Design of a Control System for Mixing Oncologic Drugs

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Abstract

Apoteket, the national Swedish pharmacy, has an oncologic department in Lund's hospital, where are produced all the drugs necessary to treat patients against cancer with the help of chemotherapy. Each drug is prepared depending on the kind of cancer and the personal features of each patient.
Since the basic drugs used for the preparations are highly dangerous products, the formula, and especially the quantities of each preparation must be checked carefully. The purpose of this work is to design a computer assisted system which controls the preparation of the drugs.

In order to get the right preparation the system has to control the name of the patient, the name and the quantity of basic drugs added for the preparation. To avoid possible failures, it has been decided to check the names of the patient and of the drug by scanning it. The quantity of basic drugs will be measured by weighing it. The most practical user interface of the new system appeared to be a touch screen.
The scan pen's tests shows that scanning the identification number on the basic drugs' bottles is easy and reliable most of the time. A large range of different weighing devices are today available on the market and a lot of them fulfill the requirements of the new system (weighing until 2,5kg with a precision of 0,1g). The constructors of touch screens are all able to produce special devices that are adapted to a medical environment. These researches permitted to validate this process.

A focus group was conducted to ensure that the chosen objectives met the expectations of the pharmacists. This meeting finally confirmed the first objectives and even gave new ideas of features for the system.
The user interface has been designed regarding the different basic rules of Design: the golden rules of Schneiderman and the advices of Donald Norman. A storyboard finally presents this user interface.

Apoteket has its own computer team which will be responsible for the implementation of the program. Thus, no algorithm but guidelines are presented in the present study for an accurate translation of the program. Some ideas of improvement follow; they can be integrated to the new system, depending on the possibilities of the computer team.

Sammanfattning

Apoteket har en onkologisk avdelning vid Lunds Universitetssjukhus. Där tillverkas alla cytostatika, dvs. blandning av läkemedel, för personer som har cancer. Varje blandning förbereds med hänsyn till typen av cancer och till personliga egenskaper av patienten.
Eftersom läkemedel som används för blandningen är mycket giftiga, måste receptet och speciellt kvantiteter kontrolleras noggrannt. Syftet med det här arbetet är att skapa ett dator-baserat system som kontrollerar blandningen av cytostatika.

För att tillverka rätt cytostatika måste systemet kontrollera namnet på patienten, samt namn och kvantitet på läkemedlen som tillsätts för blandningen. För att undvika möjliga fel vill man kontrollera namnet på båda patienten och läkemedel genom att scanna dem. Kvantiteten av läkemedel mäts genom att väga blandningen. En pekskärm verkar som den bästa lösningen för ett nytt “user interface” av systemet.

Tester med en penn-scanner visar att resultatet är för det mesta enkelt och pålitligt när man scannar varunummret på läkemedelsflaskor. Ett stort sortiment av olika vågar finns idag på marknad och många av dem uppfyller systemet’s behov (att kunna våga till 2,5kg med 0,1g nogrannhet). Dessutom tillverkas pekskärmar som är avsedda för rum med höga hygieniska krav. Dessa undersökningar bekräftade att den nya processen är möjlig.

En fokus-grupp ägde rum för att tillförsäkra att förslagen motsvarade farmacevternas behov. Mötet godkände förslagen och bidrog med att bilda nya idéer för systemet.
En storyboard har tagits fram för att framställa hur det föreslagna arbetssättet genomförs.

Apoteket har sitt egna utvecklings-team som ska vara ansvarig för att genomföra nya programmet. Fokusgruppens ytterligare idéer för förbättringar är också redovisade; de kan integreras i nya systemet om teamet har möjligheterna.

Acknowledgments

First of all, I want to warmly thank **Annsofie Fyhr**, my tutor from Apoteket. She did not only give me the opportunity of a great subject for my thesis, but she also helped me a lot for my work during these last five months. *Tack så jättemycket för att ge mig chansen att göra ett så intressant examensarbete. Och tusen tack ska du ha för att alltid hjälpa mig och lita på mig.*

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Table of content:

1 Introduction

This work has been carried on in the oncologic department of pharmacy, located in the hospital of Lund. All the drugs for patients that have a cancer and are cured by chemotherapy are prepared in this department. This kind of therapy is specific to each patient, so each drugs mix has its own formula.
The pharmacy department has around thirty different basic drugs. By mixing some of them in defined proportions, the pharmacists' team can then provide adapted drugs to all patients. These basic drugs are however really dangerous since they are a poison for healthy people. The conditions of hygiene and security are consequently very strict.
However, the mixing formula is unique for each patient, and thus it is really important to give the right mix (with the right proportions) to the right patient. Just one mistake during the mixing process can be dangerous for the patient, even fatal in the worst case.
Considering this, the control of the mixed drugs' conformity is the most important point of the process.

Annsofie Fyhr, responsible for the oncologic department in Lund asked me to help them with their control system. Today, the team has a rather accurate control on the preparations. Though, this control is only about the kind of drug (not the proportion) and entirely human. The pharmacists control by themselves and debrief the information by writing on the prescriptions. Even if this system is perfectly working today, the level of stress is high for the pharmacists since they know that they are not allowed to make any mistake. The life of their patient indeed depends on the quality of their control.
Annsofie would like to carry out a new control system, which would be assisted by computer and new software.

1.1 Background

The oncologic department of pharmacy is composed of two rooms: the drugs room and the preparation room. Both rooms follow strict rules of hygiene (see figure 4). To enter the drugs room, one must change his shoes and wear a laboratory coat. One also has to put a head covering and some gloves, all disposable after use. To enter the preparation room, more protections are required. All clothes and shoes must be changed. One also has to wear a head covering, some gloves and a mask.

The drugs room is used for the storage of basic drugs while the mix is done in the preparation room. Each basic drug has a unique code number (a reference number of 6 digits) that allows

differentiating them; this number is written on each bottle. There are around 25 basic drugs. (See figure 1)

The prescriptions depend on the kind of cancer and the features of the patient, especially its size and weight. For each kind of cancer, there is a “standard” therapy, called the ***regime*** that is then adapted to the patient, according to his features. Cytobase and Cytodose are the both databases used by the pharmacists that contain all the regimes, respectively for adults and children.

Figure 1: The storage of the 25 basic drugs.

In the drug room, the pharmacist also checks the prescriptions (***pre-control***) and gathers the material for each prescription.

Due to a different level of hygiene between the drugs room and the preparation room, some precautions must be taken. The prescription and the required material are put together in a plastic basket that is first disinfected with 70%-alcohol sprayed on it and then transmitted to the preparation room by a sterile cupboard (see figure 2). The cupboard, built in the wall, can be open from both sides; it is besides separated in two parts: one is for sending, the other for receiving. Finally, an intercom allows the pharmacists to talk to each other between the both rooms.

Figure 2: The sterile cupboard between the drugs room and the preparation room

The preparation room has the highest level of hygiene. This is where the pharmacists mix the basic drugs together, according the prescriptions.
They take a plastic basket in the sterile cupboard and bring it to the hood under which they do the mix. When the plastic bag is ready for the patient, they put it back in the basket in another sterile cupboard, where the nurses can come and get the drugs, ready to be administered to the patients.

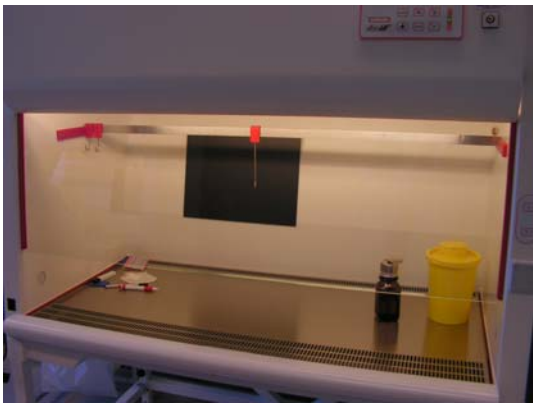


Figure 3: The hood where the pharmacists mix the drugs.

Figure 4: A pharmacist working under the hood.

When a pharmacist mixes drugs, she does not finish the bottles each time. The non empty bottles are stocked in a fridge in the preparation room. Sometimes, a label is added to the bottle, since some drugs are very instable and can only be kept open for some hours.

1.2 Today's process

Today's process can be divided in five steps, first in the drugs room, then in the preparation room.

- ***Pre-control: (drugs room)***

The prescriptions (see figure 5) made by the doctors arrive in the drugs room by fax or by mail. The information available on the paper is: which basic drugs must be used and which weight of each drug must be sampled. When a pharmacist receives a new prescription, she first has to check in the database on the computer that the prescription matches the appropriate regime. Each recipe is then approved, by redoing all the calculus of the volume of drugs to add. Then, the identification labels for the plastic bags are printed.

