Skotty

Pauline Simons
s1009281

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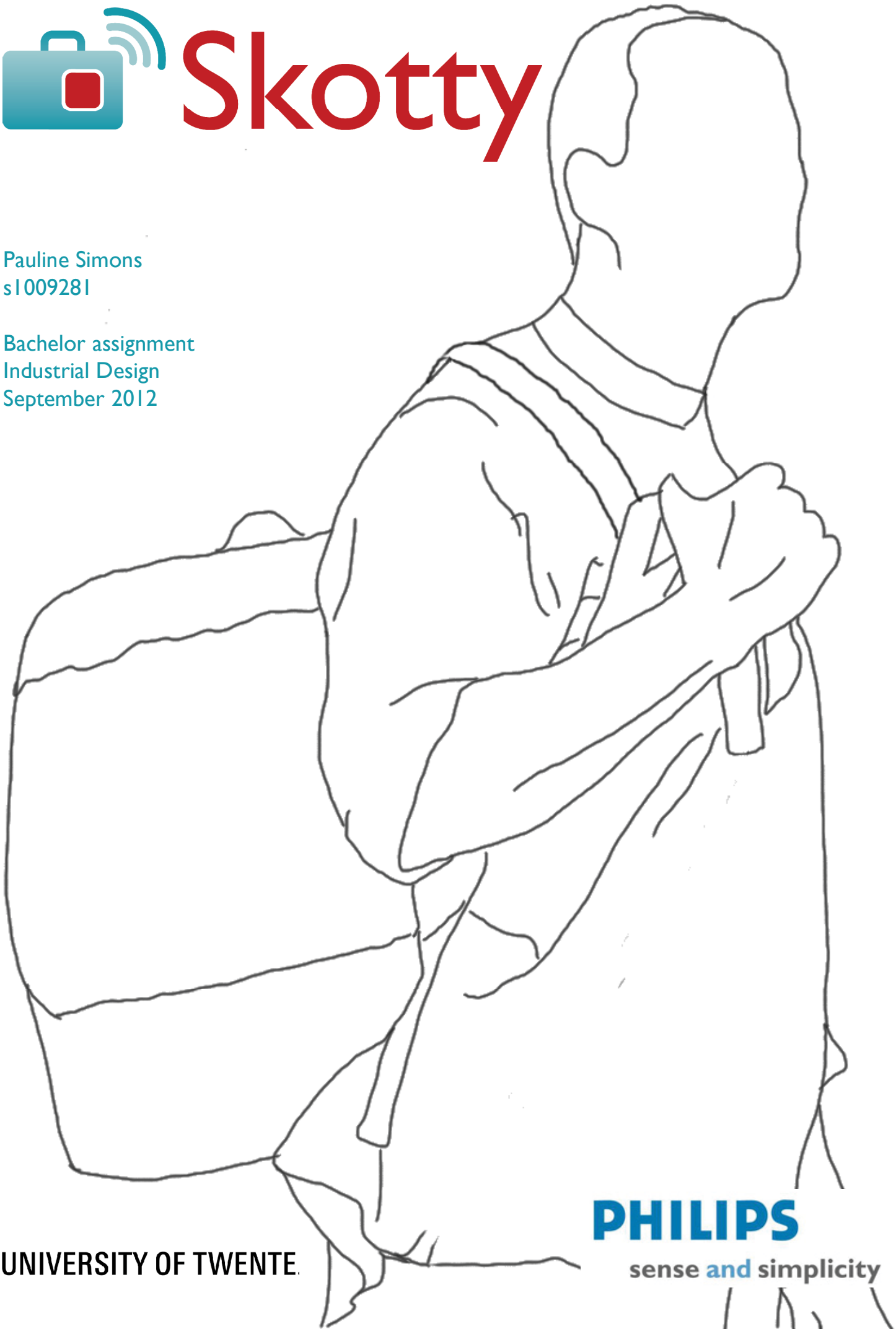

UNIVERSITY OF TWENTE.

PHILIPS
sense and simplicity

Skotty

Student
s1009281
Pauline Simons
Industrial Design
Bachelor assignment

University of Twente
Oude Drienerloweg 5
7522NB Enschede-Noord

Co-operation with
Philips Innovation Services
High Tech Campus 5 Eindhoven

Exam committee
Dr. ir. P.J.M. van der Hoogt
Dr. ir. G.M. Bonnema
Drs. M. Schavemaker

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Preface

This report contains the documentation of the final bachelor assignment, part of the study Industrial Design at the University of Twente.

This assignment consists of performing a case in co-operation with a company to apply the knowledge and skills regarding to Industrial Design in a practice. During the training these knowledge can be widened, deepened or specialised. The student shows that she is able to work systematically and planned. She communicate adequately with mentors and she has enough reflective skills to operate in a professional field.
Secondary objectives are the introduction with the future field and the offering of clues for the master choice.

In this preface my appreciation goes out to Mike Schavemaker (Philips) and Maarten Bonnema (University of Twente). They were my mentors during the whole internship and alerted me often of environmental aspects that may be important.

I also would like to thank a few employees of Philips in particular; Leontien de Roode, Arthur van Es, Jeanine Kierkels, Wouter Henderickx and Sandro Prueser for their help on very diverse topics.

Dr Ma and his medical car team, Manish Kumar Singh and Ramesh Kumar shared very interesting information about the current way of working in the healthcare sector in India and China. I would like to thank them.

Somebody else shared also a lot of interesting information about her own experiences during her graduation assignment in China. Marion de Groot, thank you very much for this!

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Summary

The purpose of the bachelor assignment is to perform a project in co-operation with a business in a professional field. This assignment is performed at the company Philips. The project that is worked on is the Skotty. The purpose of the Skotty is to develop a kit with a combination of diagnostics and communication equipment. The Skotty is easy to carry, easy to operate and includes a method to be able to set up a communication with someone at another location. This form factor has to be designed to persuade the client that this product has the potention of to be developed. The form factor prototype can be used in communication with the target group to find their user requirements.

The Skotty will be used by nurses and technicians in the remote areas of China and India. In these countries is a growing economic middle class but the healthcare providing falls behind. There are good healthcare possibilities for the population in urban areas but the inhabitants of the rural regions are not able to use those.

The Skotty consists of existing Philips' technologies, available in three configurations:
- Basic diagnostics (weight scale, blood pressure meter and glucose meter)
With these technologies the body mass index, hypertension/cardiovascular diseases and diabetes can be diagnosed.
- Advanced diagnostics 1 (X-ray)
With these technology a scan of the chest and bones can be performed. Diseases like tuberculosis (TB) can be diagnosed with the X-ray scan.
- Advanced diagnostics 2 (Ultrasound)
The ultrasound module is used for obstetrics, to perform an echo. (not researched in this assignment)

These diagnostic technologies can be fixed on a standard platform. In this platform a battery, a tablet and a LED camera light are present. The battery, powers and chargesthe other components. The tablet can connect to a 2G/3G/WiFi network. This opens the possibility to set up a connection with a doctor or specialist at another location.

If there is no coverage of 2G/3G/WiFi and the technician/nurse needs a second opinion, a satellite module can be added. With the aid of this module, there can be set up an encrypted connection via satellites.

The basic diagnostic configuration will be used by healthcare workers of non-governmental organisations or nurses in a community health center (CHC) in China. They often have little medical knowledge. With the aid of the Skotty they can perform the measurements themselves and ask a second opinion of a doctor at another location.

The X-ray module can be used by technicians in mobile hospitals such as the medical car in China. This car is part of the provincial hospital and provides TB diagnoses and treatment in rural villages. There is already X-ray equipment in the car but it has two problems: it takes one hour to develop the film and there are few well-educated doctors who are able to interpret the film. With the Skotty the technicians are able to share the images with a centralised specialist to diagnose the patients.
In these ways, the work of the doctors will be more efficient because he can diagnose all the patients in the region from one location.

The form factor of the Skotty is like LEGO: there is a platform where the modules can be fixed on. This form factor does not meet the size requirement yet, because of the use of existing technologies. The basic diagnostics can be placed in a backpack, to make it seem less expensive and to carry it easily. The X-ray module has two handles to carry it with two persons. It is too heavy for one person. The interface is not developed, it is important that this is easy to use, nurses does have just a little training.

The Skotty has potential for further development because the target group is enthousiastic and it seems to improve the healthcare in a efficient way.

Skotty

Introduction

In this report the bachelor assignment of Pauline Simons is discussed. The assignment is performed by Philips Electronics NV in Eindhoven. This company mainly develops products and markets for healthcare, lifestyle and lighting. Through innovation they try to improve the quality of consumer live. They integrate the newest technologies and designs in human centered solutions.

The topic of this report is the Skotty. This concept is focused on the combination of modular diagnostic equipment and communication devices in one compact product. The principles of this concept are easy to carry, easy to operate and it must consist of modular technologies. It must be possible to set up a communication with a specialist. With these features it is an useful appliance for medical caregivers in remote areas.

This report will start with the purpose and scoping of this assignment and it ends with a design and recommendations to improve it.

The second chapter describes a contextual analysis to frame the target group, the current form factors, the materialization and the potential diagnostic possibilities in the portfolio of Philips, followed by an explanation of the applications of these technologies. Finally, there is the construction of the Skotty, an integration and a conclusion.

In the third part, the analysis is expanded with the users: the target users are non-governmental-organizations (NGOs). The vision and way of working of (mostly Dutch) NGOs are investigated and selected on the criteria that they provide healthcare in China/India/mobile hospitals. Another part of the target users are the local general practitioners (GPs), village doctors, nurses and technicians. Followed from interviews with a few NGOs, use cases and the workflow of diagnosing a patient in a community health center (chc) and in a medical car are illustrated. The information learned from the interviews is composed to a list of requirements. As a synthesis for the next chapter, working with the modular components is explained.

In contrast with the previous chapters which were largely theoretical, in the fourth chapter more practical activities are used. Based on the information of earlier chapters, an architecture of the whole system and its subsystems is presented. A function schedule follows the architecture .The functions of the differen modules are charted and linked with each other. Furthermore, a number of drawings of possible products is made, with regard to the technological aspects. These drawings are extended in three concepts. The best concept is selected by testing using the requirements from the previous section.

In the fifth chapter the best concept will be further detailed. The platform and each module will be explained. Not only the form is visualised, also the implementing in the current workflow in India and China will be described.

In the evaluation chapter the concept will be tested: does it meet all the requirements? Each requirement is provided with an argumention whether it is met or not.

The report will finish with a conclusion and recommendations for the further development of the Skotty.

Skotty

1. Purpose and scope

This report is about a bachelor assignment at Philips Electronics NV in Eindhoven. In this chapter is described what the purpose of this assignment is. The framework about what this assignment means and what is disregarded is also explained.

Purpose

Philips has the aim to improve the quality of people's life by focusing on healthcare and welfare. By means of innovations on these areas, they would like to make the world healthier and more sustainable. Their purpose is to improve the life of three billion people in 2025.
The Skotty concept fits this purpose, so it is important to investigate the market and the (technological) possibilities of Philips.
The purpose of this bachelor assignment is to develop a detailed concept of the Skotty with a clear view of how which modular technologies will be integrated. This will be done by analyzing the existing Philips's technologies and their requirements. Another important part is analyzing the users, volunteers of non-governmental-organizations, but also doctors, nurses and technicians working in remote areas to hunt down the user requirements. In this assignment, one compact product will be developed with the technologies that are necessary. By means of drawings it will be visualized. Finally there will be made a prototype using rapid prototyping technologies. With the prototype and recommendations Philips can be recommended why the company must provide a budget and continue with developing the Skotty. Furthermore with the recommendations Philips can learn on which points the concept can be improved.

Scope setting

Skotty is a complex product because it has functions and requirements in different areas of technology. The Skotty includes a diagnostic part, a communication part and a software part. The project will be too wide if all aspects have to be elaborated, so a selection has been made.
The purpose of the project is to design a compact form factor to show how the module principle works. This means the technologies have to be chosen, the target users have to be found and asked for their opinion. The workflow of the target users has to be elucidated, so it is possible to see the gaps and the opportunities for the Skotty. Then a compact, easy to carry form factor has to be developed which includes the components that were found as necessities. This form factor will be translated into a prototype.
The diagnostic technologies, the communication module and the platform do not have to work in this prototype. The software that links the modules and the platform with each other and the specialists/doctors will be developed by another department. It is interesting to have a little research about the material options, but the production method of that material in a production process is not part of this assignment. The interface on the tablet display is also no part of the assignment. There are some recommendations about it.

There is also a financial aspect regarding to the Skotty. For the non-commercial companies the prices have to be as low as possible and maybe there is an opportunity for a service structure. For the commercial markets the product may be more expensive, so that the Skotty is not only a contribution to the goal of Philips but also a financial advantage. This financial and service aspect will not be a part of this assignment.





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2. Contextual analysis

The target group of the Skotty can be divided into two categories: the commercial users and the non-commercial users. A few examples of a commercial usage are on an airplane, a ship and an oil rig. With non-commercial users non-governmental organizations (NGOs) are meant. The circumstances in which the non-governmental organizations do their work are mostly very critical, worse than that of the commercial users. The critical circumstances form the challenge for the Skotty and so the workers of the NGOs are taken into account in designing the Skotty.
This chapter contains a research to select the geographic areas where the NGOs provide healthcare, the materials and the diagnostic technologies. The current medical suitcases are researched to learn where is the gap in this product sector. The components of the Skotty will be elucidated. At the end of this areas of analysis, there is a conclusion with the most important findings.

Geographic areas

In short the Skotty is a first aid box for the 21th century. In addition to the primary care kit, employees in rural areas can diagnose the ill people of the population. There are a lot of rural areas over the world each with their own cultural characteristics. In the beginning it is tactical to implement the Skotty in a region with a growing middle class. This gives opportunities to get a better view of the healthcare situation at that moment. By taking advantage of this network it is easier to contact the local physicians or nurses. Also the poor people are reached better. A lot of African countries are less developed and it is difficult to contact the users. In this case the medical structure is unknown and therefore it is not clear how the Skotty can fit in the workflow. China and India have a growing middle class (figure 2.1) and are appropriate countries to develop the Skotty for. The opportunities for expansion to other countries will be opened.
Both of India and China, the healthcare situation is described below.

Middle class	% of entire population
1998–99	44.92
2001–02	50.53
2009–10 (estimate)	62.95

Figure 2.1: middle class of India [1]

India

The healthcare in India [1] is one of the biggest sectors and it is still growing. This is because India is located in a vicious circle: because of the increase of the population the healthcare sector expands continuously and through the better healthcare providing there are less infant mortalities and the people live longer: the population grows.
A big part of the Indian population lives in rural areas, 25% even below the poverty limit and 300 million of children have malnutrition. The incomes in India are unfairly distributed: the average income was $620 in 2005, while more than 150 million people earned more than $1.000 a year. Businessmen earned even more: $20.000 a year! So India can be split up in two parts: 25% of the country can enjoy the healthcare on western level against 75% who is living from traditional medicine. Only 11% of the Indian population has insurance.
Diseases such as polio and tetanus are under control in the meantime, but earlier diseases as hepatitis and malaria became resistant to the medicines and emerge more frequently.

Cost of Key HealtCare Procedures				
Currency: USD	US	Thailand	India	India HC cost-x of US
Cardiac surgery	50,000	14,250	4,000	12.5
Bone marrow transplant	62,500	62,500	30,000	13.33
Liver transplant	500,000	75,000	45,000	11.11
Orthopaedic surgery	16,000	6,900	4,500	3.56

Figure 2.2: the prices of health treatment [1]

As shown in figure 2.2 the private hospitals in India are very cheap in comparison with the United States and they are provided

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Figure 2.3: collage of the Indian Healthcare

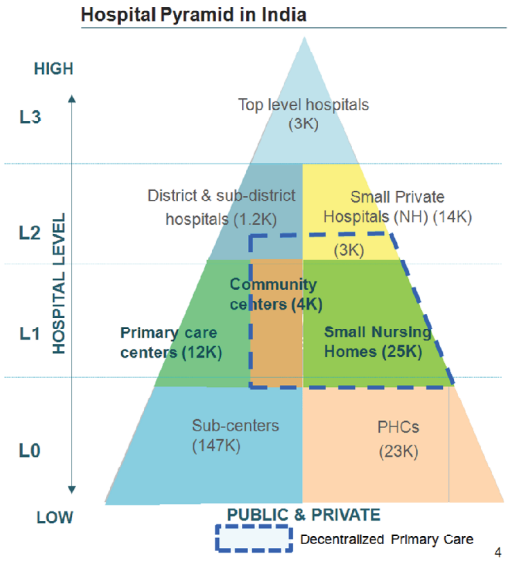


Figure 2.4: the healthcare pyramid of India [2]

with modern devices and well educated medical personnel. The consequence is that much people from abroad visits India and uses these facilities, called medical tourism. Not only the modern devices are interesting, the western visitors are also curious about the alternative medication. Beside the enormous growth in the healthcare sector; the pharmaceutical market is also increasing. International companies show more and more interest in India.

Figure 2.3 shows a collage of the Indian healthcare to get an impression.

Figure 2.4 shows the healthcare pyramid of India. In India and China it is standard to denote levels of healthcare providers in from low to high level by L0 till L3. The lowest level of healthcare providers (L0 hospitals) here consists of Sub-centers (in urban areas) and primary health centers (PHC's in rural areas). If an inhabitant of India feels ill, then he visits such a center. There the doctor tries to diagnose the patient. However, if he/she is not sure about the diagnose, he/she refers the patient to a specific clinic where he/she thinks they can diagnose and treat the patient. They try to refer the patient as little as possible to a higher level hospital because the poorly status of the population. Most of the patients do not have enough money to travel to the hospital. It is happens sometimes that the patient dies in their way to the hospital.

In India the government subsidizes a lot of programs against frequent diseases. One of these programs is in association with the Damien foundation. They have built up a lot of tuberculose (TB) centers for example around New Delhi. Patients with

TB symptoms are referred to these centers by the lowest level doctor.

There are also non-governmental organizations that work in India and provide healthcare on-site. Beside the Damien foundation, the SMILE foundation works on the improvement of healthcare. This organization has a special program called "SMILE on wheels". As the name already mentioned, it is about a mobile hospital in a van. The mobility of the van is very high so the poorly accessible people can also be reached. These poorly accessible people prefer to come to the mobile hospital instead of the corporate hospital.

China [3]

Between 1978 and 2003, the gross domestic product (GDP) in China has increased from 378 till 9101 Renminbi (RMB is Chinese yuan; $60 - $1438). This is an enormous growth with many economical consequences for China. However, the healthcare is an important aspect that has been ignored during the economic growth and is now far behind the development of the country. The government admits the immense gap between the demand for health, the opportunities of the healthcare insurances and the offer of the healthcare. The aim for the next years is to close this gap.

	1980	1990	2000	2003
Number of beds				
Urban	4.47	4.18	3.49	3.67
Rural	1.48	1.55	1.50	1.50
Number of health professionals				
Urban	8.03	6.59	5.17	4.84
Rural	1.81	2.15	2.41	2.19

Figure 2.5: distribution of healthcare beds and personnel in urban and rural areas in China. [3]

As shown in figure 2.5, in China it is quite obvious that the majority of the healthcare equipment and personnel is in urban hospitals, while 70% of the population lives in the rural areas: the devices that China has are not well divided.
Hospitals get a subsidy of 10% from the government. The rest they get for example from the sales of medicines. The results of this are not only increasing prices of medication but also patients that are prescribed an overdose of medicines. This counteracts the improvement of the healthcare sector.
The education of the physicians fails regularly: mostly they have had medical education for only twenty months. Good doctors are less present in rural areas and it does not work to attract physicians to that regions.
A third problem is the use of different data systems in each hospital so it is difficult to monitor the patients. The existing healthcare services and their facilities are represented in figure 2.6.

	Types of services	Likely delivery mechanism	Funding mechanism	Market open/closed
Public health services	• Control and prevention of infectious diseases: STD, AIDS, respiratory diseases, mental illness, reporting at regional levels, healthcare education	• Provided by public, non for profit health centers and hospitals (e.g. township)	• Government direct funding or through social insurance	• Closed market • Services provided by government
Basic health services	• Include typically required medical services for treatment and well being of population	• Largely provided by non profit hospitals	• Social insurance and company sponsored insurance programs	• Partially open • Market open to for-profit hospitals
Special health services	• Includes uncommon health services, leveraging special technology (e.g. cosmetic surgery etc.)	• Provided by specialized and for-profit hospitals • Based on free market principles	• Self-funded • Private health insurance	• Open to competition (local and foreign)

Figuur 2.6: Mechanisms of the different healthcare services in China. [3]

Through the increase in the urbanization the diseases of the people change from infection diseases to non communicable diseases such as heart infarcts. These patients benefit from acute assistance; if it takes long it can be too late.
Figure 2.7 shows a collage of the Chinese healthcare to get an impression of the situation there.

