

Chapter 1

Aesthetic of Prosthetic Devices: From Medical Equipment to a Work of Design

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Abstract Aesthetics of prosthesis design is a field of research investigating the visual aspect of the devices as a factor connected to the emotional impact in prosthetic users. In this chapter we present a revised concept of perception and use of prosthetic devices by offering a view of ‘creative product’ rather than ‘medical device’ only. Robotic-looking devices are proposed as a way of promoting a new and fresh perception of amputation and prosthetics, where ‘traditional’ uncovered or realistic devices are claimed not to respond with efficacy to the aesthetic requirements of a creative product. We aim to promote a vision for a change in the understanding of amputation - and disability in general - by transforming the concept of Disability to Super-ability, and to propose the use of attractive-looking prosthetic forms for promoting this process.

1.1 Introduction

‘Prosthetic’ is a term that refers to devices designed to replace a missing part of the body, for example an artificial arm, leg, or finger. Our research focuses on the aesthetic of transtibial prosthetic devices, or rather devices replacing the limb segment below the knee.

Prosthetic users state that it is important for a device to feel comfortable to wear and functional to use (i.e. lightweight, movement in the ankle), but they also require visual appeal in the devices to fulfil their emotional needs and connect the look of the related product to their body image. Unlike the extended work to date on prosthetics which has largely focused on the technical improvement of the devices (Cheetham, Suter, & Jäncke, 2011; Hahl, Taya, & Saito, 2000; Klute, Kallfelz, & Czerniecki, 2001; Mak, Zhang, & Boone, 2001), the field of research into aesthetic of prostheses is new, as little interest in this sector of prosthetic design has been recorded.

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By ‘aesthetic of prosthetic devices’ we mean the visual aspect (i.e. the appearance) of the products; in other words this term refers to the prosthesis form, and how it looks. The form of the device involves non-pragmatic aspects (i.e. unconnected with functionality or comfort) and is directly related to the emotional impact on the users, on their body image, and the impressions on the external observers.

In our work we discuss the role of the form of the device as a factor connected to the emotional design aspects of this medical product. Let us consider what we mean by emotional design; ‘Everything that we see evokes some kind of emotional response. [...] Love, fear, acceptance, sadness, friendship, happiness, satisfaction - these are all valuable emotions, each may be evoked by a designer, either intentionally or not, in the design of a product’². Defining prostheses as an emotional product is particularly appropriate considering that this kind of device is strictly related to the body image of a person with a physical impairment. Our research aims to address an innovative point of view by proposing one of the first studies to revise the concept of a medical device and to promote a new vision of it. The device should not merely stand as a supportive medical product for the patient, but also as a product able to enhance positive emotions in the user.

In considering the visual aspect of prostheses for below-knee devices, the models resembling the realistic appearance of a human leg are identified with the term ‘cosmetic’ (**Fig. 1.1a** and **b**), while ‘artificial’ prostheses identify devices with an appearance dissimilar to a human leg (**Fig. 1.1c**, **d** and **e**). Within the category of artificial-looking models, we identify ‘robotic’ devices (**Fig. 1.1d**) as a distinctive design type from the uncovered design (**Fig. 1.1c**). With this term we do not refer to devices with built-in complex functionality – as the stereotype of the word might lead one to think – but simply to the visual aspect of the device as clearly non-realistic and aesthetically elaborated. Our need to define and utilise this term resides in the fact that no specific term for these kinds of designs has yet been identified (they are usually referred as ‘prosthetic cover’, ‘non-realistic’ or simply ‘artificial’). Under our definition of ‘robotic’ we include devices making use of ‘fairings’ for the cover, or rather “intricately designed panels that fit over prosthetic legs - the fairings create a shell around the traditional prosthesis, giving the mechanical limb a more natural shape”³ (**Fig. 1.1d**). Within the category of robotic designs we find monolithic models, or rather prostheses with a homogeneous and continuous design from the tibia to the feet (**Fig. 1.1e**).

Our research direction addresses the appearance of robotic devices as way of making a positive change to amputee’s perception of their amputation and the

² <http://www.studiofynn.com/journal/emotional-design-what-it>

³ http://www.huffingtonpost.com/2012/05/18/bespoke-innovations-prosthetics-that-rock_n_1525455.html

prosthesis, and explores the role of robotic designs as a key factor in eliminating the social stigma connected to amputation.



Fig. 1.1 Cosmetic foam-covered (author photograph) (a), PVC highly realistic (©2012Rosemary Williams) (b), basilar uncovered (author photograph) (c), robotic cover design (UNIQ, 2015) (d) and monolithic model (Jordan Diatlo design) (e) prosthetic devices

The visual choices currently offered in most of the public UK prosthetic centres are limited to what is considered essential for the patient's motion needs, and little account is taken of the appearance of the devices. These choices usually include the uncovered device (**Fig. 1.1c**), and a basic foam covered 'cosmetic' prosthesis (**Fig. 1.1a**). Robotic designs (i.e. **Fig. 1.1d** and **e**) are usually available from a limited number of private companies, and often difficult to access by most prosthetic users. By considering that the large majority of prosthetic users have access only to basic designs like the cosmetic or uncovered device, we have identified the restricted range of aesthetic options on offer to users as an issue. The appearance of these devices generally does not correspond to the visual requirements of the users, and do not stimulate the elimination of the social stigma in users and external observers.

