Super Air
The asthma inhaler for superheroes

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# SUPER-AIR

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Children-friendly Asthma Inhaler

INTRODUCTION

Background

"Asthma is a common chronic disease that affects millions of people of all ages in all parts of the world. It is a cause of substantial burden, often causing a reduced quality of life. Asthma, a disease of the airways and wheeze is the most common symptom." (1) The Global Asthma Network Association estimates in the report The Global Asthma Report 2014 that the global burdens of asthma are the followings: 334 million people have asthma; 14% of the world’s children experience asthma symptoms; 8.6% of young adults (aged 18-45) experience asthma symptoms; 4.5% of young adults have been diagnosed with asthma and/or are taking treatment for asthma; the burden of asthma is greatest for children aged 10-14 and the elderly aged 75-79 and asthma is the 14th most important disorder in the world in terms of extent and duration of disability. (1) Despite the attention on this topic from different medical studies, associations and organizations, these numbers will continue to increase more and more in the future.

It is not easy to live with a chronic illness like asthma, especially for the most sensitive subjects like children and elderly people. It might take a while for the patient to get used to it and accept it. In fact, asthma attacks are inevitable because triggers, such as outdoor air pollution, animals’ fur, tobacco smoke, dust mites, cockroach allergens, mold, or others factors like a flu or a cold, are almost impossible to avoid and are really hard to prevent. The asthmatic lives with the constant fear of getting a new attack and for that reason he/she is more predisposed to suffer from anxiety that can lead to panic attacks or nightmares. It becomes even more difficult when the society cannot understand or help them, according to a research about impact of asthma on children/adolescents "one in ten reported they had suffered asthma-related bullying." (2)

What

An Asthmatic, in order to keep his/her life as good as possible, needs to handle many devices, some are preventive measures like: air purifier, humidifier, peak flow meter and some have curative purposes like: inhalers, inhalers with spacer, nebulizer or aerosol, travel nebulizer equipped with different masks or mouthpieces as the case and many others. The key-role is played by the inhalers that have to ensure an “adequate delivery of drug to target sites within the lung is one of the most important factors concerning successful asthma management. […] Another factor influencing asthma control concerns the reassurance and education of patients in the process of repeated application” (3) There are different kinds of inhalers on the market: metered dose inhalers (MDI) and dry powder inhalers (DPI) but inhalers in general are undoubtedly the most popular cure because they can access directly to the lungs and this is the most efficient way to take pharmacological agents.
Fig. 1 Variety of inhalers currently on the market

Why

Nothing has been done recently to improve inhalers (fig. 1). Despite their important function, there is no improvement bringing more comfort to people and attention to the user-friendly approach. The movement coordination between pressing and breathing should be facilitated by the device. Stakeholders, especially children, feel very embarrassed and awkward while they are using them. The obstruction due to the excessive thickness of the medicine is quite a common problem among these devices. Plugs and caps can be lost easily, increasing ever more the hygienic issue of the devices. Nothing is done for the use during the night or the problem that people tend to forget to carry the inhaler with them.
According to an European-based research *The need to improve inhalation technique in Europe: A report from the Aerosol Drug Management Improvement Team*, the most worrying is “many patients derive incomplete benefit from their inhaled medication because they do not use inhaler devices correctly and this may compromise asthma control. Data indicate that there is a clear need for specific training of patients in correct inhalation technique for the various devices currently available, and this should be repeated frequently to maintain correct inhalation technique. Devices which provide reassurance to patients and their physicians that inhalation is performed correctly should help to improve patient compliance and asthma control.” (4)

We cannot allow a medical device that does not take into consideration the stakeholders’ point of view adopted in an emergency situation such as asthma attacks, especially for the sensitive or minority stakeholders (like kids or elderly people) who have even more difficulties to understand, remember and be rational in an emergency situation. Someone may think that this is just a project for minorities or it is not relevant; but it is a fact that allergies and asthma rates due to pollution and chemical agents are increasing and they will spread across the world an expansion phenomena also in third world countries. This issue is really facing the actuality as: “according to data from population based surveys there has been a 2–4% annual increase in asthma prevalence rates in most European countries over the past 15 years.” (5)

**How**

In order to learn more about this topic, I will research what asthma is and how it can affect the body and psyche of people suffering from asthma or other chronic obstructive pulmonary diseases. I will try to know more about the problem and have extra feedbacks by interviewing doctors and patients and by reading the field literature.

I believe that especially for medical devices the stakeholders’ point of view is really fundamental in order to develop a product that really suits the users’ needs. For my project I want to organize a workshop with children and have a collaboration with asthma associations/institutions where the stakeholders can be directly involved into the design and the product development. The participatory design approach will be the key of my product, where I can learn feedbacks and input from the real experts of the field (the asthmatics) feedbacks and input.

I will develop the final shape with the tutor Olle Gyllang, who is the Head of Design Strategy of Propeller Studio based in Stockholm. Propeller designed their design processes “to explore the unknown, take dynamic action and actively identify mistakes at an early stage.” They strongly believe that “this is how progression occurs; doing the unexpected but always being relevant and meaningful. Feeding our culture of innovation is a thirst for new knowledge, technical developments and an understanding of the restrictions that newness can bring. […] An engaged collaboration and co-creation between different stakeholders that brings about the development of genuinely innovative product and service experiences.” (35)
CHAPTER 1 – RESEARCH

ASTHMA

Asthma

Before exploring the inhaler device in itself, I think it is important to have a general overview about asthma and its effects to the body and how the medications actually work. “Asthma is a common chronic disorder of the airways that is complex and characterized by variable and recurring symptoms, airflow obstruction, bronchial hyperresponsiveness, and an underlying inflammation. The interaction of these features of asthma determines the clinical manifestations and severity of asthma and the response to treatment. Central to the various phenotypic patterns of asthma is the presence of underlying airway inflammation, which is variable and has distinct but overlapping patterns that reflect different aspects of the disease, such as intermittent versus persistent or acute versus chronic manifestations. Acute symptoms of asthma usually arise from bronchospasm and require and respond to bronchodilator therapy. Acute and chronic inflammation can affect not only the airway caliber and airflow but also underlying bronchial hyperresponsiveness, which enhances susceptibility to bronchospasm.” (6)

Fig. 2 Why asthma makes it hard to breathe
The "treatment with anti-inflammatory drugs can, to a large extent, reverse some of these processes; however, the successful response to therapy often requires weeks to achieve and, in some situations, may be incomplete (Bateman et al. 2004; O'Byrne and Parameswaran 2006). For some patients, the development of chronic inflammation may be associated with permanent alterations in the airway structure—referred to as airway remodeling—that are not prevented by or fully responsive to currently available treatments (Holgate and Polosa 2006)." (6) There are two types of asthma medications: the first is a reliever inhaler that operates relaxing the muscles surrounding the airways; they contain bronchodilator drugs that relieve symptoms when you are feeling breathless, tight chested or wheezy. But there are also preventer inhaler that usually contain a steroid drug and are used as a means of preventing symptoms of Asthma occurring. The steroids work by reducing the inflammation inside the airways.

The asthma attack is stimulated by triggers, for example: "Many people with asthma have allergies. Common allergens include house dust mites, animal dander, molds, pollen and cockroach droppings. Tobacco smoke is an irritant that often aggravates asthma. Your asthma may also be irritated by air pollution, strong odors or fumes. Many patients with asthma develop asthma symptoms when exercising. This is called exercise-induced bronchoconstriction (EIB). Some medications can cause or worsen asthma symptoms. These include aspirin or other non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen, and beta-blockers, which are used to treat heart disease, high blood pressure, migraine headaches or glaucoma. Emotional anxiety and stress may also increase asthma symptoms and trigger an attack. Viral and bacterial infections such as the common cold and sinusitis. Exposure to cold, dry air or weather changes. Acid reflux, with or without heartburn." (7) Asthma attack can happen at any time during the day or night "28.0% of children and 30.5% of adults reported asthma-related sleep disturbances at least once a week. Sleep disruption every night was reported by 6.7% of children and 5.3% of adults. Episodes of cough, wheezing, chest tightness and shortness of breath were common, occurring in 51.5% and 57.2% of children and adults, respectively, at least once a month." (5)
Study case/people experience

I asked to Francesca Talocchi on the 2nd of February, who suffers from asthma since she was born, what was the worse aspect of suffering from asthma. She answered me that: "the fact that you feel a huge weight on your chest that you cannot eliminate in any way and which does not allow you to breathe. The fact that you feel a huge head and you are all groggy. The fact that you get tachycardia and you get anxious because you can not breathe, but at the same time you have to control yourself because if you have a panic attack it gets worse and you breathe even with more difficulties. It happened to me to be very close to die twice, once I was in my car alone and I did not know what to do and the other one I was hospitalized for several days." (34)