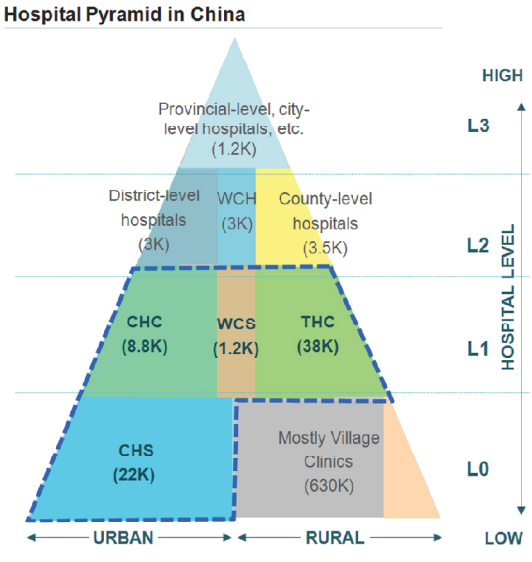


Figure 2.8: The Chinese healthcare system [4]

Figure 2.7: Impression of the Chinese healthcare.

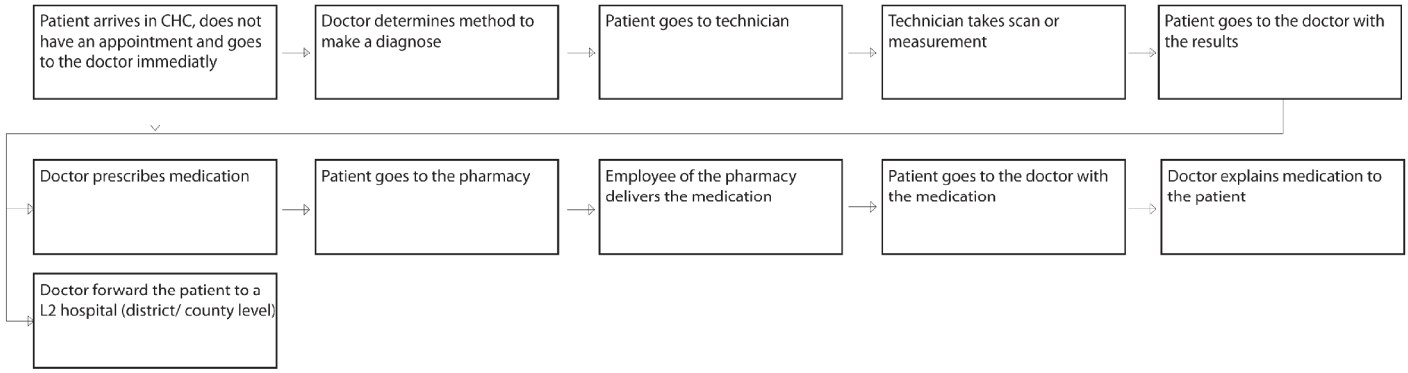


Figure 2.9: Workflow in the CHC

Figure 2.8 shows the hospital pyramid of China. The lowest level of healthcare providers consists of the CHS (community health system in urban areas) and the village clinics (rural areas). The inhabitants of China do not trust these doctors and therefore they mostly skip them and visit the CHC or district/county level hospital directly. This is because of the Chinese grades; the village doctors are often appointed by Mao Zedong. The knowledge of these doctors is minimal and the government finances these village doctors for only ten percent. As a result, the doctors gain the most of their income through the sale of medicines. Also it happens that if they do not know the disease, they provide (an overdoses of) medicines to have an income.
The workflow for patients when they arrive at the Community Health Center (CHC) is shown in figure 2.9. This is very inefficient for the patient. Especially during the peak times (in the morning) the visit takes much time. The equipment that is present in the CHC is basic diagnostics. They are focused on chronic diseases and elderly so there are for example a blood pressure meter, an ECG (electrocardiogram) and a thermometer. If the patient has complaints that cannot be explained by this equipment, the CHC doctor refers him/ her to a higher level hospital.

In an L2 and L3 hospital advanced diagnostics are present, but often there is a lack of knowledge of the technician how to use it or a lack of knowledge of the doctor how to interpret the results.

There are also non-governmental organizations working in China. Some organizations provide healthcare. One of them is the Damien Foundation which has its origin in Belgium. This organization focuses on the control and treatment of tuberculosis (TB). To perform this mission they support the medical car team: for example the provincial hospital in the region of Qinghai has one medical car available. This province has a surface of 721 000 km^2 and 5 627 000 inhabitants. The medical car travels from the province hospital to the rural areas. The car stays for a few days at that location and acts as a TB clinic. The local population can be diagnosed and treated in the car.

Comparison

In both India and China there is a growing economical middle class. There is good, well developed healthcare in both countries but it is not available for the whole population. The good healthcare centers/ hospitals are often located in the urban areas, while the biggest part of the population lives in rural areas.
The diseases that often appear in China are chronic diseases. This can be explained by the air pollution and smog in the big metropolises. In India the infection diseases occur more often. An explanation therefore can be found in the bad hygienic circumstances.
During the design of the Skotty, these differences can be taken into account. The Skotty must be hygienic, it has to be easy to clean. The complaints of the Indian patients are probably very diverse. For China it is important to know that the patients will visit the nurse more often with the same complaints, so the nurse's experience about these complaints grows.

Current form factors

Suitcases are well-known phenomena in the medical world. In this paragraph a few suitcases which provide healthcare are described.

The primary care kit can be found in almost every household and public building. In this kit materials and equipment for treatment such as bandages are included. It is shown in figure 2.10.

Figure 2.10: Standard primary care kits

A village doctor in China has a slightly more advanced suitcase. Devices for treatment still are in this case, but there is for example also an analog blood pressure meter. As shown in figure 2.11, this suitcase is very outdated, but the doctor is able to diagnose a lot of diseases because of the amount of different tools.

Figure 2.11: Suitcase of a village doctor

Philips itself has also developed a medical suitcase: the AED (automatische externe defibrillator) (figure 2.12). This defibrillator is a good example for the Skotty. It is a small portable package especially and can be used by anyone. Even the inexperienced of the population must be able to use it correctly. An important difference is, compared to the primary care kit and the suitcase of the village doctor, that with this product only one disease can be treated: heart diseases.

The suitcases shown in this paragraph are mainly suitcases to treat patients. Only in the case of the village doctor, there are a few diagnose tools. The Skotty can fill this gap with a special diagnose suitcase.

Figure 2.12: The Philips AED

Diagnostic technologies

In the portfolio of Philips Healthcare are just a few very interesting technologies. Most of the Philips technologies are not suitable because for example the size as in the case of MRI. A list of all the technologies can be found in appendix 1. Three technologies or combinations are selected as appropriate. These can be divided in two categories, basic diagnostics (weight scale, blood pressure meter and glucose meter) and advanced diagnostics (X-ray and Ultrasound).

Basic diagnostics

The basic diagnostics that are in scope for the Skotty are a weight scale, blood pressure meter and glucose meter. These technologies are meant for monitoring the patient. Diseases as diabetes or a low/high blood pressure can be detected with these diagnostic devices.

Weightscale

With the weight scale it is possible to diagnose patients that have overweight. It is a very simple tool. The nurse has to lay the weight scale on the ground and the patient stands on it. The weight scale has four rechargable batteries of 1.5 Volt. The weight of the person can also be read at the display of the weight scale. The dimensions of the weight scale are 230x180x20mm and it weights 1 kg. In figure 2.13 the weightscale is shown.

Figure 2.13: Weightscale [5]

Blood pressure meter

With the blood pressure meter patients with hypertension and cardiovascular diseases can be diagnosed. The nurse has to put the manchet around the upper arm of the patient. Then this manchet has to be pumped full. After rising a certain pressure, the manchet can be blanked slowly and the blood pressure can be measured. The blood pressure meter has four rechargable batteries of 1.5 Volt. This is equal to 1500 measurements.
The module of the blood pressure meter consists of three components; the blood pressure meter itself (130x155x84mm, 355gram), the manchet (foldable, 140x50x50 mm, 135 gram) and a stethoscope (200x80 (diameter), 80 gram. In figure 2.14 the blood pressure meter, the manchet and the stethoscope are shown.

Figure 2.14: Blood pressure meter, manchet and stethoscope [5]

Glucose meter

The glucose meter allows the nurse to diagnose patients with diabetes. The nurse punctures with a needle in the patients finger tip. The blood drop that is caused by the prick will be collected on a test strip. This strip is inserted in the glucose meter. This glucose meter measures the amount of glucose in the blood of the patient. The components that are necessary to perform a glucose measurement are the glucose meter, the sampler, the needle, the test strips, the plasters, the needle container and a wire to connect the glucose meter with the tablet. The total dimensions are 120x90x25mm. (figure 2.15) [5]

Figure 2.15: Glucose meter [5]

Skotty

Advanced diagnostics X-Ray

The first part of the advanced diagnostics is non-interventional X-Ray/digital radiography. In healthcare, digital X-ray is the name of a technology based on electromagnetic radiation. Compare it with visible light. Photons are sent by a machine through the body of the patient. A computer records the images of the scan. The white color represents the structures with a high density, because these will block most of the photons. It also represents metal and contrast liquids. The black parts are the structures containing air and the muscles, fat and fluids appear gray [6].
With X-ray equipment a scan can be made of the whole body. It is not the meaning of the Skotty to make a full body scan so the designer chose in coorperation with Philips to make it a bit more specific. There are a lot of diseases that can be diagnosed by a chest or bone scan, so it is still widely applicable, such as tuberculosis. This disease often occurs in China. This kind of X-ray scans [7] will be performed by an X-ray technician who takes two views: the first is posterior-anterior (through the chest, front to back) and the second is a lateral view (from the left to the right). The patient stands in front of the machine and has to hold his/her breath for a few seconds during the scan.

To perform an X-ray scan, there are seven components essential. The most known components are the tube and the detector, but also a grid, a collimator, a motorblock, an invertor and a generator are necessary. The dimensions of these components are listed below:

Detector: 230x180x10mm
Grid: 440x460x10mm
Collimator: 180x159x235mm (5 kg)
Motorblock + tube: 300x400x150mm (>35kg)
Invertor: 500x450x500mm
Generator: 265x80x100mm (2kg)

In figures 2.16 and 2.17 the detector and the tubes are shown.


Figure 2.16: X-ray detector


Figure 2.17: X-Ray tubes

An X-ray scan of the chest will be performed if you have any of these symptoms:

- a persistent cough;
- chest injury;
- chest pain;
- coughing up blood;
- difficulty breathing;
- signs of tuberculosis;
- signs of lung cancer;
- other chest or lung diseases.

With the X-ray technology diseases like the following can be diagnosed:

- collapsed lung;
- collection of fluid around the lung;
- lung cancer/ tumor;
- malformation of the blood vessels;
- pneumonia;
- scarring of lung tissue;
- tuberculosis.

Advanced diagnostics Ultrasound

The second part of the advanced diagnostics is the ultrasound application. Ultrasound [8] uses high frequency sound waves to inspect the organs and structures in the body. With ultrasound caregivers can inspect the hearth, blood vessels, kidneys, liver and other organs. During pregnancy, physicians use ultrasound often to explore the fetus. With the ultrasound technology the nurse can make real time moving images of the fetus and investigate the movements of it. The ultrasound technology does not use radiation so it is safe for patient and nurse.

In rural areas such as those in China and India there is a lot of infant mortality so this application of ultrasound is very interesting and will be focused on.

During an ultrasound research, a special technician moves the device called transducer over a part of your body.

To perform an ultrasound scan, there are two components essential: a transducer and a tablet to assimilate the information from the transducer and make this visible. The tablet of the platform can be used so the ultrasound module consists only of a transducer (185x75x55mm).

Figure 2.18: Ultrasound transducer

The transducer (figure 2.18) emits sound waves. These reflect on the tissues in your body. The transducer receives the waves that return. The images are made of these sound waves.

Obstetric ultrasound is a useful clinical test to:

- Determine the presence of a living embryo/ fetus;
- Estimate the period of pregnancy;
- Diagnose congenital malfunctions of the fetus;
- Evaluate the position of the fetus;
- Evaluate the position of the placenta;
- Determine the amount of pregnancies;
- Determine the quantity of amniotic around the fetus;
- Check the opening or shortening of the cervix;
- Judge the growth of the fetus;
- Judge the well-being of the fetus.

Components

In the previous section three diagnostic technologies are explained. The Skotty consists of these technologies but there are also other components. In this paragraph the construction of the Skotty will be described.

Platform

The Skotty will be built from a platform with diagnostic modules. The three diagnostic modules (basic and advanced diagnostics (2x)) are described in the previous section. The satellite module will be explained in the next subsection.
The platform itself consists of a power supply, a LED camera pen and a tablet with a possibility to communicate via 2G/3G and WiFi. With the LED camera pen, the specialist in the hospital can have a look in the eyes of the patient. The focus areas for the Skotty are as mentioned earlier India and China. In figure 2.19 [9] the coverage areas of 2G and 3G in China are shown. Especially in the inland areas there is not much coverage.

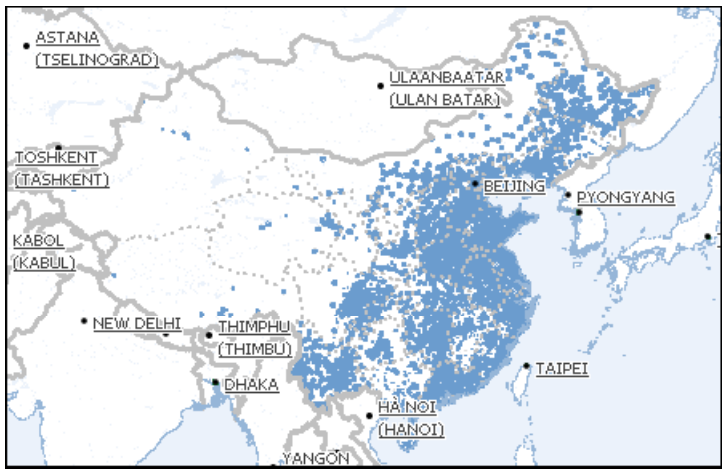


Figure 2.19: the coverage areas of 2G/ 3G in China.

Satellite

To fill in the gap of the non covered areas, it is possible to add a satellite communication module to the Skotty.
When there is no 2G/3G in the region and the nurse has to take a diagnose he/ she cannot interpret, he/she can communicate via the satellite with physicians/specialists worldwide. There can be set up an encrypted connection, as used in the army. Telemedicine is also a possibility through the addition of this satellite module.

Integration

The Skotty consists of a platform with three sets of applicable diagnostic modules; Basic diagnostics (weight scale, blood pressure

Skotty

meter and glucose meter) and advanced diagnostics (dXr and Ultrasound). The platform itself consists of a power supply, a tablet and a device to communicate. Also applicable is the satellite module.
In short, the structure of the Skotty can be described as shown in figure 2.20.

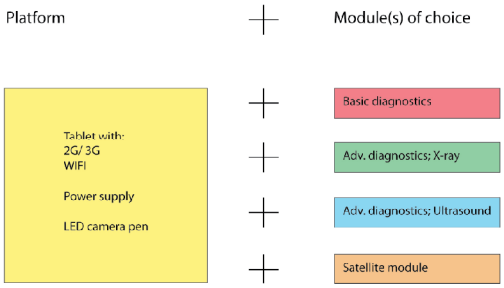


Figure 2.20: The structure of the Skotty

There are two ways of communication. The local communication uses 2G or 3G and is integrated in the tablet. The world wide communication can be connected to by the satellite module and is applicable by both basic and advanced diagnostics, but most of the time it is not necessary by basic diagnostics and will not be taken because of its weight.

In theory it is possible to combine both basic and advanced diagnostics, for example if a weight scale and ultrasound are needed, but it is not the meaning of the Skotty. The power supply is not intended for those situations. In these cases a generator should be used.

The Skotty is meant for use in rural areas and the starting countries are China and India because of their growing middle class. The option for other countries remains open.

Materialization

The casing of the suitcase or backpack needs to meet a few important requirements. For example
- it has to protect the diagnostic and communicational devices inside the bag/ case against damage from falling
- it has to protect the diagnostic and communicational devices inside the bag/ case against all kind of weather.
- a dirty case influences the appearance of the Skotty negatively so the material of the case has to be easy to clean.
- the material must be of good quality and must have a good price/ quality ratio. Good quality include that the material must have a durability of at least 10 years under normal circumstances and in all kind of weather.

With these requirements in mind, and with the help of Wim Poelman, there was searched for a suitable material. This results in the following materials:

Polypropylene pressed with long fibers

This material is used for bumpers of cars. It deforms a lot so it has a good cushioning.

Side Impact Protection System (SIPS)

This way of cushioning is well-known as it is often used in Volvo cars. In this case it can be made of cardboard with a plastic layer to protect it against water.

Expanded polystyrene (EPS)

This material is common named styrofoam. This material is interesting when we choose for a casing of two materials. The inside material then can be this EPS.

Expanded polypropylene (EPP) [10]

This foam is widely known as ARPRO. Products made from ARPRO are durable, light weight and recyclable. It has excellent energy absorption and high strength properties. It is used for packages of Philips car lights. When these drop down, they are not damaged.

Nyrim [11]

Nyrim is a thermoplastic material, commonly used for its high shape stability over a wide temperature range (-40°-140°C). It has an excellent impact strength and very high abrasion resistance. It may be too extreme for the Skotty.

Magnesium

This material has a very exclusive appearance and can be used for the casing together with for example Styrofoam.

Ethylene vinyl acetate (EVA) [12]

This material is pretty new. It belongs to the PVC category and it is a composite. Interesting characteristics of the material are that it is environmentally friendly, light

weight, viscous, strong and cushioning. It is applicable with metal inserts. It will be squirted in a mold and after removing it from the mold, it is frothing a bit. The amount of frothing can be estimated reasonable well.

In conclusion, ethylene vinyl acetate seems a good opportunity. It has many positive characteristics, and thereby it can satisfy as a mono material, which is positive additional characteristic.

Conclusion

In this chapter the framework of Skotty is drafted:

- the users are healthcare providers in China and India
- the gap in the market is suitcase with tools to diagnose patients. Treatment tools are available, also in India and China.
- the diagnostic areas are patient monitoring, tuberculosis and obstetrics
- the components and the structure of the Skotty are setted
- the potential materials are selected.

These framework is mainly about the product specifications. In the next chapter the users and the way of providing healthcare in India and China will be explained.







3. User analysis

In this chapter, the NGO's that are possible users for the Skotty are selected and explained. The NGO's are interviewed about their way of working and their user requirements. To find useful interview questions, use case scenarios are developed. These use cases facilitate communication between the different businesses in Philips/ NGO's and me during for example the interviews
The workflow of a patient aided by one of these organizations is illustrated and the requirements of these users are used for the list of requirements.
Another part of the analysis discusses the materials of the casing, the competitor research and the way of designing with modular components.
At the end of this chapter, the requirements will conclude the most important findings.

Non-governmental organizations [13]
A non-governmental organization is an example of a non-profit organization with the purpose of the improvement of human well-being. A NGO operates apart from the national government. In 2006 40.000 international NGOs were estimated.
A list of NGOs that provide healthcare via sending physicians or erecting mobile clinics is composed. This list (appendix 2) contains the interesting NGOs for this project. The Skotty will contribute the volunteers of the NGOs a lot, so the NGOs are the target users. The NGOs not only work with employees, sometimes they also work with the local population. Interviews with different educated medical workers decide on which level the Skotty can be used. Provisionally we call the user nurse. The medical knowledge of nurses is very varying. In this scenario, the nurse has little medical knowledge. The organizations that shared information during the development of Skotty are explained in the next subsections.

SMILE foundation[14]
In India, neglecting a simple preventive medical treatment can induce a more serious illness which can lead to death. The quality of the healthcare has to be increased until it meets the needs of the population and the awareness of the importance of good healthcare has to be improved. The smile foundation tries to improve these points via the smile on wheels-program. This is a unique mobile program that tackles problems about mobility, availability, accessibility of the primary care in rural areas.

AMREF Flying Doctors [15]
Flying doctors deploy all of her knowledge and expertise to catch the errors on medical facilities for example in the rural areas in Africa. Furthermore, they educate people about living healthy, but also about the medicines, safe drinking water and they distribute mosquito nets. There are medical flights to hospitals in difficult accessible areas, where during the visits not only the sick people were helped but also the local caregivers were trained. This way, the local caregivers can continue their work when the flying doctors go home.

Damien Foundation [16]
The Damien foundation combats lepra and TB in Asia, Africa and America. They manage the healthcare on the long-term. These diseases are dangerously contagious, so only cure is not enough.

India E-health [17]
E-health points provide families in rural areas with clean drinking water, medicines, understandable diagnostics and advanced telemedicine so that a doctor and modern healthcare can be applied in the village.

Interviews
The NGO's are contacted to learn us more about their workflow. The organisations first had an introduction call and after that they were asked to find someone working in the field who would like to participate in an interview. Both in India and China there are two interviews performed. In the following subsections the most important

outcomes of the interviews are illustrated. The whole interview write-up can be found in appendix 3.

