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## Context-aware Smart Object

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## Abstract

This report describes the development of a Smart Object used as an interface for CAD-programs or computer games. The main idea was to develop a more intuitive device than the existing products on the market like the 3D mouse. It was achieved by integrating an inertial measurement unit, a touchpad, a microphone and a Bluetooth interface in one small device. First the existing technologies and products in this field were analysed. Then a marketing strategy was developed. Furthermore, ideas were collected for the development and production of the smart object in a sustainable way, also considering the possible market. In addition, the project development is detailed, including all the steps for considering the object, from setting up the sensors to programming the software. To test all sensors and to demonstrate the solution a Java application was used.

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# Glossary

**Arduino** is a microprocessor that is commonly used for prototyping or for educational purposes.

**FIFO** First In First Out– the first data to be added to the queue will be the first data to be removed.

**IMU** Inertial measurement unit, the sensor that measures movement using accelerometer and gyroscope.

**Java** object-oriented programming language, that we used on the PC for 3D modelling and a Bluetooth connection to the SO.

**MEMS** Micro-electro-mechanical systems.

# 1. The Team

During a semester spent at ISEP (Instituto Superior de Engenharia do Porto) on European Project Semester our group developed the Smart Object. This project gave us an opportunity to connect our knowledge from our fields of study with practical skills and work in a team, like in real life situations. This project gave us a chance to know other cultures, cooperate with foreigners and practise English. Moreover we learned new things from each other and from the supervisors. The group consists of Anna, Jana, Toomas and Hannes. Anna is from Poland, she studies Engineering Management in Management and Organization faculty. Jana is from Lithuania, she studies Printing Engineering in the Mechanical faculty. Toomas is from Estonia, he studies Engineering Materials and Marketing in the Mechanical faculty. Hannes is from Germany, he studies Mechatronics in a Mechanical faculty.

## 2. Introduction

Progress in technology, especially in fields of embedded systems, communication and sensor systems, give rise to new types of applications and devices. Also Micro-Electrical-Mechanical Systems MEMS, where very small mechanical devices allow on chip measurement of acceleration and rotation, are part of mass market production nowadays. This has led to a price reduction and allows to combine several sensor technologies to test new methods of human computer interactions.

### **Problem**

The existing computer interfaces are bound to the table tops like the computer mouse. The user has the 2D movement freedom in x- and y-axis. The computer mouse hasn't changed a lot from the day it was invented. The user still holds his/hers hand on the mouse and moves it on a table. [1] The idea is to make the movements free and versatile.

### **Motivation**

Motivation to build a wireless interface came from the fact that we all are computer users, and the freedom of movement that our product offers is innovative. We want to "free" the users from the table tops and give them liberty of movement.

### **Objectives**

The goal of this project was to develop and construct a smart object for an interaction with a virtual environment. The main purpose of the object is for professional use for CAD-Program or as a helpful device for smart product presentations. Second, the interface could be used as an intuitive game controller as well. The user will be able to rotate the model by rotating the object, to zoom in and out with a touchpad, and to give voice commands.

### **Expected Results**

When using the Smart-Object the user will be able to turn, rotate, zoom in and out when modeling an object in CAD- programs. When the user is holding the object in his hand, the movement will be detected by an IMU (Inertial Measurement Unit) and then transmitted via Bluetooth to the PC (Personal Computer). The product will have a wireless connection to the user's PC. The product will have a battery that is rechargeable using an USB-cable (Universal Serial Bus).

### **Structure of the report:**

This report describes the development process of our smart object. It is organized as follows: In the second chapter the work plan of this project is explained. In the third part a short review of the state of art of the technologies that could be used is given. After that the marketing plan is presented, including a market analysis and a SWOT analysis, followed by a chapter on Eco-efficiency measures and sustainability. Chapter 6. describes the project development. It includes the design and construction of the device and also the programming of the object, the data connection and the representation in a virtual environment. Finally, we draw some conclusions and present possible future developments in the last chapter.



## 3. Work Plan

To better accomplish our goals, we started by setting up a work plan according to each member's skills and potential. Therefore, we assigned tasks as follows: In this project Anna is responsible for the marketing part. Jana uses her knowledge of CorelDRAW program: she will create all that is concerned with graphic design works such as poster, logo and leaflet. Toomas does the drawings in CAD-program and he is our materials specialist. Hannes will do all the programming part. So that planning would be effective, a list of real-time tasks and a Gantt chart were set up. Every task is defined by a start and end date in the Gantt chart. The task list and the Gantt chart are specified in the next subsection.

### 3.1. Table of tasks

So that everything went according to the plan and everyone knew what to do the tasks were divided among group members. Tasks are seen in the table of tasks.

Task	Responsible
Research	Jana, Anna, Toomas, Hannes
Make the final list of materials	Jana, Anna, Toomas, Hannes
JAVA modeling	Hannes
Preparing interim report	Jana, Anna, Toomas, Hannes
Drawings	Toomas
Building	Jana, Anna, Toomas, Hannes
Programming	Hannes
Interim report	Jana, Anna, Toomas, Hannes
Testing	Jana, Anna, Toomas, Hannes
Marketing	Anna
Video, Poster and Design works	Jana
Paperwork on deliverables	Jana, Anna, Toomas, Hannes
Upload all deliverables	Jana, Anna, Toomas, Hannes
EPS final assessment	Jana, Anna, Toomas, Hannes

Table 3.1.: Table of tasks

### 3.2. Gantt Chart

Figure 3.1 is the Gantt Chart we made for a preliminary plan. It details when we should finish what tasks.

### 3. Work Plan

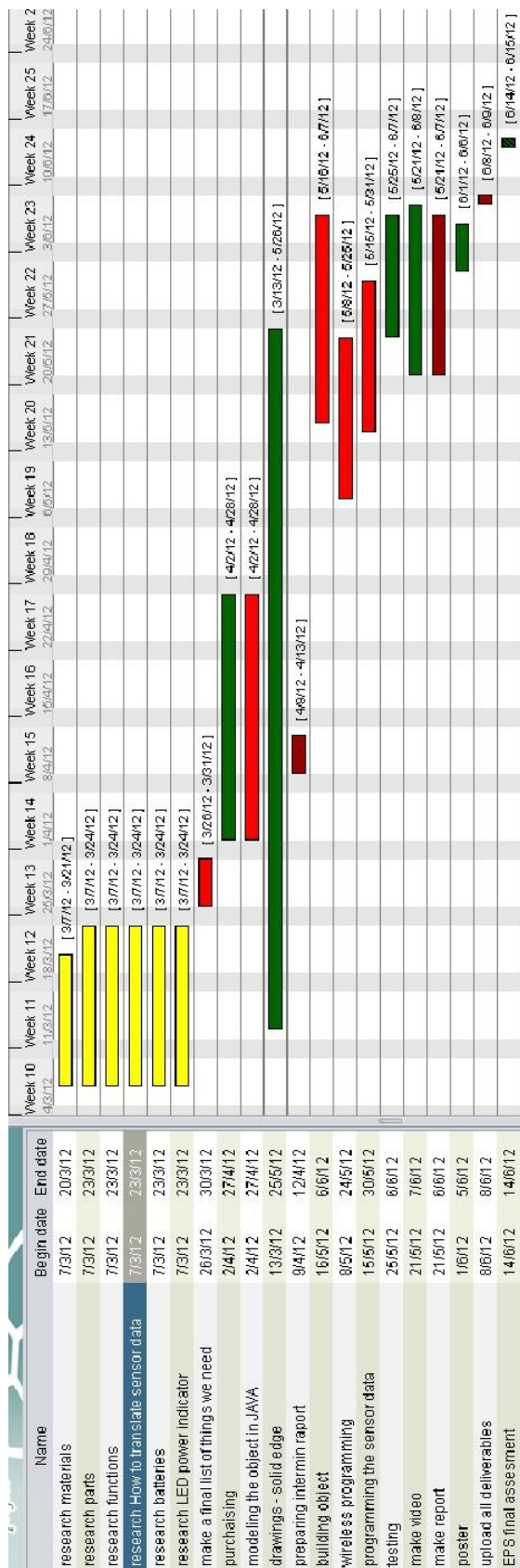


Figure 3.1.: Gantt Chart

## 4. State of the Art

Most of the technologies that will be used are part of modern electronic devices and part of a mass market.

### 4.1. Microcontroller

#### Arduino

Arduino is a popular open source single-board microcontroller, it is designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of simple open hardware design for the Arduino board with an Atmel AVR processor and on-board input/output support. The software consists of a standard programming language compiler and the boot loader that runs on the board.[2]

### 4.2. Sensors

#### IMU

IMU is an electronic device that measures and reports on craft's velocity, orientation and gravitational forces; it uses a combination of accelerometers and gyroscopes. Typically they are used to maneuver aircraft, including UAVs (unmanned aerial vehicles), among many others and spacecraft, including shuttles, satellites and landers. It is also the main component of internal navigation systems used in aircrafts, spacecrafts, watercrafts and guided missiles. In this capacity, the data collected from the IMU's sensors allows a computer to track a craft's position.[3]

In the project the IMU is going to be used for sensing movement. That sensor input is translated so that it is applicable in a CAD-program.

#### Touch screen

Touchscreen is an electronic visual display that can detect the presence and location of a touch within the display area. The term generally refers to touching the display of the device with a finger or hand, it can also sense other passive objects such as a stylus. Commonly, the touch screens are in game consoles, all-in-one computers, tablet computers and smartphones. It has two main attributes. Firstly, it enables one to interact directly with what is displayed rather than indirectly with a pointer controlled by a mouse or touchpad. Secondly, it lets one do so without requiring any intermediate device that would need to be held in the hand (other than a stylus, which is optional).[4] In this project the touchpad is meant to detect the touch of the user's finger.

#### Microphone

A microphone is an acoustic-to-electric transducer or a sensor that converts sound

into an electrical signal. Most present day microphones use different methods: electromagnetic induction, capacitance change, piezoelectric generation or light modulation to produce an electrical voltage signal from mechanical vibration.[5]

### 4.3. Power supply

To power a wireless device one could use small solar panels or rechargeable batteries. Other options would be too difficult to implement in this project. They would be too expensive and complex.

#### **Lithium-ion polymer battery- LiPo battery**

Li-Po batteries are rechargeable batteries, they are usually composed of several identical secondary cells in parallel to increase the discharge current capability.[6] They are compact and ideal for small cordless devices.

#### **Solar panels**

A solar panel is a packaged, connected assembly of photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. A photovoltaic system typically includes an array of solar panels, and inverter, sometimes a battery and or solar tracker and interconnection wiring. [7]

Solar panels would cost too much. Besides, the object works when it is held by the user, which means that the user's hand would cover the small solar panel. Also it should be cleaned often, because it comes in contact with human skin.

### 4.4. Wireless data connection

**Wi-Fi:** Wi-Fi is a technology that allows an electronic device to exchange data wirelessly over a computer network. It includes high-speed internet connection. There are a lot of devices that can use Wi-Fi, such as a PC, video game console, smartphone, tablet or digital audio player. All of these can connect to a network resource such as the Internet via a wireless network access point. In indoor use the range is about 20 meters and outdoors it's greater. Access point coverage, also called hotspot, can comprise an area as small as a single room with walls that block radio waves or as large as many square miles - this is achieved by using multiple overlapping access points.[8]

**Bluetooth:** Bluetooth is a widely spread wireless connection option. It can be found on PCs, smartphones, laptops and other devices. It is used for exchanging data over short distances from both fixed and mobile devices. Bluetooth creates personal area networks (PANs) with high levels of security.[9]

**ZigBee:** ZigBee is intended to be simpler and less expensive than other WPANs (wireless personal area network) such as Bluetooth. It is targeted at radio-frequency applications that require low data rate, long battery life and secure networking. ZigBee is best suited for periodic or intermittent data or single transmission from a single transmission from a sensor or input device.[10]

## 4.5. Related Projects and Products

For the same purpose one can use 3Dconnexions 3D mouse. The user can rotate, zoom, turn and pan the object when using it. The 3D mouse resembles a joystick a device that is placed on a table. On the products homepage one can find this sentence: “It’s a level of control that’s simply not possible with a traditional mouse and keyboard”. They launched their first product in 2009. 3Dconnexions has 5 different products that can be used for the same purpose; the difference is in segmentation.[11]



Figure 4.1.: 3Dconnexions 3d mice

## 4.6. Conclusions

Bluetooth is used for wireless data transfer because it is built in most of the computers and smartphones. When using ZigBee the users should buy a software and a receiver for that. Wifi would consume the biggest amount of energy so it is excluded because of that.