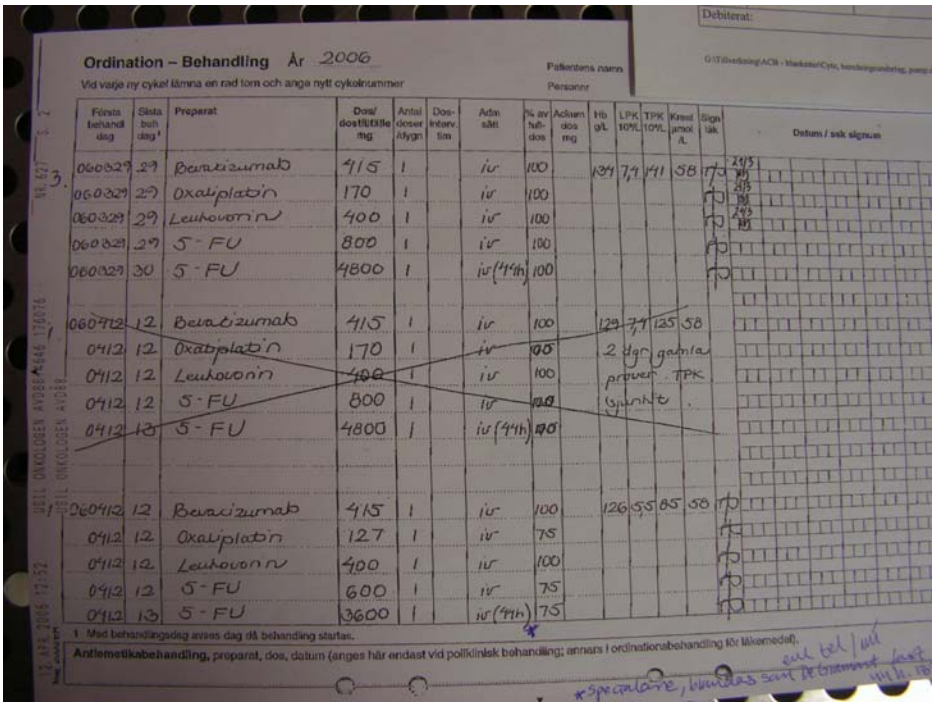


Figure 5: A prescription with the quantities of each drug that must be sampled.

- ***Gathering: (drugs room)***

In a plastic basket, the pharmacist gathers one new bottle of each needed basic drugs and the complementary material (plastic bag, three-way stopcock, tubing and an out bag). Each of these elements has an identification number that is written down on the prescription. This paper and some others (like the identification bags labels) are also put in the basket, before placing it in the sterile cupboard.

- ***Mixing: (preparation room)***

A pharmacist takes the plastic basket from the cupboard. In the fridge, she checks first if there are still some non-empty bottles of the same drug as she needs. Under the hood, she can then

prepare the plastic bag. This means fix up the three-way stopcock and tubing on the plastic bag (See figure 6)and make some sterile liquid go in the tubing part, in order to be sure not to contaminate a nurse accidentally.

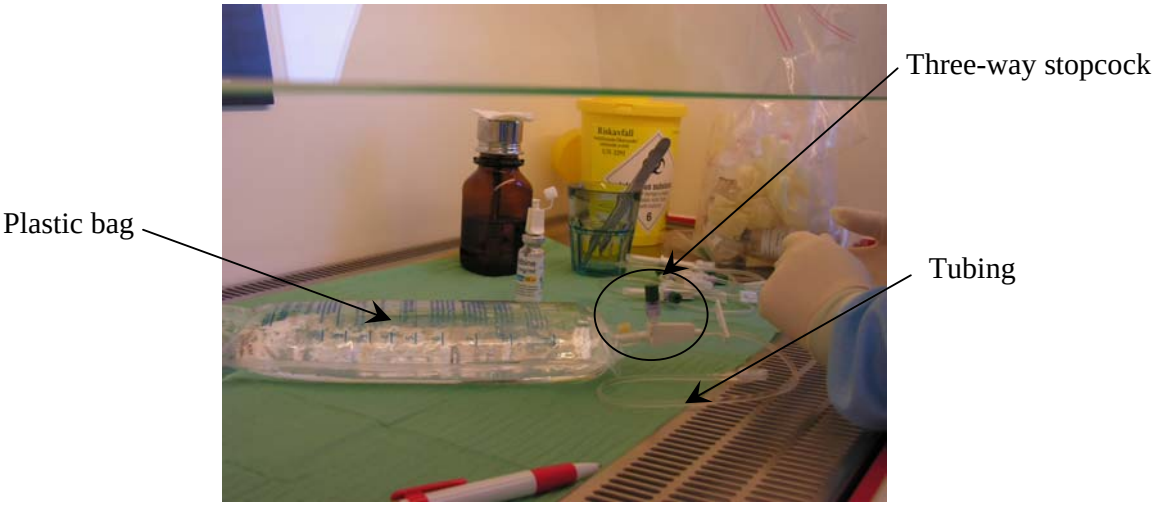


Figure 6: The plastic bag is ready; the pharmacist prepares the first drug to add.

Then, the pharmacist samples the right volume of the first drug from the bottle with a sterilized syringe (See figure 7) and adds it to the plastic bag through the three-way stopcock (See figure 8). Each syringe is used only once, and all the identification numbers of the drug bottles are written down on the paper. When all the drugs have been added, the pharmacist pastes the identification label on the bag. When all the bags for the same patient are ready, they are put on a trolley, waiting for the final control.

Figure 7: Sampling of a drug with a sterilized syringe.

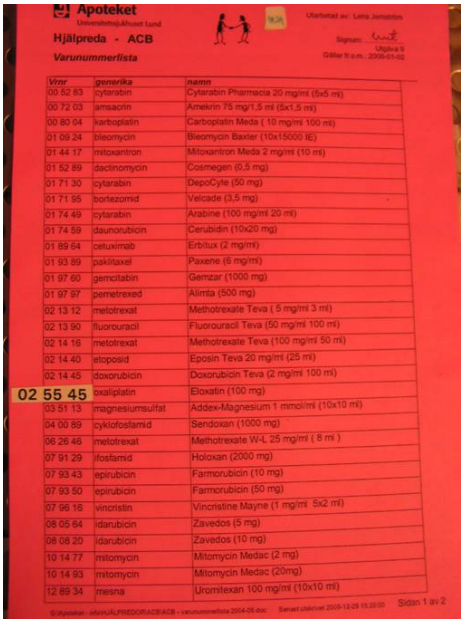
Figure 8: Addition of the drug in the bag with the sterilized syringe.

- ***Final control:***

A pharmacist (different from the one that mixed the drugs) controls the plastic bags: he checks that the identification numbers written on the paper correspond to the right basic drugs (See figure 9).

- ***Delivery:***

When the plastic bag is ready and controlled, it is placed in the other sterile cupboard in its basket, waiting to be taken by the nurses.



Apoteket

Hjälpreda - ACB

Varunummerlista

Vnr	generika	namn
00 82 83	cytarabin	Cytarabin Pharmacia 20 mg/ml (5x5 ml)
00 72 03	amsacrin	Amekrin 75 mg/1,5 ml (5x1,5 ml)
00 80 64	karboplatin	Carboplatin Meda (10 mg/ml 100 ml)
01 09 24	bleomycin	Bleomycin Baxter (10x15000 IE)
01 44 17	mitoxantron	Mitoxantron Meda 2 mg/ml (10 ml)
01 52 89	dactinomycin	Cosmegen (0,5 mg)
01 71 30	cytarabin	DepoCyte (50 mg)
01 71 95	bortezomid	Velcade (3,5 mg)
01 74 49	cytarabin	Arabine (100 mg/ml 20 ml)
01 74 59	daunorubicin	Cerubidin (10x20 mg)
01 89 64	cetuximab	Erbitux (2 mg/ml)
01 93 89	paklitaxel	Paxene (6 mg/ml)
01 97 60	gemcitabin	Gemzar (1000 mg)
01 97 97	pemetrexed	Alimta (500 mg)
02 13 12	metotrexat	Methotrexate Teva (5 mg/ml 3 ml)
02 13 90	fluorouracil	Fluorouracil Teva (50 mg/ml 100 ml)
02 14 16	metotrexat	Methotrexate Teva (100 mg/ml 50 ml)
02 14 40	etoposid	Eposin Teva 20 mg/ml (25 ml)
02 14 45	doxorubicin	Doxorubicin Teva (2 mg/ml 100 ml)
02 55 45	oxaliplatin	Eloxatin (100 mg)
03 51 13	magnesiumsulfat	Addex-Magnesium 1 mmol/ml (10x10 ml)
04 00 89	cyklofosfamid	Sendoxan (1000 mg)
06 26 46	metotrexat	Methotrexate W-L 25 mg/ml (8 ml)
07 91 29	ifosfamid	Holoxan (2000 mg)
07 93 43	epirubicin	Farmorubicin (10 mg)
07 93 50	epirubicin	Farmorubicin (50 mg)
07 96 16	vincristin	Vincristine Mayne (1 mg/ml 5x2 ml)
08 05 64	idarubicin	Zavedos (5 mg)
08 08 20	idarubicin	Zavedos (10 mg)
10 14 77	mitomycin	Mitomycin Medac (2 mg)
10 14 93	mitomycin	Mitomycin Medac (20mg)
12 89 34	mesna	Uromitexan 100 mg/ml (10x10 ml)

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Figure 9: Check-list of basic drugs, used for the final control.

1.3 What needs to be improved?

First of all, the problem in the actual process is that it is based on human control which means that failures can occur. Furthermore, assisting the control by computer would really decrease the stress for the pharmacists.

Today, the process allows only to control that the right drugs have been used for the preparation. It does check neither the volume of drugs nor the label on the bag. The improvement of the control system will thus concern the identification of the patient, the identification of the basic drugs and the control of the volume added.

2 How to improve the process?

According to the analysis of today's process, the problems to handle are: the identification of the patient, the identification of the basic drugs and the control of the added proportion of drugs.

2.1 Identifications of the patient and the basic drug

The patient is identified by his name or the barcode, both present on the prescription. All basics drugs have an identification number or a barcode. Furthermore, since Apoteket is working in collaboration with the pharmaceutical industry, they can ask for a standard identification of the drugs (identification number or barcode). So, even if today, all the drugs do not have the same kind of identification, it can be assumed that only one standard identification will be used.

The check of the identifications (of the patient and the drugs) consists now in reading and then re-writing the different names on the paper. To avoid the mistakes occurring during these operations, identification must be done by an electronic device.

This device can be a scan pen that reads letters and numbers or a barcode reader. More information about each solution must then be collected in order to choose the best solution.

2.2 Control of the proportion of basic drugs

The problem about checking the right proportion is tougher. Since a small volume (between 1 and 200 ml) of basic drugs is injected in the plastic bag that contains 100 to 2000 ml, a chemical control seems indicated. Unfortunately, this is impossible to carry on in a suitable time. But the quantity of each basic drug added must be checked. The control must thus occur step by step during the mixing process.

