Auxiliary office chair

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Bachelor Thesis Programme Innovation and Product Design

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Tutor (company):
Tutor (university): Ragnar Tengstrand
 Examiner: Rolf Lövgren
Abstract

The aim of this project is to develop an auxiliary office chair, which favorably will compete with the existing chairs on the market. Evolutions of ergonomical survey in the work environment and on the configuration of offices require new products which fulfill the requirements properly. In order to achieve it a survey about office chairs has been carried out: types, characteristics, ways of usage and products on the market besides a large antropometrical study and ergonomics related to work area study. The result is an auxillary office chair which improves significatively in ergonomics compared with such chairs found in the market survey. Moreover it is achieved a great improvement refering to apilability stackable characteristics and manufacturing, as this chair has good features as easily cleanning and innovative aesthetics and no high manufacturing cost. That means an easily marketed product.
Acknowledgements

To José Antonio Pascual, Maria Teresa Osés, Irene Pascual Osés, Luis Sangrós, Elena Campo, Ignacio Serrano.
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1. **Introduction**

Nowadays, office work is undergoing a development due to new technologies and changes in office work’s organisation and nature.

These changes lead to new user needs that demand new requirements for office furniture.

This new requirements can be met by redesigning existing products in the market, as an ergonomic adapted chair for the user.

Another way to get this adaptation is by developing new products that satisfy new required needs.

2. **Aim of the project**

The aim of that project is try to design an office chair adapted to nowadays requirements in office works, getting a functional, adapted for law, innovative and competent product.

So I would like to focus on the guest chair, those ones that are used in conference rooms or in private offices for a guest. It should be an extra chair for using only in certain occasions, for instance in a meeting where a lots of guests are coming.

3. **Project directives**

To get the aim of that project described before many different surveys should be carried out.

The first one is about office chair, a description of the main and secondary functions and components that constituted them. In short, detailed descriptions of an office chair.

Of course, to develop a product which would be in touch with users, dimensions and physical limitations should be considered, therefore a ergonomic study should be done.

To know how an office chair should be, it should be known in which kind of environment is going to be used and which are their requeriments.
Furthermore, we have to know how is the work in an office, how a employee behaviour in everyday life. That means which activities the employees do more often and how the chair could adapt to them.

On the other hand, considering the significance esthetic character of that kind of product in companies’ corporative imagen, some researches about Kansei engineering could be really useful.

4. Problem statement

4.1.- General description

Auxiliary office chair, for such new offices that are being developed nowadays, where in a common area every employee has his own working table. Those environments usually are too small, so a good chair should take up little room.

Being auxiliary involves being supplement in specials occasions as meetings in conference rooms or in director’s private office.

As this chair is not for using during long time but for sporadic ones, it does not need so many adjustsables parts as chairs used by employees.

<table>
<thead>
<tr>
<th>Technical features</th>
<th>Height:</th>
<th>400 – 530 mm</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Width:</td>
<td>430</td>
</tr>
<tr>
<td></td>
<td>Adjustable mechanism:</td>
<td>No</td>
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<td></td>
<td>Back:</td>
<td>No indispensable</td>
</tr>
<tr>
<td></td>
<td>Arm-rest:</td>
<td>No indispensable</td>
</tr>
<tr>
<td></td>
<td>Base:</td>
<td>Both possibilities: Wheels/no-Wheels</td>
</tr>
</tbody>
</table>
4.2.- Product structure

This product is constituted for many parts: seat, base, back, mechanism and arm-rest.

**Seat.**- This is the part where the user sits, it should be quilted with foam and covered with some textile material, in order to provide the user as much comfort as possible. It’s one of the parts more in contact with the user, so ergonomics should be taken into account in that part of the chair.

**Base.**- Convencional chair’s bases usually have five wheels in order to let the user moving around. Auxiliary chair does not need so many movility during using but it needs during the movement from one place to another. So, that chair may have wheels or do not, depending on the development in the design of the chair.

**Back.**- This case is the same that the base’s one. The chair has back part or does not depending on the development in design of the chair. In the case it has back, it should be ergonomic, adapted to user but not with so many adjustable possibilities as the conventional chairs.

**Adjustable mechanism.**- These height and tilt adjustable mechanism of the chair are not indispensable for that kind of chairs.

**Arm - rest.**- This component, as back, it is not indispensable, but if the chair has them, they should be ergonomics.

- All chair’s components should have some aesthetic consistency.
- Chair’s aesthetics should be according to the office’s aesthetics.
- The product should be understood like a chair by the user, it means when the employee sees it, he has to know what is that, what it is used for, and how to use it.
4.3.- Ergonomics. Analysis of use

4.3.1. Stated practical use

- Base shape provides good support for the feet.
- Formal design let user to place the whole body properly.
- Compact whole chair, to take the less space as possible and annoy the less in the office.
- Security system to not move it freely.
- Adjusted handles easy to reach and handle
- Easy to carry from one room to another.

4.3.2. Ergonomical features. Use cycle

Sequence of use of a auxiliar office chair begins going to the furniture shop to buy it and transporting it to the place where is going to be used. Then it should be stored in an appropriate place, awaiting for being used in some meeting.

When the chair is needed it should be transported from where it is stored to the place is going to be used, that means go upstairs or downstairs, go through doors, steps,... So that has to be taken into account during the designing process.

Once the chair has been transported the user sits down on it, it might be possible to adjust certain parameters in order to adapt it to his/her anatomy. During the meeting, the user might need some movility. When the meeting has ended the chair is taken back to the storage place where it will stay until next use. Cleanliness has to be easy and simple and repairs should be as simple as possible.
4.3.3. Interface man-machine

- Chair should be understood as a chair and each single part of it should be clear.

- Levers or drivers have to be easy to catched and drive; besides their use has to be recognizable.

- As this chair is going to be transported very often, it should be low weight and easy to carry, that problem could be solved with some handle or by the own shape of the chair.

- Possibility of some different heights of the seat to be adaptable to a wide range of users.

- Differents parts of the chair made in different materials could be in different colors to distinguish each part properly.

- The shape of the seat and the back should provide a seat where the user keeps the back and all the body in a proper position.

4.3.4 Physical comfort

While transporting the chair, possibility of carrying it should be avoid since it mean hazard of injuries. So it should be sliding by wheels or make it light enough to be carried. Furthermore, during the transporting back’s user should be straight up, avoiding bend it excessively.

During using position, sitting, chair should provide a normal posture to the spine, let it be in an active position and avoiding hunch forward. Also, user’s shoulder should be straight and the user should be able to step on the floor easily.

4.3.5 Antropometrics

User’s corporal dimension

The user is a man or a woman from 18 to 65 years old who will spend from 10 minutes to 6 hours (long meeting) sitting on the chair. This ergonomical chart indicates the different body dimensions of men and women. These data help to adapted the chair to the user’s body. (figure 4.01)
<table>
<thead>
<tr>
<th>Dimensions</th>
<th>MEN</th>
<th>WOMEN</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Percentil</td>
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<tr>
<td>Height</td>
<td>5 50 95</td>
<td>5 50 95</td>
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<tr>
<td>Eyes height</td>
<td>850 910 970</td>
<td>810 860 910</td>
</tr>
<tr>
<td>Shoulders height</td>
<td>735 795 855</td>
<td>700 750 800</td>
</tr>
<tr>
<td>Elbow height</td>
<td>570 620 670</td>
<td>535 580 625</td>
</tr>
<tr>
<td>Thigh width</td>
<td>190 240 290</td>
<td>185 230 275</td>
</tr>
<tr>
<td>Sacro-rotula distance</td>
<td>150 180 210</td>
<td>135 165 195</td>
</tr>
<tr>
<td>Poplitea distance</td>
<td>550 595 640</td>
<td>520 565 610</td>
</tr>
<tr>
<td>Kneel height</td>
<td>435 480 525</td>
<td>415 460 505</td>
</tr>
<tr>
<td>Poplitea height</td>
<td>485 530 575</td>
<td>455 495 435</td>
</tr>
<tr>
<td>Bideltoida weidth</td>
<td>385 425 465</td>
<td>350 390 430</td>
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<tr>
<td>Biaacromal weidth</td>
<td>425 470 515</td>
<td>380 425 470</td>
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<tr>
<td>Hip weidth</td>
<td>360 395 430</td>
<td>325 355 385</td>
</tr>
<tr>
<td>Pectoral weidth</td>
<td>330 370 410</td>
<td>330 380 430</td>
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<tr>
<td>Abdominal weidth</td>
<td>210 245 280</td>
<td>205 250 295</td>
</tr>
<tr>
<td>Shoulder-elbow distance</td>
<td>220 270 320</td>
<td>205 255 305</td>
</tr>
<tr>
<td>Elbow-fingers distance</td>
<td>325 360 395</td>
<td>300 330 360</td>
</tr>
<tr>
<td>Maxium arm reach</td>
<td>435 470 505</td>
<td>395 425 455</td>
</tr>
<tr>
<td>Shoulder-knuckle distance</td>
<td>710 770 830</td>
<td>650 705 760</td>
</tr>
<tr>
<td></td>
<td>600 655 710</td>
<td>550 600 650</td>
</tr>
</tbody>
</table>

Figure 4.01
4.3.6 Confort, perception and information process.