Our investigation aims to discuss the state of the art of the aesthetic of prostheses, and to propose a revised understanding of this aspect of prosthetic design. We believe that the concept of social stigma correlated to the amputation can be reworked by switching the understanding of the prosthetic form from a medical support product only to a creative design. Specifically, our assumption is that robotic-looking devices can provide the answer by better addressing the aesthetic needs of

amputees of today; to counter the realistic and uncovered devices which represent an old and traditional vision of prostheses. Modern times require a change in the vision of prosthetic devices, prosthetic users and disability in general.

The ‘conformist’ realistic (i.e. **Fig. 1.1a**) looking design is still connected to the old-fashioned idea that the visual requirement of a good prosthesis is to closely mimic the lost limb. This is one of the two options offered by the NHS, which states on its web site⁴ that “a prosthetic limb should feel and look like a natural limb”. Based on this same aesthetic direction, some private companies provide elaborate and expensive prosthetic solutions taking the form of a prosthetic device almost identical to a real limb (i.e. **Fig. 1.1b**).

Consider the uncovered device model (i.e. **Fig. 1.1c**), the second option offered by the NHS. Here we find a medical support product of poor appearance, without any elaborate or appealing visual interface. The components of the socket and the area of the tibia are artificial and minimalistic-looking, together with a foot shape resembling a sketchy reproduction of a real foot. The socket and the foot are often skin-colour, in contrast to a shiny metal-coloured or black coloured pole connecting the two components. This kind of design is a poor mix of mismatched sections, attempting to merge realistic with non-realistic components. The result is an aesthetically non-harmonious prosthesis resembling neither a robotic model nor a realistic device.

When considering the fact that those designs are the most accessible options for prosthetic users, our cardinal observation was that the form of these models did not respond adequately to the needs of the wearers. This observation was supported during our data collection by 16 amputees out of the 19 we interviewed. All were wearing either an uncovered or cosmetic device, and all 16 said they were dissatisfied with the form of their device. Following the focus on the problem of traditional looking devices having been designed with a form not responding to the users’ needs, our research presents devices with a robotic form (i.e. **Fig. 1.1d** and **e**) as innovative designs perceived internally (i.e. the user wearing the device) and externally (i.e. observers) as better adapted for visual acceptance of the product. We believe that the majority of prosthetic users are ready for a change in their prosthetic aesthetic, and that in 2015 times are ripe for a change in the image of prosthetic devices. Robotic devices can respond in an innovative way to the needs of prosthetic users. The reason for this statement resides in the fact that a robotic device does not try to fake the resemblance of the lost limb, and neither is it a minimalistic design of support. This kind of prosthesis represents a visually developed design work, aimed to revise the image of prostheses from medical products to visually appealing products.

⁴ www.nhscareers.nhs.uk/explore-by-career/allied-health-professions/careers-in-the-allied-health-professions/prosthetist-and-orthotist/

The attractiveness of robotic devices has to be viewed in a general context, as it cannot apply as a universal rule for all prosthetic users (or external viewers) in their perception of their device. When considering our recent qualitative data collection, it was shown that, of a total number of 19 prosthetic users, making use of traditional devices, who were interviewed, 12 stated that they were dissatisfied with the aesthetic of their devices, 4 of them were undecided and only 3 of them stated they were satisfied. Prosthetic users were shown a small set of prosthetic devices and asked to describe them as attractive or non-attractive, and to indicate their choice in relation to their preferred option. The participants were all prosthetic users wearing an uncovered or cosmetic model. These data show that, beside our driving idea that a consistent number of amputees would benefit from the use of a robotic model, there is also a percentage of amputees that do not fit in with this idea. In the following paragraphs we will present examples of the first and second category.

When describing the cosmetic leg (i.e. **Fig. 1.1a** and **b**) that was offered after the amputation, most of the users stated comments like “it just looks ugly...it just looks false (K)”, “it looked like [if I was wearing] an old lady pair of tights” (C), or “between 1 and 10 I am satisfied 4 with the appearance of my device” (R). Similarly, in the context of describing the appearance of their uncovered device, we recorded from most of the users comments such as that the prosthesis was “too skinny”, making the trousers fold in a very unpleasant way, or, in the extreme case “there is nothing that makes me like them” (JS).

Our belief that cosmetic devices would not be suitable for all users is connected to the idea that the Uncanny Valley (UV) feeling can apply to these models of prostheses. The UV (Mori, 1970) affirms that artificial entities trying to reproduce human features (e.g. robots, puppets, prosthetics) that show a very high level of human-likeness generate a negative feeling instead of attraction (MacDorman, Green, Ho, & Koch, 2007). In our previous study we detected that the UV might not universally apply for prosthetic devices in observers (Sansoni, Wodehouse, McFadyen, & Buis, 2015). However, by considering the general principle of the UV and by taking into account the declarations of some prosthetic users, our idea is that external observers might feel an unpleasant sensation when looking at a prosthetic user and discovering that the limb, which they initially mistook for a real leg, is an artificial prosthesis.