The quantity of basic drug injected in the bag can be measured by its volume or its weight. The pharmacists actually use syringes, i.e. the volume, to measure how much drug they add in the solution. Though, this volume control is only visual and the new control system must supply human control to avoid the mistakes. The weight seems to be the more adapted solution. The plastic bag should be weighed at the beginning of the mixing process and then between each addition of a basic drug. By subtracting both weights, it is possible to know how much drug has been added. Then, with the concentration of the basic drugs, it is exactly possible to calculate the proportion of each basic drug injected in the bag.

Nevertheless, the equipment has to be able to measure a difference of some grams for a range of weight between 100g and 2 kg. Further research must also be conducted about this point.

2.3 Layout of the new system

Since the new control system will be assisted by computer, a proper interface between the computer and the pharmacists has to be designed. The identification device has to be linked to the computer, as well as the weighing device.

The computer should be a help but not the one that leads the control. The basic statement is indeed that when the pharmacists and the system disagree, the pharmacists are right. Their experience is more important than a measure.

So, the pharmacists have sometimes to agree with the information gathered by the computer or to correct them. For this purpose, a whole keyboard with a mouse is more than necessary. A simple touch screen could fulfill the requirement, and besides, should be easier to handle since it can fit in a smaller place under the hood. The touch screen is also a better solution, considering the hygiene conditions of the preparation room. Some research must be carried on about this choice.

3 Review of possible technologies

3.1 Scan pens

The specifications about the scan-pen for this project are as follow:

- read and recognize Swedish
- send the data real-time to the computer
- be able to read on the little bottles of drugs (little font and wavy surface)
- be easy to use, user-friendly

There are more or less three different scan-pen constructors who offer devices which can be used like highlighters. Here is a comparative table of these devices called scan pens. (See table 1)

Table 1: Specifications of the scan pens. [1]

Brand Name	**Product Name**	**Transfer mode***	**Recognition skills**	**Price (US$)**
Wizcom Technologies Ltd	Wizcom InfoScan	USB/infrared	6-22 point font size (bold, italic, underlined, inverted text)	120
	QuickLink-Pen Elite	USB/infrared		170
C-Pen	Desktop C-Pen 20	USB	5-22 point font size	150
	Desktop C-Pen 10	USB	5-22 point font size	Old products, not sold any more
	C-Pen 800C	Infrared	---	
Iris	IRIS Pen Express	USB	---	130
	IRIS Pen Executive	USB	---	200
	IRIS Banking reader	USB	---	**

*All the data are sent real-time.

** The features of this pen are actually adapted to each customer, to perfectly fit his needs. The price is thus not pre-defined.

Observations:

- The specification of the recognized languages does not appear in the table since all pens are able to read both Swedish and English.
- When the transfer of the data is only possible by USB, that means the device also receives energy from the USB cable: there will always be a cable. On the opposite, the

infrared technology allows to have a wireless device.

- Between the different IRIS Pens, the "Executive" has been recommended for this purpose.

While checking the different features of each pen, some unexpected but really interesting features were discovered. (See table 2)

Table 2: Special features of the scan pens. [1]

Brand Name	Product Name	Speech Synthesis	reads barcodes	Wavy and distorted images	Others
Wizcom Technologies Ltd	Wizcom InfoScan	---	---	---	
	QuickLink-Pen Elite	X	---	---	
C-Pen	Desktop C-Pen 20	---	X	---	
	Desktop C-Pen 10	---	---	---	Active mouse pad*
	C-Pen 800C	---	---	---	
Iris	IRIS Pen Express	---	X (+ handwritten numbers)	X	Pen buttons** (programmables)
	IRIS Pen Executive	---		X	
	IRIS Banking reader	X	---	---	

* The "Active Mouse Pad" is a special Mouse Pad that allows using the scan pen like a usual mouse. It is also possible to "program" some special actions that will be executed when the pen is passed on some special zones of the pad.

** The pen has some buttons to which some keyboards command can be assigned.

Finally, nothing was really described about the surface quality required by the scan pens. The only indication was the "wavy and distorted images" offered by Iris. However all the constructors answered that they cannot guarantee the performances of their scan-pens (even if it was written "reads wavy and distorted images" in the description of the product). And thus the only way to validate the feasibility would be to test the pens.

3.2 Barcode readers

The basic drugs usually have a barcode printed on the sticker of the bottles. The analysis of the products on the market shows that the main technical features related to barcode readers are the languages that are recognized. Among them: EAN-8, EAN-13, UPC, EAN/JAN,

CODE 39, CODABAR, CODE 128, CODE 93, MIS, ISBN, PLESSEY, etc.
However, nobody in the oncologic department could tell me which kind of barcode is on the bottles. And since there are scan pens that can read the most usual barcodes, it was decided to use scan pens.

3.3 Weighing devices

The weigh-scale will be used to control the weight of basic drugs added in the plastic bag. Since the plastic bag's volume ranges between 100 and 2000ml, they already weigh between 100 and 2000g. The volume of basic drug added varies between around 1 and 200ml, i.e. 1 and 200g. The final weight of the bag should thus be between around 110g and 2,2 kg. So the weigh-scale has to be able to weigh until 2,5kg, for more security.
Considering a precision of 10%, the weigh-scale must have a standard deviation smaller than 0,1g.

Table 3: Comparative chart of the different weighing devices.

Brand	**Model**	**Capacity (g)**	**Readability (g)**	**Repeatibility (Std. Dev.) (± g)**	**Linearity (± g)**	**Stabilization Time (sec)**	**Platform Size (cm)**	**AC Adapter**	**Battery**	**RS-232**	**USB**
Ohaus	Adventurer SL Balance AS 3101	3100	0,1	0,1	0,2	3	14.9 x 16.2	X			
Ohaus	EB Series EB3	3000	0,1	0,1	--	>2	29.4 x 22.6	X	int.		
My Weigh	I2600	2600	0,1				14,5 x 14,5	X	6*AA		
Acculab	VIC 3101	3100	0,1	0,1	0,1		14 x 12,7	X	opt.	X	X
Svensk våg AB	CGX-3000	3000	0,1				190 x 190		X	X	
Carl Lindén	EU 3000	3000	0,1			2/3	ϕ = 19	X			
Kern	FTB 3K0.1	3000	0,1	0,1	0,3		20 x 24	X		X	
Idema	UWE typ NJW-3000	3000	0,1				14 x 17	X			
Mettler - Toledo	PL3001-S	3100	0,1	0,08	0,2	2	ϕ = 19	X		opt.	
Mettler - Toledo	BBK422-3DXS	600 / 3100	0,01 / 0,1				33,5 x 26,5			X	opt.
Vetek	JWE-3000	3000	0,1				33,4 x 24,5	X	int.	opt.	

Observations:

- "int." means that the weight-scale has an **internal** battery.
- "opt." means that the feature is available but only **optional**.
- The price does not appear in this chart since it is most of the time not available on the websites. Furthermore the prices vary a lot according to the quantity of articles bought.

The table 3 is however an overview of the different kinds of weight-scales on today's market. For a final choice, some more features can be taken into account:

- Most of these devices have different **protections** adapted to laboratory, medical environments, or special industries.
- Some of theses weight-scales also have an **Auto-Off function**, which means that the scale is shut down after a predefined time if it is not used. This Auto-Off function is sometimes adjustable or can even be turned off.

Finally, there are many interesting products on the market and a weight-scale adapted to the new control system will be found easily. The final choice will depend on other parameters, like the platform's size (big enough for the plastic bag) or the price of the transport (some companies are not Swedish).

3.4 Touch screens

The pharmacists who will use this screen will be wearing the usual "security suit", i.e. plastic gloves. The question is then to know if every touch screen can work in such conditions.
With an internet review [2], eight different technologies used for the touch screens have been found on the today's market.

- ***Capacitive technology:***

This is an electrically-sensitive technology. Four sensors are disposed in each corner of the screen and measure the variation of the electric field over the screen. When a finger touches the screen, it makes change this electrical field. So this technology can work only if the touch screen is used bare hand or with an "electrical active" object.
This technology is not suitable for our project.

- ***Resistive technology (analog or analog-digital):***

This is a pressure-sensitive technology. Four sensors are also disposed in each corner of the screen and measure the variation of an electric field, translating the variations of pressure on the screen. In this case, any kind of pressure is felt: a finger, a nail or a stylus pressure. This technology is thus interesting for the project.
This technology is applied on different ways, which gives the different following technologies.

- *analog resistive technology:*

The problem of this technology is the decrease of accuracy with time. The touch screen must then be calibrated periodically. The 5-wire version is more expensive but is also accurate during a longer time (minimum 35 millions of impacts) than the 4/8-wire version (1 to 10 millions of impact, guaranty for 1 or 2 years)

- *analog-digital resistive technology:*

This technology is better than the first one, since it almost does not need any recalibration.
Finally, resistive touch screen panels are not affected by outside elements such as dust or water and are the most commonly used today.

- ***Photo-sensitive (infra-red) technology:***

This technology uses also sensors around the screen, infra-red transducers, which makes an infra-red "pavement" over the screen. Transducers pick up anything breaking the pavement and locate it on the screen. This technology is reliable since it cannot be damaged easily. The average guaranty for these products is usually between 3 and 5 years.
Depending on the prices, this technology can be considered for this study.

- ***Acoustically-sensitive (SAW - surface acoustic wave) technology:***

As for the infra-red technology, a pavement of acoustic waves is used to pick up any object susceptible to cross the pavement to reach the screen. This technology uses more usual screens: they can be damaged by aggressive outside elements like chemical products form industry. However, the basic drugs are not that dangerous for this kind of screen.
This technology looks appropriate for our project, the prices must be checked.

