

Saimaa University of Applied Sciences  
Technology Lappeenranta  
Degree Programme in mechanical engineering and product design

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## **Innovation and product design**

Bachelor's Thesis 2011

## **Abstract**

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Description about the paraplegic wheelchair, 29pages.

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The main problem in this project is to find different part to the right material for the paraplegic wheelchair to fit the different targets group, to solve that it was required to find out an appropriate power source, battery size and many element like this.

The reason for the design is to benefit all kind of the paraplegic people for their daily life. Make them as normal people as possible. The promotion of the production should also take into considering.

The project started by brainstorming and trying to figure out the most right one to fit the most target group. The future design in the end is the goal people are trying to reach.

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## **1. Description about Paraplegic wheelchair**

I have decided to design a wheelchair specifically for the paraplegic group of users which is our main target but other groups of beneficiaries include old people who can not walk much anymore and group of people that their legs had been amputated.

The 3 kinds of product we designed is aim at those three levels of paraplegic and we got different function for each so that we can serve them well.

The different situation we face we got different product. The factor like weather, outside, inside, uphill, downhill, daytime, night, energy, are all take into consider. All I want is to design a wheelchair which can handle all these questions, more or less most of the questions. the basic part like energy part, body part, material part. Electronic part made up of my design, and all these do big effect to the wheelchair system. The system couldn't run without even one part missing.

Then I have to give a right price so than my product could come into the market. The promotion and life cycle are take into my consider.

With the remarkable improvement of people's living standard, people may not satisfied with the product we have nowadays. So the innovation part and future design are also important. We can use green energy as the power source and environmentally friendly materials. We still have a long way to go for greatly facilitated people's lives

1.1 The reasons why we choose to design the paraplegic wheel chair are the following:

- Convenience purpose for the users
- Middle stage of the disable people
- It is a design for disable, old and amputated people
- More benefit became it has a bigger range of users
- Beneficial for often users like amputated and old people who find it difficult to walk apart

- from the main target group
- To help the disabled move or do things by themselves
- Psychologically to help the user have a feeling of independence

## **1.2 Functionality parts**

- Shopping bag
- Adjustable chair
- Soft pillow or head rest
- Navigator
- Tires
- Light source
- Bell or horn
- Reflection lights
- Steering for navigation
- Brake system
- Shield for rain and hot sun
- Rear view mirror Lifting system or horizontal move
- Battery
- Control system
- Support by the side
- Comfortable seat

After going through various functions that the wheel chair could have, we have selected some specific functions we count as more important from all these numerous functions. These selected functionalities would be the ones we are going to mainly concentrate and develop on. Listed below are the selected functionalities.

- Car entry and exit
- Standing ability
- Seating comfort
- Shopping storage capacities

The reason why we have chosen this paraplegic group of users as our main target is that it helps us to put other groups of users into consideration and with these other groups included we have more users for our product in the market, thereby we make more profit.

Also taking the market into consideration, the following listed points are also important

- Mass production of our design
- More energy motivation to the design
- More technology to be included
- The cost of the renovation

## 2. The set of place the users can use the paraplegic wheel chair

### ***OUTSIDE***

Ideas for the paraplegic wheel-chair for outside users

stability	<p>Wheels (4 wheels)</p> <ul style="list-style-type: none"> <li>- Against obtain</li> <li>- Unlevel ground</li> <li>- High ground</li> <li>- Load distribution (higher and centre load on the bigger wheels support on the smaller wheels)</li> </ul>
Control system	<p>Electrically controlled</p> <ul style="list-style-type: none"> <li>- 2 wheels controlled</li> <li>• things to control <ul style="list-style-type: none"> <li>- Light</li> <li>- Bell or horn</li> <li>- Brake</li> <li>- Speed</li> <li>- Movement, turning, ring, reversing</li> <li>- Adjusting the seat</li> <li>- For lifting</li> </ul> </li> </ul>
Power source	<p>Battery (rechargeable) Solar</p>
Comfort ability	<p>Adjustable seat Soft pillow or head rest Shield against rain an sun Shock absorber Massager on the seat</p>

	Side support or arm rest Fort or puffy seat Clothed covering for chair Shopping bag (basket, location) Leg convenience support (for stretching)
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***INSIDE***