Visual perception

Both color and reflection factor are important in office work since they affect in employee’s mood and capacity to work. For instance, reflection factor causes visual fatigue. Above, a chart shows the reflection factor of each color. (figure 4.02)

<table>
<thead>
<tr>
<th>Color</th>
<th>Reflection factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>100</td>
</tr>
<tr>
<td>Ivory, lemon yellow</td>
<td>80 – 85</td>
</tr>
<tr>
<td>Bright yellow, light ochre, light green, pale pink, cream</td>
<td>60 – 65</td>
</tr>
<tr>
<td>Green, pale grey, orange, blue-grey.</td>
<td>50 – 55</td>
</tr>
<tr>
<td>Red, green, olive green</td>
<td>20 – 25</td>
</tr>
<tr>
<td>Dark blue, purple, grey</td>
<td>10 – 15</td>
</tr>
<tr>
<td>Dark</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 4.02

Therefore, apropiate colors for the chair could be these ones between 60 and 10 reflection factor.

4.3.7 Psychological comfort

- Chair’s morphology and color should communicate how the office is, in that case it would be interesting try to communicate modernity, functionality and comfort.

- Chair’s morphology should be nice for the employee, not aggressive shapes.

- Chair’s aesthetics should be in armony with the rest of the furniture in the office.

- If there is some kind of controls to adjust the height it should be easy to memorize.
4.3.8 *Product communication*

The chair has to transmit the corporate image of the company or office where is going to be used. Furthermore, it should transmit modernity, as it is a new concept of product, but also communicate functionality and comfort. Aesthetics of that product should be able to adapt with any kind of environments: office area, private office, conference rooms, conventional offices, modern offices, old offices and so on.

4.4 *Product quality. Reliability*

4.4.1 *Product quality level.*

This is not a high class chair, but a practical and affordable chair which takes priority in functionality and simplicity for any kind of office. That does not mean that the chair is a low quality one, a medium quality chair is tried to be achieved, made of materials agreement with the user’s environment.

4.4.2 *Reliability*

The chair should have some security device: An accidental movement of the chair should be avoided; the chair can not begin to roll away if the user does not want to. Furthermore stability is an important point achieve, it should not turn over when someone sits in the extrem edge. Holes between the different parts and components should be small enough to not be able to stuck a finger there and big enough to put a finger inside and be able to get it out.

4.4.3 *Security and protection*

- A risk associated to this kind of product is that it can move accidentally. So in the case it has wheels, it should has also a security system to avoid it to move freely.

- Corners and projecting parts should be avoided in order to not injure the users.

- Edge should be made around.
- Holes and nooks should be avoided as much as possible. If there is any one it should be small enough to not fit a finger or big enough to can put a finger on it and take it out easily.

- The chair’s measures should fit with body user’s measures to avoid possible spine pain.

- The material seat should not be slippery.

- When a heavy weight is on the edge of the seat, the chair should have balance enough to not turn over.

4.4.4 Hygiene and healthy in the work

There is certain kind of injuries related to bad sitting postures, or due to wrong chair design. Some of them are:

Cifosis: That disease makes you spine get curved and some parts lost the whole or certain ability to move to inside. Its symptoms are back pain, fatigue, curve looked and breathing difficulties.

Escoliosis: It is an alteration of the spine characterized by a curvature of the spine, in lateral or longitudinal way. Its symptoms are no same level shoulders, prominent ribs, raised hip, lateral stoop and cronical back pain.

Pain in the neck: Related to tourned, flexed or streched neck postures.

Pain in shoulder and upper back: Related to efforts in waist musculature. It’s caused by chair without arm –rest (while long periods using it) or too tall tables.

So the solutions for solving those healthy problems come through introducing concepts as postural movility, posibility of adjusting to different users and adjusting to different activities.

- Furthermore, there’s some kind of compulsory regulations for office furniture. (Real Decreto 488/1997)
- There’s some other regulations, not compulsory but also important, to improve the ergonomic and the healthy care of these chairs.

UNE-EN 1335-1

UNE-EN 13761

4.4.5 Work place

- The places where the product is going to be used are in offices both in conference rooms and in personal offices.

- That involves that the product is going to interact with other product used in office as: table, computer, lights, keyboards and all the space around. So, for designing this chair all that products and their measures should be take on account.

- In one office there is used to be more than one person working, that means that there would be two or more people interacting in the same area.

- In some offices, the employees have to get up, sit down and move around really often.

- As computers and other kinds of electrical devices are used in office, sometimes wires can be on the floor.

4.4.6 Legality

Some regulation related to chair design:

- Chair’s functional characteristics and dimensions:

  UNE-EN 1335-1

  UNE-EN ISO 9241-5

- Chair’s material:

  UNE-EN ISO 9241-5
• Chair’s safety

UNE-EN 1335-2
UNE-EN 1335-3

• Accessories

UNE-EN ISO 9241-5

• Adaptation for disabled persons

IBV, 1995

• Ecology

ICLEI, 200

4.4.7 Environment

- Using chairs does not involve any kind of environmental pollution but manufacturing them does.

- Plastics used should be biodegradable, reusable or easily recycled.

- When it comes to throw away the product, it could be separated in many different parts, it helps in the recycling process.

  - Seat: Plastic, recyclable.

  - Back: Plastic part, recyclable

  Foam part, recyclable

  - Wheels: reusable

  - Base: Metal, recyclable

  - Mechanism and gas lift: reusable

  - Arm-rest: Plastic, recyclable
4.5 Product communication

4.5.1 Function communication. Product identification

That product should be a whole unity with the structure of a chair: seat, base and back (if it is necessary), so any user could identify it as a chair. The different components have their own shape, colour, material and texture which make them different from the others, and identify their own function.

If the chair has some kind of shape or handle to move it from one place to another it should be clearly identify how to hold it and drive it.

In the case of retractable chair how to assemble it should be clear and intuitive, besides being as easy as possible, to get it with the less movements as possible.

4.6 Maintenance. Spare part.

The maintenance of that kind of product is really easy to deal with as they do not have any kind of electrical device. The maintenance of that chair is to keep it clean, so it should be cleaned around once each week with wet clothes. Also the adjustable mechanism should fit to work, so it should be checked once a year, or as soon the user noticed something wrong on it. If there is some problem with the wheels, the user can change them easily, just adjusting some nails. If there is some problem with the seat or the back is more difficult to solve it, as the user has to change the whole piece and it has to be made by a specialist.

5. Project limitations

The imposed project limitations are:

- The thesis work is limited 10 weeks time in total.

- The project will be a chair’s proposal. It will be limited to auxiliary chair.
- It will be presented in 3D-CAD model and in physical model.
- There is no any kind of material limitations
- The proposal solution should be able to manufacturing in a near future.
- Manufacturing and assembly costs will be estimated compared with the market survey.
Figure 5.01. Planning chart
6. Theoretical background and solutions methods

6.1 Office chair description

A chair is a piece of furniture for sitting, made up with a seat, a back, and some legs to support the seat raised above the floor, commonly use by one person. (figure 6.01)

Office chair are these ones to use specifically in office, or while doing some office work, so they should be adapted to that specific enviroment. To achieve that purpose chairs have adjustable arm rests, seats, and back. Furthermore, some of them have wheels in order to get some mobility.

