



**MÄLARDALENS HÖGSKOLA**  
**ESKILSTUNA VÄSTERÅS**

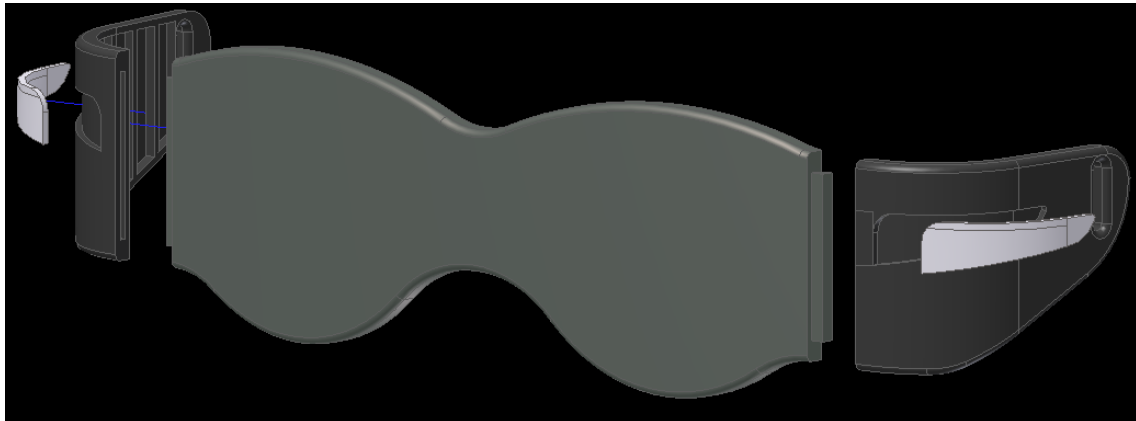
School of Innovation Design and Engineering

# Development of 3D communication

Thesis work 15 credits, C-level

Product Development Course KPP106  
Engineering Programme Innovation and Product Design

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Date of presentation: 2 June 2010  
Thesis work done in cooperation with  
students at University of Zaragoza  
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# Abstract

This thesis work is done at Mälardalen University in cooperation with students at University of Zaragoza. The project is based on 3D communication between the user and the machine. It is also involves a company brand, Wii, that's located in Spain.

Wii is a famous brand in Spain. It is based in a great variety of accessories, which they include: controllers, pistols, steering wheels, rackets of tennis, adapters of network, cables audio and video. But the most important accessory is the Wii remote.

The main problem the project is to find the correct solution for 3D communication between the user and the machine. The student has to design the devices needed to a correct communication between the Wii console and the user. It is 3D glasses with movement detector, gloves with detectors and a stand for the Wii remote.

The project is carried out with two students from Zaragoza (Spain), Álvaro Fernández y Arturo Alastuey. Their part is based on communication between the person and the Wii console. The work done at University of Zaragoza by the student there is about the display needed to display 3D objects. They have done different objects with the "3D Studio Max" program, and with the help of a previous project (reconstruction of Roman ruins), they can do the correct process. It consists in following object, which are modeled in this program, through a scenery (Roman ruins), then exported with a plug-in (<http://www.ofusiontechnologies.com/>) of 3d studio into a different format that is reading the display that the students of Spain did.

This project is interesting for the student, because Wii is a famous brand and very particular one. Therefore the student has to continue with the same design/ style according to this brand but as the design is new it has to be different in some way.. The student is going to design the devices necessary for proper communication

The result will be special glasses to get a proper communication between the machine and the user, devices that are placed in the hands for a motion control and a support to place the Wii controls and emit light in.

# Acknowledgements

The student dedicates this work, to my family, especially to my parents, because they have been supporting me, and they gave me the chance to come to Eskilstuna/ Västerås and Mälardalen University.

Also I want to dedicates it to all people who have worked with me this period; Diego Gutierrez, Jorge Lopez, Alvaro Hernandez y Arturo, University of Zaragoza, Spain; and Ragnar Tengstrand and Annika Björklund, Mälardalen Univesity Eskilstuna Sweden.

Zaragosa, August 2010

Marta Castro Rodriguez

# Wordlist

Appearance: A superficial aspect; a semblance

Cluster: A group of the same or similar elements gathered or occurring closely together; a bunch

Drawing: A picture or diagram made with a pencil, pen, or crayon rather than paint, esp. one drawn in monochrome

Ergonomics: The applied science of equipment design, as for the workplace, intended to maximize productivity by reducing operator fatigue and discomfort.

Focus: To cause (light rays, for example) to converge on or toward a central point; concentrate.

Item: An individual article or unit, esp. one that is part of a list, collection, or set

Player: A person who participates in or is skilled at some game

Pragmatic: Dealing with things sensibly and realistically in a way that is based on practical rather than theoretical considerations

Prototypes: An original, full-scale, and usually working model of a new product or new version of an existing product.

Rendering: The processing of an outline image using color and shading to make it appear solid and three-dimensional

Stand: A place where, or an object on which, someone or something *stands*, sits, or rests, in particular

Support: A thing that bears the weight of something or keeps it upright

Semantic: Relating to meaning in language or logic

<http://www.wordreference.com/>

<http://www.thefreedictionary.com/>

<http://www.google.com/dictionary>

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## 1.- Introduction

The first step in this project is to get some information about the Wii product before the start of the development. The thesis work is based on the development of 3D communication between the user and the Wii console, so the student has to study the console and how the communication is going to be.

### 1.1 Wii brand and the console

The Wii is a home video game console released by Nintendo on November 19, 2006, as a seventh generation console. A distinguishing feature of the console is its wireless controller, the Wii Remote, which can be used as a handheld pointing device and detects movement in three dimensions.



The console was known by the code name of "Revolution" until April 27, 2006. The Nintendo Style Guide refers to the console as "simply Wii, not Nintendo Wii", making it the first home console Nintendo has marketed outside of Japan without the company name featured in its trademark. While "Wiis" is a commonly used pluralization of the console, Nintendo has stated that the official plural form is "Wii systems" or "Wii consoles". Nintendo's spelling of "Wii" with two lower-case "i" characters is meant to resemble two people standing side by side, representing players gathering together, as well as to represent the Wii Remote. The company has given many reasons for this choice of name since the announcement; however, the best known is:

"Wii sounds like 'we', which emphasizes that the console is for everyone. Wii can easily be remembered by people around the world, no matter what language they speak. No confusion. No need to abbreviate. Just Wii."

The Wii is Nintendo's smallest home console to date; it measures 44 mm wide, 157 mm tall and 215.4 mm deep in its vertical orientation. The system weighs 1.2 kg, which makes it the lightest of the three major seventh generation consoles. The console can be placed either horizontally or vertically.

The console also features a recurring design theme: the console itself, SD cards, the power supply and all the sockets have one of their corners chipped off in a triangular fashion.

*[<http://en.wikipedia.org/wiki/Wii#Reception>]*

- Important for the project: Wii remote

### 1.1.1 The Wii remote

A main feature of the Wii Remote is its motion sensing capability, which allows the user to interact with and manipulate items on screen via gesture recognition and pointing through the use of accelerometer and optical sensor technology

The Wii remote has an infrared filter and a camera on the front. All events see press a button; move the accelerometer, etc. are sent via Bluetooth. As for the infrared camera, this sends the coordinates of four points of infrared light. Thus, we get the motion detector. , this is what worries us,

- Important for the project: infrared camera to detect the movement



## 1.2 Head Tracking

Head tracking is a technology; which is based on the perspective change depending on how the head move. That is, in a 3D environment we get a much more real, with different views depending on where we are looking at the screen.

- Important for the project: Detect the movement of the head

## 1.3 Display 3d objects

This part is made by the students of Spain. They have done different objects with the "3D Studio Max" program, and with the help of a previous project (reconstruction of Roman ruins), they can do the correct process. It consists in following object, which are modeled in this program, through a scenery (Roman ruins), then exported with a plug-in (<http://www.ofusiontechnologies.com/>) of 3d studio into a different format that is reading the display that the students of Spain did.

- Important for the project: Scenery



## **1.4 About the project**

### **Purpose and goal with the project:**

The main problem the project is to find the correct solution for 3D communication between the user and the machine

This problem is broken down into sub problems, design 3D glasses, devices for the hands and support for the Wii remotes.

### **Solution:**

So, the main idea for a solution of this project is based in the infrared camera. With the help of this camera, which is in the Wii Remote and various sensors in the head and hands, we can track the location of the head with precision and show the images on the screen depending on your position. This effectively transforms your display in a portal to a virtual environment. The display correctly reacts to head and body movement as if it were a real window creating a realistic illusion of depth and space.

### **Purpose of this thesis**

The purpose of this thesis is to prove that the student is capable of comprehending and solving the design needed to complete the project. The thesis will explain the steps and the conclusions made along during the project of designing glasses, devices for hands, the support of the Wii remotes and the logotype.

## **2. - Aim of project**

The aim of this thesis work is: design of devices required for the 3D good communication between the user and the Wii console.

## **3. - Project directives**

This project is collaboration with a group project done in Spain, but my part is held in Västerås, Sweden. The person in charge of helping with the project in Sweden is Ragnar Tengstrand.

### **Commissioner directives**

- Design devices for 3D communication
  - Design 3D glasses
  - Design devices for hands
  - Design the stand for the Wii remote
- Create a logotype
- Documentation
- Maintain regular contact and meetings

## 4. - Problem statement

The problems that have been solved during this thesis work are stated in this part of the report which can later be followed up in chapter 8. The problem is to design the devices necessary for correct 3D communication between the machine and user. This problem is broken down into sub problems, design 3D glasses, devices for the hands and support for the Wii remotes.

### Demand analysis

- Design glasses, transmitter-stand and gloves:
  - Market research of the various fields which houses the product design: motion detection devices, sunglasses styles, LEDs, etc.
  - Designing different concepts to compare and choose the best
  - Develop the chosen concept and make the 3D model
- Geometry and colour language
- Ergonomics
  - Prototype Design
- Brand and advertising campaign of the final product
  - Product logo
  - Promotional posters

All this will be focused to a specific user. This product is mainly used in education at schools. The user can also be a person of middle-aged adolescents.

## **5. - Project limitations**

The type of solution expected by this thesis work is a theoretical model, a theoretical procedure, a concept modeled in 3D-CAD.

### **Distance**

The project is carried out with the help of a teacher from Mälardalen University. But the project started at the University of Zaragoza. There are two students doing the computer part of the project, and two teachers there to help us. So, you have to keep in touch and inform each other of progress.

### **Development**

The biggest problem was that students in Spain had not finished its computer design. But I began to realize the design as they needed, so then they changed some staffs in their design, so I had to change mine too, having to start almost from the beginning.

The project also includes creating a proposal for a product logo for a marketing campaign.

### **Money**

The final product have to be not very expensive, because of this the student have to think about cheap and good materials and fabrication process.

### **Time**

This thesis work was thought to finish in four months, but finally the student finish in eight months, because of these limitations.

## 6. - Theoretical background & solutions methods

The methods used for completing this project have been chosen together with the Spain's teachers and Sweden's teacher

### Analysis

#### Project planning - Microsoft Project

Project planning is the process used to organizing the different tasks of the project. The student use it to easier plan when to do things also to define what actions is needed in order to solve the project problem.

Project planning is based in create a table explaining the moments of leisure and working time. Just as the stages of the project

The moment of the process is early in the project when the problem is being defined a project planning.

#### Demand Analysis

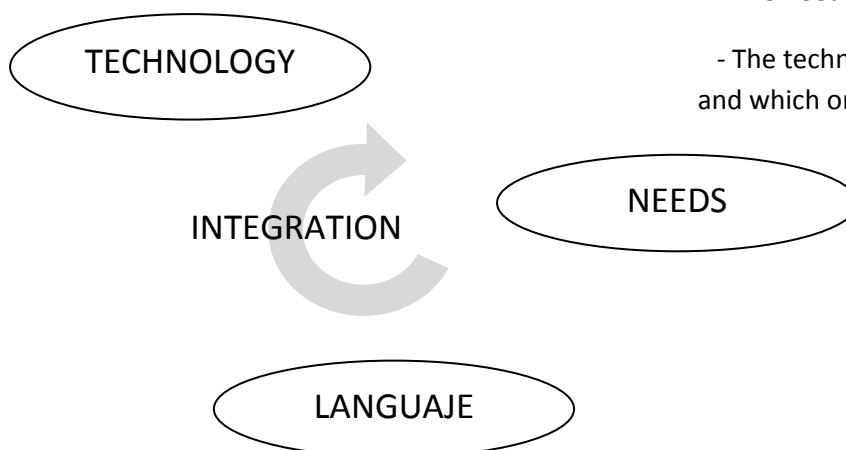
Demand analysis is a list of demands, goals that the project needs to reach to succeed, that needs to be fulfilled during the projects life cycle. The list is created to use as a measurable goals also to know where to aim the project.

The moment is when defining the problem.

The student has to take into account these ideas.

- The needs do the project

- The technology that the student can use and which one is the best



## Information search

Information search is based in finding information about the project and select the needed. It is done by searching for and reading information that the student must then select which is necessary to solve the problem.

It is good to do it during the analysis to solve the problem with the required knowledge of the subject

## Information search

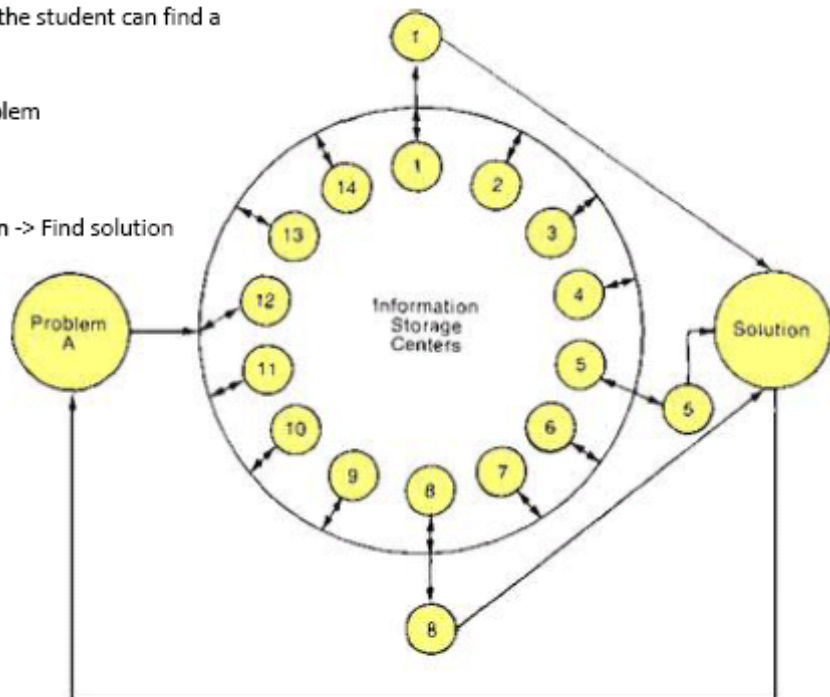
- What the project is
- What I need
- Where I can search the information
- How I can organize the information

This picture shows how the student can find a solution.

1º Definition of the problem

2º Information search

3º Select the information -> Find solution



## **Creation**

### **Customer analysis**

Customer analysis is the definition and exploration of the main type of user who is using our product. It is to select the area of marketing where we need to focus.

The customer analysis is done seeking information from people that can play this style of game and who would be interesting to direct, based on the information gathered.

It is done before trying to define the product

### **Wii analysis**

Wii analysis is the study of the Wii brand style, looking for any information, images and logos of the brand

The Wii analysis is good to follow the same style that already has the mark, and that our product is part of it. It is done before trying to define the product

### **Mood board**

Mood board is a set of images primarily relating to the subject of design. "Mood boards are often used by graphic designers to enable a person to illustrate visually the direction of style which they are pursuing. However, mood boards can also be used to visually explain a certain style of writing, or an imaginary setting for a storyline. In short, mood boards are not limited to visual subjects, but serve as a visual tool to quickly inform others of the overall 'feel' (or 'flow') that a designer is trying to achieve. Creating mood boards in a digital form may be easier and quicker, but physical objects often tend to have a higher impact on people." ([http://en.wikipedia.org/wiki/Mood\\_board](http://en.wikipedia.org/wiki/Mood_board))

It is done to create a feeling by looking at the pictures, which is created with a brainstorming. The good way to do it is creating a collage of images that are related with our product, and paste them on paper without any established order

The moment to do it is before starting to sketch on concepts.

## Creative sketching

Making several creative sketches is To find new and different ideas to choose the best concepts.

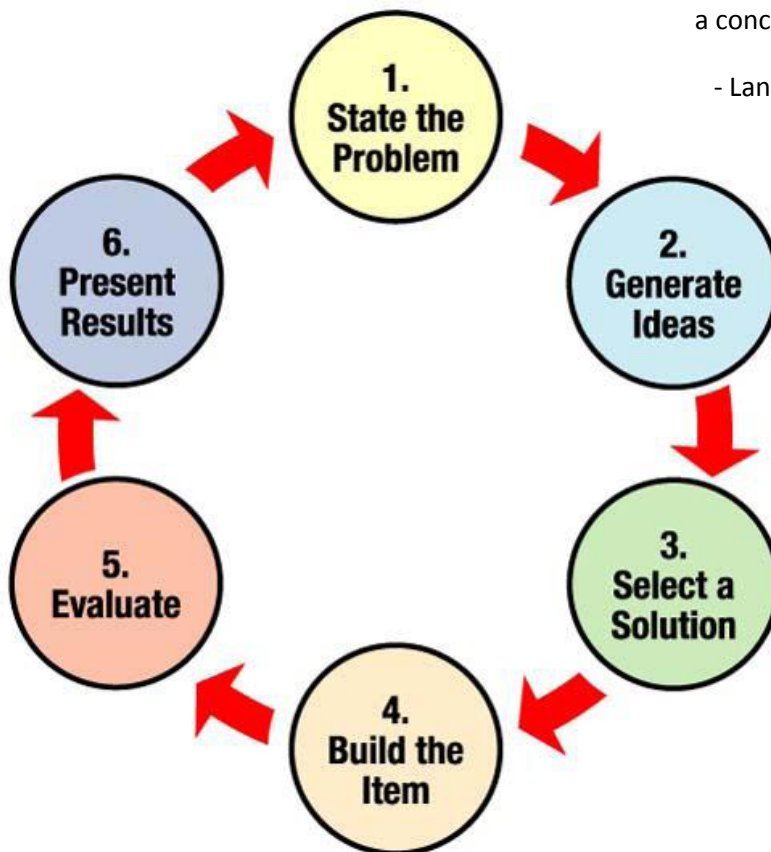
It is based in fast handmade drawings, of which rule out the worst

It s done early in the process of creation

Step 2: Generate ideas

The student has to generate a lot of ideas, although some of them are not chose to be a concept.