Ideas for the paraplegic wheel-chair for inside users

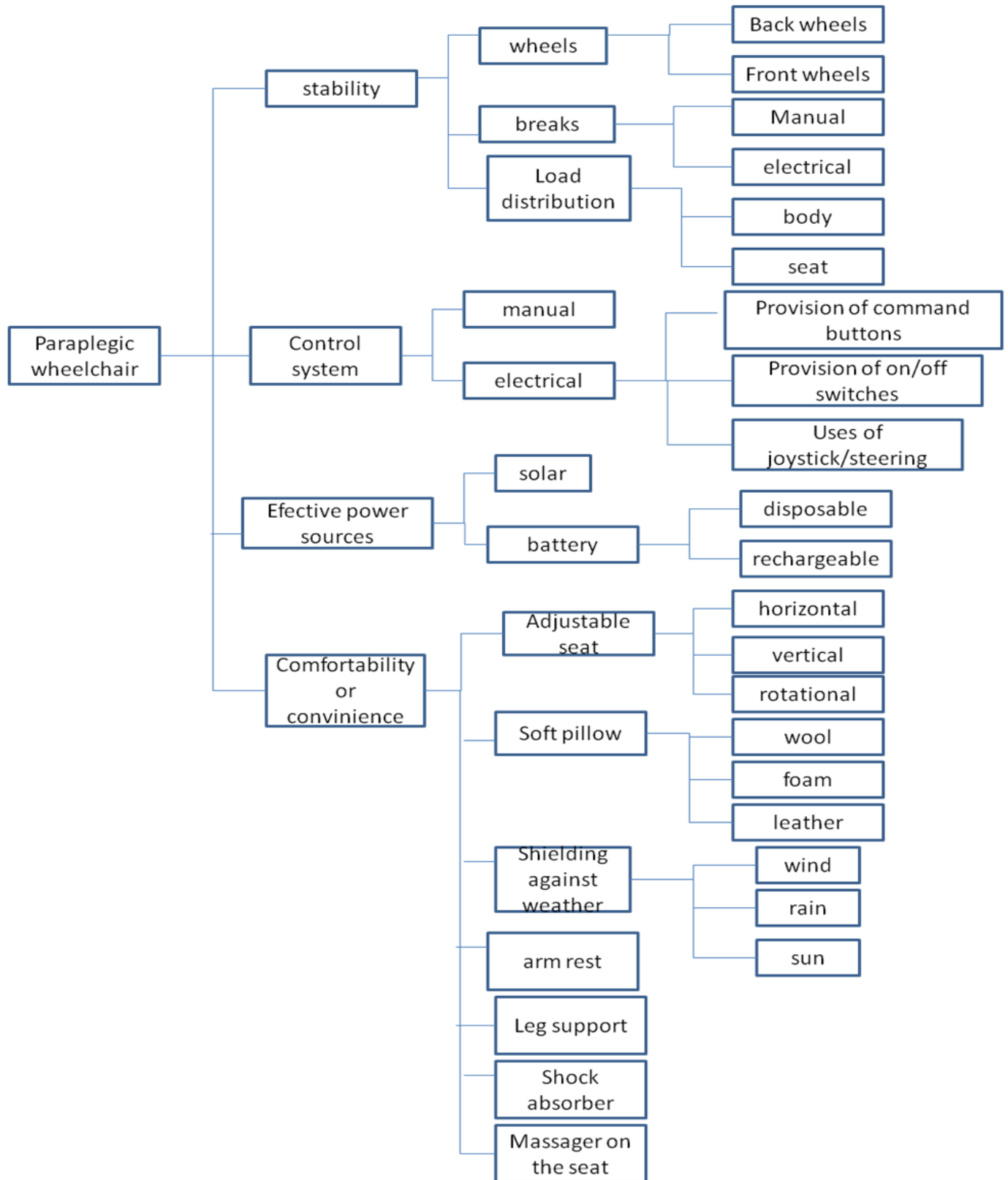
stability	Wheels (2 wheels) for movement
Control system	Electrically controlled for things to control - Movement - Lifting - Adjustment
Power source	Battery
comfort ability	Adjustable seat Soft pillow or head rest Massager on the seat Side support or arm rest Fort or puffy seat Clothed covering for chair Leg convenience support (for stretching) Easy for eating, reading and toilet Sleeping available

**2.1 For both outside and inside**

	OUTSIDE	INSIDE
Stability	Wheels (3 or 4)	Wheels (2)
Sound	Bell or horn	
Lights	Reflections light or light source	
Control system	Lifting, direction, speed and break	Lifting, direction, speed
Power system	Battery	Battery
Size	Big	Portable, small and low weight
covering	Shield for rain and sun	
Storage	Shopping bag	
Mirror	mirror	
comfort	Seat comfort, head rest and adjustable seat	Seat comfort, head rest Adjustable seat and sleeping available



### 3. Decision tree of paraplegic wheelchair



### 3.1 Morphological chart

Features	means				
Wheels	2 wheels	2 wheels 2 support	2 wheels 1 support	3 wheels	2 wheels 3 support
Power sources	Battery	Electrical	Solar		
Lifting	Electrical	Hydraulic	Manual (screw)		
Support	Wheels	Arm rest	Cushion chair		
Operating system	Automation	Simple switch			
Maneuver or turning	Land steering	Joy stick	Direction buttons	Turning wheel by hand	
tire	With tube	Tubeless	Plastic	silicon	