![Office chair](image_url)

Figure 6.01. Office chair
### 6.2 Office chair functions

<table>
<thead>
<tr>
<th>Kinds</th>
<th>Main function</th>
<th>Secondary functions</th>
<th>Technical characteristics</th>
<th>Users</th>
<th>Environment</th>
<th>Components</th>
<th>Trades</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Office chair</td>
<td>- Provide a seat</td>
<td>Ergonomics</td>
<td>Adjustable, Revolving, Inclination back, Seat height, Seat depth, Back depth, Back height, Arm-rest height, Enfolding quilt</td>
<td>- Director</td>
<td>- Office</td>
<td>- Seat, Seat depth control mechanism, Gas lift, Wheels, Base, Back part, Adjustable arm-rest/no-adjustable arm-rest</td>
<td>- EFG</td>
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<td>- Guest chair</td>
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<td>- High adjustable arm – rest</td>
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<td>- Technical experts</td>
<td>- Open office</td>
<td>- Administrative, Customer service, Guests</td>
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<td>- High adjustable seat</td>
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<td>- Administrative</td>
<td>- Conference room</td>
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<td>- Vandersluis</td>
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Figure 6.02. Office chair functions
6.3 Kinds of chairs (requirements of each one):

There are two kinds of office chairs.

**Office chair**

It is used in every day life at offices. Used for all workers at the office, should be totally adapted to duties they hold since they spend almost the whole working day sit. In order to achieve it, many chair’s parts should be adjustable for a wide range of users.

That kind of chairs can be divided depending on user’s charge, because each one has specific needs:

- *Director.*- Associated activities imply study and analysis duties as well as private meetings and less computer use than lower charges. So these charges demand more mental improvement than physical ones.

  Figure 6. 03. Director’s office chair

- *Technical expert.*- They develop task that imply certain level of autonomy and intellectual charges, besides study and analysis duties. In that case are not so important comunication and relation activities but computer ones. In conclusion, that chairs need more ergonomic charge and they should help to favoured mobility and posture changes.

  Figure 6. 04. Director’s office chair
• **Administrative.**- They have no so many creative activities but more of that ones specific procedures, so that means they do not need as much autonomy as the technical experts. To know that they use the computer as much as paper documentation should be acknowledged. *(figure 6.05)*

![Figure 6.05. Administrative’s office chair](image)

• **Customer service.**- That position imply dealing with customer face to face, entered and receive information, answer the phone and so on. *(figure 6.06)*

![Figure 6.06. Customer services’ office chair](image)
<table>
<thead>
<tr>
<th>CHARGE</th>
<th>TASK’S CHARACTERISTICS</th>
<th>OFFICE CHAIR REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director</td>
<td>• High autonomy&lt;br&gt;• High communication and relation level&lt;br&gt;• Less use of computer but more of paper documents&lt;br&gt;• Mental aspects more important than physical aspects</td>
<td>• Symbolic corporate imagine value&lt;br&gt;• High back chairs, no renouncing to ergonomics aspects.</td>
</tr>
<tr>
<td>Technical expert</td>
<td>• Creative task with intellectual charge.&lt;br&gt;• No so many communication requirements&lt;br&gt;• Intensive computer work&lt;br&gt;• Postural charge position</td>
<td>• To help to get mobility and postures change.&lt;br&gt;• Adjustable parts to adapt any user.&lt;br&gt;• High-medium back&lt;br&gt;• Wide and high adjustable arm rest&lt;br&gt;• Compatible with the usage of computers</td>
</tr>
<tr>
<td>Administrative</td>
<td>• Mechanical task, no much autonomy.&lt;br&gt;• Versatility: many different activities&lt;br&gt;• Intermediate levels of postural charge and specific functional needs</td>
<td>• To help to get mobility and postures change.&lt;br&gt;• Versatile chairs</td>
</tr>
<tr>
<td>Customer service</td>
<td>• Many different tasks dealing with customers&lt;br&gt;• High physical charge</td>
<td>• Posture mobility&lt;br&gt;• Mind the high of the table</td>
</tr>
</tbody>
</table>

Figure 6.07. Tasks characteristics and requirements for different types of office chair.

Guest chair

This kind of chair is used for the guest in an office and for meetings. (figure 6.08)

This chair should not be as adjustable and adapted to the user as the office chair as they are not used during all day, just for short periods of time. However nowadays
guest chairs are becoming more and more completed, almost as adapted to user as office chair.

This chairs should follow the same aesthetic line as office ones.

Figure. 6.08. Guest office chair

6.4 Chair functions

Main function.- Provide a seat

Other functions.- Ergonomics

- High adjustable arm – rest
- High adjustable seat
- High adjustable back
- Back angle control
- Company corporative imagen
- Match with the rest of the furniture
- Cleaning
6.5 Chair components

Figure 6.09. Office chair’s components
<table>
<thead>
<tr>
<th>Component</th>
<th>Function</th>
<th>Interaction with others</th>
<th>Interaction with user</th>
<th>How to active</th>
<th>Material</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seat</td>
<td>Hold the user and to be adapted to his body. Contribute to chair’s aesthetics</td>
<td>It’s the main part of the chair, it holds the back, the arm-rest and the mechanism.</td>
<td>Users sit in it.</td>
<td></td>
<td>Textil, plastic and foam</td>
<td></td>
</tr>
<tr>
<td>Seat depth control mechanism</td>
<td>Regulate how high the seat should be</td>
<td>It hold the seat and it’s hold by the gas lift and the base</td>
<td>User use it to regulate seat’s high</td>
<td>Pressing or rolling the bottoms</td>
<td>Metal</td>
<td></td>
</tr>
<tr>
<td>Gas Lift</td>
<td>Rise the chair’s seat</td>
<td>It’s link to the back part of the seat and to the base</td>
<td>No interaction</td>
<td>When you seat on the chair and active the mecanism</td>
<td>Metal</td>
<td><img src="image" alt="Gas Lift" /></td>
</tr>
<tr>
<td>Wheels</td>
<td>Let mobility to the user</td>
<td>Link to the base</td>
<td>No interaction</td>
<td>When you push the chair it moves</td>
<td>Plastic</td>
<td><img src="image" alt="Wheels" /></td>
</tr>
<tr>
<td>Base</td>
<td>Hold chair and user’s weight.. Contribute to chair’s aesthetics</td>
<td>It houses the gas lift and the wheels</td>
<td>Just for cleaning. Sometimes it’s step by the user</td>
<td></td>
<td>Metal Plastic</td>
<td><img src="image" alt="Base" /></td>
</tr>
<tr>
<td>Component Type</td>
<td>Function</td>
<td>Material</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back part</td>
<td>Hold user’s back and to be adapted to him. Contribute to chair’s aesthetics</td>
<td>Textil and plastic and foam</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjustable arm-rest/no-adjustable arm-rest</td>
<td>Hold user’s arm and contribute to chair’s aesthetics</td>
<td>Plastic, or plastic and metal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

User lean in it, and push the chair with it.

Users rest their arm on them. It could be adjustable, so the user decide how high he like it.

Figure 6.10. Chart of office chair’s components
6.6 Ergonomics

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standing position</strong></td>
<td><strong>Percentils</strong></td>
<td><strong>Percentils</strong></td>
</tr>
<tr>
<td>1. Height</td>
<td>1600</td>
<td>1715</td>
</tr>
<tr>
<td>2. Eyes’ height</td>
<td>1450</td>
<td>1560</td>
</tr>
<tr>
<td>3. Shoulder’s height</td>
<td>1300</td>
<td>1405</td>
</tr>
<tr>
<td>4. Elbow’s height</td>
<td>995</td>
<td>1080</td>
</tr>
<tr>
<td>5. Hip’s height</td>
<td>815</td>
<td>895</td>
</tr>
<tr>
<td>6. Knuckles’ height</td>
<td>680</td>
<td>745</td>
</tr>
<tr>
<td>7. Fingers’ height</td>
<td>580</td>
<td>645</td>
</tr>
</tbody>
</table>

Figure 6.11. General human dimensions

Dimension of the human body sitting:

8. Sitting height
9. Sitting eye’s height
10. Sitting shoulder’s height
11. Sitting elbow’s height
12. Thigh’s height
13. Sacro-rotula distance
14. Poplitea length
15. Knee’s height
16. Poplitea’s height
20. Chest’s height
21. Abdominal width

Figure 6.12. Body measures. Side 1.