- Languaje to comunicate to the user.



## Choosing concepts

Choose the best three concepts of the previous ideas, in order to develop and get some good concepts

It is done comparing the ideas and the development possibilities for a good final object. When we have several ideas and before you begin to develop concepts



### Developing concepts

Better define each concept, developing the functional and formal analysis, to improve the product and set so you can select the best product at the end.

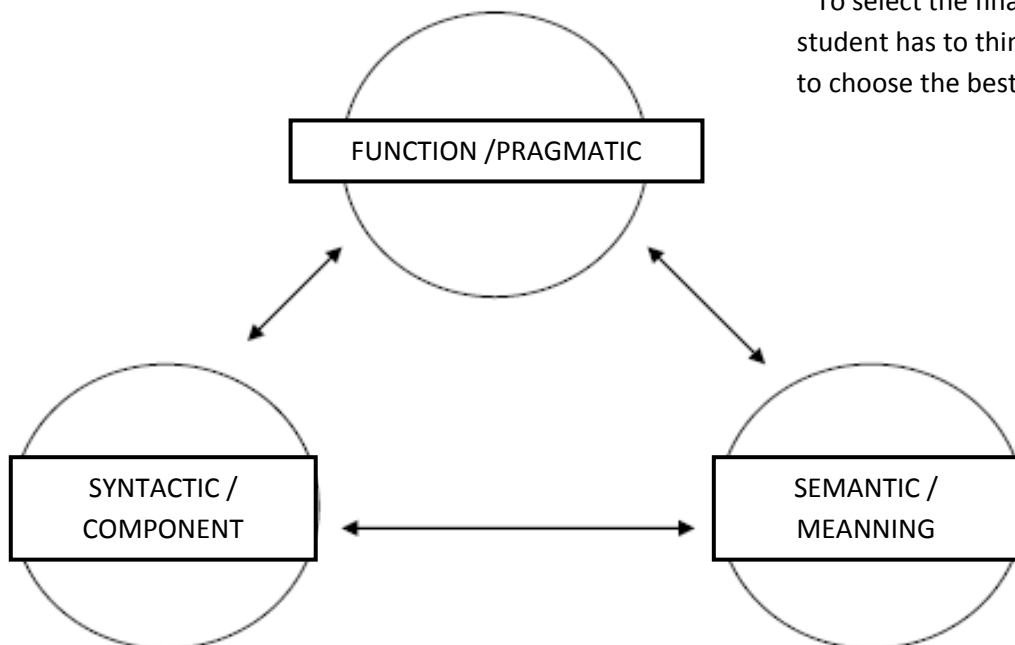
It is done after choosing concepts, using creative tools to find and develop the problems, tools like brainstorming, function diagram, creative sketching, etc.

### Evaluation concepts and choose the final concept

Evaluating and choosing the best concept to have the best product, because we need only one. It is done at the end of concept development.

There are different aspects to consider:

- Advantages and disadvantages
- Formal development
- Functional development
- Material and manufacturing
- Ergonomic development



To select the final concept the student has to think in this ideas to choose the best one..

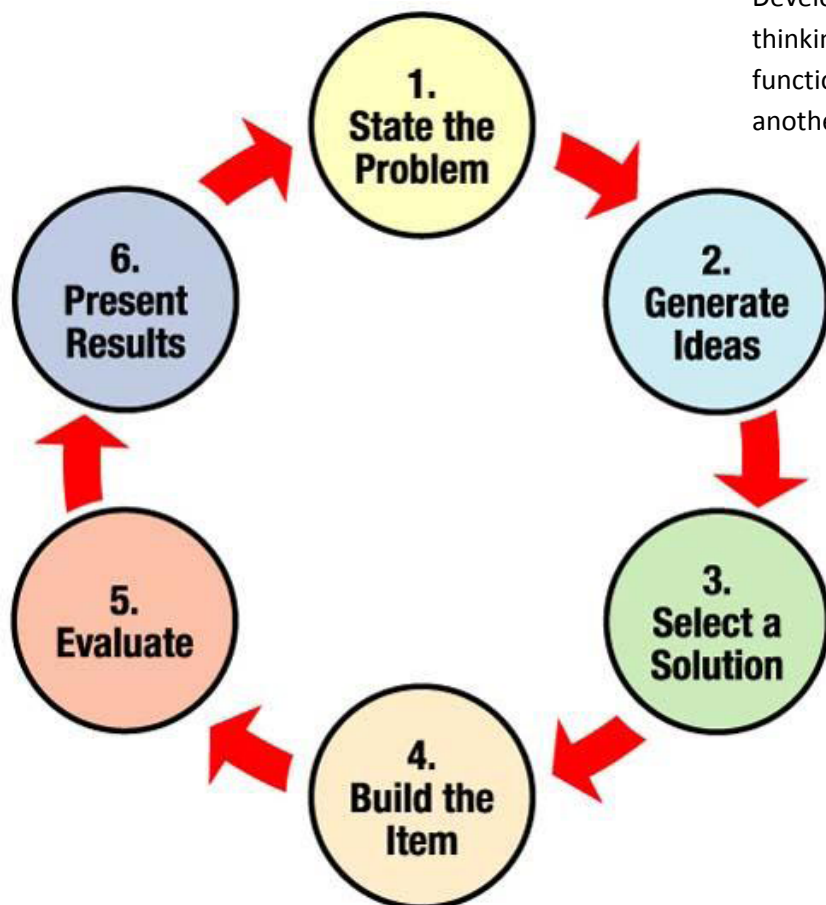
## Development

### Development of the final concept

Define the product detail for a properly defined product to sell on the market. It is done after to choose the final concept

There are a lot of aspects to develop:

- Perception/cognition
- Formal design
- Functional design
- Material and manufacturing
- Anthropometry
- Ergonomic design
- Instructions for use
- Marketing



Step 4:  
Development of the concept,  
thinking in the formal,  
functional, use, materials and  
another analysis.

### **3D modeling**

Creating the concepts in a 3D dimensional environment (using “Autodesk Inventor Professional 2008”), to better illustrate and create a model for future development.

It is done after all the final concept development.

### **Rendering**

Rendering is extracting images from the 3D dimensional model, to describe our 3D product in the most realistic possible

It is done using the specific part to create renders in “Autodesk Inventor Professional 2008”. To get the best appearance is to check: lighting, background, color, perception, reflection, etc.; in and around the model.

The moment to do it is while finishing the concept

## **Marketing**

### **Market research**

Search for images and information from various games through history, focusing mainly on the current and the Wii brand for complete information, and to compare different ideas arise.

It is done searching the Internet and in all places some information about our market: advertisements, pictures, videos, etc.

The moment to do it is when the design is almost finish.

### **Creative sketching**

Creative sketching is creating different logos to have multiple and to choose the most appropriate. It is done after the market research, in the beginning of the creation part

The process mainly consists of two parts:

- Define the ideas that we want that our logo communicate
- Draw different logos based on these ideas

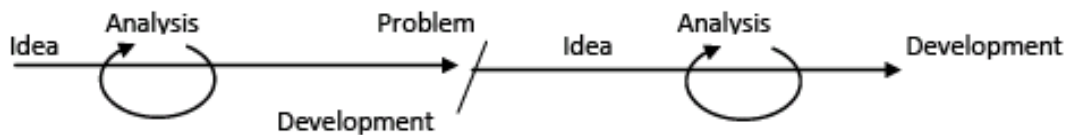
### **Evaluation and choose the final concept**

Evaluating and choosing the best concept to have the best logotype, because we need only one. It is done at the end of concept development.

The process mainly depends on the transmission of information, values that are to communicate to the user, for example: movement, youth, fun, etc.

## 7. - Applied solution procedures

The problem at the beginning of the project has been complicated to solve, so during the course of study has changed the way a couple of times. The course of this development is based in:



The idea of this scheme is that when designing the student may encounter some problems, and will have to solve them with new ideas.

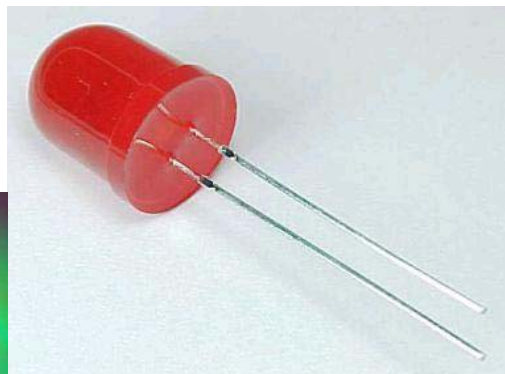
### 1) Documentation

I started to study the information my colleagues Spain had given me. With this and with the help of internet, I began to understand the problem and therefore be able to think of the solution.

The main problem the project is to find the correct solution for 3D communication between the user and the machine

### 2) Solution

Communication between the Wii and the user is achieved by the theory of Head Tracking, so we need some 3D glasses and leds on the hands and head to detect movement.



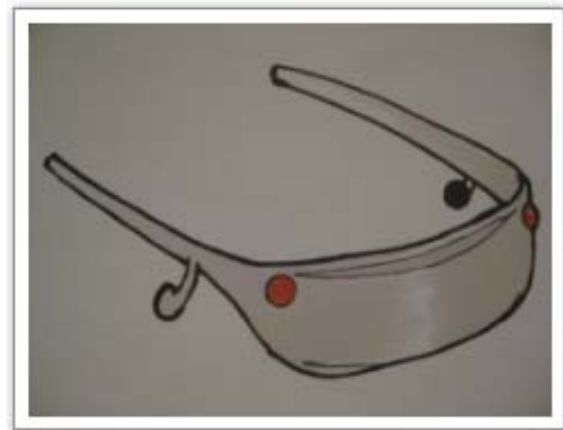


### 5) Creative sketching:

The idea was simple, glasses with LEDs on each side and some leds in their hands. The LEDs need batteries, so that the glasses had to be composed of two shells, like the hand device.

#### Glasses concepts:

- Futuristic, it is a style clean, with perfect lines and compact.



- Snowboard, this style is based in big glasses with big crystal to see perfectly. The elastic band is big also.



- Normal style, they are simple and more similar of the normal glasses.



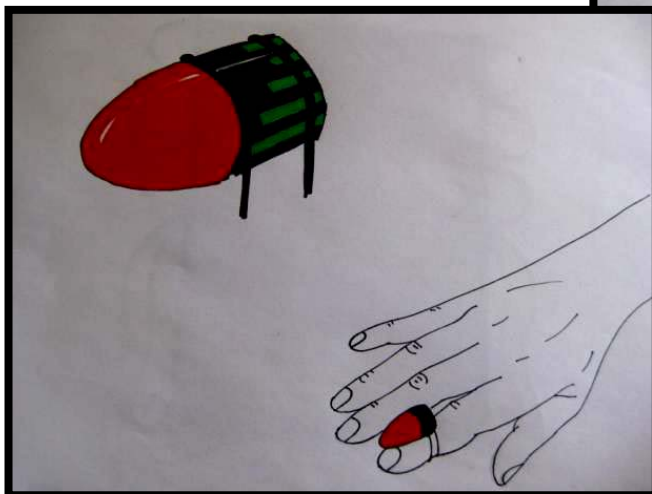
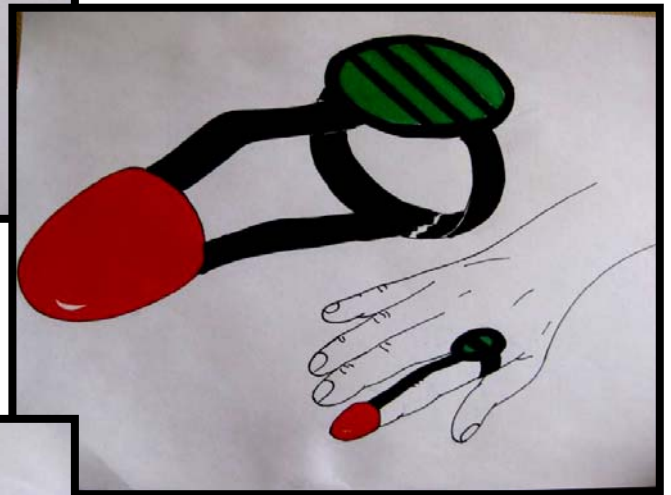
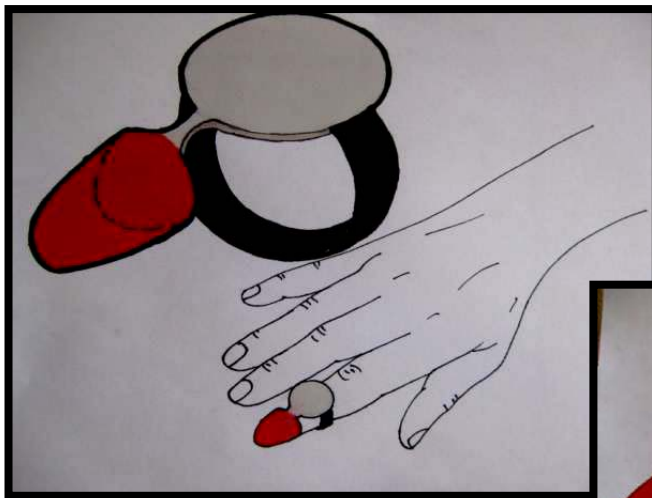
- Swimming style, this style is exactly the same than the glasses that people use to swim. They are design to be really close to the face.





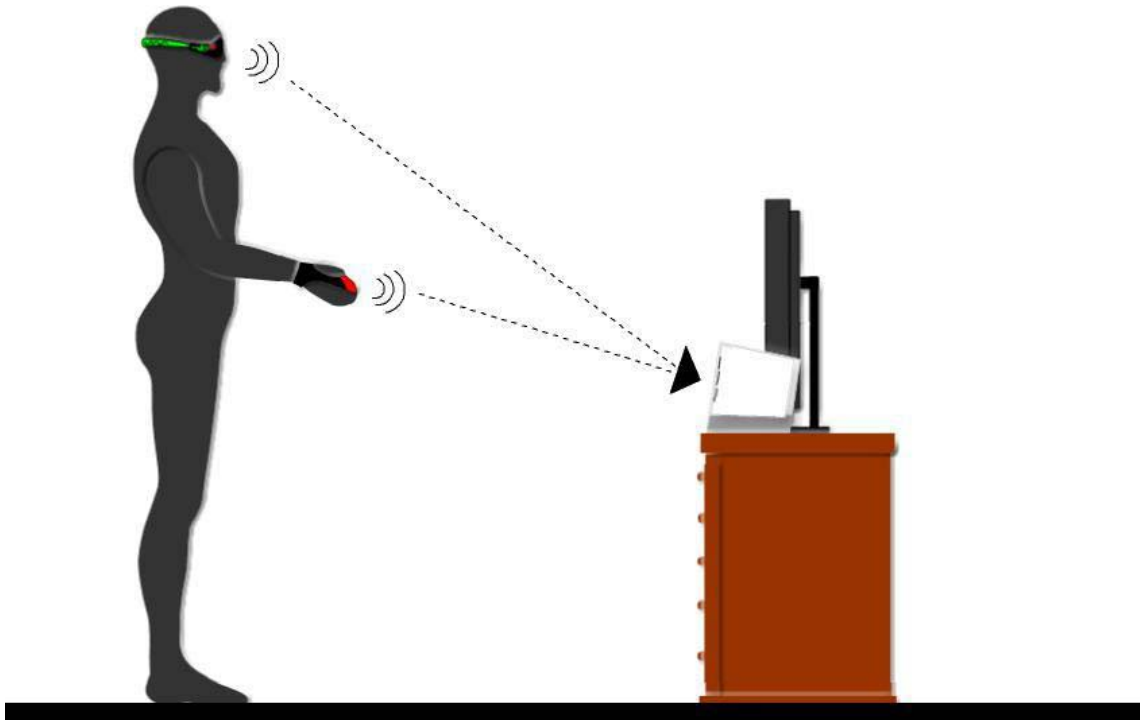
Gloves concepts:

The main idea is to attach the LED with your finger as comfortable as possible. Always thinking you need the connection to a battery.



## 6) Funcional

The operating mode is based on the light; it is emitted from the eye and from the end of the fingers, so the machine receives the coordinates of the player.

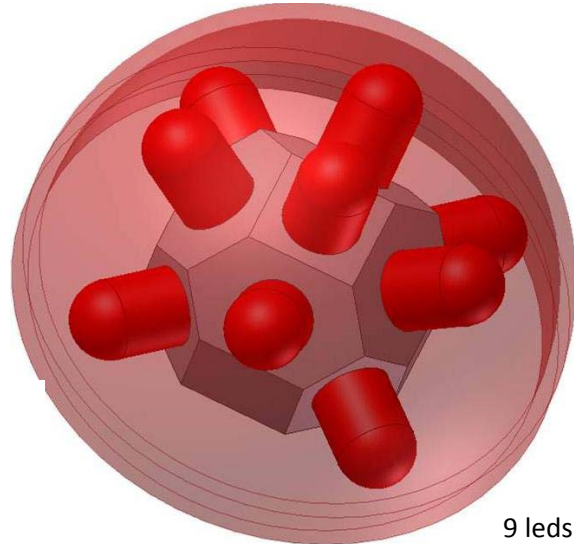
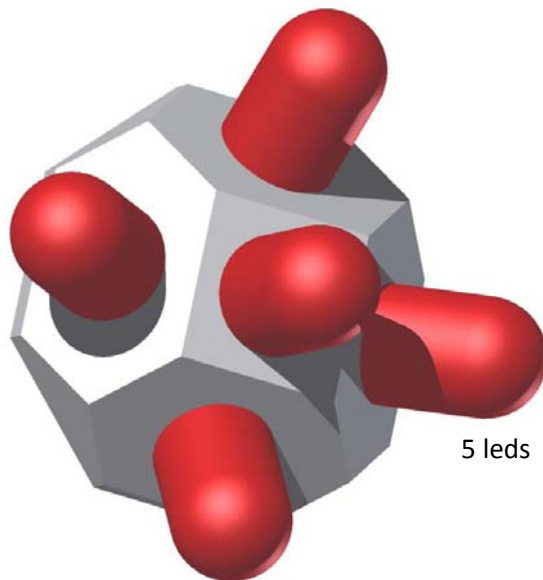


## 7) Problems with the concept

In the beginning of the project was needed led to both sides of the glasses and led in each hand, as I explained previously. But students in Spain realized that better communication between person and machine, you needed a cluster of LEDs in each place named. So I began to perform various tests.