- ***NFI (Near Field Imaging) technology:***

This technology has been developed especially for the industries with particularly difficult environments. The touch screens are then really efficient, but really expensive too.
This technology is not a suitable choice for this application.

- ***Strain gauge configuration:***

This technology uses four springs mounted on corners on the screen. Some strain gauges, associated with the springs pick up the deflection when the screen is touched. This resistant technology is essentially used for the public machines, in order to protect them from vandalism.
This robust technology is developed for other needs. It thus does not look appropriate for this work.

- ***Optical Imaging technology:***

This is a modern technology. Two or more image sensors are placed around the corners of the screen, and some Infrared backlights are placed on the other side of the screen. When something touches the screen, it appears as a shadow and each pair of cameras can then locate the touch. This technology becomes popular because it is a flexible and affordable product, especially for larger units.
Depending on the prices, this technology can be taken in consideration.

- ***Dispersive Signal Technology:***

This is the newest technology (2002). The sensors pick up the variation of the mechanical energy in the glass when something touches the screen. The strong point of this technology is its resistance to the outside elements and its excellent optical clarity. However this technology is still quite new and is not currently widely available.
This technology does not really look appropriate for this study.

Finally, the technologies that are adapted to this project are:

- Resistive technology (analog or analog-digital):

with a preference for the 5-wire version of the digital resistive technology or the analog-digital resistive technology.

- Photo-sensitive (infra-red) technology.
- Acoustically-sensitive (SAW - surface acoustic wave) technology.
- Optical Imaging technology.

After searching on internet on the constructors websites, I realized that the touch screens are not really classed according to their technology but according to other parameters like their size, the type of screen (LCD or CRT) or the type of fixation (Panel, Front-/Rack-/Rear-Mount). I decided to send some emails to the customer services of the three most common constructors: Keytech Inc., Elo touchsystems and 3M Touchsystems. I described them the conditions in which the touch screen would be used and asked for advices in the choice of a touch screen.

4 Focus Group

4.1 Preparation of the focus group

After having collected all these information on the net, a theoretical solution could be built. However, I wanted to be sure to match the needs and expectations of the working team of pharmacists.

Matching the expectations of these people is a qualitative research. In such a case, the focus group seems a good tool. According to Holly Edmunds [3], it is actually interesting to use the focus group tool to generate new ideas or support brainstorming and to test new concepts.

The first step is to decide the **research objectives**: first, a brainstorming allows knowing better the expectations of the pharmacists; and a feedback could validate the theoretical solution.

The second step, the **recruiting profile**, i.e. choosing the participants, is quite easy in this case since the only concerned people about this study are the pharmacist working in the oncologic department. Annsofie, responsible for this department, has been in charge of recruiting the participants for this focus group.

The last step, the **discussion guide**, is also simple. Since the goal is to get as many new ideas as possible from the pharmacists, the discussion will be open questions: Which problems do you have in your actual work? What should be improved? Etc.

In her book, Holly Edmunds [3] also gives warning concerning being the moderator of a focus group when you also are the developer of the project. The danger of "doing it yourself" is essentially the **bias**: the moderator may not influence the participants during the discussion. To avoid this, two moderators were chosen to lead the focus group: since she does not know so much about the theoretical solution, Annsofie led the first part about the brainstorming, and I led the second part in order to get a feedback about the theoretical solution. In such a way bias should be avoided.

The participants were told about the usual procedures.

- Someone was **recording** the meeting
- They had to **speak clearly** and one at a time, especially because Swedish is not my mother tongue.
- There are **no right or wrong answers**: their answers are only about what they think and how they feel in their work; there are no right or wrong answers about feelings.
- Need for **active participation**: since they explain their ideas one after the other, the participants have no choice: they will be active participants.
- **Breaking the ice**: all the participants already know each other since they all have been working together for some years. There is thus no need of breaking the ice between them.

4.2 Discussion with the focus group

The first part of the meeting was about general questions. Annsofie asked to the focus group what were the most important aspects in their job and what had to be improved. They wrote down on Post-It what they came up with during 15 minutes, and then we had a brainstorming all together about each idea.

The problems that were discussed are the following, ordered by frequency:

1. *Put the right ones together*: the pharmacists have to add the right drug(s) in the right proportions to the right type of bag (right volume), and then put the right label on the bag (right patient). This problem appears especially when the pharmacist must prepare different bags for the same patient. In such a case, they prepare them in a row but each bag is a different mix.

2. *Pre-control:* when the pharmacists receive a new prescription, they check if it corresponds to the good regime by using the database. This moment is one of the most stressful in the whole process.

3. *Communication*: when the pharmacists are working, they often receive phone calls, mails or faxes. All these interruptions in their work are difficult to handle, because the pharmacist have to interrupt their tasks and go back to it later, without any error.

4. *Identification of the drugs*: some bottles look very similar, and some drugs' names are also easy to mix up.

5. *New preparations*: when the pharmacists have to prepare an unusual mixture, or a mixture they never did before, they do not know how to handle it and have to search for the protocol.

6. *Maximal dose*: the drugs added in the bag are really dangerous, and some of them have a maximal dose to be respected. This means that the "regime" given by the computer must sometimes be adapted.

7. *Cytobase and Cytodose*: these are the softwares that pharmacists use to check all the prescriptions that they receive, adapted respectively for adults and children. Like the "regimes", the maximal dose is different for the adults and the children.

8. *Double prescription*: Sometimes, the same prescription can be send two times to the pharmacists (one by mail and one by fax for example). The pharmacists have to be careful to prepare the mix only once.

4.3 Analysis of the discussion

Since these problems are very different from each other, it is better to analyze them step by step.

1. *Put the right ones together*: This problem is the one I considered to be the most important to elaborate a solution. The first goal is thus to design a system that verifies that the

pharmacist adds the right drugs, in the right proportions to the plastic bag and puts the right label on it.
The precision about the quasi simultaneous preparation of different bags for the same patient must however be taken in account: The software must use in its database not only the patient's name but also which bag is going to be prepared.

2. *Pre-control:* The system must be based on the right prescription. The problem is that the right prescription can be the one received from the doctor or the one registered in the computer (regime). Both of them can also get adjustments (maximal dose). The decision about the right prescription must be done by a pharmacist, according to his experience. It is consequently impossible that this part is handled by a computer or software and thus this pre-control will not be included in the new system.

3. *Communication*: During the focus group, one of the pharmacists said that most of the disturbing calls were from people who wanted to know if the prescription was ready or not. Considering this remark, a consulting interface could be created so that doctors, nurses or everyone else can know at which step is currently the preparation.

4. *Identification of the drugs*: In order to be sure to have chosen the right basic drug, the software must give a good feedback. The name of the drug can be written or pronounced and a picture of the bottle can appear on the screen.

5. *New preparations*: the software can have a tutorial describing the process to follow for uncommon mixes. This part should be discussed with the pharmacists themselves.

6. *Maximal dose*: The maximal dose is the total quantity of drug that a patient can receive. This depends on how much drug the patient already received. This information may be possible to handle but still must be discussed with the computer team.

7. *Cytobase and Cytodose*: The new software has to use both data bases to be able to handle both adults and children.

8. *Double prescription*: If the new software could remember the prescriptions for each patient, this type of error would be easily avoided.

4.4 Conclusions

Finally, this focus group was really positive. First of all, the basic thoughts met the needs and expectations of the working team. Furthermore this meeting allowed me to improve and specify my solution.
The software that is going to be created to support this new control system must use both databases (Cytobase and Cytodose). It could moreover be great to integrate some special settings in it:

- A consulting interface, accessible by all, that allows seeing at which point is currently the preparation
- A good feedback about the drug that are used for the mix

- A tutorial for the unusual mixes
- A warning for the maximal dose (to be discussed with the computer team)
- A historic of the different prescriptions for each patient

4.5 Theoretical solution

The second goal of this focus group was to present the theoretical solution to the pharmacists' team (See the PowerPoint presentation in Appendix).
The theoretical solution is explained below.

The actual process for the preparations of drugs is divided into five steps. The first step is the reception of the prescription from the doctor. Then, there is the gathering, the mixing, the final control and finally, the delivery. Only the gathering and the mixing parts can be handled by the new system.
The gathering will be made easier by using a scan-pen or a barcode reader, decreasing the risk of confusion; and the mixing will be guided by the computer that will control the preparation at the same time.

Description of the new process:
A pharmacist receives a new prescription from the doctor. She uses the computer to check the prescription with the database. If something special must be modified (adaptation of the normal regime), she enters the modifications in the computer. She uses the scan-pen to identify the prescription, the additional equipment (i.e. the tubing with its three-way stopcock) and the bottles of drugs to be sent to the second room. From the prescription, the computer knows which drugs are necessary for the mix and can then control that the right bottles are gathered. By identifying the equipment, the system stores the necessary information in case of a problem with a batch.
In the other room a pharmacist takes the plastic basket. On the same way, she uses the scan-pen to identify the prescription. She prepares the plastic bag with its equipment and then weights it. She scans the first drug, adds it in the bag and weights again the bag. Since the balance is linked to the computer program, the computer knows, according to the difference of weight, how much drug has been added to the bag. It verifies that the quantity is the right one, by checking the prescription in its database. This procedure is repeated for each basic drug and finally, the pharmacist identifies the label before to paste it on the plastic bag.
So, the computer checked the patient's preparation according to his new prescription (modified as necessary): it checked that the right drugs were used in the right proportion and it knows that the right sticker is on the bag.

5 Tests and complementary documentation

5.1 Touch screens' Results

The three main constructors of touch screens (Keytech Inc., Elo Touchsystems, 3M Touchsystems) suggest the solutions detailed in the comparative chart below (table 4) in order to fulfill the needs: to be adapted to a medical environment.