### 3.2 Requirement of paraplegic wheelchair

State/province/government	<ul style="list-style-type: none"> <li>- Reflections (back and front) light</li> <li>- Light sources (front and back)</li> <li>- Bell/horn</li> </ul>
User	<ul style="list-style-type: none"> <li>- Leg rest and foot rest (adjustable)</li> <li>- Arm rest (adjustable) European standard code (EN12183&amp;6.4</li> <li>- Head rest pillow</li> </ul>

<p>Producer</p>	<ul style="list-style-type: none"> <li>- Maximum carrying weight of 150kg</li> <li>- Speed range (15km/hr max)</li> <li>- Seat with back rest (seat dimension ISO 7176-7)</li> <li>- 4 wheels, 2 driven and 2 support</li> <li>- Brake system controlled electrically on the 2 driven wheels</li> <li>- An hand brake for static position when mounting on or getting off the chair.</li> </ul>
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#### **4. CRITERIA**

Easy to handle

Low price

Durability

Moderate size

Light weight

Comfortability

Safety

Stability and support

Ease of manufacture

## 5. User's functionality

Customer requirements in terms of product (wheelchair) attributes.
































USER FUNCTIONALITY	
To take/move the paraplegic person from one place to another	With Very Low energy usage
	Safely
	At night
	With storage facility
	Comfortably
	Protection from bad weather

## 6. Technical attribute related to user requirements

Technical Attribute related to user requirements

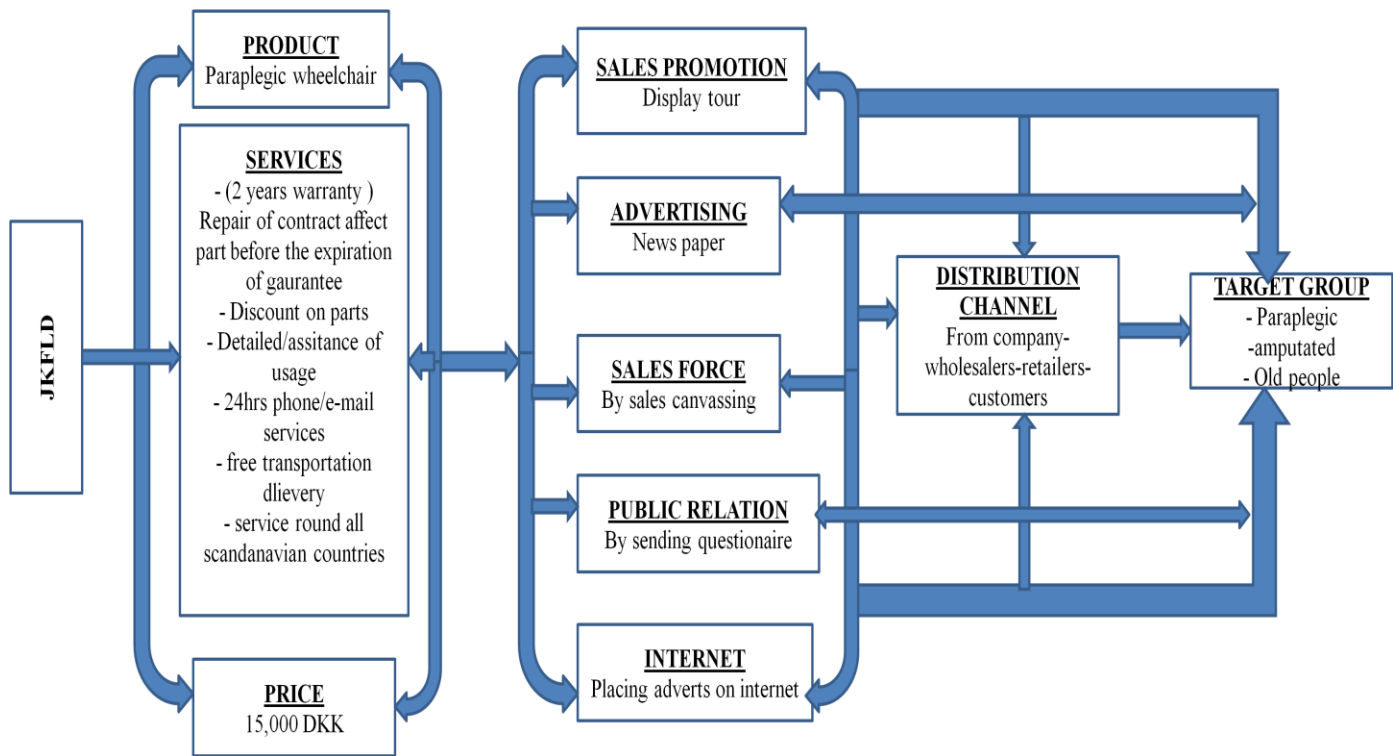
Attribute	Designation
Wheels	A
Battery	B
Electrical	C
Seat	D
Seat Belt	E
Lights	F
Sound functionality	J
Breaking system	H
Real Mirrors	I
Steering/guidance functionality	J
Arm Rest	K
Shield	L
Head Rest	M
Reflection Lights	N
Shopping Bag/Basket	O
Legs support	P

