also on the discussion afterwards.

The new design for the interface itself came out quite good. It is easy to understand and the proceedings can be done easily and quickly. Some things are not very consistent, like the use of a certain button before you can do a proceeding. The use of touch and gesture input is often forgotten, like with the replacement tool of a sample. This input methods should be used more in the interface. Also with switching between the four different main sheets that exist. The user should be able to swipe between these main sheets to get on another sheet. So for example swipe two types to the left to get from total overview to result page.

The experienced users thought it was convenient to have a button to open the graphic. In the current software a graphic can only be seen while measuring. They stated that it is in fact a desired option in the future.

The subjects said, if you look at the design on the cover it looks high-tech and 'cool'. Especially in a room where a lot of devices stand next to each other it will give a nice effect. What was expected beforehand was the fact that the background, so the inside of the Zetium, would distract a lot, but this is not the case at all. It is easy to focus on the interface itself. During the test the user does switch between the background and the interface to look where he is actually performing something. This is exactly what was meant to be achieved.

A fact that could not be confirmed in the program of requirement test was the fact that the progress bar is visible from a distance of 5 meters. After this test this can be confirmed.

The main conclusion actually is that the interface design overall is pretty good, but what arose the most in this test was the fact that performing several measurements on the cover of the Zetium is not ideal. This is mainly caused by the fact that a keyboard in vertical position is not convenient to type on. It is overall a strange position to be in for a long time. The user has to bend a lot to reach some buttons. The Zetium was lower than expected. You will reach for a chair very quickly to get seated in front of the Zetium. Then you can work on a computer just as well. The use of the Zetium was an advantage when it came to switching between using the software and doing proceedings in the Zetium. This went more quickly with the new software on the cover.

Eventually more subjects should have been tested to get a more reliable result. Unfortunately this was not possible because PANalytical only had two experienced users available.

In the next section some recommendations are made for a redesign of the interface and its use in the future.

4.3 Recommendations

- Keyboard must be placed higher on the screen, so that the users do not have to bend while typing. This also counts for buttons that are important on a certain screen.
- Another options is to, instead of using a vertical keyboard, make some adjustments to the Zetium. For example to create more space for a horizontal keyboard. For example one that can extend from the Zetium when necessary.
- Make more use of the touch screen ability, for example when a sample has to be replaced to another position. Instead of using the replacement tool you can also drag it to the right position.
- Make it possible to switch between different sheets. So use swipe movement to go from home screen to overview. Than the button to go to overview is not even necessary. But on the other hand this will be less intuitive, because none of the subjects tried this move, but it will be convenient for the use.
- If projection is used the colors must be tested. The colors that are projected look different with projection than on print-outs or a computer screen. Hereby the colors may look less dark.
- In the future the software on the computer also has to be adjusted. This should look more like the new design, so operations will be more consistent.
- There has to be indicated in the overview which sample is done analyzing. This is forgotten in the design. This ready samples could for example have another color.
- In the future it is advisable to keep the use of the cover only for simple proceedings and make the software less extensive. The all complete software design is in any case excluded. The test shows that the advanced settings are more convenient on a computer screen. Only the basic settings must be possible on the cover. Especially the large progress bar and error message should stay. Also the overview of the samples must stay, so that its clear with one look which sample is busy. There is a possibility to put it the opportunity to remove samples that are ready, by swiping them away with a finger. This way the overview stays organized.
- If there is a possibility to enter samples and sample identifications anyway, it must be combined with a barcode scanner. There has to be a list with identifications with corresponding serial numbers. By scanning these serial numbers when the identification has to be typed in, the identification will directly appear on the screen. This will save a lot of time and ensures the possibility to perform complete measurements.

Conclusion

The market of transparent displays is still in upcoming. People do not use it a lot yet and is not ready easily available. Especially the most promising technology method, OLED, is still very unknown on the market and particular unavailable for consumers. LG and other organizations are going to invest substantially to make a lot of progress with this technology, according to article placed on technzine.nl. See appendix N. So you can see that the market makes rapid progress. Also the market of input methods is making a lot of progress. This market is in full development and is making progress quickly. Recently a new technology appeared on the market that can be attached to any TV-screen. See appendix O. This technology appeared on the market the same time I was finishing this report. As you can see, the market is developing rapidly. I expect that there will be a lot more advances in the near future on both areas, like shown in the roadmap. What is also expected to rise in the future is the use of gesture input. Displays and other interfaces will be controlled from a distance, like Tom Cruise does in Minority Report.

The substantive conclusion about the design are largely discussed in the conclusion of chapter 4.2. What else came up in the User-Test was the fact that the software demo has to be elaborated more to really get the errors out. Three months research turned out to be too short for this elaboration. The analysis to transparent display and input technologies was so time-consuming that there remained too little time for creating extensive interface. This is caused by the fact that deepening in the software was not priority. It is also caused by the fact that I only went to PANalytical a few times. They helped me as well as they could, but it is really difficult to really understand the software of such an unknown device so well that a well-thought final design can be made. It was also very difficult because PANalytical does not know a lot about their clients. They do not have documents or reviews of their clients experiences with the software. They only know one way of using the software and it was therefore very difficult to find obstacles and opportunities for improvement. Eventually it became a design based on the look and a little bit more focus had to be on making the software more user friendly. It became a restyling of the look and not really a restyling of the proceedings. I recommend to focus on the client and its use more in the future to create a more improved software with the look that is created in this report.

The purpose of the research is eventually not totally achieved. There is no suitable interactive display method found that will be a solution for the Zetium at this moment. But a promising design is made, that can be used in the future when a appropriate technology appears. My advice is to wait a few years until the market has progressed more. Because you do not want the make adjustment to the Zetium, that will be redundant a few years later.

Resources

Text

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Images

Figure 1.	http://www.panalytical.com
Figure 2.	http://www.panalytical.com
Figure 5.	https://clu-in.org
Figure 6.	Inside PANalytical
Figure 7.	http://www.panalytical.com
Figure 8.	PANalytical software
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Figure 26.	http://www.theprojectorpros.com
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