Figure 6.13. Body measures. Side 2.
17. Shoulders width
18. Shoulders width
19. Hip width
27. Head width

Figure 6.14. Body measures. Back
<table>
<thead>
<tr>
<th>Dimensions</th>
<th>MEN</th>
<th></th>
<th>WOMEN</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percentil</td>
<td></td>
<td>Percentil</td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>5</td>
<td>50</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td>Eyes height</td>
<td>735</td>
<td>795</td>
<td>855</td>
<td>700</td>
</tr>
<tr>
<td>Shoulders height</td>
<td>570</td>
<td>620</td>
<td>670</td>
<td>535</td>
</tr>
<tr>
<td>Elbow height</td>
<td>190</td>
<td>240</td>
<td>290</td>
<td>185</td>
</tr>
<tr>
<td>Thigh weidth</td>
<td>150</td>
<td>180</td>
<td>210</td>
<td>135</td>
</tr>
<tr>
<td>Sacro-rotula distance</td>
<td>550</td>
<td>595</td>
<td>640</td>
<td>520</td>
</tr>
<tr>
<td>Poplitea distance</td>
<td>435</td>
<td>480</td>
<td>525</td>
<td>415</td>
</tr>
<tr>
<td>Knee height</td>
<td>485</td>
<td>530</td>
<td>575</td>
<td>455</td>
</tr>
<tr>
<td>Poplitea height</td>
<td>385</td>
<td>425</td>
<td>465</td>
<td>350</td>
</tr>
<tr>
<td>Bideltoidea weidth</td>
<td>425</td>
<td>470</td>
<td>515</td>
<td>380</td>
</tr>
<tr>
<td>Biacromal weidth</td>
<td>360</td>
<td>395</td>
<td>430</td>
<td>325</td>
</tr>
<tr>
<td>Hip weidth</td>
<td>330</td>
<td>370</td>
<td>410</td>
<td>330</td>
</tr>
<tr>
<td>Pectoral weidth</td>
<td>210</td>
<td>245</td>
<td>280</td>
<td>205</td>
</tr>
<tr>
<td>Abdominal weidth</td>
<td>220</td>
<td>270</td>
<td>320</td>
<td>205</td>
</tr>
<tr>
<td>Shoulder-elbow distance</td>
<td>325</td>
<td>360</td>
<td>395</td>
<td>300</td>
</tr>
<tr>
<td>Elbow-fingers distance</td>
<td>435</td>
<td>470</td>
<td>505</td>
<td>395</td>
</tr>
<tr>
<td>Maxium arm reach</td>
<td>710</td>
<td>770</td>
<td>830</td>
<td>650</td>
</tr>
<tr>
<td>Shoulder-knuckle distance</td>
<td>600</td>
<td>655</td>
<td>710</td>
<td>550</td>
</tr>
</tbody>
</table>

Figure 6.15 Body dimensions chart
6.6.1 Ergonomics at the office

Figure 6.16. Dimensions in a office 1.

Figure 6.17. Dimensions working in a office related to guests.
Antropometric considerations to take in account during the design and plan of the office space. (figure 6.16)

Work area should be spaciousness enough to house documentation, equipment and accessories needed in order to carry out the work assigned to the employee. As it is showed in the picture, the work-area dimension would be over 76 cm and it would be limited by computer needs.

Guest chair area ranges in depth from 76,2 cm to 106,7 cm. (figure 6.18) In order to calculate it, the designer use buttock-knee distance and toetip – knee distance of the biggest users is going to be considered. (figure 6.17)

If the table work has projecting part o the frontal panel is further than the edge of the table guest area can be reduced thanks to the extra space get. These dimensions could change depending on the kind of chair.

<table>
<thead>
<tr>
<th></th>
<th>cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>228’6 – 320</td>
</tr>
<tr>
<td>B</td>
<td>76’2 – 91’4</td>
</tr>
<tr>
<td>C</td>
<td>76’2 – 121’9</td>
</tr>
<tr>
<td>D</td>
<td>15’2 – 30’5</td>
</tr>
<tr>
<td>E</td>
<td>152’4 – 182’9</td>
</tr>
<tr>
<td>F</td>
<td>76’2 – 106’9</td>
</tr>
<tr>
<td>G</td>
<td>35’6 – 45’7</td>
</tr>
<tr>
<td>H</td>
<td>40’6 – 50’8</td>
</tr>
<tr>
<td>I</td>
<td>45’7 – 55’9</td>
</tr>
<tr>
<td>J</td>
<td>45’7 – 61</td>
</tr>
<tr>
<td>K</td>
<td>15’2 – 61</td>
</tr>
<tr>
<td>L</td>
<td>152’4 – 213’4</td>
</tr>
<tr>
<td>M</td>
<td>61 – 76’2</td>
</tr>
<tr>
<td>N</td>
<td>73’7 – 76’2</td>
</tr>
<tr>
<td>O</td>
<td>38’1 – 45’7</td>
</tr>
</tbody>
</table>

Figure 6.18 . Dimensions in office chart

Pictures below (figure 6.19 and 6.20) show the main antropometric considerations for men and women sit on their office next an auxiliary furniture. Seat height is really important and its regarding to activity runned in each module. Drecrearing height of the
work surface involves that the designer should take on account thigh spaces. This furniture assigned on this kind of work combine their dimensions with the antropometric female user requeriments.

Figure 6.19. Men working in a office around auxiliary furniture.

Figure 6.20. Women working in a office around auxiliary furniture.

Work area and seat in the picture below (figure 6.21) consist of the user, not matter which sex, turn over 180° without difficulties and reach the filling cabinet on his back. If the minimum space is not the right one reaching the filling cabinet dulls and body has to take uncomfortable postures. The total minimum dimension that fit the module is 238’8 cm.
Besides turning space and reaching files an area behind the chair should be fitted out to can go through it, it is called circulation area. This area’s limits would be defined by analysing movements and invasion of the chair in its own space, in order to not block the crossing to other employees.

The minimum able space that guarantee free crossing is the same as the maximum width body measure of the biggest user. The minimum crossing dimension for just one person should be over 76’2 cm.

![Figure 6.21. Working module with back filling cabinet](image)

The crossing and sitting areas will fit the maximum body width and buttocks-toetips distance of the biggest user. In the picture below we can see that the sitting area for guests is 61 – 76’1cm. If the designer gives extra space from knee to the table edge between 15’5 to 30 cm the total dimension became 76’2 to 106’7 cm. That involves that the guest will not move the chair behind either when he arrives neither when he leaves. Instead of that, guest should move on the sides. We can see also that lackness of projecting area in the table create an awkward situation between guest and table, affecting in the private conversations.

Dimensions of circulations area is 91’4 cm.
6.7 Regulation

Here it’s a list of some requirable requirements.

• Chair’s functional characteristics and dimensions:

  UNE-EN 1335-1

  UNE-EN ISO 9241-5

• Chair’s material:

  UNE-EN ISO 9241-5

• Chair’s safety
6.8 Criteria to design a chair

Considering the chair deeply, it should be divided in several parts:

**Cushion:** That part of the chair is crucial to provide the user the comfort he needs.

- Anatomical shape that respect anthropometric measures.
- Non–sliding material.
- Waterproof cloth that avoid dirt go trough it.
- Cloth should be washable
- Cushion should be quilted.
- It should have some kind of ventilation system, and they do not have to fit in isquial protuberances location.

**Back:** That part is crucial too.
- The back should have the average regular shape of spine, taking account of the different kinds of raquis. (figure 6.23)
  
  A- Stressed curvature  
  B- Non stressed curvature  
  
- It should let the user have a break, change position  

Figure 6.23. Different kinds of raquis

- Angle between back and cushion depends on the task the user is doing. In general it is from $93^\circ$ to $97^\circ$.

- Back height varies depending on the task requeriments.

Legs: The base of the chair should have distributed supporting points, to make it more stable.

Arm – rest: They should be used just when they are needed as they sometimes became annoying during the use of the chair.

  - They should be quilted
  - Non – sliding material.
  - Waterproof cloth that avoid dirt go trough it.
  - Cloth should be washable
  - Cushion should be quilted.
  - It should has some kind of ventilation system, and they do not have to fit in isquial protuberances location.

Feet – rests: If there are feet – rests, it should be fixed under the cushion

Finally, to get a good design of a chair it should be known:
- Every workplace doesn’t need the same kind of chairs.

- Chair are not a decorative element, the main function is to get a seat. But in this case, where the chair says about the office where it is in, both seat and esthetics have to combine as good as possible.

