DESIGNING A SERVICE MANUAL FOR LE TRIPLE BASIC OF SOWECARE

BSC GRADUATION PROJECT BY VERONICA VAN DEN GROENENDAAL

Designing a service manual for the LeTriple Basic of Sowecare

BSc graduation project by Veronica van den Groenendal – July 15th 2016

V.C.J. van den Groenendal
S1322117
Industrial Design
University of Twente

Sowecare B.V.
Twentelaan 10
7609 RE Almelo
www.sowecare.nl

Chair	Dr. Ir. M.B. de Rooij
Mentor University	Dr. Ir. A. Martinetti
Mentor University	Ir. M.E. Toxopeus
Mentor Sowecare B.V.	MSc. M.J.M. Olde Daalhuis - Damhuis
Mentor Sowecare B.V.	Dr. E.A.M. Elbertse

The service manual is the connection between the technological artefact "LeTriple Basic" and the user.

PREFACE

For the bachelor assignment I have got the great opportunity of working at Sowecare B.V. Close to the product developer and with the opportunity to watch the assemblers of the products, I developed a service manual so the dealer mechanics are able to repair and adjust the LeTriple Basic correctly. Next to that, I developed a manufacturing manual for the assemblers of Sowecare. This manual includes a structured way to assemble the LeTriple Basic so all the assemblers are able to assemble the LeTriple Basic and in exactly the same way. Moreover, I created an example manual which will instruct the next intern about developing these manuals for the other products. Lastly, a dealer presentation outline is created to offer the dealers a training. The results are presented in this report, the confidential appendix and the confidential attachments.

I really liked the working environment, the helpful employees and the challenges of the assignment. I would like to thank a few people for their help and support. A grateful gratitude for my both mentors: A. Martinetti and M.J.M. Olde Daalhuis - Damhuis for the useful tips, feedback and stimulating words. E.A.M. Elbertse and R. Nijmeijer for their feedback on the manuals and E. A. M. Elbertse also on the report. Moreover I would like to thank H. Afling for his help, explanations and patience in relation to the assembly of the LeTriple Basic. Finally, I would like to thank M.E. Toxopeus for his support and feedback.

All in all, I really liked to internship, I learned a lot, created something useful and I am even more motivated to start my master in Industrial Design: Management of Product Development.

Vera van den Groenendal

SUMMARY

As manufacturer of innovative rehabilitation devices, Sowecare strives for complete documentation of all their products. They would like to have a service manual and manufacturing manual of all their products. With the service manual they can provide the dealer's mechanics with repairing and adjusting information. The manufacturing manual will provide Sowecare B.V.'s assemblers with assembling information of the products of Sowecare B.V. Both manuals are developed for the LeTriple Basic, the "pedal" chair of Sowecare. Next to that, a dealer presentation, which will be used for the (future) trainings for dealers is made. A service overview that shows which parts should be send per service is included. Last but not least, the example manual is created to instruct the next person who will make the manuals for the other chairs.

First, the manuals are developed. To gather knowledge about maintenance and services in general, research about maintenance concepts, policies and risk analysis is done. This research is related to the LeTriple Basic to see which concepts and policies are applicable. Maintainability and reliability are taken into account. The rules described in the book "Design for maintenance" are explained for the LeTriple Basic. The failure mode effects analysis (FMEA) analyses the failure modes of the LeTriple Basic.

To get knowledge of the information that should be added to the manuals the assembly of the LeTriple Basic is closely watched. Notes were taken and with that the content of the manufacturing manuals is made. The services that should be included to the service manual are based on the possible options and the services overview. To create understandable manuals, the target groups of the different mauals are analysed. The text and outlook are adapted to users of the manuals.

As a result of the research, the manuals were developed. Also the dealer presentation and services overview were set up. The service manual, service overview and manufacturing manual meet all criteria and are now ready for use. The dealer presentation must be updated when the other manuals are ready, after that the presentation can be used. Using the manufacturing manual will allow all the assemblers to assemble the LeTriple Basic. Moreover, it will create consistency, so all the chairs are assembled exactly the same. The service manual provides the dealers with the right information about which services they may carry out and how. Moreover, there is no need of calls or emails to explain the instructions or sending a complete chair back. This will save time and money. In addition, carrying out good services will also increase the user satisfaction.

SAMENVATTING

Als fabrikant van innovatieve revalidatiehulpmiddelen streeft Sowecare B.V. naar volledige documentatie van al hun producten. Zij zouden graag een servicehandleiding en werkplaatshandleiding van al hun producten hebben. Met de servicehandleiding kunnen ze de monteurs van de dealers voorzien van informatie wat betreft het herstellen en aanpassen van hun producten. De werkplaatshandleiding zal Sowecare B.V.'s monteurs voorzien van informatie over de assemblage van hun stoelen. Beide handleidingen zijn ontwikkeld voor de LeTriple Basic, de basis trippelstoel van Sowecare. Daarnaast is er een dealerpresentatie gemaakt die zal worden gebruikt voor de (toekomstige) cursussen voor dealers. Het serviceoverzicht dat gemaakt is, geeft weer welke onderdelen er per service moeten worden opgestuurd naar de dealer. Tot slot, is de voorbeeldhandleiding gemaakt. Deze instrueert de persoon die de volgende handleidingen te maken voor de andere stoelen.
Eerst zijn de handleidingen ontworpen om kennis over onderhoud en services in het algemeen te verkrijgen. Er is onderzoek naar onderhoudsconcepten, het beleid en de risicoanalyse gedaan. Dit onderzoek is toegepast op de LeTriple Basic om te zien welke concepten en welk beleid het meest van toepassing zijn. Onderhoud en betrouwbaarheid worden in acht genomen. In het boek "Design for maintenance" worden regels beschreven met betrekking tot beide. Deze dienen toegepast te worden op het product. Deze regels zijn geanalyseerd voor de LeTriple Basic. De failure mode effects analysis (FMEA) analyseert de risico's van de LeTriple Basic.
De assemblage van de LeTriple Basic is geobserveerd om zo kennis te verkrijgen voor werkplaatsinstructies. Aantekeningen zijn gemaakt en met deze informatie is de inhoud van de werkplaatshandleiding opgezet. De services, die in de servicehandleiding moeten worden opgenomen, zijn gebaseerd op de opties van de LeTriple Basic en het serviceoverzicht met de gemaakte services van de LeTriple Basic en vergelijkbare stoelen. Om begrijpelijke handleidingen te maken, zijn de doelgroepen van de handleidingen geanalyseerd. De schrijfwijze en het design zijn aangepast op de gebruikers van de handleidingen.
Met de verkregen kennis uit de analyse zijn de drie handleidingen ontworpen. Ook de dealerpresentatie en het serviceoverzicht zijn gemaakt. De servicehandleiding, het serviceoverzicht en de werkplaatshandleiding voldoen aan alle criteria en kunnen nu gebruikt worden. De dealerpresentatie moet worden bijgewerkt wanneer de andere handleidingen klaar zijn, daarna kan de presentatie worden gebruikt. Met behulp van de werkplaatshandleiding zijn alle monteurs in staat de LeTriple Basic te monteren. Bovendien zal het gebruik consistentie creëren, doordat alle stoelen op dezelfde manier zijn gemonteerd. De servicehandleiding geeft de dealers informatie over welke services zij zelf mogen uitvoeren en hoe dit gedaan dient te worden. Hierdoor hoeven de instructies niet meer per telefoon of e-mail uitgelegd te worden. Dit is tijd- en geld besparend. Tot slot zal het verrichten van een goede service ook de tevredenheid van de gebruiker vergroten.

CONTENT

1. INTRODUCTION

Sowecare B.V. is a manufacturer of innovative rehabilitation devices since 1998. Under their own brand they design, manufacture and sell riser-recliner chairs, "pedal" chairs and wheelchairs which are sold domestically and abroad. Sowecare B.V. distinguishes itself by developing innovative solutions which enhance the independency of the user. In the Netherlands Sowecare B.V.'s products are mainly sold to large insurance companies, nursing homes, et al. Abroad Sowecare B.V. works with wholesalers and large dealerships. Besides its own products, Sowecare B.V. produces products for third parties namely, frames for X-ray equipment for Philips Medical Systems and upholstery for manufacturers of beds. Sowecare B.V.'s products are completely made in the Netherlands in their own production establishment in Almelo. The chairs are adapted to the specific needs of the customer (special seats, backrests and etcetera) (Sowecare, Eigen productie) (Sowecare, Kwaliteitshandboek, 2015).

To fulfil these specific needs a team of mechanics adjusts the chairs. If a problem with the chair occurs at a customer, the service mechanic will repair the chair. In the Netherlands this is pretty easy because the production also takes place in the Netherlands and the service mechanic can drive to the customer. However, this becomes a problem abroad; Sowecare B.V. cannot easily send a mechanic or retrieve the chair and send it back every time something should be adjusted or repaired. The dealers to whom Sowecare B.V. sells its products mostly have their own mechanics; as a result they can adjust and repair most of the products to the wishes of the customers themselves. This is the reason why Sowecare B.V. would like to have service manuals so they can send them to the dealers. This way the dealer mechanics can adjust and repair the chairs of the Sowecare B.V. Designing a service manual for the dealer's mechanics would be a solution to this problem according to Sowecare B.V. This service manual will include the most common repairs for one specific chair: LeTriple Basic; in addition the possible adjustments will be explained. This results in no more need to send a mechanic abroad to repair the chairs or to ask the customer or dealer to send the chair back.

Designing this service manual creates the possibility to easily make a manufacturing manual as well, because a manufacturing action plan is also part of the service manual. Sowecare B.V. would like to have a manufacturing manual for their employees, which can be used as reference work.

To fulfil these wishes of Sowecare B.V., the goal of the bachelor assignment is to provide the dealer's mechanics with repairing and adjusting information and Sowecare B.V.'s assemblers with assembling information of the products of Sowecare B.V.

This information will be communicated through manuals. The deliverables of the bachelor assignment are therefore three manuals, namely; the service manual and the manufacturing manual for a typical Sowecare B.V. product and a manual that explains how to make these manuals. The latter manual is called "example manual"; which includes a template with instructions for the next person who will design manuals for the other chairs. This will be designed because in three months it is only possible to realize a service manual, and manufacturing manual for one product and an example manual in general. The service manual and manufacturing manual will be designed for the LeTriple Basic. The LeTriple Basic (shown in figure 1. LeTriple Basic) is chosen because Sowecare B.V. expects that this chair will soon be the best selling product. Moreover, this chair is mainly sold to dealers abroad. Finally, this chair has fewer options so it would be possible to design proper service manuals in time.

Part of the main goal is that these manuals will be understood by the related target groups so they can adjust, repair and assemble the chair without the specific knowledge of the chair. This goal will be reached by going through a few steps of the design process; those steps are listed in the action plan which can be found in appendix A.

Figure 1. LeTriple Basic

1.1 Goals

The main goal of the bachelor assignment is to create a service manual which provides the dealer's mechanics with the right information about the LeTriple Basic. So they will be able to adjust and repair the chairs themselves. Reaching this goal means that Sowecare B.V. no longer has to send its own service mechanic, return the chair or try to explain something through email or telephone. This will save money and time. To provide the dealers with the right information a dealer presentation will be made for the dealers. To instruct them about correct adjustments, reparations, replacements and why this is important. Next to the main goal, the goal is to develop a manufacturing manual and example manual for the employees of Sowecare B.V. as well.

To reach these goals, main and sub research questions are introduced. These questions can be found in appendix B. Taking a look at these questions explains why the manufacturing manual is also part of the assignment. To gain all the knowledge of the LeTriple Basic, how to (dis)assemble several parts; it is almost the same as assembling the complete chair. By first setting up the manufacturing manual, all that knowledge can be used for the service manual. In addition, the recommendations for the product and the assembling process can be taken into account. As a result, the service manual will be designed with more knowledge about the LeTriple Basic and its assembly.

1.2 Glossary

Product; with the product is meant the LeTriple Basic.

The chair; with the chair is meant the LeTriple Basic.

A chair; one of the chairs that Sowecare has developed.

LeTriple Basic; the basic version of the LeTriple chair of Sowecare. For this chair the manufacturing manual and service manual are developed.

Service mechanic; the mechanics that carry out the services for Sowecare or the dealers.

Assembler; the mechanics that carry out the assemblages at Sowecare.

Manufacturing mechanic; the same person as the assembler.

Users; people who use one of the products of Sowecare.

Customers; people who buy the products of Sowecare.

Dealers; dealers who sell the products of Sowecare.

CE marking; the CE marking declares that the product complies with the relevant rules within the European Economic Area.