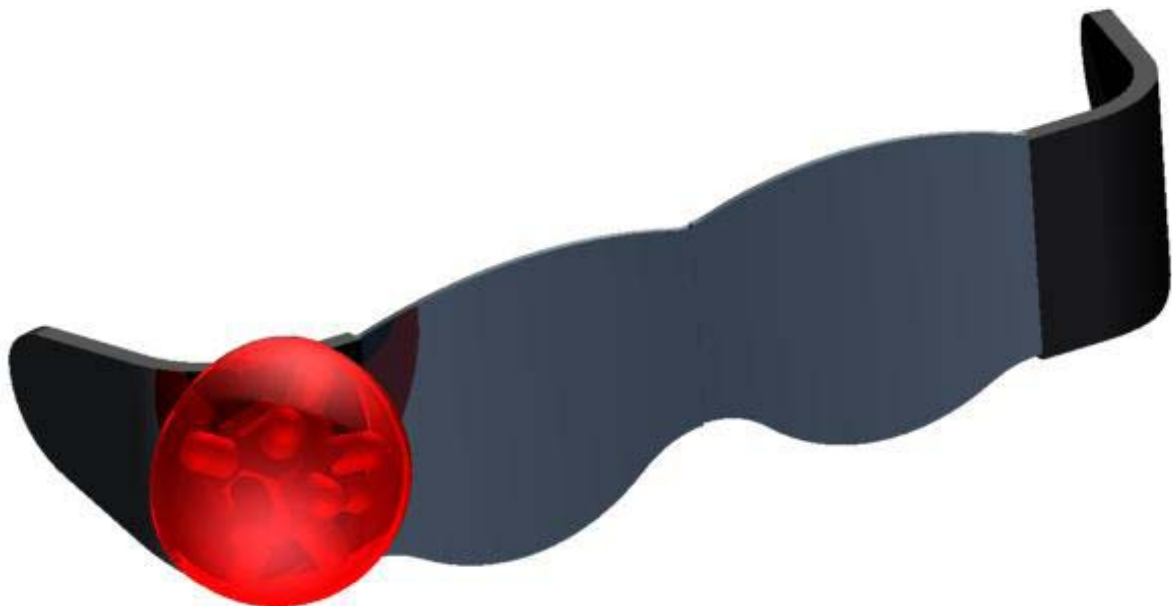
The cluster idea was this, LEDs pointing in all directions.

But something like this was too big to put on glasses.



The cluster of leds is very big and is not aesthetic.

Even if the cluster is only done for two leds is very big. (It can be seen in the next sketch)

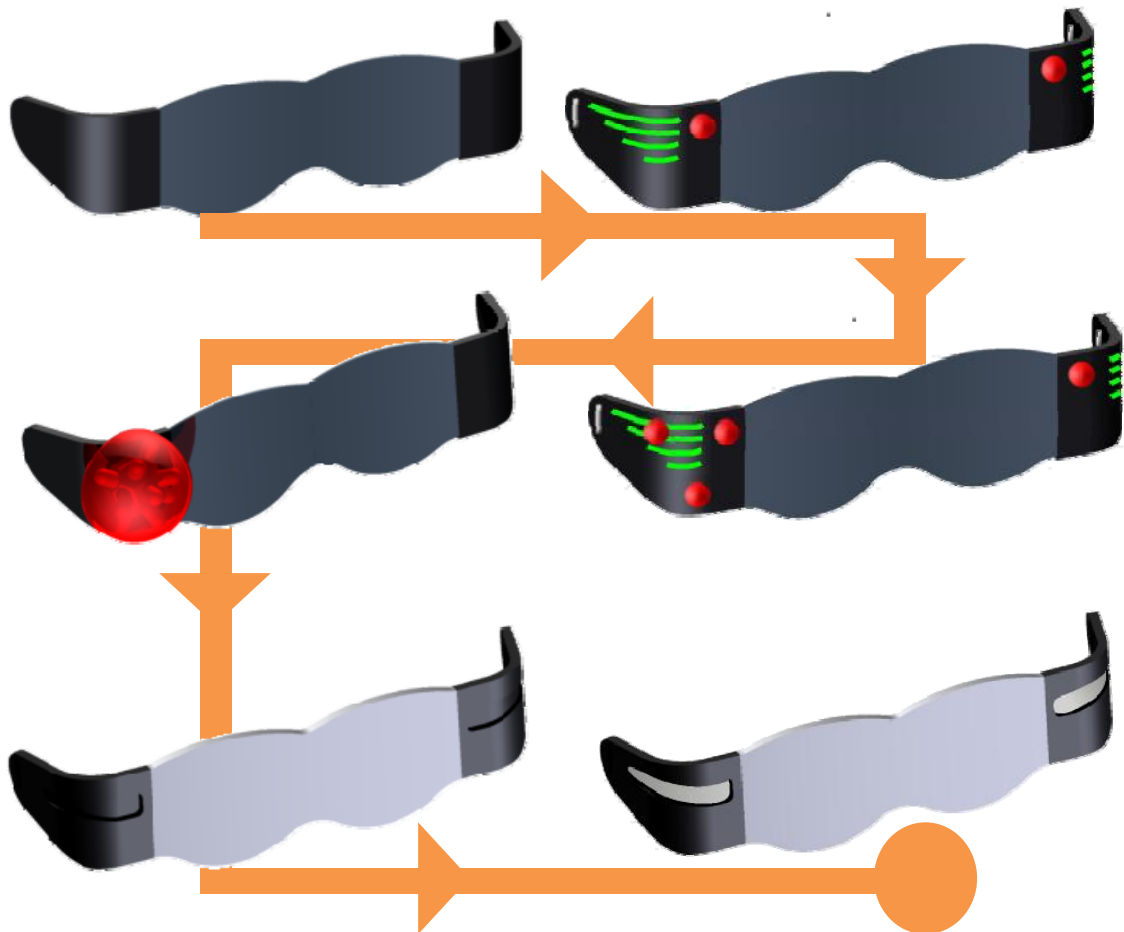


## Looking for a solution

So I thought on other solutions:

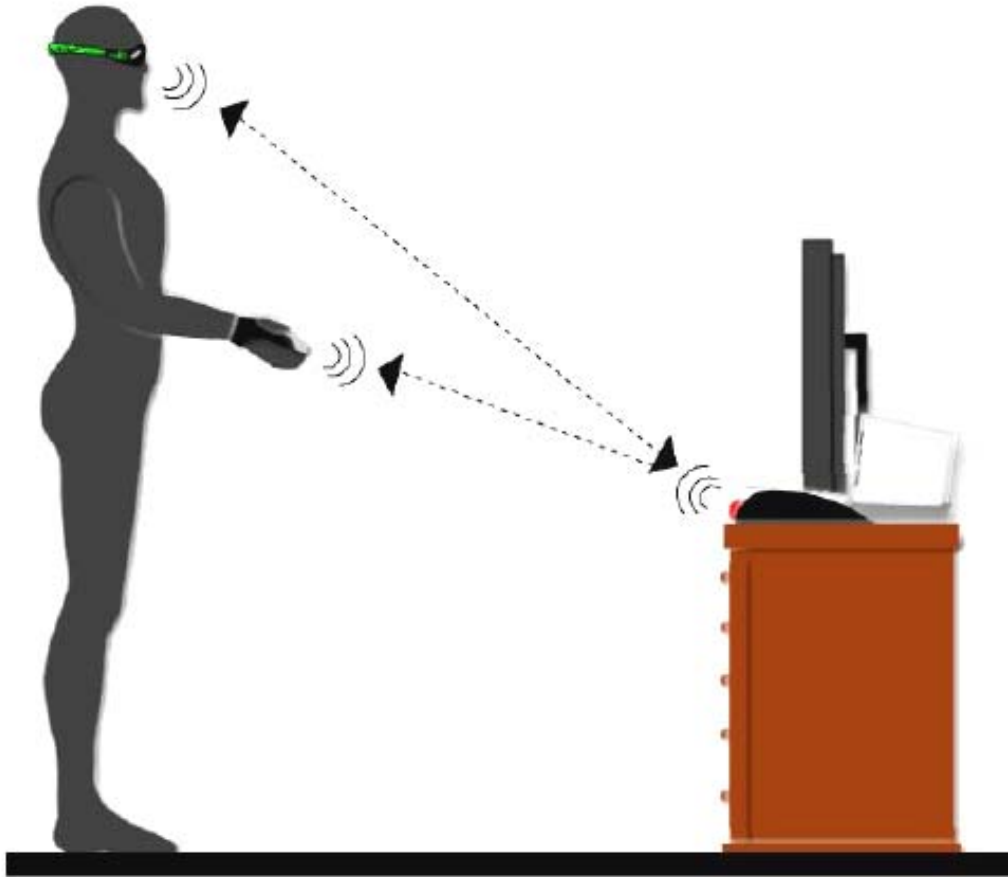
- LEDs placed in the curve formed by the glasses.
- LEDs randomly placed on the casing of the glasses.

But even so, this was not aesthetic.



### 9) New idea -> Solution

The solution is: the support of the Wii remotes emits light that is reflected in the goggles and gloves to reach the Wii remotes.



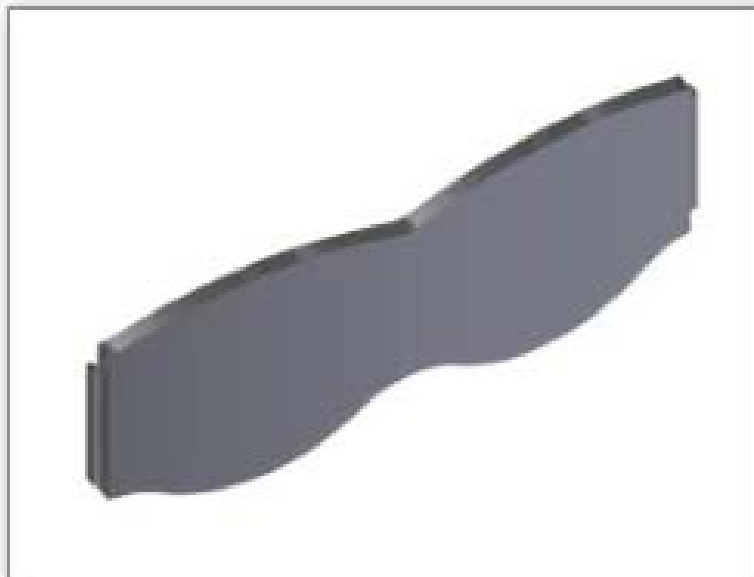
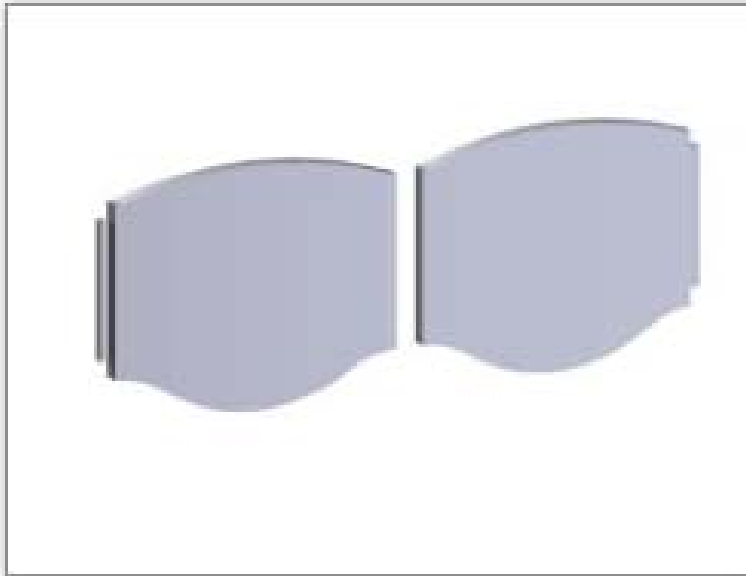
- 1.- Light is emitted by the stand of the Wii remotes;
- 2.- This light is reflected in the reflector band, which is in the each side of the glasses and at the end of the fingers
- 3.- The light, so also the coordinates, are received by the Wii remotes.

## 10) Development

Glasses development (ergonomic):

The development of glasses, her side and glass, has gone through many phases. In which sizes and shapes have changed, then the images are attached:

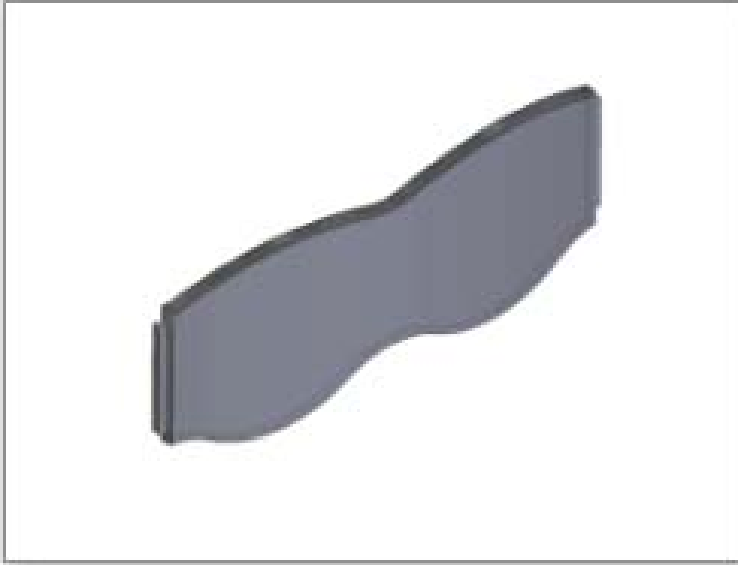
Crystal:



Crystals separated,

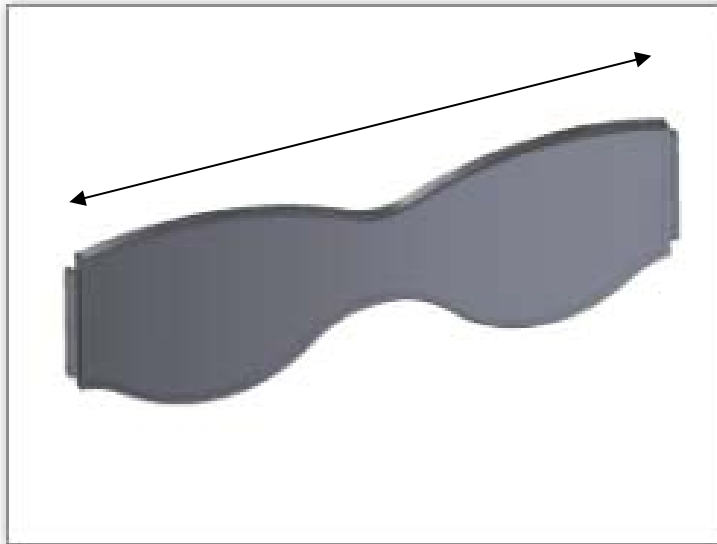
Because, the student did not know if it was better to make 3D glasses in the beginning.

It was an option.



Crystals as one piece,

It is better to the fabrication and for the user too.

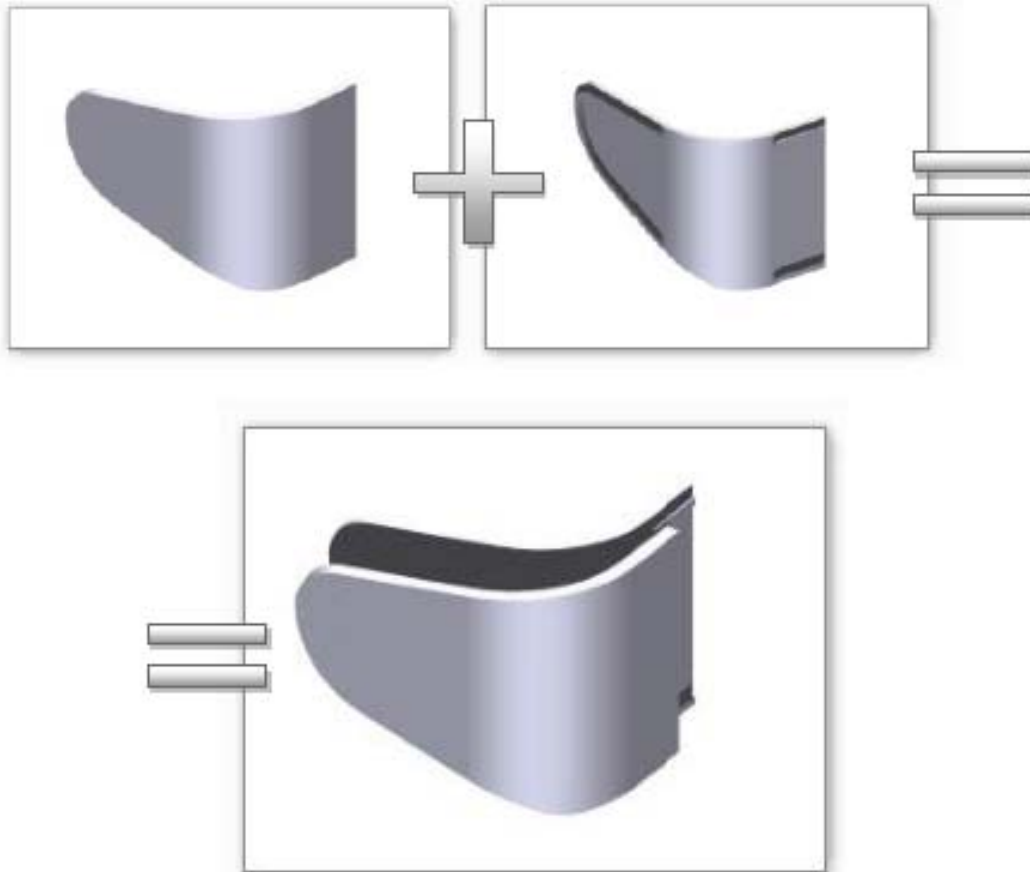


Change of measures:

-Increasing the total distance, because of this, the part for the nose is bigger and other changes, every measure are dependent. - 29 -

The side part:

In the beginning, the side part was going to be based on two casings, because in these had to be the battery and the led.



But finally, the battery and the led are in the stand. So it is not necessary two casings.