For the microcontroller a Arduino board that has Bluetooth already built in is used. For the user interaction three sensors were chosen: IMU, touchscreen and microphone. The main competitor is the 3D mouse, the company that produces it has several products segmented for different customer groups. They differ in size and in the functions that the product offers. The differences are that the bigger products have built in LCD screens and they have more functions, but they also cost more. The smallest one has only the Controller Cap and two interface buttons.

## 5. Marketing Plan

After the development of the Smart Object is finished and the production has started, the product has to be put in the market. The company will be called Smart Interfaces JATH – the name of company should express what our industry is. We have chosen JAHT because these are the first letters of our names. Nowadays, in order to sell the product it is not enough to produce it. If a company wants to sell a product it has to concentrate on customer, cost, communication and convenience. It is important to concentrate on meeting the needs of the customers. Moreover, an observation of the market is necessary to recognize changes on the market. To do it some special tools and analysis are needed.

### 5.1. The market environment analysis

In general, two types of environment are distinguished: micro and macro. Firstly, the micro environment will be analyzed, which includes the company's internal environment, suppliers, marketing intermediaries, customers, competitions, publics. Secondly, the macro environment will be analyzed.

#### 5.1.1. Micro environment analysis:

Our product will be made of high quality materials and we are trying to get a modern and innovative solution. Furthermore, it is important to know that there are no identical products in the market. In the first phase of the project our supplier is ISEP. If the product goes production we are going to address a mass market. When we are introducing the object to the market we will need some suppliers. We have to remember that all companies cooperating with us are going to be checked carefully. Important things are the price and quality of resources and time of delivery. The product will be advertised and sold on the Internet. The distribution will be done by a logistic company. The object is small so we can put it into a special package to prevent damage.

We can identify the market by:

- Type of goods traded: market for goods
- According to geographical: now local in the future could be global
- According to the criterion of scale or size of transactions: retail but in the future could be wholesale
- According to the character of the merchandise: goods and services
- According to the degree of satisfaction of needs: consumer

#### Competitors

At the moment the product that we are offering does not exist in the market. But the

market for smart electronic devices that simplify life is huge and is rapidly growing. However, one competitor for our product can be the 3D mouse. 3D mouse devices generally function through ultrasound and provide at least three degrees of freedom. On the market there are a lot of companies producing 3D mice. The product is gaining popularity. An example of such a product can be found on the Internet: [12]. The price of this product depends on its complexity and varies between 99 to 399\$.

Our product is more innovative, because one can also use voice command and the user can hold it in his/her hand. It does not have to lie on the table, but it also can. The other competitive product is the Wii Remote. It is not our direct competitor, but the product uses some of the same components and it can be used for the same purposes. The Wii remote is used for games. It is the primary controller for Nintendo's Wii console. Wii Remote has a motion sensing capability, which allows the user to interact with the game and manipulate items on the screen via gesture recognition and pointing through the use of an accelerometer and optical sensor technology. Another feature is its expandability through the use of attachments. The attachment bundled with the Wii console is the Nunchuk, which complements the Wii Remote by providing functions similar to those in gamepad controllers. This is an example of the Wii Remote:



Figure 5.1.: Wii Remote

Another product is the typical gamepad. It is a type of game controlled, held in two hands, where the fingers (especially thumbs) are used to provide input. Figure 5.2 exemplifies one of this devices.



Figure 5.2.: Gamepad

However, these two products can be used only for gaming. So our product can be distinguished from the existing product, because it gives more possibilities and can be used for a professional purpose and also for fun.

### 5.1.2. Macro environment analysis

Macro environment includes demographic, economic, natural, technological, political and cultural forces.

Demographic forces result from population age structure, sex structure, etc. Our product is addressed particularly to professionals and in the near future (one year strategy) to younger people (between 17 to 35 years old) , because they follow the course of time more. For example, young people play games which need a certain freedom of movement our product offers. Professionals, who work a lot with computers need a product which gives more possibilities than the ordinary mouse. These people can work, for example in the design field as engineers, architects, designers.

Economic forces stem from the overall economic condition. Nowadays, in many countries there is an economic recession. In this phase of development we are not 100% sure how much our product will cost. We plan that it will cost around 300 Euros. However, we would like it is price not to be higher than the price of a professional 3D mouse, which is around 400 Euros. But we also do not want to sacrifice quality.

Technological forces are arising from the level of technological development. Currently, technological progress is huge. It is a opportunity, sell new version and earn money, but it can be threat because if the company does not track the development of competitor and market it is easy to be left behind.

Political forces: In our opinion, the EU is a good place to produce, buy and sell electronic products, because the EU has similar standards for production, quality and sales of products and services.

Cultural forces result from the prevailing fashion, lifestyle or habits and culture prevailing in the area. Nowadays everyone has at least one computer, mobile phone or iPad. Our product can cooperate with any of these devices.

To summarize the environmental analysis, we did a SWOT analysis. In our case, we will focus on our company, which is our team, and in our product, which is the Smart Object.

Table following table shows the SWOT analysis:



Strengths	Weaknesses
<ul style="list-style-type: none"> <li>• ability to think logically</li> <li>• use new technology</li> <li>• access to well-equipped laboratories</li> <li>• quality of product</li> <li>• own sales network</li> <li>• sales in the Internet (7days a week, 24h per day)</li> <li>• possibility of selling the product around the world</li> <li>• good quality of materials used in production</li> <li>• modern solutions</li> <li>• functionality of the product produced</li> <li>• human potential</li> <li>• average price of product</li> <li>• possible to adapt the product to suit your needs</li> </ul>	<ul style="list-style-type: none"> <li>• problem with communication</li> <li>• lack competitive edge</li> <li>• inexperience</li> <li>• lack of a position in the market</li> <li>• only advertising on the Internet</li> <li>• short financial resources</li> <li>• instability of the production line</li> <li>• need to build a positive image</li> <li>• difficulty with the first customers</li> <li>• short product life cycle</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>• patronage of ISEP</li> <li>• opportunity to work with qualified people</li> <li>• ISEP's good reputation</li> <li>• demand for such products</li> <li>• EU membership</li> <li>• common currency in the EU</li> <li>• absorbent, growing market</li> </ul>	<ul style="list-style-type: none"> <li>• unemployment</li> <li>• low income of society</li> <li>• rapid development of technology</li> <li>• increasing competition in the market</li> <li>• strong position of technology leaders</li> <li>• existence of substitute product on the market</li> <li>• customer loyalty relative towards our competitors</li> </ul>

Table 5.1.: SWOT analyses

## 5.2. Market segmentation

The next step in the marketing procedure is to choose the market segment. This is important because we have to know the needs of our customers to meet them. Market segmentation is to make a distribution of the market into a relatively homogeneous group of consumers, because the similar characteristics reveal a similar demand. Knowing the target segment will help us to prepare a product that meets the needs of our clients and helps us to obtain advantage in the market.

We see chance for our product in two segments. The first one is people who are working with engineering programs meant for drawing. They are designers, architects or engineers. But not only those. This product can also be addressed to teachers and students who use engineering programs. They spend a lot of their time using the computer to draw sketches, diagrams, plans and models. Our product can facilitate the implementation of these activities. We are particularly interested in this segment but in the future we plan to enter to a second market segment. The second target group can be young people (17-35 years old) who use their computers or mobile phones to play games. Our product gives them freedom of movement. Moreover young people like modern things and technical innovations.

### Objectives:

- meet customer's needs – satisfied customers 100%
- achieve operational excellence in the internal processes of marketing, supplier, product development, logistics
- make that brand recognizable about 30% in the end of the year 2013
- occupy 20% of the market by the end of 2012
- by higher sales reduce the price of the product about 10% when our sales rise to 20 000 pieces
- enter in the new target after the first year on the market
- expand product lines (new version of the product) after the second year on the market

## 5.3. Basic marketing strategy

Marketing strategy comprises actions and producing plan, the sales of the product and dealing with problems. The prototype is produced for ISEP, but the product can be sold in the open market. Our Smart Object is addressed to older workers as designers, architects, engineers, teachers, etc. We are going to sell our product on the Internet, because this distribution way is cheap and we are able to address a big market. We do not have to rent space in the shop. Our offer will be on a website; we want to generate a bookmark with the product order form. Moreover on our website we would like to place a description of the product along with photos and video illustrating the use of the product. The website will be in Portuguese, English and German languages. We will pay for a position in Google. We are thinking about a place to advertise on complementary products for example: PC, drawing programs, etc. That will be a source of additional earnings. If we have to think about distribution, we use companies in the fast delivery of mail, shipments of goods

and advertising. The object is small so we can put it in a special package which prevents damage. If our product is well received by users of ISEP, we would like to sell it on a broader market. If there is a big demand for our product, we can afford to cut prices. When it comes to promotion we will make posters and some leaflets for advertising and distribution. We address it to workers and students, so they should be professional and factual.

After the first year our company plans to address a new target. This target group will be young people (17-35 years old) who use their computers or mobile phones to play games. Our product gives them freedom of movement. Moreover, young people like modern things and technical gadgets. We plan to make minor changes to lower the price. We are thinking about two types of advertising. We still want to keep advertising for the first segment and create advertising for the second one. Advertising for young people should be more modern, and we can do some animations, 3D effects, for example.

If we consider a the long-term strategy (three years) we would like to develop a product line. For example we can develop a product for professionals with very precise sensors and supporting many engineering software. Another aspect is the aesthetics of the product. It is possible to extend the color variations of the product, change shape or make a more compact design to better fit a woman's hand and to meet the needs of young consumers.

## 5.4. Marketing MIX

Marketing mix is a business tool used for marketing products. It is composed of four Ps/Cs .

- Product / Customer
- Price / Cost
- Promotion / Communication
- Place / Convenience

### 5.4.1. Product / customer

One can use the Smart Object as an input device for CAD-programs. By using the device one can turn the model (with the sensor data) in the program 3D space, zoom in and out (with the touch pad) and use some voice commands (microphone). With the acceleration data the program decides if the SO is held in hand or lies on the table. The wireless connection is achieved via Bluetooth.

### 5.4.2. Price / cost

We do not know yet how much our product will cost, but the price includes: cost of materials, cost of packaging, distribution costs, advertising costs and labor costs. We know that we have to remember the fact that the price can not be too high because if the price is high, no one will buy the product. If we have production lines, we will buy materials in bulk so the price of material will be lower. Advertising costs will be spread over more units so that the price of the product in mass

production will be lower. As for the price of the product, we can give only the costs incurred for materials and it is around 300 Euros (VAT included) for the prototype. In the production stage we can cut costs already when we order materials in large quantities - we save money on transport and probably get a discount for ordering a bigger amount.

In terms of available payment methods, there are:

- Prepayment
- Transfer
- Check
- Credit Card
- Online Transfer

The payment will be facilitated to the customer is preference. Furthermore we want to apply some discounts for the customers: who purchases 5 units of our product is offered a discount of 5%. The customers who purchase more than 10 units of our product are offered a 10% discount.

### **5.4.3. Promotion / communication**

Promotion implies the various types of advertising the product. Find out clients wishing to own the product and encourage them buy it. Moreover, it is communication with the client. In this phase of the project we would like to make some posters and leaflets.

We are thinking about some slogans:

- Catch the corner
- touch the corner
- Feel the motion
- Touch the motion
- It's the smart thing
- See what you keep in mind
- Let's make things better/rotate/easier
- Easy as XXX
- Control your power/motion of mind

When we create a web page for our product we are going include there a description along with photos, videos illustrating the use of the product. The web page will be available in Portuguese, English and German language . We will pay for a position in Google, because for the clients it will be easier to find us. We want to design two types of devices: for professionals and on the following year for people playing games. First, one should be more professional and factual. Second, one can be modern and less official. If ISEP agrees we could put a link to our offer at ISEPs web page. Moreover we will have opportunities to present our Smart Object to clients in events organized by ISEP that will be cheap promotion addressed to the large number of consumers. Collaboration with ISEP gains the trust of customers, thanks

to their good opinion of ISEP.

To attract the customers attention and encourage them to purchase our product we want to send our product to reporters working in experts / professional magazines. These reporters can test our product and write an objective view about it. We would like to send our product to four of the biggest professional magazines. The readers will have independent opinion about the product. Good opinions in these magazines are the best publicity.