Table 4: Comparative chart of the answers from the different constructors [4]

Company	**Touch screen's name**	**Technology**	**Size of the screen**	**Price***	**Other specifications**
Keytech Inc.	KTLC-19NA-USB/B	Resistive	largest size (19")	$925 (+ $107)**	integrated monitor
Elo touchsystems	ET1926L-7UWA-1 - 19" / ET1926L-8SWA-1 - 19"	Resistive / Surface Acoustic Wave	19"	14 882 SEK	Medical standard
Telac	T150	Resistive	15"	from 6000 SEK (T150: 9000 SEK)	Monitor sealed around the edges

*The prices in SEK is the price "exklusiv moms".

** The price in brackets is the shipping cost since this company is located in the US.

Observation: Telac is the Swedish partner company of 3M Touchsystems.

The information gathered in the table above is indicative. For example, the quantity of touch screens ordered, the specifications required or the time of warranty will have a big influence on the prices. Anyway, the Elo Touchsystems and Telac companies have their own developers; which means that they can fit any requirement from their client.

5.2 Scan pens' Tests Results

The first test with the scan pens is to determine the ability of the scan pen to read small letters because the identification number printed on the bottles is indeed quite small. Furthermore, the bottles of basic drugs can be very small and the scan occurs on a quite bended surface.

To be as close as possible to the reality, the font "Lucida Sans Unicode" is chosen. An identification number is printed on a usual paper sheet. The scanning occurs directly on the sheet to avoid the influence of the bottles' shape.

Already with this first test, it clearly appears that the writings must have a **font's size of 5 points minimum**.

Furthermore, since one of the basic drug has its identification number written in white on a dark green background, it is also tested to scan white numbers printed on black background. In this case, the recognition is almost impossible. So the identification number printed in **white numbers on a dark background must be banished**.
It is also important to notice that **a free background is better**. In fact, the scan pen shows a better recognition rate if the identification number is the only line or the top line of a group.

The second test handles with the fact that scanning on a bottle means scanning on a bended surface.
The aim of this procedure is to reproduce the bended surface of the basic drug's bottles. Two plastic cylinders with diameters of 16 and 21mm (i.e. the diameters of the smallest drug's bottles) have been made for this test. A piece of paper representing the identification number is then pasted on the plastic cylinder.
The scan has been tried on different fonts' size: 6, 5 and 4 points.
The results are considered to be "nothing" when the scan pen is not able to recognize anything; "bad" if something useless appears on the screen, "good" if what appears on the screen is exactly the words that have been scanned. During the test, the identification number is often scanned right but sometimes either with additional characters, or without the first characters. It should nevertheless be possible to program the software so that it searches for six consecutive numbers in the scanned letters. With this feature, the scans should be really more effective. These results have thus been considered as "almost" good.

Table 5: Results of the second test: the bended surface.

Font's Size	Diameter	Nothing		Bad		Almost		Good	
		Nbr	%	Nbr	%	Nbr	%	Nbr	%
6	21	1	5%	5	25%	9	45%	5	25%
6	16	1	5%	11	55%	5	25%	3	15%
5	21	1	5%	5	25%	7	35%	7	35%
5	16	2	10%	12	60%	4	20%	2	10%
4	21	2	10%	6	30%	7	35%	5	25%
4	16	5	25%	13	65%	1	5%	1	5%

Observation: These results just reflect the results over 20 tries. They are just approximate numbers that allow finding a trend but cannot be used on another way.

In order to assess a trend, the results have been grouped: "failed" for the "nothing" and "bad" scans; "OK" for the "almost" and good scans. Two tables present the same results as below, ordered according to the font's size (See table 6) or the bottle's diameter (See table 7).

Table 6: Results sorted according to the size of the font.

Font's Size	Failed		OK	
	Nbr	%	Nbr	%
6	18	45%	22	55%
5	20	50%	20	50%
4	26	65%	14	35%

Table 7: Results sorted according to the diameter of the bottle.

Diameter	Failed		OK	
	Nbr	%	Nbr	%
21	20	33%	40	67%
16	44	73%	16	27%

The font's size seems to play a role in the recognitions rate of the scan pen, but the influence of the diameter is even more important!

It is indeed to remark that a font's size of 6 or 5 points does not change the recognizing efficiency of the scan pen. The font's size of 4 points is nevertheless less efficient than the others.

Finally, this leads to recommend **having a font's size of 5 points minimum**.

By looking at the table 7, it can be concluded that the diameter of the bottle is a very important factor. A difference of 4 mm in diameter leads to a difference of 40% of the scanning efficiency. That's why **the bottle should have, at least, a diameter of 20 mm**.

Furthermore, it is to notice that the learning of the scanning is really quick. Over 20 tries, the first are most of the time bad, but it goes better and better. So as the pharmacists will use this device every day, and most of the time in better conditions (the major of the bottles have bigger diameter), it is reasonable to think that they will not have any problem after some days of experience. The time of a scan is besides very short, 1 or 2 seconds. Thus, even if the pharmacist has to scan two or three times the numbers during the first weeks, they will not loose so much time.

Sum up of the restrictions for the identification number:

- Bottles of basic drugs with a minimum diameter of 20mm.
- Font's size of 5 points minimum, 6 points preferred.
- Black numbers on white background.
- Free background (or at least the identification number on the top line).

6 Final solution

6.1 Analysis of basic usability rules

- ***Schneiderman's height golden rules:*** [5]

1. **Strive for consistency**: This rule has to be kept in mind when designing the screen layouts.

2. **Cater to universal usability - Enable frequent users to use shortcuts**: In this system, each step is important. To accomplish one step, the user or the system has always an action to do. It is therefore impossible to have shortcuts in this program.

3. **Offer informative feedback**: The user must know what the system is currently doing. Thus, a picture appears on the screen for informative feedback. During the whole process, most of the actions are done by the pharmacists; the system is only dealing with the scanning and the weighing steps. These two actions must however be represented on the screen while they are accomplished (See respectively figures 10 and 11).

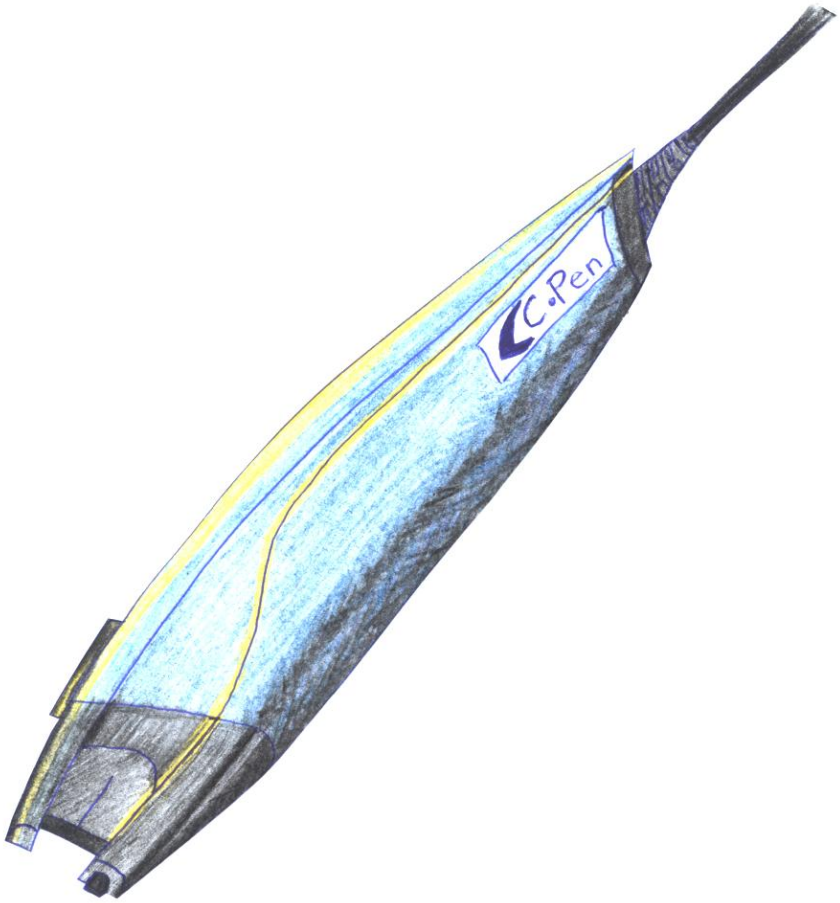


Figure 10: Picture of the scan pen appearing on the screen during the scanning operation.

Figure 11: Symbolic picture of a weighing device
appearing on the screen during the weighing operation.

4. **Design dialogues to yield closure**: During the mixing process, there are two "ends" that can be marked by a dialogue: the end of the addition of a basic drug in the plastic bag and the end of the preparation of the whole preparation. A dialogue box will thus inform the user when the operation is finished.

5. **Prevent errors**: Since this program is a control program, its purpose is to be able to handle all the possible user's errors. Its goal is also to help the user to rectify his mistakes.

6. **Permit easy reversal of actions:** Each time it is possible, a "back-button" is on the screen, in order to come back to the previous action (See figure 12). This feature gives a total reversibility to the system.

7. **Support internal locus of control**: Especially in this case, the user must have the control over the computer. It has been decided that the pharmacists, with their experience and their human reflection, are always right even if the computer disagree. This program is also designed to warn the user but, then, the user can decide to follow the warning or not.

8. **Reduce short-term memory load:** As much as possible, this program does not ask the user for anything to remember. All the necessary information is always on the screen.

