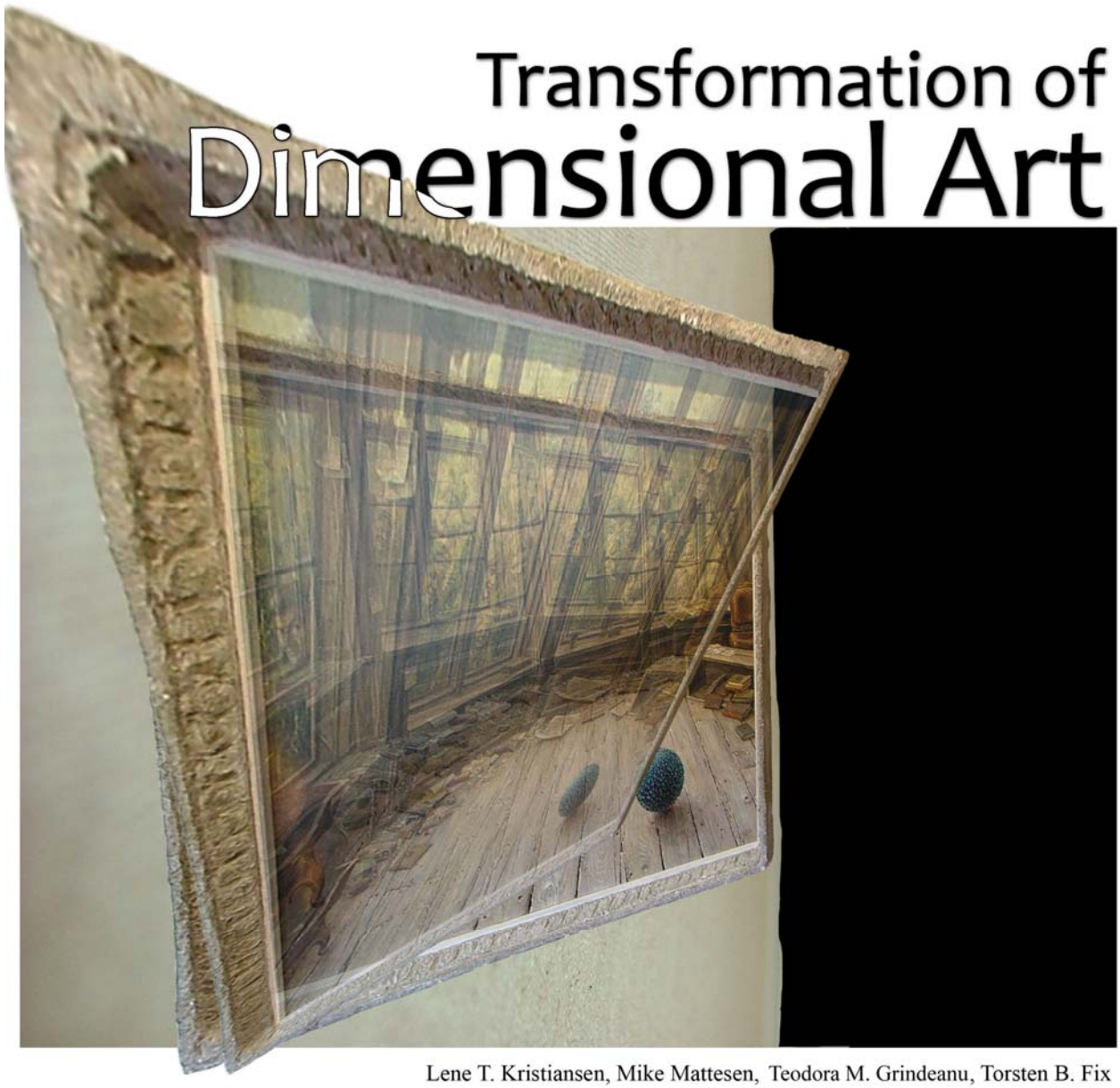
Transformation of Dimensional Art



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Abstract

The purpose of this report is to provide the theoretical background for our transformation concept. It contains a description of the necessary dimension theories and an art parallel between these dimension concepts. There is a case study approach to the different technologies that can be used in the practical realisation of the transformation product. Finally, there will be a description of how the product will be realised.

Keywords: Otto Frello, Art history, 3D, 4D, time, space, Lenticular Sheet, transformation

1 Introduction

The overall purpose of our report is to enhance our understanding and state about the research process we are making in order to solve the problem of converting time and movement elements into design products. In order to do that we will elaborate artistic and technical references that will backup both our project and the concepts we will work with.

The concrete purpose of this paper is to elaborate a visual expression of the transformation from 2D to 3D or even 4D in the context of visual interpretations of time and space.

The aim of our research is to gain an insight of how to realise an experiment of a 4D experience. Throughout this paper we will, with the use of theoretical and technological backgrounds, report about the development of our experiment.

Furthermore, to explore our horizon and to gain knowledge and inputs, we will research the different technologies on the market today and how they can be used in the practical realisation of our idea.

With this knowledge we will transform one or more of the paintings into an impressed experience of higher dimensions with the help of the chosen technology and thereby give ourselves the opportunity for an approach to prove or disprove the theories we are going to investigate.

In order to gain understanding from reading this paper, the reader has to be aware of the terminologies 2D, 3D and 4D. Furthermore, the reader needs to have an insight of the different art movements, especially about surrealism, naturalism and realism, and Jugendstil or modernism.

In the development of the paper we have made use of the following methods of research:

- Interviews
- Documentation reviews
- Case studies

Each of the mentioned methods is used in specific parts of the paper depending on what is the information we want to retrieve and use.

In this report, we will first outline the theoretical background that will serve as fundament for the further development of this report. We will do this by using interviews and documentation reviews. Second, we will consider the different existing technologies by investigating case studies, so that the more appropriate technology will be used. Finally, we will examine the particular chosen technology and how it can be used in our situation. The achieved result will than be tested intern in the project group and if the time permits we will try to get the impressions from other observers.

We will do that by interviews and careful observations of the way the observers react to the exhibition. We will conclude with a brief comment about the achieved results in the theoretical and practical sense and a summary of our findings.

Convention:

We chose to use the following notations in the title translation of Otto Frello's paintings:

'Københavnerbillede' (e.g. 'Picture of Copenhagen')

2 Theoretical background

The purpose of this section is to establish a correlation between the Danish artist Otto Frello's paintings and his placement in the history of art. We will start by looking at Otto Frello's distinguishing style and later on we will try to describe the most significant art concepts that would possibly be important for the analysis of his paintings. The reason why we have chosen to use Otto Frello in the further research is that he, in our case, is very interesting. Not only because he is a local artist but also because of the high amount of detail and his manipulation with time and space in his work made our choice final.

2.1 Otto Frello (1924 -)

In a very young age the Danish painter Otto Frello was passionate in expressing himself throughout drawings and illustrations. In his twenties he started working as a house painter in the city of Esbjerg, but after 4 years in this job he moved to Copenhagen to educate himself in the art history. After finishing his studies he became a teacher at the same school. His primary public work was illustration drawings for various publishers and by working with this kind of art he developed the technique of perfectionism that later on from 1970 was mirrored in his paintings.

Born in a little village close to the city of Varde and later on established in Copenhagen, he changed his vision about the landscapes and lifestyle. The crowded life and the fact that he was living in the centre of Copenhagen marked his paintings. He was inspired by both the surroundings of his own house and by the life around him.

In almost every painting we can distinguish a high degree of detail. Almost every inch of the painting is filled with information in such a manner that the painting itself is not heavy to look at. At first glance his paintings may seem confusing, but at a closer look we are introduced to a story that for every painting is more or less hidden. The more time we spend looking at a certain painting the more we discover its meaning, and the hidden story becomes clearer. The way in which Otto Frello chooses his storytelling is made in such a way that it is open to individual interpretations, which does not make the paintings less interesting.

The artistic 'mystery' about Otto Frello is the fact that, if we had the chance to meet him and ask him about his paintings, he would not divulge the secret or the meaning of it. Every person who has seen his work has developed their own idea of the meaning, and to Otto Frello, they could all be right. It is not about what the painter himself has been thinking when painting, but instead it is

about what every individual person gets out of the paintings. One interpretation can be just as right as others. This fact makes the experience of admiring his work more exciting and fulfilled, because you as the spectator do not need to have a predetermined way of understanding the different paintings. [1]

2.2 Artistic effects

In this section we will focus our attention on the characteristics of Otto Frello's paintings and what exactly make us say: 'This is an Otto Frello painting'.