## 6.1 Relating comparison

attribute	Chair A	Chair B	Chair C
wheels			
battery			
electrical			
seat			
Seat belt			
lights			
Sound functionality			
Breaking system			
Real mirrors			
steering			
Arm rest			
shield			
Head rest			
Reflection lights			
Shopping bag			
Leg support			



### Promotion mix



### Sales estimate

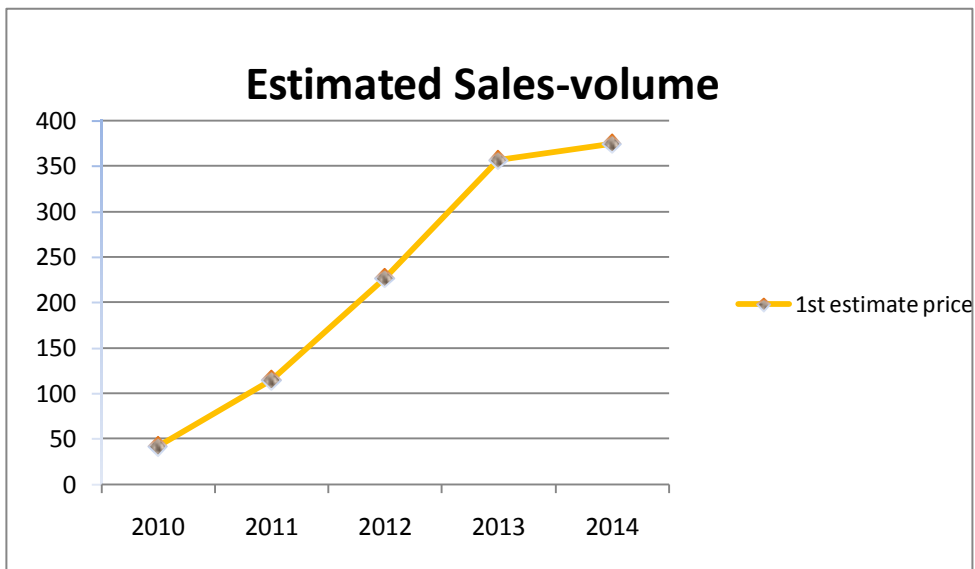
Sales Promotion (display tour)	1,700 EUR
Advertising of the products (news papers)	700 EUR
Sales Force (sales canvassing)	2,000 EUR
Public relation (Questionnaires)	900 EUR
Internet (advertising on internet)	3,000 EUR
Total of estimation per annual	8,300 EUR

## 7. wheelchair for paraplegic and old people, amputated

First estimate are based on the following assumptions:

	2010	2011	2012	2013	2014
No of Potential Customers 1	1,000	1,000	1,000	1,000	1,000
No of Potential Customers 2	1,500	1,500	1,500	1,500	1,500
Life Cycle Percentage 1	2.0%	4.0%	7.0%	9.0%	8.0%
Total Market Penetration 1	2.0%	6.0%	13.0%	22.0%	30.0%
Life Cycle Percentage 2	2.0%	4.0%	7.0%	9.0%	8.0%
Total Market Penetration 2	2.0%	6.0%	13.0%	22.0%	30.0%
Market Share 1	90.0%	80.0%	70.0%	65.0%	50.0%
Market Share 2	80.0%	75.0%	70.0%	65.0%	50.0%

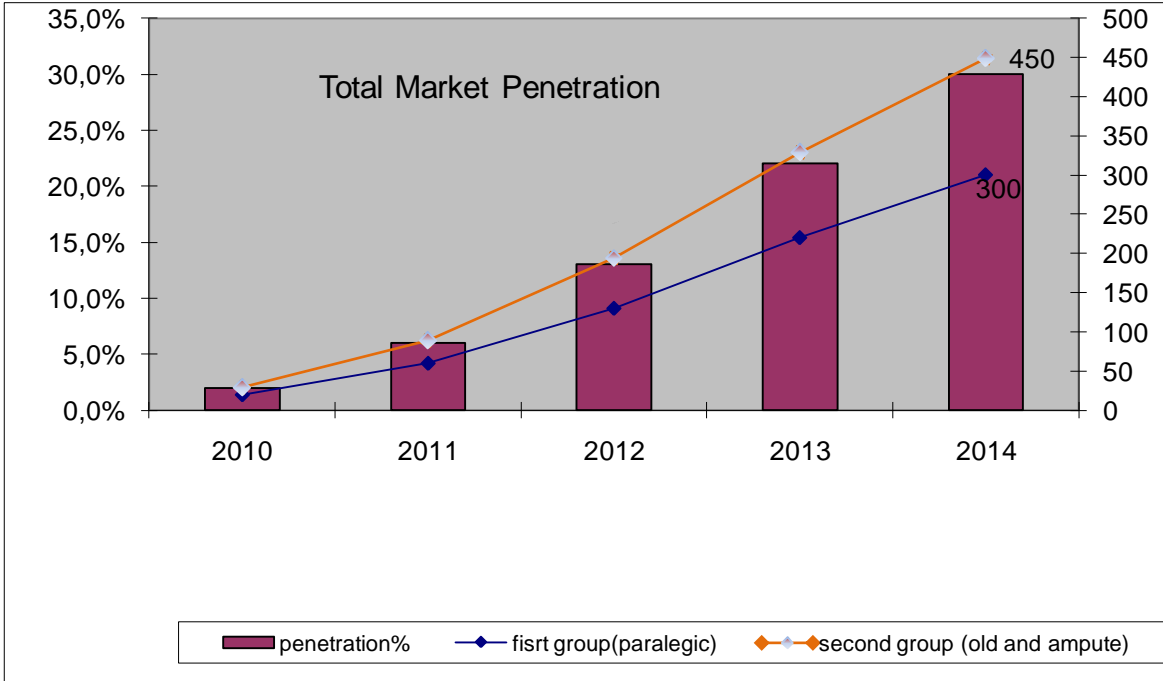
Market Price 1	15000	15000	15000	15000	15000
Market Price 2	15000	15000	15000	15000	15000
	2010	2011	2012	2013	2014
<u>Customer Group</u>					
Paraplegic	18	48	91	143	150
old people and amputated	24	67	136	214	225
1st estimate price	42	115	227	357	375