SMILE on wheels (India)

SMILE on wheels is a program provided by the SMILE Foundation. It contains a mobile hospital in a van that visits remote areas. The sequence of the visits is predetermined. The population prefers visiting the van compared to 'normal' hospitals because the distance and availability.
The van contains basic equipment but also X-ray. It is not focused on a special disease. The employees of the van are mainly interested in the communication part of the Skotty.

Tuberculose centers (India)

In a TB center a healthworker and a technician are working. The local village doctor refers patients with TB symptoms to these centers where the technician performs lab tests. Two times a week a doctor visits the center to have a consultation or examinations with the patients. He visits in the center during a half hour six patients. If the patient does not have TB symptoms, the doctor refers the patient back to the village doctor. If there are symptoms, the patient get treatment and if the doctor doubts, the patient is referred to a hospital to perform an X-Ray scan.
The doctor that visit these centers is not very enthousiastic about the X-Ray application, he prefers the lab test. The communication possibility is interesting in case of consultation, not in case of examination.

Medical car team (China)

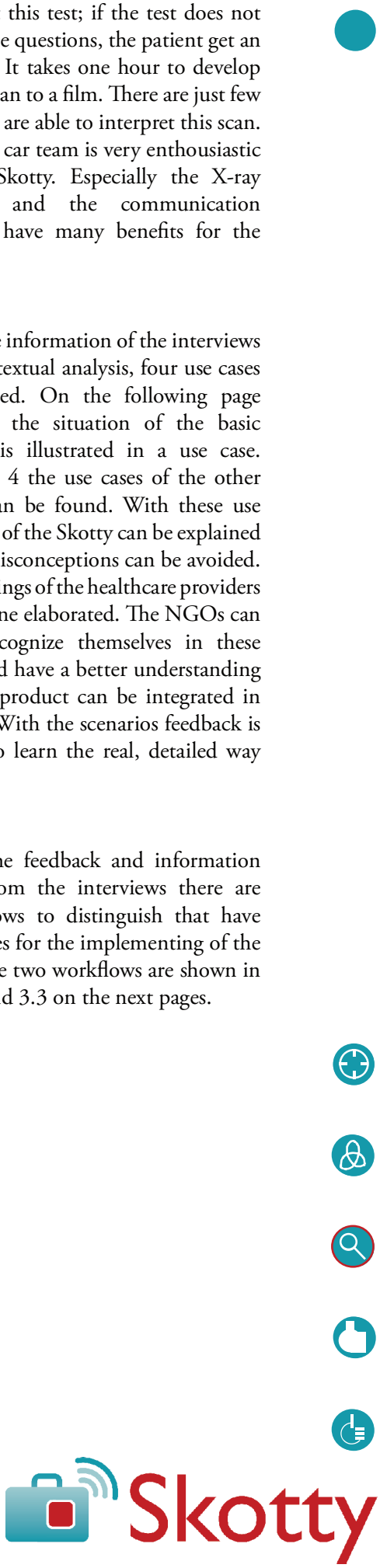
In the province Qinghai in China the provincial hospital has a special medical car that visits the rural villages to provide TB diagnoses and treatment.
Five or six times each year this team makes a tour of twenty days along ten villages. The planning of this tour is based on the information from the village doctors. This village doctor has basic information about the patient as for example the blood pressure/glucose measure. Also information about the family and the disease history of the patient.
The technician in the car perfoms a lab test of each patient. The doctor in the car interpret this test; if the test does not answer all the questions, the patient get an X-Ray scan. It takes one hour to develop the X-Ray scan to a film. There are just few doctors who are able to interpret this scan. The medical car team is very enthousiastic about the Skotty. Especially the X-ray application and the communication possibilities have many benefits for the team.

Use cases

Based on the information of the interviews and the contextual analysis, four use cases are elaborated. On the following page (figure 3.1) the situation of the basic diagnostics is illustrated in a use case. In appendix 4 the use cases of the other situations can be found. With these use case the idea of the Skotty can be explained easier and misconceptions can be avoided. The proceedings of the healthcare providers are one by one elaborated. The NGOs can probably recognize themselves in these scenarios and have a better understanding of how the product can be integrated in their work. With the scenarios feedback is provoked, to learn the real, detailed way of working.

Workflow

Based on the feedback and information extracted from the interviews there are two workflows to distinguish that have oppurtunities for the implementing of the Skotty. These two workflows are shown in figure 3.2 and 3.3 on the next pages.



Skotty

1

Healthcare houses are a common phenomenon in the highly urbanised regions of China, such as Shanghai.

2

Regularly elderly should come to the healthcare house to check the measure of their blood pressure, glucose, weight, long function and hart rate. These measurements are performed by a nurse required from the patients healthcare insurance in order to be compensated during the patients monitoring.

3

Although common in highly urban areas in China, the healthcare houses are not spread widely over the country.

4

This is a drawback for the elderly because they have no transport; therefore they come less frequently as they would have to.

5

Furthermore if they come to the healthcare house, the results are not correct because of the tiredness caused by the travel.

6

Audrey, a volunteer of HealthNet, is sent to China to help these elderly people. She takes the Skotty containing similar diagnostic technologies as in the healthcare house with her.

7

Audrey visits with this quite compact and portable Skotty all villages in the specific region, far away from the health-care house. The travel time of the patients is reduced so it takes less effort and they will be checked more frequently. Besides, the data will be more accurate and representative.

8

Audrey's next patient is a very tired looking woman called Lakshmi. She often feels weak and she is regularly dizzy.

9

Audrey recognizes these symptoms as being a result of low blood pressure. She uses the electronic blood pressure meter in the trunk to verify her thought. Her thoughts initially appears right.

10

Audrey finishes her full diagnostic san enabled by the Skotty in order to ensure no other elements are left undetected. Finally she gives Lakshmi the appropriate medication for blood pressure increases. She will have more energy. And due to Audrey's full diagnostic scan Lakshmi can rule out the propensity to diabetes and further syndromes.

Pauline Simons, s1009281, 14th of September 2012, version 2.0

< Figure 3.1: Use case basic diagnostics
> Figure 3.2: The workflow in a CHC

Patient arrives in the CHC in China

Patient

Leave home
Walk to the CHC
Open the door of the CHC
Walk straight to the doctor's office
Arrive at the doctor's office
Wait till you are on turn

Time: depend on distance, <30 minutes
Location: County CHC
Equipment: -

Pharmacy

Patient by the doctor (1)

Patient
Doctor

Describe the complaints to the doctor
Listen to the complaints
Interpret the complaints
Determine the best way to diagnose
Send the patient to the technician for a measurement.
Inform the technician about the method of measure that has to be performed.

Time: 5 minutes
Location: Doctor's office in CHC
Equipment: -

County CHC

Patient by the technician

Patient
Technician

Go to the technician
Receive the patient
Get information from the doctor about the way of diagnose
Take the diagnose tool

In case of weight scale:
Lay it on the ground
Stand on the weight scale
Wait for the measurement
Note the results
Give the patient the results
Leave the room

Time: 10 minutes
Location: Laboratory
Equipment: otoscope, weight scale, bloodpressure meter, stethoscope

Doctor's office in CHC

Patient by the doctor (2)

Patient
Doctor

Go back to the doctor's office
Wait till it is your turn
If it is your turn, take a seat
Hand over the results
Interpret the results
Determine the best treatment
Send the patient to another hospital/ clinic or prescribe medication
Leave the doctor's office

Time: 10 minutes
Location: Doctor's office
Equipment: -

Laboratory

Patient by the pharmacy

Patient
Pharmacist

Go to the pharmacy
Wait till it is your turn
If it is your turn, deliver the recipe from the doctor
Look for the medication
Provide the medication
Tackle the medication
Leave the pharmacy

Time: 10 minutes
Location: Pharmacy
Equipment: medicine cabinet

Patient by the doctor (3)

Patient
Doctor

Go back to the doctor's office
Wait till it is your turn
If it is your turn, take a seat
Hand over the medication
Explain the medication
Indicate how often the medication must be used and under which circumstances
Leave the doctor's office
Take the medicines with you
Leave the CHC

Time: 10 minutes
Location: Consult area
Equipment: -

Medical car team comes to village

County CHC doctor
Provincial hospital

Keep all the information of the patients
Send information to provincial hospital
Make a quarterly planning
Inform the county CHC doctor

Time: -
Location: County CHC
Equipment: Computer ??

1

Patients come to medical car team

County CHC doctor
Local village people

Come to the medical car
Announce your visit and wait for your turn
Provide basic information about patients to the medical car doctor

Time: 60 minutes
Location: Surroundings of the medical car
Equipment: Health card with information about age, diseases before, complaints at this moment in time, family members, neighbors (are there similar symptoms?), Village situation (are there similar symptoms? and contact information).

2

Lab test

Technician
Local village people

Invite patient to come in the car
Come in the car
Take a injection-needle from the stock
Remove the packaging
Take a seat
Relax yourself
Clean the skin of the patient
Take a blood sample
Leave the car
Wait outside

Look at the sample under the microscope
Tell the doctor what you see

Time: 60 minutes
Location: Laboratory
Equipment: Microscope, needle, cottonwool, desinfectant

3

Interpret the lab test

Medical car doctor

Get the lab results from the technician
Interpret the results

Time: 15 minutes
Location: Doctor's office
Equipment: Lab test results

4

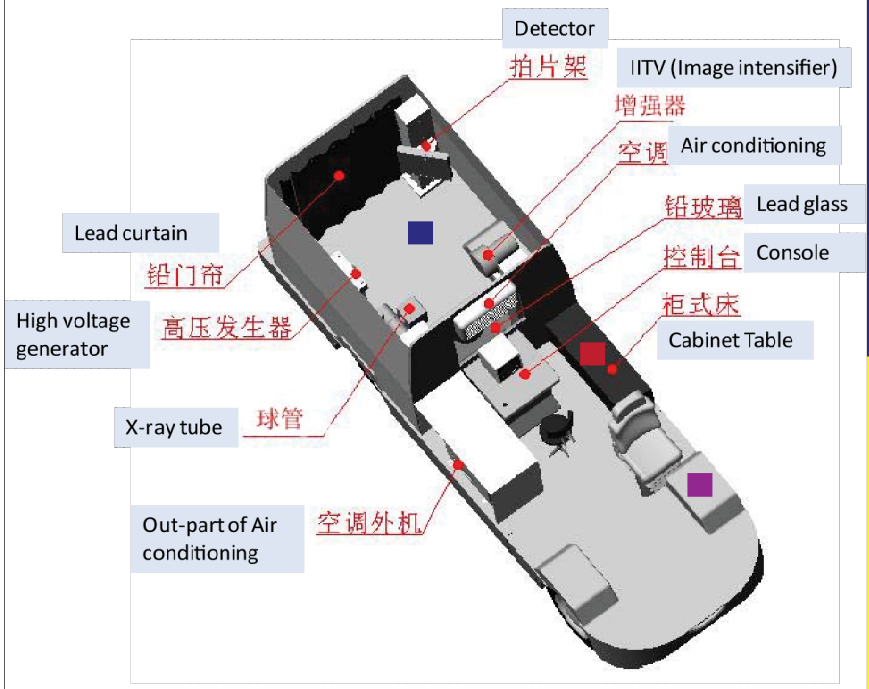
Inform the patient

Medical car doctor
Patient

Invite patient to come in the car
Come in the car
Communicate with the patient about treatment or X-ray scan
Provide medicines to the patient

Time: 10 minutes
Location: Consult area
Equipment: -

5



County CHC
Surrounding of the medical car
Village

Perform the X-ray scan

Technician
Patient

Get clothes and jewelry off
Turn X-ray machine on
Place the detector and tube
Remain motionless
Leave the room
Start the scan
Turn the X-ray machine off
Get dressed
Leave the car
Wait outside the medical car

Make the film
Provide the film to the X-ray doctor

Time: 2 minutes + 60 minutes
Location: X-ray area
Equipment: Tube, detector, X-ray machine

6

Interpret the X-ray scan

Medical car X-ray doctor
Medical car doctor

Get the X-ray scan from the technician
Interpret the scan
Inform the medical car doctor about the scan
If there is doubt, have a groupssession with the medical car team about the X-ray results.

Time: 15 minutes
Location: Doctor's office
Equipment: X-ray scan

7

Inform the patient

Medical car doctor
Patient

Invite patient to come in the car
Come in the car
Communicate with the patient about treatment
Provide medicines to the patient

Time: 10 minutes
Location: Consult area
Equipment: -

8

Medical car team leaves the village

County CHC doctor
Medical car team

Take care of the patients
Take care of the medicines providers
Visit the patients at home
Educate the family members about the need of the medi cines
If there is no village doctor near to the patient, then come back

Check if the patients take their medicines
Perform a lab test or X-ray scan again

Duration: 6 months
Location: Patient's home/ medical car
Equipment: Microscope / tube, detector, X-ray machine

9

Medical car and the resources

Medical car team

Contact the local facilities
Order the supplies are necessary
Collect the supplies

Sometimes:
Take a photo of the patient
Send it via internet to the provincial hospital
If no internet available, go to the county level hospital for internet
Get help by diagnose

During the visit
Location: Village/ County CHC
Equipment: camera, car

10

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< Figure 3.3: The workflow in a medical car

Requirements

With the information in the previous paragraphs and the interviews done with different health care workers the requirements of the Skotty can be composed. These requirements are listed by their origin. In appendix 5 each of the requirements is provided with a short explanation.

Environment

- The Skotty must provide primary care.
- The product has to diagnose at least 50% of the frequently common complaints.
- The usability of the product is very important. Therefore, a nurse must be able to use the product after a short training.
- The product must be weatherproof. It will be used in different areas of the world so it must resistant rain and temperature changes (-20 /+60 degrees Celsius [18] [19]).
- The product has to be resistant to environmental factors such as sand and dust.
- The Skotty may not look very expensive because of theft.
- The product price of the platform and the basic diagnostics may not exceed €500,00.

Patient

- The product must be hygienic. It is not allowed that the patient get an infection via for example blood residues of the previous patient.
- The appearance of the product must be friendly and intimate. The patient is not familiar with this product, so the product has to satisfy him/her.
- The product must be in the same style of design as other products in the Philips Healthcare line.

Technician/nurse

- The product must be safe and may not damage the nurse/patient.
- The language must be adjustable or chosen by ordering.
- The interface must be consistent with the knowledge and experience of the nurse: most nurses cannot type.
- The interface must join the habits of the people living in remote areas.
- The product must be reliable. It has to work always and if the battery is low, it has to give feedback about that. The data cannot be lost.
- The product must contain a second opinion option.
- It must be possible to share patient data via the product with a person at another location. This person needs a computer/ tablet or smartphone.
- The Skotty must contain a communication module so a connection with a specialist can set up.
- The product must be easy to clean. It should be possible to clean the surfaces in one minute.

Use

- The product must be a compact kit. The dimensions of this kit with basic diagnostics must be less than 25x20x15 cm (based on the dimensions of the Philips AED).
- The product must be portable. This means that the weight of the product must be less than 5 kg.
- The product must be easy to carry. This means the user has at least one free hand.
- The technologies must be modular.
- The modules must be clicked on/off/ changed in 10 seconds.
- The product must be accurate: the precision must be even high - or higher - as the individual products without Skotty.
- The product must be ruggedized. If it is not operating and it drops down from the car/table/.. with a height of 1m, it must be undamaged. If it operates and it drops down from the car/table/.. with a height of 0,5m, it must be undamaged.

Society

- Under normal circumstances, the product must have a durability of at least ten years.

Modular components

As mentioned earlier in this report, the Skotty consists of a platform with modules. The non-governmental organizations can decide which modules has the most advantages in their workflow and buy for example nine Skotty's with basic diagnostics and one with X-ray. The volunteer who needs the X-ray

module can order it at a central place. The modules must be easily to fix on/ in the platform. Therefore are a lot of ways to fix the modules. These ways are illustrated in appendix 6.

Later, during the concept development a few of these fixation possibilities will be applied in the design to experiment which method or which combination of methods is the best.
Beside the way of fixing the modules, there are more issues associated with modularity. The Skotty will be used in rural areas which means that the hygiene and comfort is less developed. During designing with modules, these points are more important than during designing a X-ray machine for a hospital in Europe.

4. Concept creation

In this chapter the requirements of the Skotty will be transformed in a concept for the form-factor. Via an architecture, a function diagram and an amount of sketches, three concepts are created.
These concepts will be evaluated on the basis of the requirements found in the previous chapter. The best concept will be selected and elaborated in chapter five.

Architecture

In figure 4.1 is shown the architecture of the Skotty. In this diagram all the components of the Skotty and their relation with each other are displayed.
The black lines are communication interfaces, the green lines are constant connections with the power supply and the red lines are connections with the power supply to charge the component.
The components with USB communication with the tablet are charged via that connection.
The components located in yellow square represent the platform.
At this moment it is unknown how the satellite module and the ultrasound transducer are connected with the tablet.

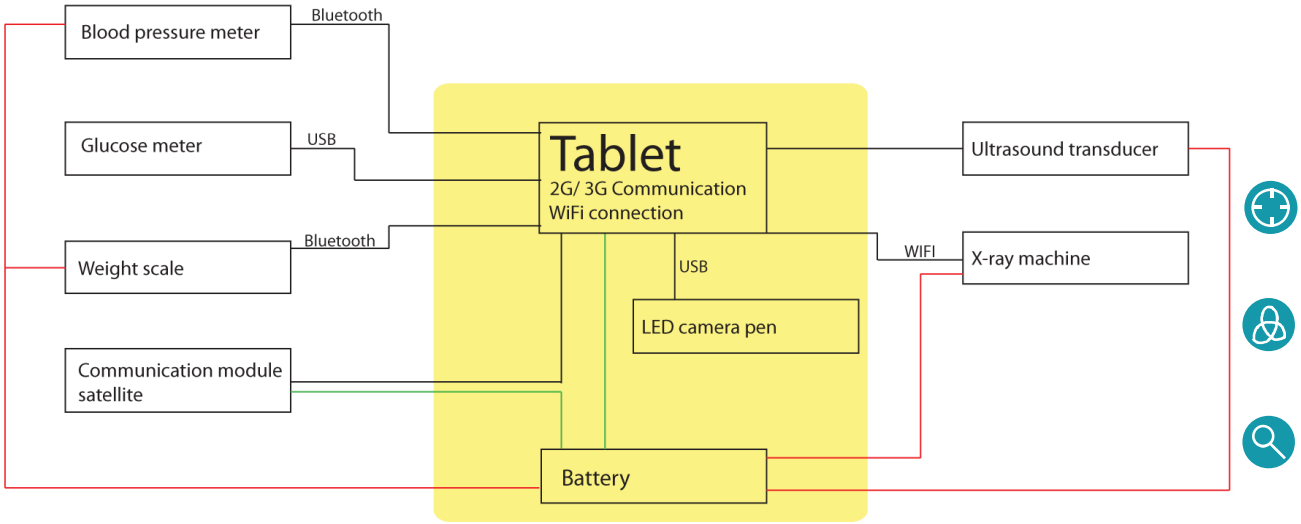


Figure 4.1: Architecture

Function diagram

Each of the subsystems have its own functions. These functions are at a number of moments related with functions of the platform. To get a clear view of this during the time, in figure 4.2 is shown the function diagram of the Skotty.

Sketches

In figures 4.3 en 4.4 a few sketches of the possible form factors with the modular components kept in mind are shown.