One of the characteristics of his paintings is that they are organised in a way that the spectators gets an illusion of being in a place that could possibly be somewhere in the real world. It is therefore important to place the paintings so that the painted horizon matches the height of the spectator's eyes. By doing so, this feeling of being present is increased, and it is possible to get a feeling that makes you want to enter the paintings and to be a part of the created scenery.

Among the most important effects that Otto Frello uses we find the 'Trompe l'oeil' and the 'ClairObscur'. [2]

'Trompe l'oeil' is an eye-deceiving graphic elaboration built on linear perspective mathematical rules, which is used by many artists in order to create objects that trick the viewer into believing that he or she is looking at a photographic reality. When artists use this technique they make a deliberate attempt in constructing artificial and fake perspectives, which in many cases results in the wanted eye-tricking effect.

'ClairObscur' is another painting technique that is based on the light and darkness opposites. This method is used to create a strong contrast of light and dark shading with the purpose of creating space as realistic as possible.

Another art technique that can be accentuated in Otto Frello's paintings is plasticity, which is related to the 'Trompe l'oeil'. This is used to create the 3D sensation on a 2D canvas by making use of light and shadows, and you will as a spectator achieve the feeling of presence.

The picture to the right illustrates the 3D sensation by interacting lights and shadows in order to create an illusion of depth. In other words, if you are not aware of the fact that it is a painting, you would properly think that this is real, and some people would be drawn to the painting, trying to touch and feel the depth and texture.

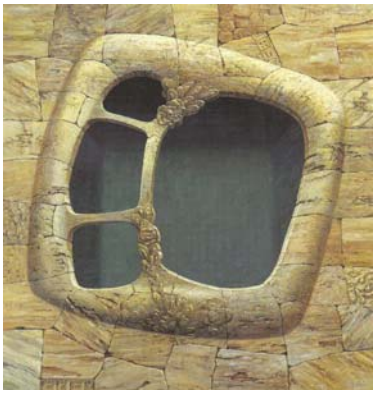


Figure 1: Otto Frello, 'Gennembrud' (e.g. 'Breakthrough')

Another characteristic element is the framing of the paintings. Their importance is at the same level as the painting itself.

Figure 2: Private photo of the painting – Otto Frello, 'Det sidste Menneske' (e.g. 'The Last Person')

Figure 3: Private photo of the painting – Otto Frello, 'Det sidste Menneske' (e.g. 'The Last Person'). The frame is intergrated in the painting.

The picture above illustrates the idea of the last person alive. The frame is a part of the overall impression that the painting reveals. The doubled frame seems to tell us that we have to be aware of the degeneration process. It is necessary to have the second frame in order to protect the painting against the worms, but as it can be observed in the picture, the worms got to the painting's inner frame and have already begun to eat their way through the last person alive.
Worms eating the frame or old wood in general is very common, but it is though important to understand that the holes in the painting and the fingers are constructed by the artist, and not a natural process. This is again an example of the high amount of detail, and it gives us a great idea of Otto Frello's structured way of thinking.

Like every artist, Otto Frello has developed his personal 'poetics', which is his way of articulating concepts, techniques, physical and/or pictorial elements, his own life experience, time and space, etc. in order to build his work through the years. Besides this he attends to experiment with different references from both himself and other known artists, without plagiarizing their work.

Figure 4 and 5 are examples of how Otto Frello makes use of elements from known artists in the context of his own paintings. Marc Chagall, Leonardo DaVinci and P. S. Krøyer are the sources of inspiration for the above examples.

Figure 5: Otto Frello, 'Stormvejret' (e.g. 'The Stormy Weather')

The picture in figure 4, 'Chagalls modeller' (e.g. 'Chagall's Models') is painted with inspiration from both Marc Chagall's work and Leonardo DaVinci's 'Last Supper'. The painting reveals the 'Last supper' atmosphere, but the characters are not of religious background like in the original painting of DaVinci, but of imagined features like in Chagall's work. The pictures below in figures 6, 7 and 8, shows the similarity between Otto Frello's painting 'Chagalls modeller' (e.g. 'Chagall's Models') and the references. As it can be seen, the way Marc Chagall paints both animals and humans is not completely realistic, but they are still close to reality, or at least we can

Figure 6: Leonardo DaVinci's 'Last Supper'

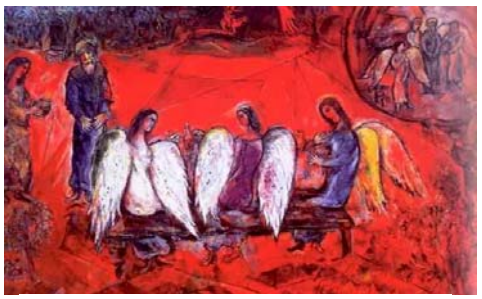


Figure 7: Marc Chagall, 'Abraham and the three angels'

Figure 8: Marc Chagall, 'Feathers In Bloom'

differentiate the interpretations of the different characters that populate his paintings. There is not a single painting that contains all of the characters that Otto Frello's 'Chagalls modeller' (e.g. 'Chagall's Models') exposes, but at a closer look at Chagall's painting style and amount of work, we can easily distinguish the similarity of the style reflected in Otto Frello's painting. In other words, Otto Frello has picked out some essential characters from different paintings and has recreated his own idea of Leonardo DaVinci's 'Last Supper'.

For a more detailed reference and more pictures, check the enclosed CD.

Figure 9: P.S. Krøyer's 'Sommeraften på Skagen Strand' (e.g. 'Summer Afternoon on Skagen Beach')

In the picture 'Stormvejret' (e.g. 'The Stormy Weather') figure 5, Otto Frello refers to the artist P.S. Krøyer's 'Sommeraften på Skagen Strand' (e.g. 'Summer Afternoon on Skagen Beach'). The referring elements in Otto Frello's painting are the two women hiding from the storm behind the boat. P.S. Krøyer's painting is shown in figure 9, and it is here possible to see the comparison. Even though the colours on the women's dresses are different from one painting to the other, the reference is still obvious.

In addition to referring to other artists, Otto Frello makes use of repetition both from painting to painting, but also in the individual painting. He uses elements from his previous work into new contexts. To better illustrate this we will take a closer look at the following cuttings in figure 10, 11 and 12, which are just a few examples of where Otto Frello uses this kind of repetition.

Figure 10: A cutting of 'Skorstenen' (e.g. 'The Chimney')

Figure 11: A cutting of 'Regnvejret' (e.g. The Rainy Weather)

Figure 12: A cutting of 'Stormvejret' (e.g. 'The Stormy Weather')

In the painting called 'Skorstenen' (e.g. 'The Chimney') Otto Frello has painted small men running around in the background, and one of these men is repeated in a number of his other paintings. It is the same man, but he is put into another situation and environment. As it is shown in the above pictures, the running man is used in 'Regnvejret' (e.g. The Rainy Weather) and 'Stormvejret' (e.g. 'The Stormy Weather'). This clever use of repetition gives the spectators an idea of a whole, because it is rather obvious that the 'running man' crosses boundaries between paintings in these represented worlds.

2.3 Otto Frello & Art History

After accentuating the characteristics of Otto Frello's style, we will continue this section with the analysis of his work in the context of art history in general. The brief introduction from the previous section gives an idea of which features to look for in the different art movements. It should though be mentioned, that Otto Frello can not be compared directly to one or more of these movements, but rather elements from his individual paintings can be associated with the different characteristics from these art movements.

2.3.1 Surrealism

Surrealism is an artistic movement and an aesthetic philosophy that aimed for the liberation of the mind by emphasizing the critical and imaginative powers of the unconscious. We have to notice that 'surrealism' is not about 'dreams' or 'dreaming'. [2]

To be able to compare Otto Frello's work with the surrealism we have to find elements of his paintings that can be surrealistic, but it is not right to place Frello into this category, because of his realistic way of expressing himself.

As an example, Otto Frello's paintings are not quite surrealistic even if some objects or elements seem to be. As he reveals in an interview, he paints elements from the real life.