For younger people we can generate a profile on Facebook. Nowadays, everyone has Facebook and get a lot of information from this platform. There we can put information about our product, some simulation, prices and promotion. Users can share their opinion between them.

#### **5.4.4. Place convenience**

Place is a really important thing. If you have a shop near the main street you have more clients. But currently a lot of people use online shops. We want to sell our product . It is better because we do not have to pay rent for a shop. It is more convenient for the client because he/she can do his/her shopping seven days a week, twenty four hours a day without leaving home. To distribute our product we use outsourcing, it is a cheaper alternative for us than creating our own department, at least at this stage. We want to sign a contract with a logistic company. Moreover we need some special packages to carry the product. This package should prevent damage to the SO. In our opinion this solution is convenient for the client. They send us their order and after five days they have the product in their house. If our product does not meet the customer's needs, he/she can return it within fourteen days. This is a good solution, because it is cheap. But in the first phase of the product life no one knows if placing the product in a shop would be a better solution.. The client can see the product and buy it in chain stores. After signing the contract because our product is in every chain store.

### **5.5. Action program**

We will sell the Smart Object in stores with multimedia devices and in the internet. In the first promotion phase we are going to make some posters and leaflets addressed to all users from ISEP. By this time we are going to create a web page. Moreover on our website we would like to place a description of the product along with photos, videos illustrating the use of the product. After that we want to make more posters, leaflets and advertising on web pages addressed to the two segments we have already presented. Advertising for young people should be more modern and we can use some animations and 3D effects. Advertising for engineers should be more professional and factual.

For promote the Smart Object we also want to use professional magazines. For example:

- PCWorld: <http://www.pcworld.com/>
- PCPro: <http://www.pcpro.co.uk/>

- Blueprint Magazin: <http://www.blueprintmagazine.co.uk/>
- DesignEngineering:  
<http://www.canadianmanufacturing.com/design-engineering>

We will offer the magazines a free exemplar of the product for them to test it and write an article about it. Another way to promote the product can be Facebook. If our promotion is effective we can reach our goals (occupy 20% of the market by the end of 2012; to reach this we need to sell 10 000 pieces, by higher sales reduce the price of the product about 10% when our sales rise to 20 000 pieces, make that brand recognizable about 30% in the end of the year 2013). All time we have to observe situations on the market and we have to be flexible to adapt to customer's requirements. If we do that we can satisfy our customers. We have to pay particular attention to the objectives set. Operational excellence in internal processes, marketing, supply, product development and logistics can be achieved through appropriate management of resources. After two years of existence on the market we would like to expand product lines (new versions of a product). That will be possible if sales in the previous year exceed 3000 pieces. The last one but not the least is to make that brand recognizable about 30% in the end of the year 2013. It can happen if we have good cooperation with publicity and our clients are satisfied with the use of the product.

## 5.6. Marketing Budget

To well manage the project it is necessary to have permanent control over the costs incurred. Everyone remembers about cost of materials and employment costs but usually we forget to think about marketing costs. This cost includes: advertising, leaflets, posters, websites, etc.

The estimated annual costs on our marketing plan might be (only marketing cost):

- Cost of posters: 100€ per month /1200€ per year
- Cost of leaflets: 100€ per month /1200€ per year
- Cost of the web-site: 450€ (one-time cost)
- Cost of position in Google: about 35€ per month /420€ per year
- Cost of advertising in the media: about 120€ per month /1440 per year

## 5.7. Control

To control if our marketing strategy is successful, we have to observe all time the micro and macro environment. It is important to study the strategies of our competitors, analyze their product, promotion and clients. Otherwise we will not follow the changes and we will be left behind. We are also planning to look at customer needs and adapt to changes, keep customers and attract new. We should all the time look at offers for the materials because in the market new businesses can develop and they might have more favorable contracts. Good solution is to change your ad at least every six months to attract customers' attention. Otherwise it becomes monotonous and not effective. Another important thing is to monitor changes in macro environment. We have to be up-to-date with law and economical situation

in Portugal and around the world. Of course the most important thing in our case is the technological forces, because the technological development in these fields is very fast. We must be up-to-date and continuously improve the product, otherwise it will be obsolete soon. Also we should follow fashion, because one of the segments is young people, and they like to be fashionable.

Moreover, we have to have control over our objectives. This control will consist in comparing the present state of theoretical assumptions. To have a good control of the situation we are going to prepare quarterly reports. Then we compare the results with previous ones, and the strategy plan and draw conclusions. After that we should do a plan for the next quarter and try to accomplish that.

## **5.8. Conclusion**

We did a market analysis which includes micro and macro environment. After that we chose two segments for our product. The first one is people who work with engineering programs that are meant for drawing. They are designers, architects, engineers, teachers and students. They spend a lot of their time using computers to draw sketches, diagrams, plans, models. Our product can facilitate the implementation of these activities. The other target group is young people between 17 to 35 years old who use their computers or mobile phones to play games. In our marketing plan we adapt our promotion to these segments. We set up goals and prepare an action and control plan, which helps us to achieve our objectives. We have valued price of our Smart Object on 300 Euros. Cost of production per one product is 230€. We plan to earn 70 Euros per piece, but from this we have to withhold the price of transport.

## 6. Eco-efficiency Measures for Sustainability

Eco- efficiency is one way to generate more perceptible value and profit. When we reduce the material consumption, implement the concept of energy conservation and the concept of energy efficiency we have to make investments for the future. After the investments are made we start to see the impact that they have on profit (we produce more with the same amount).

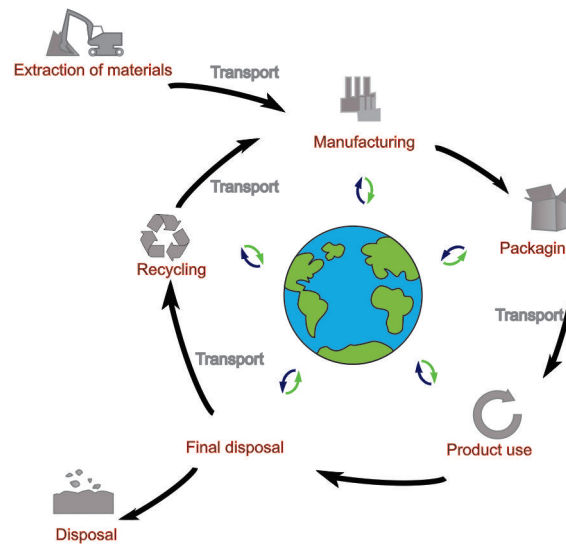


Figure 6.1.: Lifecycle

The ideal version to use the materials would be in a circular usage like shown in Figure 6.1 above. After extraction they stay in the manufacturing-usage-recycling loop. When it comes to sustainable development the strategy includes the whole lifecycle of the product. It starts with the extraction and production of intermediate goods needed for further production, design of the product, the production for a mass-market, the transport and the recycling and also the culture of the company.

### 6.1. Design of the product

For producing the prototype the following parts/materials are used:

- outer shell (acrylic glass (PMMA- Poly(methyl methacrylate)- thermoplastic)
- boards (silicon, metals, plastic ...)
- screws/nuts (metal- stainless steel)
- Lithium Polymer Battery (Li, plastic...)
- touch screen (plastic, ....)



- microphone (metals, silicon, plastic,...)
- wires (metals, plastic)
- angle brackets (aluminium alloy)
- washers (rubber)

In the design stage we consider the impact that our product has in the environment. Our goal is to use sustainable ways to solve the problem. Most of the parts are made of recyclable materials. From the design stage we have kept in mind sustainability. Unfortunately we can't use renewable materials like wood to make the outer shell because wood expands in contact with humidity. Moreover our product should not come into direct contact with water, it can not get wet. Wood also cracks. So we try to use materials that are recyclable. For prototyping, the outer shell material should be easily shapeable and machinable. We are considering two materials what we could use: acrylic glass and ABS-plastic (Acrylonitrile Butadiene Styrene). Both of the materials are hard to be recycled.

They both are usable for this purpose. We have easy access to acrylic glass so for that purpose we are going to use it for the shell material. All the boards and microphone are made from silicon, metals and plastic, all these materials are recyclable.

The battery is rechargeable, we are going to use a USB cable to charge the battery because it can be used for other tasks as well. Lithium Polymer Batteries are also made from recyclable materials and they are rechargeable. The nylon standoffs that we are planning to use are made from thermoplastics- also a reusable material. The wires are made from metal and covered with plastic.

## 6.2. Extraction and production of intermediate goods

### 6.2.1. Metals

**Stainless-steel**—The screws and nuts that are used are made of stainless steel. Steels are alloys that have 0,2 to 2,1% of carbon content. Steel is one of the most recycled materials in the world. Ferrous metals contain an appreciable percentage of iron and the addition of carbon and other substances creates steel. The steel industry is recycling in large part because it is economically advantageous to do so. It is cheaper to recycle steel than to mine iron ore and manipulate it through the production process to form new steel. Steel does not lose any of its inherent physical properties during the recycling process, and has drastically reduced energy and material requirements compared with refinement from iron ore. The energy saved by recycling reduces the annual energy consumption of the industry by about 75%, which is enough to power eighteen million homes for one year. Recycling one metric ton (1,000 kilograms) of steel saves 1.1 metric tons of iron ore, 630 kilograms of coal, and 55 kilograms of limestone. [13]

**Aluminium**— The angle brackets are made of aluminium alloy. Aluminum is theoretically 100% recyclable without any losses in its properties. Recovering the metal via recycling has become an important part of the aluminium industry. Recycling involves melting the scrap metal, a process that requires only 5% of the energy used to produce aluminum from ore, though up to 15% of the input

material is lost as dross (ash-like oxide). The dross can undergo a further process to extract aluminium. [14]

### 6.2.2. Plastics

**ABS-plastic**—Production of 1 kg of ABS requires the equivalent of about 2 kg of petroleum for raw materials and energy. It can also be recycled. The advantage of ABS is that this material combines the strength and rigidity of the acrylonitrile and styrene polymers with the toughness of the polybutadiene rubber.[15] ABS-plastic is group 7 plastic among recyclable plastics.

**Acrylic plastics**—Acrylic plastics manufacturing involves highly toxic substances which require careful storage, handling, and disposal. The polymerization process can result in an explosion if not monitored properly. It also produces toxic fumes. Recent legislation requires that the polymerization process be carried out in a closed environment and that the fumes be cleaned, captured, or otherwise neutralized before discharge to the atmosphere. Acrylic plastic is not easily recycled. It is considered a group 7 plastic among recycled plastics and is not collected for recycling in most communities. Large pieces can be reformed into other useful objects if they have not suffered too much stress, crazing, or cracking, but this accounts for only a very small portion of the acrylic plastic waste. In a landfill, acrylic plastics, like many other plastics, are not readily biodegradable. [16]

**Rubber**—Rubber recovery can be a difficult process, but there are many reasons why rubber is reused. Firstly, the recovered rubber can cost half of that of the natural or synthetic rubber. Recovered rubber has some properties that are superior to the properties of a virgin rubber. [17]

## 6.3. Production

In the first year we are planning to sell 10 000 pieces of our product in Europe and USA, if we have more orders, then we may rise production. Because we want to find our first customers in EU and USA then it would be economically useful for us to start our first production factory somewhere in Europe. Because we are nearer to the end consumers and we can save on transportation costs.

There is 252 working days in a year. If we plan to make 10 000 pieces in the first year and we have 252 work days then we should produce around 40 devices a day.

To make the product shell we are planning to use ABS-injection molding. The molds and the machine are rather expensive. We also would need two mold pairs to make the two shell halves of the product. The molding machine maybe has to work for one week in a month to produce the parts needed for assembly in that month. Therefore it would be reasonable to use another company's services at this point to make these parts. Later, in the stage where production amounts are bigger and we have more different products we should consider having our own production department.

All the electronical parts we are planning to order and buy from the companies that produce them. So at first we would only do the assembling the products.

Our production volume is small at first, so we should not consider moving out from Europe before it grows up to 50 000 pieces per year or more ( 200 pieces per day, if we have 252 workdays). The factories have to comply with all the rules and regulations for the environment protection. Also we have to introduce safe methods of working to exclude work related accidents and injuries. All the employees get a fair salary because we need their special skills and to show that we appreciate that. The salary consists of baseline salary plus bonuses that motivate employees to be more productive. We are thinking of employing maximum 40 people in the beginning.