Then I asked her if she finds some difficulties or problems while using the inhalers, and she replied: "I have never had problems to synchronize the spray and the inhaling, but I think it is due to the habit as I use inhaler since I was very young. Of course you must be coordinated. The criticism that I have is that sometime the nozzle blocks and you have to clean it and many times it happens to lose the inhaler's cap in the bag. When I was a child I felt so ashamed and uncomfortable while using inhalers, also because they are ugly and have sad color like pale blue or gray." (34)

I was curious to know how once life with asthma is and which kind of medications or medical surgical devices are necessary, and she told me: "I was born with asthma but before age of six I had very little problems, so I just used aerosol. At six years old I started the therapy with inhalers of ventolin. I have always been independent in taking the medication like ventolin inhalers or aerosol, there was no other option. The last two years I feel fine thanks to the right therapy and constant visits every month. But last time I was hospitalized I was almost dying, I arrived at the hospital cyanotic with 10% oxygen in the blood and doctors were about to intubate me. It was a really bad experience." (34)

INHALERS

History and patents

Inhalers are so widely used due to the immediate benefits of delivering medication directly to the affected site. In fact, rudimental inhalers were used since Ancient Egyptian times. "The inhalation of the vapour of black henbane is recorded in the ancient Egyptian Ebers papyrus (1554 BC); Egyptian physicians threw the weed onto hot bricks, causing the alkaloid contents of the plant to vapourise so that the breathless patient could inhale." (9) Several remedies were studied in the past ages, more or less toxic and therapeutic, however all of them concerning the inhalation of different chemicals vapors or smokes. In 1865 "a new invention was reported in The Lancet – the Improved Nelson Inhaler from the well-known pharmacy supplier S.Maw & Sons in London. The Nelson inhaler (96,4) is still manufactured
to this day, with very few modification.” (9) Later produced by different companies and with different design.

Fig. 4 The improved Nelson inhaler, 1865
Fig. 5 Meshburg, Metering valve, 1956

The most significant event for the asthma devices development was in 1956 when “the pressurized metered dose inhaler, as we now know it, became a possibility when the metering valve was invented (fig.5) (Mesburg 1956). In that same year 3M Healthcare, then Riker Laboratories, combined the Meshberg valve and CFC propellants with a number of respiratory compounds and the pressurized metered dose inhaler was born. Since that time the pressurized metered dose inhaler has become the most popular form of respiratory drug delivery system.” (10) Nowadays, pMDIs have become a very important inhalation technology with annual sales currently in excess of 400 million units. The drugs, of course, have been updated and the propellant technology improved through the use of less environmentally-damaging HFA.s.” (9) Nowadays there are different kinds of inhalers (fig.1) but they are quite similar, however the MDI inhaler is the most common one. To better understand how inhalers work in practice, several know-how illustration guides (fig.6) are available online and help asthmatics use their inhalers.
Know How to Use Your Asthma Inhaler
Using a metered dose inhaler (inhaler in mouth)

1. Take the cap off the inhaler and make sure the mouthpiece and spray hole are clean.
2. Shake the inhaler 10-15 times.
3. Without the inhaler, take a breath and...
4. ... breathe out all the way.
5. Hold the Inhaler upright.
6. Put the inhaler in your mouth, above your tongue, and between your teeth. Seal your lips around the inhaler.
7. Begin to breathe in slowly. Press down on the inhaler one time and keep breathing in.
8. Hold your breath for 5-10 seconds.
9. Open your mouth...
10. ... and breathe out slowly.

Fig. 6 How to use asthma inhaler – inhaler in mouth method

Materials

Generally, the material used in pMDIs actuators is Polypropylene PP but other thermoplastic material such as: Nylon PA, Polysters PET, Polyethylene PE and Polytetrafluoroethylene PTFE are also used. (20) Polypropylene “is produced in very large quantities, its molecule lengths and side branches can be tailored by clever catalysis, giving precise control of impact strength, and of the properties that influence molding
and drawing. Standard grade PP is inexpensive, light and ductile but it has low strength. It is more rigid than PE and can be used at higher temperatures. The properties of PP are similar to those of HDPE but it is stiffer and melts at higher temperature (165–170 °C). Stiffness and strength can be improved by reinforcing with glass, chalk or talc. It is more easily molded than PE, has good transparency and can accept a wider, more vivid range of colors. PP is an exceptional inert, easy to recycle that can be incinerated to recover the energy it contains. PP is made by processes that are relatively energy-efficient, making them the least energy-intensive of commodity polymers.” (21) Basically PP, in comparison with others polymers, is easily molded, durable, tough and low cost. Polyethylene, in contrast, is not as tough as PP; while Nylon and especially PTFE are much more expensive than PP.

Critical analysis

I decided to focus mainly on MDI inhalers (Fig. 8) because they are the most common inhalers on the market and especially because in comparison to other devices, these are actually suitable for emergency situations. However, despite the popularity of this device, it has been proved that “in most metered-dose inhalers aerosol inhalation has to be coordinated with dose actuation. Several studies have demonstrated that up to 70% of patients fail to complete the correct inhalation manoeuvre. This problem is overcome by breath-actuation or inhalation aids like spacers and holding chambers, which contrariwise are more bulky to carry.” (11) “The use of pMDIs has been limited by several drawbacks: the need to co-ordinate the inhalation and
the actuation can prove difficult for patients; the inhalers have lacked dose-counters; and their ability to deliver large doses of drug is limited." (9)

Moreover, currently the inhaler does not deal with the following issues: the night-use and effectiveness during asthma's sleep disturbance (easy to reach, to find, to use in the darkness); the social impact of having Asthma and anxiety/panic attack related to Asthma; Hygiene and maintenance of clean inhalers; the probability to forget carrying the inhaler at school/gym/job/.. with you.

Interviewing the pharmacist Dr. Guida (36) about other problematics related to the inhalers I discovered that the users often bring back the inhaler to the pharmacy because they think it is broken. However what really happened was that they tried to use the device upside down and no medication was nebulized, because the inhaler works only if the canister is in the 'high' position and the mouthpiece is 'down'.

About the device itself, it has not been developed that much in the last decades; small changes in shapes and colors but basically there are no huge variations. In my opinion that could be acceptable for normal people with average physical and mental capabilities, however when I take into consideration a specific group of people like children or elderly, something more has to be done. Especially for designing home healthcare products the inclusive design needs to be taken into consideration, there is no space for design negligence or mediocrity, considering the seriousness of this field "The idea of inclusive design, also sometimes referred to as 'universal design' is to provide products that are easy for everyone to use, including those with various disabilities. […] to make home-healthcare products appear as normal as possible" (12)

Now as it is, the inhaler is an apathetic device that does not transmit any feeling to the patient, it is a boring tool made in sad color, embarrassing when shown and carried, for the mere functional use and nothing more. I believe that attractive objects can play a remarkable role in our emotional sphere and make people feel better. Attractive objects in fact are strictly related to emotions. "Emotions are inseparable from and a necessity part of cognition. Everything we do, everything we think is tinged with emotion, much of it subconscious. In turn, our emotion change the way we think, and serve as constant guides to appropriate behavior, steering us toward the good. Some object evoke strong, positive emotions such as love attachment, and happiness." (46) as Donald Norman stated in his book Emotional Design. It is very difficult to give a clear and universal definition of attractive design true for everybody. The new object might stimulate more attraction to one person and less to another one because it can provoke positive/negative feelings and emotions during the interaction object-user. Somehow the new object conquers more or less the heart of the user for its new quality that may vary from product to product, maybe because it is related to a good design aimed to fulfill stakeholders needs and expectations or to an innovative and smart solution or to other aspects. Attractiveness is related to aesthetic, as Dieter Rams stated in his list of Ten points for a good design. For him "The aesthetic quality of a product is integral to its usefulness because products we use every day affect our person and our well-being. But only well-executed objects can be beautiful." (47) In this sense aesthetic quality and the attraction that people have for it, are part of the
design utility. With no doubt, it is stressful to handle with annoying products that are difficult to be related to, that create confusion, that make noise and so on. At the same time, it is difficult to work on aesthetic because a visual aspect might be interpreted differently by people. Aesthetic is a matter of details, harmony, rhythm, colors and shapes and how they work all together to define the object.

"Aesthetic design are perceived as easier to use than less-aesthetic design. The aesthetic-usability effect describes a phenomenon in which people perceive more-aesthetic designs – whether they are or not. The effect has been observed in several experiments, and has significant implications regarding the acceptance, use, and performance of a design."