> Otto Frello vil dog ikke betegne sig selv som surrealist, for han bliver altid indenfor virkelighedens rammer, selvom hans billeder indeholder besynderlige elementer. 'Surrealister tillader sig jo hvad som helst', siger han. 'Man kan ikke være inde i en verden hvor ting svæver i luften og ure smelter – det er en drømmeverden.' [3]

In other words Otto Frello does not see himself as a surrealist, because he always creates objects and environments from reality, even if his paintings contain bizarre elements. He means that the surrealists are allowed to paint anything, but we can not live in a world where everything is floating and watches are melting; this describes a dream world and not the reality.

This lays down the ambiguity of whether to place Frello in the surrealistic way of thinking or not, and as he states himself, he is not a surrealistic artist.

In the overall work that Otto Frello has made, we can observe that he focuses much on the experiences from his own life, and it is influenced by everything that surrounds him. This is why he in his paintings tries to reproduce with accuracy and detailed elements from the reality. The

‘worlds’ represented on his paintings are not ‘real’ although composed with real-like features. What amazes is the weirdness that comes from the painting all together built from little microscopic realistic like details. This is the reason why we took a closer look at the naturalism and realism movements in the context of art history.

2.3.2 Naturalism & Realism

Naturalism is an art form, which is often defined as having a strong touch of subjectivity. It is some kind of a slice of reality seen through the artist’s own personality and point of view. The different subjective ideas of what reality really is are revealed in the naturalistic work. [4]

The treatment of particulars is also a great deal in this art category, because in order to create a world close to reality, you have to be very detailed in all your work. A garden is not ‘real’ if the artist did not paint all textures, pebbles, grass, flowers etc. with a high amount of detail, and this is one of the reasons why Otto Frello’s paintings are such a good example of a naturalistic or realistic way of working. All of Frello’s paintings are very detailed, and his subjective sight on reality is very well reflected in his work. As mentioned earlier, the objects, persons or surroundings in his paintings may at first glance seem imagined, but if you take a closer look into his own world of reality, you will soon find out, that nothing ‘dream-world-like’ is to be found.

Figure 13: Otto Frello, ‘Læsende pige’ (e.g. ‘Reading girl’)

Figure 14: Niels Strøbek, ’Margrethe II’

The details ‘persuade’ us and show us, that maybe this could – also for us – be just as real as Otto Frello sees it. And the important issue in this case is that Otto Frello shows us as the audience his idea of reality, and if we disagree, it is not up to him to convince us into believing otherwise. In figure 14 is a portrait painting made by the realistic painter Niels Strøbek, and in the figure 13 is the

‘Læsende pige’ (e.g. ‘Reading girl’) made by Otto Frello. There is an obvious similarity between the two paintings; we can see the ‘reality’ that the two painters have chosen as surrounding elements and the details on the two main characters. We have seen before the personal way in which Otto Frello paints the ‘alive characters’ in his paintings; although the animals does not look like real-like animals, it is still a fact that the reading girl is surrounded by her pets.

It is important to remember, that this is not an attempt to frame Otto Frello as being a naturalist or a realist, because he still creates thoughts and fantasies without being surreal, but it gives us a better idea about how he works and why he does so.

2.3.3 Jugendstil

Another art style that grasped our attention is Jugendstil, also known as Art Nouveau or Modernism. This international movement was very wide spread into the domains of painting, arts and crafts, interior architecture and commercials. The movement took various names according to the different regions where it could be found, so that in Germany it was called ‘Jugendstil’ and in Denmark ‘Skønvirke’. The overall characteristic of this style is the fact that it refers to a young and new style that was against historicism and those who tried to imitate it. The representatives of this movement tried to unify the decorative art with the architecture and to combine the slinging forms of the nature into their work. [5]

There can be distinguished between two flows in the context of Jugendstil: an organic figurative style, and a more abstract style. The organic flow is sentimental and naturalistic with great importance on the natural forms, whereas the more abstract flow focuses on how art could be combined within the industry, and how the ornaments can agree with the functionality. [6]

At a closer look at Otto Frello’s work, we can distinguish elements of Jugendstil in the way the artist chooses to paint some of the details. The human characters that populate his paintings have often clothes or parts of the body that remind us of some flowers or plants we once saw in a tour in the forest, or the way in which ones clothing ornament can be recognized in the architectural ornaments that lay in the

Figure 15: Otto Frello, ‘Nyheder’ (e.g. ‘News’)

background.

The strong touch of ‘Jugendstil’ characteristics is revealed in an unusual manner. The architectural details are very strong, full of life and colours, so that they are integrated perfectly with the overall spirit that the painting reveals. The above picture is a part of the painting called ‘Nyheder’ (e.g. ‘News’). As it can be seen the construction of the building is made of decorative forms and has a familiar touch of nature. In the rest of the picture it is possible to find similarities to this building. This is mirrored in the human body structure, clothing and different body parts.

Until now we have only talked about Otto Frello as being a painter. But another interesting feature about him is the modelling techniques he possesses. This is revealed in the house model he has build. The interesting part of this aspect is that, at a closer look at the house model, we can easily recognize one of the ends of the building as being the same as the one in the painting ‘Nyheder’ (e.g. ‘News’). We have not been able to see the house model in reality, because of the fact that it was not exhibit at the museum in Varde at the time we visited, but it may be possible that other architectural features from his paintings can be recognized in the house model.

Figure 16: Pictures of Otto Frello’s house model

Recall the Introduction where we are talking about the transformation within the context of Otto Frello’s work. At this point in the development of the project, one may ask where we are going to fit the transformation concept. Besides visualising one or more of his painting in a 3D environment, we also talked about introducing the term of the 4th dimension from within the paintings. We will start by describing what the 4th dimension is or more precise how we perceive it, and later on we will establish a correlation between the 4th dimension and Otto Frello’s work.

2.4 Dimensions and art

In this part of the report we will concentrate on the art domain in the context of a multidimensional level. We will start by describing the dimensions in general and later on how we can relate this dimension terminology into the work of Otto Frello.

2.4.1 Dimensions

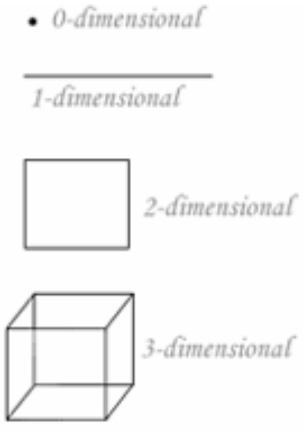
In this section, we are going to describe some of the theories about space and time and we will show our approach to the area of 4D where time and space are important elements.

The concept of a fourth dimension is one that is often described in considering its physical implications, that is, we know that in three dimensions, we have dimensions of length, width, and height. The fourth dimension is said to be at right angles to these three, and is often described as time. [7]

Using the term 'dimension' is a way of describing the space around us. We are moving through a three dimensional (3D) space in our known plane of existence, but in our modern world, many believe that our space of movement might include even higher dimensions. In the discussion about what the fourth dimension (4D) is, 'time' often seems to be a good explanation.

Space

The space is physically measured and estimated throughout 3 dimensions, which are: height, width and depth. It is also the presentation of our mobility as humans - we can move through physical space in these three directions.



When looking at the 3 dimensional spaces, they can be visualized in 2D drawings of each single dimension. This representation is depicted in figure 17, in our case after an axonometric representation. We have chosen this kind of representation because of the better way of justifying the movement across the 3 axes.

Figure 17: axonometric representation [8]

The first one is only a dot; this visualizes the “zero dimension” (i.e. no movement). The second is showing a line, representing the one dimension (going in only one direction). The third one shows a square (moving in two directions), and now space is created, because you can now coordinate points in the two-dimensional space. The fourth example shows the 3 dimensional space – a cube, describing possibility of movement in depth. With these three possible directions of space, we can describe the position of any point with three values, for instance: (x, y, z).

The idea that the space around us is build up through 3 dimensions, seems to be an undeniable statement, because it is a fact, that these 3 dimensions describe the possibilities of movement.

Because we can not see or touch something does not necessarily mean that it is not there. This is why we have to ask ourselves: ‘are there any further dimensions around us, and do these further dimensions affect our presence? And if they do not, how can we be sure that there are not any further dimensions of space that we just do not interfere with?’ A number of both physicists and mathematicians believe that our universe has far more than just three dimensions. They claim that there are up to eleven different dimensions to consider [9].