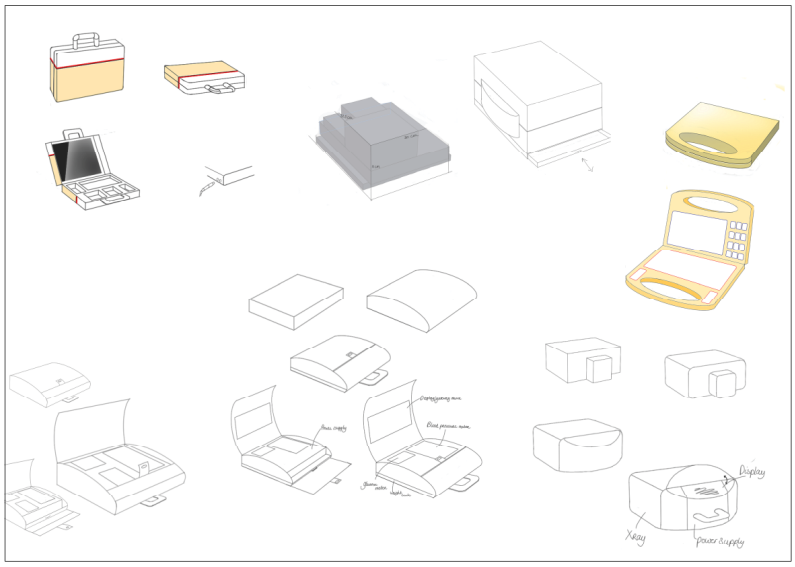
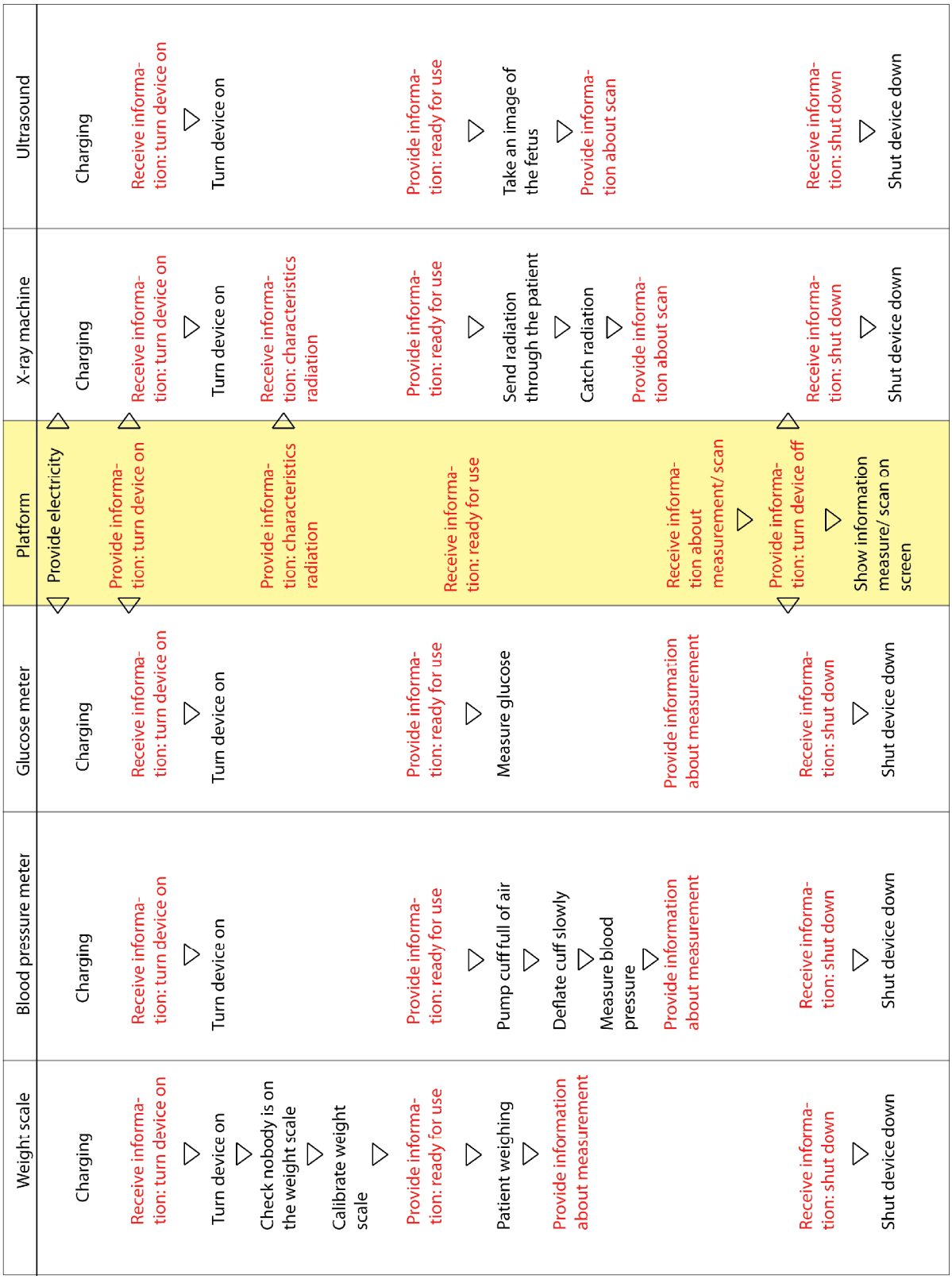


Figure 4.3: sketches

Skotty

In this diagram are illustrated in red the information flows between the platform and the components. In black is displayed what the actions of the components are owing to the message of the platform.

Figure 4.2 Subsystems and functions



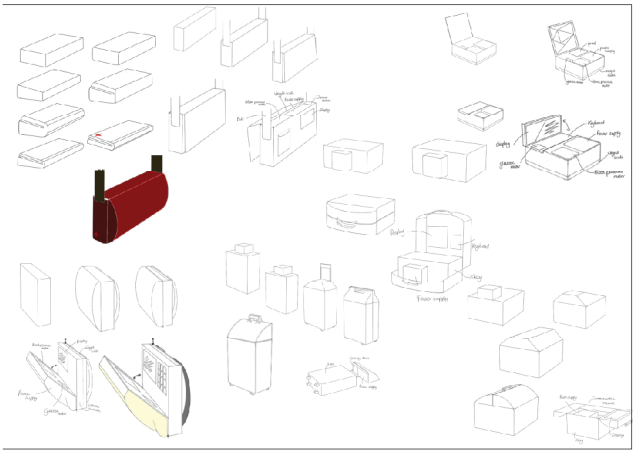


Figure 4.4: Sketches

Concepts

From the sketches three concepts are developed. In this paragraph, the idea behind each of these concepts is described. The way of working in the field and the advantages of each concept in the workflow are illustrated.

Concept 1

The first concept is based on a briefcase. You can carry it vertically and very easily. While you use it, it has to lay horizontally on the ground or on a table. Large modules like the weight scale or the X-ray detector can be fixed at the back side. The other modules can be layed in the foam in the case. This foam is flexible so the size of the modules does not matter. Under the short flap, the power supply and an extra communication device (router) are located, in the large flap is inserted the display. The outside of the briefcase is made of cotton: this is easy to clean and makes the appearance of the product a bit less expensive. The building of this concept is illustrated in figures 4.5, 4.6 and 4.7.

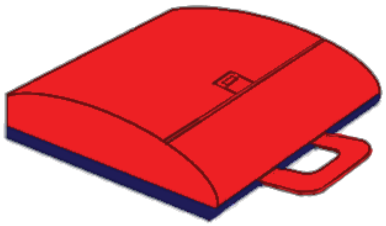


Figure 4.5: concept 1, during transport or in stock

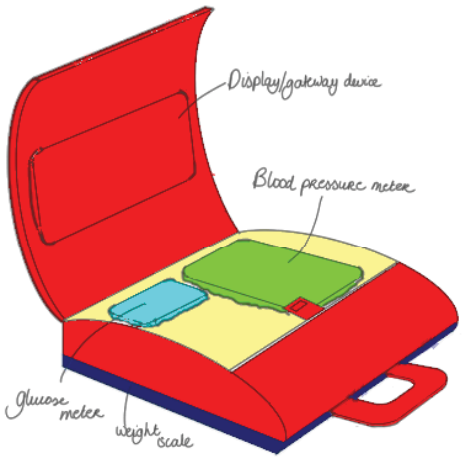


Figure 4.6: Concept 1, when opening the flap and taking the modules you need.

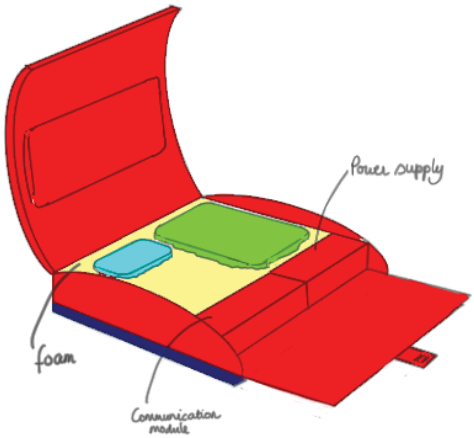


Figure 4.7: Concept 1, showing the power supply and communication module. Normally, this flap in front is closed.

Note: the placement of the power supply in this concept appears not clever. When the suitcase is upright, it topples.

Concept 2

Concept 2 is shown in figures 4.8, 4.9, and 4.10. This concept idea is a very flat suitcase. It is not only easy to carry but also easy to pile up, so if the nurse had a lot of stuff to take with her, it cannot damage. Most of the platform components are located in the upper flap, except the power supply. This is in the lower part otherwise the suitcase topples. The screen is the screen of the tablet, but there are also physical buttons in cases of dirty hands or other reasons why the touch screen does not work. There are standard dimensions for the modules, so they fall in the openings in the lower part and are well protected

against shocks.
This concept will be made of polypropylene, strengthened by pressed fibers. Inside the suitcase there is Styrofoam.

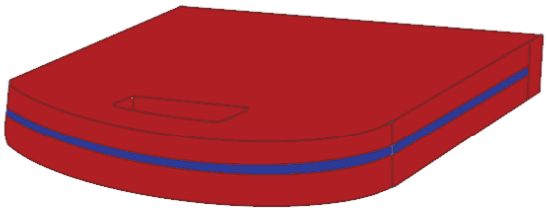


Figure 4.8: Concept 2, because of its straigt form, the suitcase is easy to pile up.

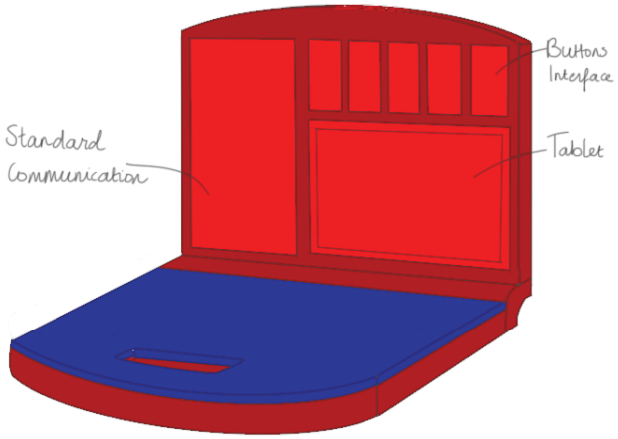


Figure 4.9: Concept 2, most of the standard components are located in the upper flap.

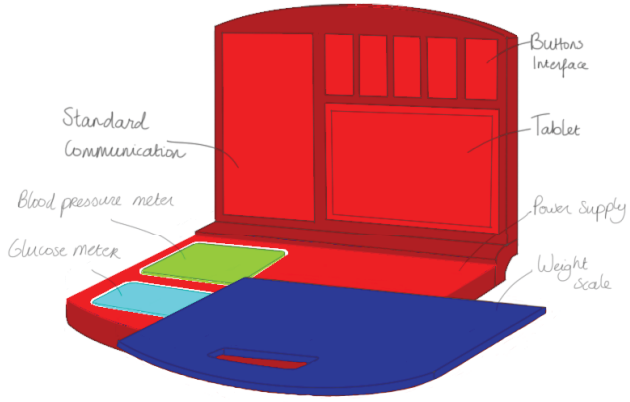


Figure 4.10: Concept 2, the weight scale scan be placed between the two parts of the suitcase. The diagnostic modules can be placed in the lower flap.

Concept 3

Concept 3 is a concept which emphasized the modular principle. As shown in figures 4.11 and 4.12, the form factor contains of platform (red color) which is in all configurations the same. On the platform the modules can be fixed via a simple click system. It is like LEGO. The nurse or technician determines the size of the case herself. If she takes just one module it is quite small, if she takes all the modules it will be bigger and heavier. It is not the purpose of the Skotty to take both basic and advanced diagnostics but if the nurse wants it, it is possible. In that case, a notification must be made to the power supply: this has not more power, so they can perform fewer diagnoses or they had to find a generator to charge the power supply in the platform.
An addition by this concept is a bag of cloth where the case can be inserted in. Through this bag, the nurse can wear the case on her back. Another advantage of the bag is that it camouflages the modern, expensive product and protects it against theft.
The casings of the modules and the platform will be made of the material EVA as already described in the paragraph about materials.

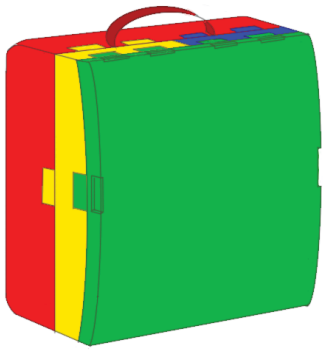


Figure 4.11: Concept 3, the platform (red)with three diagnostic modules.

Figure 4.12 : Concept 3, the modules can be clicked on/ off easily.

Note: In figures 4.11 and 4.12 an error is present. The convex side of the modules must be straight, otherwise the modules cannot be changed in sequence.

Selection of concept

The requirements of page 23 are a bit shortened shown in figure 4.13. The author of this report has decided what are the scores of each concept (1=worst, 5=best) per requirement. Some requirements are for each concept the same or not yet developed and therefore these requirements do not have a score.

Environment	Concept 1	Concept 2	Concept 3
Provide primary care.	-	-	-
Diagnose at least 50% of the common complaints.	-	-	-
A non-specialist must be able to use the product	-	-	-
The product must be weatherproof.	3	4	5
The product has to be resistant to sand and dust.	4	5	3
It may not look very expensive because of theft.	5	3	5
The product price is maximal €500,00.	3	4	3
Patient			
The product must be hygienic.	4	3	4
The appearance of the product must be friendly and intimate.	4	4	2
The product must fit in the Philips Healthcare line.	2	4	4
Technician/ nurse			
The product must be safe and may not damage the user.	-	-	-
The language must be adjustable.	-	-	-
The interface must be consistent with the knowledge and experience of the user.	-	-	-
The interface must join the habits of the people living in remote areas.	-	-	-
The product must be reliable.	-	-	-
The product must have a second opinion option.			
It must be possible to share patient data.			
The Skotty must have a communication module.	-	-	-
The product must be easy to clean.	4	5	5
Use			
The product must be a compact form-factor, less than 25x20x15 cm	4	4	4 (can be 5, depend on user)
The product must be portable, the weight of the product must be less than 5 kg.	5	5	4
The product must be easy to carry.	4	4	5
The technologies must be modular.	4	3	5
The modules must be clicked on/ off/ changed in 10 seconds.	4	3	5
The product must be accurate.	-	-	-
The product must be ruggedized.	3	5	5
Society			
The product must have a durability of at least ten years	4	4	5
Total	57	60	64

Figure 4.13: Test the requirements

Conclusion

As figure 4.13 shows, concept 3 meets the most requirements but the scores do not differ much. Concept 3 loses relatively many points on the appearance of the Skotty, so there is a specific point of interest to improve the concept.
Furthermore, the modular principle of the Skotty is emphasized in this concept, which clarifies the thought of the product. Therefore, there is chosen to continue developing concept 3.

5. Concept detailing

In the previous chapter concept 3, the concept based on the LEGO principle, seems to have the most opportunities to develop more. In this chapter this concept will be further elaborated. This is done per component of the Skotty. It starts with the platform, followed by the basic and advanced diagnostics and ends with the satellite module.

Platform

The platform of the Skotty is in each configuration the same. The function of the platform is to display the results of the measurements or scans and to set up a connection with a doctor or specialist. In this paragraph the characteristics and appearance of the platform will be illustrated.

Components

The first component of the platform is a tablet. On this tablet the results of the measurements and scans can be imaged and visualized for the technician. Furthermore, it is possible to communicate with the tablet via the local communication infrastructure (2G or 3G). It can also be connected to WiFi. On the tablet special software is installed to encrypt the information that is sent and received, to abuse prevention. The data of the patients is handled confidential.
Besides the tablet, there is also a power supply in the platform. This power supply provides electricity to the modules and the tablet. For some modules this is necessary to work, for others it is just for charging. This will be explained per module.
Another part of the platform is the digital pen camera with led light. With this pen the technician can make pictures of the patient, for example of the eyes. This camera is connected to the tablet via USB.

Interfaces

All the modules can be connected with the platform to show the results. This can be done via different ways:

Weight scale:
Bluetooth to communicate the results.
Special plug for the electricity.

Blood pressure meter:
Bluetooth to communicate the results.
Special plug for the electricity.

Glucose meter:
USB to communicate the results and charging.

X-ray:
The detector can communicate with the detector via WiFi. How the other X-ray components communicate is still unknown.
The X-ray machine has its own generator for electricity.

Ultrasound:
This is still unknown.
Special plug for the electricity.

The platform can also be connected by a local generator to charge the power supply. Therefore is a special plug in the casing of the platform.

Formfactors

In this section concept 3 (chapter 4) will be further developed. A few more detailed opportunities for the design of the platform will be illustrated. An important note that must taken into account are the display: this must be visible and on the surface while operating, while transporting it must be protected.
The touch screen must be placed in the operating position under the right angle for the best visual quality. It must be supported at the back side, otherwise the screen flips.
The battery must be locally divided over the suitcase. This component of the platform is the heaviest and if it is at one side, it does not carry comfortable.
Furthermore, the platform must have a handle to carry it and a possibility to click the modules on.






Skotty

Figure 5.1: Detailing concept A. One of the possible form factors for the Skotty platform.

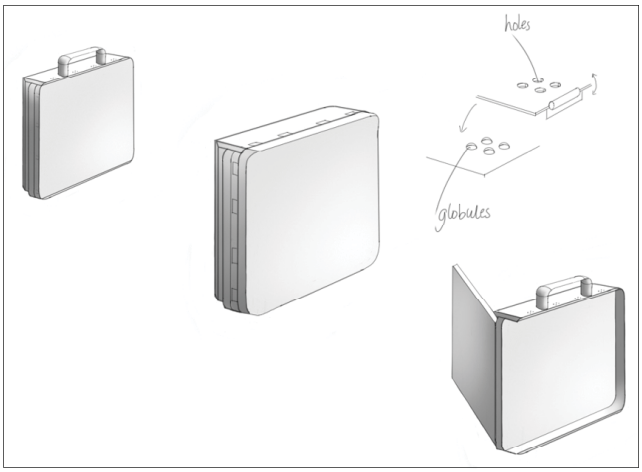


Figure 5.2: Detailing concept B. One of the possible form factors for the Skotty platform

In chapter four is concept 3 chosen to be further developed. The exact form of this concept is not yet established. The LEGO principle is sure and with that aspect in thought, three opportunities for the platform-form factor are devised.
In figure 5.1 is shown concept A. In this concept the screen flips around a horizontal axis and can be moved to the position that is fine with the (sun) light. The standard position is against the bevelled edge, which supports the screen then. At the side is the LED camera light positioned. It is connected by a wire to the platform. Also at the side is a plug to connect a local generator to the Skotty for charging the power supply. Below the screen are USB ports for the connection with the diagnostic modules. The modules

Figure 5.3: Detailing concept C: One of the possible form factors for the Skotty platform.

can be clicked on this platform because of their wider outer edge.

In figure 5.2 is shown concept B. In this concept the screen flips round a vertical axis. A disadvantage is that the screen cannot be adjusted to a fine angle regarding to (sun)light.
The modules can be clicked on the platform with small hinges.

Figure 5.3 shows the third idea of the Skotty platform. In this concept the handle can be collapsed. Then the screen flap in front can be flipped over the horizontal axis above at the platform. At the back side is a magnet, so if the whole system is tilted, it stands in a good angle to read the screen. The rest of the things are the same as by the concept A.

The final concept will be composed from concept A and C. The position of the display in the third form is better and has less chance for deflection when pushing on the screen. This is experienced by the author by using a laptop screen as touch screen. The USB ports will be below or beside the screen because of the annoyance of wire in front of the screen. An electricity plug for the local generator misses in the third concept so that will be applied.
When the technician does not operate the Skotty, the modules and the platform can be fasten to each other to have a compact product left. It is easier to carry the Skotty

as it consists of one part instead of a few accessories.

Final platform

The final form factor of the platform is illustrated in figure 5.4. The dark grey strip in the upper part of figure 5.4 shows the magnetic strip, which ensures that the platform does not topple.