Here you can see the estimated sales-volume is increasing year by year



The graph below show the Total Market Penetration for the first estimation based on the two potentials group



## 8. The Product Life Cycle

The table above show the aspect of potentials user which are paraplegic are estimate to be 1,500 and in the long run 2/3 of the estimate potentials user are expect to buy the product which is estimate to be 1000 people.

Also the other beneficiaries like old people who are not be able to walk and those people which there legs was amputated was estimate to be 2250 and the 2/3 of them are expected to buy the product.

When the functionality of the design is being increase the product is going to be stagnancy for the first time but when the product is known in the market, the sales will be increase and later there would be a time the product is going to be drop down because of another new design in the market.

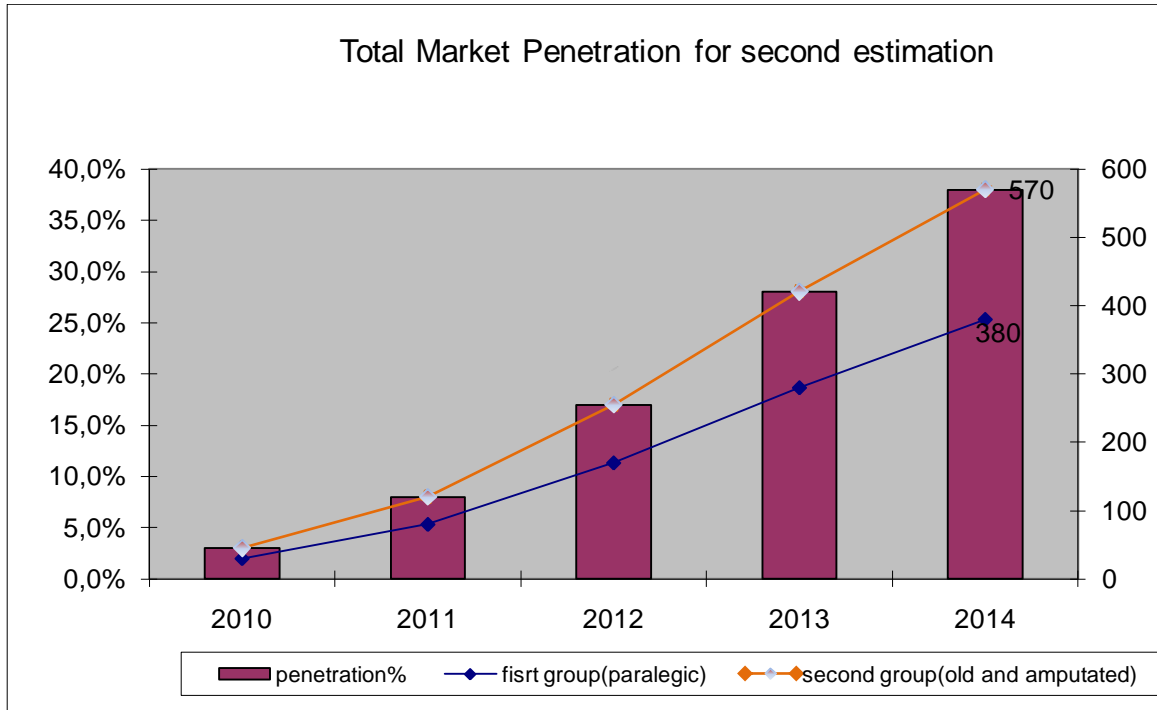
second estimate are based on the following assumptions:

	2010	2011	2012	2013	2014
No of Potential Customers 1	1,000	1,000	1,000	1,000	1,000
No of Potential Customers 2	1,500	1,500	1,500	1,500	1,500
Life Cycle Percentage 1	3.0%	5.0%	9.0%	11.0%	10.0%
Total Market Penetration 1	3.0%	8.0%	17.0%	28.0%	38.0%
Life Cycle Percentage 2	3.0%	5.0%	9.0%	11.0%	10.0%
Total Market Penetration 2	3.0%	8.0%	17.0%	28.0%	38.0%
Market Share 1	90.0%	80.0%	70.0%	65.0%	50.0%
Market Share 2	80.0%	75.0%	70.0%	65.0%	50.0%
Market Price 1	15000	15000	15000	15000	15000
Market Price 2	15000	15000	15000	15000	15000
	2010	2011	2012	2013	2014
<u>Customer Group</u>					
paraplegic	27	64	119	182	190
old people and amputated	36	90	178	273	285

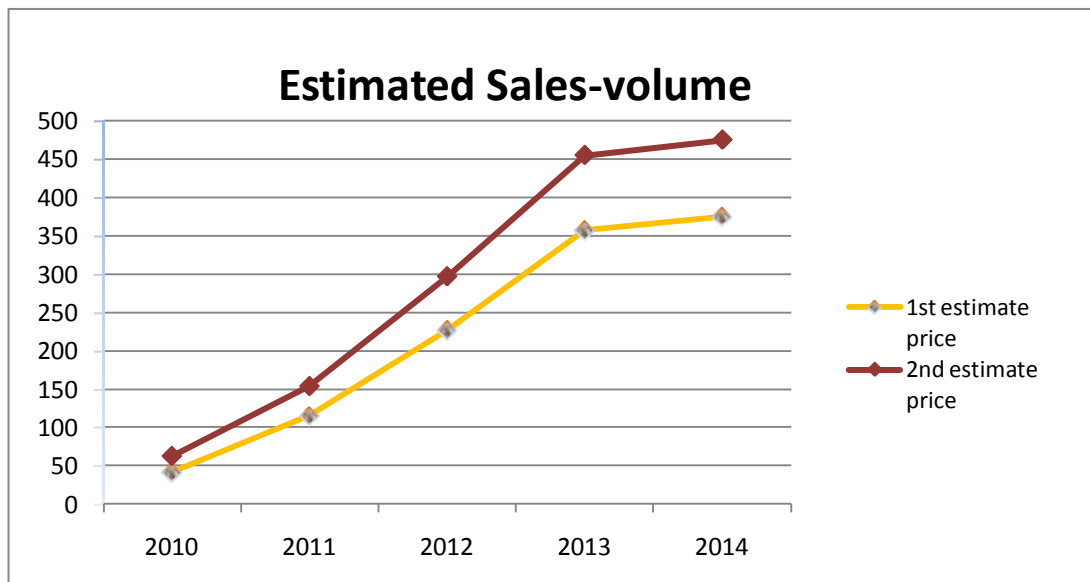
2st estimate price

63 154 297 455 475

The graph show the Total Market penetration for second estimate based on assumption of the two potentials group



The graph below show the estimated sales volume for first and second estimation for the two potential group

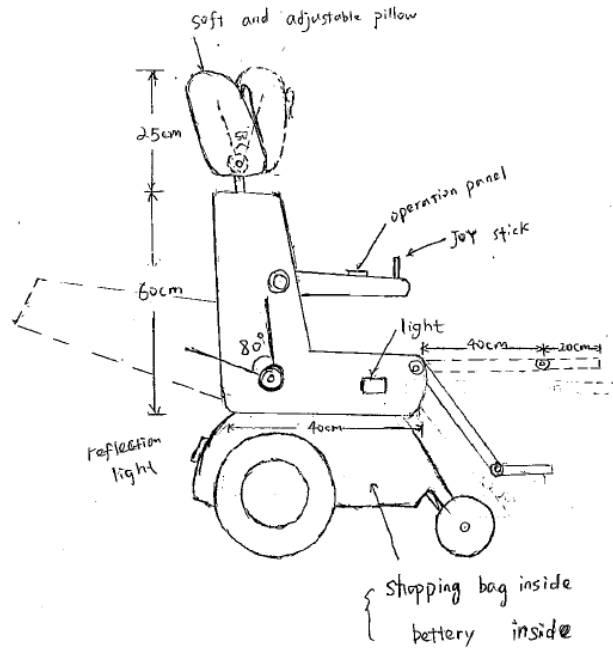


When the assumption remain on the number of the potential group, but the life cycle percentage of the design and the total market penetration is increase the estimated sale volume is increase, it show that the more the percentage of the market penetration increase the more the estimated sale volume increase.