2. BACKGROUND ANALYSIS SOWECARE B.V.

2.1 Sowecare B.V.

In the introduction some general information about Sowecare B.V. is given. This paragraph will provide some extra information about Sowecare B.V. As a manufacturer of rehabilitation devices and thereby partner in the healthcare industry, their mission is to develop and produce innovative products, which improve the living conditions of people with disabilities, so they will be longer independent and can comfortably function during their (daily) activities.
To fulfil this mission, forty employees are working at Sowecare B.V. Of all employees more than 80 percent are from the sheltered workshop or Employed Persons Act ('WAJONG-er'). They are divided over two departments and a small staff. The production is split up in the upholstery department and the assembly department. All the departments are established in their building in Almelo (Sowecare, Eigen productie) (Sowecare, Kwaliteitshandboek, 2015).
The development of a new product also happens at their establishment. The product designer works together with a few other people who are working in the workplace. Taking the information from the field into account, Sowecare B.V. improves the products or develops a new product. In the field they get feedback from the users but also from the occupational therapist and healthcare insurances. The product designer works out a new idea, makes concepts and together with the people in the workplace prototypes will be made. If they are satisfied with the prototype they start with the first test. The first tests they do by their selves. If the product, the documentation (including technical file), (risk) analysis and the (clinical) investigation are ready they will test if the product complies with the Medical Device Directive and meets the harmonized standards. Sowecare B.V. asks a relevant persons to test the product. When the product passes all the tests Sowecare B.V. draws up a confirmation of conformity and labels the product with a CE marking. After the product is registered as a class one medical device it is ready for production.
Apart from improving and developing new products they also adapt their chairs to the wishes of the customer. Every chair is custom made. The customer can choose from several options, but if the customer has specific needs Sowecare B.V. seeks for a solution and will adapt (if it is safe) the chair to those specific needs. For example, a small chair with small seat and back for a child.

2.2 Products Sowecare B.V.

Sowecare B.V. produces and sells riser-recliner chairs, "pedal" chairs and wheelchairs. A short introduction of each chair is given in this paragraph. First an explanation of the three types of chairs is given.
The riser-recliner chair is a customized chair that simplifies people with physical disabilities can get up from a chair. Using an electric motor the chair helps you with standing up. The chair does not only tilt the person but also helps to sit down; it prevents the chair 'plumping down' in the chair. When the chair is in the highest position the person can sit down and the electric motor makes sure the chair (including the person) goes back down to the ground (Wikipedia®, Sta-op-stoel, 2013).

"Pedal" chair is a chair in which you sit stable. But moreover makes it possible to be able to easily move yourself at home. The advantage of the triple chair is that you do not always have to stand up and sit down (Wikipedia®, Trippelstoel, 2015).

A wheelchair is a vehicle for people who are ill or unable to walk. By using your hands you can turn the wheels and move yourself (Wikipedia®, Wheelchair, 2016). The Sowecare wheelchairs distinguish with a high-low column.

LeChair
The riser-recliner chair Sowecare developed is the LeChair (shown in figure 2. LeChair). LeChair is developed to solve the difficulties the user has with sitting down and standing up. This is possible by following of the exact kinetic reaction of a person as they stand up or sit down. The virtual centres of rotation of the chair correspond exactly to the centres of rotation of a person's joints. With the correct set up, the chair provides maximum stability and when sitting down the pressure points are taxed to the minimum. The ergonomic kinetic action of the LeChair ensures that you are lifted up onto your feet when standing up. Next to that, the chair is constructed in such a way that your feet can be shifted slightly back, while your knee joints move slightly forward when standing up. Moreover, the chair has a very high "riser-recliner" function, providing lengthy support as you stand up. The modular design, the solid construction, and the simple settings of the LeChair guarantee you will have a long-lasting and cost saving chair (Sowecare, Sowecare producten) (Sowecare, Flyer LeChair, 2013).

Figure 2. LeChair

LeRoulé Plus

LeRoulé Plus (shown in fgure 3. LeRoulé Plus) is an innovative wheelchair with many adjustments; moreover, it can be used as "pedal" chair. It is optimally adjustable to the user, due to the modular construction; the wheelchair can be adapted to individual wishes and requirements. Various sizes and options result in high sitting comfort.

Figure 3. LeRoulé Plus

LeRoulé Plus is provided with electric high-low and riser-recliner functions. Since users can operate the options themselves, they are less dependent and can continue to make use of their own possibilities as much as possible (Sowecare, Sowecare producten) (Sowecare, Flyer LeRoulé, 2013).

LeTriple

LeTriple (shown in figure 4. LeTriple) is a "pedal" chair with a different undercarriage that makes is easier to "pedal'. The M-shape provides a perfect combination of a great deal of movement, stability and great looks. With the electric high-low system almost everything is in reach of the user (Sowecare, Sowecare producten)(Sowecare, Flyer LeTriple, 2013).

Figure 4. LeTriple

LeTriple Wheels

LeTriple Wheels is very light to move and can be both shifted and rolled (see figure 5. LeTriple Wheels).

Figure 5. LeTriple Wheels

The sprung rear wheels of the LeTriple Wheels ensure that indoor obstacles such as bumps can be easily and safely traversed. Moreover, the large wheels ensure that even in a small space you can still manoeuvre with excellent flexibility. The electric high-low system makes it possible for the users to work at different heights. And just like the LeTriple, there is still space so the user can easily "pedal". Nevertheless, the LeTriple Wheels is fully adjustable (Sowecare, Sowecare producten) (Sowecare, Flyer LeTriple Wheels, 2013).

LeTriple Basic

The LeTriple Basic (shown in figure 6. LeTriple Basic) is the simplified version of the LeTriple. This chair is made because of the wishes of several customers. It had to have the same functions as the LeTriple but fewer options. Other parts and materials made it possible to reduce the selling price. Sowecare B.V. developed an own chassis which they produce in their own workplace. The chassis makes it possible to "pedal".

Figure 6. LeTriple Basic

The electric adjustment is different from the LeTriple but it still reaches almost the same height, so the user can easily get something from the kitchen cupboard for example. Because the LeTriple Basic is the chair for which the manuals will be made, the next paragraph includes more information of the LeTriple Basic, such as the possible options (Sowecare, Flyer LeTriple Basic, 2013).

3. BACKGROUND ANALYSIS LE TRIPLE BASIC

3.1 Possibilities LeTriple Basic

The LeTriple Basic is a 'pedal' chair designed for people who have difficulties with walking, or people who have osteoarthritis. LeTriple Basic is the ideal solution to still be mobile; it creates new possibilities for those people. The chassis is very compact which makes it easier to enter through doors or 'pedal' between the table and cabinet for example. In addition, the chair runs smoothly. The sitting comfort is high and the armrests are retractable. Also the logistics are optimal, the control handles and brake are easily adjustable to the left or right by the mechanics, depending on the users preferences. Moreover, the seat and back are easily exchangeable in case some configurations needs to be replaced or changed. Services are easy to perform because of the 'simple' design (Sowecare, Flyer LeTriple Basic, 2013).

3.2 Options of LeTriple Basic

Although, the LeTriple Basic is a basic 'pedal' chair, there are still a few options possible to adapt the design to the customers' wishes (see appendix XX). These options are variations of the standard configuration, shown figure 7. Standard configuration LeTriple Basic. Only the standard fabric should be grey instead of blue. In case of the LeTriple Basic, the dealer is allowed to adapt the options when using the service manual. Changing the options correctly would not make the CE marking invalid

Figure 7. Standard configuration LeTriple Basic

3.3 Production of LeTriple Basic

The production of the parts of the LeTriple Basic takes partly place at Sowecare B.V. Several parts are purchasing parts because it is not worthy to produce them at Sowecare B.V. Machines (like a laser cutter etcetra) are expensive and moreover, producing prices are sometimes lower abroad. Though, Sowecare B.V. still produces a few parts, such as the frame of the LeTriple Basic. The seat and back cushions are produced at Sowecare B.V. for almost all the chairs. Despite that, the assembly of the entire chair is done at Sowecare B.V. The activities of the employees are divided over the spare parts sub-assemblies of the chairs the main assemblages. Because the assembly is totally done at Sowecare B.V., there are a lot of possibilities. An example is when someone wants a chair that is five centimetre higher, they are able to adapt that and to fulfil the wish of the customer (if the tests are positive about the safety). These chairs are so called "specials": chairs that are especially produced for one customer. However, this is not applicable for the LeTriple Basic because this will raise the price (and also effort) too much while the customer then could probably choose a more advanced chair. Sowecare B.V. produces several standard options for the LeTriple Basic. Sowecare B.V. has split up the assembly of the LeTriple Basic in four groups. The assembly the seat support, the assemblers of the armrests, upholsters the seat and backrest and a persons use these sub-assemblies to assemble the complete chair.

4. TARGET GROUP ANALYSIS

4.1 Target group manufacturing manual

The manufacturing manual is only meant for employees of Sowecare B.V. Because of the detailed description of the assembly of the LeTriple Basic this manual is confidential information. This manual it is meant for the people who have to assemble the LeTriple Basic.
As said, many employees at Sowecare are form a sheltered workshop. The employees have different capabilities. For this manual is assumed that the employees who assembled the chair only a few times or employees who are new and have to learn how to assemble the chair, have to understand the manual.
This manual will be a solution for the employees who do not assemble the LeTriple Basic on regular basis (in case the employees who assembles the LeTriple Basic is ill or if there are lots of orders). If they assemble the chair once per quartile for example, they may have forgotten something. In this case they can read beforehand the manual to refresh everything or they search in the manual for the part they have a question about. As a result, they are independent of others and do not have to ask questions (about which they might feel uncomfortable). Next to that, when Sowecare B.V. hires a new employee who has to assemble the LeTriple Basic, he or she would be able to this on his own by following the manual. This person will have the same background information about assembling as the people who already work there. Therefore these two types of persons will be described as one target group. Moreover, the goal of this manual is creating consistency. Following the instructions in the manual will result in a structured way of the assembly. Even more important, all the products will be exactly the same assembled.
This theoretically means that everyone with a technical practical background should be able to assemble the LeTriple Basic with the workplace manual. However, the average employee of Sowecare B.V. does not prefer to read too much. They have a more practical mind and prefer visualizations. This is something that should be taken into account, designing the manufacturing manual.

4.2 Target group service manual

The service manual is meant for the dealers in the Netherlands and abroad. The LeTriple Basic is sold in the Netherlands, but also in countries like France and Iceland. Customers come to those dealers to buy or lease-lend a chair. This means when there is something wrong, the customer calls the dealer and the dealer has to fix it.
However, Sowecare B.V. made the chair and knows everything about it. The dealer only knows the sales aspects and its function, but they do not know how to repair or adjust spare parts of the LeTriple Basic. Therefore, they have to call Sowecare B.V. to help them with the reparations or adjustments. Luckily, they do have their own service mechanics, which have a background in maintenance. These service mechanics do not know automatically everything about the LeTriple Basic, but with their knowledge and an understandable service manual they will able to repair or adjust some parts of the LeTriple Basic. They are capable of reading a manual and have knowledge of several kind of tools.

4.3 Target group example manual

This target group includes the people who are going to make the service manuals and workplace manuals for the other chairs that Sowecare B.V. develops. This example manual is an explanation of how the manuals of the LeTriple Basic are made and in addition a template for the next ones is added. Each intern should be able to understand the text and template so he or she can develop a manual for another chair. The background of the intern is at the moment unknown, but it is a pre that he or she has a technical background and knowledge of graphic design and InDesign. The reason for this is that the manuals and templates are made in InDesign and some feeling with graphic design will create good looking, consistent and structured manuals.

4.4 Other stakeholders

Other stakeholders that will profit from (one of) the manuals are the users and the dealers. The user of the chair will also profit from the service manual. With the service manual, dealers will be able to carry out earlier the services. Because they already have the information, only the parts which are not in stock have to be ordered. Quicker services will increase the user satisfaction. Moreover if the dealers will adapt more chairs to the preferences of the user they will be even more satisfied. The ease of use of the chair will be improved.
Not only Sowecare B.V. but also the dealers will profit from satisfied users. User satisfaction is closely related to the sales of the company. Increased user satisfaction will lead to a positive spread of word (Thomassen, 1994). People will recommend the chair(s) to others. Next to that, the chance a satisfied user will buy a new chair at the same company is bigger (F.E. Reichheld, 1990). Both reasons are a reason for the dealer to keep up the user satisfaction. Because it will lead to more profits.