(22) "How could aesthetics affect how easy something is to use? [...] so, if aesthetics would change our emotional state, that would explain the mystery. We have long known that when people are anxious they tend to narrow their thought process, concentrating upon aspects directly relevant to a problem. This is useful strategy in escaping from danger, but not thinking of imaginative new approaches to a prom. Isen’s results show that when people are relaxed and happy, their thought process expand, becoming more creative, more imaginative. These and related findings suggest the role of aesthetics in product design: attractive things make people feel good, which in turn makes them think more creatively. How does that make something easier to use? Simple, by making it easier for people to find solutions to the problems they encounter." (13) The intention is to catch the attention of the stakeholder through a pleasing design, calm and relax him or her in order to allow a more efficient use of the device. Donald Normal presents three levels of processing an object (fig. 9): reflective, behavioral and visceral. The inhalers are currently a perfect example of a behavioral process because present a large degree of functionality and usability (despite there is still something missing), but there is no aesthetics or emotion value in it. I believe that a device like this has also to present some personal involvement for the case and be a sort of magic companion to carry and use by necessity, rather than being a cold and boring device to be scared of. Or should it only be a functional matter?

[Fig. 9 Three levels of processing: Visceral, Behavioral and Reflective.

“The visceral level is fast: it makes rapid judgments of what is good or bad, safe or dangerous, and sends appropriate signals to the muscles (the motor system) and alerts the rest of the brain. This is the start of affective processing. These are biologically determined and can be inhibited or enhanced through control signals from above. The behavioral level is the site of most human behavior. Its actions can be enhanced or inhibited by the reflective layer and, in turn, it can enhance or inhibit the visceral layer. The highest layer is that of reflective thought. Note that it does not have direct access either to sensory input or to the control of behavior. Instead it watches over, reflects upon, and tries to bias the behavioral level." (14)
Colors play also a fundamental part in the analysis, a lifeless low-saturated color in the shades of grey and blue can give to the user just the feeling that him/her is using a boring hospital tool. Infact, in the positive and negative side, colors can stimulate a range of determined feelings. About colors and health care there are “a number of findings concerning color. Young children are attracted more by color than shapes. Red definitely results in a faster heart rate, and experiments have shown that people placed within a red environment are energized and seem mentally alert and creative. A pink environment has a calming effect but still allows creativity to be heightened. Yellow and orange will activate and increase energy levels. It has been shown that blood pressure is elevated by experiencing red, orange, or yellow environments. Blood pressure decreases when people are in a green, blue, or black environment.” (25) However, color at different ages is perceived in a different manner. Children toys are usually bright and of highly saturated primary color, because they found to be more appealing to children. On the contrary, “elderly people see color differently, but are not color blind in the medical sense of the term. Vision declines with age, with yellowing and darkening of the lens and cornea, and a shrinking pupil size.” (25)

Emotion are also stimulated by contrast “pure white and pure black produce the greatest clarity, sharp contrasts produce the effect of precision, firmness, objectivity and alertness. Close values produce feeling of haziness, softness, vagueness, indeterminacy, quiet, rest, introspection and brooding.” (24) So, in this specific case for the current inhaler, a shining and reflective plastic that tends to make high contrasts is not suitable to stimulate the correct emotions to the patient.

TOWARDS THE NEW SOLUTION

Product inspirations

I found many interesting examples about how a medical device can be better integrated in everyday life, having a better user-friendly and less invasive approach to the stakeholder.

The following selected medical product examples related to my project treat aspects (as attractive medical design, medical vs toy design, ...) that I will handle also in the new inhaler development. In particular, I took inspiration from design choices as affordance, colors, shapes and transmitted feeling.
The first example is a respiratory unit (Fig.10) “designed for children with high portability, Roam Lightweight Respiratory Unit features, compact size and stylish appearance. It’s a humanized oxygen cylinder that comes with a nasal mask, easy on the user’s face to breathe in the oxygen. For a person suffering from sudden asthma attacks, oxygen therapy is the fastest way to treat this medical threat. Unfortunately, it remains inaccessible due to its tank physical weight and size. Roam Lightweight Respiratory Unit has been especially designed for children since they often feel socially misplaced and uncomfortable in their environment with nasal prongs up their nose.” (16) Resuming the discussion about aesthetic and attractive objects, this might be an example of a good medical product with a positive emotional impact. The aesthetic here plays a central role and makes the connotation of the object more easily acceptable. The mere function is the same of other respiratory units, but working on the detail, shaping the object with gentle and rounded curves, using colors that evoke a sense of cleanness and relax like white and blue (as mentioned in the previous chapter in the color section), resizing the object to children dimensions make the respiratory unit a more pleasing and well executed medical design object. The front display with the digital number together with the combination of glossy white plastic, semi-transparent blue plastic and transparents tube and mouthpiece give a digital and futuristic/technological connotation to the object. These are all aspects which highlight the change from the old design device to a unit with fresh identity and new impact.
The company Medquip has in its catalogues several kinds of nebulizers designed specifically for children, like the Airial™ Pediatric Nebulizer “a quiet, easy-to-use unit with a child friendly design. While receiving treatments, children will love using their imagination to build things on the compressor’s top portion using the included colorful blocks. Promotes patient compliance through creative and fun therapy.” (17) It is well known that toys and medical devices are very different from each other as they belong to separate fields. However, in this case the designer solved the design in a very interesting way merging one single object with two clear and different connotations: it is evident where the medical device ends and the toy part starts. The top part has a yellow play-base that attracts the attention and makes a visible and clear separation from the medical device that is in blue (as we can see, blue is very popular among medical devices due to its properties explored in the previous chapter). The play base has an obvious interaction affordance that the kid can immediately perceive as a toy part; he/she can interact and play with the vivid and colorful bricks. As explored before, kids are very attracted by colorful objects, so it becomes instinctive for them to explore and build with the bricks. Bricks have cylindrical connections, quite sharp edges and well defined cubic volumes, again, to stimulate the interaction and the positive feeling related to the play action. In contrast, the medical part of the nebulizer has this soap-bar volume, that at the same time wants to be a non-aggressive shape and non-interactive part. No grips, no color excitement, no extra details, just two starting buttons and a tube for the nebulization.

Another example of child-friendly design is the safety animal band “a medical needle designed to make the experience of injections less traumatic for children. The band itself covers the needle and keeps it firmly in place in case the child suddenly moves. Plus, it’s shaped like a friendly baby elephant, an animal that kids are familiar with.” (18) In the first example, the noisy and boring nebulizer is turned into something to play with like a playfellow; in the second case the scary and annoying needle and safety band components are turned into a band not to be afraid of and more easily acceptable. Both examples show that just with small changes it is possible to give a completely different connotation to serious medical devices.
Anthropomorphic appeal

It has been proved that anthropomorphic forms, that appear humanoid or show human-like characteristics, are more appealing than form that do not have any. "Humans are predisposed to perceive certain forms and patterns as human-like—specifically, forms and patterns that resemble faces and body proportions. This tendency, when applied to design, is an effective means of getting attention, establishing a positive affective tone for interactions, and forming a relationship based, in part, on emotional appeal." (23) As example we can see the Adiri Natural Nurser baby bottle (fig.14) that it is designed “to look and feel like a female breast, and not surprisingly it elicits the positive associations people have with breastfeeding. The affective tone set by the bottle is one of the naturalness and caring.” (23)

The second example is the Method Dish Soap (fig.15) bottle nicknamed “dish butler” the bottle "transforms the perception of dish soap bottle from utilitarian containers to be hidden beneath counters to sculptural piece to be displayed proudly atop counters. It is more than a dish soap bottle—it is a helper, an art piece, and a symbol of sophistication and cleanliness." (23) As I mentioned before, we can clearly see in these two examples the obvious effect of no-contrast surfaces; the reader can immediately perceive the object as a quite, relaxing and non invasive solution. This is also due to the translucency effect that makes it look softer than it really is.
The theme of appealing shapes related to healthcare devices is debated in the Animation movie *Big Hero 6* (fig.16) produced by Walt Disney Animation Studio, based on the Marvel character with the same name from the Marvel Comic *Big Hero 6*. The main character is Baymax, a healthcare robot.

"Baymax was created by the brilliant Tadashi Hamada as a healthcare providing robot nurse for his brother Hiro. Tadashi’s goal in creating Baymax was to help improve healthcare around the world, basically wanting nothing more than to use his creation and genius for the better of humanity. To provide him with his programming, and overall personality, Baymax was given a special chip with Tadashi’s inscriptions, which makes him the lovable robot he truly is. Without it, he can be conceived as an entirely different being. As programming would have, Baymax is instantly summoned by the sound of distress, and can only deactivate once his current patient states 'I am satisfied with my care'." (31) If you have seen the movie, you can immediately perceive the positive pathos and empathy that Baymax, the giant marshmallow, gives to ‘his’ patient, its only job is to guarantee Hiro satisfaction, trying to help him as best as it can. In some way, the audience can really have the feeling that it is a robot with a soul, in fact, during the movie, a relationship of trust between Hiro and Baymax is created and they turn into inseparable friends.
Fig. 17 Superformula to fight the cancer and comic book in which the superhero goes through the cancer experience, JWT/A.C. Camargo Cancer Center.