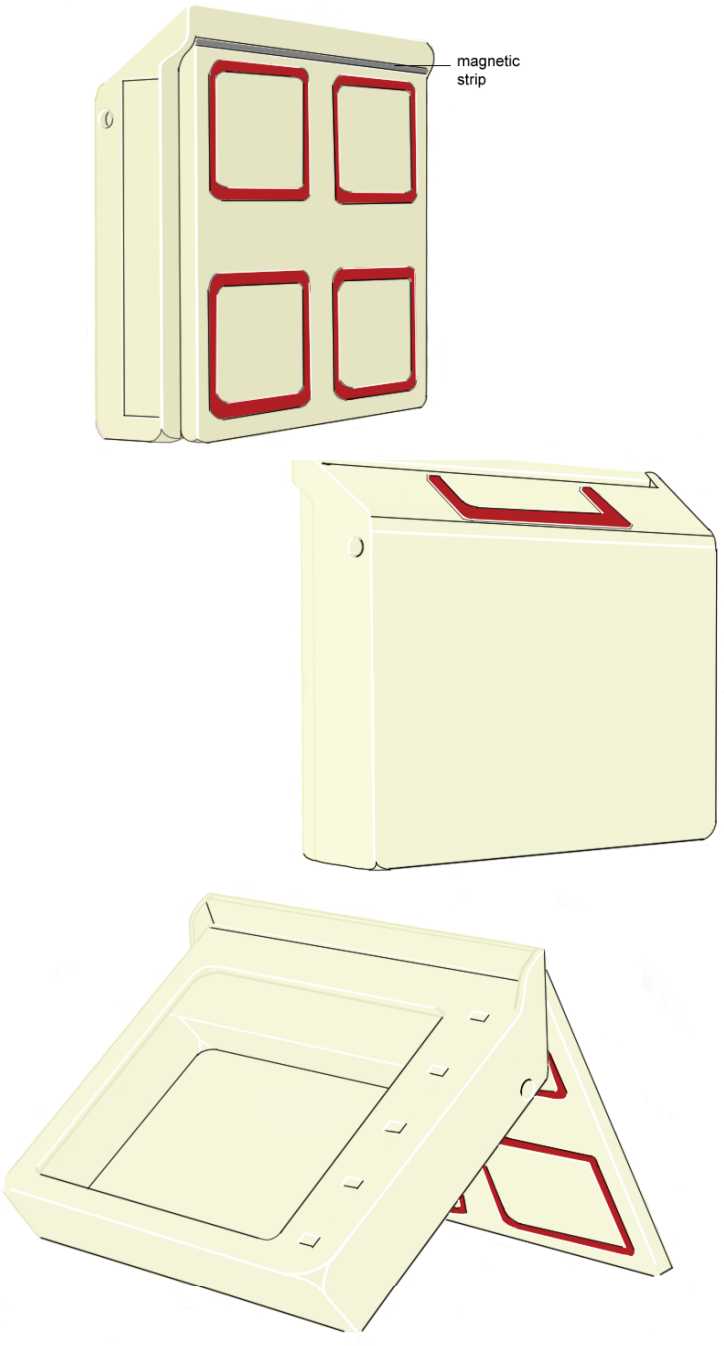


Figure 5.4: The final platform.

To avoid that the platform topple, the magnet has to be strong enough. The force of the magnet can be estimated by using the law of moments. At the front side the moment is 75mm x 39N, at the back side the arm is 10mm. Therefore the force of the magnet has to be at least 294N.

In figure 5.5 the locations of the components in the platform are shown and in figure 5.6 the dimensions are applied.

On the left side of the casing is an opening to insert the tablet and the power supply in the casing. There is also a plug to connect the platform with a local generator.

The Skotty is designed to use existing diagnostic technologies. The dimensions of these products are taken into account in the modules that are described in the next sessions.
The power supply in the platform is not chosen already and it is not clear which power supply have to be chosen. The size of the battery depends on the duration of the use and the power that is necessary per measurement/ scan. At this moment the maximum space for the power supply is 220x130x20mm.
Also the exact material of the platform (and the modules) is not known. If the EVA material with a density of 30 kg/m^3 is used, the estimation is that the platform will not break. In rest, standing upright, the platform pressures 826Pa on the underside of the casing (39.24N/0.0475m^2)

Skotty

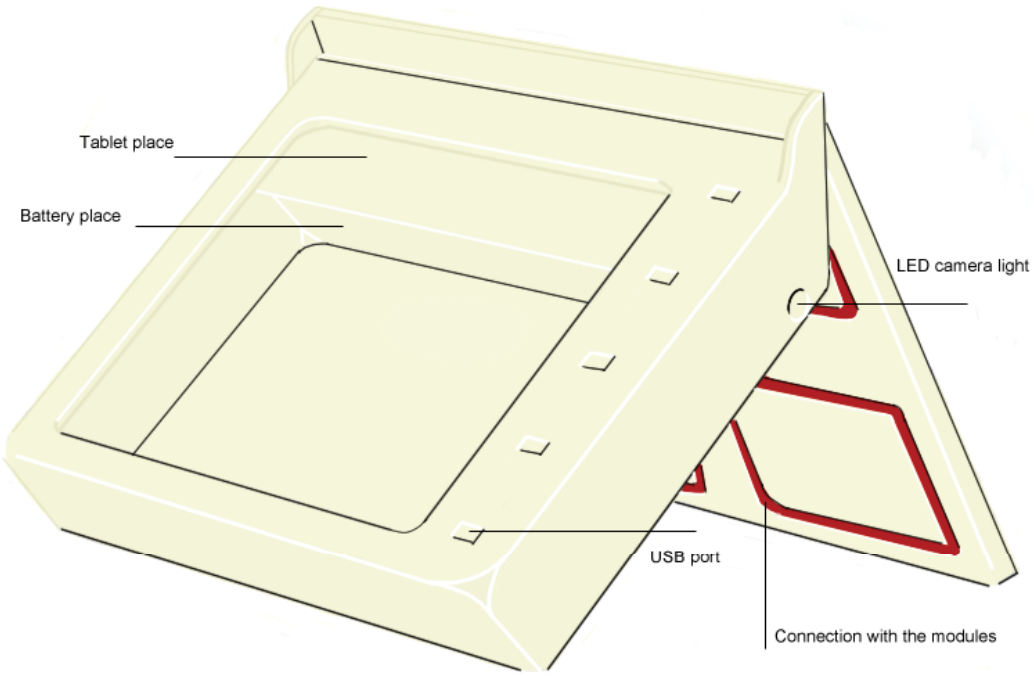
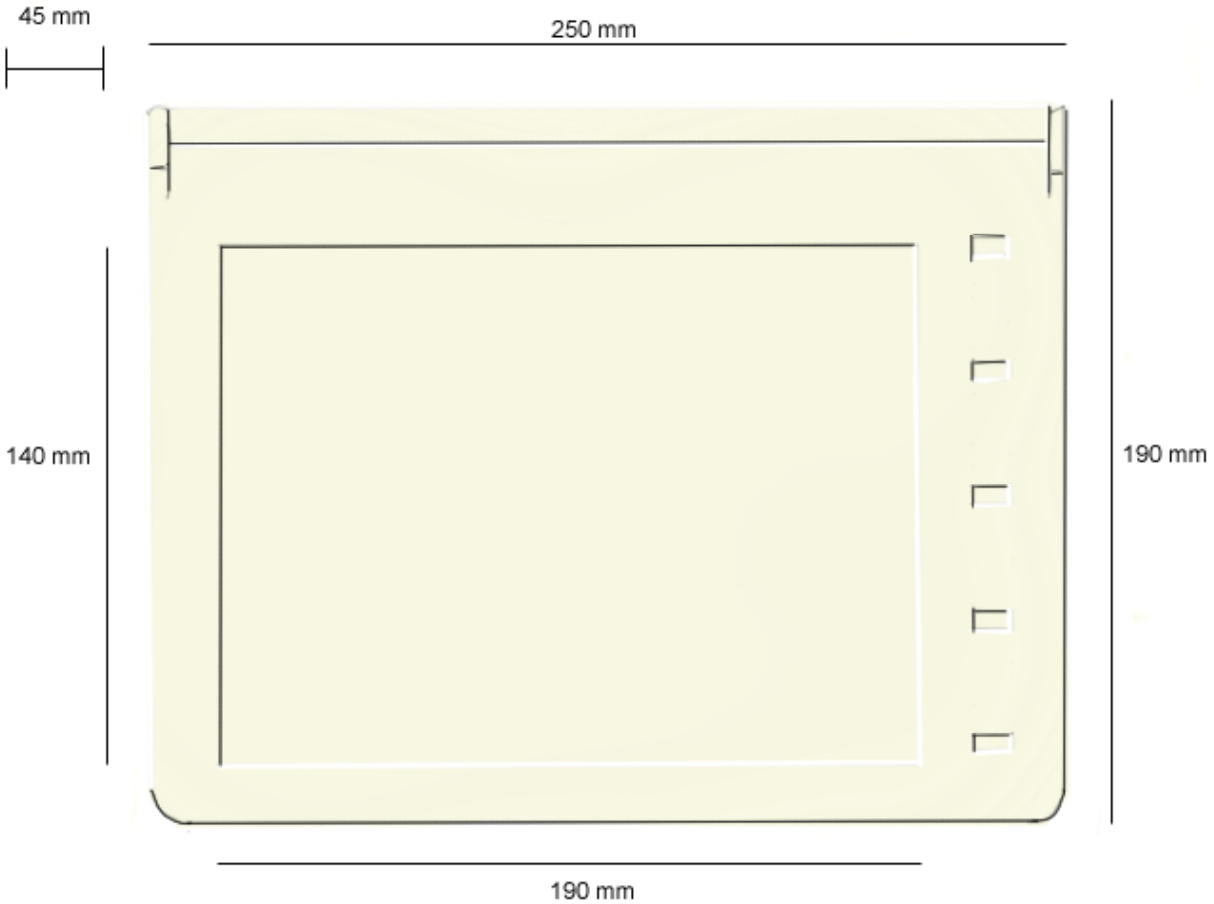


Figure 5.5: The locations of the components in the plaform.

Figure 5.6: The dimensions of the final platform.



Basic diagnostics

The first configuration of the Skotty consists of a platform with the basic diagnostic modules. The modules that are used are existing technologies of Philips Healthcare as illustrated in chapter 2, processed in a new casing. In this section the characteristics and appearance of the basic diagnostics will be illustrated.

Components

This module consists of three parts: the weight scale, the blood pressure meter and the glucose meter.

Weigth scale

The dimensions of the weight scale module are 240x190x30mm. The weightscale as illustrated in chapter 2 fits in this module. In figures 5.7, 5.8 and 5.9 the weight scale module is visualised.

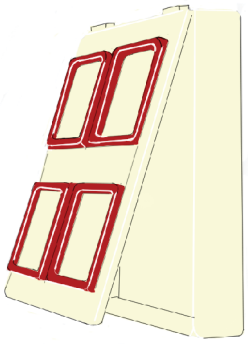


Figure 5.7: The back side of the weight scale module

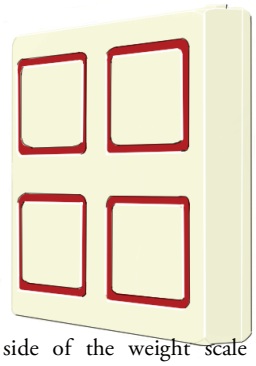


Figure 5.8: The front side of the weight scale module.

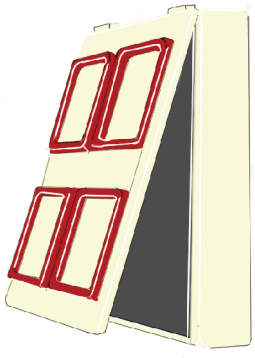


Figure 5.9 The weight scale in the module.

Blood pressure meter

The module of the blood pressure meter has to store three components; the blood pressure meter (130x155x84mm, 355gram), the manchet (foldable, 140x50x50 mm, 135 gram) and a stethoscope (200x80 (diameter), 80 gram) (figures 5.10, 5.11 and 5.12).
The information about the measurements can be sent to the tablet via WiFi.

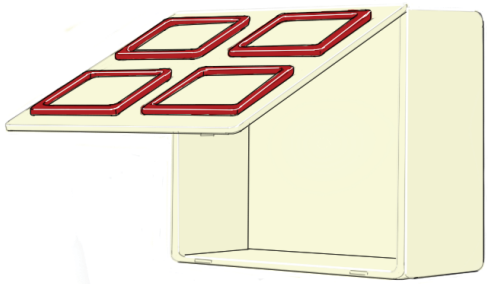


Figure 5.10: The back side of the blood pressure meter module.

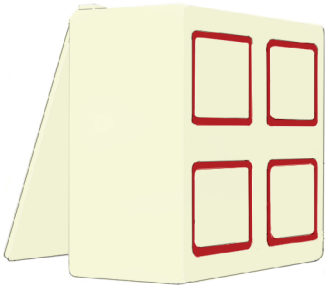


Figure 5.11: The front side of the blood pressure meter module.

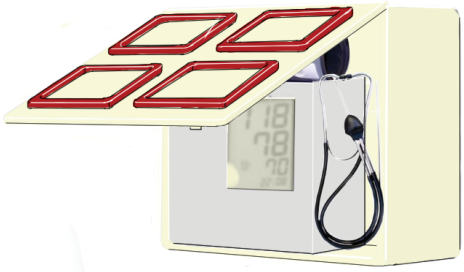


Figure 5.12: The components in the blood pressure meter module.

Glucose meter

The dimensions of the glucose meter module are 120x90x25mm. (figure 5.13, 5.14 and 5.15)

Skotty

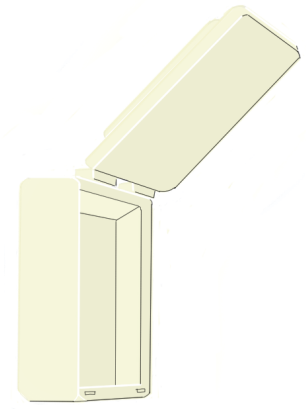


Figure 5.13: The back side of the glucose meter module.

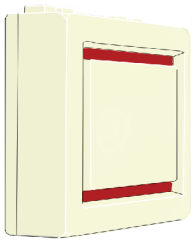


Figure 5.14: The front side of the glucose meter module.

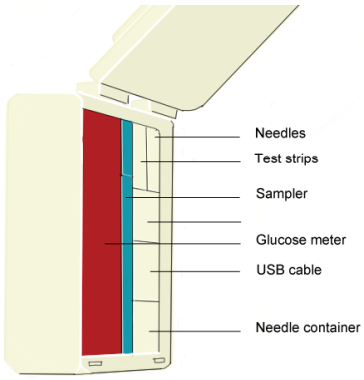


Figure 5.15: The components in the glucose meter module.

In figure 5.16 the platform with all the basic diagnostic components is shown.

With this basic diagnostic module, the workflow in the CHC changes.

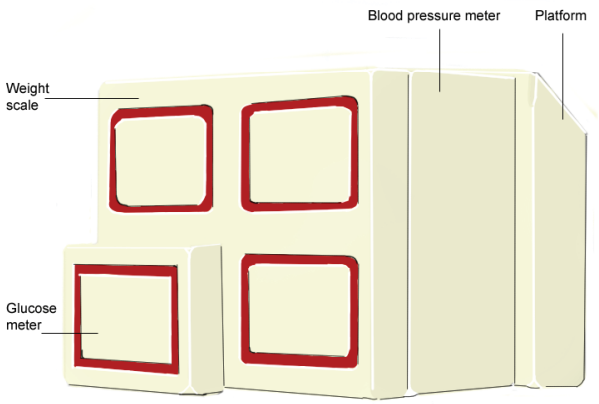
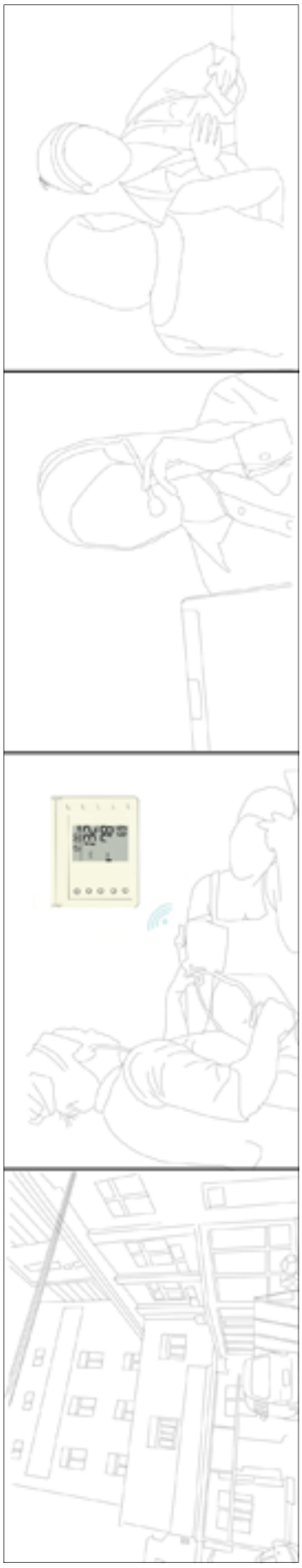


Figure 5.16: the platform with the basic diagnostics modules.

The workflow was very inefficient. In figure 5.17 the new use case is shown.
The workflow in the CHC improves when the Skotty is implemented. The new workflow is shown in figure 5.18.

Figure 5. 17: the new use case



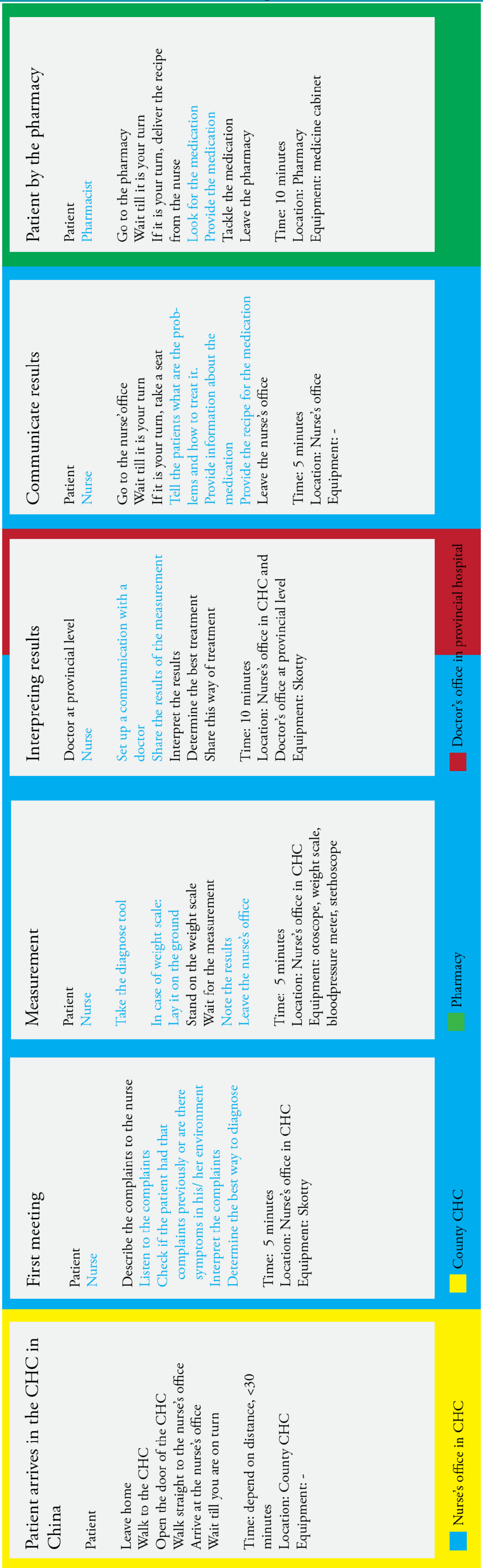


Figure 5.18: the new workflow of the CHC.

Advanced diagnostics-X-ray

Another configuration of the Skotty consists of a platform with equipment to perform an X-ray scan. The components that are used are existing technologies of Philips Healthcare, processed in large box with the dimensions 690x520x510mm. In this paragraph the characteristics and appearance of the X-ray module will be illustrated.

The components that are necessary to perform an X-ray scan are very large and heavy; cannot just be clicked on the platform. Therefore there is a casing developed for all these components together. These casing has two handles and must be lifted by two persons. In figure 5.19 and 5.20 is this casing illustrated. In figure 5.21 is indicated which component where can be placed.

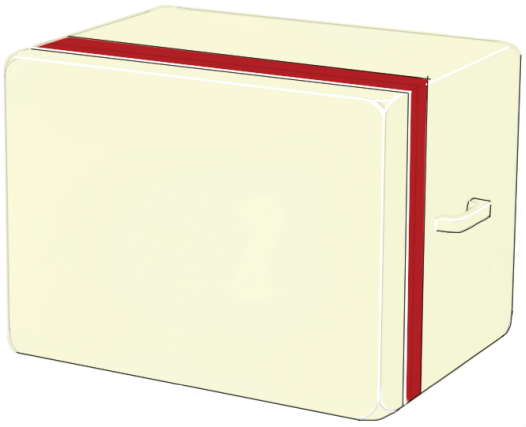


Figure 5.19: The X-ray module in non-operating position. The red line suggests a zipper.

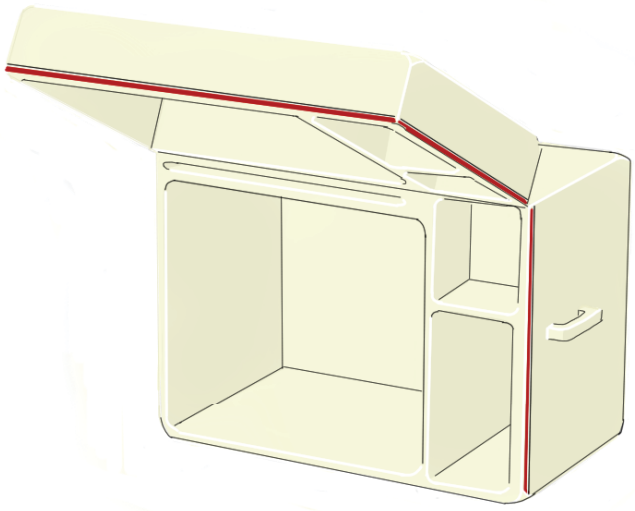


Figure 5.20: The inside of the X-ray module.