In production we see some solutions to be more ecologically friendly and sustainable. With the production plan and appropriate management of materials we can save materials, that is to say reduce the amount of waste generated during the production. If we will employ qualified staff they will know how to do their job, so they will make less mistakes. Consequently there will be less defective products and less waste. Work should be planned so that the machinery and equipment is not turned on for nothing - not to waste energy. But it is also important not to stop them too often, because it wastes time and energy to start them again. Moreover we can design production halls so that road transport is as short as possible. We also have to consider the supply of raw materials. If we order larger batches of materials they will not have to be so often transported. In our opinion a good idea could be taking the materials from local suppliers because, firstly, cost of transport will be less and transportation of materials will be much lower. Secondly, this solution gives employment to local community and will develop the region economically.

#### **6.4. Packaging, Recycling and Transport**

Our products packaging can be made completely from recyclable materials. The package can be made from cardboard, in the middle of the box there is a special bracket that is supporting the Smart Object and protecting it against damage. The package can be recycled again.

When it comes to supplying our product to the customers we want to use a logistic company with the highest standards of environment protection. They have to use modern cars that have low fuel consumption and low CO2 emission.

General outsourcing saves costs. This is the main reason to choose a logistics company to distribute the product. Also it is more sustainable. Because if the company provides products it would send cars with only one package at a time. When using logistic companies, they send cars full of different packages to the same area. When using logistic companies they transport our products to the customers and other packs at the same time.

## **6.5. Conclusion**

The plan is to use recyclable materials for packing the Smart Object. After buying the product, the consumer can throw the package to recyclable materials container. To distribute the product the plan is to use logistics companies that have already invested in the labor force and equipment for that. The idea is to use a economically friendly logistics company.

## 7. Project Development

This chapter describes the state of our product development, this includes the system architecture and hardware specifications. The main part of the object is an Arduino microcontroller. The board is connected to different sensors. Main part of the sensor system is an IMU, to get a full 6 degree of freedom measurement of the position of the object. The sensor data is transmitted to a PC over a wireless data connection. On the PC the object is modelled in a virtual environment. The programming language for this part is Java.

### 7.1. System Architecture

All the parts are inside the outer shell except the touch screen. The outer shell is made from acrylic glass machined and bent to the needed shape. There are several holes and openings machined in for bolts and parts, the corners of the object are bent. The shell is screwed together because we are making a prototype and there might be a need to reopen the shell. Also the parts and components are screwed together like Figure 7.1 below shows. Figure 7.1 Represents the modelling stage of the Smart Object.

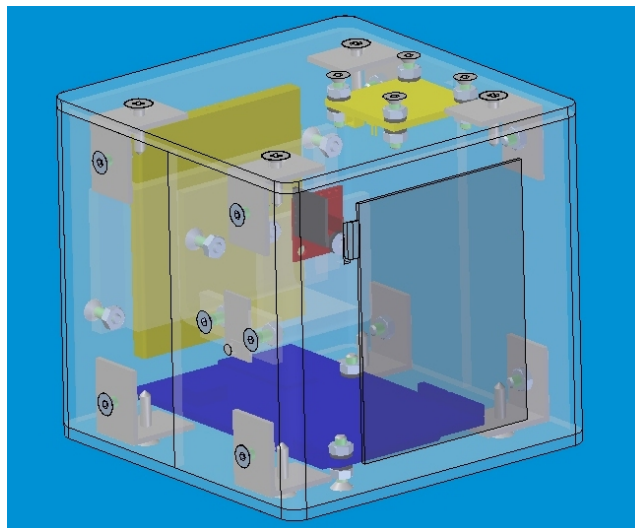


Figure 7.1.: Smart Object in the modelling stage.

### 7.2. Hardware Specifications

Typical modern wireless devices contain the following building blocks: A controlling platform with a CPU, sensors, wireless communication interface, memory and a power source. In this project we chose these blocks considering the following constraints: price, ease of use, flexibility and energy consumption.

### 7.2.1. Arduino BT

The Arduino BT 7.2 is a microcontroller board based on the ATmega328 and the Bluegiga WT11 bluetooth module. Main features a a wireless serial communication over Bluetooth, 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, a 32 KB Flash Memory and 2 KB SRAM. [18] Figure 7.2 shows the Arduino BT.

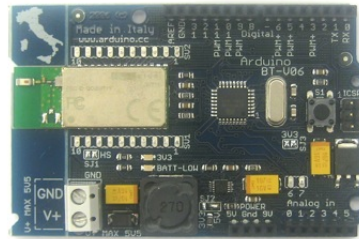


Figure 7.2.: Arduino BT

### 7.2.2. IMU Digital Combo Board - ITG3200/ADXL345

The IMU 7.3 offers a 6 degrees of freedom measurement. The communication is solved over I<sup>2</sup>C with the Arduino. Figure 7.3 shows IMU Digital Combo Board.

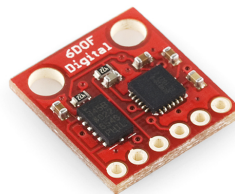


Figure 7.3.: IMU

#### ITG-3200 Integrated Triple-Axis Digital-Output Gyroscope

The Gyroscope is single-chip, digital-output, 3-axis MEMS gyro optimized for gaming, 3D mice, and motion-based remote control applications. It features three 16-bit analog-to-digital converters (ADCs) for digitizing the gyro outputs and a Fast-Mode I<sup>2</sup>C (400kHz) interface. The Digital-output X-, Y-, and Z-Axis angular rate sensors have a sensitivity of 14 LSBs per °/sec and a full-scale range of  $\pm 2000$  °/sec. [19]

#### Digital Accelerometer ADXL345

The ADXL345 is a small and ultra low power 3-axis accelerometer. It measures the static acceleration of gravity, as well as dynamic acceleration resulting from motion or shock. The measurement is done with high resolution (13-bit) at up to  $\pm 16$  g. The data is formatted as 16-bit twos complement and is accessible through a I2C digital interface. The resolution of 3.9 mg/LSB) enables measurement of inclination changes less than  $1.0^\circ$ . [20]

### 7.3. Information Flow from the Sensors to the PC

The movement of the object is registered by an IMU. IMU sends that data to Arduino. At last the Arduino board sends the data via Bluetooth to a PC. The microphone registers the voice input and sends it to the Arduino. The Arduino sends the data to a PC via Bluetooth. The touch screen detects the input (touch) and sends it to breakout board. In the end the data is sent to the Arduino and from there it's sent to the PC via Bluetooth. All the data movement is represented in the Figure 7.4.

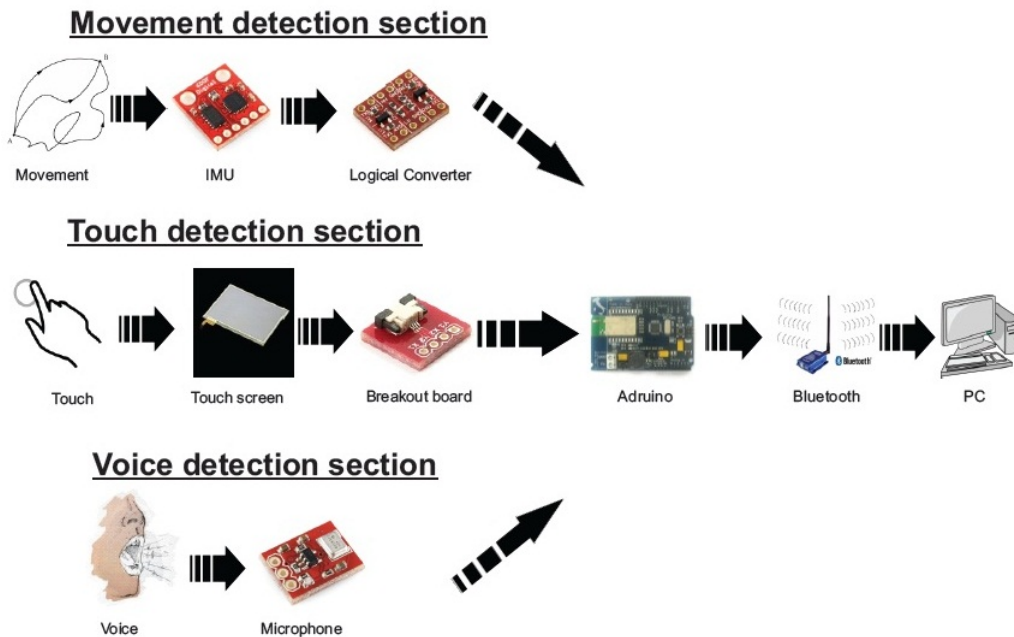


Figure 7.4.: information flow

### 7.4. Programming the Smart Object

The programming part of the SO can be divided in two sections. On the device side we have the Arduino program, written in C. The programming language on the PC side is Java. To get a powerful amount of functions we use a Java OpenGL engine called "jmonkeyengine"[21]. To develop the Java program we use the open source software Eclipse[22]. Figure 7.6 gives a overview over the software architecture. The Java application is separated in three parts. A data management thread for the serial Bluetooth connection, a thread to visualize the 3D-environment and the cube and a thread for plotting the sensor data.

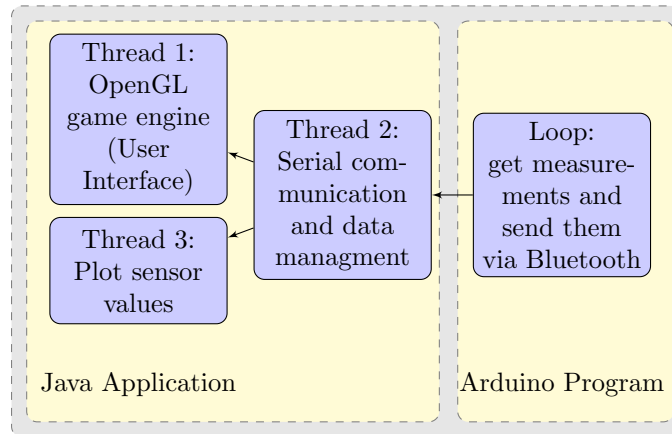


Figure 7.5.: Structure of the software architecture

### 7.4.1. The Arduino Program

The program is structured like the typical Arduino application in a Setup and a Loop part. In the Setup the Serial Connection is established. Furthermore all the digital and analog ports, which are connected to the sensors, are defined. At least an array of double values is allocated for saving the sensor values. After the Setup the Loop starts to run. The first step in the Loop is to check, if a connection to the PC exist. If not, the Arduino has to do nothing. If a connection exist, the values from each sensor are called. For the IMU a library is used, that can be found here: [22]. The library was very helpful and makes the IMU easy to use. Inside this software, the gyro values and acceleration values are fused together to calculate a more stable position. As one result it is possible to get directly the Euler Angles of the sensor. The touchpad is directly connected to an analog port, but it is not possible to read x- and y-position at the same time, because a special pin configuration is necessary. After reading the touchpad position, the microphone value is read, which is also a analog read. At last all values are send via



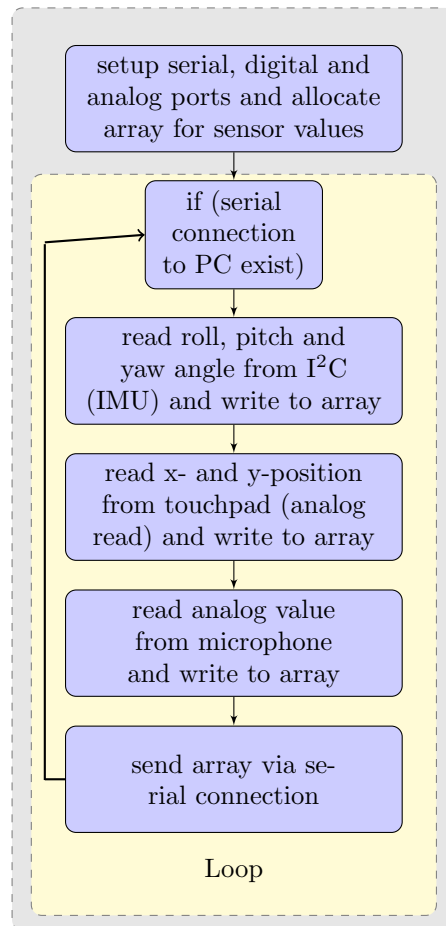


Figure 7.6.: Arduino Program

### 7.4.2. Data Management Thread

The thread is used to create the connection to the SO. The used Bluetooth profile is a serial connection. If the Bluetooth connection is working, all incoming data is stored in 3 different FIFOs (First In First Out). The FIFOs are declared as public. The implemented data structure is thread save, to avoid data crashes. This is necessary because multiple threads have to access the data.