Figure 18: hypercube [8]

If we try to visualize how a fourth dimensional space would look like, the so called ‘hypercube’ is an excellent and classic example which can be seen in figure 18.

If we take a closer look at the hypercube, we will soon discover a great feature with the 4 dimensional space, because the form of the hypercube allows different 3D spaces to be present in the same space at the same time. This means that we can physically be in two or more different places at the same time, and it should then be mentioned, that this description of movement in 4D is only possible in theory.

Both a cube and a hypercube can be represented as 2D drawings of higher dimensional space objects. So if we can visualize objects from the 3rd and 4th dimension on a 2 dimensional drawing, would it be possible to visualize even higher dimensions in a 3D space?
In order to understand how higher dimensions work and can be visualized, we should take a look at how lower dimensions are visualized.

Edwin Abbot, an English schoolmaster and theologian wrote in 1884 a mathematical satire called *Flatland* [16]. This is the story about a fictional character called ‘A. Square’ and a 2 dimensional world that the A. Square lives in, called Flatland [10].

In his world, A. Square has only two dimensions of movement, namely the 4 directions of a 2D square: left/right and back/forth, and because of these restrictions of the 2D space, it is not possible for A. Square to go up or down [11]. If we apply this to us in the 3rd dimension, we would never be able to move in a 4th dimension.

If for instance a 3D sphere would roll over Flatland, it would not be possible for A. Square to see the sphere, but instead it would only be able to see the 'touch point' of the sphere on the surface of Flatland as being nothing more than a 2D spot [11].

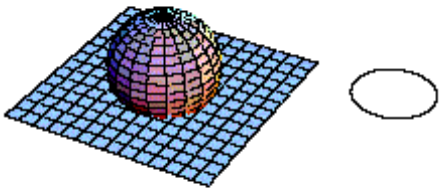


Figure 19: sphere example [12]

If the same 3 dimensional sphere would pass through Flatland, and then stop right in the middle of the 2D plane, the sphere would appear in Flatland as one circle, which A. Square would be able to see. (Figure 19)
If we take a number of circles in different sizes and stack them on top of each other, they will eventually take the form of an actual 3D image of a sphere [11].

The same would be the case if a 4D sphere suddenly appears in our 3 dimensional space, then we would see a 3D sphere appear out of the blue and it would keep growing until the 4D sphere would be halfway through our 3D space, and then it would shrink again until it would disappear back into the blue. This means that we, in theory, should be able to stack these 3D spheres in order to form a 4D sphere. [13]

It will always be possible for us humans to observe all the details from a lower dimension, like the 2D plane because it only visualizes one single perspective for each object. As a 3 dimensional being, it would be possible to place a finger inside the object in a 2D plane, without touching any of the sides. On the other hand, A. Square would not be able to do so, because it is bounded of its 2D surroundings, so it would not be able to enter an object without breaking through one of the sides. This means, that if a fourth dimension exists, 4D beings would have the ability to look down at a 3D object and see the entire 3D form - both sides - of it. We as humans are only able to see one half at the time [13].

This leaves us with a good picture of how difficult it is to figure out how to extend our possibilities of movement in 4D and probably impossible to do.

So what about the possibilities of visualizing higher dimensions in our 3D space? Although it is not possible to be at two different places at the same time, it seems to be possible to visualize the

idea of it. So in theory it should be possible to visualize the idea of movement in even higher dimensions within our 3D environment.

Until now we have only discussed the possibilities of movement into the different dimensional spaces. The following section will cover the time factor within higher dimensional spaces.

Time

In order to keep a common understanding and agreement upon the fourth dimension, we have chosen to look at time as being the fourth dimension throughout this section of the paper. As we saw in the previous part, it is theoretical possible to have overlapping spaces. This means that we can be in different spaces at the same time.

But what is time then? We perceive ’changing’ and we reference changing with the concept of ‘time passing’. Then we establish conventions in order to measure this ‘time passing’, such as the calendar, the divisions of days into hours, minutes and seconds and so on.

The reason for doing this division is simply because in order to understand ‘our time’, we need some kind of ‘representative interaction’ to relate to. The term ‘time’ itself is somehow ‘non-existent’, because no one can give a fulfilling explanation of what ‘time’ is. Instead we have developed a process of movement and change, because time can only be explained by measurement. Living beings have the ability to perceive change in their surroundings, and it is through this change the understanding and perception of ‘time’ is achieved [14].

When we look at ‘time’ as being the 4^{th} dimension, we can also consider it as being a spatial concept. But how do we explain the ‘time’ in consideration of known theories, is there an ‘absolute’ time or space that we can rely on as being the truth? In 1905, Albert Einstein wrote his well-known ‘theory of relativity’; he introduced his idea that there is no such thing as ‘absolute space’ or ‘absolute time’, but a relative mixture of the so-called ‘two-space-time’ [11].

This dependency relation between time and space is confirmed by Einstein’s theory, because the further away the events are in space the longer time it will take to reach us. If we take a look at sunlight for instance, the sunlight we see on Earth is actually sunlight from the past, because of the fact that this sunlight takes about 8 minutes to reach the Earth [15]. In the case that the Sun will stop illuminate the Earth, we will only see the total darkness after about 8 minutes, but for someone outside the area of Sun and Earth, the total darkness will be observed at the same time the Sun stops shining. [11]

Technology has somehow given us a way of jumping through time, simply by inventing a way of transforming information from one piece of readable 'tool' into another - from a piece of paper to a computer-screen and through this transformation, the 'tool' perfectly fits the possibility of transporting information with an incredible speed - through a computer-network, and after the information has 'travelled through time' so to speak, it can be transformed back to it's original form, more or less, through the printer on a piece of paper. This way of 'transforming tools' could be looked upon as an actually travel through a fourth dimension, because it is, through technology, a new direction that we follow.

Here 'time' is the main factor, because the new technology of today gives us the possibility to shorten distance, and according to Einstein's theory, the longer the distance - the longer the time, which at the same time means; the shorter the distance, the shorter the time. So if it one day would be possible, through technology to shorten the distance and thereby the time it takes for a human to travel from one point to another, you could say that it would be the same thing as jumping through time.

Because of this relation between time and space, we think that 'time' could definitely be a reasonable approach to the answer about what the fourth dimension is. We also think that technology is possible the only way, to influence the possibilities of movement in the fourth dimension. Transformation is also a keyword in connection with the possibility of travelling through time, because, as mentioned in the above example, information can only travel so fast, after it is transformed into the 'fitting tool'.

2.5 The fourth dimension in art

In the previous section we have agreed that we will use 'time' as being the 4^{th} dimension. This is why, in this part of the paper we will concentrate on the subject of 4^{th} dimension in art.

If we look at time as being the representative of the fourth dimension, many artists have visualized this fourth dimension of time in their art. In modern art of today, the use of visualizations which reflects further dimensions of both movements and impressions are more and more often seen to be an advantageous artistic tool to use. Here 'time', as a further dimension, is often seen, in the form of visible elements, as a tool to describe changes in reality. [17]

Through different art movements, artists have been limited to visualize their work on a 2D canvas, communicating their messages with the help of tools such as light, shadows, depth, movement etc. Their expression of realism has always been a part of both cultural background and

historical periods in question. When it comes to artificial impressions in 2D, from cave painting to comic strips, art has always required to include reality showing higher dimensions in for example space and time.

The Dutch artist Piet Mondriaan once said, that “The important task of all art is to destroy the static equilibrium by establishing a dynamic one” [18]. To bring dynamism by using the time element into art, time-related elements and items from different historical periods, are brought together in the same image or piece of art. If for example an artist wants to paint a picture, showing an image of the First World War, and wants to visualize an idea of time changing, he could include elements such as a modern computer or maybe a modern automobile in the painting. In this way the change, evolution and movement will be described without the use of any actual motion.

In the first two decades of the twentieth century, the fourth dimension was looked upon as being an exaggeration of our movement in physical space, which had a great influence in the developments of the early nineteenth-century geometry.