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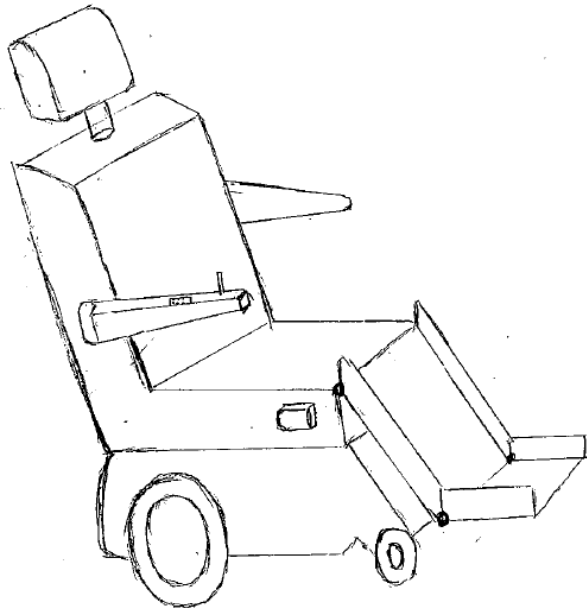
## 9. Component design

Blue print for the design



the Technic attribute to users' requirements

- wheels
- Electric
- Adjustable Seat
- Joy stick
- operation panel
- Arm rest
- feet support
- Shopping bag
- bell
- Light and reflection light
- soft and adjustable pillow
- warm seat



The material for different part

the seat, back, head rest : leather.  
 advantage: easy to clean, keep warm, can be keep for a long time.

hand rest, feet support : Al Alloy  
 advantage: firmly

wheel: rubber tyre  
 advantage: protect, from jolt  
 can be fit for different situation

The bone of the frame: Al Alloy  
 advantage: firmly.

## 9.1 Components design

### Material selection

The different components in the design play a different roll. So I have different material for this wheel chair

The material for different parts:

1. Seat.....leather  
[leather factory](#)

It is easy to clean by using leather as the material for the seat. it is comfortable and good **ventilation property** for the customers.

2. Bone structure.....aluminum alloy

Safety first, so I choose high strength aluminum alloy. It lights the weight in the whole system for its property. The outside condition will also do little effect to the design for its corrosion resistant. That is what we need.

[London metal exchange](#)

3. Tire.....rubber of course

We all use rubber as the material for the tire. But we can choose different type of the tire in different season especially in Finland.

[Rubber](#)

Energy source: battery (rechargeable)

Purpose: support to drive for driven wheel (2 back wheels)

Light,

Bell

Warm seat

Electric folding seat

Joy stick

Operation panel



A storage battery

Principle :electrolysis 22%-28% H<sub>2</sub>SO<sub>4</sub>

36V 20A

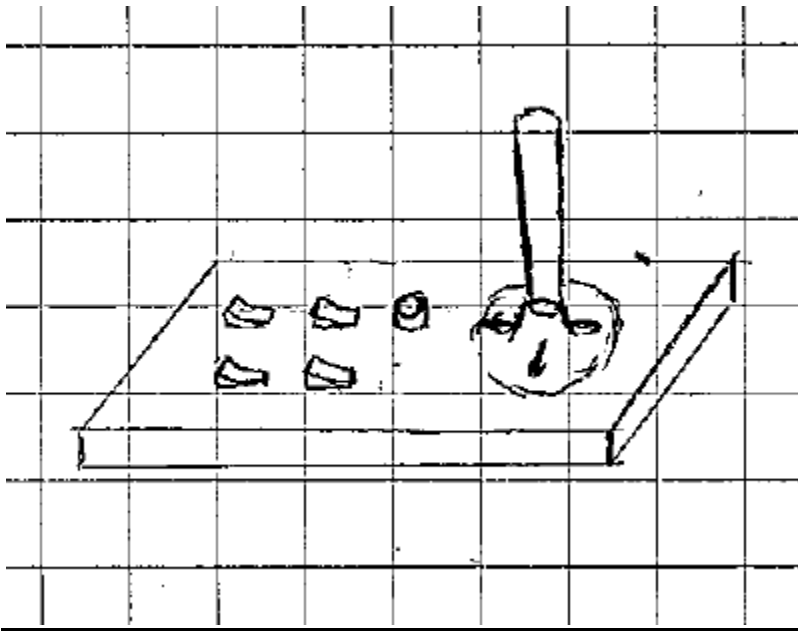
Charging time: 4-5h

Can drive 40miles way

[Battery University](http://Battery University)