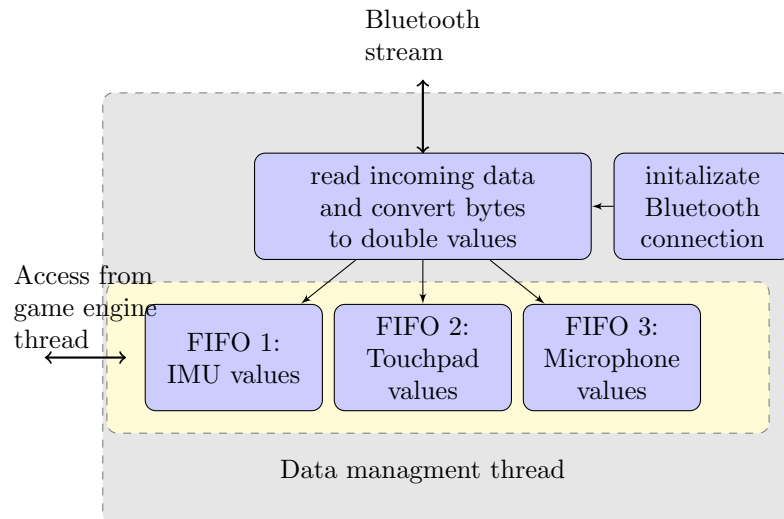


Figure 7.7.: Data Management Thread

### 7.4.3. Game Engine Thread

The Game Engine Thread implements the OpenGL game engine. After setting up the world and creating the cube the thread tries to get data from the data management thread. If data is available a loop is started to permanently update the visualization. To detect the zoom, the touch pad data is analysed in a separate function. If the values are decreasing or increasing the zoom value is calculated new. By analysing the acceleration data for big chnges in a short time period, a shake of the object can be detected. With this information two modes are implemented. In the first mode the cube can be rotated. In the second mode the camera around the cube can be rotated. For both modes the three Euler angles from the IMU are used to change the rotation of the cube or camera.

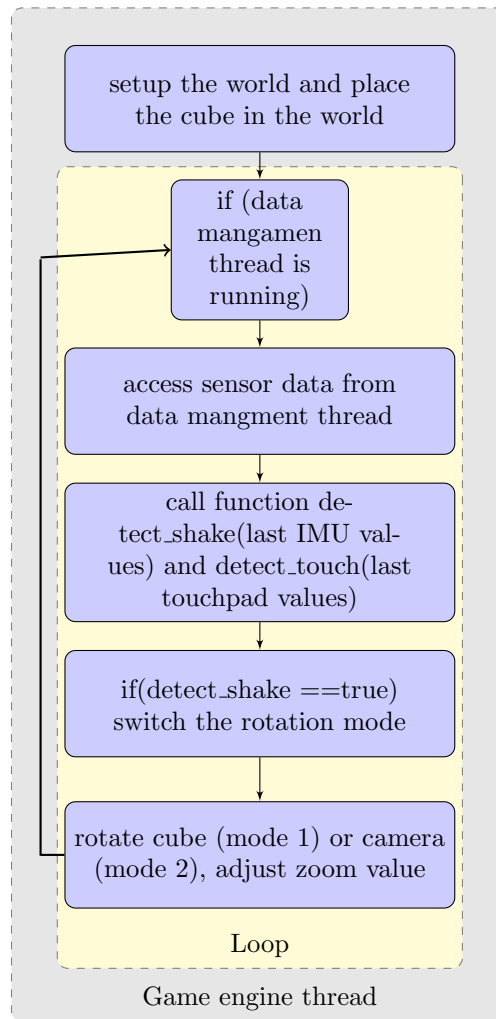


Figure 7.8.: Game Engine Thread

In Figure 7.9 the result of the game engine with a default 3D-world and the SO is presented. The visualization is added to tab of a tabbed pane in the Java application.

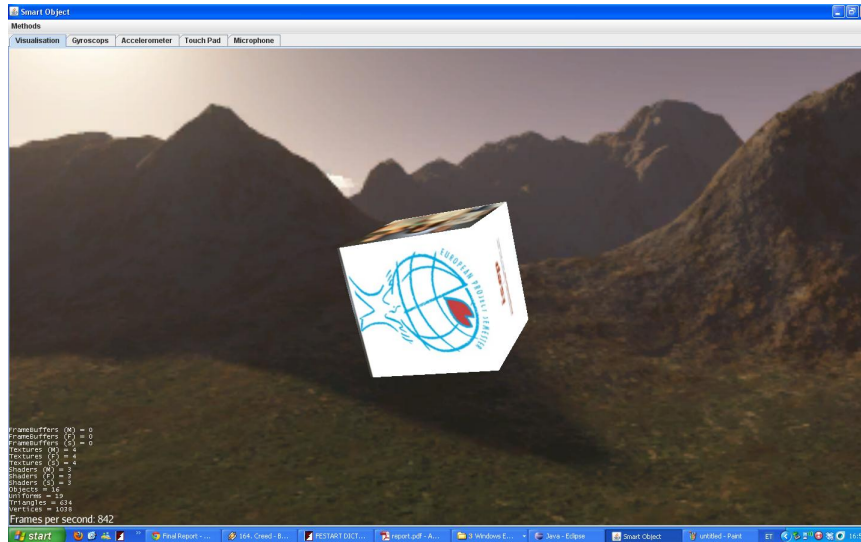


Figure 7.9.: Java Application with visualisation tab

#### 7.4.4. Plot Thread

The thread is used to plot the sensor data in real time. If a new value is added to the FIFO of the data management thread, the plot thread adds a time stamp to each value and refreshes the plot. Each plot is added to tab of a tabbed pane in the Java application, so the user can easily switch between the different plots or the object visualisation. Figure 7.10 describes the structure of the plot thread.

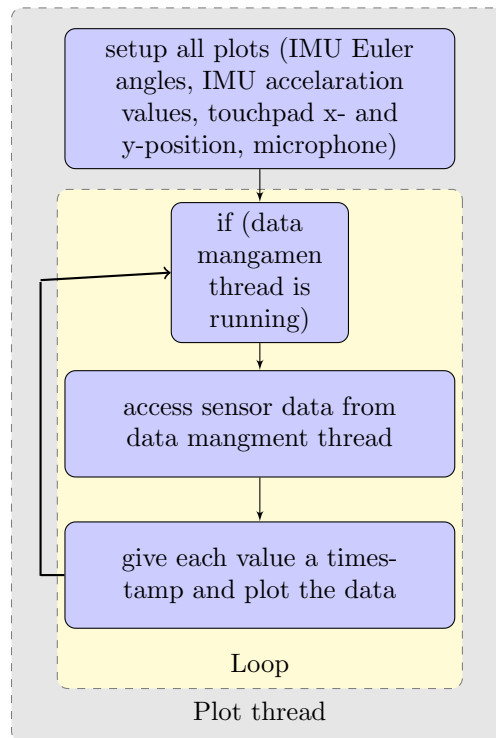


Figure 7.10.: Plot Thread

The following picture shows one of tabs with the values of the Euler angles (Roll, Pitch and Yaw angle).

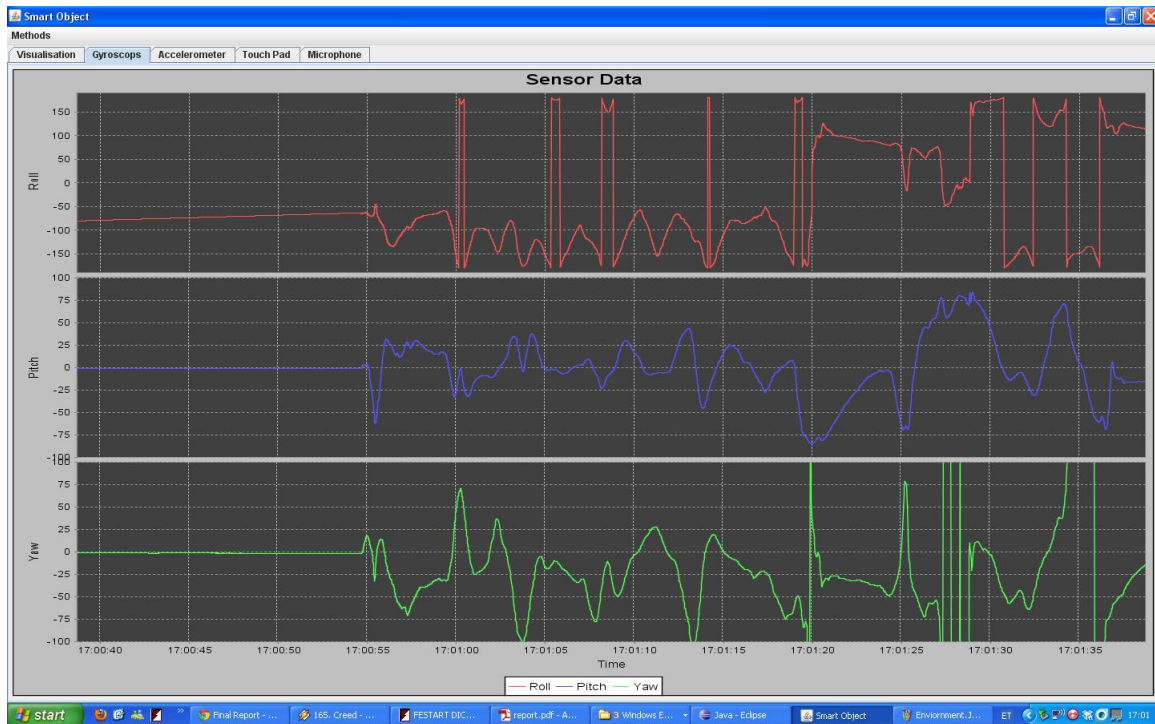


Figure 7.11.: Plot Tab

### 7.4.5. Visualization of the object and the data

To get an interesting application we set up the surface of the cube with the logo of the ISEP and a picture of the group. The result is shown in the following picture.



Figure 7.12.: Smart Object in Java

## 7.5. Building and assembly

### 7.5.1. Building angle brackets

The plan was to buy the angle brackets that suited the best with our needs. Unfortunately we couldn't get them. The angle brackets were made from an aluminium alloy L-profile. The L-profile had to be cut in 20 mm wide pieces and then two holes

had to be drilled into each angle bracket for the screws. The first hole drilled was 2 mm in diameter and the second one was in 3 mm in diameter. Files were used to make the edges surfaces smoother, because a metal saw was used for the cutting. Angle brackets for the bottom part had to be smaller from one side so that the Arduino could be taken out if needed. Thus angle brackets were grinded to size.

### 7.5.2. Bending the Acrylic glass parts

For bending acrylic glass some heat source was needed. ISEP doesnot have a machine or some other device meant for that. In the Electro Mechanics laboratory the university had some devices that could be used for this purpose. Before bending, the parts were cut into size and some small cuts were made where the bending line should run, the cut was 0,3-0,5 mm deep. This cut relieves stress that the bending causes. The small cut should be made on the side that is going to be inside of the bent corner. A voltage regulator was used to heat up a wire that was fastened between two clamps. The wire was couple of mm ( 3 mm) hire then the piece of acrylic sheet. At those circumstances, after testing, was found that the best bends can be made with 3.1 V and 11.8 A, at this point the wire was around 400 deg C. This suited best with the 3mm thick acrylic glass sheet that was used and the heated part didn't have any bubbles. There was also a problem with the wire it started to bend because the material elongated when the temperature grew. The solution for that problem was that it had to be held under tension manually to avoid that. The bent acrylic parts can be seen on Figure 7.13.



Figure 7.13.: Bending the Acrylic

### 7.5.3. Machining the acrylic parts

The holes for the screws were drilled after bending the acrylic parts, this was done to achieve higher precision. Chamfers were made so that the screw heads would be

at the same level as the acrylic. A drilling machine was used for this purpose. Also some holes were made for the touchpad connector and the hole for the USB cable to charge the assembled device.