Change of measures in the final idea:

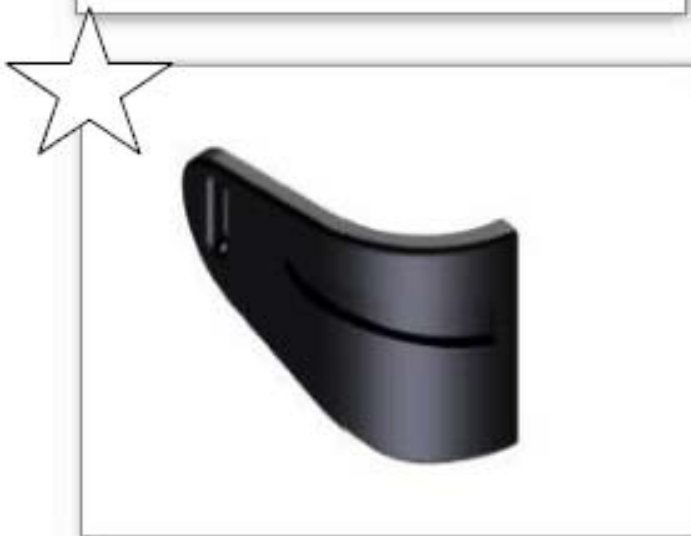
- Remove distant ○

- Decreased angle ☆



Remove distant:

- to the side of the glasses is not outgoing

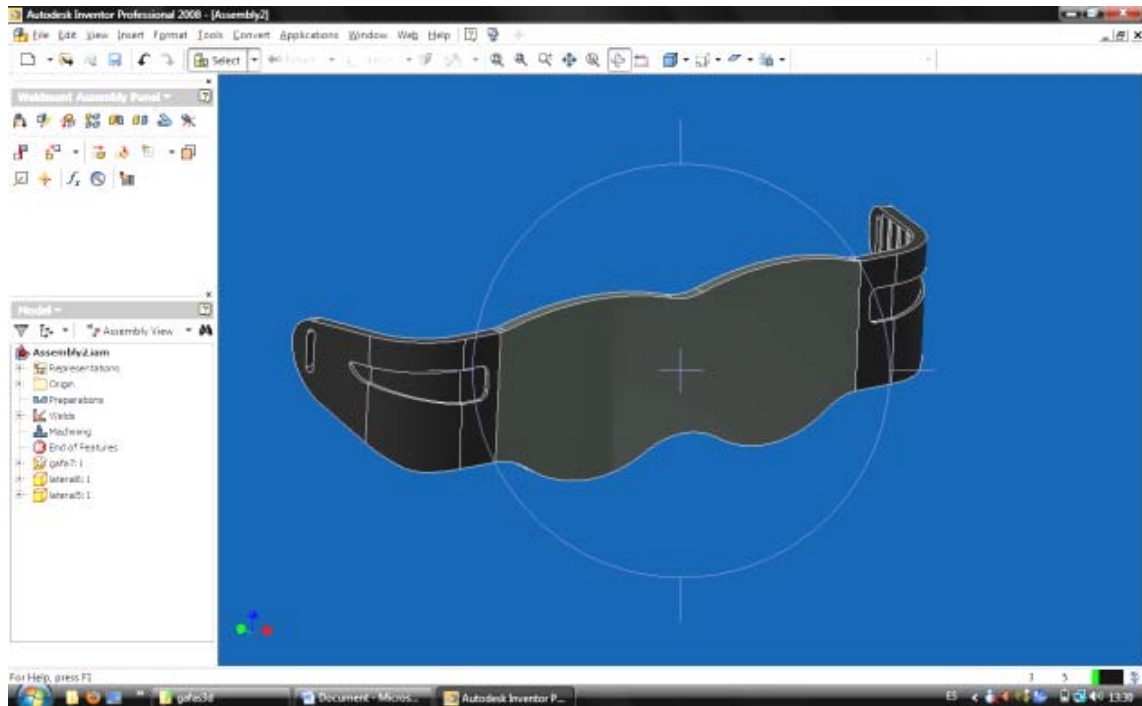


Decrease angle:

- for a better fit to the head

## 11) 3D modeling

All development is made in this program to model in 3D, Autodesk Inventor:



## 8. - Results

The final concept is based on different devices, which use a light transmitter and a reflector, working a correct 3D communication between the user and the machine.

The needed devices are a Wii remote stand with a light transmitter, 3D glasses with reflectors and gloves with reflectors.

### **Stand - transmitter:**

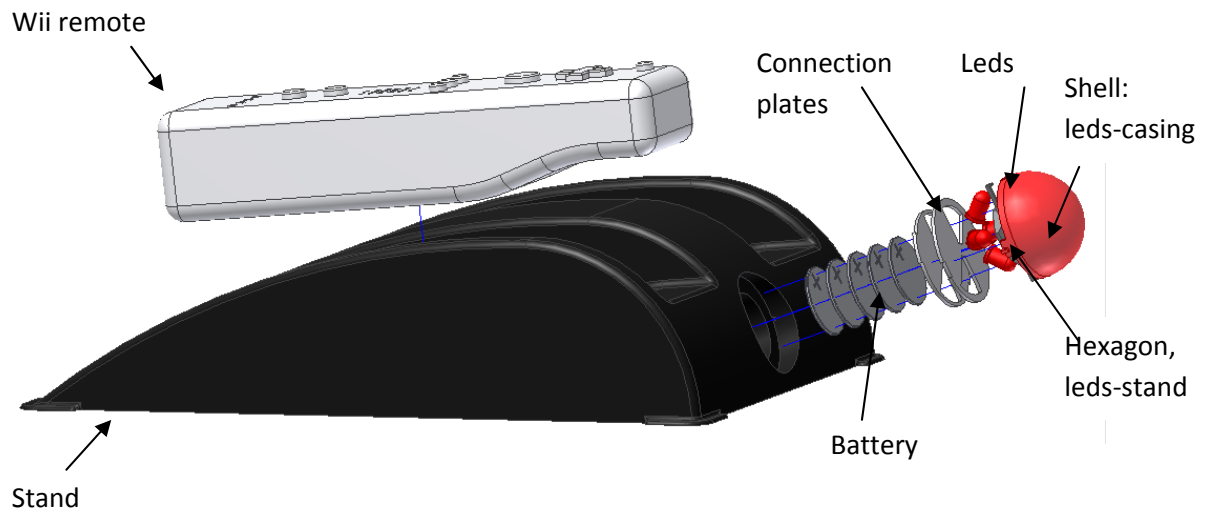
This is a stand for the Wii remotes, but the main function is to give out light to the others devices.

It has five leds in different directions, like this the glasses and the gloves receive light in any position.

Items: batteries, Wii remote and LEDs, we will not study because they are all commercial.



- **Formal analysis**



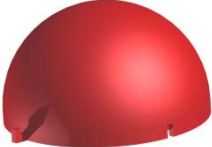



**Appearance:** It is curved with highest point at the front for the proper dissipation of light and thus creating an angle to the Wii controls.





**Representative image:** The main color is black, thus creating a contrast with the white color of the Wii controls.

**Semantic connotation:** It's a friendly-looking device that inspires curiosity, what is needed for a product like this. Also in form and material is consistent in the sector for which this thought something very important when you are recognized by the market.



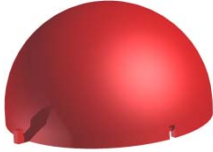

**Relation shape/environment - user:** They are aged between 14 and 16 years, so easy to understand product use.

	Shape	Colour	Finish
<p><b>Stand</b></p> 	<p>Curved shape with greater height in the front, sides vertical</p>	<p>Black, Pantone Black C</p>	<p>Smooth, shine</p>
<p><b>Hexagon: leds-stand</b></p> 	<p>Hexagon shape is polygonal, with 5 holes for the placement of LEDs in different directions, with two side tabs for placement in the shell</p>	<p>White, Pantone 7499 C</p>	<p>Smooth, mate</p>
<p><b>Shell: leds-casing</b></p> 	<p>Semicircular shape with two side tabs for placement in the stand.</p>	<p>Red, Pantone 186 C</p>	<p>Smooth, shine</p>
<p><b>Connection plates</b></p> 	<p>Circular plate with different grooves</p>	<p>(material colour)</p>	<p>Smooth, mate</p>

- **Functional analysis:**

	<b>Main function</b>	<b>Secondary function</b>
<p><b>Stand</b></p> 	<ul style="list-style-type: none"> <li>- To give out light to the others devices</li> </ul>	<ul style="list-style-type: none"> <li>- To support the Wii controls</li> <li>- Aesthetic appearance</li> <li>- To support the battery</li> <li>- To support the shell</li> </ul>
<p><b>Hexagon: leds-stand</b></p> 	<ul style="list-style-type: none"> <li>-To support the leds</li> </ul>	
<p><b>Shell: leds-casing</b></p> 	<ul style="list-style-type: none"> <li>-To protect the leds</li> <li>- To turn the light</li> </ul>	<ul style="list-style-type: none"> <li>- Aesthetic appearance</li> <li>- To support the hexagon</li> </ul>
<p><b>Connection plates</b></p> 	<ul style="list-style-type: none"> <li>-To control the flow of electricity</li> </ul>	

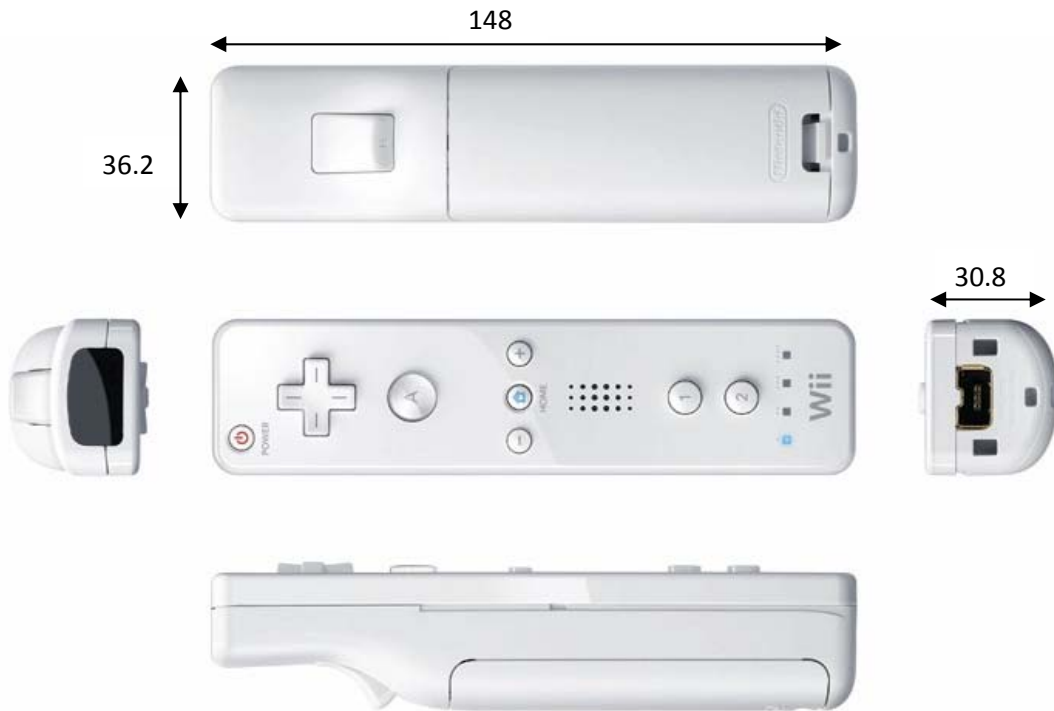
- **Technical monograph:**

	<b>Material</b>	<b>Fabrication</b>
<p><b>Stand</b></p> 	<p>ABS with color pigments Pantone Black C</p>	<p>Injection molding.</p>
<p><b>Hexagon: leds-stand</b></p> 	<p>ABS with color pigments Pantone 7499 C (white )</p>	<p>Injection molding.</p>
<p><b>Shell: leds-casing</b></p> 	<p>Polycarbonate (PC) with color pigments Pantone 186 C (red)</p>	<p>Injection molding.</p>
<p><b>Connection plates</b></p> 	<p>ABS</p>	<p>Injection molding</p>

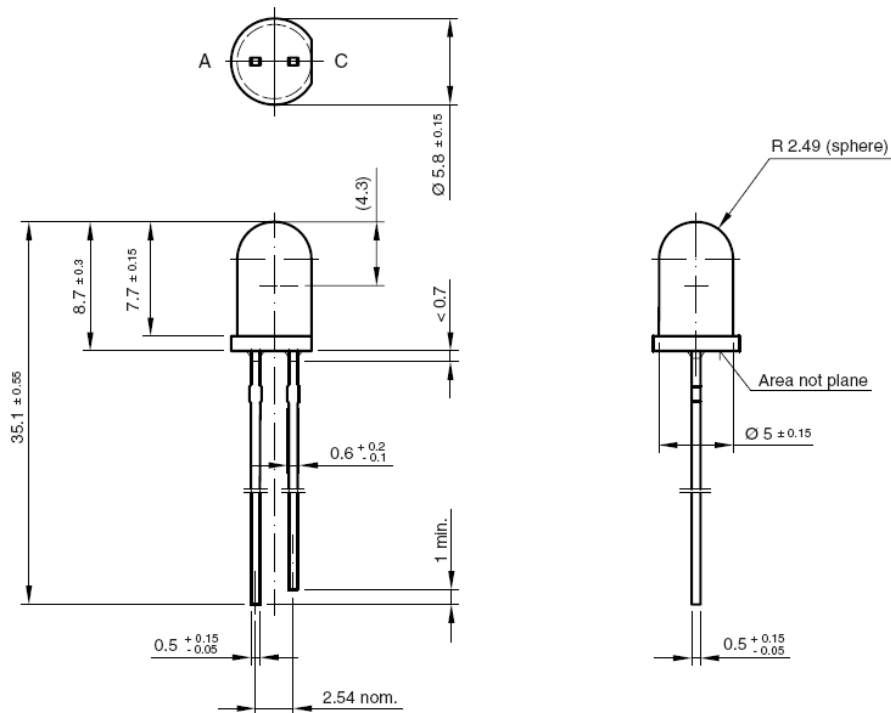
- **Ergonomic analysis:**

For ergonomic analysis we must bear the measures in mind of the Wii Remote and the LEDs, the LEDs should be cluster.

Wii remote:



Leds:



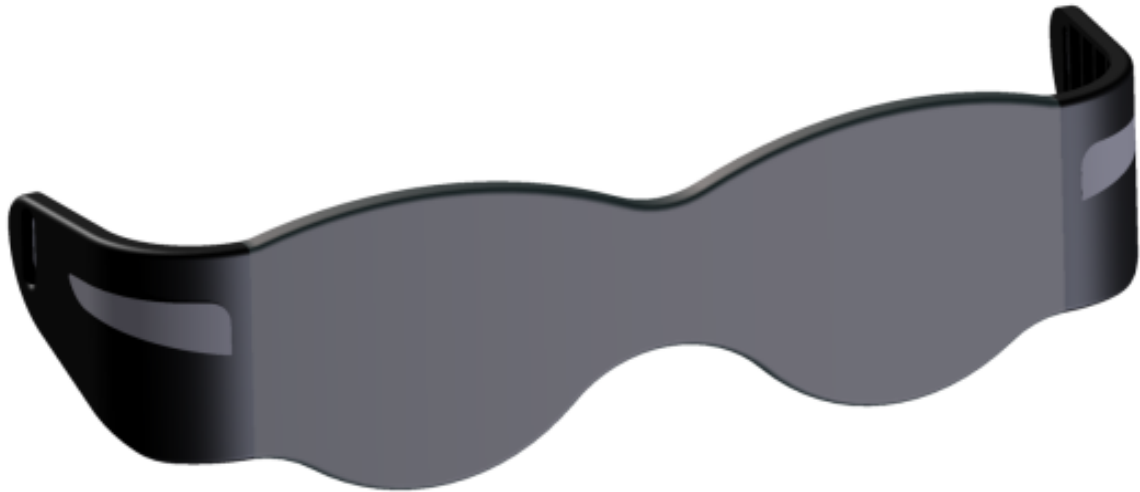


### **3D glasses:**

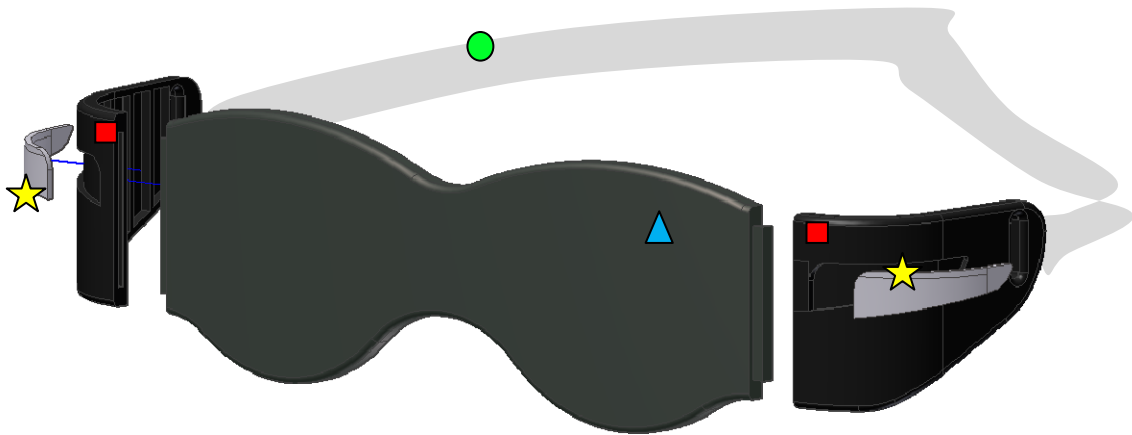
This are a 3D glasses composed of different parts. They have two functions:

- To see in 3D
- Receive and give out light

They are based in different parts: the crystal part, the side parts, the reflector and the elastic band.



- |             |                |
|-------------|----------------|
| ■ Side part | ▲ Crystal part |
| ★ Reflector | ● Elastic band |




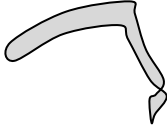


**Appearance:** Form without holding glasses in their ears, instead there is an elastic band. It has a dynamic and youthful




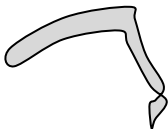
**Representative image:** It is in black and gray to highlight the green brand.

**Semantic connotation:** It's a friendly-looking device that inspires curiosity, what is needed for a product like this. Also in form and material is consistent in the sector for which this thought something very important when you are recognized by the market.