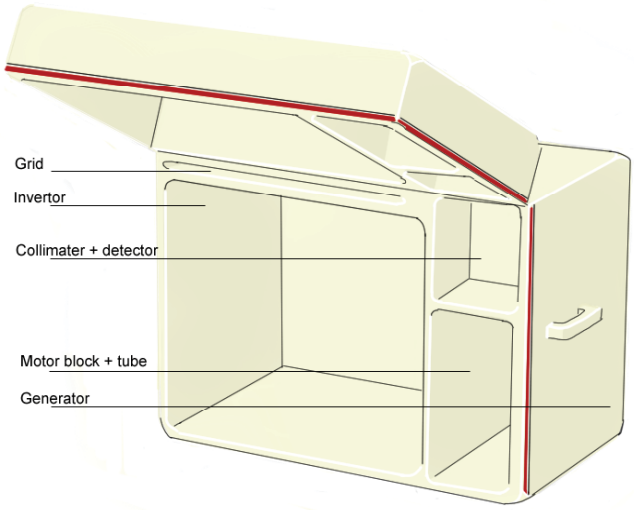


Figure 5.21: The components of the X-ray module are indicated.

The platform can be clicked at the upside of the X-ray module as shown in figure 5.22.

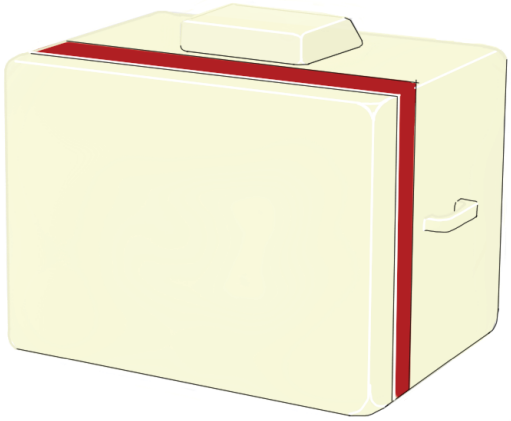


Figure 5.22: The platform and X-ray module.

With this X-ray module, the workflow in for example the Medical car of the Damien Foundation changes. The X-ray machine now can produce images and these can be interpreted by an X-ray doctor externally. This is much more efficient. As shown in figure 5.23, this workflow is improved.

In figure 5.24 the improved workflow is visually illustrated.

>> Figure 5.23: the improved workflow in the medical car.

Medical car team comes to village

County CHC doctor
Provincial hospital

Keep all the information of the patients
Send information to provincia. hospital
Make a quarterly planning
Inform the county CHC doctor

Time: -
Location: County CHC
Equipment: Skotty

1

Patients come to medical car team

Driver
Local village people

Come to the medical car
Announce your visit and wait for your turn
Make a list of the patient
Share this list with the doctor

Time: 10 minutes
Location: Surroundings of the medical car
Equipment: Pen and paper

2

Lab test

Technician
Local village people

Invite patient to come in the car
Come in the car
Take a injection-needle from the stock
Remove the packaging
Take a seat
Relax yourself
Clean the skin of the patient
Take a blood sample
Leave the car
Wait outside

Look at the sample under the microscope
Set up a communication with the doctor
Share the microscopy results

Time: 30 minutes
Location: Laboratory
Equipment: Microscope, needle, cottonwool, desinfectant, Skotty

3

Interpret the lab test

Doctor in provincial hospital

Have a communication with the technician
Get the lab results
Check if the patient had the complaints previously or are there symptoms in his/ her environment
Interpret the results

Time: 15 minutes
Location: Doctor's office in p. hospital
Equipment: Skotty, Lab test results

4

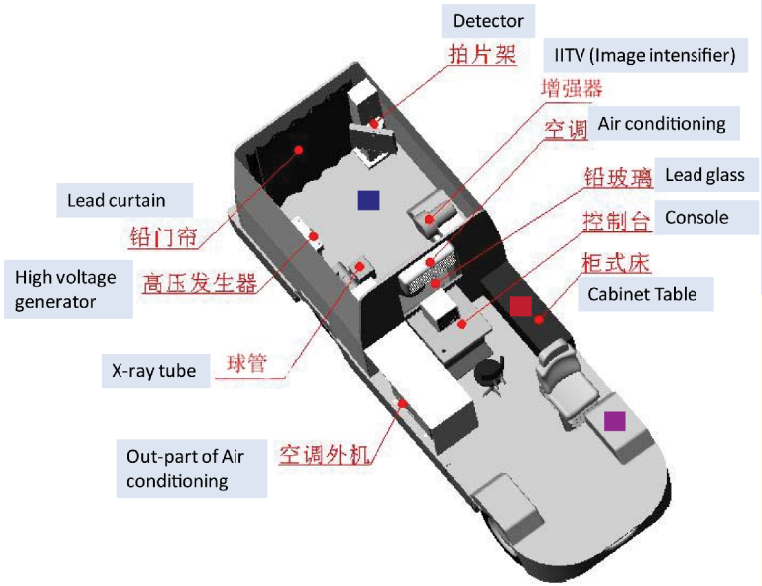
Inform the patient

Technician
Patient

Invite patient to come in the car
Come in the car
Communicate with the patient about treatment or X-ray scan
Provide medicines to the patient

Time: 10 minutes
Location: Consult area
Equipment: -

5



County CHC
Surrounding of the medical car
Village

X-ray scan

Technician
Patient

Get clothes and jewelry off
Turn X-ray machine on
Place the detector and tube
Remain motionless
Leave the room
Start the scan
Turn the X-ray machine off
Get dressed
Leave the car
Wait outside the medical car

Make the images
Share the images to the X-ray doctor in the provincial hospital

Time: 2 minutes
Location: X-ray area
Equipment: Tube, detector, X-ray machine, Skotty

6

Interpret the X-ray scan

X-ray doctor in provincial hospital

Get the X-ray scan from the technician
Interpret the scan
Set up a connection with the medical car doctor
Inform the medical car doctor about the scan

Time: 15 minutes
Location: Doctor's office in p. hospital
Equipment: X-ray scan, Skotty

7

Inform the patient

Technician
Patient

Invite patient to come in the car
Come in the car
Communicate with the patient about treatment
Provide medicines to the patient

Time: 10 minutes
Location: Consult area
Equipment: -

8

Medical car team leaves the village

County CHC doctor
Medical car team

Take care of the patients
Take care of the medicines providers
Visit the patients at home
Educate the family members about the need of the medicines
If there is no village doctor near to the patient, then come back

Check if the patients take their medicines
Perform a lab test or X-ray scan again

Duration: 6 months
Location: Patient's home/ medical car
Equipment: Microscope / tube, detector, X-ray machine, Skotty

9

Medical car and the resources

Medical car team

Contact the local facilities
Order the supplies are necessary
Collect the supplies

Sometimes:
Take a photo of the patient
Send it via2G/ 3G to the provincial hospital
If no internet available, use the satellite module
Get help by diagnose

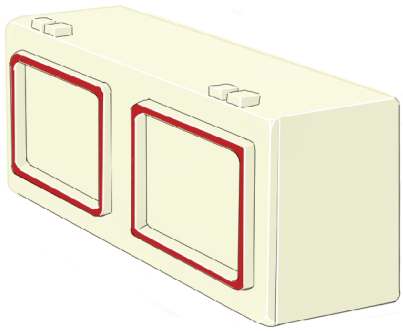
During the visit
Location: Village/ County CHC
Equipment: camera, car, Skotty

10

Skotty

Advanced diagnostics-Ultrasound

The third configuration of the Skotty consists of a platform with equipment to perform an echo with ultrasound.
The ultrasound module consists only a transducer (185x75x55mm). This is shown in figure 5.25.



Satellite communication

Beside the diagnostic modules the Skotty also have a communication module. This module consists of a satellite beacon to set up a connection with a specialist on the other side of the world.

Components

The beacon is the only component in this module. The diameter of the beacon is 80mm and the height is 222mm.
The casing of this module is shown in figure 5.26.

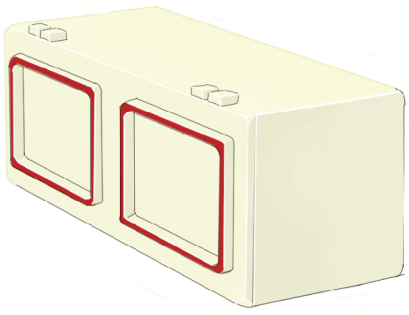
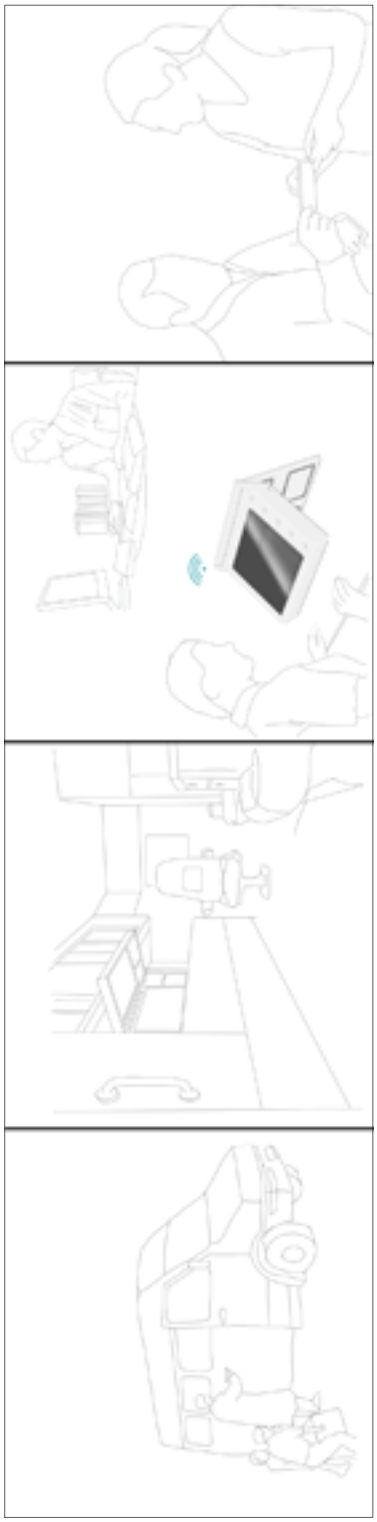


Figure 5.26: the satellite module.

Figure 5.24: The use case of the medical car using the Skotty with X-ray.



Integration

As shown in figure 5.16, the platform with the basic diagnostics is very thick. This does not wear very comfortable. To improve this comfortability and to prevent an expensive look, in figure 5.25 is shown a bag in which the whole bag can be fitted.

Figure 5.25: The backpack for the Skotty with the basic diagnostic module.

The dimensions of the bag are 190x250x190mm. The heaviest component is the platform (the power supply). The nurse is recommended to put the Skotty in the bag with the platform the nearest to the backrest.

Evaluation

In the previous chapter the concept for the Skotty is extensively explained. In this chapter the design will be tested: does it meet the requirements? which points do need extra attention when developing this concept?

Environment

The Skotty must provide primary care.

Primary care means that the health care provider consults patients and refers them to the specialists they need. The Skotty helps the technician/nurse with diagnose the patients via the communication opportunity. After diagnosing the patient, the technician/nurse is able to refer them to the appropriate specialist.

The product has to diagnose at least 50% of the frequently common complaints.

Infant mortality and tuberculosis are two of the common diseases in India and China. These diseases can be diagnosed by the Skotty. Also diseases under elderly are present frequently. These diseases often are things like hypertension or a incorrect body mass index (BMI). The exact percentages of patients with these diseases are unknown but the Skotty covers certainly a wide range of diseases.

The usability of the product is very important. Therefore, a non-specialist must be able to use the product after a short training.

This requirement is important for the design of the interface, what was not part of this assignment. An opportunity to meet this requirement is to have two interfaces: One for unexperienced health care providers and one for professionals/ trained people.

The product must be weatherproof. It will be used in different areas of the world so it must resistant rain and temperature changes (-20 / +60 degrees Celsius).

The technologies used in the Skotty are existing technologies. They are already used in areas all over the world. Also in India and China they are used but only in the urban hospitals. The material of the casing, EVA, is resistant against water and these temperatures.

The product has to be resistant to environmental factors such as sand and dust.

The material of the casing is resistant to sand and dust. This material is also used in highchairs on bicycles. The technologies are less resitant to sand, dust and water. These have to be used only inside a building/car so the amount of sand, dust and water is minimal. Outside, the technologies are prepacked in the special casing which is protect the diagnostics.

The Skotty may not look very expensive because of theft.

As shown in the subparagraph about the basic diagnostic concept, there is a backpack in which the Skotty can be stored. The satellite module and the ultrasound module can also be stored in this bag. The X-ray module is much larger. This module get a permanent place in the medical car, there it cannot be stolen. Furthermore, this module has a weight of more than 35 kg so it is not easy to steal it.

The product price of the platform and the basic diagnostics may not exceed €500,00.

This requirement is not researched yet, but the costs can be estimated. The selling prices of the components are:

diagnostic technogies:	3x20=€60
tablet:	€200
power supply:	€30
casing:	€20
Total:	€330

This amount will be multiplied by 1,5 for the design costs, the manufacturing costs and the profit. This is because the Skotty uses existing technologies. The price is then €495.

Patient

The product must be hygienic. It is not allowed that the patient get an infection

via for example blood residues of the previous patient.
The diagnostic technologies that are used in the Skotty are existing technologies. This requirement was also a requirement when those technologies were developed. The casing is new. The material of the casing is a sort foam which can be cleaned with a wet wipe.

The appearance of the product must be friendly and intimate. The patient is not familiar with this product, so the product has to satisfy him/ her.
The product has rounded corners and a light, soft color to satisfy the patient. These characteristics sarisfy Dutch patients. It is still unknown of that is the same for Chinese/Indian patients.

The product must be in the same style of design as other products in the Philips Healthcare line.
In the Philips Healthcare line there are no diagnostic technologies at this moment. There is the Philips AED defibrillator, which will be the guideline for the interface design.

Technician/nurse

The product must be safe and may not damage the nurse/ patient.
This requirement is mainly important for the X-ray module. This module produces radiation which can be dangerous. In the software on the tablet, there must be a limitation programmed of the amount of radiation broadcast each time. Furthermore, the technician who performs the X-ray scan gets a training to learn to operate with the equipment and the safety regulations.

The language must be adjustable or chosen by ordering.
This requirement refers to the interface design. This is not developed yet.

The interface must be consistent with the knowledge and experience of the nurse: most nurses cannot type.
In the interface design must be buttons among which the technician/nurse can choose.
The interface must join the habits of the people living in remote areas.
This requirement is related to the interface design.

The product must be reliable. It has to work always and if the battery is low, it has to give feedback about that. The data cannot be lost.
The reliability of the product differs per module and is for each module the same as the reliability of the same existing product.

The product must contain a second opinion option.
With the Skotty a connection can be set up with a specialist. This specialist has the second opinion of the patient. And if the specialist also doubts, then it is possible to add a third person in the conversation.

It must be possible to share patient data with the product.
The tablet can connect with 2G/3G and WiFi to share data. If these networks do not cover the area of the Skotty at that moment, the satellite module can help to share the data.

The Skotty must contain a communication module so a connection with a specialist can set up.
The Skotty contains a tablet with 2G/3G/ WiFi connection opportunities and it is possible to add a satellite module to set up a connection.

The product must be easy to clean. It should be possible to clean the surfaces in one minute.
The casing of the product is flat with rounded corners. There are no cracks which are difficult to clean.

Use

The product must be a compact form-factor. The dimensions of the box must be less than than 25x20x15 cm (based on the dimensions of the Philips AED).
The concept does not meet this requirement. Only the platform meets it. This is because of the existing technologies: these are often bigger, mainly in depth. If these requirement would be met, the technologies themselves should be redesigned.

Skotty

The product must be portable. This means that the weight of the product must be less than 5 kg.
For this requirement the same applies as in the previous requirement. The existing technologies have a certain weight which can only be decreased by redesigning the technologies. The weight of the platform depends on the battery.. It is not clear how many voltage battery is necessary. For the EVA material casing, the variant with the lowest density is chosen, to avoid a heavy casing.

The product must be easy to carry. This means the user has at least one free hand.
The plaform has a handle to carry the Skotty with one hand. For basic diagnostics there is also a backpack developed, in which it is easy to carry the platform with the basic diagnostics. Then the user has both hands free.

The technologies must be modular.
The diagnostic technologies are prepacked in casings which can be clicked on/off the platform, with the aid of the LEGO principle.

The modules must be clicked on/ off/ changed in 10 seconds.
The modules can be clicked on/ off with the LEGO principle. The only difference is that the insertion is not at the edge but one cm near to the edge.

The product must be accurate: the precision must be even high - or higher - as the individual products without Skotty.
The technologies that are used in the Skotty are existing technologies. These are protected by the casing, which maintains the quality.

The product must be ruggedized. If it is not operating and it drops down from the car/table/.. with a height of 1m, it must be undamaged. If it is operating and it drops down from the car/table/.. with a height of 0,5m, it must be undamaged.
It is not clear of the Skotty meets this requirements. There has to be more research about the material EVA and the thickness that has to be used. It is also possible to use inserts.

Society

Under normal circumstances, the product must have a durability of at least ten years.
The material EVA is a very durable material. This material protects the technologies against bumps, which increases the durability of the diagnostic technologies. Of the durability is really ten years can not be predicted.

Conclusion

The Skotty does not meet all requirements and a lot of points are still open for development, but nevertheless for a first form factor the concept is successful. It is possible to use this form factor to hunt down more user requirements when visiting the remote areas in India or China.

Conclusion

The development of the Skotty has taken a new path. The possibilities of Philips are researched; basic diagnostics (weight scale, blood pressure meter and glucose meter) and advanced diagnostics (X-ray) at this moment are real oppurtunities. With these technologies the workflow of the doctor and the specialist can be efficiently improved. Now the doctors and specialists can work at a centralized location. They do not lose time for travelling anymore. Furthermore, the nurse and the technician get more responsibility to the patient. For the patient the Skotty is also a positive addition to the CHC or medical car. There are less waiting lists because also less educated people are able to help them now. The patients trust the nurses and technicians because of the professional equipment and the second opinion of a doctor/specialist.

The different modules can be clicked on/off the platform in a few seconds and the data of the diagnostic technologies are communicated to the tablet very fast. Through this tablet it is possible to share the data with doctors/specialists at the other side of the world.

The concept itself does not meet all requirements as shown in the previous chapter, evaluation. The diagnostic modules now are just casings around existing technologies/products. This is why they are larger and heavier then required. To reduce the size and the weight, the sizes of the existing products have to decrease.

The requirements regarding to the interface are also not met at this moment, this is because the interface design is not part of this assignment.

The next step is to make construction drawings which are necessary to produce a prototype. After that the rapid prototype can be made.
With this prototype the target users will be contacted, to ask them what they think about the idea. In this contact moment, it will be clear if the user requirements are interpreted properly.

This last step takes place around October 2012, so that is not a part of my assignment.






Recommendations

The Skotty concept at this moment is not perfect. It must be further developed with more details. There are a few recommendations that must be taken into account during this development.

At this moment there are performed four interviews, two of it with Chinese healthcare providers and two with Indian interviewees. During these interviews the way of working is illustrated and the user requirements for the Skotty are listed. At this moment the final concept is not evaluated by the target users. Before further development of the concept, it would recommended to contact the target users to learn their opinion regarding to the concept.

EVA is selected to be the material of the casing. The characteristics of this material are not assimilated in the product. For example, it must be researched what the best thickness is and if inserts are necessary.

The Skotty will be used in India and China. At this moment the electricity connection there is unstable. A feature to the Skotty can be a solar battery. This product is provided with a solar panel which convert solar energy to electricity. The panel is optional. It is extra weight and size to carry so the nurse/technician has to decide if it is necessary to operate at the specific area.

The nurse who will use the Skotty gets a training about handling the product, for what it is meant and for what not, how the technologies work, what the users has to do if they do not understand the measurement/ scan or if they doubt about it. This training can be provided by an organization as Empower School of Health [20]. They supply trainings vary from two days till three weeks, taught by doctors, pharmacists and dentists.

The differences between the education levels of the nurses/ village doctors/ general practitioners (GP)/ specialist are enormous. Not only their medical knowledge differs, but also the reading and writing skills are not the same. The people of all the medical levels have to be able to work with the Skotty. It must be simple for the nurse, but for the specialist the work has to remain a challenge and the interface cannot be too simple. A solution for that problem is two interface modes. When you turn the Skotty on, the simple mode will start up. Next to the screen is a button placed to switch the interface from simple in professional mode or vice versa. Furthermore, the guideline for the interface design is the Philips AED defibrillator. This products helps the user step by step how to resuscitate the patient.