Superheroes like Batman, Spiderman, Superman, Hulk, … are always very fascinating for children and the interest never seems to wane during decades. Children often identify themselves with Superheroes, sometimes they become a little bit obsessed by these heroes with super human qualities, fearlessness and protection of values. However, “from a psychological standpoint, superhero worship can be beneficial,” says Jeff Greenberg, Ph.D., a professor of social psychology at the University of Arizona. “Kids are pretty powerless and vulnerable, so pretending they’re superheroes is one way for them to gain a sense of confidence and competence in a positive way.” (28) “One of the biggest reasons kids love superheroes is the sense of control and power they can exert on the world vicariously,” says Naeema Jiwani, a child development psychologist at the Human Relations Institute, Dubai. “By channelling their energies into these fictional figures, they can conquer bad guys, rule the world and be kings or queens of their own universes.” (29) It has been proved that asthmatic kids, especially kids with severe asthma, suffer more from bullism and are more vulnerable than normal kids. Therefore, why not using the super hero essence to help the kids to feel more powerful in an unconscious way, confident and able to get over the asthma attack, like the superhero definition suggests “superhero is someone who rises above his or her fear and limitation to achieve
something extraordinary” (33). Like in the example of Superformula to fight the cancer [fig.17], where the IV cover is based on characters from the Justice League. This program is based on the idea that “the first step in the fight against cancer is believing in the cure. But chemotherapy is difficult, even more so for child. To give these covers a more powerful meaning” they worked “with Warner Bros to produce a special edition of cartoons and comic books in which the super heroes go through a similar experience to the kids, and recover their strength thanks to this ‘Superformula’ ” (32) The frightening treatment is turned into an hope-inspiration and to better understand the disease. An example of children-friendly design that change the perception of kids, from a weak cancer patient to a superhero with super powers.

Crucial information

As we saw above, completing the correct inhalation manoeuvre in the proper way is tricky for many patients, and I thought that the coordination can be helped by the design itself, as intuitive design and reassuring shapes assure an easier operation and a calmer patient. However, the availability of proper instruction informations is important. Devices’ developers should not design a product that rely on training, instructions for use, warnings, memory and present overload information. “Caregivers do not always receive proper training before using a given device. Even when users receive proper training they may forget what they learned by the time they use the device, especially if the device is used infrequently. The instruction manual will often be difficult or impossible for users to access while also using the given device. Therefore, designers should not count on users reviewing and absorbing information found only in the instructions for use. The presence of many warning and on-device instructions often indicates user-interface shortcomings. The best way to address a hazard is to eliminate it or design a user interface to guard against it. People can be forgetful and are often easily distracted. Operational sequences should not require users to remember next steps. It is far better to present users with the crucial information they need to perform a task correctly.” (26) It is very important not to exaggerate with providing information and avoid information overload otherwise the stakeholder “cannot receive and process the information fast enough for it to be useful. One solution is to provide users with information of primary interest at the moment it is needed while allowing them to easily obtain secondary information at a later time.”(26)

Furthermore, we also need to take in consideration external factors that might influence the task performance, such as special weather conditions, sound noise, weak light, wearing protective gear, other distractions, and so on.

In order to ensure an effective sharing of crucial information with the stakeholders, I analyzed several possible methods to display and present informations the above points.
Fig. 13 Philips, HeartStart FRx, Automated external defibrillator

What a better example of emergency device than a defibrillator (fig. 13). An interesting device is the defibrillator made by Philips, it is "built for rugged environments. It is easily used on infants and children due to unique Infant/Child Key that allows you to use the same pads for both adults and children. Detailed defibrillation guidance so you know what to do during the emergency, The FRx guides you through every step of a rescue, even reminding you to call emergency medical services (EMS). Once EMS arrives, hand-off is fast and easy because the FRx pads are compatible with most EMS equipment. EMS personnel can attach their own defibrillator to the pads already on the patient and this saves precious time." (19) I believe that the medical devices for emergency cannot only have security affordance but they have to communicate other values too, such as clarity of information, easiness and simplicity of use, immediacy. They shall not present obstacles and barriers or arouse negative feelings to the user. Every day new technologies and materials are available, so why not use them in order to produce more efficient products.

Fig. 20 LED indicator symbols form fitness tracker Up24, Jawbone.

I do not want to talk about fitness trackers but I found quite interesting the LED system (fig. 20) used by Jawbone for this specific case. “A simple LED indicator light shows your mode status, at a glance.” and the “band is rain, splash, sweat, and shower-resistant, but you should remove it before
swimming, surfing or exposing to other extreme conditions and activities.” (27) The inhaler should have 
a series of symbols that represent the crucial phases that help the user step by step during the 
manoeuvre. The positive aspect is that it is quite easy to use, no extra device is needed, just a battery. It 
can be activated by holding the inhaler.

![Image of Digital fever thermometer FT 09, Beurer.](image)

Similar to LED symbols, are LCD screens (Fig. 21) that could provide basic information for 
emergency purposes. This technology is widely used for digital thermometer due to the fact that is 
inexpensive, thermometers can be made waterproof and disinfectable.

![Image of Dose counter of asthma inhaler](image)

![Image of Patent of dose counter](image)

Fig. 21 Digital fever thermometer FT 09, Beurer.

Fig. 22 Dose counter of asthma inhaler

Fig. 23 Dose counter patent
One more example for information display could be a mechanical tool activated by pressing the canister for the normal use of the inhaler, like the dose counter (fig.22-23) of inhalers based on a rotary gear which show the updated information in a small window on the device. With this solution no battery is necessary, however the information shown needs to be very concise.

The last, most simple and economic solution, could be the one providing a series of printed-on-device symbols that guide the patient during the use of the inhaler.

Despite some companies are developing “breath-operated actuator” inhalers that are activated with the breathing and no co-ordination are needed, however those devices are not completely safe and reliable. “One of the drawbacks of self-administration from an inhaler is that users often experience difficulty in determining when the charge in the medicament-containing vessel has nearly run out. With aerosol canisters, part of the reason for this difficulty is that a surplus of propellant may remain in the canister even though the drug supply is nearly used up. Alternatively, the near-exhausted state may result in a surplus of drug in relation to propellant. Thus, the illusion is created that the inhaler is still capable of providing useful doses of medicament simply because the canister contains liquid. This is potentially hazardous for the user since dosing becomes unreliable and because few people routinely carry a back-up device.” (30) In conclusion, the inhaler will not be able to cope with an emergency situation like the traditional inhalers that deliver the drug without the need of extra breath effort for the asthmatic, who at the moment is not really able to have some extra breathing power.

**Summary and reflections**

Millions of people all over the world suffer from asthma or diseases related to the respiratory system as COPD. Basically those pathologies affect the bronchial tubes, causing airway inflammation and obstruction, impeding the airflow to reach the lungs. The therapy with anti-inflammatory drugs that relax the muscles or preventing the symptoms is mainly performed by inhalers with different kinds of medication as the case.

Looking at history, inhalers have been used since Ancient Egyptian, the medicament changed among centuries, but the fixed point is always the inhalation of vapors or smokes that reach directly the lungs. The most significant invention related to inhalers is the pressurized metered dose inhaler equipped with the Meshberg valve and also nowadays it is the most popular respiratory drug delivery system in use. It is composed by a MDI actuator usually in polypropylene with a mouthpiece and an Aluminium canister with the drug suspension inside. When the canister is pressed in the actuator nozzle, a medication spray comes out. However, the device presents some problems: patients have difficulties in the coordination between pressing and breathing; nothing has been done to design a more children-friendly device, less embarrassing to carry and use; no one took into consideration the inclusive design, as mobility and cognitive disabilities; the use in special condition with various difficulties of performing; it is easy to lose around and the problem related with the device obstruction by dust.
Many are the things that can be done in order to have a better design. It has been proved that attractive things are easier to use than less-aesthetic design, this is called the aesthetic-usability effect. Also colors, colors’ contrast and texture material can stimulate feelings and body responses. Anthropomorphic shapes with humanoid appearance are more emotional appealing and relationship based. The use of media that divert the focus from the problem can be positive in order to avoid panic attack or similar. Superheroes worship, for example, have beneficial potential for children, can help them build more confidence and power control and reducing the fear of the illness. An information system that helps the patient perform the inhalation needs to be done, there are several possibilities nowadays, thanks also to the technological development.