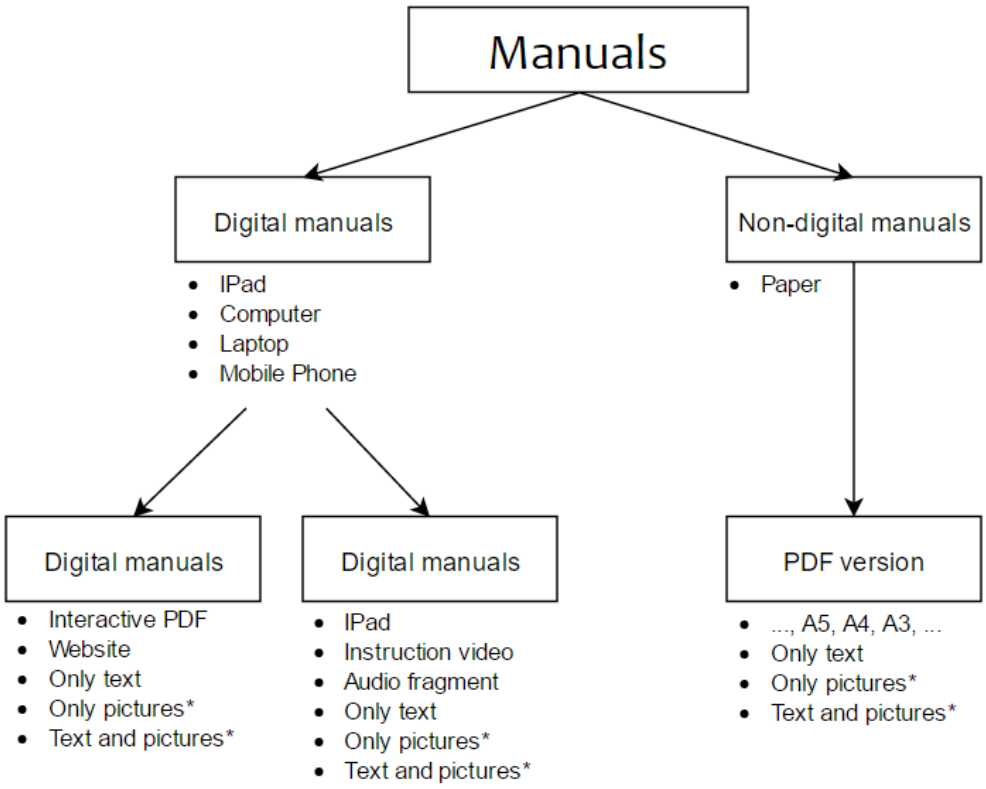
5. MANUAL ANALYSIS

5.1 Communication through manuals

To be able to communicate through a manual, you first have to know your target group very well (Manualise). This is the first step of making a manual, finding out what their capabilities and preferences are. If you know in what context you have to write you can decide which kind of manual will fit. Also the language needs to be adjusted to the target group.
It is important to keep consistency because this looks more professional and the chosen design also fits for the example manual. Therefore, the person who will make the manuals for the other products must be motivated to follow the example manual. Thinking like the user will help to write an attractive manual (W. Mulder, 2012).
The text should be easy to understand. Quickly knowing what should be done will motivate the user and keep the manual attractive. Explanations should be brief, short sentences and preferably step-by-step explained (Greogory, 2010).

5.2 Possible manuals

In this part different kind of manuals are evaluated. In figure 8. Manuals overview, the possible options are explained (Groenendal, 2016). This paragraph explains the pros and cons of each option. After that, the results with an underpinned choice a given.
Choosing the right way of instruction, the requirements of Sowecare B.V. were taken into account. For the manufacturing manual there were not many possibilities, because the assemblers of Sowecare B.V., those who have to work with it, do not use a computer or IPad. Taking that into account, a digital manual and a manual with instruction through videos are no longer applicable. Because of the background of the target group and complexity of assembling, an audio instruction is not an option either. The target group does not prefer reading, so 'only text' can be eliminated. Moreover intuitive instructions do not include text (W. Mulder, 2012). This means the manual will be printed and handed out to the people who really need it. The size of the paper is chosen for practical reasons: A3 format (or bigger) is not a manageable size when you are reading and carrying out the instructions: A5 (or smaller) will not fit enough pictures, the pictures need to be clear and preferably not one picture per page, otherwise it will become a bookwork.
To conclude, A4 for would be the perfect size, pictures can be big enough and the dimensions are manageable during work. Next to that, it can be printed with a standard printer.
The next question is how to present the instructions. With only pictures it is too hard to explain the instructions, because than you also have to make pictures of all the tools and parts that are used during that specific step. So that is why textual instructions are kept because they explain everything in detail and the pictures illustrate and make a visualization of what should be done.



*Pictures could be: technical drawings, 3D pictures, animated drawings (like IKEA) or photos

Figure 8. Manuals overview

To find out what kind of pictures would best to visualize and illustrate, a test was set up. This test (which can be found in appendix D) includes three kinds of visualization. For this test the brake is chosen to assemble. The text how to do this is kept the same in each situation. The first option is with technical drawings figure 9. Example technical drawing picture. The second option is 3D pictures, taken from the 3D model figure 11. Example 3D picture. The last option includes photos that were kept during the assemblage of the LeTriple Basic, shown in figure 11. Example photo picture.

Figure 9. Example technical drawing picture

Figure 10. Example 3D picture

Figure 11. Example photo picture

During the test four workplace employees (who assemble the chairs) were asked to highlight their preferences. Which option is the most clear and understandable? Giving an explanation for their choice is something that they find hard to explain (because of their social disabilities). But they spoke the truth and you can hear the enthusiasm about their preferences. These options were also presented in the technical team to discuss with them the outcome of the test. Based on their arguments, and taken the workplace preferences into account, a decision is made. In table 1. Test results options pictures, the outcome of the test is illustrated. The '+' before the feedback means that the feedback is positive an argument to choose that option. The '–' means negative feedback which is a reason not to choose that option.

To conclude, photos will be taken of every step of the assemblage. If it is not possible to make everything clear with photos, a picture of the 3D model is allowed. In the end it is more important that the manuals are understandable instead of completely consistent, professional and good looking. In the book design for maintenance is highlighted that exploded views can help to get a better understanding (W. Mulder, 2012). To keep the consistence and to make it possible to take good photos, a photoshoot corner is established (more details about the development will be explained XX).

Because the information that is used in the manufacturing manual can also be used for the service manual it would be best to keep the same and clear way of illustrating. The background knowledge of the service mechanics is assumed to be the same as the employees of Sowecare B.V. who assemble the chairs; they only do not know the assemblage of this specific chair. But that will not be a problem with a good manual. So because a lot of knowledge for making a manual that includes photos and text is gained during the first phase (and taking the timeframe into account) it would be best to keep the same structure for the service manual. Moreover, it is more logical that the service mechanics or dealers have the possibility to print than that they all possess an IPad they can take with them to a service. A PDF version of this manual will be send to the dealers.

OPTION 1	**Workplace employees**	**Technical team**
Technical drawings	- No connection with the actual product	- Workshop employees do not understand it
	- Does not look like the real parts	- Less clear than the other options
	- Unclear	+ Possibility for exploded view
	- Does not look good	

OPTION 2	**Workplace employees**	**Technical team**
3D model pictures	- Unfamiliar	- 3D model must be updated
	- Not realistic	- Workplace employees are unfamiliar with the pictures
	+ Looks good	+ Possibility for exploded view
	+ Explode view is clear	+ Professional
		+ Consistent

OPTION 3	**Workplace employees**	**Technical team**
Photos	+ Familiar, recognize the parts	- Problems with dark pictures
	+ Understandable	- Less professional
		- No possibility for exploded views
		+ Exactly the same as the product
		+ Workplace employees understand it the best

Table 1. Test results options pictures

5.3 Content and design manufacturing manual

The main goal of the manufacturing manual is to standardize the assembly method. At the moment, all the assemblers have their own way of assembling. Following the instructions in the manual will result in a structured way of the assembly. Even more important, all the products will be exactly the same assembled.
Next to that, it will be an outcome to someone who does not know the chair but has experience in assembling. He or she would be able to assemble the LeTriple Basic. To realize this, the content of the manual should be complete, clear and understandable. Understandable maintenance instructions include intuitive, concise and unambiguously maintenance (W. Mulder, 2012). Because of the time frame the sub-assemblies will not be taken into account because these are not necessarily needed to make the service manual (the main goal). Therefore, only a manufacturing manual has been made for the main assembly of the LeTriple Basic. Developing this manual increases background information about the LeTriple Basic, its instruction, its options and its strengths and weaknesses. With this information the service manual can be developed properly.

5.4 Content and design service manual

The service manual is meant for the dealers in case reparations or adjustments have to be done. Nevertheless, not all reparations could be done by the dealer mechanics because of the complexity and the uniqueness of the product. In case of carrying out adjustments it is also important that the CE marking is preserved. So the service manual should include instructions for the parts that may be replaced by a dealer mechanic. Moreover, the dealer reuses the chairs. In preparation for the reuse the dealer repairs (if necessary), sanitizes and adjusts the chair, because the preferable options of the customer can be different, for example the direction of the control handles. Adapting these preferences is pretty simple. Therefore the dealer can let their own mechanics fulfil these adjustments. Though, they still need to know how they should do that without causing problems. So that is why the service manual also includes adjustments. Taking the Failure Mode and Effect Analysis (FMEA) (see chapter 6 about the FMEA) and previous services of the LeTriple Basic (and similar products) into account the most common reparation list is made and translated to the content of the service manual. If possible all those reparations should be added to the manual. To create a clear overview the manual is divided in chapters that include specific parts of the LeTriple Basic. Per paragraph the possibilities of (dis) assembling and adjustments are explained in steps. The order of the chapters is based first on the most critical parts; electrical versus mechanic. The electrical parts are non-adjustable excluding the position of the manual control. The high-low column is the most important part of the chair because without the column the whole high-low option is useless. The battery pack is crucial for the working of the other components and that is why these electric components can be found in chapter two, three and four of the service manual. Chapter five is about the manual control, the manual control is an electric part but also adjustable to the preferences of the user. That is why this chapter is more or less a transition between electrical parts and mechanic parts. All the mechanic parts are adjustable or replaceable. The mechanic parts will follow up from chapter six.
The design (outlook) of the service manual is mostly kept the same as the manufacturing manual to keep consistency. Nevertheless, the structure is a little different but fits more with the goal of the manual. The manufacturing manual is one big instruction to assemble the whole chair but the service manual is more focused on the possibilities of the different parts. The mechanics should be able to quickly find the part that he or she has to replace. Despite that, it should be clear where to start when you are finished and moreover if you did it right and the problem is fixed. That is why this is explicit mentioned in the end of each instruction.

5.5 Content and design example manual

The example manual includes the instructions to write the manufacturing manual and service manual. To make it easier to develop the manuals for the other products, two templates are made so these can be used to create consistency and lower the time of development. This manual also includes instructions that include the approach of creating the pictures and gaining the knowledge of the assemblage and services.
The information must be understandable for someone who has (at least not in the beginning) no knowledge of Sowecare B.V.'s products. Therefore the example manual should give information how this knowledge could be gained and gives information about the company and what they want to reach with these manuals. The person who will develop (some of) the other manuals will then know why he or she is doing it and have a better understanding.
Last but not least, this manual provides tips that can be used, these include things that were correctly done the first time but also tips that include instructions of things that could be done in an easier way. The recommendations are "extra's", these "extra's" are not necessary for the mechanics to understand the manufacturing or service manual but can improve the manuals to give a better understanding of the instructions in general. The design is kept the same as the manufacturing manual and service manual. Although these instructions are not explained in steps, the outlook is kept the same.

6. MAINTENANCE CONCEPTS, POLICIES AND RISK ANALYSIS

In this chapter the risk analysis is explained. The Failure Mode and Effect Analysis is used to carry out a suitable risk analysis for the LeTriple Basic. In order to prevent risks, maintenance is needed. The three types of maintenance are explained in order to identify the most suitable for the LeTriple Basic. Moreover, the choices of Sowecare are clarified. The maintenance policies that are applicable for the LeTriple Basic: maintainability and reliability are taken into account. Finally, the importance of the replacements is explained.

6.1 Risk analysis

The manufacturer is responsible for meeting the medical devices directive. He must continue taking the steps of the CE marking. Member States shall presume that products meet the essential requirements of the directive (ISO13485:2012 - medical devices in this case) if they conform to national standards according to the harmonized European standards. Standardization Institute NEN provides these standards in the Netherlands (Rijksdienst).
Sowecare B.V. has to meet up the NEN-EN 12182 standard for assistive products for persons with disability – General requirements and test methods. The general requirements in paragraph four of this norm state that a risk analysis is required. Hazards should be identified and the risks associated with them should be estimated using the procedures specified in EN ISO 14971 (Normalisatie-insituut, 2012). The risk analysis for the LeTriple Basic exists of two parts. Namely, "intended use and identification of characteristics related to the safety of the medical device" and "estimation of the risk(s) for each hazardous situation". Both plus the results of the risk analysis should be included in the management file (Normalisatie-instituut, 2007).

In general there are four main risk analysis methods, these will be shortly explained:

- Preliminary Hazard Analysis (PHA) is a technique that can be used early in the development process to identify hazards, hazardous situations, and event that can cause harm when few of the details of the medical device design are known;
- Fault Tree Analysis (FTA) is especially useful in safety engineering, early in the development stages, for the identification and prioritization of hazards and hazardous situations as well as for analysing adverse events;
- Failure Mode and Effect Analysis (FMEA) and Failure Mode, Effects and Criticality Analysis (FMECA) are techniques by which an effect or consequences of individual components are systematically identified and is more appropriate as the design mature;
- Hazard and Operability Study (HAZOP) and Hazard Analysis and Critical Control Point (HACCP) are typically used in the latter stages of the development phase to verify and then optimize design concepts or changes (Normalisatie-instituut, 2007).