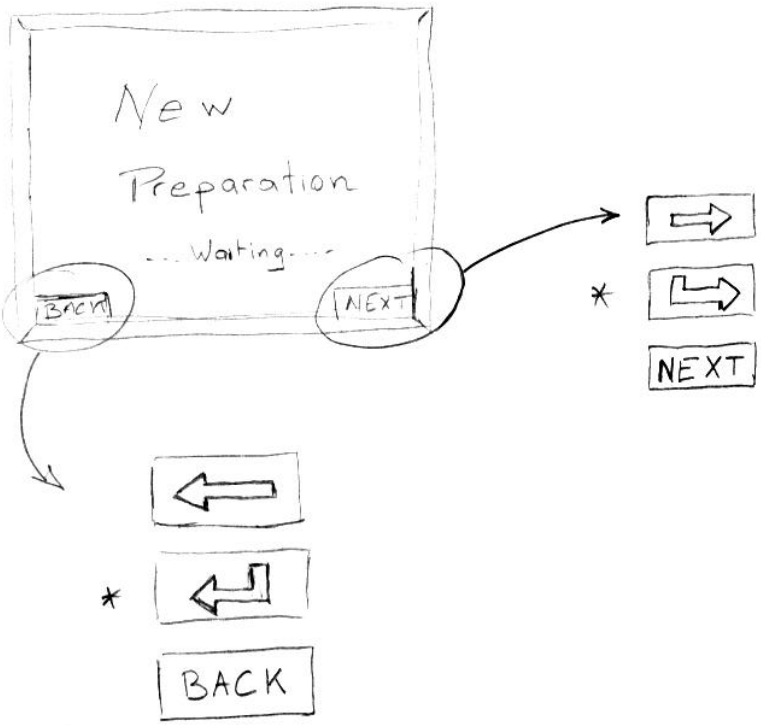


Figure 12: Sketches about the menu buttons of the program.
The button marked by a * is the design finally chosen in this project

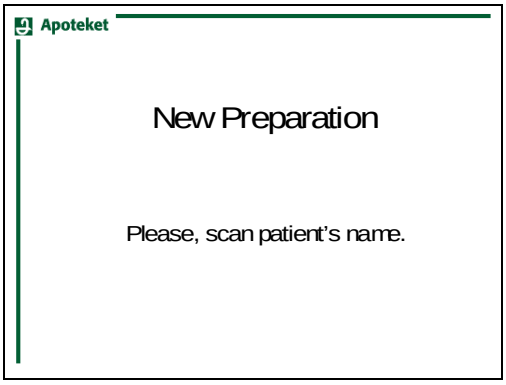
- ***Donald Norman:*** [6]

D. Norman warns also from overloading the short-term memory. He advises to use the so called ***knowledge in the world***. In this program, all the functions will clearly appear on the screen, mixing pictures and text.

Furthermore, D. Norman underlines the **importance of a good feedback** to the user. Already during the focus group, it was pointed out that some bottles look very similar. Consequently, the feedback about the identification of the bottle has to be efficient. This will be done by three different ways: the identification number, the name and the picture of the bottle of the basic drug will appear on the screen. This should prevent any error.

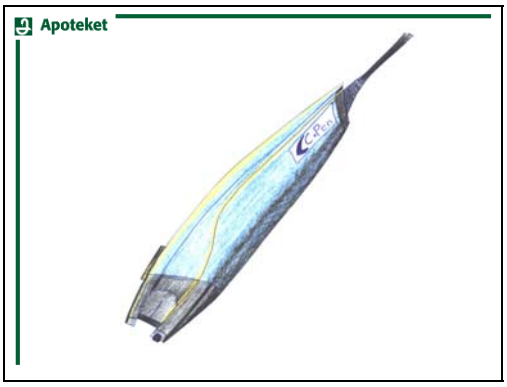
6.2 Structure of the software: Storyboard

With the help of the literature [7] [8], a storyboard of the final solution has been built. Some particular numbers and names have been used as examples for a better understanding.
The arrow in the bottom left corner is the “back” button. This one will not be taken in account in this storyboard because it always comes back to the previous screen.



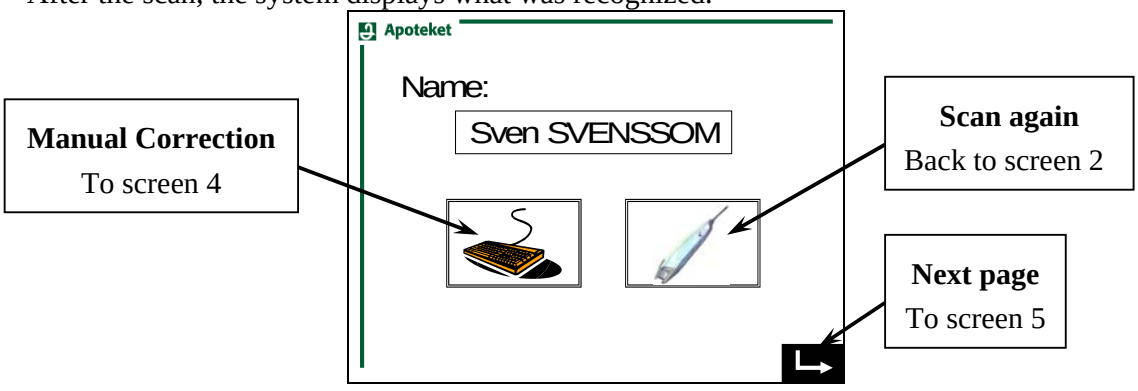
Screen 1

When the scan starts, the system goes automatically to the next screen.

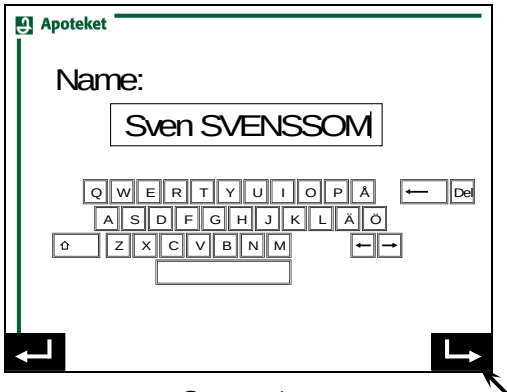


Screen 2

After the scan, the system displays what was recognized.



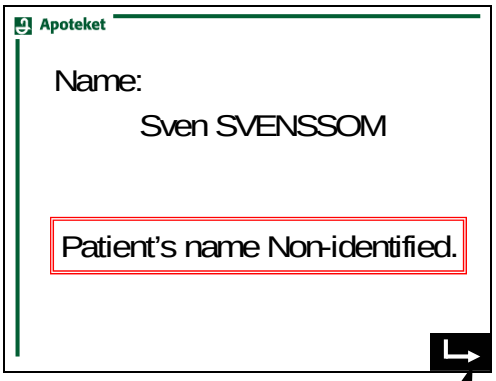
Screen 3



Screen 4

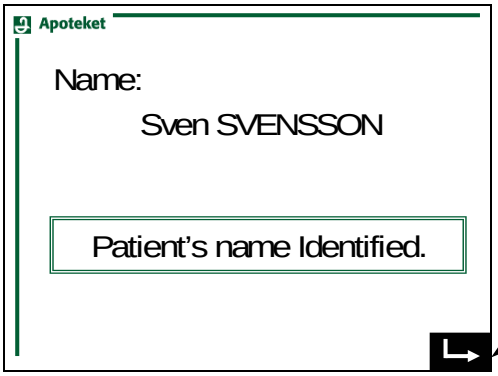
The user can now correct the name using the fictive keyboard on the screen.

Next page
To screen 6



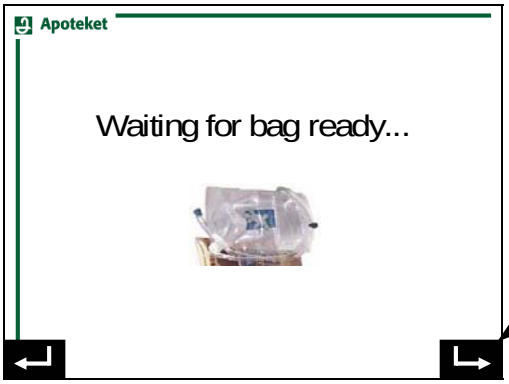
Screen 5

Next page
To screen 3



Next page
To screen 7

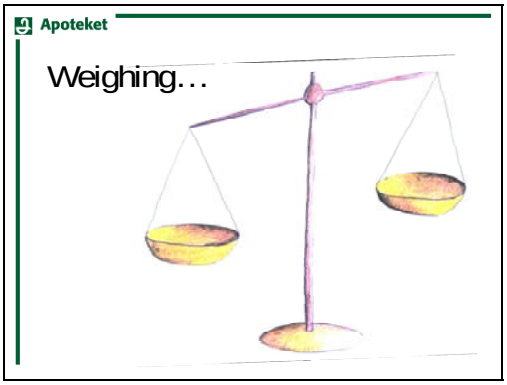
Screen 6



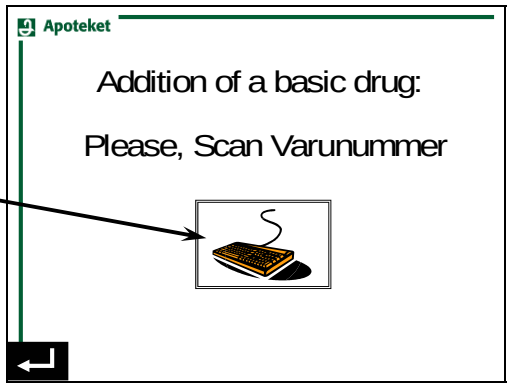
Next page
To screen 8

Screen 7

During the automatic weighing the system displays the next screen.