With this suggestion of a higher dimension in space, new complex spatial possibilities where created, and followed by the curved space of non-Euclidean geometry, many artists took these possibilities as an opportunity to a rise from the materialism and positivism, and created a new era of art in which artists, believed in the possibility of expressing higher spatial dimensions of space through visualization in their art. The big movement that fits into this concept is Cubism [17].

Art of both today and from the past often seem to include different messages to tell a story or to visualize some thoughts by the artist. Through his or her work, the artist can visualize fragments of a reality which he or she creates on the basis of personal visions and thoughts, and if these thoughts include the passion of explaining the flow of time and change, the artist uses visible elements which can be combined with the common understanding of time and space.

It is more interesting to admire a piece of art in which we perceive dynamism, because of our nature; our perception contains different functions of our senses, we react according to our perception and this reaction is highly dependent on changes in our environment [18].

Imagine that you are standing in front of a painting, concentrating on discovering and analyzing elements and features in it, and suddenly you realise that something in the painting seems to change, in that exact moment your full attention will be pointed at that change.

Many artists are aware of the fact that we are reacting more strongly to dynamic than static images, our extent of interest seems to be more dependent on the perception of movement than the

image itself. It is therefore understandable that in the world of art the visualization of time, as being the impression of change and movement has become a very dependent tool to use [18].

2.6 Otto Frello and the 4th dimension

After going through the previous section, it may give an idea about what the 4th dimension is and how it can be conceived. In this part of the paper we will try to take this gained knowledge and go a step further. We will grasp this 4th dimension from Otto Frello's work.

If after reading the previous section is still unclear what we presuppose 4th dimension to be, we will highlight again that we are going to work with time within this context.

The very high amount of detail that Otto Frello's paintings reveal, make the work easier for us, in that it is easier to observe the specifics that lead us to the conclusion that time is the 4th dimension in his work.

To be more specific in how we perceive time in Otto Frello's paintings we will go through a concrete example, which is the 'Københavnerbillede' (e.g. 'Picture of Copenhagen').

Figure 20: A private photo of Otto Frello's 'Københavnerbillede' (e.g. 'Picture of Copenhagen')

The painting is an illustration of 'Amagertorv', a place in Copenhagen, which the artist finished painting in 1986. The observer has to be aware that the actual date written in the right corner on the canvas (1992) is not the real date. Already here it is obvious that Otto Frello manipulates with time.

If we take an imaginary tour from left to right, we can easily observe the differences in time and style throughout the characters and objects that populate the painting.

The painting is made of many layers with different time characteristics. These features are represented by the 'rituals' that were current at that moment. Among these features we can observe the greengrocers selling their vegetables, the 'cosy meetings', the typical drunkard and the showing-off tours, the different social positions etc.

The most shuttering elements of time passing are the clothes of the characters. They start being ragged and colourless, and end up being full of style and colours. There are obvious elements of past, present and future in the painting. If we take the noble man for instance, we can admire his elegance and exclusive style, but at a closer look, the clothes are shabby. The same goes for the woman he is 'almost' talking to. 'Almost', because it is impossible for two people from different decades to meet and talk to each other.

The Punker to the right of the painting is quite the opposite of the noble man; his presence accentuates the difference in popularity of the dissimilar time periods.

The painting is full of such time dissimilar elements, but we have only covered a few. We think that this is enough to convince the reader of our point. We are physically in the same place while a range of different time periods are passing by.

With these ideas in mind we will continue the report with investigating closely the available technologies which will permit the further realisation of our concept.

3 State of the art

As stated in the problem definition, we will make use of some technologies in order to realise a 3D presentation of a 2D canvas, which in our case is the Danish painter Otto Frello's work. This is why we in this section will look into some of the areas of the 3D technologies that could make this transformation possible. We will also cover the research in the field of similar and future products in the development of 3D representations.

3.1 Projecting 3D

As you probably remember from the section about dimensions, we are living in a multidimensional world, where it is up to the individual experience to define and understand each of them.

Because we are dealing with transformation, the most important thing is to get an insight into how the different technologies work and what has to be changed in order to achieve our goal. We will start by looking at the most common technology which is the computer screen. How is it possible to display real 3D on computer screens? To be able to answer this question we need to know how the computer screen functions in general.

A computer screen is basically a television screen but it has a higher resolution. The screen gets information from the computer about how and what needs to be displayed. Further on, some areas of the screen will become black, some blue, red, etc. At the end, the image will be created on the screen.

When we need to display something 3 dimensional on a computer screen the computer adds depth to the image. There will simply be calculated how objects need to be distorted in order to look like they are placed in a 3D space. In this way the illusion of depth in the picture is achieved. This way of obtaining depth into a 2D picture on the computer screen can be called a 3D projection on a 2D surface.

There are technologies that give the possibility to project real 3D images and environments. There are three distinct technologies that are affordable for the general consumer, and several that are still under development.

3.1.1 Stereographic images

One of the affordable technologies is the Stereographic images, which is very basic. The viewer places two images in front of his eyes and makes his eyes a bit cross eyed, so that the two images overlap each other.

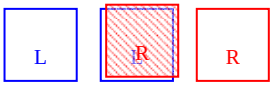


Figure 21: Image overlay

In the 1990s it was very popular to create all kinds of stereoscopic images. These kinds of images went under the name of 'the magic eye', and are still possible to find. Below can be seen an example of such image.

Figure 22: Magic Eye picture [19]

The stereoscopic images are mainly used for amusement. The reason for this is that not all people are able to see these kinds of images; others find it uncomfortable and straining to the eyes. Another feature about these pictures is the way in which the 3D information is encoded. This is time consuming, and we can not always be sure to decode it again.

3.1.2 Anaglyphic stereo glasses

Another affordable technology is the Anaglyphic stereo glasses, which are very cheap or can even be homemade.

Figure 23: Anaglyphic Stereo Glasses

These glasses contain two pieces of coloured plastic usually one is red and the other is blue.

The 3D image on the computer needs to be separated into two colours on the computer screen, in order to make use of the glasses. This can be done by the drivers for the graphics card, but the only inconvenience is that, at this time, there is only one hardware manufacturer that can deliver this kind of drivers. This means that each game or attend of 3D visualisation have to support anaglyphic colouring or there needs to be found 3rd party software that can support this. Figure 24 shows a screenshot from the game Quake where the anaglyphic colouring technique has been used.

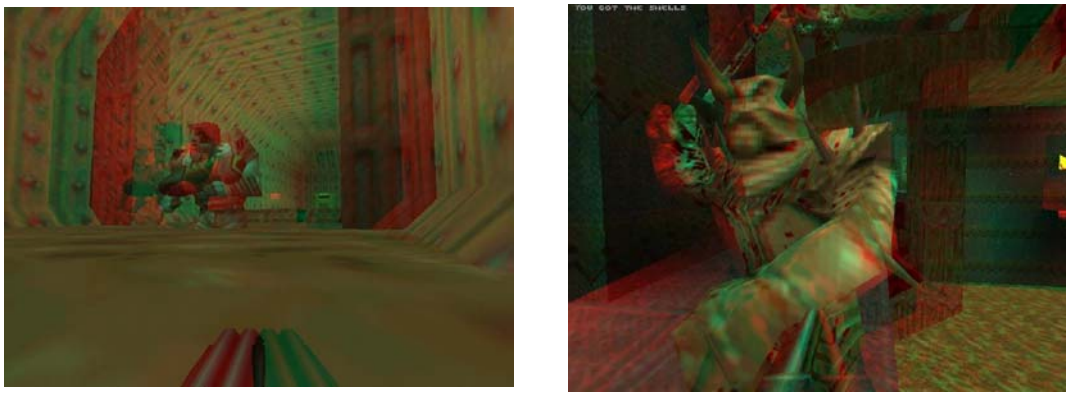


Figure 24: Screen shot from Id software's Quake

There are some disadvantages to this way of creating 3D. The first and primary is that it needs 100% accurate colours in the colour settings or else the 3D effect will disappear. Another disadvantage is that there will be lost some details in the picture.

3.1.3 LCD shutter glasses

An additional technique is the shutter glasses which basically work by blocking the image of one eye and letting the image on the other. This shifting is synchronized with the image on the computer screen where it shows the correct image when the glasses open the right shutter.

Figure 25: LCD shutter glasses

This technique gives very good 3D images. People that test these glasses really think that the 3D depth is strikingly clear and objects truly are coming out of the computer screen.