In case of the LeTriple Basic the FMEA is chosen for two practical-driven reasons. First, Sowecare B.V. chooses this method already for their product. Because they also want to focus on the several spare parts of their products. Second, the LeTriple Basic is already developed so it will not be possible to choose an analysis that must be carried out during the development process. In the next paragraph the enlarged version of the FMEA of Sowecare B.V. will be evaluated.

6.2 FMEA LeTriple Basic

The failure mode and effects analysis (FMEA) is a technique that analysis the possible failure modes of a working product or system (Put J. v.d., 2004). In this case, the LeTriple Basic will be analysed. Both, the product and process will be evaluated. Improving the product and the process will increase the operational reliability. This will eventually lead to lower costs (Put J. v.d., 2004).
Sowecare B.V. wants satisfied customers; in order to reach this a qualitatively good product design is needed. This decreases the risk and prevents dangerous situations. The primary objective of the International Standard ISO13485:2012 is to facilitate harmonized medical device regulatory requirements for quality management systems. The quality management system (ISO 9001: approved 2008) Sowecare B.V. takes into account is part of the risk management system. Sowecare B.V.'s research and development department executed the risk analysis (Damhuis M. O., 2011). In this paragraph the FMEA will be analysed. Norm NEN-EN-ISO 14971 centralizes that the risk exists of two components: the chance of danger and the consequences of the danger. Sowecare B.V. included one more factor in their analysis namely "chance of finding the failure" (Damhuis M. O., 2011). The three risks are ranked, a high number is bad because after the ranking the risk priority number will be calculated by multiplying these ratings, the outcome may not be higher than seven. Taking these requirements into account the structure of the FMEA is made. The outline is based on the outline which is used by NASA (NASA, 2008). Table 2. Example FMEA LeTriple Basic shows three examples of how the FMEA is structured.

"Chance of failure" is divided from 1 to 5. Some parts are more likely to fail. All the failures are registrated in an overview (Damhuis M. O., 2015-2016). The services

are registrated Rating 1 means unlikely and rating 5 means most likely to happen.
1. Unlikely: it is 1 in 10.000.000 times when a product is used.
2. Not likely: it is 1 in 500.000 times when a product is used.
3. Occasionally: it is 1 in 10.000 times when a product is used.
4. Probable: it is 1 in 500 times when a product is used.
5. Most likely: it is 1 in 10 times when a product is used.

"Consequences of failure" is also divided from 1 to 5. Rating 1 is negligible and rating 5 is catastrophic.
1. Negligible: a pain which is gone the same day.
2. Small: a scrape that does (almost) no pain.
3. Seriously: not permanent injury which temporarily restricts a person, such as a small bruise.
4. Critical: permanent injuries, but not restricted like a large wound or permanent injury which limits a person for quite a long time, like a big bruise.
5. Catastrophic: is permanent injury which limits a person in his / her activities or serious not permanent injury such as a broken bone or injury which results in death.

"Finding the failure" means the chance that the cause of failure will be found. This is important for the service mechanic. If the failure is easy to find and he can quickly repair it, the customer will be more satisfied. The scale of the risk goes from 1 to 1.5. This is done due to the fact that this is less important in relation to the other two risks. Giving the risk the same scale the Risk Priority Number would increase. That would not be fair because of the lower importance. Therefore, the change is split up in 1 and 1.5.
1. Normal - high chance to find the failure.
1.5. Small chance to find the failure
(Damhuis M. O., 2011).

With this information the FMEA can be analysed. This analysis is necessary because the rating of the FMEA is subjective. Checking the failures and the ratings gives an overall knowledge of how the failures are rated. Failures that are added to the FMEA (red in the FMEA, appendix E) should be rated equally.
The action plan to set up and fill in the FMEA is as followed (Damhuis M. O., 2011):
1. Divide the product in subsystems because it is easier to think of failures per or in subsystems.
2. Analyse the functions of the subsystems and think of the several parts.
3. Determine the possible failures.
4. Determine the cause of each failure.
5. Determine for each failure the chance the failure will occur (scale 1-5).
6. Determine the consequences of each failure.
7. Rate the consequences of each failure (scale 1-5).
8. Rate the chance that the cause of the failure will be found (1-1.5).
9. Calculate the Risk Priority Number by multiplying the change rating, consequences rating and chance of finding the cause rating.
10. All risks that have a Risk Priority Number higher than 7 should be evaluated.
11. Lower the Risk Priority Number.

Decreasing the Risk Priority Number means that something about or in relation to the product must be improved. First thing that must be tried to improve the product is redesigning (part of) the product. If that is no possibility some extra measurements must be taken to cover the risky parts. So the user is protected. If it is not possible the change the product, the user should wear protection. And if even that fails some warnings should be added to the product, the product manual or other product information. When a Risk Priority Number less than eight is reached, the product is approved and it is responsible to sell the product. Luckily, the improved version of the FMEA of the LeTriple Basic includes no Risk Priority Numbers higher than six.
The improved version of the FMEA of the LeTriple Basic is an enlargement of the possible failures. During the development of the manuals more knowledge about the LeTriple Basic is gained. Those insights are used to create an updated FMEA. The FMEA is important as risk analysis to prove to the public health and to increase the trust of the company. A more extended FMEA will give more prove of quality product. Being able to show that the risk is thought trough will convince the inspector of the public health more. It is impossible to mention everything that might be possible. The FMEA includes now the most crucial, important or obvious failures. A remark per added failure is described in table 3. Explanations improved FMEA LeTriple Basic, which can be found on the next two pages. Even though there are multiple failure modes, often the effects of failure are (almost) the same in nature. So the outcome of any component failure may result in the same cause (NASA, 2008). The explanations are therefore sometimes the same. The complete version of the FMEA of the LeTriple Basic can be found in appendix E.

6.3 Maintenance

Maintenance is defined as a process in which working condition of plant or machinery is maintained at the optimum level as to give maximum output. Maintenance is done through repair, partial replacement and total replacement (policy, 2016).
Maintenance policy ensures that companies are always prepared to maintain the asset or product reliable, available and safe. Trying to avoid problems and downtime in order to save money. Take preventive actions for problems that could occur is the best preparation. Equipment should always be ready and in reliable condition. This ensures that the company is able to respond to any changes in demand. So the costs and production will not increase or dangerous situations will occur (policy, 2016). Especially in healthcare, it is important to avoid failure during actual operation because it can be dangerous or disastrous. Therefore, maintenance on the products of Sowecare B.V. is necessary. Maintenance can improve reliability, availability, maintainability, safety, security, health, environment, economics and politics (RAMSS-HEEP) (Wang, 2002).
To get a clear overview of which improvements are the most important in this case, a brief explanation of each aspect is given by W. Wagner.
- Reliability: indicates the failure probability of a system in which its functions cannot be fulfilled.
- Availability: indicates the time duration in which the system is functional and its functions can be fulfilled.
- Maintainability: the ease in which the system can be maintained over time.

• Safety: the absence of human injuries during using or maintaining the system.
• Security: a safe system with respect to vandalism, terrorism and human errors.
• Health: the objective argument of good health with respect to the physical, mental and societal views.
• Environment: influence of the system on its direct physical environment.
• Economics: a serious reflection in terms of costs versus benefits (as well direct as indirect) to provide more insight for an economical responsible choice.
• Politics: a rational decision on all the previous aspects (W. Wagner, 2014, p. 704).

In case of the service of the LeTriple Basic the reliability is important because indicating the failure rate gives indirectly an indication of the amount of services. Moreover, the maintainability is very important because it is important that the reparations can be done quickly. Quick (and of course good) reparations will increase the user satisfaction. Also when a service must be carried out quick, the actions to accomplish this service should be easy. This is an advantage for the service mechanic. The FMEA is developed to analyse aspects such as the reliability and maintainability (W. Wagner, 2014). Both reliability and maintainability will be explained in the next paragraphs.

Maintenance is always related to costs and investments. It depends on the vision and the kind of product that is developed. The complexity of the product in general says something about the maintenance cost. The more complex the product, the higher maintenance costs are. It also depends on the quality of the product and if there are electrical parts included. The MTBF (Mean Time Before Failures) of electrical parts is lower than the MTBF of mechanic parts (Verwoerd). Nevertheless, it starts with designing the product. A well designed product, of which is thought about maintenance and FMEA during the design process can be developed in such a way that already known possible failures are tackled. Also it has to be taken into account that the product should be user friendly as well for the end user as for the assembler and service mechanic.

Name & function / performence requirement	Potential failure mode	Potential failure effects	Criticality	Probability	Detection	Risk Priority Number	Remark*
Slippping wheels	Plump in the LeTriple Basic	Slide backwards with the chair	2	1.5	1	3	
Loosen bolts (vibration)	Bumpy floor	Seat / frame can loosen	4	1	1	4	
Battery pack shoves from seat support	Nylon sleeve is broken or lost	High-low column cannot be used	4	1	1.5	6	

*The remark are written in table 3. Remarks improved FMEA LeTriple Basic

Table 2. Example FMEA LeTriple Basic

Potential failure mode	Potential failure effects	Remark
Chassis and high-low column		
Slippping wheels	Plump in the LeTriple Basic	The wheels were not included in the FMEA, though it is possible that there occurs a failure. Despite that the wheels are on brake, the chair could slip over the floor, when someone plops in the chair. The slipping will happen the same way it would have happen in a normal chair without wheels. This can result in the user slipping with the chair or the chair slipping without the user. In the last case the user falls down in front of the chair. Because the results differ a lot in consequence, this failure is split up. The result is the same as slipping in a normal chair, most of the user of the LeTriple Basic are also able to sit in a normal chair so the risk will be the same and moreover this means that they will be able to handle sitting in a normal chair and dealing with the possibility of slipping.
	Plump in the LeTripple Basic	See previous explanation.
Wheels are stuck	User bumps into something with the LeTriple Basic	Damage of the frame will decrease the strength of the frame. In the most extreme way the frame could break after some time. Though the frame is designed pretty well and can handle some bumps. The chance it will happen is small because the frame is not bigger than the seat with armrests.

Potential failure mode	Potential failure effects	Remark
Loosen bolts (vibration)	Bumpy floor	Because the LeTriple Basic may only be used inside the house the chance of (constant) bumpy floor is very small.
Control box does not work	Disconnected cable	If the control box does not work anymore, the high-low column cannot be used anymore. This is an important function of the LeTriple Basic, so it must be repaired quickly. Nevertheless, the chair can still be used as "pedal" chair. A big problem will occur when the high-low column is in the highest position and the user is stuck in the chair. This consequence is included in the high-low column failure (see appendix E - FMEA LeTriple Basic)
	Damaged cable	See previous explanation.
	Battery pack empty or defect	See previous explanation.
Battery pack shoves from seat support	Nylon sleeve is broken or lost	The battery pack is also needed for the high-low column, therefore the previous explanation counts. Moreover, if the battery pack and cable are lying on the floor the LeTriple Basic cannot be used as "pedal" chair anymore.
Cable clips break	Screw too tighten or cables are pulled	Cable will hang on the ground, this can be dangerous when driving over or when they get stuck behind something.
Buttons manual control are stuck	Rough usage or failure of the purchasing part	It depends on which button got stuck; the chair will go down or up. Down is not a dangerous problem for the user. Up can be a dangerous problem (see the explanation about the high-low column).
Cable(s) is / are broken	Wrong usage	The high-low column cannot be used. Moreover there could something happen with the broken cable in relation to open wires (fire or electrical breakdown).
Upper part		
Control handles break or bend	Extremely usage	Back angle adjustment and tilt adjustment cannot be used.
Plastic grip shoots from control handle	Glue does not work or is forgotten during assembly*	Obnoxious use of the control handle. This is only uncomfortable but does not limit the function of the LeTriple Basic. *This should be added to the 'control list before sending'.
Retaining stopper is lost	Retaining stopper is lost	Backrest slide out of the seat support, the LeTriple Basic cannot be used, or at least not with backrest.
Bolt back angle adjustment or tilt adjustment is loosen	The bolt isoosened by vibrations	Adjustments cannot be used properly. The LeTriple Basic is uncomfortable or the chair cannot be used anymore. The bolt must be screwed in order to adjust the LeTriple Basic.
Missing parts during service	Not broken parts can get lost during the break so the user does not have it anymore and the service mechanic did not bring it	Service cannot be done. This is a huge failure. In order to prevent this failure the parts that could possible get lost during the break-down are included with the new part that the service mechanic takes with him. Together with the service manual an overview is made with the parts that are necessary for a service. This overview is attached to the report, named: services overview.
Options		
Headrest breaks	Wrong material	When the headrest breaks, the backrest is probably damaged. The headrest cannot be used anymore and it is possible that the backrest also cannot be used anymore. So the LeTriple Basic can probably not be used anymore.
Remainders		
Sharp edges or corners	Bad workmanship of un-assembled parts	The assembler could get hurt. But probably a scratch, which is not good but not disastrous. Sowecare B.V. could make a notification and send it to the seller of that part.