List of terms

CHC	Community Health Center
Form factor	Product
GP	General Practitioner
Skotty	Philips concept that combines diagnostic technologies with communication equipment.
TB	Tuberculosis
Technician	Person who performs measurements and scans
Workflow	Way of working

Skotty

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Skotty

Appendix I

Existing Philips Technologies [21]:

Computed Tomography
Diagnostic ECG
Emergency Care & Resuscitation
Fluoroscopy
Clinical Informatics
Interventional X-Ray
Magnetic Resonance
Mammography
Mobile C-arms
Monitoring
Nuclear Medicine
Radiation Oncology
Radiography
Refurbished Systems
Hospital respiratory Care
Supplies
Temperature Modulation Therapy
Ultrasound

Skotty

Appendix 2

NGO selection

The NGOs that are contacted to learn more about healthcare providing in India and China are listed below.

1) AIDS Fonds [22]
2) AMREF Flying Doctors [23]
3) Artsen zonder grenzen [24]
4) Caritas HongKong [25]
5) Christian Action [26]
6) Damiaan actie [27]
7) Dokters van de Wereld [28]
8) Female Cancer Program Foundation [29]
9) FIND diagnostics [30]
10) Imaging the World [31]
11) India E-health [32]
12) Kanchan foundation [33]
13) Red Cross [34]
14) Salvation Army [35]
15) Save the Children [36]
16) SOS International [37]
17) Smile foundation [38]
18) Terre des Hommes [39]

Skotty

Appendix 3

Interview Manish Kumar Singh

10.08.2012
Manager programmes at SMILE Foundation as national level health programs.

SMILE Foundation
V - 11, Level - One, Green Park Extension, New Delhi - 110016, India
T : 43 123 700 | F : 41 354 454 | M : 9654383837I[India +91; New Delhi 011] |Tel: 9310103401 & 9654383837

Manish starts with explaining about his job. He works for still two days at SmIle. Nitasha is the successor of Manish and we will keep in touch with her.
Manish explains in short that SMILE on wheels is a mobile hospital program.
Manish was very engaging to participate in the interview. He was fluent in his English vocabulary.

In General

In general there is a healthcare shortage in India. Because of the lack of awareness and the lack of services there is an accessibility problem.

Onsite – the 'SMILE on wheels Team'
SMILE on wheels is a program with a mobile hospital in a van. The portability of the van is very high so the under accomplished people can also be reached. These under accomplished people prefer to come to the mobile hospital instead of the corporate hospital.
They try to handle the patients on the same way as in the standing hospitals. The patients come to the van and have to wait in the counter. Before the consultation they give all the information about the problem for the health card? In this counter they are for 6/7 minutes and then they go to the doctor. Then the doctor decides which diagnostic method will be used. The technician performs this method by the patient. With the results the patient goes back to the doctor who determines the method of treatment. Afterwards the patient visits the pharmacy in the car to get the medication.
In the SMILE on wheels van the patient gets diagnose and treatment. If the doctor is not able to diagnose, he refers the patient to another hospital.
In urban areas the doctor helps around 70 patients per day. In rural areas this amount is only 35/40 patients a day. The Skotty can help to increase this number because of the possibility of using remote systems.

Team

In the mobile medical van are:
- 1x doctor
- 1x nurse
- 3x technician
- 1x Lab (depend on the doctor for performing the Xray)
- 1x driver (also used to effort mobilization)

They are satisfied with this team – they think the current staff is optimal, because they have all the functionalities filled. Sometimes there is a limit of equipment: there is only one X-ray machine, so they do not need more personnel for Xray. They work in this combination since a long time ago.

Schedule and location

The SMILE foundation has a strict schedule for the locations that were visited by the van. Generally the van visits 10 places a week and every place 4 times a month. First they select a community and then they select a place where the maximum amount of people is able to come to. In urban areas the van is located at a central location, in the rural areas it is more a health camp: there is no hospital where the van is located. It is important that the people get aware of the van. There is a public entrance in the van so they make an announcement to the villages if the van will be visiting them.
In the van are present basic diagnostics, lighters in de lab, an imaging system, portable Xray and MR.
Note: In the mobile hospital they do not use second opinion, they are not experienced

Skotty

with it. However, it would be a good kind of support and an improvement of quality if it is possible with the Skotty. The second opinion can be done by every doctor.
Note: we have requested Manish for pictures / photos of the SMILE on wheels van, including sharing the current configuration of the SMILE on wheels van (equipment, utilization, etc).

Focus

The SMILE foundation does not have a target to a specific disease. In India there are programs to almost every disease but these are not functional.
It is possible to identify TB, the lab in the van is used. But after that the patient will be referred to another doctor in a town centre. The patient cannot be treated in the car because of the routine consultations that are necessary.

Training

The gap between the lower class and middle class becomes even greater. It is the purpose of the SMILE foundation to decrease this inequality. They work together with Empower India to live up to this goal.
Few times a year the SMILE foundation hires a professional to train the staff. They organize two trainings; one for the medical staff and one for the technical staff.

Patient data

The SMILE foundation has a major system where they compile all the information about all patients: each micro information about the patient and the patient history. They collect what kind of treatment they perform and which diseases are usually present. The tools and mechanisms to save patient data are in the van. They do not use this information for statistical purposes. This information is shared with community leaders.

Partnerships and payment

The SMILE foundation concerns partnerships with both private and public companies because then the best way to provide the best service to the people that are not able to visit a doctor can be organized. The foundation has selected 10 to 12 urban … with which they are in touch. Not more than 12 because the level of demand. They develop also a network with the private and charity hospitals, but with charity hospitals it is not a financial partnership.
The corporate hospitals are located in and around a community and they would like to partner with the SMILE on wheels van in that community because of the money and accessibility to data and the village people. These hospitals are not able to effort all the facilities like SMILE on wheels. The SMILE on wheels team provides this service for the hospitals. Furthermore, the government determines that the corporate hospital has to do some services.
They also have partnerships with diagnosis companies like Fortis and Apollo. These companies must have a non-profit background. Diagnose and treatment in the van is free for the patients.

Note: Manish is very much involved with the public and private partnerships; because of he believes that it is the best way to provide the services to the people who are not able to entrance the quality service.

Possibilities for the Skotty

Regarding to the dying number, there is an increasing gap between the people who are under accomplished and the people who are accomplished. The accomplished people are able to go to another village, they are able to get the quality service. For under accomplished people the quality services are not accessible because of the lack of portability. There is a need to fill this gap, a need to come out with a second solution so that these quality services can be operated by the under accomplished people.
The Skotty can develop the mobile hospital as health deleverages system. And not only the process will be improved, it can also develop the mobile hospital with the technologies and quality equipment so the SMILE on wheels – team will not provide just services but quality services.
It is important to make people aware at all. What can they improve their selves? At this moment this does not core with the Skotty but maybe later.

Manish would like the Skotty helps them to come out, increase the range of diagnostics. A positive aspect he mentioned is that the Skotty can share information, which has potential because of its technical assistance and information.

Note: The Skotty must be portable – it must be able to use the Skotty in the SMILE on wheels van. It is not required that the Skotty is easy to carry because they do not carry it. They do not visit patients at home. Furthermore, they do not have interest in using special X-ray cars.

General note: Manish would love to know in what areas the Skotty can help him.

Interview Dr. Ramesh Kumar

14.08.2012
Chief medical care
CMO Incharge DFIT Delhi Project
New Delhi
India

Mobile number : +91 9268460419, +91 7503081225

Arranged via Tine DeMeulenaere – Damien Foundation

Dr. Ramesh Kumar starts with explaining what his function is as chief medical office and how his day is look like.
Dr. Ramesh Kumar was very enthusiastic about having this interview. He was fluent in his English vocabulary and it seems he has everything under control.

New Delhi Healthcare structure

The Delhi healthcare facilities are tiered. Overall you have the corporate hospitals like Fortis and Apollo, followed by the TB centers/ DOT centers/ private clinics and finally the village doctor. The patients first visit the village doctor. If he/ she does not have enough knowledge or equipment, the patient will be referred to a higher level. The patients do not go to the corporate hospital directly.
The patient can also choose to visit a private diagnostic center. This is a charity based center and it is less expensive: here an X-ray scan costs five dollars.
In India there is a gap of diagnosis and treatment because of the costs of diagnostic material and the availability. Furthermore it is not easy to access to that.

Providing specialist diagnosis and care locally

The patients that are ill first visit the village doctor. If the village doctor thinks the patient potentially has TB, he/ she refers the patient to the TB center. The SMILE foundation also refers patients to a DOT center. The patients visit the TB center and do not go to the corporate hospital directly because of the price. They are unable to travel to the hospital and pay for the scan. Furthermore, the patients trust the government because the programs are proven driven; the TB centers are a special program against TB, subsidized by the government. At this moment, there are few TB programs running in India: Damien foundation and stop TB.
In the TB centre the following happens:

- The patient comes in with fever and other health problems.. This will be two times a week around 5/ 6 persons. In the centre there is a lab technician. This technician prepares the patients for the visit of the doctor.
- In de morning (between 9.00 and 11.30) the doctor visits the centre for half an hour. In this time he sees the complaints of the patients and performs diagnostic measurements as listen to the rhythm with a stethoscope. The patients get a basic consultation and if the patient is new in the center also examination. After the first examination the technician is going to research under the microscope. If there is a specific microbactery found, the patient has TB. In the afternoon the doctor registers all the patients, he focuses on microscopy and he starts the treatment.
- If the patient needs an X-ray scan, the doctor refers the patient to the TB hospital (around ½ persons per center per visit). If the patient is a child, the doctor always refers the patient to have an X-ray scan. This is around ten km away. This is for many patients a problem, because of their poor economic status. They cannot carry a long distance for the X-ray scan, the scan costs 10 dollars and the travel

to the hospital is 2 dollars. In the TB hospital they have X-ray, a biomedicine lab, a microscopy center and drugs to the disease. The rest of the patients with a negative TB result get a follow up with consultation.

- In the afternoon the health visitor of the TB centre visits the patients at home. On the one side they check if the patients take their medicines good and on the other side, they look at the economic status of the family. It depends on the economic status which medicines the patients get.

During this visit the health visitor also looks at the patient. After 2/3 days it is possible that the patient gets side effects of the TB medication.

Note: Unfortunately, there is no feedback from the corporate hospital to the TB center about the status of the patient.

Note: The feedback from one institution to another is difficult because each situation is different. There are big differences in economics between two geographic areas.

Note: Sometimes the patients referred to the TB hospital come back to the TB center because it was impossible to make an X-ray scan.

Team in the TB centre

- 1x Lab technician
- 1x health visitor. The visitor looks at the complaints and decides if the patient is eligible for consultation.
- 1x part time doctor. This doctor visits in the morning five centers (around 30 patients). Each center covers 100.000 people. The centers are located 2/3 km from each other. The doctor visits on Monday and Wednesday the same five centers and on Tuesday and Thursday another five centers, so he covers 1.000.000 people.

Ideal team:

- 1x full time doctor
- 1x nurse
- 1x technician

Note: Unfortunately, in Delhi it is at this moment not possible to have a doctor in each TB center. A professional doctor needs a big salary and they do not have so much money.

Equipment in the TB centre

In the TB centre is present a lab with microscopy and basic diagnostics. They provide consultation and examination of TB. Although X-ray is widely available, there is no X-ray equipment. It is not possible to have an X-ray machine in each TB center and a portable X-ray machine is not available. A portable X-ray machine for the doctor can be an opportunity.

Investments

The TB centers do not experiment with new technologies. They are satisfied with the way they work at this moment. They are not in need of an X-ray machine; with microscopy TB is visible in an earlier phase.

Note: we have requested Dr. Ramesh Kumar for pictures / photos of the TB center, including sharing the current configuration of the TB center (equipment, utilization, etc).

Providing healthcare virtually

At this moment in time, virtual diagnosis is no opportunity. There is no equipment present to perform a virtual diagnose. Ramesh mentioned that if there is virtual equipment, it is only possible to have a virtual consultation. This will be a good aid for Ramesh, he does not have to travel ten km again and again. Examination of TB is not possible because the doctor has to check the patient manually, for example the chest and the eyes. Furthermore, the patient-doctor relation is important. For X-ray scans it is possible to send the image via email and diagnose it somewhere else.

Training

There are a lot of multiple streams of audits & trainings. The employees of the Damien foundation provide training to the doctors and technicians working in the TB centers. They organize this by hiring someone external who is performing the training. After the training is evaluated, the external person visits the next center.

There is also an education system during which the employees at the TB hospital

levels get a multiple choice questionnaire. The technicians get two microscopy slides as exam. These training is provided by Damien and sometimes by the district government and supported by the state government.

Patient data

At all healthcare facilities there is a system to record the patient data. At some institutions it is manual and at others it is in the computer. The maintaining of the data at the level of TB centers is proper but the system of the government is expensive.

Payment

The TB centers are subsidized by the government programs. The patient does not have to pay there for treatment. In the corporate hospitals the patients have to pay but the insurances compensate also a part. The private hospitals get a subsidized fee so the patient has to pay less.
Some medicines are funded by the Damien foundation.
10% of the population around New Delhi is insured. This can be with private insurances, government insurances and employee insurances.

Potential for the Skotty

Ramesh mentioned that he prefers a microscope for X-ray because with a microscope it is possible to diagnose TB in a early phase. After 10/20 days TB symptoms are visible on an X-ray scan. On the other hand, it takes an hour to perform a microscopy check in contrast of one minute of an X-ray scan.
The Skotty must be affordable and practical. It must allow the feedback mechanism system.

Note: To learn more about the feedback system, the senior doctor of hospitals like Apollo and Fortis can be contacted. He knows the most things of the hospital as for example the finance. He is the top person of the hospital.

Interview Dr. Ma Yongcheng

27.07.2012 & 16.08.2012
Deputy director - Center for disease control and prevention Qinghai province China
Director - Provincial tuberculosis control institute
66 Ba yi road Xi ning Qinghai 810007
Tel:+86-971-8801 368(0) +86-971-8809 251(h)
Fax:+86-971-8801 318
Mobile: 13519753336

Arranged via Tine DeMeulenaere – Damien Foundation

Dr. Ma starts with explaining how the structure of the Healthcare facilities is organized in the Province of Qinghai.
Dr. Ma starts with an introduction of the medical team members that are with him. The first one is Kangsin, an X-ray doctor and the other participant of this interview was Chaqu, a lab technician in the TB laboratory.
Dr. Ma Yongcheng was very engaging, cooperative and was very enthusiastic about the Skotty solution and the improvement if would potentially bring. He was fluent in his English vocabulary and structured in his line-of-thought.

Qinghai Healthcare structure

Particularly he favored improving the diagnosis using electronic imaging, the capability of sharing the patient images -and data at the Provincial hospital level and globally, and the idea that you easily can carry the solution along to the desolate area site.
The Qinghai healthcare facilities are tiered. Overall you have on the highest aggregation level the Provincial Hospital, followed by District/County level hospitals and finally the township/village doctor clinics.
All tiers cooperate together.
Typically, the bottlenecks on county hospital level are:

- No availability of specialists
- Lack of working, or available equipment
- (for sure) lack of diagnostic equipment
- No laboratory

Village doctors, or township clinics often have general medical expertise.

Because of the limited diagnose equipment they sometimes just provide medication.

Providing specialist diagnosis and care locally

The initiation of specialist care devised from the Provincial hospitals to the county level hospitals and even to the township level clinics works on several ways:

- On demand of the county hospi tal or village clinic directly to the Provincial Hospital.
- Here the local facility has to perform a survey locally in order to affirm the need on the to-be-treated-disease, or
- The local village doctor suspects a break out based on the symptoms of the disease (in the case of TB e.g. two weeks of extensive coughing etc.) and reports this to the county level hospital, who on its turn reports this to the Provincial hospital.
- On the request from the Province Authorities, the Provincial hospital organizes a program to counter a certain disease pattern in a region.

There are two ways that Provincial doctors, or specialist perform diagnosis for county / village level clinics:

- Either they assess preliminary diagnosis based on pictures,
- Either they arrive on-site with a 'Medical Car Team'

Preliminary diagnosis based on pictures

In this case the county hospital doctor, or township clinic doctor takes a picture of the patient with his/her mobile phone and sends it by email to the Provincial hospital. The doctor at the Provincial hospital assesses the picture and recommends further treatment accordingly, or to have the patient travel to the provincial hospital. The limitation here is that often the patient dies when travelling to the nearest available quality facility, or even worse: the outbreak of epidemic disease has matured by the time that deterministic diagnosis has taken place.
Further limitations are that if the pictures are taken the specialist doctor is often not even present, or emails get lost, or diagnosis of the pictures takes a long time (days or even weeks).

- Travel distances to county level hospitals are typically 250km – 400km for any patient. By road.
- Travel distances to provincial hospitals are typically 1000km – 1200km for any patient. By road.

Note: In September the Provincial hospital, dr. Ma Yongcheng will pilot 'tele-consultation'. In this pilot they have contact with a national group of specialists and also at provincial level. They would like to group together to solve the problem. With tele-consultation, the hospital will pilot to set up a video connection with the county level/ local township clinic and test if this could work in combination with acquiring, sharing and storing patient data real-time, performing diagnosis remotely. Also a county level doctor can set up the communication with a specialist at provincial or national level.
Dr. Ma offers to share the results of the pilot with us. That would be excellent. If Philips can play a role in co-creating a solution there, Dr. Ma will contact us.

On-site – the 'Medical Car Team'

If the Provincial hospital organizes for the specialists to be on-site, the local facilities (township, or county hospital) have to create awareness at their community when, where the specialists (i.e.: 'the Medical Car Team') effect their services locally. The provincial hospital in the region of Qinghai has one medical car available. The 'medical car team' makes 5 or 6 times a year a tour along 10 villages. This tour takes 10 to 20 days. During this tour the medical team is working daily and the patients can visit the car from morning to evening, each day. The only exception is while the team is travelling from the one village to another. Some villages are really close and others are far from each other. 50 – 200 Patients visit the medical van on an average day. With the medical car team they cover a population of 2.000-7.000 people per location.
The Provincial hospital will drive to the

village level/ doctor with a medical team in a medical car.
The medical team is typically a 5-headed operation consisting of:

- A radiologist, or X-ray doctor
- Two GPs, or doctors
- A lab doctor (~ technician)
- A nurse
- A driver

Roles

The X-ray doctor performs the specialist view on the X-ray film (not image) to diagnose the patient's condition.

The GPs are a GP from the Provincial Hospital and a local GP from the county hospital.
The Provincial Hospital GP makes sure that the basic foundation of medical acumen (knowledge, experience, training) is present.
The county level GP particularly knows the area and the local people (e.g. village doctors, community leaders, minority leaders). He decides which village most needs help and there he selects the population who may use X-ray.
Both GPs and the X-ray doctor perform both a pre-assessment, or triage to the patient population in order to prioritize the immediate / non-immediate patients.
The lab doctor develops the X-ray film and supports the operation.
The nurse is providing elementary care.
The driver organizes everything on site. Makes sure that the equipment is ready-to-use. Mobilizes resources locally.

The Medical Car

In order to provide quality healthcare based on advanced diagnostics (in this case X-ray for diagnosing TB) the Provincial hospital in Qinghai has built on their own medical car.

The medical car is equipped with the X-ray device, the lead-bed, the laboratory (including the film development and microscopy). Additionally, they equip the car with a power generator to ensure that power supplied.
A large limitation currently is that the team has to work with X-ray film. This takes a long time to develop, causes administrative hazards of loss / mix-ups etc. However, the film is interpreted the same day because of the distance.
A giant leap forward would be to interpret the X-ray from electronic images.
The site (physical location) where the 'Medical Car Team' is operational is the county hospital, or at the village clinic.
The team brings its own medical equipment to perform the diagnosis.
They sometimes visit patients at home, when the people cannot go out because of their illness. They travel with the X-ray car to that place and screen all the village residents.

Note: in many desolated areas there is a lack of power/ low electricity generators, especially in the winter there is hardly any power at all. This has implications regarding sharing, or storing patient data, or to deploy power consuming systems like X-ray.

Note: often during a trip to the site, due to the rough drive, equipment brakes down or supplies (like films) are short-supplied.
Note: we have requested Dr. Ma for pictures / photos of the Medical Car, including sharing the current configuration of the Medical Car (equipment, utilization, etc).

Note: we have requested Dr. Ma to interview the 'Medical Car Team'; as these team members will likely not be able to speak English, Dr. Ma volunteered to act as interpreter.

Workflow on-site

The workflow of the medical car team is visualized in the diagram below.
The county CHC doctor has to keep the information of the patients. He sends this information to the provincial hospital. There they make a quarterly planning and tell the CHC the time that the Medical Car team will visit the village. There is also an annual planning in the provincial hospital but in this planning they do not capture where they go to, so that is flexible.
The local people of the village come to the car. If they have TB or have not, they would like to see a doctor. The village doctor has typically basic information of the patient:

Skotty

- Age,
- Diseases before,
- Complaints at this moment in time,
- Family numbers,
- Neighbors (are there similar symptoms?),
- Village situation (are there similar symptoms? / contact information).