The shutter glasses are either controlled by 3rd party control software or by the graphic card drivers. nVIDIA is one of the manufactures who has great shutter glass support.

There are some disadvantages to this form of 3D. The primary is that after a while one may feel a certain tension in the eyes or a feeling of dizziness.

Another disadvantage is that the objects on the screen create visible shadows. This is also known as the ghosting effect. Normal monitors show between 60 and 100 images per second. The ghosting effect appears due to the fact that when shutter glasses are used, the number of images has to be divided by 2, so that there is one unique image to each eye. If the images move too fast or there is strong contrast between colours, the glasses may pick up a small part of the old image. This creates the streaking or ghostly shadow effect across the screen.

3.1.4 Head mounted displays

Until now we have been describing the most affordable techniques. A more expensive way of getting the 3D effect can be achieved by using the head mounted display or HMD. This performance system is a helmet with two LCD screens placed in front of the eyes. The HMD have been used in the project BENOGO with some success because of the almost perfect 3D images that can be reproduced.

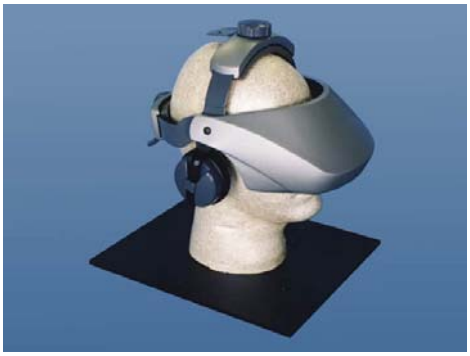


Figure 26: Head mounted display

Because the two LCD screens display the image information for each eye, the ghosting problem with the shutter glasses is eliminated.

There are many positive elements in the HMD technology. One of them is the mobility that it offers because it has only to be placed on the user's head. This way the user feels more surrounded by the virtual environment and the feeling of presence is accentuated.

As mentioned above, this technology is far more expensive than the others stated previously in this section. It requires special hardware installed on the computer and an additional motion capture technology that can track the orientation of the HMD in case the user wants to use the full potential of the device.

Because of the high cost of the system there are not many developers who are developing for example games for this device.

3.1.5 3D displays

Another way to visualize 3D is to incorporate technologies directly in the computer screens. There are a few companies that develop this screens, one of them is ‘Sharp’. [20] The monitor described in the article is available today as a 15 inches TFT monitor and they have also developed a laptop computer with the same technology.

Figure 27: Laptop with 3D display

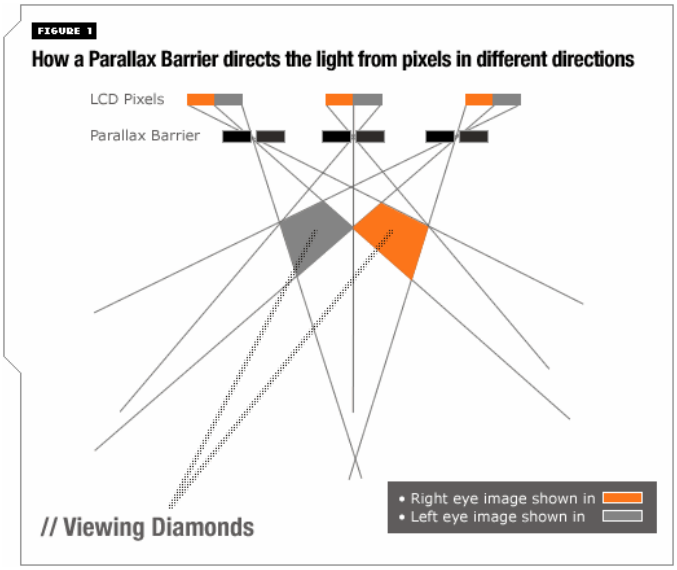


Figure 28: ‘Sharps’ 3D display technology [21]

The most interesting about ‘Sharp’s’ displays is their technological approach [21]. The picture to the left shows a diagram of how the image is being displayed on a screen.
The normal LCD pixels are displayed behind a parallax barrier. Then light is slipped through the pixels and the barrier which gives what ‘Sharp’ calls ‘Viewing Diamonds’.

The technology ‘Sharp’ uses looks like the basic technology behind the ‘lenticular sheet’, which will be described in the following section.

4 Lenticular Sheet

In the previous section we have described different technologies for visualizing 3D environments. In this section we will continue with the description of the chosen technology in creating our product, which is the lenticular sheet. Before we can talk about lenticular sheet we have to mention the basic technology and the progress development until lenticular sheet.

4.1 Background

The basic concept is called Auto-stereoscopic (AS) representation. Auto because there is no need for any special equipment for viewers to see the images. [20]

- The first time that AS was used was in the experiment made by G.A. Bois-Clair in 1692. In his experiment he used a derivation of AS, namely the method of barrier technique. This derivation supposes that the image is cut into slices and then aligned behind opaque bars. This gives the viewer the opportunity to perceive a change in the image when moving in front of it.

- The further development of the AS resulted in the so called Parallax Stereogram made by Fredrik E. Ives in 1903. The difference from the barrier technique to this one is the concept of stereo-view. This means that this new development gave the possibility for each eye to be able to see a corresponding image as a whole. The only impediment with this new development was the viewing area. In order to perceive different images on each eye, the viewing area has to be very limited.

- In 1908 the physicist Prof. Gabriel M. Lippmann proposed the idea of using a series of lenses instead of the parallax barriers. The technique is called the integral method. The method made use of a great amount of convex lenses placed at the picture, which made it possible to view the picture from different angles. The lenses are, as depicted in figure 29, almost like the eyes of a fly e.g. the nickname “Fly’s-eye lens array”. Although this way of obtaining 3D images is the most optimal

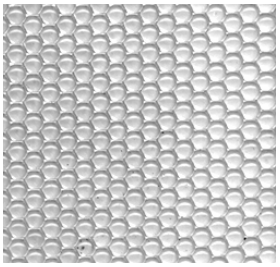


Figure 29 - enlarged fly's-eye lens [20]

one, it is also time consuming, in that there are a lot of calculations that has to be done.

After going through the development in the area of AS, we will now take a closer look at the lenticular sheet and its properties.

4.2 The Lenticular Sheet

The lenticular sheet is physically made of pieces of plastic or glass. The surface consists of cylinders that are responsible for only letting parts of the underneath image through.

There are a number of parameters that need to be set before creating the image for the lenticular sheet, like the viewing distance, the size of the picture and so on.

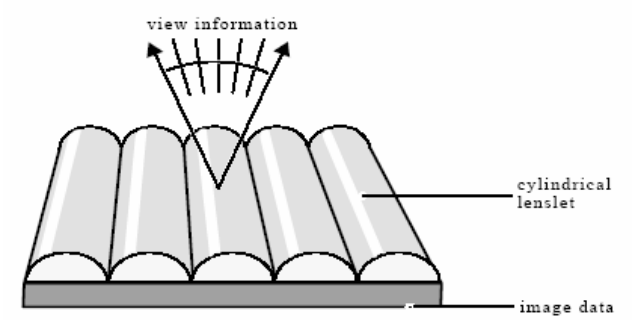


Figure 30 - Lenticular sheet cylinders [23]

There are several types of lenticular sheet, which differentiate on resolution, physical size and viewing angle. Depending on the image the light source can be either behind or in front of the image.