Table 3. Remarks improved FMEA LeTriple Basic

6.4 Corrective, preventive and predictive maintenance

There are three types of maintenance: corrective, preventive and predictive maintenance (J. Braaksma). Corrective maintenance is done after failure. It is a strategy that is used to repair or replace some parts to its required function after it has failed (Wang, 2002). This can lead to high production loss and maintenance costs (Tsang, 1995). Corrective maintenance can be split up in two types. Firstly, planned corrective maintenance, this includes a run-to-failure maintenance plan. This means that the maintenance will be done after the failure. Though, the company is prepared to these failures and has maintenance parts in stock, service can directly be planned. The other type is unplanned maintenance, like reactive maintenance. There is no plan and therefore this type is even more costly than planned maintenance (Inc, Corrective Maintenance, 2016).

Preventive maintenance is done before the failure even occurs. By systematic inspections, detection and correction of incipient failures, the incipient failure can already be solved. Thus, the goal of preventive maintenance is to decrease the failure rate or failure frequency of the product. This will lead to lower failure costs and machine downtime (S.J.H. Usher, 1998). Preventive maintenance can be split in two different types: time based maintenance and condition based maintenance. Time based maintenance focusses on failure time data or used-based data. Time based maintenance assumes that the failure behaviour of the equipment is predictable. This bathtub curve shows this prediction, which is based on hazards or failure rate trends, as shown in figure 12. Bathtub curve (R. Ahmad, 2012). The Bathtub curve assumes that in the beginning of the life cycle, the failure rate will decrease. Thereafter a steady period, this includes the useful life of the product. When this period is over the end of the life cycle is reached and the product increases failure rates (Ebeling, 1997). This is illustrated in the figure below (Wyatts). Analysing the failure data and investigating the failure characteristics of the product the failures can be predicted.

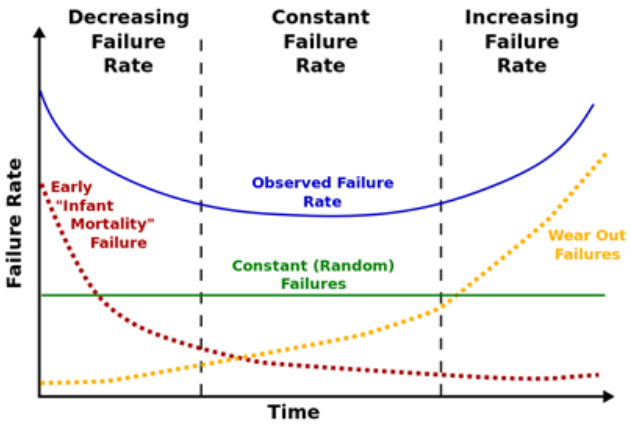


Figure 12. Bathtub curve

Predictive maintenance is the third type of maintenance. The aim of predictive maintenance is to predict when the product might fail and moreover to prevent occurrence of the failure by performing maintenance. Predictive maintenance creates a low maintenance frequency. As a result, unplanned maintenance can be prevented, without incurring costs associated with doing too much preventive maintenance (Inc., 2016). Condition based maintenance is a maintenance program to predict the failure. To give useful feedback about the chance of failure, the product is monitored. Measuring several parameters like vibration and noise levels give an overview of the conditions of the product. Condition based maintenance assumes that failures are always preceded by certain signs, indications, or conditions that the failure is going to occur (H.P. Bloch, 1983). When those signs are detected maintenance activities will be performed. Thus, just before the failure the product will be fixed and therefore no failure will occur.

Sowecare B.V. applies corrective maintenance for their products (except from the LeChair, preventive maintenance). The reason for this is that most dealers are not interested in non-corrective maintenance, because of the higher costs. Most of the maintenance is planned. For the LeTriple Basic all the maintenance is planned because the parts are always in stock. Though for the "specials" of the other chairs this is not possible. Sowecare B.V. cannot have a stock of all the special parts that would be too expensive. What they do check is making sure they can directly make or order these parts so they will receive it quick. The advantage of corrective maintenance that is planned, is that nothing has to be scheduled in advance. Only planning a service after a breakdown. Moreover, it is pretty simple and therefore easy to implement (Inc, Run to failure maintenance, 2016). The owner (dealer or user) has to pay for the preventive maintenance, which they find too expensive (especially abroad). Executing preventive maintenance would cause a lot of travelling time and therefore be very expensive. A solution could be that the dealers and health care insurance to who they sell their products execute maintenance but that would also cost money, which might be too expensive. Predictive maintenance could be an outcome to Sowecare B.V. though they do not sell mass products and there are a lot of "specials" so it will be harder (and more expensive) to predict the failures for each chair.

6.5 Maintainability

Maintainability says something about how quick a service (corrective, preventive or predictive) could be executed. The core of the time lays down in the design of the product. If the design is relatively easy to execute, a service can be carried out in less time and also less labour hours are required (W. Mulder, 2012). This will of course also save money. Product maintainability design deals with those features and characteristics of the product that will increase ease of maintenance, make maintenance more cost-effective, and in turn lower logistic support needs (Dhillon, 1999). In the book "Design for maintenance" thirteen rules are given to improve the product to lower the service time (W. Mulder, 2012). These rules are analysed in relation to the design of the LeTriple Basic.

- Rule one: "Use materials that do not prolong maintenance activities". In case of the LeTriple Basic for a lot of parts this rule is taken into account, for example the use of hex key bolts. But on the contrary still some screws are used to assemble the manual control. Moreover, all the parts of the LeTriple Basic are galvanized to prevent corrosion.

• Rule two: "Use standard, universal applicable components". This is especially important for the services; the dealer mechanics have probably a standard tool package. Therefore the services of the LeTriple Basic must be done with standard tools, so in every country the service mechanics can repair them. Additionally, the less different tools the mechanic needs (this is also the case for the assemblage of the chair) the quicker the assemblage or service will be done. The mechanic does not have to search for a different tool every time.
• Rule three: "Use fasteners that accelerate maintenance activities". For assembling the complete chair this is (almost) impossible. Nevertheless, for the services this could be an outcome. The more parts that could be replaced or adjusted without tools the quicker and easier the service will be. The backrest, battery pack and control box (if you do not count removing the seat) are replaceable without any tools.
• Rule four: "Ensure that the operators of installations are also able to maintain them". So no technicians need to be called up for maintenance. This rule applies for the user manual, which will not be taken into account in this report.
• Rule five: "Provide sufficient space around the maintenance points". Space for tools is something that should be taken into account during the development phase. This point is taught through for the LeTriple Basic. There is only one problem, the swivel wheels (front) are purchasing parts are not so well designed. To assemble the wheels a special key is needed because there is no space for a standard tool.
• Rule six: "Design equipment in such a way that it can only be maintained in the right way". Poka-Yoke is a technique for avoiding human error at work (M. Dudek-Burlikowska, 2009). Rule six states the same. The conviction behind Poka-Yoke is that it is not acceptable to produce even a small number of defective goods (Shimbun, 1988). This technique can be used to design products so shutdowns, controls and warnings can be prevented or reduced. Moreover, this will result in standardization of LeTriple Basic (goal of the manufacturing manual).
• Rule seven: "Components that are regularly replaced need to be easy to transport". None of the parts of the LeTriple are too big to transport. The parts are packed in boxes and transported.
• Rule eight: "Guarantee safety by the design". This is perfectly included in the design of the LeTriple Basic. For example, the battery pack is a tight box which the service mechanic does not have to open. If there is something wrong a new battery pack will be sent.
• Rule nine: "Design modular". The armrests and seat support are sub-assemblies that can be repaired as a module at a different place.
• Rule ten: "Use standard interfaces". This rule is not applied to the LeTriple Basic, but on the other hand it is hard to use standards for such specific chair.
• Rule eleven: "Design the weakest link". When you design a product you know what the weakest part is. Therefore, you must ensure that the weakest part can be easily replaced or repaired. As a result, the failure would not have major consequences.
• Rule twelve: "Position components that often need to be maintained at an easily accessible place". Developing your product like this will make profit when a service has to be done. Almost every part of the LeTriple Basic is easy reachable, so it is no problem for services. The most difficult part is the high-low column, though it is the core of the product and therefore more difficult to replace.
• Rule thirteen: "Position the maintenance points near to each other". This rule is not applicable for the LeTriple Basic because it is not a huge system so all the maintenance points are already close to each other.

6.6 Reliability

Reliability of a product influences the failure rate and the probability of proper functioning for a specified period of time (W. Mulder, 2012). You can count on high reliable product, when you need them, they will function. Reliability centred maintenance (RCM) is a method for optimizing and develop preventive maintenance program of a subsystem with the goal to have a high availability against low costs (J. Braaksma). In the book "design for maintenance", is also a part included for the rules for reliability (W. Mulder, 2012). These rules will be evaluated the same as the rules for maintainability.
• Rule one: "Design-out moving parts". Unnecessary movements need to be avoided. When the product is installed the only moving part of the LeTriple Basic is the high-low column, but this part cannot be designed-out because it is one of the unique functions. The advantage is that it is one part and only bottom and top are assembled with the other parts, so the movable part of the high-low column cannot cause friction with the other parts.
• Rule two: "Avoid unnecessary components". Non-essential components must be eliminated. The LeTriple Basic is a simple standard chair which exists of way less components than the other chairs of Sowecare B.V. During the internship the focus did not lie on improving the LeTriple Basic so it is not possible to give some underpinned feedback on this part. However, the function of the reinforcement pin is unclear (see paragraph 13.5 about the recommendations). This should be investigated and removed if the function is not essential.
• Rule three: "Avoid non-rigid parts / avoid rigid parts". There are advantages of rigid and non-rigid parts that need to be taken into account when designing a product. It depends on the functionality which one fits best. The LeTriple Basic only exists of rigid parts (except form the cable, but those have no mechanic function). Taking the functions of the chair into account, it is not necessary to have non-rigid parts. The advantage in general of rigid parts is that the last for a longer time period.
• Rule four: "Design for understressed use". Design the product in such a way that it is only a few situations is operating at full capacity. So the normal loads and peak demands can be handled. The high-low column of the LeTriple Basic is chosen based on the peak moments of the chair, with maximal weight. It always depends on the user what the peak moments are.
• Rule five: "Provide redundancy". Reliable systems have a back-up component that can overtake the task of the component the failed. The LeTriple Basic does not have such back-up component. In this case it is not that important. The users of the LeTriple Basic are not people who are dependent of the chair. They will not be satisfied with a break down but that is not worth the increase of money to include a back-up compo-

nent. The only disastrous problem that could occur is when the high-low column stops working when the chair is in the highest position. The LeTriple Basic is designed by taking safety factors into account. This means that dimensions of critical components are developed larger than minimal required.

- Rule six: "Overdesigning components". Dimension critical components larger than minimal required. This is not investigated during the bachelor assignment and therefore hard to give a proper comment about.
- Rule seven: "Choose materials that can withstand environmental influences". The LeTriple Basic is used indoor. Using the chair only indoor will decrease the bad environmental conditions in which the chair has to operate. In the user manual is advised to use the chair only indoor and between a temperature of 0° C and +40° C and a relative humidity of 20-80% without condensation. Moreover, the chair is coated and plated so it will be resistant to corrosion. Only damaged parts have a chance of corrosion. But looking at the environment (room temperature) this will not be a problem.
- Rule eight: "Do not use coated, painted or plated components". Despite that the LeTriple Basic is plated and coated (as said in the previous step). This option is still chosen because the LeTriple Basic may be only used inside the house. This decreases the the chance of repairs and so maintenance activiteies. The maintenance costs do not outweigh the cost of materials that do not need maintenance.
- Rule nine: "Use components and materials with verified reliability". Sowecare B.V. uses parts with a CE marking and tests the combination of those parts. In addition, they test the complete product according to the Dutch norms. However, they are pretty unique with their "pedal" chairs, those chairs are only made in the Netherlands and Scandinavia, which makes it impossible to use of verified and reliable components, is hard.
- Rule ten: "Design robust interfaces between components". Interaction between components has strong influence on the reliability of the system. Interfaces in this case mean the connectors, gear contacts, bearings, and etcetera (W. Mulder, 2012). The seat support of the LeTriple Basic is the most important component in relation to connection because almost all the parts are connected to the seat support. Most connections of the LeTriple Basic are designed that they fit to each other, like the head of the high-low column and the pot of the seat support or the construction of the armrests. Despite that, these constructions must be fixed with bolts.
- Rule eleven: "Use parallel subsystems and components". There are no parallel subsystems developed in the LeTriple Basic. So if one component fails, there is not another who catches up the failures. But in general the chair does not include systems that could be adapted to a parallel system. Only the swivel wheels are parallel, nevertheless those are not a parallel subsystem.
- Rule twelve: "Distribute workload equally over parallel subsystems or components". This step is not applicable for the LeTriple Basic because the chair does not include parallel component as explained before.