All the patients get a lab test, performed by the lab technician with microscopy. The doctor interprets the results and speaks with the patient. This takes on hour. If the lab test cannot answer all the questions, then X-ray will be performed also by the lab technician. In one hour of time, the X-ray will be translated into a film. The X-ray doctor interprets this film. The doctor shares the results with the patient. Sometimes they make a photo and send that via internet to the provincial level hospital. If there is no internet at village level, the go back to the county level and send the photo. They try to diagnose the patient in one day. If the laboratory results are not clear, the medical car team will have a group discussion and the patient should wait.

After diagnose the patient gets the right treatment, also provided by the medical car team. If the medical car team leaves the village, the village doctor takes care of the patient (and the medicine provider). The village doctor visits the patient and will educate the family member about the need of the medicines. In some desolate area where a village doctor is not close to the patients, the car comes back to check if the patients really take the medicines through doing a lab test of X-ray scan again. Normally the treatment takes six months.

The medical car team goes to the village level and works together with the village doctor. The location of the village doctor is often used to place the car. In the villages the medical car team has contact with facilities that provide them in stock. Things like laboratory equipment or the X-ray machine and generator they carry along.

Note: Some patients hope that there is X-ray in the van. It is an evidence for the patients themselves that they do or do not have TB. On this way they can see it themselves.

Note: The current equipment and staff is good, except the X-ray film machine but the quality is good. Furthermore this X-ray car is old and cannot provide good services for a long time.

Training

Overall, the Provincial hospital works together with the ICN (the International Council of Nurses) for providing training to nurses and local doctors. This training takes place twice a year and focuses on treatment. The ICN also provide advanced information.

The provincial hospital has twice a year contact with the X-ray doctors and organizes then a (reading) training/ course. In the training they learn to use the tools.

Note: the ICN as first sight closely resembles Empower India in the description of dr. Ma.

Note: They also have a good corporation with the education system. They contact with boarding schools. If the students suffer from TB, the medical car team goes immediately to the schools. The car is then a sort of emergency car, in order to have a first assessment.

Learning and cooperation on Provincial level

Increasingly Provincial program or hospital directors in China (such as Dr. Ma) are sharing their best practices among their peers. In this context Qinghai is one of China's most desolated areas and is occupied with lots of different minorities. Therefore, Qinghai is probably regarded as one of most innovative, or creative Provincial hospitals, of which the medical car, tele-consultation and the patient workflow handling are clear examples of their urge to pragmatic healthcare solutions. Their standpoint towards implementing new technology is very welcoming. Quote Dr. Ma: "we really like your machine, it provides a great improvement to providing good healthcare locally; especially countering TB".

Sharing data/ resources

The county level hospitals have a record system for all the patient data. They share the data via internet. It will take two years to have the data of the whole population on township/ county level.
The basic information about the patients (from the village doctor) will be shared with the county level hospital and the provincial level hospital.
Directors communicate and share information/ experiences in case of troubles with other directors. For doctors it is difficult to share information because of the lack of qualified people. They would like to share the resources and try to find a way to connecting with other qualified people. They try to connect via national organizations, NGOs and ICN. Sharing the tools helps to improve the local population.

Note: Because of the temporary electricity it is not always possible to share the data.

Payment

The Province is paying for all disease related programs, such as in the case for TB. The patients visit the medical car for free; they get a free lab test and a free X-ray scan.

The Province pays a larger portion of the total healthcare expenses if this disease is chronic, e.g. diabetes, hypertension, chronic diseases, cancer, etc.

The Province pays only 30% - 40% of the medical expenses to cover basic medical care, e.g. doctor visit, etc.

Note on context of TB: as TB has an epidemic character, it is vital to diagnose TB in an early stage before a potential epidemic breakout. Therefore the Skotty is regarded by Dr. Ma a great machine to quickly assess the patient condition and share that with a central hospital location, or even share globally.
If TB patients can be diagnosed immediately, not only the treatment can be started very soon, also the local doctor can educate the patients about for example wearing a mask and prevent an epidemic.
At this moment, the difficulty of diagnose delays the treatment and gives a lot of financial problems.

Note on definition:
Local doctors: county hospital level doctors, or township clinic level doctors.

General Note:
Quite a number of similarities have been noted with the operations of the Indian Smile Foundation. Particularly, the ingenious way-of-working 'fit' to their local circumstances and the creative & pragmatic solutions (e.g. piloting 'tele-consultation', the role of the driver, etc.)

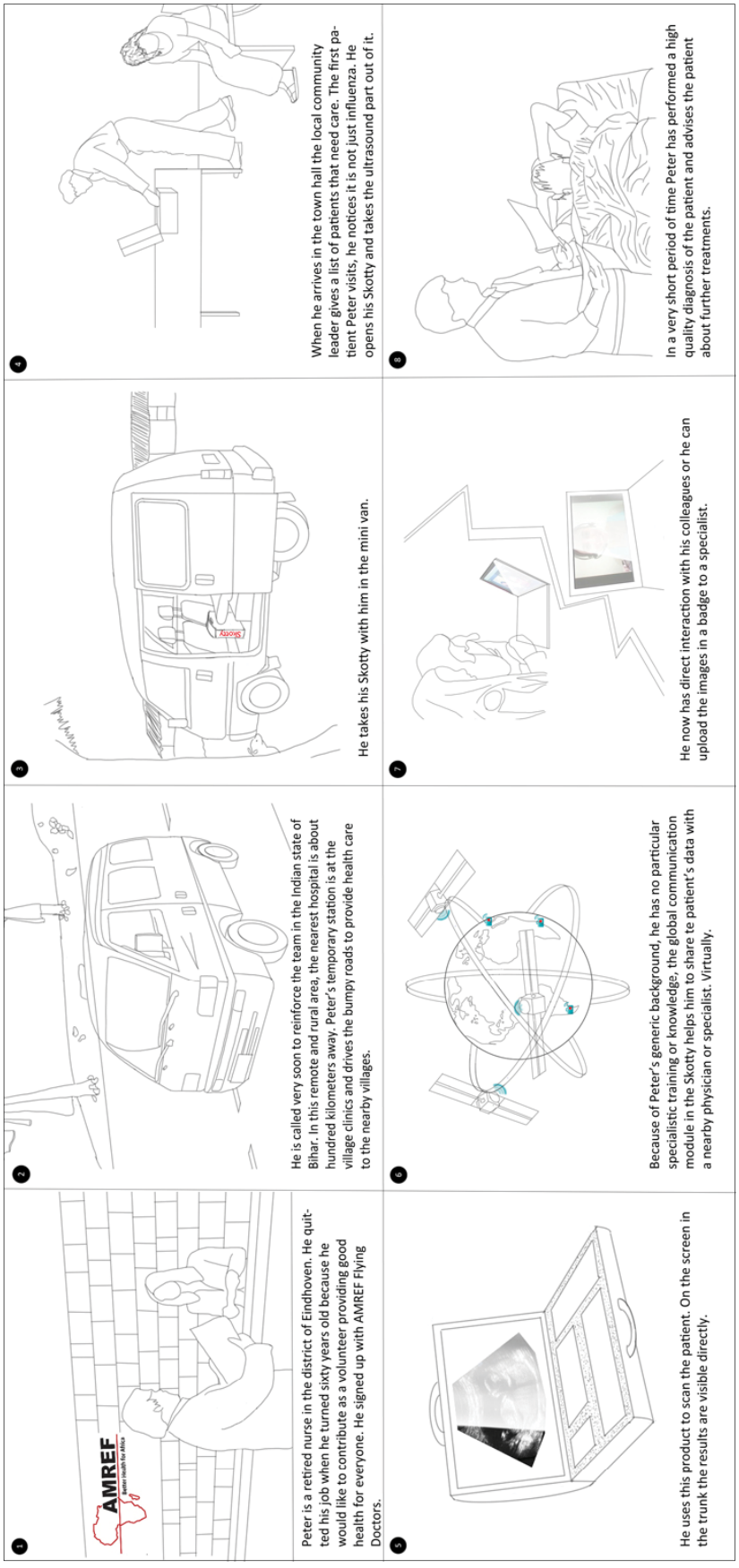
Skotty

Dr. Ma and his team think the Skotty will be a welcome TB kit. With this diagnose tools it easy for them to operate, they are able to easily make diagnose in some really desolated places. It is a machine to contact with others. It could be used for training, for diagnose and provide good services for the locally. The second opinion- sharing the images- is a good option.

Note: we have requested Dr. Ma if it is possible that we send the remaining questions and he will answer them via e-mail.

Skotty

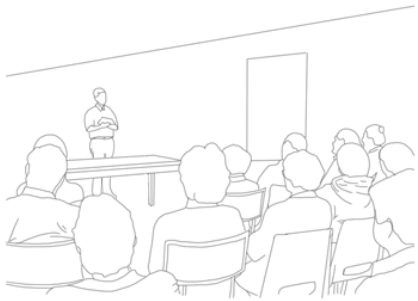
Appendix 4



Skotty

Skotty

1



One of the activities of the Female Cancer Program Foundation in 2006 was to organize See & Treats in Indonesia. During this program, they provide information about cervical cancer and raise awareness of prevention.

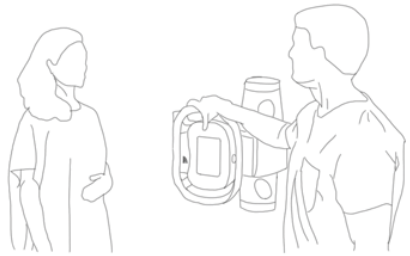
2

After registration, the women are screened with Visual Inspection. When there is diagnosed something strange, the woman will be treated directly or she will be referred to a hospital nearby.

3

In the continuation of this activity, Donald uses the Skotty. He visits the local tribes in India and gives them the opportunity for a whole body scan.

4



The Skotty contains X ray equipment. That means it scans the patients not only on cervical cancer but also on pneumonia, lung cancer, pulmonary edema, gallstones and kidney stones

5

The result of the scan is visible on the scren in the Skotty directly.

6

Furthermore a satellite communication is integrated. On this way, Donald can communicate with his colleagues and specialists all over the world about the scan and make up an appropriate proposal for treatment.

7

Donald has to take care of radiation so if the scan is ready he shuts down the X ray equipment. If people receive too much radiation it can cause cancer and we would like to avoid that.

8

After helping this patient, Donald cleans the X ray equipment. This is very simple.

Pauline Simons, s1009281, 14th of September 2012, version 2.0

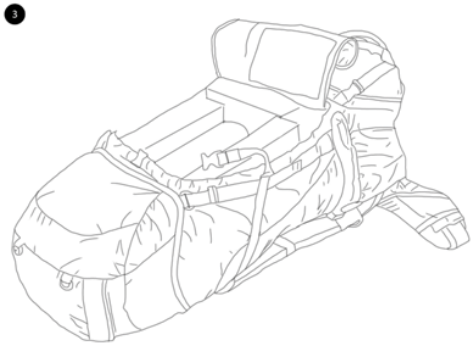
1

Sammy works for the partner organization of the Simavi foundation, the CHC hospital. In the outlying Yichun in China she visits villages that are far away from hospitals.

2

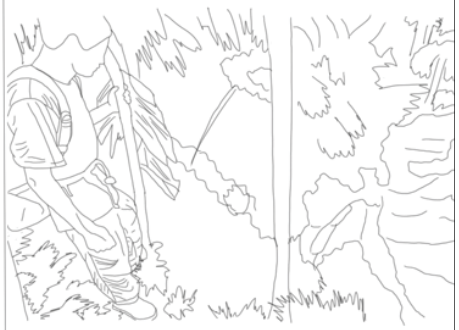
Together with two other physicians, she has a mobile clinic that she takes into the hills to bring the health to the residents there.

3



Her part of the equipment of the clinic is integrated in one small bag, the Skotty which she can tie up her back so her hands are not prevented.

4



In the rainforest parts of the country that can be useful.

5

The patients, who have an appointment with Sammy, are mostly pregnant women.

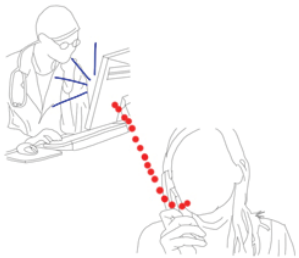
6

Sammy's Skotty disposes of ultrasound equipment which she uses to image the fetus. One part of this equipment is the transducer, which she moves over the belly of the woman.

7

Another part is the screen in de Skotty. The parts are wireless connecterd; on the screen you can see the live images of the fetus. The position of the fetus can be studied.

8



By wrong or strange observations, Sammy can communicate with other specialists and colleagues immediately via the communication module that is also integrated in the Skotty. Whit ths Skotty deviations can be noticed very early in the pregnancy and mother and infant mortality can be avoided.

Skotty

Appendix 5

Each of the requirements from page X is provided with a short explanation.

Environment

The Skotty must provide primary care.
In the rural areas of India and China the healthcare sector is not well developed at all. It is important to first improve the primary healthcare before investing in advanced healthcare facilities is worthy.

The product has to diagnose the majority (>50%) of the frequently common complaints.
The product is meant to help the nurse or technician with their work, diagnose as much as possible patients. The complaints are not always the same and therefore it is important that the majority of the complaints can be diagnosed with the Skotty.

The usability of the product is very important. Therefore, a non-specialist must be able to use the product after a short training.
In India and China there is a lack of medical doctors and specialists. This product must allow the nurse/technician to facilitate the pressure on the doctor. On that way the doctor can work at a central location, diagnosing the scans and measurements on distance. The nurse/technician does not have the same medical knowledge as the doctor/ specialist. The interface of the product must be harmonized with them.

The product must be weatherproof. It will be used in different areas of the world so it must resistant rain and temperature changes (-20 /+60 degrees Celsius).
The temperature in China and India varies from -20 to +40 degrees. In the summer, in cars the temperature is often higher than outside so there is a tolerance of 20 degrees.

The product has to be resistant to environmental factors such as sand and dust.
The environmental circumstances in India and China are not as in the Netherlands. In some regions sandstorms are not rare. The product has to be resistant in all these situations.

- The Skotty may not look very expensive because of theft.
In the rural areas of China and India the people are often very poor. The product with the diagnostic technologies is much more expensive than the doctors/ technicians and nurses earn with their work. To avoid theft it is important that the appearance of the product is not expensive.
- The product price of the platform and the basic diagnostics may not exceed €500,00. As mentioned by the previous requirement, the people in China and India are very poor and do not have much money to pay for their treatment. The treatment methods therefore cannot be very expensive: then the doctor makes loss. Also when the product is sold to non-governmental organizations there is just a low budget available because all the revenues are from donors and grants.

Patient

The product must be hygienic. It is not allowed that the patient get an infection via for example blood residues of the previous patient.
In the remote areas there is often a lack of clean running water. This results in a lack of hygiene, which is the cause of many diseases. It is important that the patient cannot be infected by the Skotty – it is meant to help people when they are ill and not to make them ill.

The appearance of the product must be friendly and intimate. The Skotty is a new product and the patient is not familiar with it, so the product has to satisfy him/ her. If the patient feels uncomfortable, the results of for example the blood pressure measurement can be incorrect.

The product must be in the same style of design as other products in the Philips Healthcare line.
Philips is a known brand in the global healthcare industry. People all over the world recognize the Philips products and their quality. This is a good starting position of the Skotty: if the patients recognize the Skotty as a Philips product, they feel more relaxed instead of distrustful.

Technician/ nurse/ doctor

The product must be safe and may not damage the nurse/ patient.
This requirement is obvious: if the product damages the users they will not use it anymore. Furthermore, the product is meant to improve the health of many people and not to deteriorate their health.

The language must be adjustable or chosen by ordering.
The population in remote areas in India and China had just a little training and they are not able to speak the same language. It matters that the user can choose the language of the product so they can use the product in the best way.

The interface must be consistent with the knowledge and experience of the nurse: most nurses cannot type.
To be ensured that the product will be used in the intended way, the product must be adapted to the level of the users. Also if the users cannot write, they have to be able to operate the product.

The interface must join the habits of the people living in remote areas.
The product must be suit in the way of working in the remote areas. It is not the meaning that the Skotty set up a new healthcare system: it must be implemented in the system there already is present. This is important for the technician/ nurse because they would not lose their job by the arrival of a new product.

The product must be reliable.
In China often the population does not trust the doctor. If the Skotty is reliable this trust can increase.

The product must contain a second opinion option.
The technicians/ nurses have just a little medical knowledge: they are not able to interpret the measurements or scans. Through a second opinion possibility they can connect with a doctor or specialist who can help them with diagnosing the patient.

It must be possible to share patient data with the product.
If the technician/ nurse performs a blood pressure measurement, a glucose measurement and it is then not clear what is the diagnose, the patient will be referred to a higher level hospital. It is efficient that the results of the measurements can be shared with the higher level hospital, so they do not have to do these tests again. On the other hand it is interesting for the technician/ nurse who performed these measurements, to know what was the final diagnose of the patient. The technician/ nurse can learn a lot from that feedback.

The Skotty must contain a communication module so a connection with a specialist can set up.
This requirement belongs to the second opinion option. If the technician/ nurse is able to set up a connection with a doctor or specialist directly, they are able to help more patients at the low healthcare level.

The product must be easy to clean. It should be possible to clean the surfaces in one minute. The technician/ nurse would like to help as many patients as possible each day. If the cleaning of the Skotty takes too much time, the danger exists that they will not clean it at all.

Use

The product must be a compact form-factor. The dimensions of the box must be less than 25x20x15 cm (based on the dimensions of the Philips AED).
The compact form factor is one of the principles of the Skotty. If the nurse visits the patients at home, she has to take the Skotty with her. It might not be too large because then she cannot take it easily and will leave it in the CHC. Also it will be used in mobile hospitals and other mobile vehicles. There is just a little free space to

place the Skotty.
The X-ray component does not have this requirement: the vans already dispose of a X-ray machine, so there is a place reserved for it.

The product must be portable. This means that the weight of the product must be less than 5 kg.
This requirement has agreements with the previous one. The product with the basic diagnostics or with the ultrasound equipment must be easy to take to the patient's home. If it is too heavy, the nurse will leave it in the CHC and that is not the purpose.
The X-ray component stays in the vehicle and will not be used at home. The weight of this component therefore is of less importance, but it cannot be heavier than 42 kg [40], the maximal lift weight for two persons.

The product must be easy to carry. This means the user has at least one free hand.
It is not always easy to reach the patient's homes. If the road is very small with a abyss at one side, the user would be able to grasp something. It is also possible that the nurse has to take a first aid box with her too.

The technologies must be modular.
This requirement is one of the principles of the Skotty. The care giver can decide which technology he/ she needs and add that component to the platform.

The modules must be clicked on/off changed in 10 seconds.
The modules can be fixed on the platform to carry it easily. While operating, the modules have to be removed from the platform. The fixing method must allow that this does not spend much time, because the technician/ nurse do not have time for it.

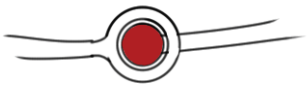
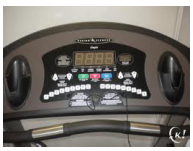
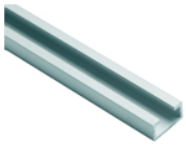
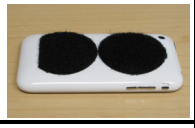
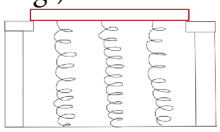
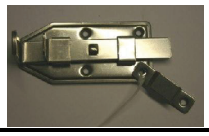
The product must be accurate: the precision must be even high - or higher - as the individual products without Skotty.
If the quality of the Skotty is not high enough, it is not possible to have a reliable diagnose.

The product must be ruggedized. If it is not operating and it drops down from the car/table/.. with a height of 1m, it must be undamaged. If it is operation and it drops down from the car/table/.. with a height of 0,5m, it must be undamaged.
The circumstances in remote areas are not the same in each region. In some regions there are no straight floors, just bumpy stones. The product must be strong enough to survive when it drops down.

Society

Under normal circumstances, the product must have a durability of at least ten years.
In remote areas the arrival of the Skotty is an expensive investment. The local population is very poor and does not have money to substitute the machine frequently.
In helicopters and that kind of environments, the Skotty will not be used very often, only in case of emergency. They do not have money to renew the product regularly.

Appendix 6

Button 	Installation 	Sliding tray 
Push button 	Velcra on the device 	Tape or glue 
Buckle 	Snap system (springs) 	Holes and pins, with cap 
Two rings 	Magnetism 	Holes and pins, without cap 
Rachet closure 	Bolt 	Suitcase closure 
Backpack closure 	Snap system (used for batteries) 	Zipper 
Strap 	Clip around the whole device 	Screw 

Skotty