The top and bottom parts were cut into size, the sides and corners were grinded and filed. Then the holes for the screws were drilled. Chamfers were also made to hide the screw heads.

#### 7.5.4. Assembly

To assemble everything different screws, washers and nuts are used.

The angle brackets hold together 4 acrylic glass parts that form the shell. Two types of flathead screws are used to fasten the angle brackets to the acrylic: metal screws and M3 screws. The metal screw is screwed straightly in the angle brackets 2 mm diameter hole. The M3 screw goes through the 3 mm diameter hole and is fastened with a nut.

To fasten all the electrical things to the acrylic M3 screws, rubber washers and M3 nuts are used. The M3 screw is fastened to the acrylic with a nut. This method should relieve some stress from the electrical parts. Then the electrical parts are but between 2 rubber washers and to hold them in place another nut is used. The last nut is loosely fastened on the screw to keep the electrical parts in place.(Figure 7.14).

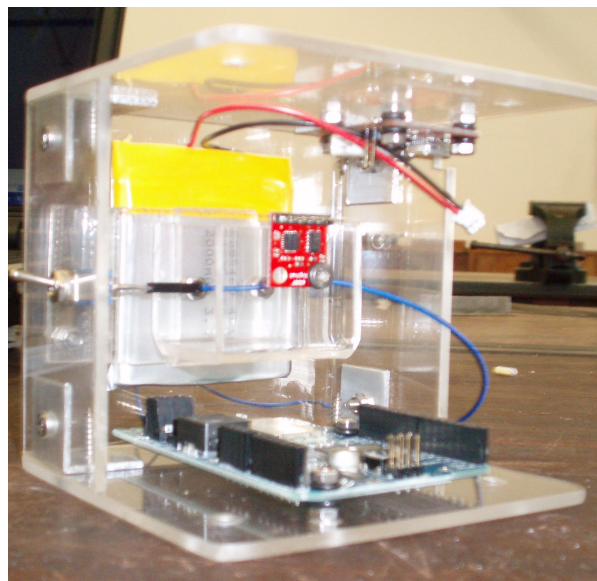


Figure 7.14.: Fastening electric parts

The touchpad is taped onto one side of the shell. The touchpad pin goes through the hole that was made before into the acrylic glass. The connector is placed inside the shell. When the Smart Object is assembled it looks like what we see on Figure 7.15.



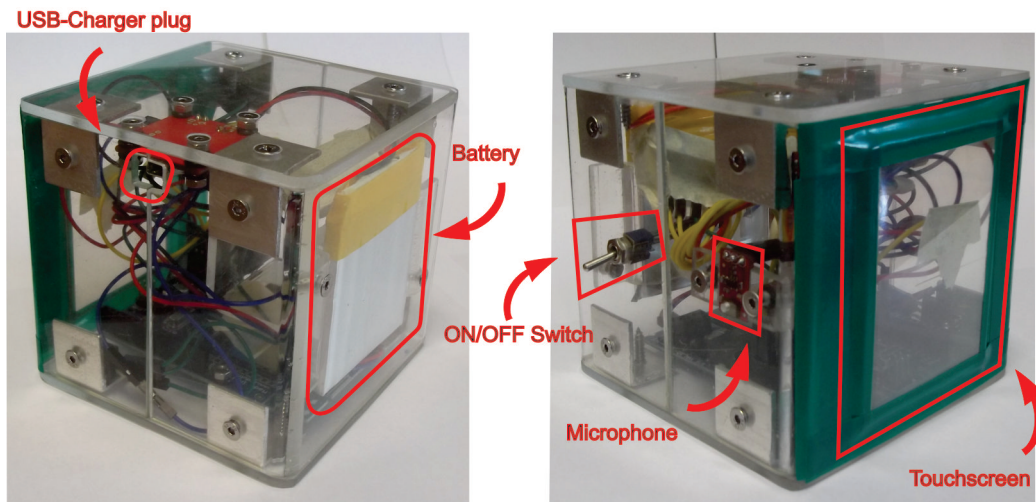


Figure 7.15.: Assembled SO

## 8. Conclusions

This report presented the work done on the Smart Object and the achievements made by the team of international students who attended the European Project Semester in ISEP. The teamwork was not easy because of several reasons. One of the reasons was collaboration with people from different countries and habits. Sometimes we had some communication problems and different ideas about, how to solve some problems. With time we got to know each other more and more and the teamwork also got better. Now after four months we know both our and teammates' and our strengths and weaknesses. Thanks to that we know now better how to divide tasks between ourselves.

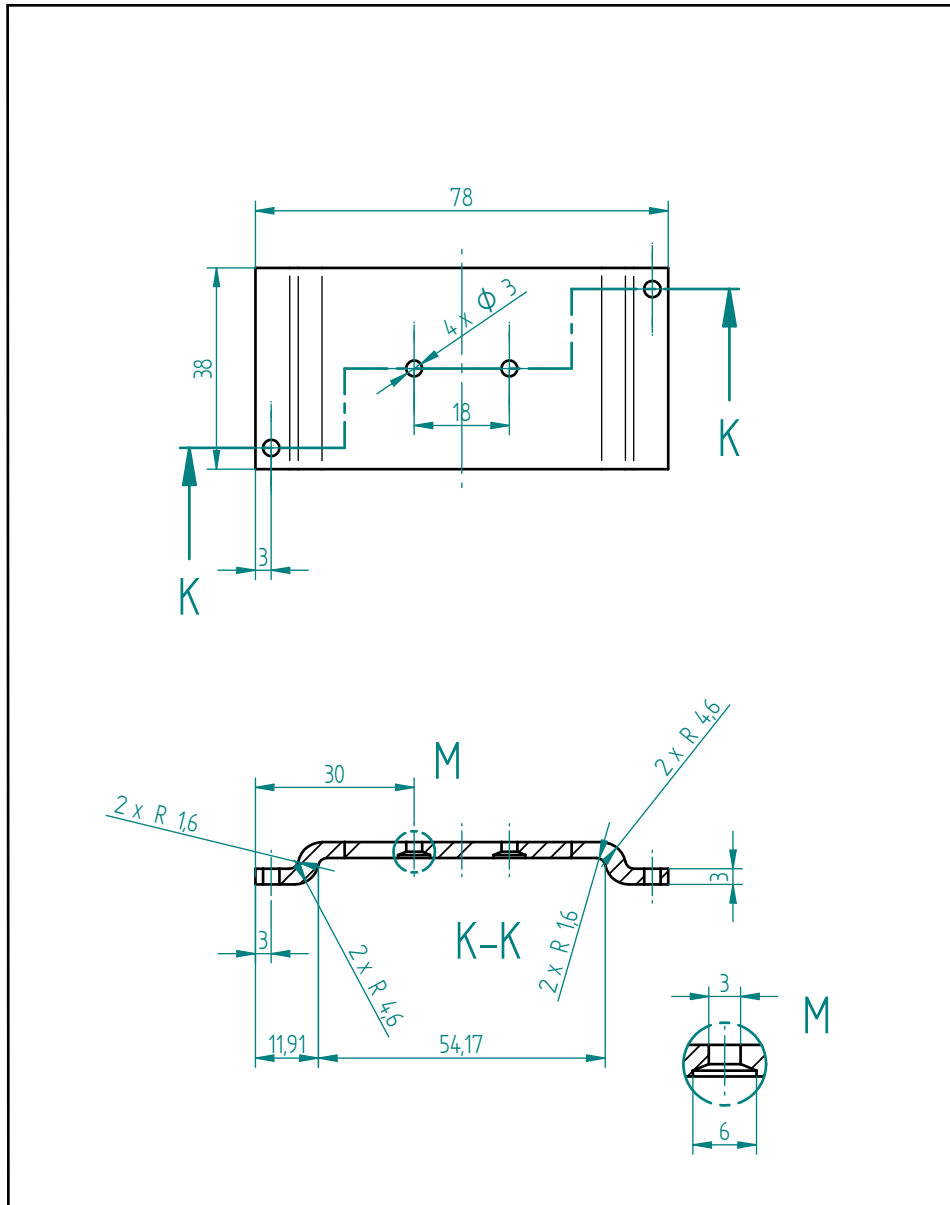
This project gave us an opportunity to combine our theoretical and practical knowledge. Also all of us have now a better understanding of what it means to work in an international team.

We had many ideas when we began working on the Smart Object. Starting from defining the functions and ending with the material selection. Making these decisions was not easy but when it came to the building all went smoothly. The Smart Object should facilitate work with CAD-programs. This described object consists of three parts: (1) Arduino microcontroller, which connects with board of sensors, (2) an IMU that gets a full 6 degree of freedom measurement of the position of the object, and (3) a wireless data connection and a virtual environment programmed in JAVA. We also presented other aspects of the product/project development, like the marketing plan and project management. We had some problems during the work with Arduino, touchscreen, IMU, microphone and many others but we found solutions and now we can say that our Smart Object is working.

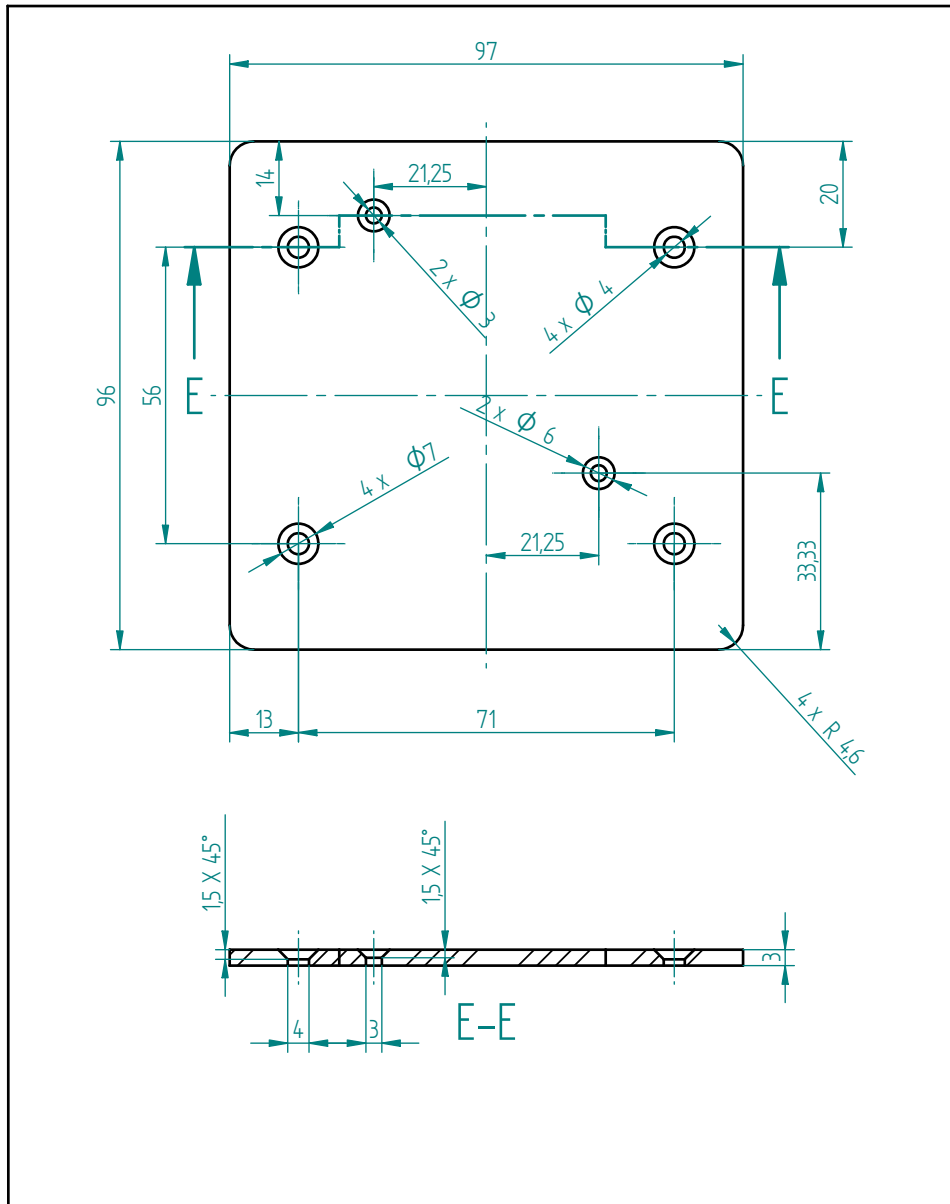
## 9. Future Developments and Improvements

The product has to be more marketable. At the moment the prototypes shell is made of acrylic glass. This material is not suitable for mass production. When the Smart Object is going to hit the market the shell should be made from a moldable material like ABS- plastic. A lot of appliances and electronic devices have enclosures made from ABS-plastic. The material is tough and has a good impact resistance. The material can be easily molded with proper machines. Also the outer design should be more attractive. At the moment it looks like a box where we can put our hardware. Also the product can be made smaller. At the moment Arduino BT is used as a microcontroller: it is ideal for prototyping. The microcontroller can also be a lot smaller because it is specially made to fill the given tasks. Besides that the battery can be more compact to take as less space as possible.