## Joy stick and operation panel

Purpose: easy to operate



joy stick for driving

light switch

bell button

warm seat switch

adjustable seat switch

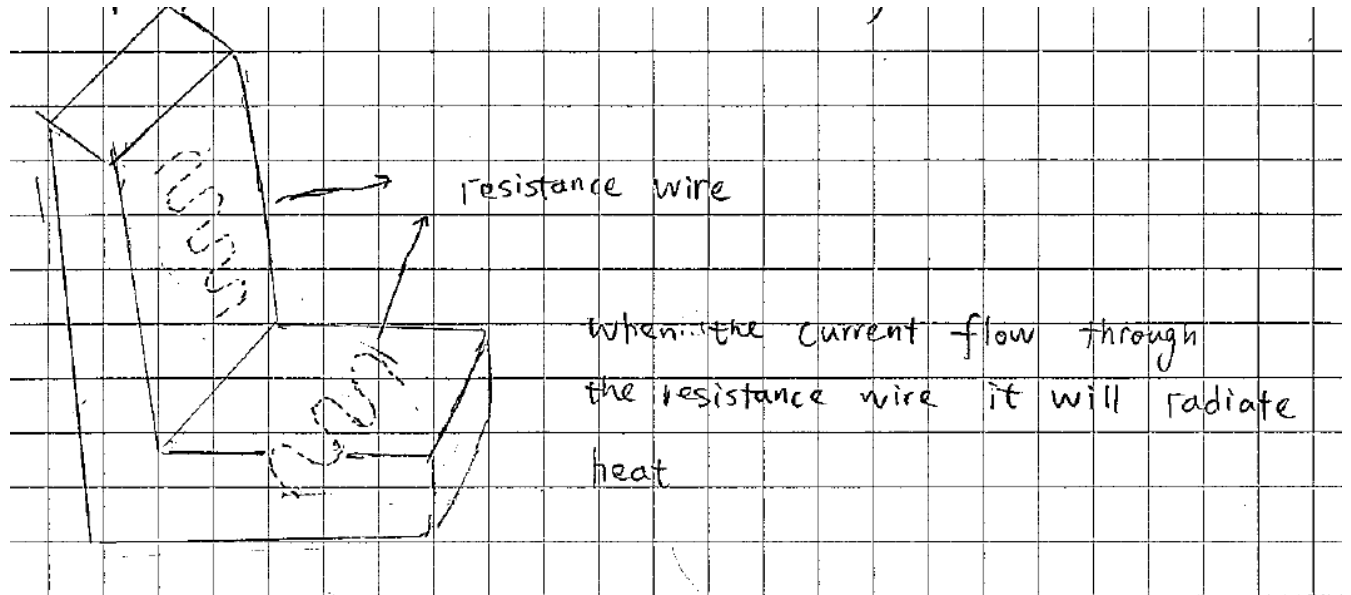
adjustable head rest switch

[Computer hope](#)



## warm seat

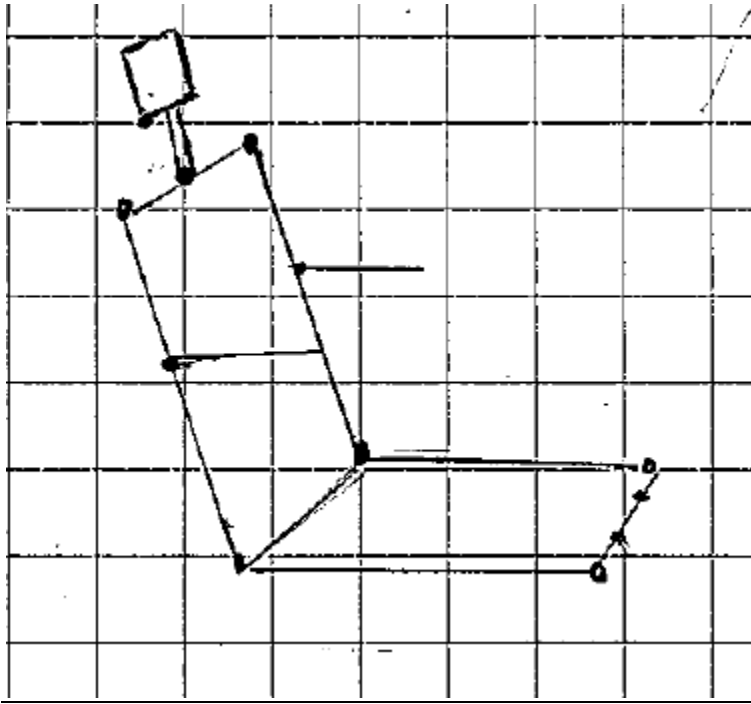
purpose: warm your seat



When the current flow through the resistance wire it will radiate heat

[Warm seat](#)

The bone for the frame



## 10. Future design

I suppose that we can have high quality material which can be light and firmly

And we also use renewable energy as power source such as solar



[Future wheel chair](#)

## 11. Conclusion

In this project I am trying to find out the most right and suitable wheelchair for different level of paraplegic and amputated. In the project I have faced many questions like power source, material selection, marketing promotion, function part future design and so on. I have to handle all of those and made my design. In this process I have learned much more than the project itself. The ability of find out the question and solve it. The ability of solve it in many ways. with the remarkable improvement of people's living standard, advanced science and technology are required more and more. As a modern student, you have to get the message from all kind channels but only in the classroom from teacher. Just like the idea of the heat seat in my design, the idea knock my mind when I saw a advertisement of Toyota. They got heat seat in car, so I think whether I can transplant the idea into my wheelchair. So the idea is everywhere, you have to find it yourself.

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