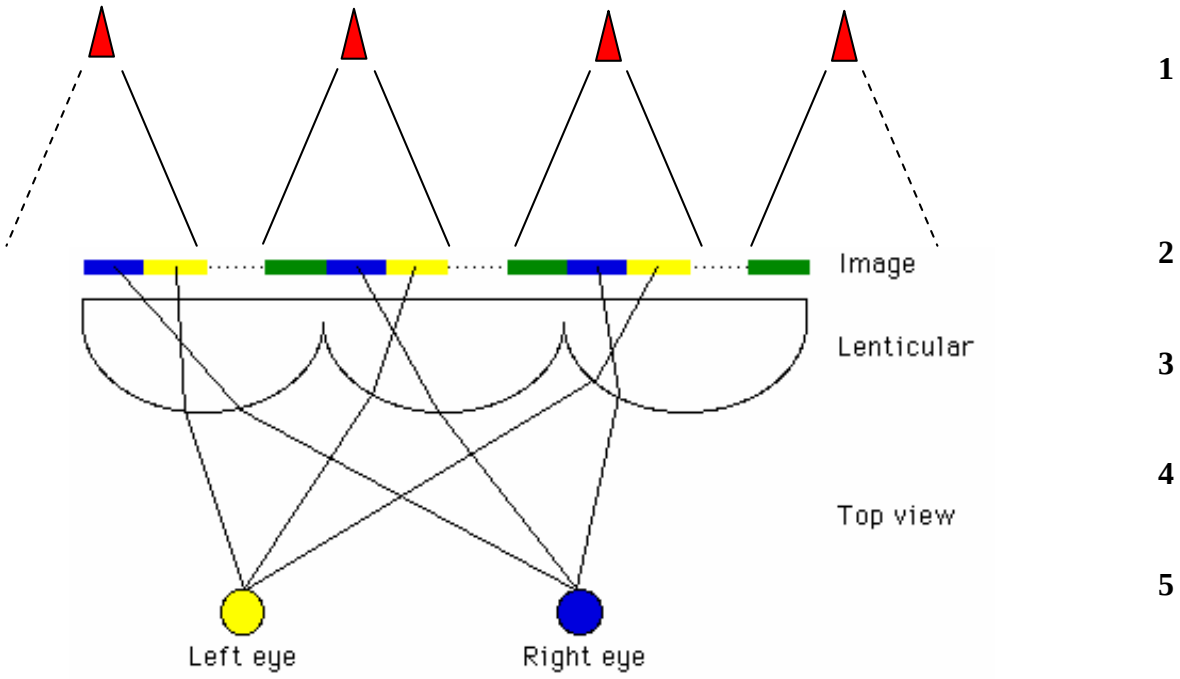


Figure 31 - Image projection in parallax barriers [22]

The way that the lenticular sheet works is described in figure 31.

1. Light source
2. Interlaced image
3. The lenticular sheet
4. Views of partial images
5. Eyes of the spectator

The following example illustrates how a lenticular sheet is used in order to obtain a 3D version of a 2D picture, in this case a Picasso painting. In order to achieve a good 3D effect, the source images has to have a high quality and need to be shot from specific angles. Depending on what effect we want to accomplish, the underlying picture do not necessarily have to be shot from specific angles, we can also modify the pictures so that specific elements within the pictures are changed, like the background, the position of some elements and so on. All this can be realised by different programs, like for instance Photoshop.

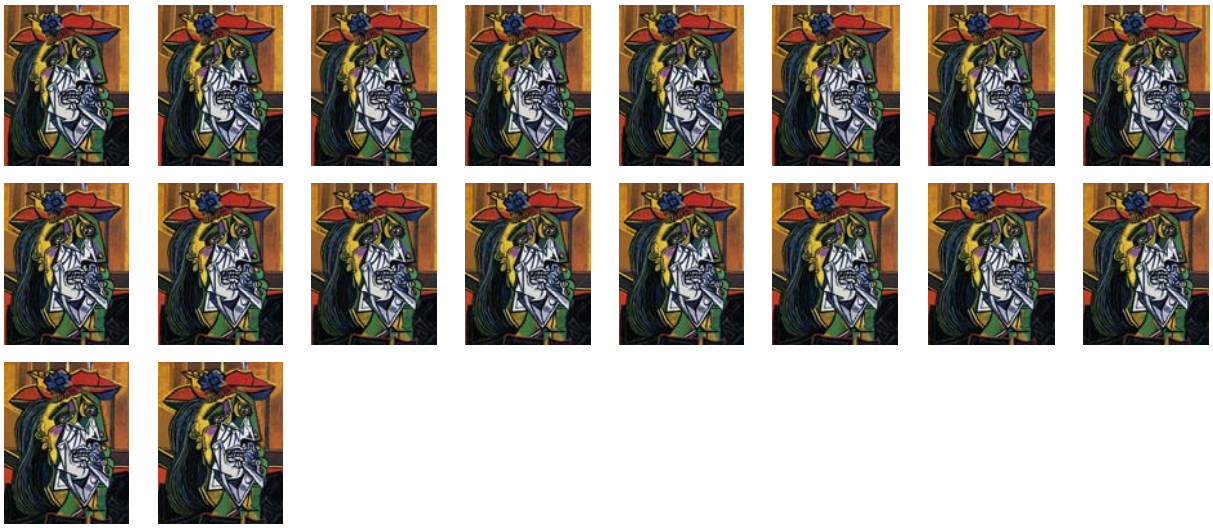


Figure 32 - Single frame animation of a Picasso picture

In figure 33 the images from the previous example are combined into one single interlaced image.

Although very useful, this technique is fairly expensive, if a large size and a high resolution of the lenticular sheet is needed. Otherwise we only need a good light source, the software to create the interlaced image and a printer capable of printing on transparent paper.