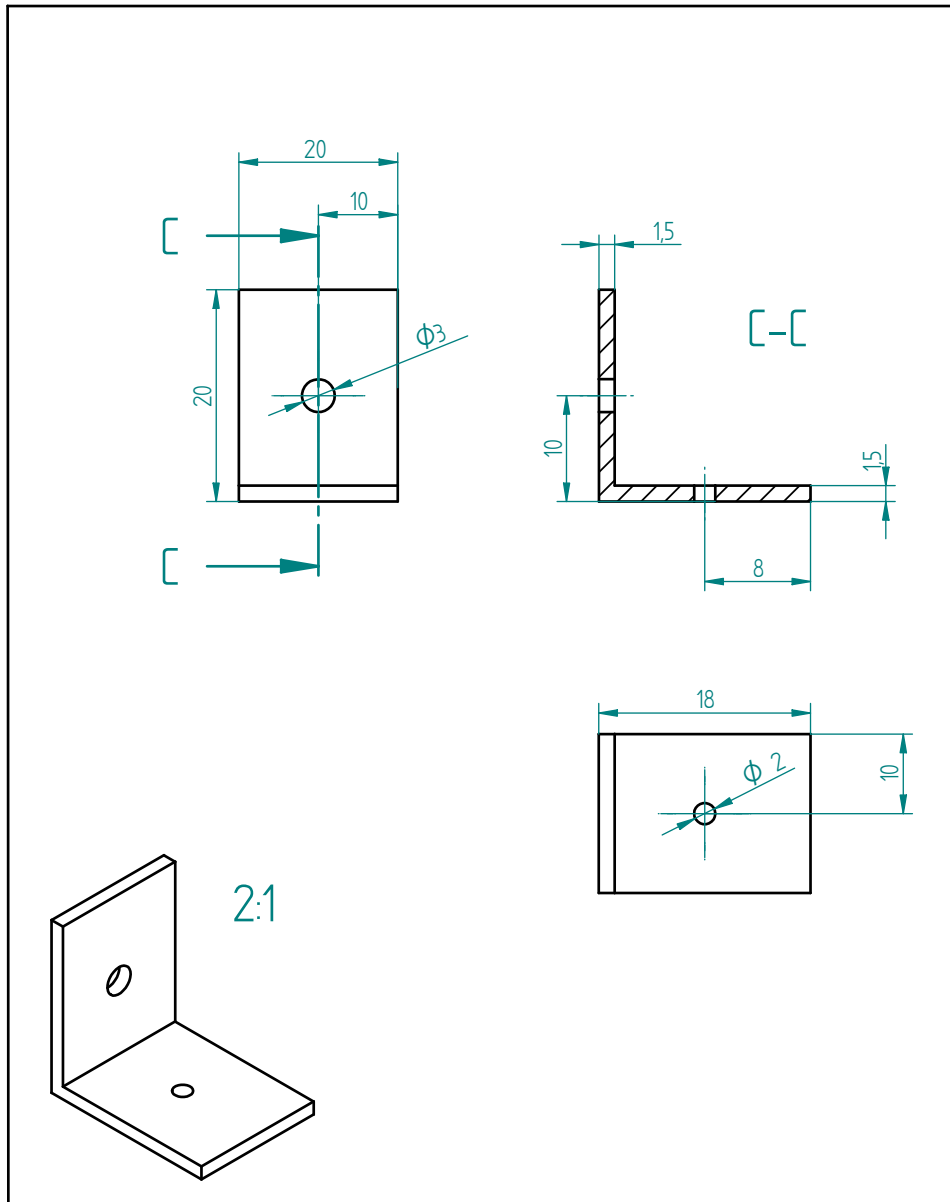
# A. Drawings



	Material:		Unmarked limits of tolerance:	Weight:	Format: A4
	Drawn	T. Juht 5th of June 2012	Title:	File name:	
Checked	T. Juht	Battery cover		SO-draifts.dft	
Verified		Sheet:	Mark:	Scale:	
ISEP EPS 2012		1 of 1	SO 01.07	1:1	



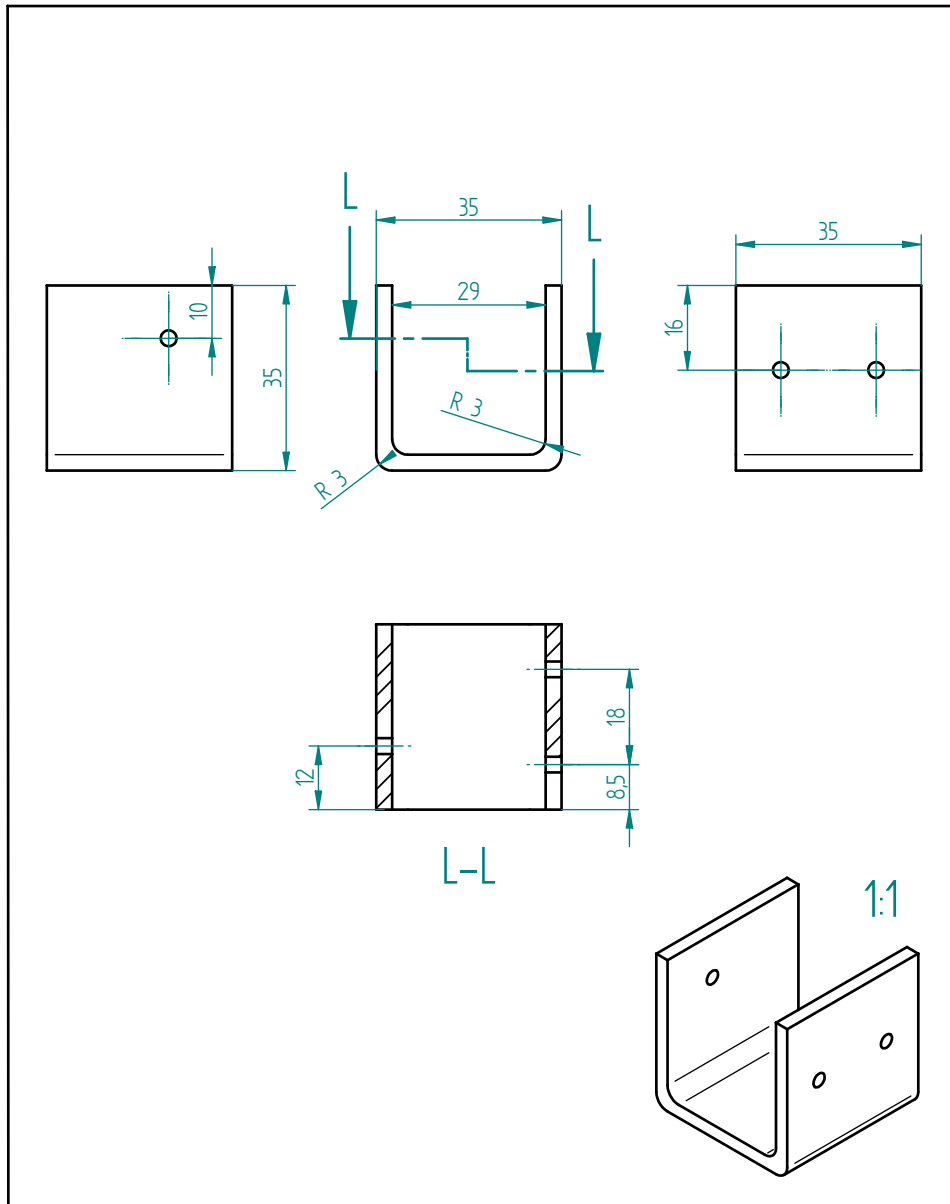
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	Checked	T. Juht			
Verified			Sheet: 1 of 1	Mark: S0 01.02	Scale: 1:1



	Material:		Unmarked limits of tolerance:		Weight:	Format: A4
	Drawn	T. Juht 5th of June 2012	Title: Bottom angle braket		File name: SO-drafts.dft	
	Checked	T. Juht				
Verified		Sheet: 1 of 1	Mark: SO 01.06	Scale: 2:1		

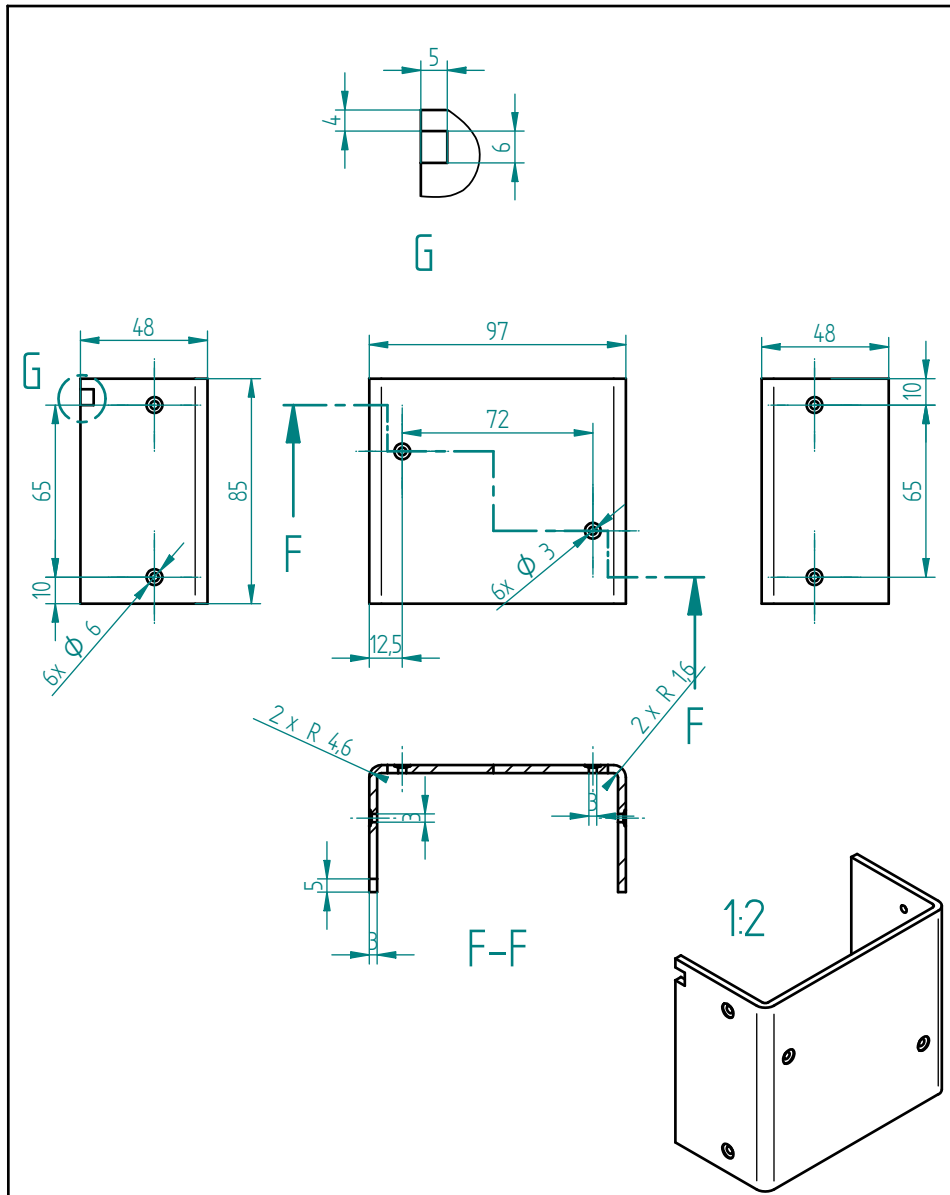
ISEP EPS 2012 SOLID EDGE ACADEMIC COPY

A. Drawings



	Material:	Unmarked limits of tolerance:	Weight:	Format: A4
Drawn	T. Juht 5th of June 2012	Title:	File name:	
Checked	T. Juht	IMU base	SO-drafts.dft	
Verified		Sheet:	Mark:	Scale:
ISEP EPS 2012		1 of 1	SO 01.08	1:1