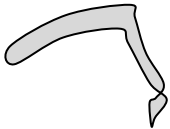
**Relation shape/environment - user:** They are aged between 14 and 16 years, so we have taken into account, measures of the head of this age range and tastes of them

	<b>Shape</b>	<b>Color</b>	<b>Finish</b>
<b>Crystal part</b> 	Form of two unit spectacle lenses, slightly elongated	Almost transparent	Smooth, shine
<b>Side part</b> 	Curved, narrower at its end.	Black, Pantone Black C	Smooth, shine
<b>Reflector</b> 	Curved, narrower at its end.	Reflective color, Pantone 877 C	Smooth, shine
<b>Elastic band</b> 	Strip elongated	White, Pantone 7499 C	Smooth


- Functional analysis:

	Main function	Secondary function
<b>Crystal part</b> 	- 3D View	- Aesthetic appearance -Junction with the lateral
<b>Side part</b> 	- Union side glass	- Aesthetic appearance -Union crystal elastic band
<b>Reflector</b> 	- Light reflectance	- Aesthetic appearance
<b>Elastic band</b> 	- Head fastening	- Aesthetic appearance

• **Technical monograph:**

	<b>Material</b>	<b>Fabrication</b>
<b>Crystal part</b> 	Polycarbonate (PC)	Injection molding.
<b>Side part</b> 	ABS with color pigments Pantone Black C	Injection molding.
<b>Reflector</b> 	Reflector material	Cutting reflective material
<b>Elastic band</b> 	Elastic band	Cut this material

• Ergonomic analysis:



**1 Head breadth.** The maximum breadth of the head, usually above and behind the ears.

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 13.9 (5.1)	14.2 (5.4)	15.2 (5.8)	16.15 (6.3)	16.75 (6.5)
B	Women	cm 13.3 (5.2)	13.7 (5.4)	14.4 (5.7)	15.3 (6.0)	15.7 (6.1)

**2 Interpupillary breadth.** The distance between the centers of the pupils of the eyes (the eyes are looking straight ahead).


Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 5.7 (2.2)	5.9 (2.2)	6.5 (2.7)	7.1 (2.8)	7.4 (2.9)
B	Women	cm 5.5 (2.0)	5.7 (2.2)	6.0 (2.4)	6.8 (2.7)	7.0 (2.8)

**3 Face breadth (zygomatic).** The breadth of the face, measured across the most lateral projections of the cheek bones (zygomatic arches).

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 12.8 (5.0)	13.2 (5.2)	14.0 (5.5)	15.0 (5.9)	15.4 (6.1)
B	Women	cm 12.1 (4.8)	12.3 (4.8)	12.8 (5.1)	14.0 (5.5)	14.4 (5.7)

**4 Fore length (menton-subnasale).** The vertical distance from the tip of the chin (menton) to the deepest point of the nasal root depression between the eyes (subnasale).

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 10.8 (4.3)	11.2 (4.4)	12.2 (4.8)	13.2 (5.2)	13.7 (5.4)
B	Women	cm 10.1 (3.4)	10.4 (4.0)	11.3 (4.5)	12.4 (4.8)	12.9 (5.1)



**5 Biacanthial breadth.** The distance from the outer corners of the eyes (right and left ectocanthi).

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 11.0 (4.3)	11.3 (4.5)	12.2 (4.8)	13.1 (5.2)	13.6 (5.4)
B	Women	cm 10.8 (4.3)	11.1 (4.4)	11.6 (4.5)	12.9 (5.1)	13.3 (5.3)

**6 Strepion breadth.** The breadth of the head from the right tragus to the left. (Tragus is the cartilaginous notch at the front of the ear).


Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 13.1 (5.2)	13.5 (5.3)	14.5 (5.7)	15.5 (6.1)	15.9 (6.2)
B	Women	cm 12.5 (4.9)	12.8 (5.4)	13.3 (5.4)	14.3 (5.7)	15.0 (5.9)

**7 Orbita to back of head.** The horizontal distance from the most anterior point of the forehead between the brow ridges (orbita) to the back of the head, measured with a headboard.

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 18.3 (7.2)	18.8 (7.4)	20.0 (7.9)	21.7 (8.3)	21.7 (8.5)
B	Women	cm 17.5 (6.9)	18.0 (7.1)	18.1 (7.5)	20.2 (8.0)	20.7 (8.1)

**8 Menton to back of head.** The horizontal distance from the tip of the chin (menton) to the back of the head, measured with a headboard.

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 15.7 (6.2)	16.5 (6.5)	18.2 (7.2)	20.0 (7.9)	20.7 (8.2)
B	Women	cm 15.2 (5.0)	15.6 (5.2)	17.3 (5.8)	18.9 (7.4)	19.6 (7.7)



**9 Orbita to top of head.** The vertical distance from the nasal root depression between the eyes (orbita), to the level of the top of the head, measured with a headboard.

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 9.7 (3.8)	10.1 (4.0)	11.2 (4.4)	12.4 (4.9)	12.9 (5.1)
B	Women	cm 8.0 (3.5)	8.5 (3.5)	10.5 (4.1)	11.7 (4.6)	12.2 (4.8)

**10 Menton to top of head.** The vertical distance from the midpoint of the chin (menton) to the level of the top of the head, measured with a headboard.


Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 16.9 (6.7)	17.4 (6.6)	18.6 (7.3)	19.9 (7.8)	20.6 (8.1)
B	Women	cm 15.7 (5.1)	16.3 (5.4)	17.5 (6.0)	18.8 (7.4)	19.4 (7.6)

**11 Orbita to back of head.** The horizontal distance from the nasal root depression between the eyes (orbita), to the back of the head, measured with a headboard.

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 14.0 (7.1)	14.5 (7.3)	15.7 (7.8)	17.0 (8.2)	17.4 (8.4)
B	Women	cm 12.4 (5.8)	12.8 (5.7)	14.0 (6.0)	15.2 (6.6)	15.5 (6.4)

**12 Pretriale to back of head.** The horizontal distance from the tip of the nose (prae-triale) to the back of the head, measured with a headboard.

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 20.0 (7.8)	20.5 (8.1)	22.0 (8.7)	23.2 (9.1)	23.9 (9.4)
B	Women	cm 18.2 (7.6)	18.7 (7.8)	21.0 (8.3)	22.2 (8.7)	22.8 (9.0)



**13 Head length.** The maximum length of the head, measured from the most anterior point of the forehead between the brow ridges (orbita) to the back of the head (occiput).

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 18.0 (7.1)	18.5 (7.2)	19.7 (7.8)	20.9 (8.2)	21.3 (8.4)
B	Women	cm 17.2 (6.8)	17.6 (7.0)	18.7 (7.4)	19.8 (7.8)	20.2 (8.0)

**14 Menton to top of head.** The vertical distance from the tip of the chin (menton) to the level of the top of the head, measured with a headboard.

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 21.2 (8.4)	21.8 (8.4)	23.2 (8.6)	24.7 (9.1)	25.5 (9.4)
B	Women	cm 19.8 (7.8)	20.4 (8.2)	21.8 (8.6)	23.2 (9.1)	23.8 (9.4)

**15 Menton-orbita length.** The vertical distance from the bottom of the chin (menton) to the midpoint of the hairline (orbita).

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 16.6 (6.3)	17.4 (6.6)	19.1 (7.3)	20.9 (8.2)	21.6 (8.5)
B	Women	cm 15.5 (5.1)	16.1 (5.3)	17.7 (6.0)	19.2 (7.4)	19.9 (7.6)

**16 Menton-subnasale length.** The distance from the bottom of the chin (menton) to the base of the nasal septum (subnasale).

Sample	Sex	Percentiles				
		1st	5th	50th	95th	99th
A	Men	cm 6.1 (2.4)	6.5 (2.7)	7.3 (2.9)	8.3 (3.3)	8.7 (3.3)
B	Women	cm 5.7 (2.2)	6.0 (2.4)	6.5 (2.7)	7.8 (3.1)	8.3 (3.3)

## Gloves:

They are like a gloves, but only for two fingers, because you are going to use the index and middle finger.

There is a reflector at the each end of these fingers, to receive and give out light.

- **Formal analysis**





**Appearance:** Form two fingers glove, is designed to fit the hand properly



**Representative image:** It is in black to highlight the green brand.

**Semantic connotation:** It's something curious about its mode of use, since your fingers are going to control the screen. It is therefore a product sufficiently attractive, because its function is more important.

**Relation shape/environment - user:** They are aged between 14 and 16 years, so we have taken into account, measures of the hand of this age range and tastes of them



	Shape	Color	Finish
<p><b>Gloves</b></p> 	<p>Form glove, but only with material for the fingers index and middle finger.</p>	<p>Black, Pantone Black C</p>	<p>Bright stretch fabric</p>
<p><b>Reflective</b></p>  <p>part</p>	<p>Form to cover the ends of the fingers</p>	<p>Reflective color, Pantone 877 C</p>	<p>Bright stretch fabric</p>

- **Functional analysis:**

	Main function	Secondary function
<p><b>Gloves</b></p> 	<p>To place the reflective at the ends of the fingers</p>	<p>- Aesthetic appearance</p>
<p><b>Reflective</b></p>  <p>part</p>	<p>- Light reflectance</p>	<p>- Aesthetic appearance</p>



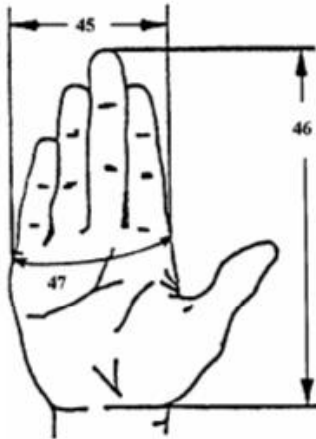
- **Technical monograph:**

	<b>Material</b>	<b>Fabrication</b>
<p><b>Gloves</b></p> 	<p>Lycra with color pigments Pantone Black C</p>	<p>Sewing</p>
<p><b>Reflective part</b></p> 	<p>Reflective material</p>	<p>Sewing</p>

- Ergonomic analysis:

**45 Hand breadth.** The breadth of the hand, measured across the ends of the metacarpal bones (metacarpal-phalangeal joints).

Sample		1st	5th	Percentiles			
				50th	95th	99th	
A	Men	cm (in)	8.1 (3.2)	8.4 (3.3)	9.0 (3.5)	9.8 (3.9)	10.0 (3.9)
B	Women	cm (in)	7.1 (2.8)	7.3 (2.9)	7.9 (3.1)	8.6 (3.4)	8.9 (3.5)



**46 Hand length.** The distance from the base of the hand at the wrist crease to the tip of the middle finger.

Sample		1st	5th	Percentiles			
				50th	95th	99th	
A	Men	cm (in)	17.3 (6.8)	17.9 (7.1)	19.3 (7.6)	21.1 (8.3)	21.9 (8.6)
B	Women	cm (in)	15.9 (6.3)	16.5 (6.5)	18.0 (7.1)	19.7 (7.8)	20.5 (8.1)

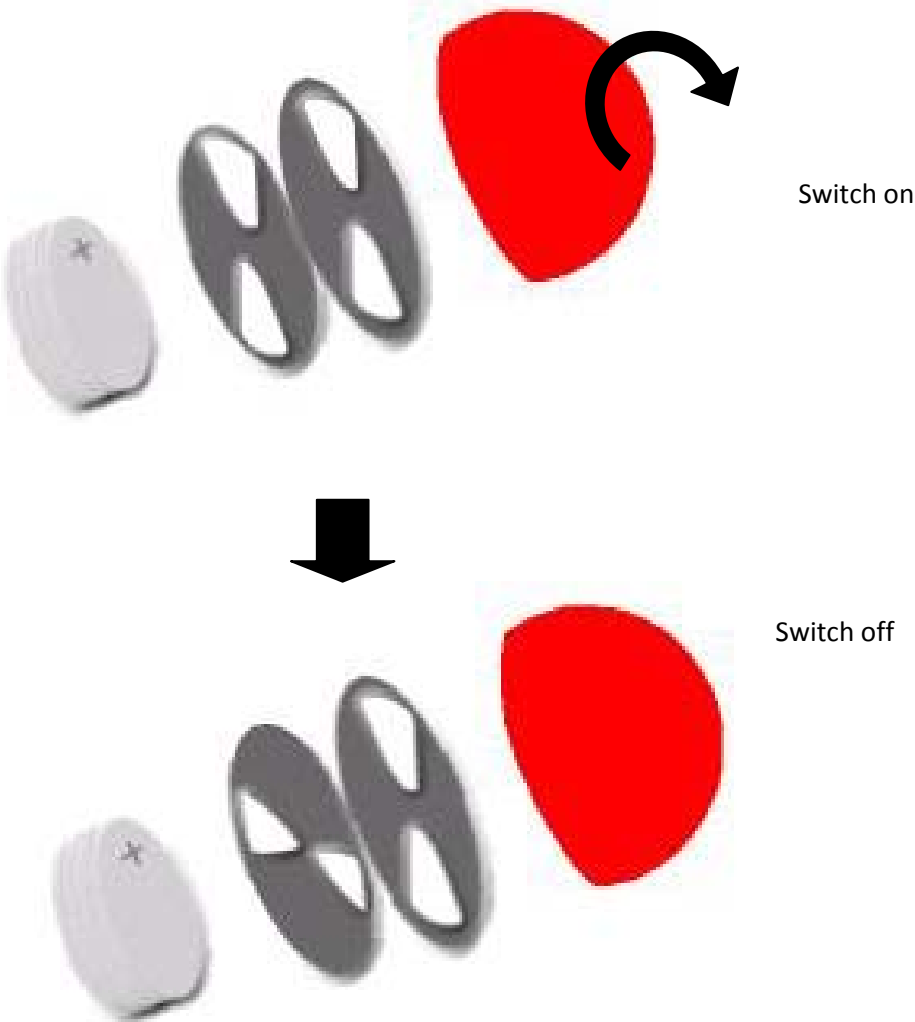
**47 Hand circumference.** The circumference of the hand, measured around the knuckles (metacarpal-phalangeal joints).

Sample		1st	5th	Percentiles			
				50th	95th	99th	
A	Men	cm (in)	19.2 (7.6)	19.9 (7.8)	21.3 (8.4)	23.0 (9.1)	23.7 (9.3)
B	Women	cm (in)	16.7 (6.6)	17.3 (6.8)	18.6 (7.3)	20.0 (7.9)	20.7 (8.2)

**How the electronic part:**

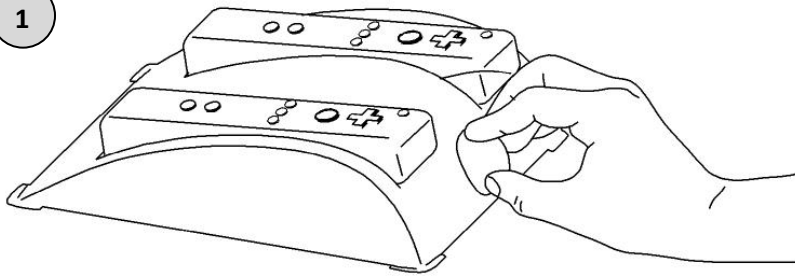
There are two sheets between the LEDs and batteries, which according to their position or not permit the passage of electricity.

Turning the wheel causes the plates to be rotated in turn, closing or opening the flow according to the position of the holes.



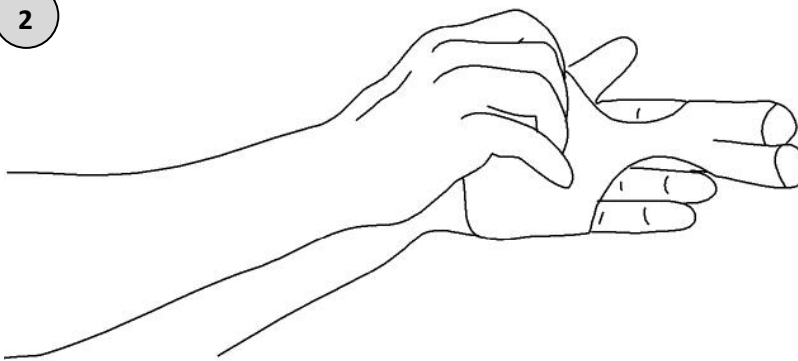
## Use analysis

1



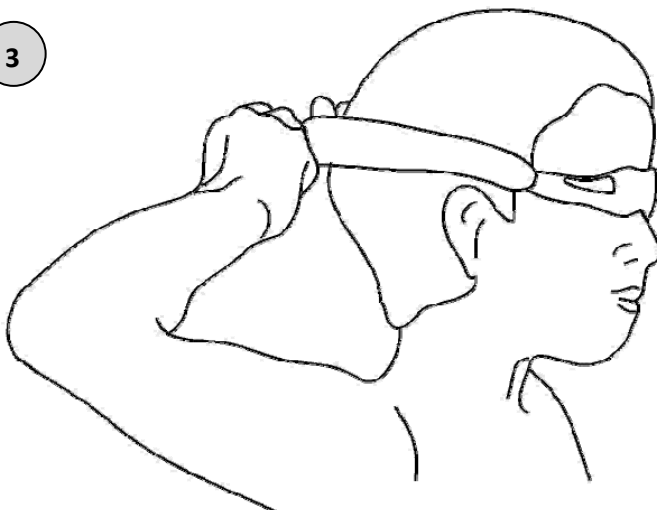
Turning on, turning the red button

2



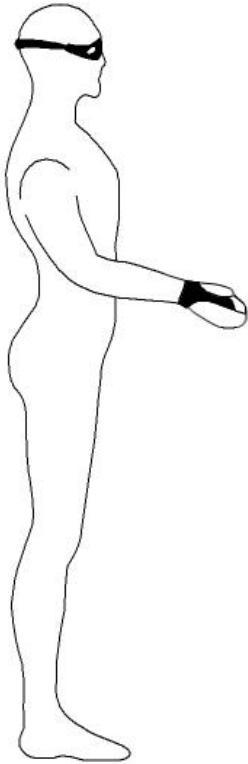
Put two gloves, remembering gloves are only for two fingers, index and heart.

3

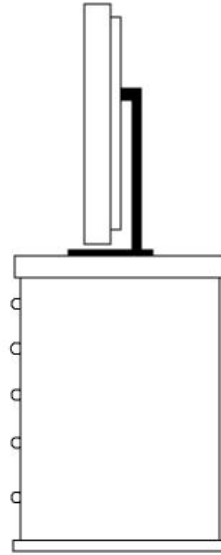


Put the glasses, helping from the elastic band.

4

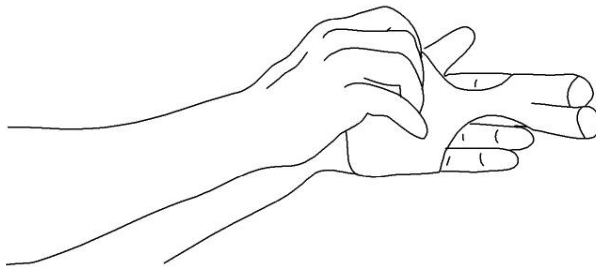


Play, the fingers focus towards the  
Wii remotes, which detect the  
movement.