To handle Asthma is not very easy, especially for children, as during an attack, the asthmatics have the feeling to finish their breaths and because of that it often happens to get tachycardia or panic attack, which are not helping the asthma attack and the administration of the medication. It is common that children suffering from this condition are more often victim of bullism and suffering from panic attacks since the tender age may influence the attitude of the boy/girl and make them more insecure and fearful persons. I believe that a new inhaler design for children is needed, a device that can make the kid less socially lost and uncomfortable. No more a cold device but a trustful companion that gives ‘super-powers’ to the kids as a main point of the design. Furthermore, the new design of inhalers should solve all the weaknesses listed above, keeping in consideration the research studies done about the following topics: displaying crucial information; how to make an attractive and appealing design can make the device easier to use; materials, colors and texture and how they can influence the mood of the patient and the anthropomorphic and super hero essence in order to relate the kid to something tangible.
CHAPTER 2 – CONCEPT & SKETCHES

CONCEPT

The main goal of this project is to design an inhaler for children that can assist them in the above mentioned coordination fase. In the market there are some devices called “spacers” (fig. 24) used specifically to solve this problem. “A spacer is a clear plastic container shaped like a football or a tube with a mouthpiece or mask at one end and a hole for an inhaler at the other. Spacers help to get asthma medication into your lungs. The medication is ‘fired’ from the puffer into the spacer device and is then inhaled through the mouthpiece or a face mask.” (38) However, in addition to the excessive clutter of the spacer, part of the drug is electrostatically attracted to the spacer’s surface, consequently, part of the drug is wasted in the device making the spacer not suitable for the emergency use. Spacers are quite expensive, around 25-45 euro depending on the model, so it will be also an economical advantage not to buy the spacer.

The direction of use must be obvious as children should not make mistakes by pressing the inhaler upside down. The inhaler must also be aesthetically pleasing and assist “psychologically” the kid during the asthma attack. The graphic above show a summary about the case scenario and the critical points to fix in relation with the user.

Fig. 24 Spacers for asthma inhalers
DESIGN PROCESS

Superheroes drawings

Fig. 25 Workshop at Istituto Comprensivo “Alberto Manzi” with the third grade

In order to obtain an efficient design, I believe it is important to involve into the project a stakeholders group. In co-design "the role of user, researcher and designer get mixed up: the person who will eventually be served through the design process is given the position of 'expert of his/her experience', and plays a large role in knowledge development, idea generation and concept development." (37) As presented in the previous chapter, superheroes worship can be used in a beneficial way in medical devices through the exploitation of the essence and values perceived from kids; it is possible to obtain advantages also for medical treatments with reported positive effects (at least for the psychosomatic aspect). This is why I contacted an Elementary School (Fig. 24) to conduct a drawing workshop during which the children could use their fantasy and creativity to draw a new superhero. Drawing is a comfortable communication medium for children, infact, they draw every day and are used to express themselves and their feelings with paper and colors. I wanted to learn more about how they perceive superheroes. On 17th March 2015 I went to the Istituto Comprensivo "Alberto Manzi" Elementary School of Cordenons, Pordenone – Italy where I met the Teacher Agnese Turrin and her lively class of 24 children at the third grade (8-9 years old). I explained the task to the group that was really happy and enthusiast to help me and to draw superheroes.

It is interesting to note that the anthropomorphic connotation is very present among the superheroes’ drawings (Fig. 26): 49% of the drawings show a classic superhero with a mantle, of which 21% remind Superman and 28% remind Superwoman (sex definition); 21% of the drawings emphasize the natural elements, especially fire and water; 11% have robotic appearance; another 11% have food-connotation and 8% animal connotation. As you may see from the color map (Fig. 26) derived by pixelating the drawings with Photoshop, it is evident that the use of blue and light blue is strongly present (also among girl’s drawings); different tones of green and red are also very used. In general the figures are vivid and with bright colours.
Fig. 26 Workshop results: kids' drawings

Fig. 27 Color map
No gender design

Before proceeding with the design process I want to provide a context to my workshop that will help me analyze the results of the workshop and make more conscious choices from an informed perspective. I believe that the way to proceed is to make a no gender oriented inhaler so to obtain one device suitable both for boys and girls. Thus, in this paragraph I am going to analyze what gender is and the distinction between sex and gender.

Much material about gender identity is available from the feminist theory, and from this I borrowed some definitions in order to make clear the distinction between sex and gender. First of all, it is not correct to talk only about sex differentiation merely related to organs as “sex was what was ascribed by biology: anatomy, hormones, and physiology. Gender, we said, was an achieved status: that which is constructed through psychological, cultural, and social means.” (44) Furthermore, Simone de Beauvoir stated in her feminist book *The second sex*. “One is not born, but rather becomes, woman.” (41). The different sexual apparatus related to the mere biological distinction and the individual identity perceived by the person belongs to two completely different levels. This quote was recited also by the gender theorist Judith Butler and re-explained as "gender is no way a stable identity tenuously constituted in time – an identity instituted through a stylized repetition of acts. Further, gender is instituted through the stylization of the body and, hence, must be understood as the mundane way in which bodily gestures, movements, and enactments of various kinds constitute the illusion of an abiding gendered self." (42) The key role about everything is the acting: identifying ourselves as a male or female regards our way of acting in relation to time and repetition of actions. One can feel like a woman/man despite he/she is trapped into vice versa bodies. She also say “My suggestion is that the body becomes its gender through a series of acts which are renewed, revised, and consolidated through time. From a feminist point of view, one might try to reconceive the gendered body as the legacy of sedimented acts rather than a predetermined or foreclosed structure, essence or fact, whether natural, cultural, or linguistic.” (42)

Over history the social meaning constructed on being a man or a woman has shifted depending on social, economical, historical events not strictly related to biology and sexuality. “In the past, when it was a question of carrying heavy clubs and of keeping wild beasts at bay, woman’s physical weakness constituted a flagrant inferiority: if the instrument requires slightly more strength than the woman can muster, it is enough to make her seem radically powerless. But on the other hand, technical developments can cancel out the muscular inequality separating man and woman: abundance only creates superiority relative to a need” (48) The affirmation of the man as a superior gender has started in the Stone Age with “strength” as an evaluating criteria, but in history the criterias are changing according to events, most of the times to prove female inferiority. With the Industrialization of Modern Age, the machineries are “the new strongest”, diminishing the superiority of the men and bringing equality among sex. History events may vary from periods with needs of productive capacities to periods with
needs of repopulation; in the last case women are considered just for their reproductive functions, bringing back the female to her inferiority. Political events pushing for population growth make women as sexual objects who have to be sensual and attract men in order to make more children for the country. As we can see the general tendency is to privilege men.

Among children, however, the first perception of male and female as two different genders is actually related to noticing the biological/physical difference between girls and boys. At the beginning, among babies the distinction is not really evident, but it becomes relevant after the self perception phase and the perception of the other as diversity. "Only the mediation of another can constitute an individual as an Other. Inasmuch as he exists for himself, the child would not grasp himself as sexually differentiated. For girls and boys, the body is first the radiation of a subjectivity, the instrument that brings about the comprehension of the world: they apprehend the universe through their eyes and hands, and not through their sexual parts." (41)

It is quite difficult to make a completely no gender design connotation but keeping in mind the above definitions and reflections I will try to cut from my design every masculine/feminine actions and sexual biological connotation.

Superheroes and gender

The next step is investigating how traditional superheroes are portrayed in terms of sex and gender differences. In general, "historically, most of these characters were male and were defined by their musculature and strength, as well as their keen minds and problem solving abilities (Bongco, 1999). In contrast, female heroes have been defined by their passivity: innocent and selfless in situations of forced submission whether through physical confinement, muteness, or death (Seiter, 1993)." (43) Making an overwhelming analysis of the entire history of superheroes is not my aim, so I analyzed two representative examples: Superman and Wonder Woman, as they represent gender in male and female mainstream and traditional superheroes.
Superman appears in the scene the first time in 1938 in US, he is not totally human, has man appearance but comes from Krypton and has super, mental, physical and technological capacities with almost no limitation. In his second life he is portrayed as a shy and fearful reporter subordinate to Lois Lane, who is in love with his masculine superhero version. The analysis of this hero is interesting because we can clearly see the difference between the superhero and the normal man in the same character and also the features belonging to the hero and to the average person. The masculine gender in the hero is clearly shown by his attitude of being the strongest, having endless powers, strength and physical qualities. The tight costume is a media to display and show off every single muscle and the masculinity of the character. Despite Superman is also very smart and has many other powers that could have been highlighted, it seems that the most important point is to follow the stereotypical way of presenting a strong man as from the prehistoric perception: the bigger, the more muscular, the more masculine. Although the authors decided to present male gender through huge muscles display, prominent chin bones and power position postures, however they made no reference or highlighted the sexual organ, which maybe is not needed to define the male gender or is a tabù. Superman human alter ego does not present the same masculine gender attitude. All the prominent muscles are perfectly covered by loose clothes and his attitude is much more similar to an insecure and timid woman, a sort of Dr.Jekyll and Mr.Hyde for genders, where being an hero means to be a man and being normal means to be a woman.
Wonder Woman is a very mainstream example of Superheroine, she "is Princess Diana of the immortal Amazons from Greek mythology. When army pilot Steve Trevor crashes on the warriors’ secluded island paradise, Diana wins the right to escort him home and make her people known to the world. Entering our cynical world for the first time, there’s a lot she must wrap her head around, especially our ways of war, hate, and, well… dating. Helping her are her superhuman strength and speed, as well as the trademark bulletproof bracelets, but it’s probably her Golden Lasso of Truth most people really wish they had. The full package of beauty, brains, and brawn, she’s been a feminist icon since her star-spangled intro in 1941.” (45) I don’t agree completely with the last sentence. In the first editions Wonder Woman (fig.54) was created as an icon to support and sustain women during the difficult years of the world war, as at that time women needed to do men jobs to replace the men busy in the conflict. With the years, as you can see in the pictures (fig. 54-55) Wonder Woman changed her identity quite much. Her costume is reflecting the society and historical events: at the beginning Wonder Woman was portrayed with a discrete costume and she was a feminist icon, while nowadays she is gradually diminishing the feminist icon into a super sexy and provocative icon. A women hero needs to demonstrate many different aspects: first of all she has to show masculine attitudes as super strength and invulnerability, not at all typical for female. Secondly, being female with men features is not enough so she needs more, for instance magic weapons, in order to be “superhero-enough”. Finally, with nowadays addition of an erotic costume where nothing is left to the imagination, sexual organs and female curves are really shown off and for heroines this is no more a tabû; as a matter of fact we know that the attractive appearance it is not essential to save the world. Speaking about super-
gender, it is like having a combination between a superhero-gender and superheroine-gender in a character of female sex.