6.9 Sequence of use

Buy the chair
Fit it on the office
Sit down on it
Adjust some measures
Stay sitting on it
Get up from it
Cleaning
Waiting time
Repairing
Discard

Conclusions

The first step of this sequence of use is buy the chair, this action is used be made by the boss, the purchase deparment but not for the employee, the one who is going to use it, clean it or do the maintenance. That means that the purchaser probably would not take on account preferences, likes and dislikes of the user.
That also affects the adjustment point, as the user probably is not going to read chair’s user guide, he will try how to use the handles and levers until he get the movement he wants.

Working in an office, employees use to go to get information to other office, move around their own offices, go to meetings, so the cycle use sit down, stay sitting and get up will be repeated several times in one day of use.

While waiting time the chair stays at its place in the office, next to the table or under it, in the case of auxiliary office chairs this is storage in another place.

6.10 Kinds of offices

Companies’ building and offices can be organized and structured in different ways:

**Hive:** That kind of office are used to task which take priority over individual work and really systematic. Communication between individuals is not important. That layout is found in administrative offices, customer services, banks and so on. *(figure 6.24)*

![Figure 6.24. Hive office](image_url)
**Cell:** Employees who work in that kind of office developing a high concentration work. In these cells work function is complemented by privaty meetings. This kinds of offices are directed to directive positions. (*figure 6.25*)

![Cell Office](image)

*Figure 6.25. Cell office*

**Conference room:** Communication between the team work is the most important characteristic in these areas, where they should get certain freedom in their movements.

![Conference Room](image)

*Figure 6.26. Conference room*

**Club:** Nowadays a new kind of office is developing and composing in company’s structure. Communication tasks between work team and concentration are tried to
compose in that area where teams met physically to work in multidisciplinary projects. That office is also known as CoCon.

![Figure 6.27. Club office](image)

**Conclusions**

Knowing all kinds of office it can be found in a company building, conference room and club are the ones where the idea of auxiliary office chair can fit better.

So functions of that chair should be thought to fit the characteristics that these areas require.
6.11 Market survey

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Sit-A-Round Ball Chair</th>
<th>Posture Chair with TEMPUR Material</th>
<th>Jobri Wood Accent Kneeling Chair</th>
<th>Freedom Saddle Seat</th>
<th>Swopper Chair</th>
<th>BackSaver Kneeling Posture Chair</th>
<th>WellBack Kneeling Posture Chair</th>
<th>Space chair</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIAL</td>
<td>Vinyl ball Pneumatic cylinder 5 stars base</td>
<td>Tempur material Viscoelastic, anti-allergenic</td>
<td>Tempur material Visco-elastic Wood</td>
<td>Steel grey 86% Visco-elastic anti-allergenic</td>
<td>Aluminium die casting Plastic injection Steel Foam material</td>
<td>-</td>
<td>Injection molded foam pads Steel</td>
<td>Air Grid back Black leather seat Steel</td>
</tr>
<tr>
<td>WHEELS</td>
<td>YES</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>DIMENSIONS</td>
<td>Height: 57cm to 66cm</td>
<td>Height: from 61cm to 75cm</td>
<td>Height: from 40,6 to 54,6 cm</td>
<td>Height: from 55,9 to 69,85 cm</td>
<td>Height: 89-102 cm</td>
<td>Width: 43 cm</td>
<td>Height: 111,7 cm Width: 69,9 cm</td>
<td></td>
</tr>
<tr>
<td>STORAGE</td>
<td>It can’t be piled up or folded</td>
<td>It can’t be piled up or folded</td>
<td>It can be folded</td>
<td>It can’t be piled up or folded</td>
<td>It can’t be piled up or folded</td>
<td>It can’t be piled up or folded</td>
<td>It can’t be piled up or folded</td>
<td>It can’t be piled up or folded</td>
</tr>
<tr>
<td>ERGONOMICS</td>
<td>release spinal pressure</td>
<td>strengthen muscles</td>
<td>encourage spinal alignment</td>
<td>increase circulation and energy</td>
<td>opens the angle between your thigh and the trunk straightening of your spinal column reducing the strain on discs and joints in your lumbar region swivel movement</td>
<td>Ideal for those who suffer from back, hip, prostate, or other lower torso discomforts while using traditional chairs.</td>
<td>Saddle posture lowering your thighs, opening up your hips and positioning your spine in a healthy lordotic curve reduces pressure points for long-term comfort</td>
<td>Prevents deconditioning of the spine. Provides relief from back pain. Strengthens and conditions back and abdomen improves posture and stabilization of the spine. Improves nourishment to the inter-vertebral disc. Improves circulation to the lower extremities.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>CLEANLINESS</strong></td>
<td>Simple</td>
<td>Simple, maybe difficulties</td>
<td>Some difficulties in the nooks</td>
<td>Simple, there are no nooks</td>
<td>Simple, there are no nooks</td>
<td>Simple, but too many different parts</td>
<td>Simple</td>
<td>Simple, the grid could be difficult to clean</td>
</tr>
<tr>
<td><strong>PRICE</strong></td>
<td>3150 SEK</td>
<td>3950 SEK</td>
<td>2590 SEK</td>
<td>2950 SEK</td>
<td>5990 SEK</td>
<td>2950 SEK</td>
<td>2900 SEK</td>
<td>3990 SEK</td>
</tr>
<tr>
<td><strong>WEIGHT CAPACITY</strong></td>
<td>170 Kg</td>
<td>127 Kg</td>
<td>130 Kg</td>
<td>124 Kg</td>
<td>127 Kg</td>
<td>135 Kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.28. Comparative of office chair in the market
Conclusions

After doing that comparative chart about all kind of products that carry out the function wanted to be covered, conclusions can be obtained about their commun characteristics and differences.

First of all, there are three kinds of chairs which carry out that function: regular office chair carried to the conference room or that are directly leave them there; ergonomic stool, which are used also as office chair and folding chair, which are stored easily. These ones are charcterized for not solving really good the ergonomic function. In general, office chairs are made of steel, plastic, foam or wood. Steel is used in the structural parts making the most of it characterist, resistence; back and seat casing are made of plastic as its characterists solve really good that function, cheap to manufacture and lightweight. Foam is used for the cushion because it is perfectly adapted to the body shapes and finally wood is used in structural parts, it is not the most usual, because it is expensive and heavy, but it depends which kind of environment the chair is going to be used. Seat height is between 45 cm to 100 cm, depending on what type of chair it is. In all these chairs height is adjustable, as different kinds of users and environments should be take in to account. Mechanical systems and gift elevator get that adjustment, second one is easier to use and more precise. Almost every model has wheels in order to transport the chair from one office to another and has a break to avoid unexpected movement. About the ergonomics, chairs are thought to get a back posture which avoids injuries; although folding ones are not good designed in that way, as storage take priority over ergonomics aspects. Finally, chairs’ weakness is storage that is focused in all day use not in using them just in certain occasions.
7. **Applied solution procedures**

7.1 Concepts

7.1.1 *Concept 1. One piece chair*

The first concept consists of an auxiliary office chair made in only one piece, that will help in the storage and cleanliness of the chair.

The environment they are directed to is “club” offices, where several chairs can be stored in a little space in the room.

Made in plastic, to get cheap products plus a modern looking chair for those new dynamic offices with opened spaces.

The shape of the chair is based in ergonomic criteria which encourage you to sit in saddle position, opening your hips and keep your spine in a lordotic curve. As it is going to be a not long use chair the adjustability is not the main issue, so it will just be adjustable in high.

**Development**

In the first idea of the chair, this is the 3D sketch that I get (*figure 7.01*):

![Figure 7.01. Sketch of the one piece chair 1.](image-url)
It is a kneel-position chair which shapes come up paying attention to the body’s user position during the use. (*figure 7.02*)

![Figure 7.02. Sketch of the one piece chair 2.](image)

The seat is circular in the back part in order to adjust to the user’s body. The down part of the chair is thought to user lean his legs comfortably and at the same time the chair be able to piled up. To get that, it has two projection surfaces covered by foam.

Seating area and leaning legs area are covered with foam or some kind of tempur material which makes the position comfortable and adjusts to the body. (*figures 7.03 and 7.04*) The foam shape does not covert totally these areas but it has a little margin, about 20 mm. and it has the same shape as the chair, to keep an aesthetic line in the whole product.
Seat’s shape is semi-circular to adjust to the body and save material and space.

Down part’s shape is has been defined in that way to let the user lean his legs and at the same time chair be able to piled up. In order to get it, there are two projecting parts where legs and foot would lean.

In order to check if the chair was able to be piled up I made an 3D assembly (figure 7.05):
By that checking I just realized that there was a problem to pile up the chair, as the areas in touch for the piling were not good designed. One chair does not fit in the other one.