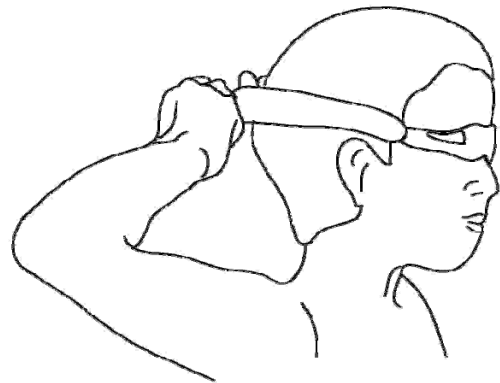
5

Take off the gloves



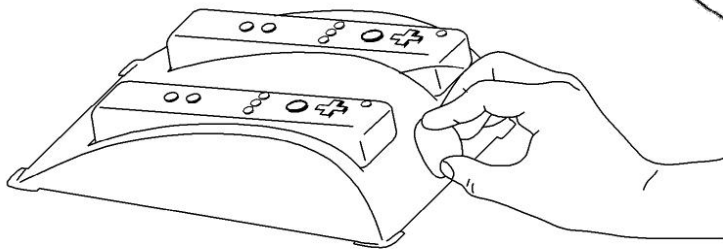
6

Take off the glasses



7

Switch off



## Product image: logotype

The logotype is based on different ideas you have to communicate to the user:

- Movement
- Youth
- Wii Brand
- Fun
- ...

It has been thought of a simple logo based on the green. It appears the Wii logo and added the "3D" with different shades of color and in different positions to give the appearance of movement.

After several ideas that have been chosen:

- Logo with white background:



- Logo with black background:



## 9. - Analysis

Here, it has analyzed the proposed solution according to the problem of this project.

### **Problem**

The problem is to design devices for communication in 3D between the user and the machine. Other students in Spain developed the technique of communication. So, the student had to design according to the needs of students from Spain.

#### **Purpose and goal with the project:**

The main problem the project is to find the correct solution for 3D communication between the user and the machine

This problem is broken down into sub problems, design 3D glasses, devices for the hands and support for the Wii remotes.

### **Ideas**

In the beginning of the project, the student designed a glasses with one leds each side of it; and a gloves with leds at the end of the fingers. The receptor of the light was going to be designed by the students from Spain.

But, the glasses and the gloves needed more than one led each side. They needed several leds pointing in different directions. So, the student started to think about this new problem, but put several LEDs on each side of the glasses was unattractive, it was very big.

Finally, the student designed a light transmitter, so the glasses and the gloves did not need give out light, they needed to reflect the light emitted.

### **Development**

The student development this last idea, with different drawings, different tests and measures a 3D model in Autodesk Inventor.

#### **What The student has achieved:**

The student has to solve the problem, eventually designing a stand for Wii remotes, 3D reflective glasses and reflective gloves.

The final performance is the support for the Wii remotes emits a light that is reflected in the gloves and glasses, to be received for the Wii remotes that control movement through an infrared camera



**What the student has not achieved:**

The student has not solved the small advertising campaign planned to make, since the project became more complicated than previously thought

**What are the student's verified results?**

The student, with the help of students from Spain, has been found that good 3D communication is done between the Wii console and the user.

**What is not verified?**

The dimensions of the gloves and glasses for good ergonomics with the player were not verified. Rapid prototypes were made and compared the tables to create good measures. But the student did not make the final model.

**Solution**

Finally the student got the 3D model, drafts and renders of the 3D glasses, gloves and stand.

**The practical implications of the student's work are:**

The student has designed devices for a 3D communication between the Wii and the user. With the design done, anyone can move around a stage (pre-designed) and play or know the place.

**Technology used:**

Autodesk Inventor - 3D modeling

Freehand - drawing

3DS Max - Rendering

## 10. - Conclusions & recommendations

### Recommendation

It could be for anyone wishing to use the produced information in this project to continue to look at the points below:

- Create a Bill of material list
- Check the materials
- Continue with the advertising campaign
- Establish a contact with Wii company

### Recommendations for future work:

For future work would be good if done the real prototype and if necessary change in measurements for proper ergonomics with the user.

In addition to make a publicity campaign for the product because it is something new and different.

### Interesting further implications of my work:

Interesting implications of this work could be:

- Learning games for children
- Possibility of touring maps to work as a taxi driver, mail delivery, police, firefighters or ambulances drivers.
- Activities for people who have lost range of motion
- 

### Ways in which your work could be improved:

The designs could be improved in details of his appearance. Place the logo on different devices.

And on the computer, you should realize the game mode, specify how you click the buttons, what to do with your fingers.

### Learned from the project

The biggest lesson learned is to work in collaboration with a group of students from another field. No project has a perfect result no matter how hard one try's, from every step taken towards the goal hidden paths appear and missed shortcuts can be seen reaching the top. Las but not least call instead of email

## **Overall impression**

The time spent in Sweden has been invaluable lesson to the student, all the mistakes will she now know how to avoid and all the great results will she take with her for her future career.

## **Conclusions**

Devices for 3D communication are a system designed with three separate parts: glasses, transmitter stand and gloves. The system is technically designed and tested by a group of students at Zaragoza University. This secures the technical function and that the system will work properly.

The aim of the project was to design the three system parts. Design proposal are presented and developed to final concepts. The next step is to continue as listed in "recommendations".

The product; glasses, stand and gloves, will fit the customer because of the design that is based on ergonomics, communication design (machine/user), similar product design like motion detection devices, sunglasses, colour language and geometry.

The project is done by demand analysis, customer analysis, product analysis and mood board. This makes the proposals fit the demands that the customer wants. To use a mood board when working with product development gives you a good start when you are seeking for ideas for proposals. Studying and trying to learn from others It's easier and better.

# 11. - References

## Literature

Design-Inspired INNOVATION

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[http://www.google.com/images?um=1&hl=es&client=firefox-a&hs=W2R&rls=org.mozilla%3Aes-ES%3Aofficial&tbs=isch%3A1&sa=1&q=gafas&aq=f&aql=&oq=&gs\\_rfai](http://www.google.com/images?um=1&hl=es&client=firefox-a&hs=W2R&rls=org.mozilla%3Aes-ES%3Aofficial&tbs=isch%3A1&sa=1&q=gafas&aq=f&aql=&oq=&gs_rfai)

10 February 2010

<http://www.yankodesign.com/>

## **(12. – Appendices)**

Number and give describing names to your appendices to help the reader to grasp the content of your report.

### **1) Analysis**

#### **1.1 Demand Analysis**

- The most appropriate methods are chosen for designing Devices for a communication in 3D.
- These chosen methods are used in a controlled and traceable way.
- Design Devices for a communication in 3D
  - Being attractive and eye-catching to try and sell this new product.
  - 3D communication between the machine and the user.
- Creating a concept that can give inspiration for other projects
  - Being attractive
- Perception
- Cognition
- Anthropometry
- Geometry and colour language
- Ergonomics
  - Visualizing the concept in realistic way

## 1.2 Planning

	September			November			December			January		
Planning	X	X	X				X	X	X	X	X	X
Documentation	X	X	X	X	X	X						
Definition problem	X	X	X				X	X	X			
Solution	X	X	X							X	X	X
Design	X	X	X				X	X	X			
Solution of potential problems	X	X	X							X	X	X
Development	X	X	X									
Detail design	X	X	X									
Marketing	X	X	X									
Report	X	X	X	X	X	X	X	X	X	X	X	X
Presentation	X	X	X									

	February			March			April			May		
Planning	X	X	X	X	X	X	X	X	X			
Documentation	X	X	X	X	X	X	X	X	X			
Definition problem	X	X	X	X	X	X	X	X	X			
Solution	X	X	X	X	X	X	X	X	X			
Design	X	X	X	X	X	X	X	X	X			
Solution of potential problems	X	X	X									
Development	X	X	X	X	X	X	X	X	X			
Detail design	X	X	X	X	X	X	X	X	X			
Marketing	X	X	X	X	X	X	X	X	X			
Report	X	X	X	X	X	X	X	X	X	X	X	X
Presentation	X	X	X	X	X	X	X	X	X			



Spare time



Working time





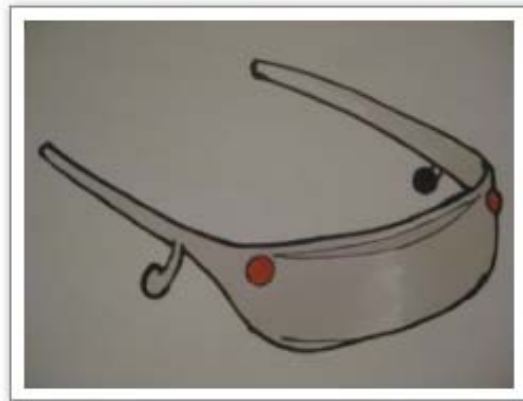
### 3) Ideas

The student started thinking in different concepts. Everyone based in the same function, but different style.

\*The draws are added in the end of the report.

#### Glasses concepts:

- Futuristic style



- Snowboard style



- Swimming style

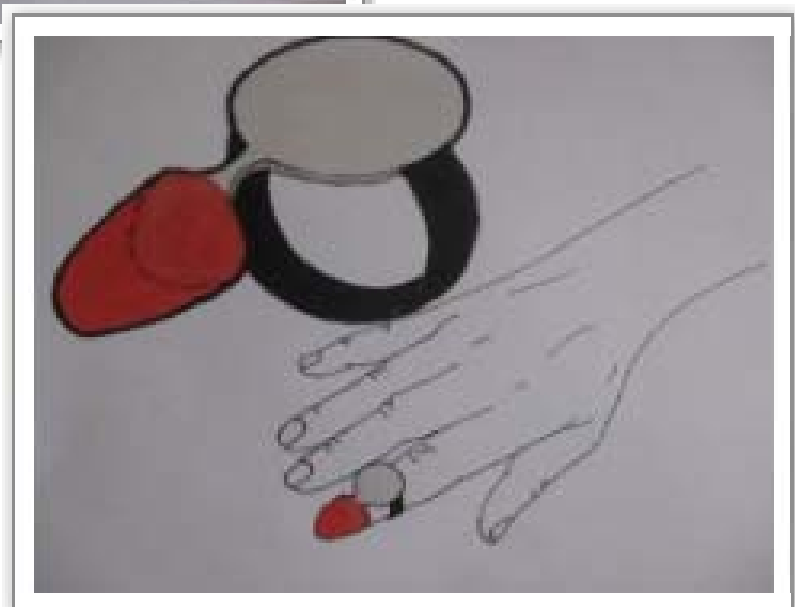
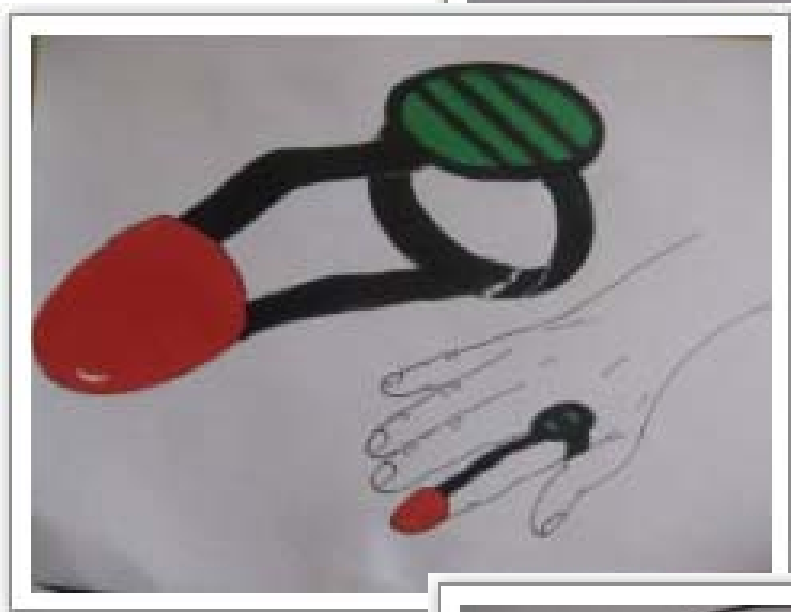


- Normal style



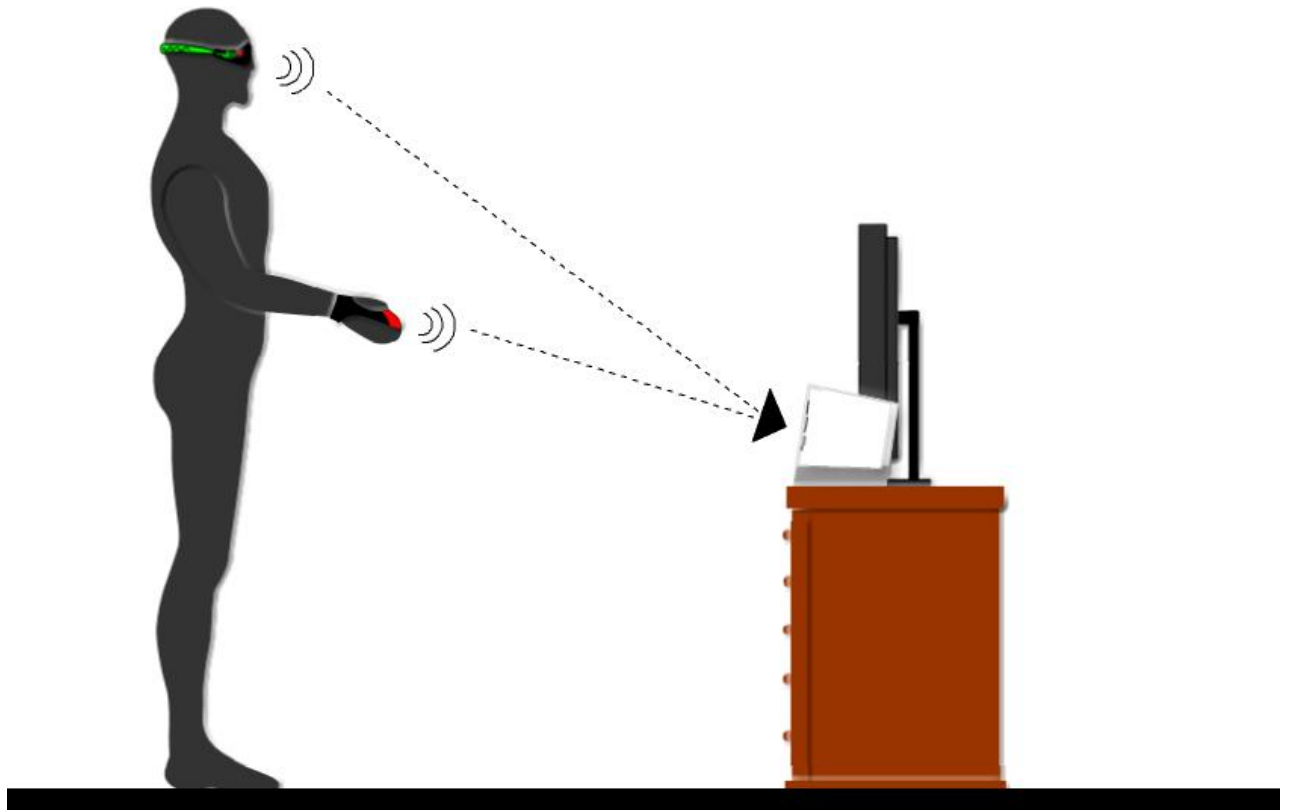
Gloves concepts:

The main idea is to attach the LED with your finger as comfortable as possible. Always thinking you need the connection to a battery.



**Functional:**

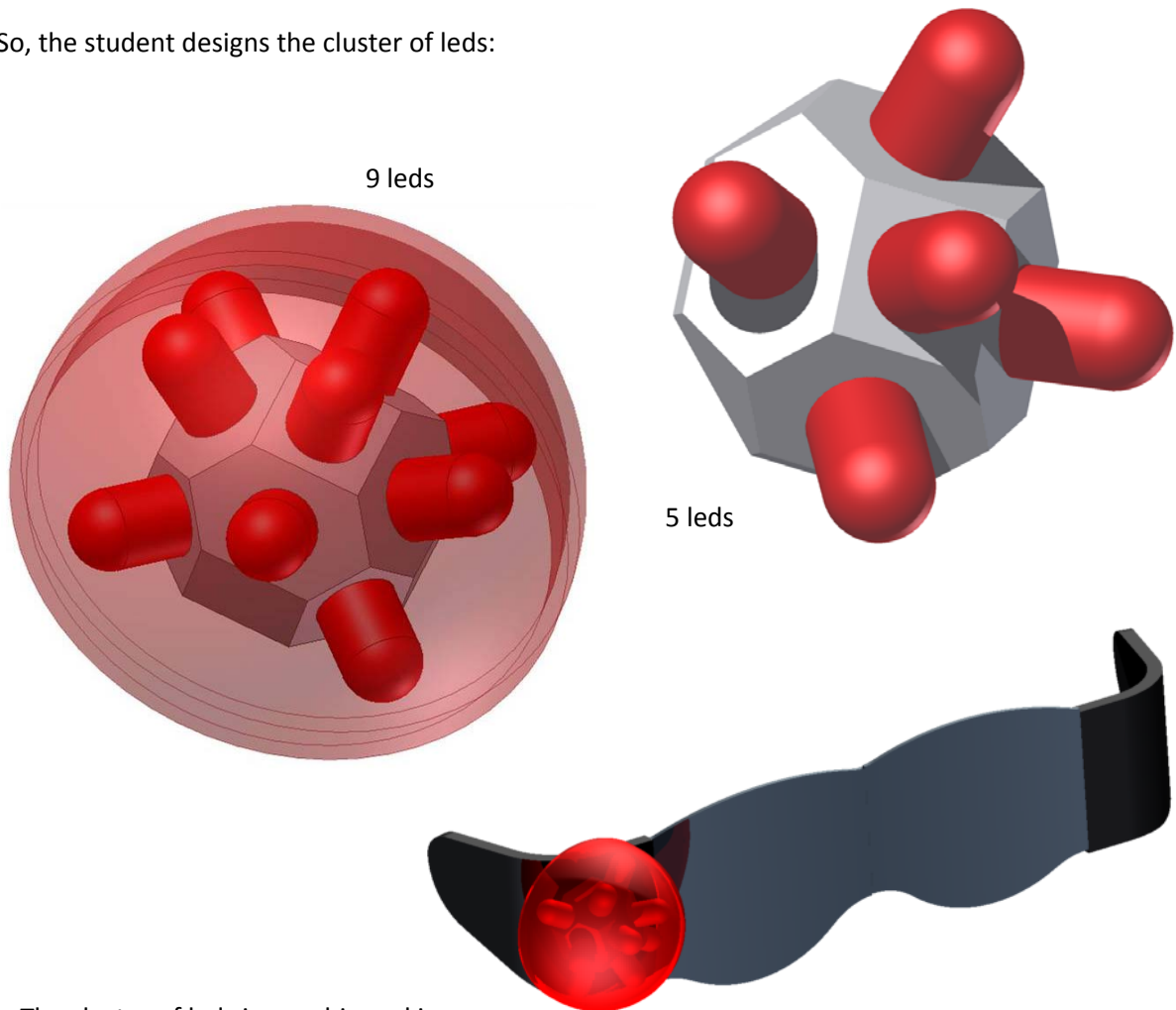
The operating mode is based on the light, it is emitted from the eye and from the end of the fingers, so the machine receives the coordinates of the player.