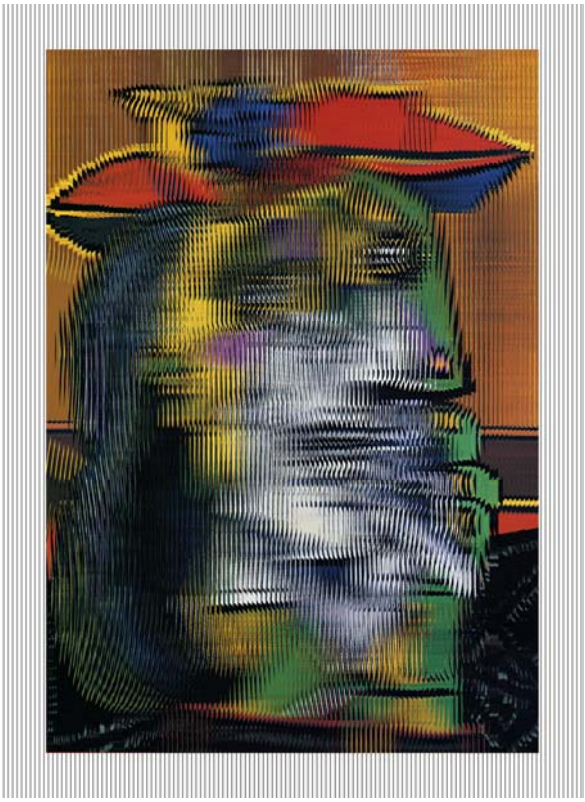


Figure 33 - Interlaced Picasso image

5 Our exhibition

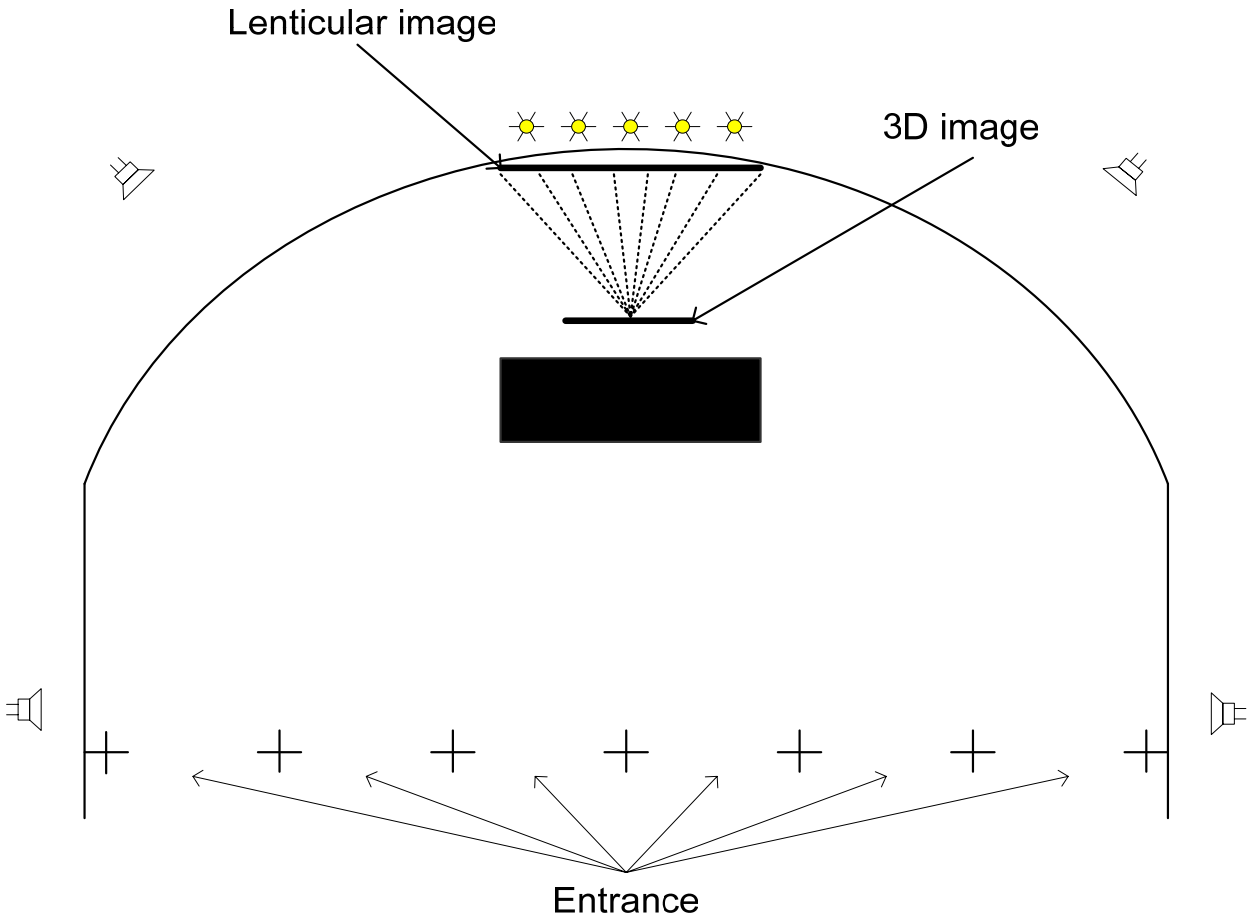
Until this point in the development process we have discussed about the different concepts that will serve as content for the transformation product. In this section we will cover the technical aspects necessary in order to construct our product.

The basic technology we are going to use is the Lenticular Sheet. We will adopt a slightly different approach from the standard use of this technology in that, the picture we want to enhance to the observer will not be glued onto the lenticular sheet because we want to have the opportunity of changing the picture. In order to be able to expose holographic elements, the underlying picture has to be printed on a transparent piece of plastic. Afterwards, with the help of halogen spot lights we will illuminate the transparent picture that will subsequently reveal these elements.

We expect that the following equipment will be used in our final exhibition.

1. Set of surround speakers
2. Light sensors that register which image that will be displayed
3. Lenticular sheet
4. Halogen lights
5. Black fabric as a wall
6. Small piece of carpet or fabric
7. computer controlled motor

The picture below is a visualization of how we want the exhibition to look like.



The way in which we are going to expose our product will be done in an exhibition approach. By doing so, the spectator will witness a unique experience. It will be possible to choose among four different pictures, so that the contentment of participating in the exhibition will be increased. This and the fact that the exhibition is meant to be a first person experience will strengthen the effect.

We will make use of sensors in order to activate the chosen picture to the spectator. The black square illustrates a figured restricted area. By using this, we can be sure that the spectator will not stay too far or too close to the picture, and thereby miss viewing some details.

The exhibition will be exhibit in the start of 2006 and will be a part of a project concerning collaboration between different art institutes. At the exam we will present a prototype of the final exhibition.

6 Conclusion

Throughout this report we have been investigating areas concerning the problems of converting elements of time and motion into artistic design products. We have gained a great understanding of how the artistic use of these elements can create an impression of the 4th dimension in a static environment. In the process we have been investigating different theories concerning both the 4th dimension in general and how higher dimensions are perceived as being either a spatial dimension or a dimensional expression of time.

Furthermore, we have used the Danish painter Otto Frello as leading example concerning the implementation of differences in both time and space. We have investigated the art done by Frello and thereby increased our understanding of his impressions related to the mentioned implementations. During our investigation of Otto Frello's art, we have additionally given an approach to how his art can be placed in relation with different known artistic styles.

During the practical part of our assignment, we have been researching the different technologies on the market concerning our concept idea, with the purpose of achieving knowledge of the possibilities of transforming tools.

Based on this knowledge, we have developed a way of visualizing the transformation of 2D paintings into a 3D/4D image, with the use of lenticular sheet technology combined with specialized software. This way there can be created the illusion of transforming an image into a floating representation of different Otto Frello paintings.

7 References

[1] Faber, Ole. (2004). *Otto Frello – En utidig maler.* Museet for Varde By og Omegn

[2] (2005).*Surrealisme.* Retrieved May 2, 2005, from <http://www.kunstonline.dk/diverse/ordbog/?id=27>.

[3] Kjørup, Charlotte.(12 Aug. 2000).*Kunst: Detaljens mester*. Aktuelt, 1. section pp. 19

[4] Knudsen, Jørn Ingermann.(2005). *NATURALISME*. Retrieved May 2, 2005 from <http://www.textanalyse.dk/Naturalisme.htm>

[5] Petersen, Kirsten. (2005). *TIDSTAVLE_Jugendstil*. Retrieved May 2, 2005 from <http://www.artstamps.dk/TIDSTAVLE_Jugendstil.htm>

[6] Christensen, Torben. (2002). *Kunstleksikon*. Aschehoug Dansk forlag A/S

[7] Wikipedia. (2005). *fourth dimension.* Retrieved May 2, 2005 from < http://en.wikipedia.org/wiki/Fourth_dimension>

[8] Saltsman, Eric. (Jan 2003). *What is the Fourth Dimension?.* Retrieved May 2. 2005 from < http://www.geocities.com/CapeCanaveral/7997/whatis4d.html>

[9] Odenwald, Sten. (1984). *Does Space Have More Than 3 Dimensions?* Retrieved May 2. 2005 from <http://www.astronomycafe.net/cosm/dimens.html>

[10] Wikipedia. (2005) *Edwin Abbot Abbot*. Retrieved May 2. 2005 from <http://www.abacci.com/books/authorDetails2.asp?authorID=325&misspellID=548>

[11] Lawson, Robert W. (2000). *Relativity: The Special and General Theory*. Retrieved May 2. 2005 from <http://www.bartleby.com/173/>

[12] Image from http://www.astrosurf.org/lombry/Documents/flatland.gif

[13] Saltsman, Eric. (Jan 2003). *What is the Fourth Dimension?.* Retrieved May 2. 2005 from < http://www.geocities.com/CapeCanaveral/7997/whatis4d.html>

[14] Abbas, Rand. (2003) *Metamorphosis*. Retrieved May 2. 2005 from <http://www.arch.mcgill.ca/prof/mellin/arch671/winter2003/studentwork/Abbas/web/bib.html>

[15] Al-Khalili, Jim.(1999).*Black Holes, Wormholes & Time Machines*.IOP Publishing Ltd,.ISBN: 0 7503 0560 6

[16] Abbot, E. – Flatland.(1984).*A Romance of Many Dimensions*. New York: New American Library

[17] Henderson, Linda D.(1983).*The Fourth Dimension and Non-Euclidean Geometry in Modern Art*.Princeton University Press,

[18] Robert van de Voort. (2003). *Art of seeing no 5*. Retrieved May 2. 2005 from <http://www.albanystudios.co.nz/Artof%20Seeing5.htm>

[19] www.magiceye.com

[20] Roberts, David E..(xxxx).*The history of the lenticular sheet* http://www.lenstar.org/history/hmain.htm (LenticularHistory_Lenstar-org.pdf)

[21] Sharp Technology. (2004) *How sharp 3D works* Retrieved May 2. 2005 from <http://www.sharp3d.com/technology/howsharp3dworks>

[22] Bourke, Paul.(December 1999).*Autostereoscopic lenticular images*.– http://astronomy.swin.edu.au/~pbourke/stereographics/lenticular.(Autostereoscopic lenticular images.pdf)

[23] Halle, Michael.(May 1997).*Autostereoscopic displays and computer graphics*.Surgical Planning Laboratory Dep. Of Radiology, Brigham and Women's Hospital, Boston MA. USA (Autostereoscopic displays and computer graphics by M Halle.pdf)