6.7 Replacements

Replacements represent indeed also a very important step to the products of Sowecare B.V. in the maintenance programme. Dealers buy the chairs from Sowecare B.V. and lease-lend them to their customers. When a customer needs another chair for example the old chair will be lent to someone else. The options need to be adjusted to the preferences of the new owner. Therefore replacements of for example the seat need to be done. The replacement can be an adjustment for which no new parts are needed to adapt the chair. But as said, a seat needs to be replaced by another seat that fulfils the wishes of the new customer. Replacements are almost always the same as disassembling a part and then assemble the new part. Sometimes they are explained easier. Adjustments do not remove a part with another but just change some settings of a specific part.

7. SERVICE ANALYSIS

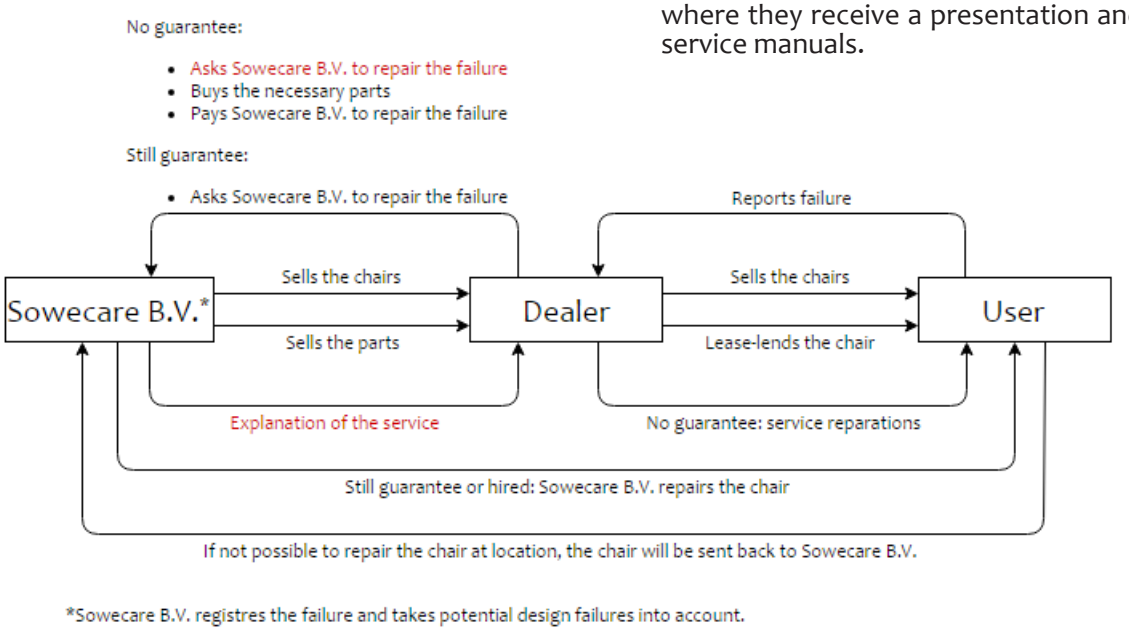
7.1 Current and future approach

At the moment there is no standard procedure for services, at least not abroad. In this paragraph is explained how the services in the Netherlands and abroad are done. These approaches apply for all Sowecare B.V.'s products. Figure 13. Current and future approach shows the relations between Sowecare, the dealer and the user. The red lines will not be necessary anymore in the future.

7.2 Communication between Sowecare B.V. and dealers

At the moment, most communication is by phone, email or both. There is nothing wrong with the medium of communication. But the information that has to be shared is a bit complex for these mediums. If it includes repairs or adjustments it is hard to describe this only in words. Therefore Sowecare sometimes sends a photo. But they do not have these on a database or something, so every time it takes time to send the right instructions to the dealer. The service manual is an outcome for this problem. If the dealer asks for information about a repair they can quickly search for the right pages of the service manual and send those to the dealers. Only the necessary parts are sent so there will not be a misunderstanding and it will save time for the dealer. Dealers in the Netherlands can choose for the dealer training session, where they receive a presentation and the complete service manuals.

Services in the Netherlands and abroad***



*Sowecare B.V. registres the failure and takes potential design failures into account.

**The Neterlands also included place closely to the boarder.*
***Abroad guarantee differs per contract that is made.*

Adjusments in the Netherlands and abroad

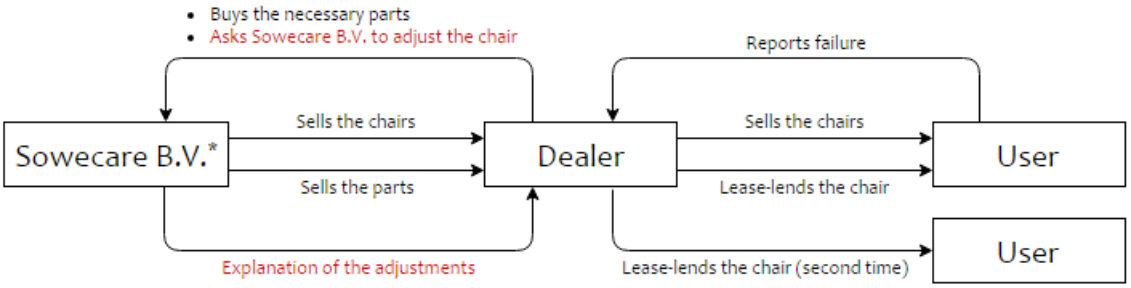


Figure 13.

8. MANUFACTURING MANUAL

8.1 Relevance of the manufacturing manual

As explained in, Sowecare B.V. would like to have a documentation of the production process. Therefore, a manufacturing manual which describes the assemblage of the LeTriple Basic would be an outcome. In general, a few persons know how to assemble the chairs. Those persons get the orders from the workplace manager and start working. The LeTriple Basic is a relatively new chair and only a few know exactly what to do. The others assembled this chair maybe once or twice. So if the persons who assemble normally the LeTriple Basic are not available, problems can occur. Problems such as; not know how to assemble or not assembling in the same way. The manufacturing manual is an outcome to that problem because required information can be found in this documentation. Moreover, when a new employee has to learn how to assemble the chair it can use the manufacturing manual to learn it step by step.

8.2 Requirements of the manufacturing manual

- The manufacturing manual must be understandable for the assemblers.
- The manufacturing manual should at least include the main assemblage of the LeTriple Basic.
- The manufacturing manual should be made in InDesign.
- The size of the manufacturing manual should be A4.
- The manufacturing manual should give an overview of manufacturing tools of the LeTriple Basic.
- The manufacturing manual should give an overview of manufacturing parts (spare parts, bolts, nuts, and etcetera) of the LeTriple Basic.
- The manufacturing manual should give asembly time indication.
- The manufacturing manual should give a clear overview of the actions that must be done.
- The manufacturing manual should give an explanation of the content and instructions that are used in the manual.
- The instructions of the manufacturing manual should include:
    - o Instruction photos;
    - o Instruction text (but the pictures should ex plain the most);
    - o If necessary 3D pictures instead of a photo.
- Important information in the manufacturing manual should be highlighted.
- Cautions and tips should be included to the manufacturing manual.
- Sowecare B.V. corporate style should be applied to the manufacturing manual.
- The standard configurations of the LeTriple Basic must be included to the manufacturing manual.

8.3 Parts and tools LeTriple Basic

To get an understanding of which parts and tools are used to assemble the LeTriple Basic, several observations of the assemblage are done. As a result, the list of parts and the list of tools could be made for the manufacturing manual (these can be found in the manufacturing manual in losse toevoeging). It turned out that there are still a few steps that need to be done to create full consistency. Therefore, the best names (meaning logical and understandable) are chosen for the parts of the LeTriple Basic. Those names are listed and used in both manuals. Consistency will improve the production because when someone is talking about a part, everybody knows what is meant by that. Less miscommunication between the employees will improve the working environment. In order to assemble the LeTriple Basic several tools are needed. Most of these are standard tools, but one tool is specially made for the swivel wheels, the swivel wheels are purchased parts and unfortunately cannot be mounted with available standard tool (see the recommendations 13.2 on this part). Within the company this is not a problem. However this is a problem for the services that will be or are done by dealers. There are some things that could be improved, regarding to the parts and tools of the LeTriple Basic; these things are listed in the recommendations.

Using standard tools to assemble is very important, because it makes it possible to sell your product worldwide without someone having trouble with the reparations or adjustments. Moreover, less tools decreases the assemble time (W. Mulder, 2012) (W. Mulder, 2012). Nevertheless, standard tools depend on the situation, what has to be assembled? In case of the services and assembly of the LeTriple Basic, it would be best if there is no need of drilling, tapping, scraping or reaming. Preferably do not use tools that have a battery, because the battery can die.

8.4 Concept manufacturing manual

To fill in the content of the manufacturing manual several assemblages of the LeTriple Basic are observed and questions about assemblage order and technics are asked. For good communication something more is needed than just instruction lines and pictures. The instructions and pictures are the core of the manual. An informative content that can be used as overview, a tool list, a list with parts and an exploded view are needed. Despite that, the instructions and pictures need an upgrade and have to be combined. In this manual is chosen for steps (1, 2, 3, …) and sub steps (a, b, c, …) which explain the specific actions. These letters can be found in the pictures that show what is meant by the instruction. Arrows and circles and zoomed pictures make the instructions more understandable. Because it is not possible to explain everything by pictures, textual instructions are needed; those instructions can be found below the picture and explain the actions in more detail. In or after each step the necessary tool is mentioned. Also the parts that are need are highlighted. If a part is new and should be added to the assemblage it is written in Italics. When there are some important side notes that are necessary for the step, these are explained below the step. These notes or called "caution" when it is about something important which is necessary to assemble the product as it is tested. Without the "cautions", problems will occur. "Notes" as they are called, are small tips or related to the design or to the way of assemblage. It will make the action easier or the product prettier. In appendix F these choices are highlighted. The complete manufacturing manual is attached to the report.

8.5 Testing the manufacturing manual

Before testing, the manual was checked and read a few times. The members of the technical team gave feedback. The technical team exists of the director, the workplace manager, the person who makes the prototypes and the product developer. After processing the feedback several times the manual was read by a service mechanic of Sowecare B.V. who was enthusiastic and found the manual understandable. A assembler looked over the manual and gave the pictures some extra attention. He was also satisfied. Finally the manual was ready for testing.

To gather good feedback from the test an assessment form was designed, at this form the test person could assess every step. Every step could be assessed by filling in the scale from 1 (clear) to 5 (not clear). Clear means that all sub steps were understood and not clear means that you did not understand most of the sub steps and therefore could (almost) not perform this step. If the grade was not one, an explanation was asked, this explanation is written down. The assesment form including the results and feedback can be found in appendix G. The test is done at the workplace of Sowecare B.V. The required tools and parts were divided over two tables so the test person had a good overview and does not have to search in the toolbox for the right tools. The manual was in hand of the test person and he was observed to see what happened.

The test person was a layman who knew the chair and its possibilities but not how the chair is assembled. The person was capable of giving underpinned feedback. This description is not the definition of the people who have to work with the workplace manual, despite that this person knew less, so it can be concluded that if the manual is understandable for this person it will be understood by all the assemblers of Sowecare B.V. Because the employees who assemble the chairs at Sowecare B.V. have limited schooling, it was good choice to choose this test person. The only disadvantage of choosing this test person is that the employees do not prefer reading and that is why they are more dependent of the pictures. That is why the service mechanic and assembler already overlooked the manual, to check if the were satisfied with the pictures. It would have been best if the manual was tested several times, even with an assembler of Sowecare B.V. who is actually a suitable candidate, unfortunately there is not enough time.

The feedback is processed, most feedback were some textual changes. Although, one step had to be redesigned. This step was unclear during the test. Therefore this step is improved by making use of a picture from the 3D model. This gave overall overview. To make sure the step is now understandable another small test is done. A test set is made so only this particular step had to be done. For this test an intern is asked (this test can be found in the appendix H). He had never assembled the LeTriple Basic before (only once the LeTriple Wheels) so he has the same background knowledge as Sowecare B.V.'s mechanics have. He understood the improved version without asking something, both text and pictures were clear according to him.

8.6 Final concept manufacturing manual

After processing the feedback from the tests the final concept was ready. There are still improvements possible to make the manual in general more understandable. These improvements are explained in the recommendations (see chapter 3). This improvements can be taken into account developing the manuals for the other products but also to make a second version of this manufacturing manual. The final manufacturing manual is attached to the report.