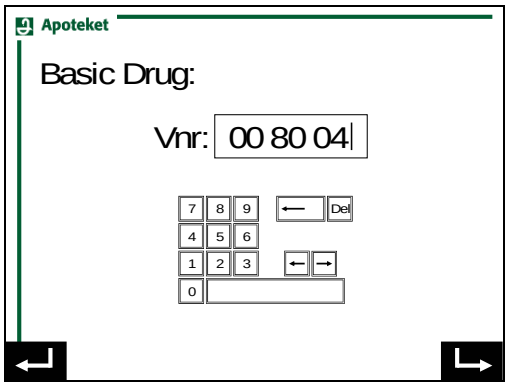
Screen 8



Manual Entry
To screen 10 (blank)

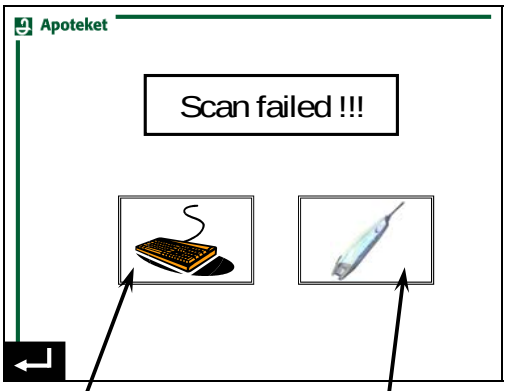
Screen 9

During the scan, the screen 2 is displayed. Then, the system displays what was recognized.



Screen 10

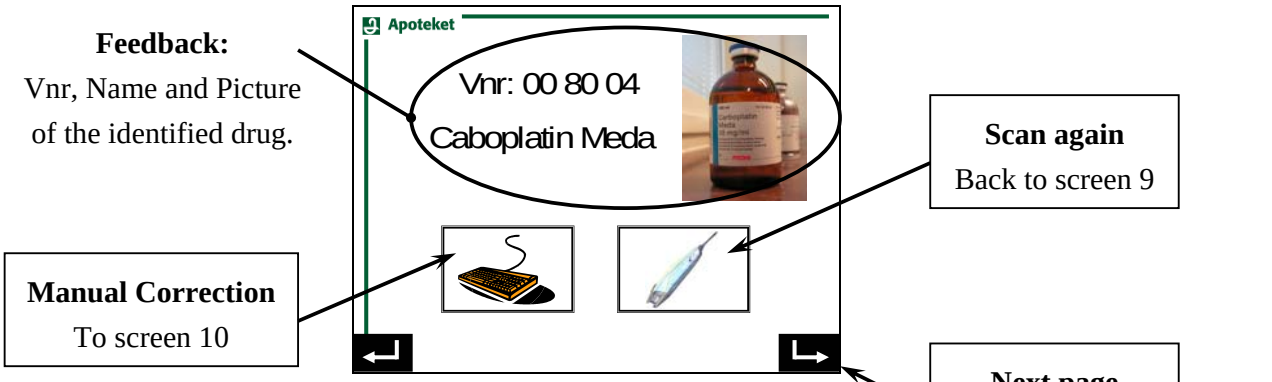
After correcting the identification number (if it is necessary), the user uses the "next page" button to validate:
To screen 12.



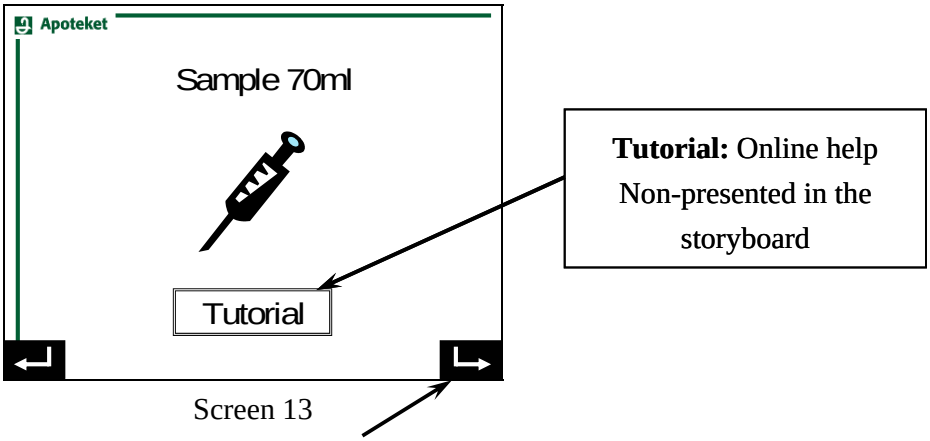
Screen 11

Manual Correction
To screen 10

Scan again
Back to screen 9



Screen 12

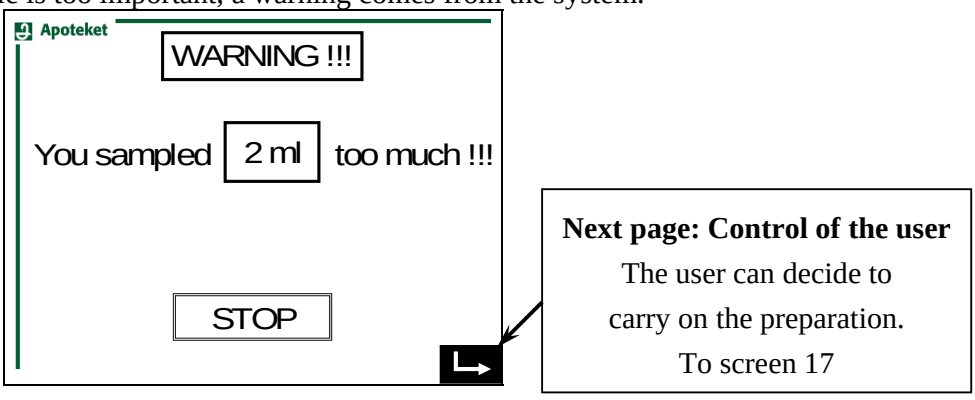


Screen 13

After sampling, the user uses the “next page” button to validate.
During the automatic weighing, the system displays the screen 8.

After the weighing, the system comes to one of these three issues:
the quantity of drug sampled is too big, too little or right.

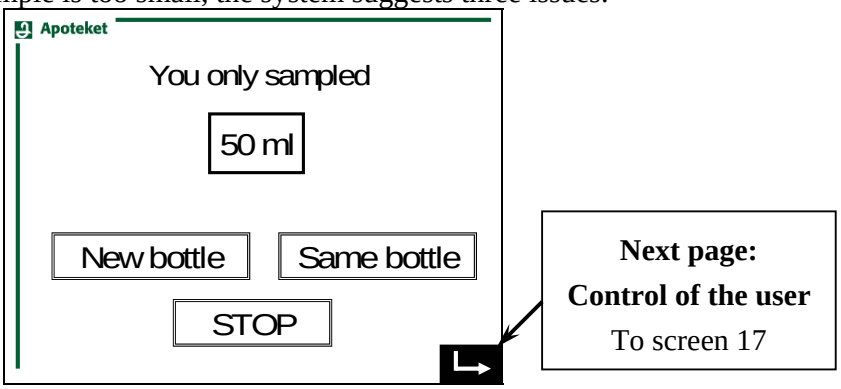
If the sample is too important, a warning comes from the system.



Screen 14

Touching the “stop” button stops totally the procedure. If the user confirms his decision on the following screen the procedure starts again from the beginning (To screen 1).
The preparation is bad and assumed to be trashed.

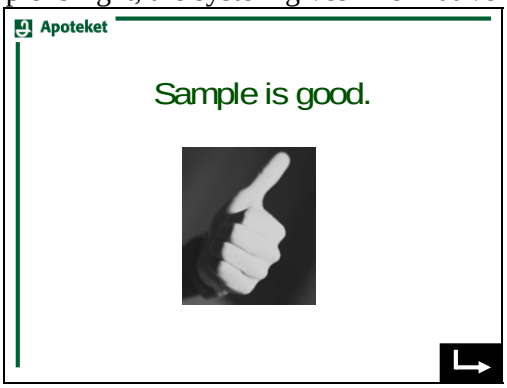
If the sample is too small, the system suggests three issues.



Screen 15

The user can choose if he wants to sample more drug from a “New bottle” (To screen 9) or the “Same bottle” (To screen 13). He also can stop the system (See screen 14).

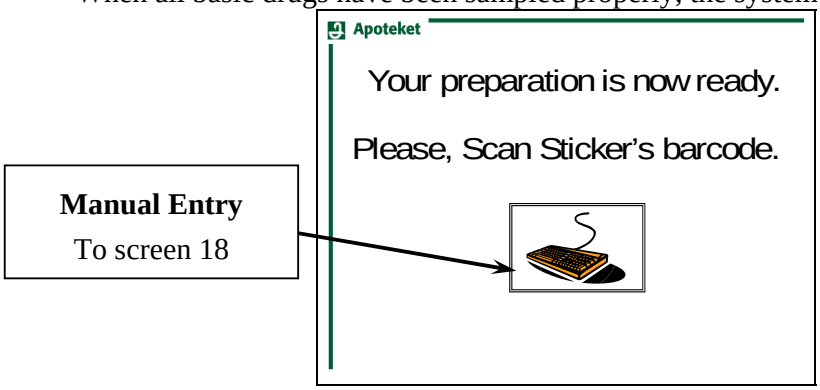
If the sample is right, the system gives informative feedback.



Screen 16

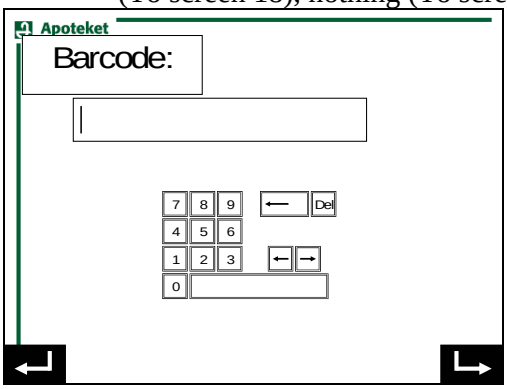
If another basic drug must be added in the preparation, the system is aware about that and comes back to the screen 9. This cycle is run as many times as necessary.

When all basic drugs have been sampled properly, the system goes on as follows.