It is interesting to notice that colors do not play a gender definition: both Superman and Wonder Woman have exactly the same color palette. Also colors proportions look almost the same (if we consider the entire costume, both of them use blue and red almost fifty-fifty). Red and blue are used for the main surfaces and gold yellow for the small details, with a clear reference to the US national flag (in particular, in the case of Wonder Woman it is obvious from the white stars on the panties).

**Processing of results - sketches**

![Fig. 28 Design process; from superheroes drawings to the inhaler.](image)

A no gender character will be appreciated both by girls and boys and be suitable to both of them, so I decided to select superhero drawings that have no gender connotations as much as possible (fig. 28). In particular, I chose the “Cloud-hero” with fire tail, the “Hand-hero” with fire and ice power and the “Milk-hero” which can eat everything without mercy. As you may agree with me, they do not show off particular masculine or feminine shapes: clouds and hands have no specific gender correlation contrarily to huge musculature or prominent breasts. In addition, also super powers were portrayed with fire-power or bottomless stomach which do not belong, as well, to a specific gender.
Fig. 29 Use of the inhaler:

a) remove the protection cap from the mouthpiece;

b) the red triangular shield reminds you to breathe out before the use;

c) the mouthpiece is placed between the lips, when the kids press the inhaler, the “little buddy” goes down and the shield will turn into green: this is the signal to breathe in for 10 seconds.

Description and analysis of the result

Fig. 30 Section of the operation
The inhaler consists of three pieces (fig. 30): the actuator, the spring and the superhero-cap. The basic use is the same as for the old inhaler; to release the drug the kids have to press the top part that now has the shape of a white superhero.

The design innovation is that a spring, highlighted in yellow in the drawing (fig. 30), lengthens the stroke of the canister allowing the superhero-cap to display a more visible information which will help the kids to breathe out and in in the correct moment. The spring is in plastic and it is really soft so no extra effort is needed to press the device. The anthropomorphic superhero can also work to communicate the correct use direction of the device inasmuch our natural behavior leads us not to orientate the face upside-down. Talking about the lines and shapes, in general they are very soft and smooth, with an anthropomorphic appearance to avoid the look of an hard and cold medical device.

Let me open an important parenthesis here just to better explain what I mean for an object that looks medical and the attractive and non attractive medical aspect. What I mean for a medical device is whatever object used to prevent, cure, diagnose, treat or be related to a medical condition, disease or illness. I want to connect the medical look of the object with the discussion of attractive objects and aesthetic done in the previous chapter in the critical analysis (page 12); I think it is more relevant for my project, rather that a mere identification of the medical looks per se (which can be a quite wide discussion). I guess that everyone, at least once in his/her life, has experienced some kind of medical device, and it happens that the shapes, design, colors and materials designed with a proper mix arouse sometimes a positive, sometimes a more neutral or a really negative feeling. An example for a more neutral medical approach is the flue thermometers that check the body temperature in few seconds just being placed (without pressure) in the hears; easy and quick to do and children do not even realize the performance of the action. The experience is different when children go to the dentist and remove a caries with the surgical drill that looks like a medieval weapon of torture. Another experience is the nebulization with the nebulizer presented before (fig. 11) which may even result funny for kids. The material choice and colors play a role in the experience. Colorful plastic is viscerally perceived as fun, while grey steel is viscerally perceived as scary and dangerous.

Going back to the inhaler, the system is completely close and this is a big advantage for the maintenance of the inhalers as this feature prevents dust and cloth fluffs inside the device. The mouthpiece cap is made of transparent silicon and being fixed to the actuator it will not be lost in the pocket, bag or rucksack. Thanks to the silicon characteristic grip it may be easily removed and used for the treatment.
Since the shield space is very limited, I focused more to display an effective and simple symbol and I worked on several possible symbols (fig. 32) suitable to show when ‘to exhale’ and ‘to inhale’. The inhalation in the first green shields is represented by a vortex that symbolizes the suck/aspiration phase.
of the drug. In the last samples this phase is represented by fully air lungs. The exhalation is shown as an air flow in the first shields and as empty lungs in the last samples.

The first shields are a synthesis of the air flow, inspired mostly by looking into common symbols used to represent the air flow and rearranged according to the design of the inhaler. While the lungs-shields remind to empty the lungs at first and then to proceed with the inhalation of the medication.

Fig. 33  Different sketches of superheroes masks: the mask is needed to identify the white guy as a superhero. It will not appear as an evil character but as a good buddy with a reassuring face that will give extra powers to the kid.
The first four examples want to evoke a superhero’s assistant, ready to help and fight during emergency. Some of them have a robot-shape and could be a sort of technological gadget of a superhero. The white and light blue combination really suits the robots-design and gives a futuristic/technological style to the old device. The buddy in the top on the right is more anthropomorphous in comparison with the other robot-assistants, however its style reminds more an assistant than an actual superhero. On the top of its hat there is a star that can be a practical link for the kid to know the exact point to press. The last two drawings have a superhero looking and cute appearance ensuring confidence and not frightening the kid. In all the examples the design approach wants to be minimal without distorting completely the shape of the inhaler so that the final inhaler will not be mistaken for a toy: the inhaler components need to be visible and easily identifiable.
The use at night

Since asthma attacks might come even during the night, the inhaler has to be properly designed in order to be easily findable in dark conditions during emergency situations and must be present in the room to reassure the kid. The use of photoluminescent plastic (fig. 36 - 37) in the most relevant parts might be a simple and inexpensive solution. The normal light exposition, even only for 10-15 minutes, will ensure the inhaler to glow for the entire night. In fact "Luminescent plastic master batch is a kind of self-luminous plastic pellets, made of luming luminescent materials through the deep processing. It can be directly injected or proportionally mixed with similar plastic in the injection molding, which is made into all kinds of luminescent plastics, absorbing visible light for 10-20 minutes, and then emitting more than 12 hours in the dark with safety instructions and decorative effect." (39) It is possible to use self-luminescent material mixed with the most common polymers on the market (PVC, PE, PP, EVA plastic and many others) but also to have it as a paint. Luminescent plastic master "are non-radioactive, toxic-free, non-flammable and harmless, containing no phosphorus or lead, or any other hazardous element or chemical, and can be recharged an infinite number of times. The term phosphorescence is sometimes used to describe luminescence, but LightLead's PL materials contain no phosphorus. It is not recommended to eat." (40) There are several possible applications: "Electrical products:
switches, phones, manual machines, windows, handles, trademarks, logos, keyboards, mouses, etc. Plastic products: handicrafts, jewelry toys, cups, plates, dishes, zippers and other daily necessities.” (39)

By the color palette available (Fig. 36), it is possible to obtain the proper light-blue directly with luminescent plastic (as you may see in the first example below (Fig. 38)). A possible alternative is to paint a pattern that highlights the most relevant parts, the superhero-button and the mouthpiece exit (as you may see in the second example below (Fig. 38)).

Fig. 36 Example of photoluminescent plastic with normal light exposition and in the dark

Fig. 37 DIY inhaler with photoluminescent tape (facebook post from an asthmatic experience)
The photoluminescent plastic or paint presents several advantages: first of all the device will be easily findable in a dark room but also in a dark bag or backpack (that are usually big and full of stuff); in this way it will also be faster to check if really carrying the inhaler. The luminescent technology is inexpensive and very durable and no extra batteries are needed. The kids might feel safer with a fun device that can glow in the dark.