The problem was that down part and seat should have a cot (certain angle on his surfaces) but they did not, so the chairs did not fit in others. (*figures 7.06 and 7.07*)

Other aspect that could be a problem was the fact that if the chair was supposed to be made of plastic it maybe could not support so many weight. Looking for information to find out if that shape was possible to made or not I found that there are some kind of chair that have similiar shape between the seat and down part (the most problematic area) and it was not a problem. If thickness, materials and radius of curvature are the right ones it should not be any problem.

So, in the next step of the development I tried to solve the pile up problem. The solution was to give a little angle in the surface’s seat. (*figure 7.08*)
The same operation should be done in the down part. *(figures 7.09 and 7.10)* Furthermore, this angle between the surfaces will be useful to make the chair well-balanced and has more stability.
7.1.2 Concept 2. Folding chair

That is a office chair for conference rooms and all kind of offices, as it can be moved easily, and it could used for long and short periods of time.

The main characteristic of that concept of chair is the ergonomy (really demanded nowadays) that helps the body to get the proper position during the use of it. Furthermore, hight’s chair can be adjusted as in any other office chair thanks to its lift.

Storage is handy due to its folding system that let it to take up the less space as possible to be able to fit in any place of any office or conference room.

Thanks to that folding system two sitting positions are get: regular one and kneel one. So, that means a really useful chair and not limited use.

It is made with the less pieces as possible, for maintenance and possible repairs being the easiest and cheapest as possible.

Development

The first view that I get of that concept was that one (figure 7.11):

![Figure 7.11. Folding chair](image)

This chair has two positions: kneel-position and regular position.
In order to get the kneel-position chair, a part is unfolded. This part is made up with two extending bars and support for the knee with certain angle, to get a good position for the body.

This support is made of textile material in order to adjust to the body perfectly, and to be folded easy and not take up a lot of space.

I do not still know which mechanism could do that work but I think it would not be a problem to develop it later.

The base’s chair consists of tree legs chair with a wheel each of them. (figure 7.15) This wheel help to move the chair easily and it does not involve a problem to storage it.
In order to storage that chair, the knee part is folded and the seat is folded until get a vertical position (figure 7.16). In that way, the chair just take up the minimum horizontal space and it can be stored one side or the other on the wall. (figure 7.17)

![Figure 7.16. Chair folded](image1)

After analysing that concept a little deeper I found some problems:

The first one is that the base is very narrow and does not provide the chair enough balance, the solution for that come up making longer legs chair but paying attention that they should be long enough to provide balance to the chair and narrow enough to be storaged easily (figures 7.18 and 7.19).
Other problem is the seat, the position and shape is not ergonomic enough. So the first improvement should be giving certain angle to the seat to make the body be straight and not let spine get curve and stand all the weight (figure 7.20 and 7.21).
7.1.3 Concept 3. Bouncing chair

This third concept comes from the knowledge of seating bouncing a little, it means in a dynamic position, could be beneficial for the spine as it strengthens the deep muscles of the spine and trunk as you sit and cajoles you into an upright, healthy posture.

So what I want to get is a chair which you can sit on without move or just bounce a little bit to strengthens the muscles.

So with that concept it wanted to get an ergonomical chair to use in conference rooms, as auxiliary chair in office or even as office chair at home.

It should be easily to store, that involves that it could be stockpiled with at least 5 chairs upon each other.

Development

In order to begin to develop that concept ergonomic measures were checked.

<table>
<thead>
<tr>
<th>Knee heigth (chair height)</th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>50</td>
<td>95</td>
</tr>
<tr>
<td>385</td>
<td>425</td>
<td>465</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leg length</th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>435</td>
<td>480</td>
<td>525</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hips’ width</th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>330</td>
<td>370</td>
<td>410</td>
</tr>
</tbody>
</table>

Figure 7.22. Ergonomics dimensions chart
To design a chair which fit the most people as possible, I will use values between 50 percentil for men and 50 percentil for women. That means that I will use aproximately 410 mm for knee height, 460 mm for leg length and 380 mm for hip’s width.

This is the first sketch of the chair *(figure 7.23)*.

![Figure 7.23. First sketch of bouncing chair](image)

The simple shapes of the chair make it easily to manufacture and to storage during its use.

The seat has curve shapes to adjust to the user’s body.

Chair’s shape provides the user for proper seat and at the same time let him to have and up-down movement that make the user to have keep the spine straight and the body in movement *(figure 7.24)*.
Such a big piece made just of plastic could have some problem during manufacturing. Furthermore, it could be really expensive. In order to solve this problem the part that is in contact with the floor is modified.

The solution comes from take material off from that part and leaves the shape proper to lean on the floor and support all weight (figure 7.25).

This last configuration of the down part of the chair is not good for the balance of the whole chair, because there is not weight enough down, so it is quite possible that the chair turn over. Moreover, the curvature in that part of the chair may not support the stress and break.

A possible solution for that is to have metal legs for the chair. Manufacturing that kind of pieces, plastic and metal tubes is able by overinjecting (figure 7.26 and 7.27).
In that way the chair has improved its balance but the aesthetics is not appropriate for the way the kind of product it wanted to achieve (figure 7.28 and 7.29).

That chair can be easily storage and do not take a lot of space from the room.
Figure 7.30. Stackable 1

Figure 7.31. Stackable 2

**Concept sum up**

After describing development process of each concept and explain all their characteristics I made a sum up-chart in order to see and compare all chair’s characteristics and have a general look (*figure 7.32*).
<table>
<thead>
<tr>
<th></th>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measures</strong></td>
<td>Height: 500mm</td>
<td>Height: 500 mm</td>
<td>Height: 450</td>
</tr>
<tr>
<td></td>
<td>Weidth: 550 mm</td>
<td>Weidth: 520</td>
<td>Weidth: 400</td>
</tr>
<tr>
<td><strong>Parts</strong></td>
<td>1 big piece for the whole chair</td>
<td>Seat Elevator column</td>
<td>Legs</td>
</tr>
<tr>
<td></td>
<td>One seat cushion</td>
<td>Base Knee supportNet</td>
<td>Seat</td>
</tr>
<tr>
<td></td>
<td>Two knee cushion</td>
<td>knee supportWheels</td>
<td></td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td>PVC</td>
<td>Steel and aluminium for the structure. Tempur</td>
<td>Steel for the legs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>material for the seat</td>
<td>PVC for the seat</td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
<td>Chair: Inject molding</td>
<td>Seat: Injected Structure: Mechanize steel bars:</td>
<td>Legs: Mechanize steel bars: cut, bending,</td>
</tr>
<tr>
<td></td>
<td>Seat cushion: Foam overinjecting</td>
<td>drilling, lathe, milling machine and thermical</td>
<td>Thermical treatments.</td>
</tr>
<tr>
<td></td>
<td>Knee cushion: Foam overinjecting</td>
<td>treatments. Welding</td>
<td>Seat: inject holding and overinjected legs</td>
</tr>
<tr>
<td><strong>Ergonomics</strong></td>
<td>It makes the user keep a straight spine position during all using time.</td>
<td>User can be in kneel position, keeping his spine straight, and in regular position, that is not as healthy as kneel one.</td>
<td>It makes the user to be active during the use, so the spine is straight and it strengthens the spine and the abdomen.</td>
</tr>
<tr>
<td><strong>Carrying it</strong></td>
<td>Carry it by hands. One or two can be used.</td>
<td>Easy to carry, sliding it by the wheels</td>
<td>Carry it by hands One or two can be used</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>Piled up one on the other</td>
<td>One beside the other</td>
<td>Piled up one on the other</td>
</tr>
<tr>
<td><strong>Weight capacity</strong></td>
<td>120 Kg</td>
<td>150 Kg</td>
<td>150 Kg</td>
</tr>
<tr>
<td><strong>Wheels</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Figure 7.32. Comparative concepts chart

7.2 Concept evaluation
To decide which one of the three concepts is the most viable to be produced, I made an evaluation chart (figure 7.34). In that chart the concepts are evaluated and compared in different levels all of them compared to a current chair in the market. Each level has a specific weight in the whole evaluation concept. This chair is the “well back Kneeling Posture Chair” (figure 7.33) studied in the market survey made before.

---

Figure 7.33. Well back kneeling posture chair

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**Ergonomic:** In that level how the chair is adapted to user’s needs and capacities is value. That means that the chair has to adjust to body measures beside let him keep a comfortable and healthy position during all the use.