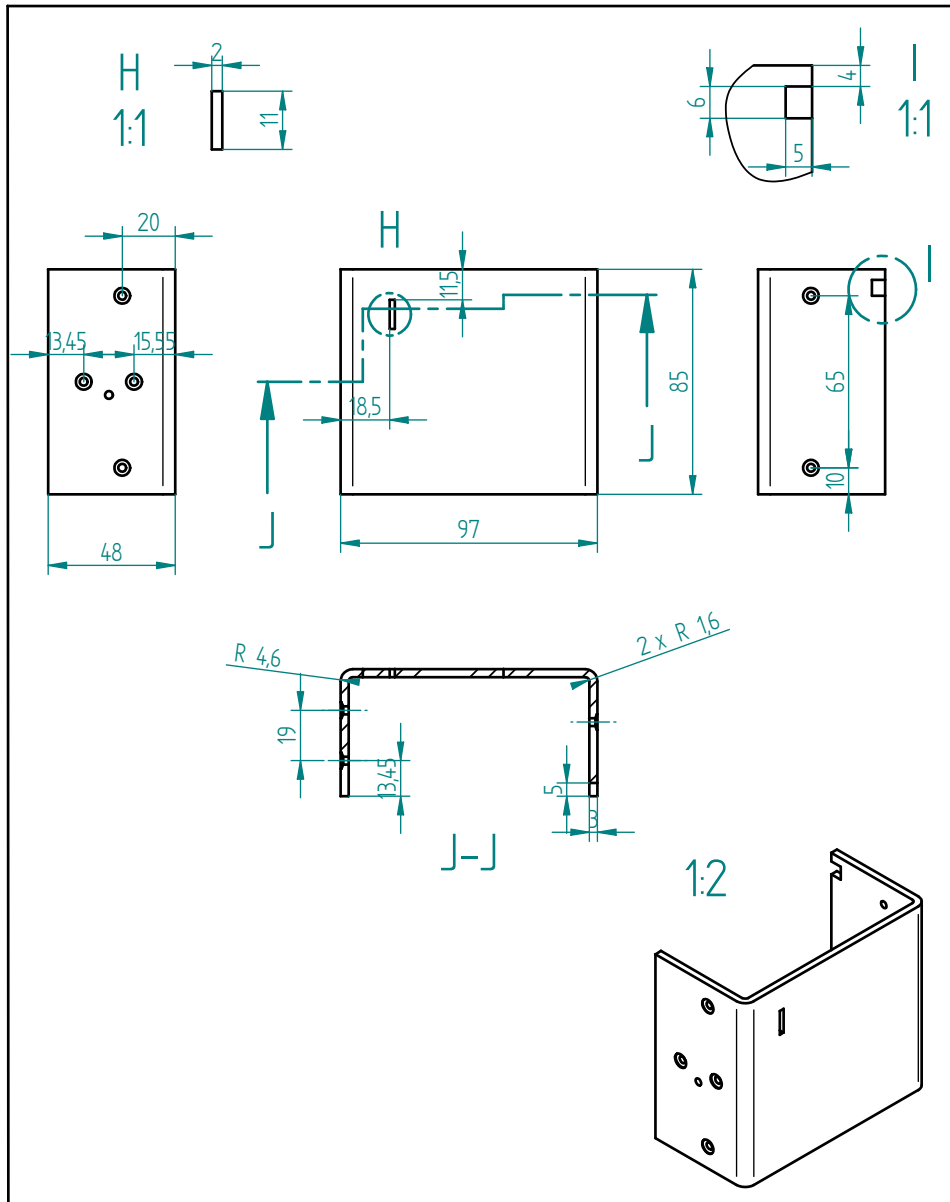
A. Drawings



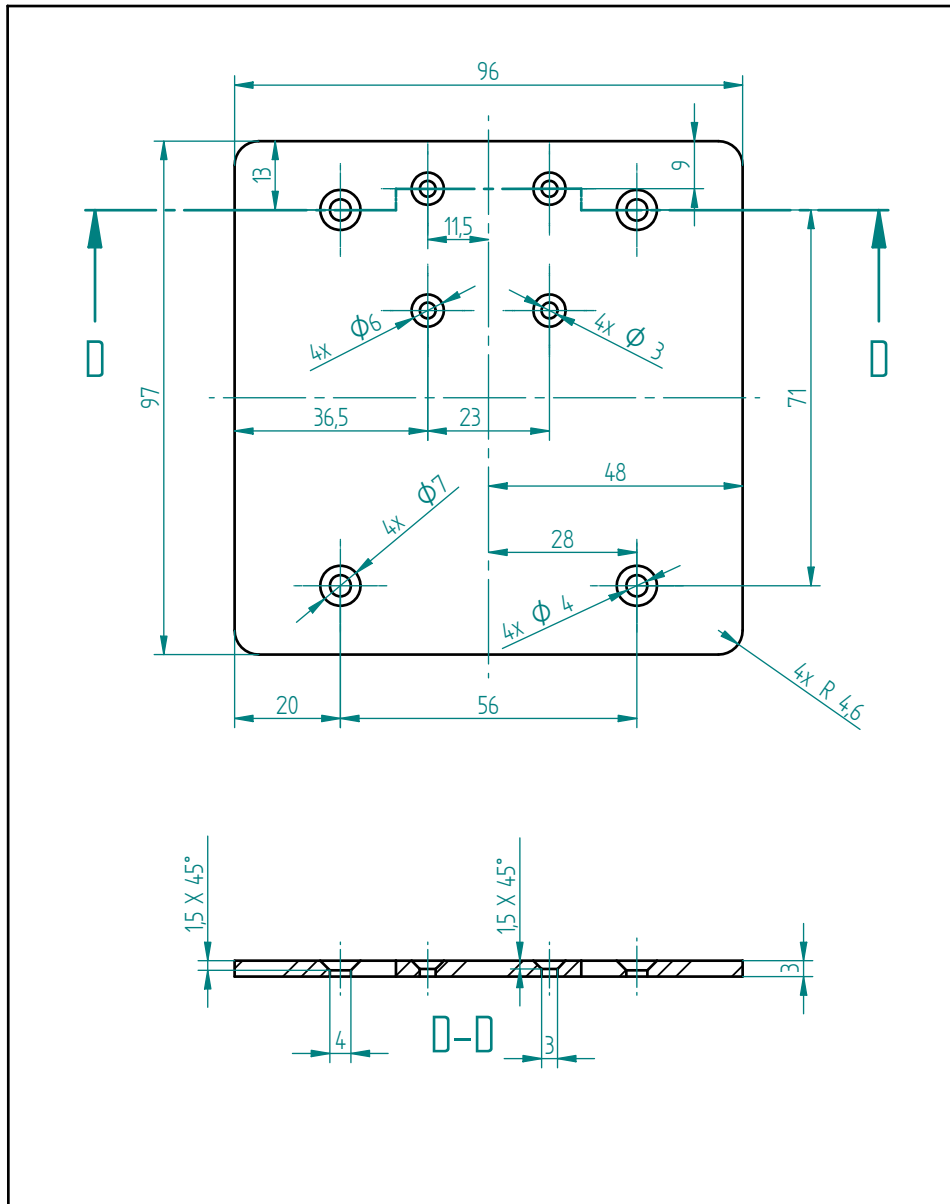
	Material:		Unmarked limits of tolerance:	Weight:	Format: A4
	Drawn	T. Juht 5th of June 2012	Title:	File name:	
	Checked	T. Juht	Left wali	SO-draitts.dft	
Verified					
ISEP EPS 2012		Sheet: 1 of 1	Mark: SO 01.03	Scale: 1:2	



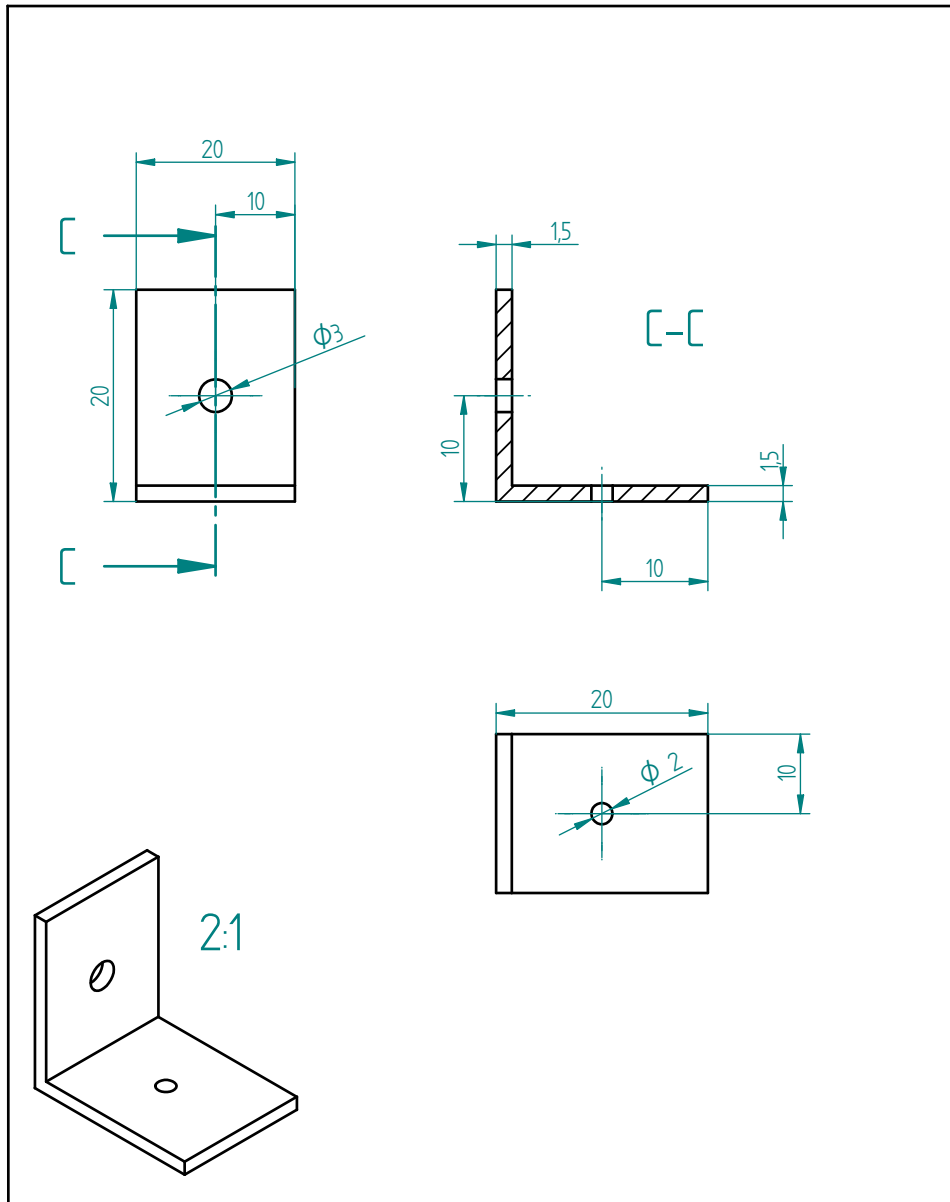
A. Drawings



	Material:	Unmarked limits of tolerance:	Weight:	Format: A4
Drawn	T. Juht	5th of June 2012	Title:	File name:
Checked	T. Juht		Right wall	SO-drahts.dft
Verified				
ISEP EPS 2012		Sheet: 1 of 1	Mark: SO 01.04	Scale: 1:2



	Material:		Unmarked limits of tolerance:	Weight:	Format: A4
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Checked	T. Juht				
Verified					
ISEP EPS 2012			Sheet: 1 of 1	Mark: SO 01.01	Scale: 1:1



	Material:	Unmarked limits of tolerance:	Weight:	Format: A4
Drawn	T. Juht	5th of June 2012	Title:	
Checked	T. Juht	Top angle bracket		File name: S0-draitts.dft
Verified			Scale: 2:1	
ISEP EPS 2012		Sheet: 1 of 1	Mark: S0 01.05	

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