Fig. 38 Luminescent pattern

Feedbacks survey and data analysis

To verify my design and be able to decide which is the most effective choice, I made an online survey among asthma’s forums and facebook groups. I posted my survey on forums like: forum.asthma.org.uk, www.healthboards.com, www.healingwell.com, www.dailystrength.org, ehealthforum.com and facebook groups as: “Brittle Asthma Support Group” and “Asthma, Allergies and Prednisone!” and I asked parents to take a small survey with their children. I reached a wide sample of users from different USA states and UK, with different culture and habits. (Refer to the survey layout and results at page 34).
SURVEY RESULTS

GENDER
- 58% boys
- 42% girls

AGE
- 3-5 years
- 6-10 years
- 11-13 years
- 14-17 years

FROM
- USA: 9 children
- UK: 9 children
- No answer: 2 children

ABOUT THE SUPERHERO SHAPE

COMMENTS
- “White eyes are creepy.”
- “Not sure on copyrights but my boys would prefer superheroes such as batman and superman etc.”
- “More of a boy design than a girl’s choice.”
- “I think the eyes should be all black but like the ones I said best by shape!”

ABOUT THE INFO

COMMENTS
- “Both boys use spacers which may not work with this idea.”
- “I like pics but don’t really understand what they mean mum said a face in profile with arrows might work.”
- “It says the words”, “Because she “likes” it!”
- “Showing the lungs is great,” “Great idea!!”
- “She didn’t think they looked like superheroes but it wasn’t a problem.”
- “I like the pics on C better. However telling my child to copy the ‘O’ shape would be easier from A.”
- “Paint the “shirt” on the inhaler with a glow in the dark paint, easier to find at night and adds a cool aspect for the kid.”

Favorite choice
- A: 20%
- B: 16%
- C: 16%
- D: 10%
- E: 11%
- F: 11%
- No answer: 15%

Second favorite choice
- A: 56%
- B: 11%
- C: 20%
- D: 10%
- E: 11%
- F: 11%
- No answer: 15%

Most liked symbols
- A: 45%
- B: 21%
- C: 15%
- D: 10%
- No answer: 19%

Symbols that better represent “breathe out” and “breathe in”
- B: 64%
- A: 21%
- C: 15%
- D: 10%
- No answer: 24%

“Your designs are good but have you used an inhaler? I find that when you put the mouthpiece in your mouth the front of the inhaler touches your nose so you wouldn’t be able to see the breathing in/out icons that you’ve incorporated into your designs so therefore a child would not be able to see it upon using the inhaler. I think children would use it as a thing to show off to their friends & therefore would waste the doses rather than use them for their lungs. I can see it working as an Instructional piece in a hospital/doctors surgery. You may be better off designing a case that the inhaler can sit inside. I can see there would be a good market for these especially if you did superheroes!”
The children that answered to my survey were twenty and I asked them which was their favorite inhaler among six options and which pair of info-shield they liked the most and better represent the inhalation and exhalation phases. As you may see from the Survey Result infographic at page 34, kids did not have a clear preference about the superhero shape (Fig. 39). However, more than one thought that the eyes with the white hole are scary/creepy. I will proceed to make digital 3d models and prototypes of the superheroes characters and I will verify the design in another way.

As for the information displaying, children like the most and think that text ‘out’ and ‘in’ (Fig. 39) is a clear message because better remind the actions ‘breathe out’ and breathe in’. I will keep this preference for my final design.

Fig. 39 Final decision of the interaction system but design is not yet completed.

Summary and reflections

The main concept of my project is to make a children friendly device. Specifically, helping children to proceed the inhalation without making mistakes in breathing coordination or using the device in the wrong direction and integrating the idea of superhero. My solution is to place a superhero cap on top of the inhaler with an informative shield that will guide the kid during the use.

The hero has a clear anthropomorphic design suitable to communicate the inhaler direction of use. The device shapes and color palette have been developed with the inspirational drawings from the children workshop. Despite light blue/white palette might look gender oriented, many girls drew superhero in
light blue and the design shapes are simple and no gender related. I believe that the inhaler should not be mistaken for a toy as it is a medical device not to play with. Light blue and white evoke the medical and clean appealing as well as simple shapes make it into a non gadget toy device.

The new design will grant a better sealing to the inhaler so it becomes more hygienic as less dust will enter and clog up the spray. The use of luminescent plastic will facilitate the children while looking for the device in a dark room or backpack. This is an inexpensive solution that will be appreciated also for its fun aspect.

From the online survey it emerged that kids have no specific preference on superhero shapes but they preferred to have the 'out' 'in' shields to be guided in the use. The next task is to develop more superheroes shapes and work further on the instructions for 'out' 'in' shields.

Olle Gyllang from Propeller Studio analyzed my work so far and agreed with my research, with the main concept of my product and with the superhero idea. However, also from his point of view, I need to develop more superheroes proposals by making some more abstract proposals with pure shapes and examining also pure anthropomorphic shapes. As for the interaction and the information displayed, the message is still a little bit confused, in particular the color code is not working properly. The red color reminds 'stop', which is not the proper message to be transmitted. I need to re-think more logically and reflect how to make it more simple and obvious.
CHAPTER 3 – FINALIZATION OF THE DESIGN

SUPERHERO

Render

Fig. 40 Render prototype

Despite the superhero design is not defined yet, there are some examples about how the current heroes proposal might look like (fig. 40) with a more advanced media as sketches. It is possible to check
materials’ features and details. The matte light blue inhaler shape is simple and with very rounded edges. The cap is made of a transparent rubber material, with good grip and easy to be removed.

More ideas

![Fig. 41 More superheroes sketches and color palette variations](image)

I tried to give another input (Fig. 41) to my superheroes, making them more basic and with less details. But later I thought it might be difficult for children to refer to abstract shapes of superheroes. In addition, where superhero appearance is more obvious (Fig. 41 - character in the center) the character has a masculine appearance (big shoulders, big torso). Since there are not many details to recognize the character as a superhero, I thought to experiment with a different color palette, using primary colors as yellow, red and cyan. Superheroes always have a combination of strong colors to be easily identified; in addition, children are attracted to bright and primary colors. I have also applied the new color palette to the old design and checked the final effect. In this case the risk is that the inhaler could be mistaken for a colorful toy instead of a life-saver device.
For the first proposal (Fig. 42) I focused deeply on the action of breathing, analyzing the two actions and the movement connected to the breathing. As you may see from the infographic (fig. 42), when you breathe the body changes its shape, with fully air lungs the torso becomes bigger, making a sort of imaginative triangle. This triangle will turn upside down when you breathe out. The graphic idea comes directly from the body shape movement, so I have made the font according to the triangle direction. I decided to use yellow/black and light blue/white combinations to have a good contrast and nice visibility of the letters.

I chose the yellow to attract the patient’s attention and remind him/her to exhale first, in fact, yellow stands out properly from the white and blue guy. Then the light blue/white text will follow to inform when it is time to breathe in. Furthermore, young patients that cannot read already, might rely better on colors than on the text.
In the second proposal (Fig. 43) the main idea is to underline the empty and the full lungs as two opposite aspects. Font’s shapes and colors are used to communicate the opposites. For the ‘breathe out’ phase and for representation of the empty lungs, the regular or condensed font’s version has been chosen, while the extra bold fonts give an idea of fully air lungs. Light blue and white are used as negative and positive.

The third proposal (Fig. 44) is a sort of combination between the first and the second one; the different fonts’ variations represent the air in the lungs, and the colors underline more the variations between the two shields.
FINAL DESIGN

Super-inhaler

Fig. 45 Final design
The final decision (Fig. 45) about the superhero shape is the cylindrical guy because among the options that I have drawn it is recognizable as a defined character personality and it has superhero distinguished features. It is a no gender character, suitable both for girls and boys. As I discussed in the previous chapter, the heroes-genders are represented by superheroes in different ways. In order to have a no gender character, every gender relation was eliminated from the device. In fact, the final version does not have recognizable and peculiar male or female features or posture (the other design option with the prominent chin and the power position posture might still remind a more male gender). The eyes choice has been suggested by the survey’s comments.

The main colors are white and light blue, to evoke the medical feeling and to remind that it is a serious device. With “medical” feeling I mean the positive feeling evoked by a device where the affordance of the healthcare product, through its features, materials, colors, shape, and so on, makes it look clean, hygienic, aseptic, new, and all the other positive adjectives that make you feel safe and comfortable when using the object which has to penetrate/come in contact with the body. For example, we can say that white gives a more suitable affordance to a medical device than brown, a smooth surface gives a more suitable affordance than a wrinkled one, a pure volume gives a more suitable affordance that
an object full of interstices, and so on. The color yellow is used for small details to emphasize important functions and components.

The inhaler and the superhero cap have an oval section, to make them slide one into each other without twisting. I decided that the cap has to be made of soft yellow rubber because with the time and use the transparent and clean rubber/silicon will turn into a yellowish dust-magnet. The yellow rubber cap will highlight the mouthpiece location and, thanks to the bright and color contrast, it will make clear that it is an extra component.