**Manufacturing:** That level evaluates difficulty and economic cost that the mass production of that chair has. It means which one combines this two characteristics better and makes sure that the investment would be paid off quickly, that is profitable to produce that chair.

**Storage:** One of the main problems wanted to be solved in that project was the storage of the chair. In that level how easy the chair is to storage, how many space it takes, if the product can suffer any accident or if it can make it happen during this period of the use life.

**Repairs:** When a product break down it can mean it is no useful any longer. Let a chair be reaped easily, change any piece quickly or with not special help are issues handle to get a easy to use product.
**Adjustability:** That issue regards ergonomics; although adjustability does not involve having ergonomics features. Important chair characteristics are adjustability to different measures of the user’s body: seat height, knee support height, back angle and so on.

**Cleanliness:** One of the most important part of use cycle of a product is cleanliness as in some cases, when the product get really dirty, it can get broken or useless. In that case, chair is the company imagen so, it is needed to get a easy clean product, that take little time to be cleaned and not getting dirty easily.

**How it can be understand:** That level means how a user, not having any previous knowledge about the product, can understand and interact with the product, recognizing different parts and knowing how to handle them.

**Esthetics:** The aesthetics’s office chair is important as it was said before, it is the company imagen and it said how serious, modern, awaring of environment and so on the company is.

**Reciclable:** Recycling involves each of the materials that make up the chair can be reciclable, that the process not be really complicated and, in the case of the chair is made up with different materials they should be easily separated.

**Transport:** As this chair is an auxiliary one, it is going to be carried from one place to another really often, so the transport is an important issue. How to catch it, if it slide or not, if it is heavy...
## CONCEPT EVALUATION

**Project:** office chair

<table>
<thead>
<tr>
<th>Requeriments</th>
<th>KRAV VIKT</th>
<th>Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ref</td>
</tr>
<tr>
<td><strong>Ergonomic</strong></td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td><strong>Repairs</strong></td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td><strong>Adjustability</strong></td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td><strong>Cleanliness</strong></td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>How it can be understand</strong></td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td><strong>Esthetics</strong></td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td><strong>Reciclable</strong></td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td><strong>Antal +</strong></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>Antal -</strong></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>Summa</strong></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>Viktad summa</strong></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 7.34. Evaluation concept chart.
Conclusions

After making the evaluation concept chart, I found out that the most suitable concept to develop it is the number one, the piled up chair. As final result, it get 47 points while the second concept get 38, and the third one 29.

In terms of ergonomics the three chairs are better than the current on the market, because they provide an ergonomic position, but the piled up chair is much better as the position it provides is the most appropriate for user’s healthy.

Storage is an important characteristic that it was wanted to achieve running that project, the winning chair and the bounced one get that really good, but not the folding one. On the other hand, transport is not so good in those two concepts as in the folding one, as it has 3 wheels to provide balance for a sliding transport.

Adjustability is not the strong point of these concepts, not having a great improvement from the current ones on the market.

As the first and the third concept are made in just one or two pieces the manufacturing can be simplified a lot, saving money and production time and assembly. For the same reason, they are easy recyclable.

Besides provide sit on a office, chair gives a image to the company, so in that stage of development the chair which has the best aesthetics are the first and the second one.

Repairing is a weak point of the first and second chais as it can not be repared but change the whole piece.

So, from now I am going to develop the piled up chair, trying to keep the strong points; as ergonomics, storage and aesthetics; and strengthen them and try to enhance and improve the weak ones as transport and repairs.
7.3 Concept evolution

In the development of the chair, the main point that I wanted to improve it was the ergonomics, the storage and the aesthetics.

For improve the ergonomics, I wanted to get the best spine position according to antropometrical studies and refort the back support.

So I began to model the chair taking the suitable measures to get it. In order to strengthen the back support I modeled a middle back to protect the lumbar area (figure 7.35).

![Figure 7.35. Chair with lumbar support](image)

The main measures that should be taken on account to fit the biggest user’s range as possible are:

- Sit height: 555 mm
- Sit angle: 15 °
- Leg’s length, from knee to feet: 550 mm
- Leg’s angle: 30 °
- Width: 395 mm
That back support is provided by a surface with certain curve to fit with user spine that goes around the entire sitting perimeter (*figures 7.36 and 7.37*).

While developing that concept I realized that some part may get broken when the user sit on the chair, because they were weak with a extrem angle and any kind of reinforcement. Those parts are show in the picture below (*figure 7.38*):

*Figure 7.36. Chair with lumbar support 2   Figure 7.37. Chair with lumbar support 3*

*Figure 7.38. Weak areas of the chair*
In order to reinforce these parts I modeled a second piece, a tube which would work as a reinforcement structure.

These tubes would be below the piece and joined to them by some kind of click system (figure 7.39).

Besides providing a great reinforcement the tubes will help to improve the balance of the whole chair.

![Figure 7.39. Chair reinforce with metal tubes](image)

After analysing pros and cons of this solution I realized those would make the chair much heavier. Moreover, this chair would be much more expensive to manufacturing and assembly.

So I decided to get that strengthen that the chair needs by the surface of the chair, giving them the proper shapes, curves and angles and be as good reinforcement as the tubes. Moreover, in that way the chair will be an armonic whole that communicate modernity, comfort and quality.

About the back support, I thought that all that surface makes the chair really limited and possible to the user get blocked on it (figure 7.40). Furthermore, this kind of support is not so necessary in that kind of chair which is not for using continously.
Besides that they have been provided with several nerves distributed to make the chair able to piled up, that means with certain angle (figure 7.41).

Furthermore, the down part is with a curve shape and more opened angle in order to stability and strength.

In the knee support down part, an area has been set for lean the foot (figure 7.42).
An finally I developed the cushions, they had to carry out some requeriments:

They should fit with the user’s measures and shapes.

They should be made of soft material.

They should fit with the whole chair, making a nice looking whole chair, with the same aestethics lines (figure 7.43).

Figure 7.43. Final views of the final concept of the chair
7.3.1 Material survey

In order to know which the most suitable material to manufacture the chair a material survey is going to be carried out:

**Polypropilene**

*Properties*

It is a non-polar high hardness and rigidity thermoplastic, it has excellent impact and corrosion resistance. It is used in several industrial processes due to its good electrical, chemical and mechanical properties. Its insulating properties make the material tend to get electrostatic charge and be covered by dust.

- Working temperature range: 0ºC +100ºC
- Good elastic recovery capacity.
- Resistance to application weight in 70 ºC environment and not getting deformed.
- Resistance to penetration of microorganisms.
- Big resistance to comercial detergent at 80ºC
- Due to its density, it floats on water

*Process*

It can be: Injection molding
- Blow
- Extruded

*Current applications*

- Bottles, containers,...
- Furniture
- Toys
- Films for packing food
- Hygenic towels, honeycomb
- Clothes

**ABS**

*Properties*

That material has important properties as good mechanical and impact resistance and easily processing.
- As much as impact resistance increases strain resistance reduces.
It can be get in almost any color.
No toxic.

**Process**
It can be: Extrude
  Injecting mold
  Blow
  Pressed

**Current applications**
Car pieces
Electrical appliance
Office machines, computer and telephone casing
Electrical and electronical devices
Plane’s inside
Prototype
Coating in sterile areas

**PET**

*Properties*
Pet or tereflalato of polyethylene, it’s a hard rigid material which is resistant.
It has a low friction coefficient and high dimensional stability.
Regular use temperature is from –40 °C to 110 °C
High resistance and rigidity
High resistance to flow
High surface hardness
Suitable to be polished
High dimensional stability
Good qualities of friction by sliding
Resistance to abrasion
Good electric insulate behaviour
High resistance to chemical substances
Suitable to be varnished
Sensitive to hydrolysis

*Process*
It can be: Blowed
Injected
Extruded

Current applications
Containers
Films and sheets
Engineering pieces

PMMA
Properties
It is an amorphous thermoplastic transparent and colourless material.
It is hard, rigid but brittle and sensitive to some kind of strenght
It has good abrasion and UV-rays resistance.
Low resistance to high temperature and to solvents.
It is flammable

Process
It can be: Blowed
Inject molding
Extruded

Current applications
Sinks
Baths
Signs
Lents
Light covers

POLYESTHEREN
Properties
Polyestheren is a thermoplastic which possess good elasticity and low density.
Its chemical attack resistance is not really high. Regarding to mechanical, thermical
and electrical resistance are good.