9. SERVICE MANUAL

9.1 Relevancy service manual

The service manual is important for the dealers. The service mechanics of Sowecare B.V. know the chairs and know how to carry out repairs and adjustments. The service mechanics of the dealers do not know that because they do not work on a daily basis with Sowecare B.V.'s chairs. In the current situation the dealer requests service information from Sowecare B.V. (per service). The workshop manager or product manager then tries to explain what kind of service needs to be done and how, but this takes time. If the explanation is not well understood, problems can occur. Like the chair cannot be repaired or is wrongly repaired which can cause even more failures. The service manual will make it easier to help the dealers abroad because the information does not have to go over the phone or email with some quickly made pictures to illustrate. Moreover, the costs of a few parts are much lower than the shipping cost of a complete chair.
In the Netherlands Sowecare B.V.'s service mechanic will be sent to the customer. Abroad this is not possible because of the distance. These chairs must be sent to Sowecare B.V., which costs time and money. Because of the increasing export of the LeTriple Basic and thus the likelihood of repairs and adaptations, the service manual is an important communication tool. The relevant section will be sent to the dealer if a service must be carried out. With these instructions, the service mechanic of the dealer can independently carry out the service.

9.2 Requirements service manual

- The service manual must be made for the LeTriple Basic.
- The service manual should explain all services that can be done by a non Sowecare B.V. service mechanic.
- The service manual should be understandable for the dealer's service mechanics.
- The service manual should include an introduction and general information.
- The introduction must be readable in less than two minutes.
- The general information must be readable in less than one minute.
- The service manual must prevent unsafe actions.
- The service manual should be made in InDesign.
- The size of the service manual should be A4.
- The service manual should give an overview of the tools that are needed per service.
- The service manual should give an overview of the parts (spare parts, bolts, nuts, and etcetera) that are needed per service.
- The service manual should give a time indication per service.
- The service manual should give a clear overview of the actions that must be done.
- The service manual should give an explanation of the content and instructions that are used in the manual.
- The instructions of the service manual should include:
    - o Instruction photos;
    - o Instruction text (but the pictures should ex plain the most);
    - o If necessary 3D pictures instead of a photo.
- Important information in the service manual should be highlighted.
- Cautions and tips should be included to the service manual.
- Sowecare B.V. corporate style should be applied to the service manual.
- The standard configurations of the LeTriple Basic must be included to the service manual.

9.3 Maintenance parts LeTriple Basic

The FMEA that is presented in paragraph 6.2 shows the most crucial components. These parts have more chance of failure. To execute corrective, planned maintenance it is important to know which parts should be in stock. In the FMEA the following parts are included:

- High-low column (replacement)
- Battery package (replacement)
- Cables from the high-low column, control box and manual control (replacement of the complete part)
- Brake (replacement and adjustment)
- Wheels (replacement and adjustment)
- Control box (replacement)
- Cable clips of the manual control and high-low column (replacement)
- Manual control (replacement and adjustment)
- Armrests (replacement and adjustment)
- Seat (replacement)
- Backrest (replacement)
- Upholstery of the seat and backrest (replacement of the complete part)
- Control handles (replacement and adjustment)
- Footrest (replacement and adjustment)
- Headrest (replacement backrest)
- Charger
- Frame
- Seat support
- Bolt back angle adjustment or tilt adjustment

Except from the headrest, charger, frame and seat support all the parts are included in the service manual. The product manager and workplace manager assume that those are acceptable parts for services. Though, when the cables of a part are broken the

whole part must be replaced. The same goes for upholstery. A new seat or backrest must be placed in order to solve the problem with the upholstery. The cable clips are not included with a special paragraph in the manual but if they are broken the paragraph of the high-low column or manual control help to attach new cable clips. The headrest can be replaced or added by replacing the complete backrest. Only Sowecare may attach the headrest to the backrest (because this is more than only assembling). The dealer can buy a new backrest with headrest and assemble both to the current chair. The seat support is complicated to repair. For the frame the same reason applies as for the seat support. Luckily, it never happened that something went wrong with one of those parts (Damhuis M. O., 2015-2016). The charger is a very vulnerable part, but also easy to replace. The charger is not included in the service manual because no service mechanic is needed. The user is able to use the charger him- or herself. The instructions of the charger are included in the user manual. Lastly, the bolts for the adjustments, this is not included in the service manual because it almost never occurred. Though it would be a good idea to include this in the next version of the service manual to prevent possible questions and problems.

9.4 Replacing parts LeTriple Basic

There are some rules about replacing parts of the LeTriple Basic. The CE stamp only covers the original Sowecare B.V. parts. This means that replacing is only allowed if you replace a Sowecare B.V. part for another. The options of the LeTriple Basic could be replaced for one another. In case of the LeTriple Basic the dealers are allowed to replace all the possible options by themselves. Some few notes about the translation from the option form to the possible services: first, changing the fabric means changing the seat (with fabric). Second, only Sowecare B.V. can replace a standard backrest to a high backrest. Finally, the headrest can be replaced by the dealer but only including the backrest. If the dealer would like to adapt something else they have to take some action before they can do that. This will be explained in the dealer presentation, chapter 10.

9.5 Adjusting parts LeTriple Basic

Currently, most customer complaints are about the settings (Elbertse, 2016). Often these settings can be easily adjusted to the preferences of the customer. Unfortunately, not all the dealers know that. Especially the adjustment for which no new part is needed should be done more often. The user will be more satisfied, which important to Sowecare B.V. More user satisfaction will result in customers who buy more chairs form Sowecare B.V. but also spread a positive word about Sowecare B.V. Presenting the dealers the several services they can do and sending them a dealer presentation they will gain more knowledge about the products of Sowecare B.V.

9.6 Service tools LeTriple Basic

The tools that are necessary in order to execute the services are mostly standard tools. The only non-standard tool is needed for the standard front wheels. This tool will be delivered when the dealers asks for a service instruction of the standard wheels. Besides, the Cordless drill is a tool you preferably will not like to use because it works on a battery, which can cause problems with reloading. The wire nipper is a tool that is only needed for cutting the Tie-wrap. Improving the chair as mentioned in the recommendations, chapter 13, would reduce the amount of tools. More use of the same tools will improve the service itself and also the service time (W. Wagner, 2014). Nevertheless, improving the chair will not change the chairs that are already sold. This means that the service manual and this set of tools are still needed.

9.7 Testing the design service manual

Before making the service manual a few little tests were done. These texts were more about the graphic understanding. People like to understand in a blink of an eye the whole step. This means that the pictures have to be clear and should illustrate the action. In the service manual it is not only assembling, but also disassembling. To disassemble you have to unscrew, remove etc. The question arised how people will implement arrows in a picture if the task is the unscrew something. Seven people were asked for the test (the test can be found in appendix I). Three of them were directly clear about their choice. The other four thought about it and then choose the same option. A positive outcome that means that the arrow displays the direction parts must be assembled or disassembled.

The next question was about the ellipses (the test can be found in appendix J), making the manual it came through that of course not all pictures are the same. In the specific situation, is used in the test the problem the bolt are very close to each other. Therefore the arrows and ellipses make it unclear. Some others said that it did not mind if the ellipse was in the picture or not. Moreover, if you have the chair in front of you, it is very obvious what is meant by the picture. So, the yellow ellipses will only be used in pictures where the parts are less obvious.

9.8 Concept service manual

The concept of the service manual is based on the manufacturing manual. Above all, the graphic design is kept the same because there should be consistency between the manuals of Sowecare B.V. The content of the service manual is different. The focus of the service manual is based on different parts that need service. Therefore, the chapters represent each a part of the LeTriple Basic. This will improve the reading guide because if there is a problem with a part, that part can be searched for and then the paragraph with the matching service can be chosen.

The service mechanic needs to know which tools and parts are needed for the service. This differs per service and therefore the tools and parts are given per service. The necessary parts that are given per paragraph are the parts that must be ordered from Sowecare B.V.

The manufacturing manual includes one process, the service manual several, which is why the service manual has more confirmation sentences. Moreover, the service manual includes "checking points". These are a sentence that reminds you to check the functions of the chair, to know for sure your executed the service well. Each paragraph includes a single action; therefore the time frames are mentioned per paragraph. The notes and cautions are kept. Cautions include warnings; these are actions that must be taken in order to realize a good design. The notes include some extra information to prevent confusion or to give a tip about executing the action. In addition, some italic sentences are added, these sentences give some general information about the service in general. And of course the results of the test about the arrows and ellipses are included. The outlook of the service manual is shown in appendix K. Next to the introduction, some general information is added. The general information provides the dealer with information about executing services and rights

9.9 Testing the service manual

The concept of the service manual is read by the product developer. Because of time schedule it was not possible to test the whole service manual. Hence, the most crucial chapters are chosen for testing. Crucial includes the chapters that are not explained in the manufacturing manual and therefore never tested. New parts that are introduced in the service manual in comparison to the manufacturing manual are the armrests with manual control, 150 mm swivel wheels, the footrest and high backrest. Despite that all the options that make it possible to adjust a part to the left side are new. It is still a lot of work to test all those parts. Most instructions are the same for left and right so those are skipped. Only the ones that are different are at which problems could occur are included in the test. Moreover, the (dis)assembly of the column is tested because this step includes a lot of action steps which are more difficult than assembling the high-low column during the assemblage. To conclude, the first test will exist of the following parts: disassemble and assemble high-low column, adjusting preference side manual control from manual control under seat to manual control under armrest, replacing the brake handle from the right to the left, replacing swivel wheels by the 150 mm wheels. This test will be carried out by the product developer who never assembled the LeTriple Basic. Except from the development knowledge there is assumed she has the same background knowledge as for the service mechanics.
The second test includes adjusting the depth of the armrests and the assembly and disassembly of the footrest. This test will be carried out by an intern who has no technical background or knowledge of the LeTriple Basic. Though, these actions are simple and no background knowledge is needed. The high backrest is also new and should be tested but with no "test chair" and lack of time this step in left out of the test. Luckily this is not a complex step, which includes only a few actions.
The results of the second test were positive. The steps were easy to executed and did not cause problems or raise questions. The first test resulted in some useful feedback. The test including the results can be found in appendix L. Mostly, textual feedback such as a missing tool in the text. Also removing the high-low column cable is necessary to disassemble the high-low column. The same goes for assembling the high-low column and plug in the cable. Some trouble with the wheels, the picture of putting the wheels on brake does not match with the picture where the wheels are mounted to the frame. Using the brake handle is only possible by turning the brake handle backwards. This is not user friendly and should be solved. The last important point of feedback was about testing the electrical components after executing the service to know for sure everything is working again. This is included for all the chapters, are describe in the paragraph about the content of the service manual.
The feedback is processed. This means that every paragraph ends with a statement to check the components. In addition, the pictures of the wheels are improved so they match with each other. Some text about the high-low cable is added. Last but not least, the rest of the comments are processed. After improving the manual, the manual is send to the technical team for the final check, which is approved.

9.10 Final concept service manual

Now that the service manual is approved by the technical team it is finished and ready for use. Though, there are still improvements possible to make the manual in general more understandable. These improvements are explained in the recommendation (see chapter 13). This improvement can be taken into account developing the service manuals for the other products but also to make a second version of this service manual. The final concept of the service manual can be found in.

10. EXAMPLE MANUAL

10.1 Relevance example manual

Sowecare B.V. strives to have a service manual (and manufacturing) of all their products. This will eventually save time and money. During the bachelor assignment the service and manufacturing manual are developed for the LeTriple Basic. A next intern has to develop the manuals for the other chairs. To develop the next manuals the same way as the manuals for the LeTriple Basic should be taken into account. Therefore, templates and some additional information are needed. The example manual is made to provide the person that will develop the other manuals with all the necessary information. So he or she can start making the other manuals on their own in the same way.

10.2 Requirements example manual

- The example manual should include a template of the manufacturing manual.
- The example manual should include a template of the service manual.
- The example manual should include or refer to some examples.
- The example manual should include some general information about making the manufacturing manuals.
- The example manual should include some general information about making the service manuals.
- The example manual should include some tips (also for observing how the chair is assembled).
- The example manual should include the recommendations for the service manual.
- The example manual should include the recommendations for the manufacturing manual.
- Sowecare B.V. corporate style should be applied to the example manual.
- Design of the service manual must be explained.
- Design of the manufacturing manual must be explained.
- The example manual should include the relevance of both manuals.
- The example manual should include a part of the target group of both manuals.

10.3 Concept example manual

To make the person who has to work with the manual already familiar, the graphic design is kept the same as the service and manufacturing manual. The manual starts with an introduction about the goal of the example manual, the goal of the manufacturing and service manual and the target group of both manuals. Next chapter is explained what the best approach is to develop the manuals and what things you have to do in order to be able to develop the manuals. First, all the information including tips and notes, are given for the manufacturing manual. Developing the manufacturing manual will give insights on the chair and provide you with a lot of information. The service manual can be made easier because a lot of knowledge that is gained by making the manufacturing manual. The example manual includes information about making the pictures for the manuals, writing the text, putting everything together, testing and finishing up. In the example manual is referred to other documents like the templates, the LeTriple Basic manuals by given the location of the document on the driver of Sowecare B.V. Last but not least the example manual includes recommendations to improve the manufacturing manual and service manual as they are now.