As for the logo, I believe that the yellow/blue combination is easier to be understood by any children, if they are able to read or not, because they can refer to the changing of colors. Even if white and light blue might seem a more elegant solution, when using these two colors the changing of icons may not be clear because of negative and positive optical illusion. The text has also a logo connotation to remind once more time the superheroes’ world. The logos do not need to be read but only to be seen and recognized by the kids.
Mockup and prototype

Fig. 47 Mockup in foam of the inhaler

Fig. 48 Prototype 3D printed. Printed on a ProJet3510, Multi Jet Printing and made of photopolymer.
Fig. 48 Prototype 3D printed. Printed on a ProJet3510, Multi Jet Printing and made of photopolymer.
Dimensions and ergonomics

Fig. 49 Dimensions

Fig. 50 Ergonomic grips for small hands and bigger hands
PRODUCTION

Materials choice and features

The components of the inhaler should be made of the same kind of polypropylene PP of the inhalers already existing on the market, with matte texture and opaque. The cap, however, must be made of another kind of polypropylene composition with a rubber/silicon consistency and opaque matte texture. Another possible alternative might be the use of the polyethylene PE. It is very important that the cap has a good grip on the inhaler surface to ensure that it will not open in the bag/backpack/… . It must also have a low electrostatic charge to prevent dust collection and dirty appearance, with a good combination of softness and rigidity for easy cap removal in case of asthma attacks.

Production technique

All the components will be manufactured by injection molding technique in four different molds. Since the hero-cap needs undercuts for the interlocking, it must be made by two molds and assembled in a second time thanks to some small joint connections. The spring and the inhaler made by only one mold ensure that the spring is integral with the device and cannot change its position (eventually arresting the device during emergency use).
All the components will be produced in one polypropylene color and all the details as the hero’s mask, eyes and shields will be added by pad printing in a second time. Pad printing is a convenient solution to print on any shape, surface and material without distortions, with limited costs. Furthermore, with this combination of production techniques it will be very easy to make the device in other colors’ combinations just by changing the master color and paint. In case, other colors’ inhalers might be used for other kinds of asthma medications and different color codes might represent different medications typologies.

INSTRUCTIONS

Comic strip

To explain to children how the new inhaler works and what asthma is, I have made a comic strip (see below) that illustrates the main phases during an asthma attack and the device operation. The story is located in a fantasy world, the inhaler is no more a cold medical device but a super hero that fights against triggers and with its super-powers releases the airways muscles. This printed material might be helpful both for doctors and parents to support their patients/children. The idea is that the boy/girl will feel more part of the story and have ‘super power’ as well as the superhero. The comic’s aim is to strengthen the superhero concept even more.

Fig. 52 Comic strip
SUPER-AIR
the battle against asthma

I need Super Air Inhaler, I'm wheezing!

I'm Mr. Trigger, the cause of your asthma

Breathe out Joe!

...now take a deep breath in!

Joe is wheezing because oxygen cannot go out from bronchis

muscles are tightening the airways

Mr. Trigger makes them produce a lot of mucus

With the corticosteroid power I can release the muscles

Now the oxygen is free

We defeated Mr. Trigger one more time together!

the end!
PACKAGING

I believe that it is important to think about the whole identity of the project so I want to present also a concept for the packaging. The packaging has the power to give the first impression to customers, speaking about children they need to understand immediately that something is really made for them and due to that I decided to mix between the normal medical packaging and toys packaging. The open window with the transparent film comes from the toys world and the simple and abstract graphic is from medical fields. The graphic aim is to create a good balance about seriousness without the frightening mood, a sort of line/ribbon wraps the box and add dynamically to the concept too as this inhaler must to be active in the asthma fight.

The logo font chosen is the same font used for the informative shield for a style coherence, while for the informative text a font that ensure a better readability in small sizes is chosen. The packaging is made of printed cartone and a transparent plastic film, die cutted and assembled with glue. The cartone can be printed with offset printing technique. The box will include the inhaler, the accompanying direction and the comic strip for kids. Packaging is developed in order to take less space as possible and stacking without loss of space (check packaging pattern, dimensions and stacking pattern in the next page).
**Final conclusions and reflections**

Asthma is an expanding chronic disease that affects people all over the world. It is not simple to live with asthma and deal with a disease that does not allow you to breathe properly. There are many devices needed by an asthmatic needs; the most important is the MDI inhaler used for emergency during the attack. It is sad to notice that almost nothing has been done in order to make this life-saver device more user-friendly and efficient. In particular, it has been demonstrated that children have difficulties in the correct consumption of the drug. They feel embarrassed to carry the inhaler and they forget to bring it with them. Plugs and caps may be easily lost, causing problems of hygiene and obstruction of the inhaler due to dirt and dust. All these factors might compromise asthma control causing a worsening of the disease.

For the reasons listed above, I decided to design a new device to better help children and facilitate the intake of the drug. We are not only talking about making a pleasing design with no thoughts behind. The theme of the inhaler is the superhero as children need to be reassured during the attack and have extra help/power to overcome the emergency. It has been found that superhero worship might have a positive effect on this case.

Established this, the device has been developed, a superhero is placed on the top of the inhaler in order to help the breathing coordination through an informative shield and identification of the inhaler use direction. In general the new device has a better sealing, ensuring more hygiene, less obstruction issues and no loss of components. The luminescent plastic facilitates the use during the night and help find the device quickly in the dark or in the bags. In this way the inhaler turns into a device even more appreciated by kids, the appealing shape and features make it less embarrassing for carriage and use.

The interpretation and the operation of the device is further supported by a comic strip which illustrates how the device works and explains asthma to children.
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Fig. 25 Workshop at Istituto Comprensivo “Alberto Manzi” with the third grade class, photo by Lavinia Rossetti, Cordenons, 17 March 2015

Fig. 26 Workshop results: kids’ drawings, Istituto Comprensivo “Alberto Manzi”, Cordenons, 17 March 2015

Fig. 27 Color map, Lavinia Rossetti

Fig. 28 Design process; from superheroes drawings to the inhaler, Lavinia Rossetti

Fig. 29 Use of the inhaler, Lavinia Rossetti

Fig. 30 Section of the operation, Lavinia Rossetti

Fig. 31 Display info, Lavinia Rossetti

Fig. 32 Others symbols experiments, Lavinia Rossetti

Fig. 33 Different superheroes masks sketches, Lavinia Rossetti

Fig. 34 Different sketches of superheroes body and superheroes assistants, Lavinia Rossetti

Fig. 35 Combination between the different superheroes’ bodies and info-shields

Fig. 36 Example of photoluminescent plastic with normal light exposition and in the dark, Luming Technology Group Co., Ltd., Photoluminescent plastic, available online at: http://www.luminggroup.com/english/product/index.asp?sid=164&sel_id=151&sel_id_02=164

Fig. 37 DIY inhaler with photoluminescent tape (facebook post from an asthmatic experience), Shalynn Marie GioVinco, Facebook group “Asthma, Allergies and Prednisone!”

Fig. 38 Luminescent pattern, Lavinia Rossetti

Fig. 39 Final decision of the interaction system but design is not yet completed, Lavinia Rossetti

Fig. 40 Render prototype, Lavinia Rossetti

Fig. 41 More superheroes sketches and color palette variations, Lavinia Rossetti

Fig. 42 Breathe out-in info, proposal 1, Lavinia Rossetti

Fig. 43 Breathe out-in info, proposal 2, Lavinia Rossetti

Fig. 44 Breathe out-in info, proposal 3, Lavinia Rossetti

Fig. 45 Final design render, Lavinia Rossetti

Fig. 46 Components, Lavinia Rossetti

Fig. 47 Mockup in foam of the inhaler, Lavinia Rossetti

Fig. 48 Prototype 3D printed. Printed on a ProJet3510, Multi Jet Printing and made of photopolymer, Model printed by 3D Center, Västervik AB, Lavinia Rossetti

Fig. 49 Dimensions, Lavinia Rossetti

Fig. 50 Ergonomic grips for small hands and bigger hands, Lavinia Rossetti

Fig. 51 Components, Lavinia Rossetti

Fig. 52 Comic strip, Lavinia Rossetti

Fig. 53 Packaging, Lavinia Rossetti

Fig. 54 Superman, comic book cover, available online at: http://www.supermanhomepage.com/images/comic-covers/Pre-Crisis-Covers/1971/adv233s.jpg

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Appendix 1- Survey layout

1. Is your daughter or your son taking the survey?
   - Yes
   - No

2. How old is your child?

3. Where do you come from?

4. Look at the image above. Which of the 9 superhero characters do you like the most for an inhaler?

5. Any comments about the superheroes?

6. Look at the image below. Which symbol do you like the most?

7. Which of these bottles represent the "breath out" and "breath in" section?

8. Any other comments?