Process
It can be: Blowed
Inject molding
Extruded
Thermoforming

Current applications
Food containers
Crockery
Electrical appliance
Toys
Footwear
Insulate plate for construction

PVC

Properties
PVC is one of the most versatile plastic, it depends which kind of additive is used different properties can be get.
It has good technical properties as abrasion resistance, low density and mechanical and impact resistance.
PVC is exceptionally durable and easily reciclable.
It can be burn easily or burn by itself.

Process
It can be: Blowed
Inject molding
Extruded
Thermoforming

Current applications
Construction
Packaging (bottles, films, bags)
Furniture
Wires
Medical applications
Credit cards

SAN

Properties
SAN is an copolymeric material composed of styrene and acrilonitrilo. It is flexible, rigid, deformable in a plastic way, hard and fragile.
It is transparent and easily processable. It has also really good mechanical properties as impact, strength, flexion and thermal resistance.
SAN has a good surface brightness and is cheap to process.

**Process**
- Blowed
- Inject molding
- Extrude
- Thermoforming

**Current applications**
- Car appliance
- Electrical and electronic industry
- Home product

Analysing all these materials, I found out that the most suitable material to manufacture the chair is polypropylene due to both its elasticity and resistance. It is already used in some furniture with good results.

Moreover, it can be processed by extrusion, which is the process by which the chair is going to be manufactured.

**7.4 Concept description**

**7.4.1 General description**

**USER:** Men and women from 18 years old to 60 years old who work in an office or make a sitting work.

**ENVIRONMENT:** This product is used as an auxiliary chair in office as the ones in conference rooms or in a new kind of office, the club offices.

**DESCRIPTION:** This chair is in the kneel position chairs group. User sit on his bottom and lean on his knees acquiring a great spine position that avoids injuries and pain.
The chair is made up of four different pieces: the chair itself, back cushion and two knee cushions.

Shape’s cushions are taken from anthropometrics charts to get the best adaptation body-cushion to the most number of users. They are made of tempur material, which is a kind of foam that takes body’s shape and adjust to them. In order to get a better adjustment, cushions are not flat but they have the body marks slightly.

The main piece, the chair is made of plastic in an only piece. In that way, manufacturing expenses are saved and repairing simplifies a lot. Parts where pressure exerted by user’s weight could end up breaking the chair have been repaired with several nerves place to keep the chair being piled up.

Nowadays lack of space at office is a really big problem so that chair is stackable in order to save space and create a nicer place to work and spend many hours a day. To make it able to pile up the down part has a wedge shape, both surface are in angle between them, besides that make it has the balance enough to stand a user sit on it.

That product cleanliness is very easy. The user can clean it with a wet rag. Its straight shapes and lack of nooks help to keep it clean.

7.4.2 Sequence of use

Selection and purchase of the chair: This stage of the sequence of use is made by the director or the company’s purchases department. Aesthetics, in that case inspires modernity and movement, and value for money influences in the purchasing decision

Location in the environment of use. Storage. That means where this chair is going to stay the most of the time, it should be in an accesible place, and not to disturb the employees. With that chair the storage is really easy as you can pile at least 5 of them taking the place that just one would do.

Take it to the place to use it. In some moment during the day the employee may need a chair to discuss some issue with a mate or more extra chairs to have a meeting in a conference room. That moment is when the employee takes the chair from the storage
place that could be in a side of the office itself. The employee should take one of the chairs from the pile and carry it to the using place, as the chair is not really heavy and its shapes are easy to hold it is not a difficult task.

Sit down. The employee should lean the bottom in the top of the chair and then the knees in the cushions provided for that. That kind of chairs may not be really familiar to some employee but it is easy to understand how to use it.

Stay sit. While the user is sitting, his hips will be opened and his spine will be straight, getting satisfactoy ergonomical position in an easy way.

Get up. That stage is just the same as the sit down stage.

Take back to the storage place. The user has to carry the chair to the storage place.

Maintenance. cleanliness and repair. Thanks to the straight surfaces and no-nooks shapes the chair is really easy to clean just with a wet rag. About repairing, as it is a one piece plastic chair it is difficult to it get broken. In the case it breaks, the whole chair should be replaced.

7.4.3 Materials and manufacturing

<table>
<thead>
<tr>
<th>Pieces</th>
<th>Manufacturing</th>
<th>Material</th>
<th>Finished</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chair</td>
<td>Moulding injection</td>
<td>Polypropylene</td>
<td>Smooth</td>
<td>Customer can choose</td>
</tr>
<tr>
<td>Bottom cushion</td>
<td>Over moulding injection</td>
<td>Tempur material</td>
<td>No sliding</td>
<td>Customer can choose</td>
</tr>
<tr>
<td>Knees cushion</td>
<td>Over moulding injection</td>
<td>Tempur material</td>
<td>No sliding</td>
<td>Customer can choose</td>
</tr>
</tbody>
</table>

Figure 7.44. Manufacturing and material chart
7.4.4 General measures

Figure 7.45. General measures of the final chair

8. Results

The problem to solve carrying out this project lie in developing an auxiliary office chair better than the ones in the current market which mainly improve ergonomics and storage during waiting time besides transport, manufacturing expenses and quality.

The solution that I reach is an auxiliary office chair made of polypropilene in only a piece in which the user sit in kneel position on it. That way a right spine position is insured while using it in an easy and comfort way to the user.

Thanks to its morphology five chairs can be piled up saving space in the working area and improving the environment.

The fact that the chair is made of plastic in just one piece helps to save money in the manufacturing process as well as in the assembly process.

To sum up, an innovative and modern looking chair is achieved, to use in offices which improves ergonomic, storage and manufacturing aspects regarding to the ones search in the current market (figure 8.01).
Figure 8.01 Four final renders pictures of the final chair
9. **Analysis**

In order to carry out this project the following steps were taken:

Planning: In it, each action was assigned a certain time to run it properly. In that way I get a guide of how to carry out the project.

Aim of the project, project directives, statements and limitations were set while several meetings with the teachers.

Analysis of use of the office chair in order to know strong and weak points and possible improvements could be done in order to get a more useful and comfortable product to all kind of user.

To know the product’s competitors I did a market survey. Survey’s conclusions were used in order to define the characteristics that the chair needed to be superior to the others in the same range.

Ergonomics study, both human being’s antropometrics dimensions and about work area related to the user. Here, I concluded data about how to fit the chair to the user.

A little research about laws related to office furniture was carried out, in order to achieve a legal product.

And finally, a list of criteria to design a chair was written, in order to know some tips about how to get a comfortable office chair.

Later, based on the conclusions get from different studies three concepts where develop enough to be evaluated in a chart. Then, one of them was chosen as the best one to keep developing it.

The chosen concept was developed to achieve a product that fulfilled the expectations.

Finally, a description and a presentation of the product were written in order to let to the possible customer to know the product perfectly.
10. **Conclusions and recommendations**

The beginning of this project was to study the wide number of office chairs nowadays in the market. From a great market survey I could find the most important characteristics for an auxiliary office chair.

About ergonomics, there are numerous surveys related to anthropometrics, office furniture and office work. Among all these data I could conclude the requirements a chair needs to be useful in its environment and improve the existing products.

After developing the three pre-concepts, evaluate them and find out that the best one was the “one piece chair” I looked for information about all kind of plastic materials that exist, check their characteristics and choose the best one for that chair.

So finally I achieved to develop an office chair which fulfills the most of the proposed aims in the beginning of the project. Ergonomic has been improved remarkably, also its stackable features is perfect for the environment it is going to be used in and the material which is made of let the chair be both flexible and light for easy transport.

Transport has not been improved as much as I proposed at the beginning of the project. The suitable idea would have been to use wheels on the product, but it was not compatible with the other characteristics, that were more important to the chair as ergonomics, apilability and easy and cheap manufacturing.

Finally, through the 3D- CAD model I checked that the chair fits to an average user, that means that the measures in the whole chair were right.

Mechanical resistance and flow material analysis were not runned as this is a pre-project of a deeper report to produce this chair.

Keeping with this project, it would have to focus on flexibility and resistance of the materials while the product is on use on the most extrem situations, it means when it is going to be used by the user with the highest percentil.

How the chair works in the office area should be checked also: that it fits on the office and interact properly with the rest of the objects in it.
11. References

LITERATURE AND MAGAZINES


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