10.4 Test example manual

A complete test of this manual is hard to execute. There are no interns or employees who directly will start with developing the manuals for the other products. In order to become surer of the quality of the example manual, the manual is read by two other interns and the product manager. Both gave comments on the manual. Most comments were some small notifications, about grammar or word choices. The most important feedback was to include a part about why the services abroad are important (increasing market etc.). All the feedback is processed and a few lines about the "relevancy" are added. The interns think they will be able to work with the manual and had no further questions about the approach that is written down in the manual.

10.5 Final concept example manual

The exact locations of the necessary documents on the driver of Sowecare B.V. are added to the example manual. With the feedback processed the example manual is ready for use. The final example manual is attached to the report.

11.1 Relevance dealer presentation

A Dutch dealer of Sowecare B.V. asked a few questions in relation to services. This in order to be sure that the CE marking does not have to be removed for certain adaptions. Sowecare also wants that their products are handled well. The service manual can be used to make sure the dealer carries out the correct services. Nevertheless, some dealers would like to adapt the products with parts that are not included in the service manual. For these adaptions special rules are applicable. These rules are also included in the dealer presentation. So the dealer presentation will provide the dealer with information what to do when a service has to be carried out. Both are included in the service manual. After attending the dealer presentation the dealer will know exactly what to do when he or she wants to adapt something to a Sowecare product. Unfortunately, this presentation will be only available for the dealers in the Netherlands or large dealers abroad because it would be too expensive and time consuming to travel to all the dealers abroad to provide them with this information. Though, it would be nice if there is an online presentation in the future which they could attend.

11.2 Requirements dealer presentation

- The dealer presentation should provide the Dutch dealers with service information.
- The dealer presentation should explain all the possible services.
- The dealer presentation should explain what the rules are when the dealers wants to adapt something.
- The dealer presentation should include the importance of the presentation.
- The dealer presentation explains to the dealer what to do when the want to carry out a service.
- The theoretical part of the dealer presentation should not take longer than fifteen minutes.
- The dealer presentation should give examples of the services.
- The dealer presentation should include a part about the tools that are needed to carry out a service.
- The dealer presentation should include an explanation about how to use the manual.
- Sowecare B.V. corporate style should be applied to the dealer presentation.

11.3 Concept dealer presentation

The concept of the dealer presentation is based on the requirements that came from Sowecare B.V. and the requirements that are set up to give a proper explanation of the service manual(s). The content should include information about why this presentation is important. So something about the European requirements, the CE marking and the supervision must be told. Next to that there should be a more practical part that gives explanation about the service manual(s). Last but not least the options for other adaptions should be mentioned. If possible, a few parts of the service could be done as exercise during the training. The presentation that is made during this bachelor assignment includes the outline for the dealers' presentation. When all the other service manuals are ready they will be included. After that the presentation will be given to the dealers. An outline of the presentation text is written in the notes beneath the slides in PowerPoint. The PowerPoint presentation is attached to the report.

11.4 Test dealer presentation

For now it is enough to have a proper outline which can be used to explore when the other manuals are ready. If all the manuals are ready the presentation can be presented to the staff. Now of the director of Sowecare gave some feedback on the presentation to make sure this first outline is complete and correct.

11.5 Final concept dealer presentation

After processing the feedback the dealer presentation is ready. This means that in the future when the other service manuals are ready the presentation must be updated.

12. CONCLUSION

12.1 Conclusion

The service manual of the LeTriple Basic is successfully developed. The development of the first version of the service manual of Sowecare can from now on be send to the dealers. This will help to save money because the dealer's service mechanic can now correctly carry out the services by themselves with a proper and well-structured guide.
Moreover, a start for the dealer presentations is already created. The outline can be used and only has to be updated with the information from the other service manuals. This will provide to the dealer service information and make them aware of the importance of properly executing the services.
The first step towards a complete documentation is created with the example manual and templates. These allow the next internships to develop the manuals for the other chairs.
Last but not least, the LeTriple Basic can now be assembled following the same structure. So all the LeTriple Basics will be sold exactly the same. Moreover, all the assemblers are now able to assemble the LeTriple Basic with the instructions explained in the manufacturing manual.

12.2 Future research

Future research should include tests with Sowecare B.V.'s assemblers and the dealer's service mechanics. These results must be taken into account for the updated version of the manuals. Hopefully the recommendation (mentioned in chapter 13) will help to improve the product, production and documentation.

This chapter is divided in several paragraphs to create an overview of the several recommendations. During the development of the manuals some difficulties were found. Those difficulties were in relation to the manuals, the product itself or the assemblage of the LeTriple Basic. Recommendations for the manuals also included improvements that could be done with more time. The problems in relation to the assemblage that were found were reported to the workplace manager. Problems related to the product were reported to the product manager. So some problems could be directly tackled. These are mentioned in the recommendation with a note.

13.1 Recommendations manufacturing manual

Because the timeframe is only three months some details are left out. These details will be added to the example manual so the next person could maybe add them to a new version to improve the manual even more.

- Include the sub-assemblies to the manufacturing manual. For the manufacturing manual the sub-assemblies are also important because there are also employees who have to assemble those. For the sub-assemblies the same arguments count as for the head assemblage.
- Icons in front of the cautions and notes. In the user manual Sowecare B.V. uses icons to illustrate cautions and notes. This could be a nice detail to add to the manufacturing manual. It would be nice to put those icons in front of the word “caution” or “note”. It will improve the manual because the important sentences which have to be read with the actual instruction are more highlighted are noticeable.
- Exploded view of the whole chair and of the sub-assemblies that need to be assembled. Adding exploded views in the beginning of the manual will improve the overall knowledge of the chair. In the exploded view all the parts that are mentioned in the instructions can be added so you know which part is meant. Not all the names are obvious from the part, so without mentioning it would be hard. For example the “Drehklummung” in step 13, that is mentioned in the picture.
- Another improvement will be to put the parts and tools in the order that they are needed in the manual. For the tools this is not possible because they are several times needed.
- Include article numbers so the employees can always check the number.

13.2 Recommendations service manual

- Icons in front of the cautions and notes. To create consistency, but moreover because it will make the manual clearer. The same recommendation applies as for the manufacturing manual.
- Exploded view of the whole chair in the beginning of the manual. But not as detailed as the exploded view for the manufacturing manual. This will explode only the parts that will be handled in the service manual. Moreover, it would be nice to add an exploded view per chapter of the sub-part that will be explained. Starting the service you will know more about the action you have to execute.
- Article numbers: not all the parts and assemblies have article number. This could make the communication more difficult. If the article numbers are written in the service manual that dealers can check the number with the number of the part they have in stock or they received form Sowecare B.V.
- Include instructions for adjusting the bolt back angle adjustment or tilt adjustment (see paragraph 6.2).
- The tool to mount front swivel wheels to the frame is a customized ring spanner (17 mm). It is not possible to expect that the dealer would make such tool. Therefore a standard tool should be recommended or as customized or standard tool should be send to the dealer. Which standard tool that should be has to be investigated. A ring spanner with nod would maybe be a solution.

13.3 Recommendations example manual

The example manual is not a manual that must be reproduced. The manual can be used for all the developing both service and manufacturing manual. Though there could be an update of the manual with some extra tips or something that followed from making the other manuals. Creating updates that will improve the example manual is highly recommended.

13.4 Recommendations dealer presentation

For the dealers abroad it would be nice to also have an opportunity to get more information about the services. Therefore it would be nice if there is an only version of the presentation which whey can watch ad afterwards call or send an email if they have questions. The practical part must be adapted because it will not be possible to carry out some example services. Though, it might be an idea to include a video of someone else who is carrying out the example service. This is something that needs some research. To start with, checking if the dealers abroad are really interested in such presentation.

13.5 Recommendations to improve the services

- Redesign the brake so there is only one way to assemble the brake. Improving this will prevent failures because in the current design the brake can be assemble in several directions but only one is the good way. Improving the brake so there is only one options will be a solution to this problem and the service mechanics will quicker repair or adjust the brake. For the left side there is probably another direction necessary, this must be investigated. The solution could be to create two unique options. If it is not possible to adapt the part a template could be made to prevent failures.
- Designing a template for the direction of the brake handle. It is important that the brake handle does not hit the control handles. Moreover, it will always look and be the same.
- Improve or remove the reinforcement pin. Mounting the reinforcement pin into the frame is a pretty hard because there is a lot of tension between the ring, the chassis and the reinforcement pin. The question is what the actual function of the reinforcement pin is. Asking this to the product developer it was unclear. But there are two possible options: the reinforcement pin undersets the protective plate or the reinforcement pin prevents torsion. The torsion that will occur when the user if the user exert a force on the backrest, the column will dodge and so the ring will. The function must be investigated so the design could be improved.
- Redesign the control handles so there are only two (right and left) possibilities to assemble the control handles. Improving this will create consistency which means that the entire chair will be exactly the same. Moreover, the control handles will never hit the brake handle because both are only able to assemble in one direction. If it is not possible to adapt the part a template could be made to prevent failures.
- The bottom edge of the seat must be improved so that there is no need of a cordless Drill anymore. This means that there should be mounting point in the bottom edge which can be used to assemble the manual control with an Allen key. This will decrease the assemble time and create consistency because the manual control will always be assembled the same. Moreover, there is no risk anymore with the coating that could be released.
- Improve the (bottom edge) seat by including a confirmation point for the battery package holder. Make sure the assemblage can then be done with an Allen key.
- A cordless drill should not be necessary during services, with the two recommendations above this is not necessary anymore.
- Tie-wrap should not be necessary with the improved seat. This means there is no wire nipper needed anymore (less tools, improve assemblage).
- Use bolts instead of screws, bolt are made to (dis) assemble several times. With screws the problem can occur that the head of the screw gets damaged.
- A template for the height and width of the armrests so you can easy set them.
- A template for the standard height for the footrest so there cannot occur a problem if you use the high-low column.

Improving the product will take time but the LeTriple Basic is a product that Sowecare B.V. keeps selling in the future. Therefore, the costs will be paid back in saving time with services and assemblage (Put J. v., 2011).

13.6 Recommendations to improve the assemblage

All the recommendations that will improve the services will also improve the assemblage. This is logical since a lot of actions of both manual are the same. Even finding an standard tool for the front wheels would be nice because otherwise a workplace employee has to adjust more ring spanners which takes time and still some ring spanners must be bought.

- Replace the M4x10 mm bolts for more subtle bolts.
- Better adjustment of the ring and frame (step seven) so there is no need of “brutal power”.

Improving the product will take time but the LeTriple Basic is a product that Sowecare B.V. keeps selling in the future. Therefore, the costs will be paid back in saving time with services and assemblage.

13.7 Recommendations in general

- It is always important to test your product (in this case the manuals). This is due to the time frame only done for the service manual and manufacturing manual. For a next follow-up assignment some extra tests would be nice. Then the example manual can be tested, the service manual should be completely tested. Also important is that the manuals will be tested by one or more persons from the target group. In that case it would not be an assumption anymore that the manuals are understandable by the target group. The dealer presentation could also be given to a dealer to see the result and gather some feedback.
- Try to minimise the number of different types of fasteners, this will improve the service and assembly time but also reduce the stocks (W. Mulder, 2012).
- Buy or make more customized ring spanners in case the head assembler is ill and the service mechanic is away for a service. Otherwise there is no tool available for the assemblage of the swivel front wheels.

- Check the templates more often to make sure they are up-to-date.
- Make more use of templates to create consistency.
- Make sure the bolts are degreased before screwing them with Loxeal 83*21, to make sure the glue is useful.
- Drilling, tapping, reaming does not belong in the assembly (see step 2, 14ab, 18a-f and 22b-l). This must be done before the assemblage in order to improve the assemblage. These actions must be carried out precisely in the metal workshop. Where it is needed, make use of templates.
- Polish (step 27) and grating (step 3) should not be necessary, the purchasing parts should exactly fit with the parts that are made at Sowecare B.V. Luckily, the template of the backrest is already adapted to the purchasing part. So this will not be a problem anymore.
- Define "screw" and "tight" so all the bolts are screwed with the same power. Make use of a torque wrench.
- Create name consistency in Creo, the BOM and in the workplace. This means by taking the updated BOM and parts list of the manufacturing manual into account change the names in the 3D model, the BOM and the stickers in the workplace.
- Prevent unnecessary "walking" during the assemblage. Make sure everything (parts and tools) you need is closely to the table where the product will be assembled (Put J. v., 2011).
- One possible way of assembling will create more consistency and make the assemblage easier and quicker.
- Improve the 3D model; some parts are not included in the 3D model. Having a complete 3D model can be helpful with for example improving the design. The missing parts list is send to the product developer.
- Redesigning the chair with improvements named in these recommendations should be done together. Is it is time-consuming, expensive and not a good promotion to improve the product step by step. Therefore research should be done on all these recommendations to see if it is possible to re-design the chair once. Do not forget to analyse the LeTriple Basic once more because the product in not analysed in this report.

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