Problem:

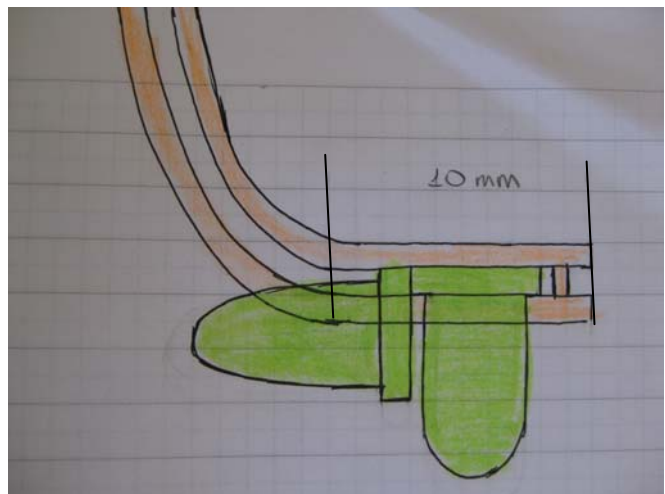
It is necessary some leds in different directions, like a cluster, to detect the player in any place.

So, the student designs the cluster of leds:



The cluster of leds is very big and is not aesthetic.

Even if the cluster is only done for two leds is very big. (It can be seen in the next sketch)

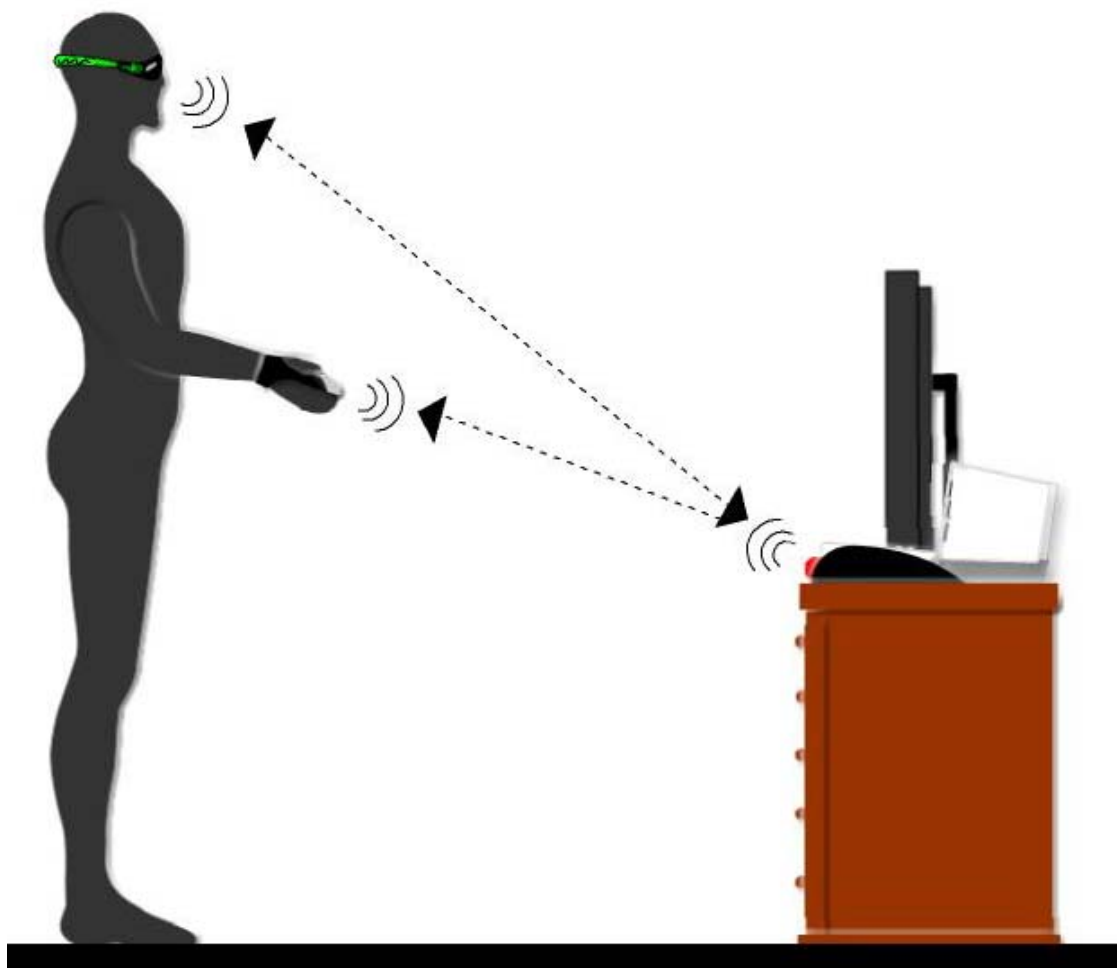


Solution:

The student developed a **new functional** mode:

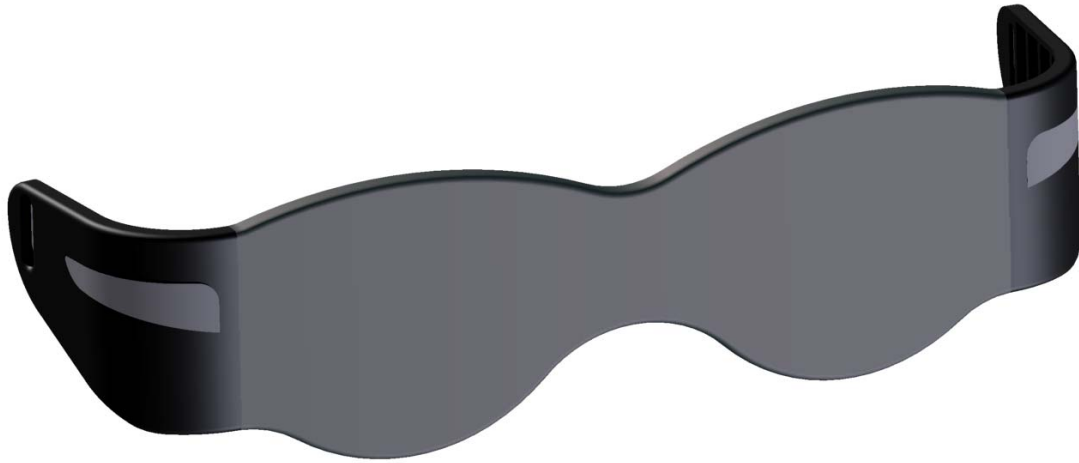
The new mode is based in two steps:

- 1.- Light is emitted by the stand of the Wii remotes;
- 2.- This light is reflected in the reflector band, which is in the each side of the glasses and at the end of the fingers
- 3.- The light, so also the coordinates, are received by the Wii remotes.



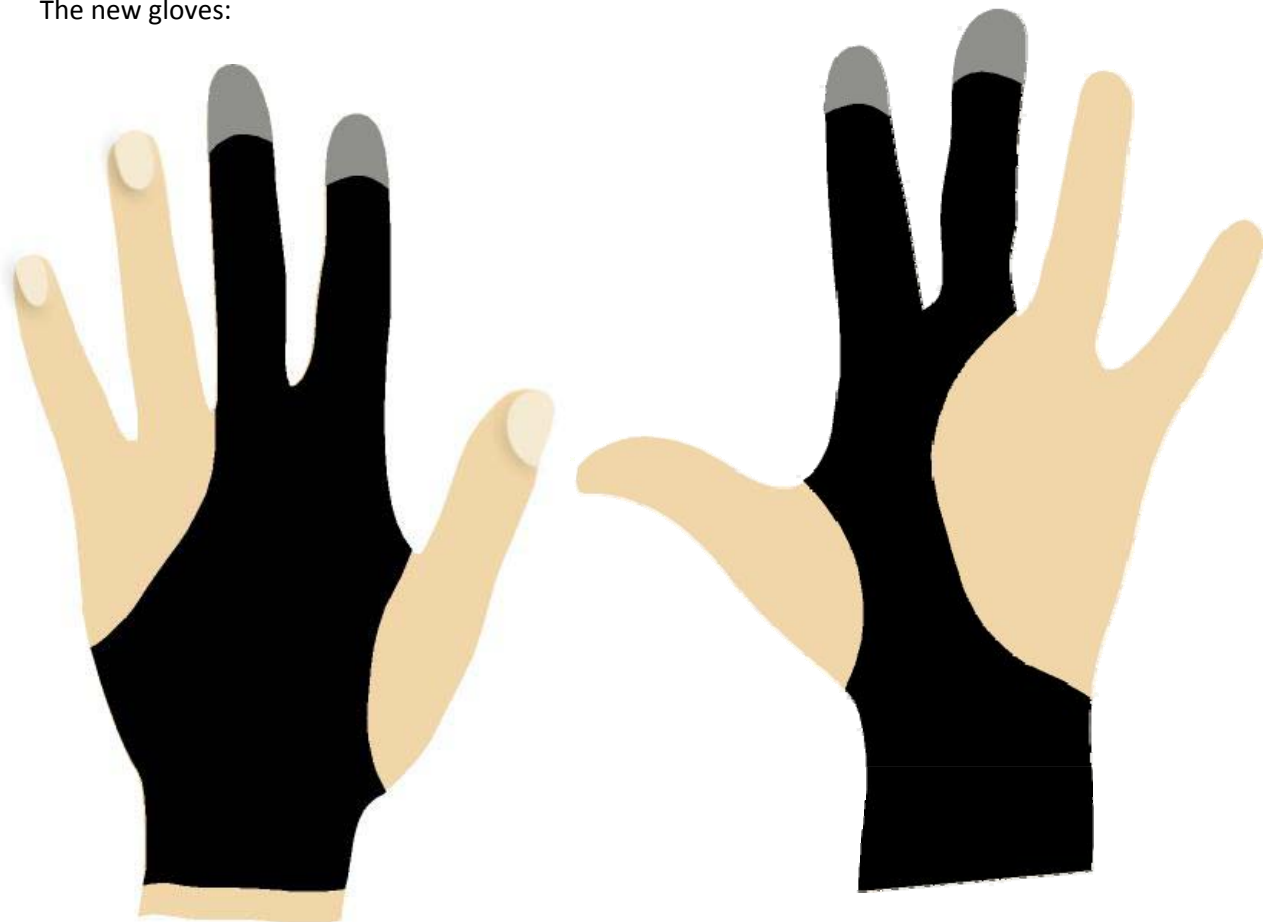
After this change, the aesthetic of the parts have to e changed, and also now the student has to design the light transmitter.

The new glasses:



The ergonomic development process of the glasses was the longest. It is explained after this.

The new gloves:



Wii remote stand/ light transmitter:

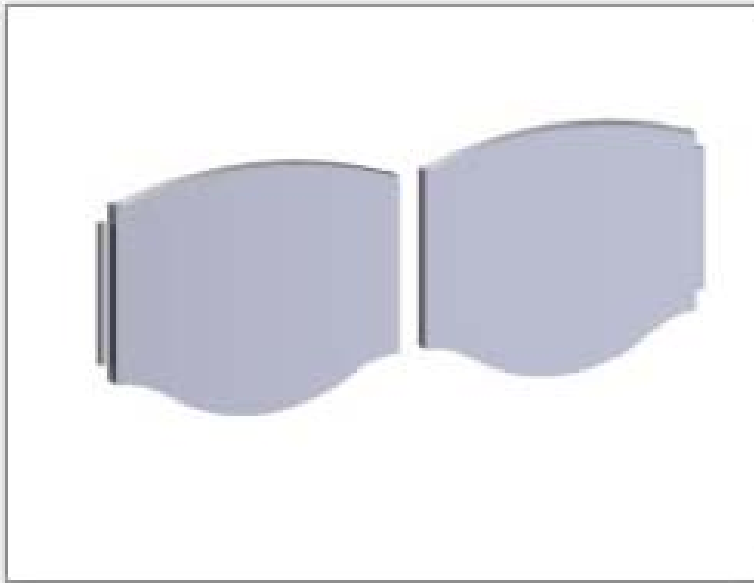




Glasses development (ergonomic):

The development of glasses, her side and glass, has gone through many phases. In which sizes and shapes have changed, then the images are attached:

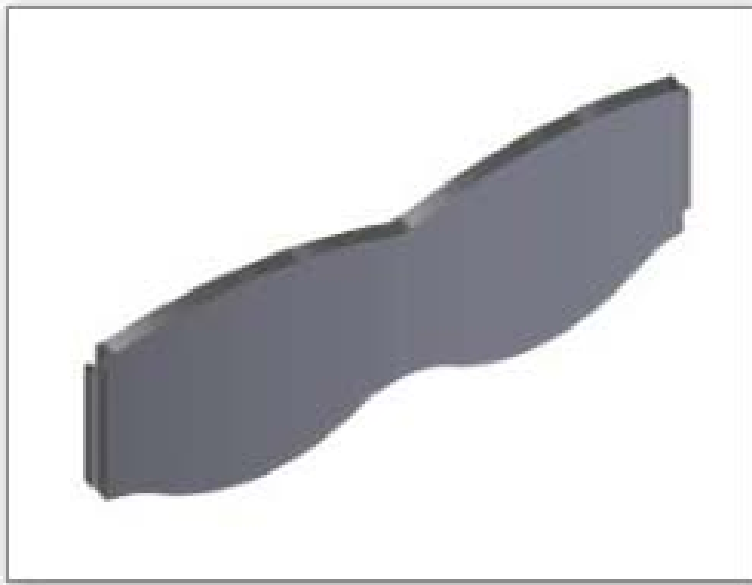
- Crystal:

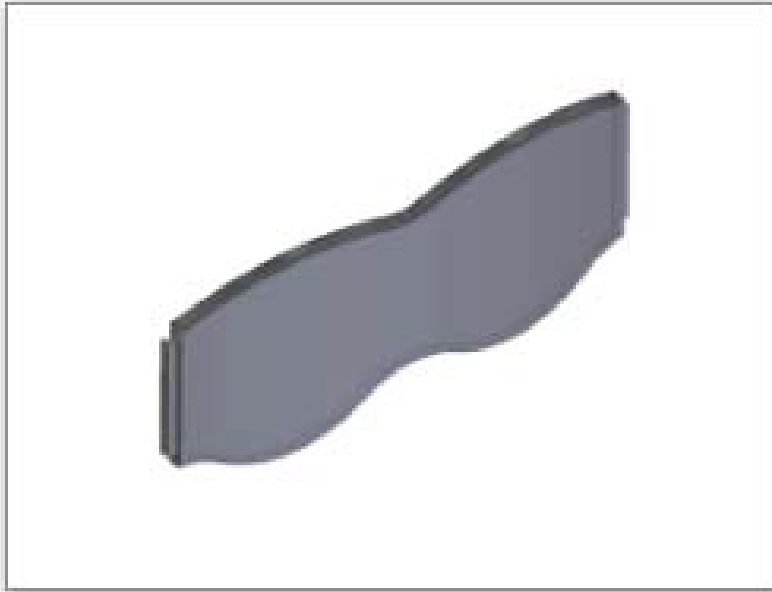


Crystals separated,

Because, the student did not know if it was better to make 3D glasses in the beginning.

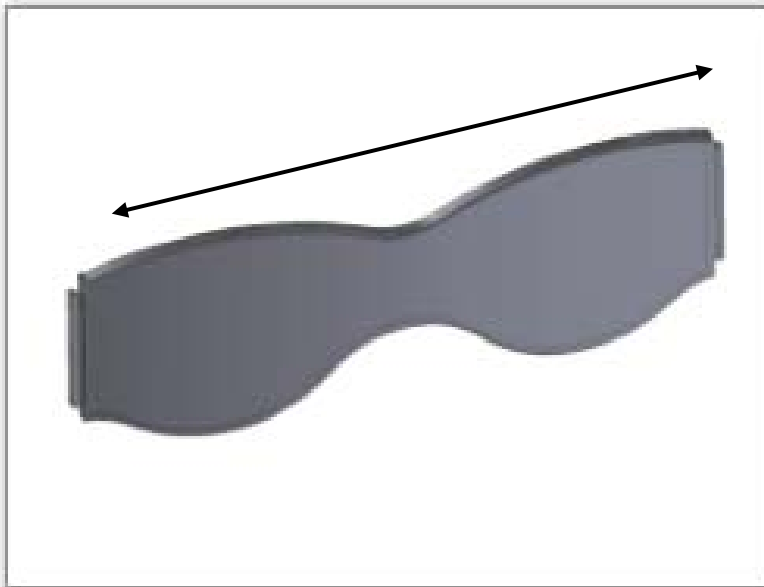
It was an option.





Crystals as one piece,

It is better to the fabrication and for the user too.