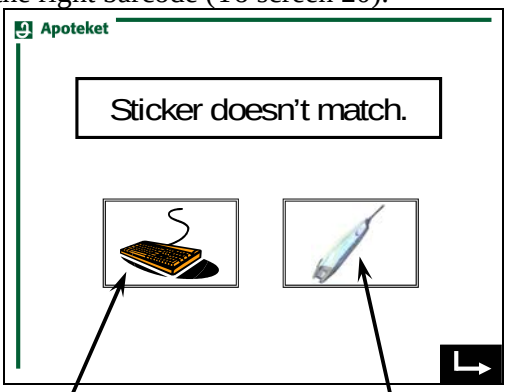
Screen 17

During the scan, the screen 2 is displayed. Then, the system recognizes a part of the barcode (To screen 18), nothing (To screen 19), or the right barcode (To screen 20).



Screen 18

After correcting the barcode number, the user uses the "next page" button to validate: To screen 19 or 20.



Screen 19

Manual Correction
To screen 12

Scan again
Back to screen 17

When the sticker is right, the system gives informative feedback.

Next page
To screen 21

Screen 20

Next page:
New preparation
To screen 1

Screen 21

At the end, the user is informed that the procedure is finished and has succeeded.

7 Guidelines for Apoteket – Ideas for improvement

7.1 Warning!

Before building the whole system, **the densities of the different basic drugs have to be checked**. If the different densities are different from the density of water, then some calculus must be done by the computer during the weighing phase.
All the argument of this work is actually based on the fact that the density of each drug is known or assumed to be equal to water's density.

7.2 About the software:

- ***Correction of the data:***

During the mixing phase, the program must have all information about the basic drugs: volume, concentration, etc. So, the program can control that the pharmacist effectively realizes what was expected.
However, this means that the eventual adjustments concerning the regime of the patient must be done before the mixing phase. **All the rectification about the regime must thus be done and entered in the system during the *pre-control* phase.** Otherwise, the system will not be able to control the mixing of the drugs.

- ***Help for scanning:***

Most of the time, when the scan is not perfect, the identification number has been correctly scanned but either the first letters "Vnr" do not appear correctly or some other letters appear after the identification number. This scanning could anyway be used if the system uses **a program able to identify a group of six consecutive numbers**.
This kind of program could increase the results from 30 to 65% right scans in most of the cases. Considering these results, such a program seems necessary.

- ***Tutorial:***

The tutorial is the answer to one of the problems pointed out during the focus group. When the pharmacists have to prepare a mix or add some drugs, they must follow a special procedure. But for the uncommon mix (or with unusual drugs), they do not always remember the procedure.
This tutorial would be an on line help, available for the unusual mixes and showing the procedure to follow on the screen. Since this help is not always necessary, this tutorial would appear on the screen only if the pharmacist chooses to have it.
The builders of the system have to decide with the pharmacists which mixes should have their procedures registered in the tutorial and what should be the content of this tutorial.

7.3 To the pharmacists:

- ***Scanning:***

The operation of scanning is not that easy, especially at the beginning and even more on the small bottles. However, the most tries you give, the easiest it get. So, **even if it is always possible to enter the identification number by hand, keep trying to scan it!**

7.4 Ideas for improvement:

These both ideas are (as the tutorial) answers to some problems underlined by the focus group. These ideas have not been integrated in the system yet because they do not really concern the control of the process. However, these ideas would probably be a help for the pharmacists and people collaborating with them.

- ***Maximal Dose:***

During the pre-control phase, a pharmacist checks the prescriptions received by comparing it to the normal "regime". But under some particular conditions, the normal regime must be changed and adapted to the patient. One of these conditions is the maximal dose.
The drugs used by the pharmacist are indeed very strong and one patient cannot receive more than the maximal dose. Consequently, the pharmacists always have to pay attention to this.
The system described in this report could be extended to the pre-control phase and help the pharmacists on this point. Actually, if the program registers the preparations for each patient, it should be able to calculate the amount of each drug already received by each patient. **So, during the pre-control, the pharmacist could be warned when the maximal dose is about to be reached or exceeded.**

- ***Consulting access to the system:***

Most of the drugs prepared by the pharmacists cannot be conserved during a long time. Thus, preparations are often done just on time, which means that the nurses pick the preparations as soon as they are ready. Sometimes, the nurses are even waiting for the preparations. And in such a case, they are calling the oncologic department to know if the preparations are ready or not; doctors also do it. These calls disturb the pharmacists working in the drugs room, but an interruption, during the pre-control for example, is absolutely not suitable.
The system could thus be even more extended so that **everyone working in relation with the oncologic department could have a "consulting access" to the system.** They could so visualize at which step of the process is currently the preparation they are looking for, without disturbing pharmacist. They would of course not be allowed to modify anything in the system but they would only have a "consulting access".

8 References

[1] Scan pens: Companies websites

Webpage used	Scan pen
http://www.wizcomtech.com/Wizcom/products/product_info.asp?fid=100	Wizcom InfoScan
http://www.wizcomtech.com/Wizcom/products/product_info.asp?fid=101	QuickLink-Pen Elite
http://www.cpen.com/Products/Desktop/d2/technical_specification	Desktop C-Pen 20
http://www.cpen.com/Products/Desktop/d1/technical_specification	Desktop C-Pen 10
http://www.cpen.com/Products/Portable/technical_specification?model=p3	C-Pen 800C
http://www.irislink.com/c2-509/features.aspx	IRIS Pen Express
http://www.irislink.com/c2-512/features.aspx	IRIS Pen Executive
http://www.irislink.com/c2-286/IRIS-Banking-Reader.aspx	IRIS Banking reader

All these webpages have been consulted the 7 august 2006.

[2] Touch screens: General information

http://fr.wikipedia.org/wiki/%C3%89cran_tactile (consulted the 8 august 2006).
http://en.wikipedia.org/wiki/Touch_screen (consulted the 8 august 2006).

[3] Focus group:

Holly Edmunds. *The Focus Group - Research Handbook*. The American marketing association, 1999.

[4] Touch screens: Internet and mails documentation:

See table next page.

Basic usability rules:

[5] Ben Shneiderman and Catherine Plaisant. *Designing the User Interface: strategies for effective human-computer interaction*. 4th edition. Pearson Education, Inc.
[6] Donald A. Norman. *The design of Everyday Things*. New York: Doubleday 1990.

Storyborad:

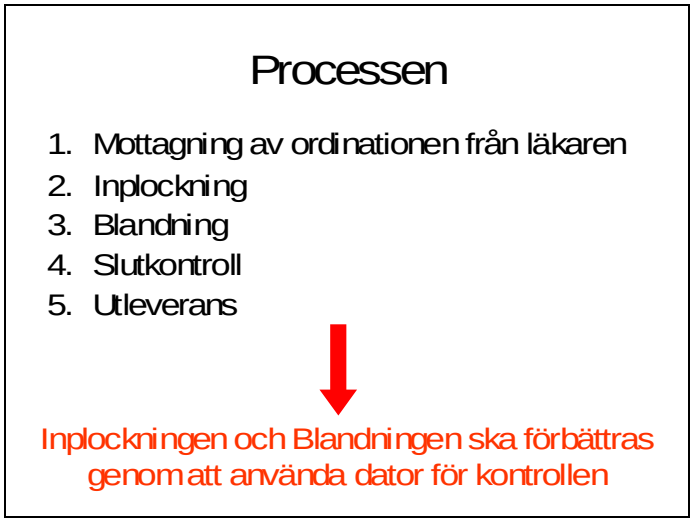
[7] Xristine Faulkner. *Usability Engineering*. Grassroots Series, 2000.
[8] *User Interface Design for Electronic Appliances*, Chapter 4: *"Creativity techniques"*, Irene Mavrommati; editors Konrad Baumann and Bruce Thomas, Taylor & Francis, 2001.

[4] Touch screens: Internet and mails documentation:

Company	Name	Adress	Phone	Mail	Fax
http://www.magictouch.com/index.html					
Keytech Inc.	Robert Ferguson		1-972-272-7555		1-972-272-7501
http://www.elotouch.com/forms/products/custsols.asp					
3M Touchsystems	Henrik Malmberg Market Development Manager	3M Touch Systems, Fabriksparken 15, 2600 Glostrup, Danmark	(direct): +45 4348 0206	hmalmberg@mmm.com	
	Caroline Picken Logistic and Customer Service		Office: +44 1235 4444 05	cjpicken@mmm.com	
http://www.telac.se/					
Telac	Pia Frostell Marketing and Sales	Telac, Box 1253, SE-181 24 Lidingö	Phone: +46 8 767 62 80 Mobile: +46 70 562 47 36	pia@telac.se	+46 8 767 61 80
http://www.elotouch.com/forms/products/custsols.asp					
Elo Touchsystem	Kristofer Öhman	*Visiting adress:* Hälsingegatan 431 *Postal address:* Box 21196, 100 31 Stockholm	Direct: +46(0)8-441 56 11 Cell: +46(0)706-97 94 14	kristofer.ohman@tesch.se	+46(0)8-441 56 19

9 Appendix

Power Point from the focus group: Explanation of the theoretical solution



Idé av en Ny Process

Information som redan finns i dator, förre inplockningen

För patienten AAA:

- regim/ordination

⬇

- Läkemedel som ska användas

Inplockning

- Identifiera patienten (streckkod)
- Boka flaskor av läkemedel (streckkod eller varunummer)
- Boka också utrustningen som behövs (idem)

⬇

För patienten AAA:

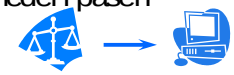
- *för varje läkemedel:* flaska som ska användas
- *för utrustningen:* exemplar som ska användas

Blandning

- Identifiera patienten (streckkod)
- Förbereda påsen

Avvägning av påsen 

- Identifiera första läkemedel (streckkod eller varunummer)
- Tillsätta första läkemedel i påsen

Avvägning av påsen 

- Osv…
- Identifiera påsen (etikett med streckkod)

Blandning

För patienten AAA:

- Flaska X har använts
- Vikt av Y g har tillsatts i påsen
- Rätta etiketten finns på rätt påsen