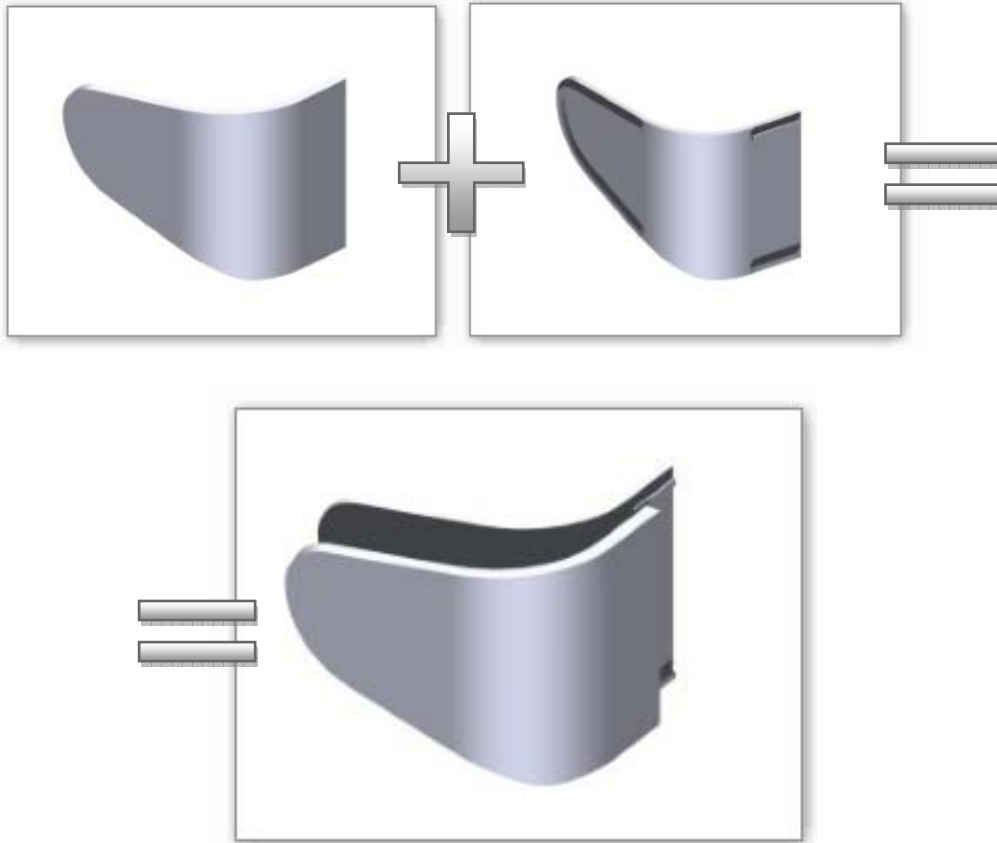


Change of measures:

-Increasing the total distance,  
because of this, the part for the  
nose is bigger and other changes,  
every measure are dependent.

- The side part:

In the beginning, the side part was going to be based on two casings, because in these had to be the battery and the led.

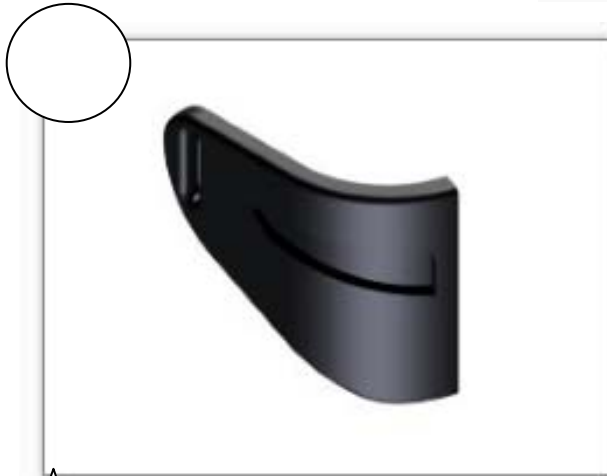
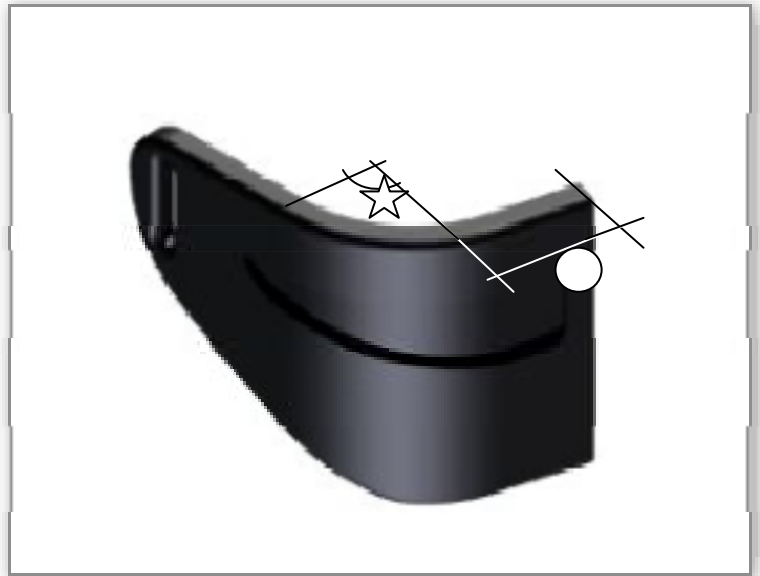


But finally, the battery and the led are in the stand. So it is not necessary two casings.



Change of measures in the final idea:

- Remove distant ○
- Decreased angle ☆



Remove distant:

- to the side of the glasses is not outgoing

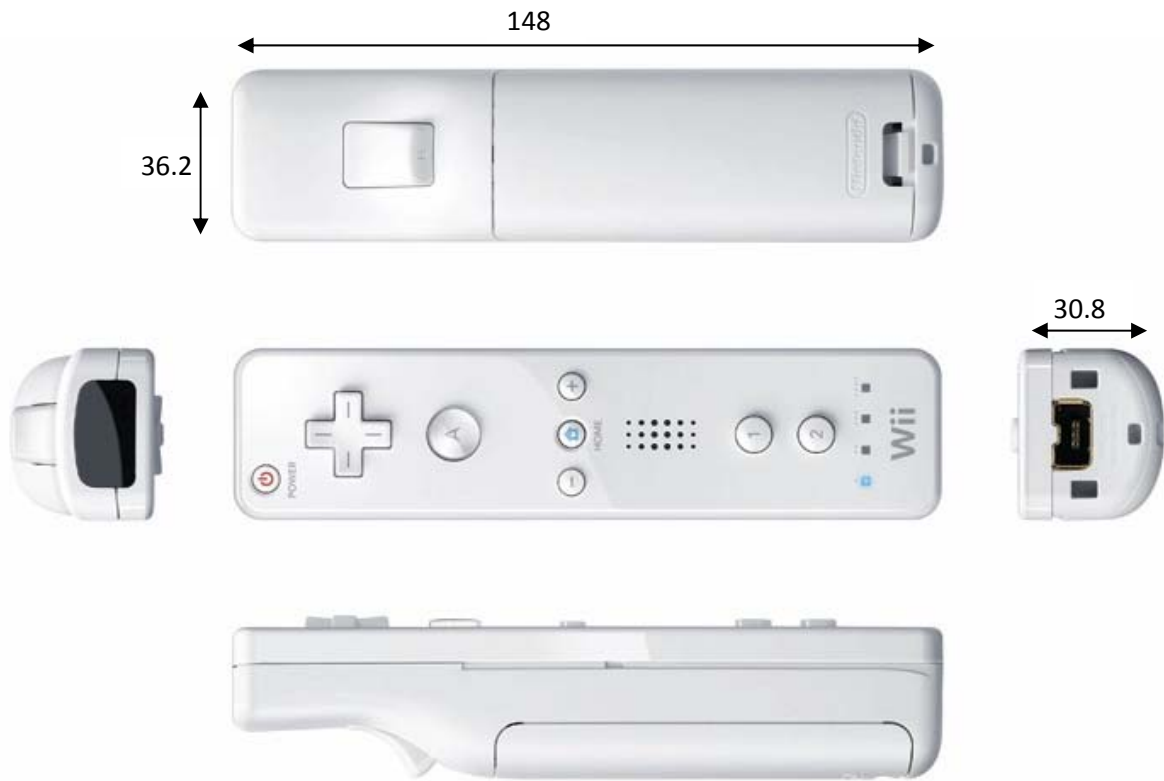


Decrease angle:

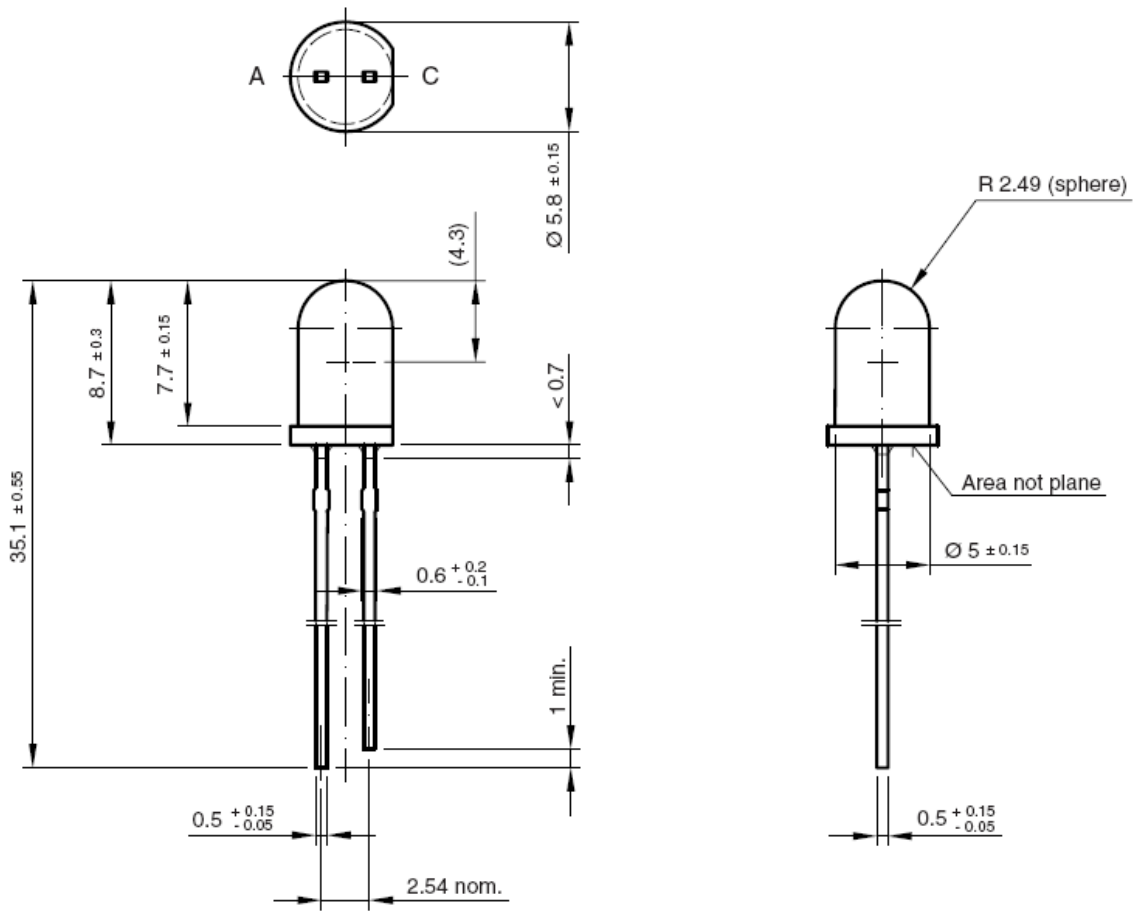
- for a better fit to the head

1) Ergonomic:






Wii remote:



Leds:



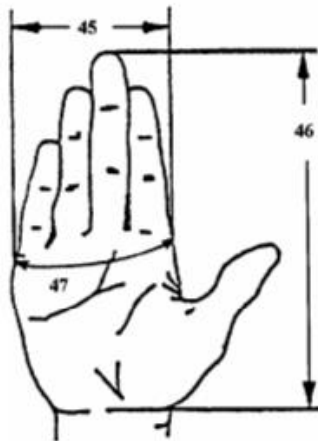
Head measures:

 <p><b>1 Head breadth.</b> The maximum breadth of the head, usually above and behind the ears.</p> <table border="1"> <thead> <tr> <th rowspan="2">Sample</th> <th colspan="5">Percentiles</th> </tr> <tr> <th>1st</th> <th>5th</th> <th>50th</th> <th>95th</th> <th>99th</th> </tr> </thead> <tbody> <tr> <td>A. Men</td> <td>cm 13.9 (5.1)</td> <td>14.3 (5.6)</td> <td>15.2 (5.9)</td> <td>16.15 (6.3)</td> <td>16.5 (6.5)</td> </tr> <tr> <td>B. Women</td> <td>cm 13.3 (5.2)</td> <td>13.7 (5.4)</td> <td>14.4 (5.7)</td> <td>15.3 (6.0)</td> <td>15.7 (6.1)</td> </tr> </tbody> </table> <p><b>2 Interpupillary breadth.</b> The distance between the centers of the pupils of the eyes (the eyes are looking straight ahead).</p> <table border="1"> <thead> <tr> <th rowspan="2">Sample</th> <th colspan="5">Percentiles</th> </tr> <tr> <th>1st</th> <th>5th</th> <th>50th</th> <th>95th</th> <th>99th</th> </tr> </thead> <tbody> <tr> <td>A. 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Men	cm 16.9 (6.7)	17.4 (6.8)	18.6 (7.3)	19.9 (7.8)	20.6 (8.1)	B. Women	cm 15.7 (6.1)	16.3 (6.4)	17.5 (6.9)	18.8 (7.4)	19.4 (7.6)	Sample	Percentiles					1st	5th	50th	95th	99th	A. Men	cm 18.0 (7.1)	18.5 (7.3)	19.7 (7.8)	20.9 (8.2)	21.4 (8.4)	B. Women	cm 17.4 (6.8)	17.8 (7.0)	18.9 (7.4)	20.0 (7.8)	20.5 (8.0)	Sample	Percentiles					1st	5th	50th	95th	99th	A. Men	cm 20.0 (7.8)	20.5 (8.1)	22.0 (8.7)	23.2 (9.1)	23.9 (9.4)	B. Women	cm 19.2 (7.6)	19.7 (7.8)	21.0 (8.3)	22.2 (8.7)	22.8 (8.9)	<p><b>13 Head length.</b> The maximum length of the head, measured from the most anterior point of the forehead between the brow ridges (glabella) to the back of the head (occiput).</p> <table border="1"> <thead> <tr> <th rowspan="2">Sample</th> <th colspan="5">Percentiles</th> </tr> <tr> <th>1st</th> <th>5th</th> <th>50th</th> <th>95th</th> <th>99th</th> </tr> </thead> <tbody> <tr> <td>A. 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Men	cm 21.2 (8.4)	21.8 (8.6)	23.2 (9.1)	24.7 (9.6)	25.5 (9.9)	B. Women	cm 19.8 (7.8)	20.4 (8.0)	21.8 (8.5)	23.2 (9.1)	23.8 (9.4)	Sample	Percentiles					1st	5th	50th	95th	99th	A. Men	cm 16.6 (6.6)	17.4 (6.9)	19.1 (7.5)	20.9 (8.2)	21.5 (8.5)	B. Women	cm 15.5 (6.1)	16.1 (6.3)	17.7 (6.9)	19.2 (7.6)	19.9 (7.8)	Sample	Percentiles					1st	5th	50th	95th	99th	A. Men	cm 6.1 (2.4)	6.5 (2.5)	7.2 (2.8)	8.3 (3.3)	8.7 (3.3)	B. Women	cm 5.7 (2.2)	6.0 (2.4)	6.5 (2.5)	7.8 (3.1)	8.3 (3.3)
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Hand measures:

**45 Hand breadth.** The breadth of the hand, measured across the ends of the metacarpal bones (metacarpal-phalangeal joints).

Sample			Percentiles				
			1st	5th	50th	95th	99th
A Men	cm	8.1	8.4	9.0	9.8	10.0	
	(in)	(3.2)	(3.3)	(3.5)	(3.9)	(3.9)	
B Women	cm	7.1	7.3	7.9	8.6	8.9	
	(in)	(2.8)	(2.9)	(3.1)	(3.4)	(3.5)	



**46 Hand length.** The distance from the base of the hand at the wrist crease to the tip of the middle finger.

Sample			Percentiles				
			1st	5th	50th	95th	99th
A Men	cm	17.3	17.9	19.3	21.1	21.9	
	(in)	(6.8)	(7.1)	(7.6)	(8.3)	(8.6)	
B Women	cm	15.9	16.5	18.0	19.7	20.5	
	(in)	(6.3)	(6.5)	(7.1)	(7.8)	(8.1)	

**47 Hand circumference.** The circumference of the hand, measured around the knuckles (metacarpal-phalangeal joints).

Sample			Percentiles				
			1st	5th	50th	95th	99th
A Men	cm	19.2	19.9	21.3	23.0	23.7	
	(in)	(7.6)	(7.8)	(8.4)	(9.1)	(9.3)	
B Women	cm	16.7	17.3	18.6	20.0	20.7	
	(in)	(6.6)	(6.8)	(7.3)	(7.9)	(8.2)	

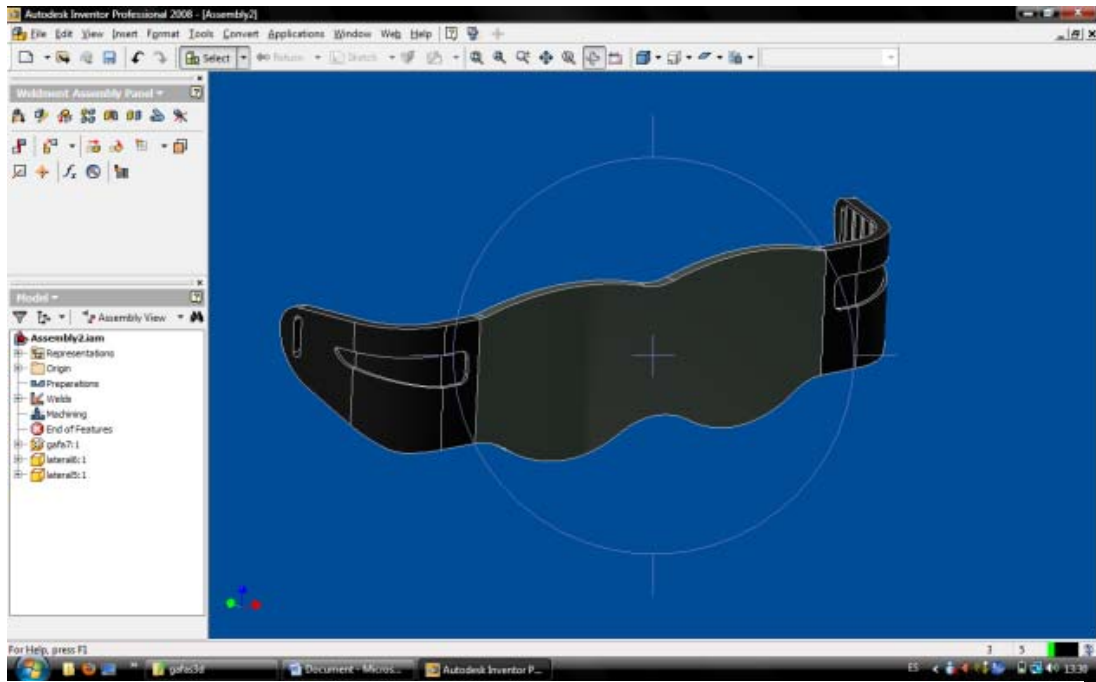


- Futuristic style



- Snowboard style







Wii™ 3D

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