E, a 54 year old wearer of a cosmetic prosthesis from the age of 2, stated that “We do not have a choice of prosthesis, you just wear what you are given – it will be nice to choose the design sometimes, but I have never had an option...” This point shows that for prosthetists, the visual appearance of the device may, in a case like that, be considered so non-relevant that they will not even consult with the patient before assigning a model.

The visual aspect of prosthetic devices is an underestimated element of the design, and the designs provided often do not meet the expectations of the users. Our research direction is that the idea of ‘suitable’ prosthetic aesthetic for users should switch from the representation of a realistic limb (cosmetic) and/or uncovered device to an individual appealing robotic product.

Unlike the previous examples, some categories of users have a different view of their device, and the taste for both the appearance and design of a prosthetic device is strongly individual. As a matter of fact, not all prosthetic users find the appearance of the prosthetic device as their main priority, or attach any importance to it at all for their device. It appears that all users have as their first priority the factor of comfort, and some of them express functionality as a second priority, and pleasant appearance as their third requirement (User group 1 - **Fig. 1.2**), other users rate appearance in second place, even despite a lower level of functionality (User group 2 - **Fig. 1.2**). Some categories of users are more functional-orientated and attribute little or no importance to the look of their device (User group 3 - **Fig. 1.2**).

User group 3 includes people for which dissatisfaction with the traditional prosthetic design does not apply.

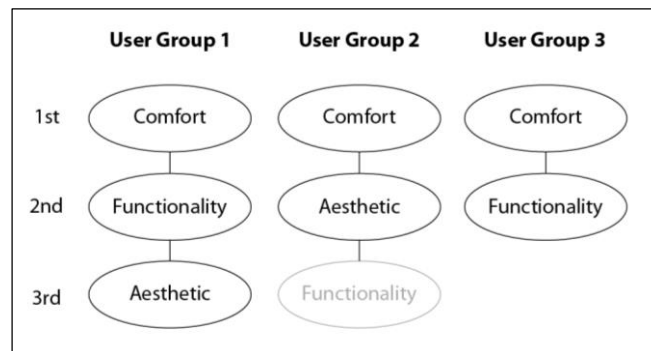


Fig. 1.2 Representation of the priorities for the issues of comfort, functionality and aesthetic in prosthetic devices by below knee prosthetic users

Some prosthetic users prefer the use of an uncovered device and do not seek a more visually enhanced model. It has been shown that some (former) soldiers view their amputation as a symbol of pride, and by showing the minimal easy to notice uncovered device, they are displaying a status symbol of their profession.

Other amputees can find themselves attracted to realistic devices for reasons connected to fashion. For instance, some women wearing formal clothes showing the legs consider it more appropriate to display a device which better combines with their clothes in a natural way, rather than an artificial device. The same issue can be applied to males, for example Scottish amputees wearing formal traditional clothing which shows their legs (the kilt).

The reasons for people being attracted to devices can be different and taste is strictly personal, so we do not intend to explore all the reasons behind the preference for a cosmetic, an uncovered or a robotic device.

Our position for this chapter acknowledges the fact that the choice of a robotic device over more ‘traditional’ devices would not satisfy the whole population of prosthetic users. However, we stress the importance of the direction of our work as we believe that a negative perception of traditional devices can apply to a consistent number of amputees, and we believe that a revision of prosthetic devices using a different approach is needed – where the use of robotic devices can overcome stigma. In other words, we propose the vision of a robotic device as a matter of innovation in the context of prosthetic design.

1.2. Social Stigma in Disability

Perceived social stigma is defined as an individual’s perception that others hold negative stereotypic attitudes about him or her as a result of a disability (Rybarczyk, Nyenhuis, Nicholas, Cash, & Kaiser, 1995). This factor has been linked to problems of adjustment towards amputation, and in our opinion also affects amputees’ confidence in showing their prostheses and in the choice of devices.

Specifically, we believe that ‘hiding’ a medical device by using some ‘mimetic model’ (i.e. a cosmetic device) might foster the perception of stigma in both the user and any external observer, whereas the use of a device with a robotic look might reduce it. The more a disability, in our case an amputation, is ‘hidden’, the less able the user will be to cope with the acceptance of the disability, and the more likely external observers will feel a sense of ‘surprise’ or discomfort. For instance, a prosthetic user hiding the amputation in a situation where they could wear short clothes (i.e. summer, seaside) might demonstrate low self confidence in exposing his disability. This might be partly due to a natural process of acceptance, or of a low confidence generated by feedback from external observers. When focusing on prostheses, the more the amputation is ‘covered’, the less the benefit to the user, and the greater the likelihood of generating a sense of ‘surprise’ in external observers.

1.2.1 Stigma in Amputees

During our data collection, we recorded the presence of amputees who had developed acceptance of their amputation – for instance, users described self-acceptance and were supported by external observers not showing negative feedbacks towards the ‘disability’. Besides the amputees who had accepted the missing limb, there were some who had not developed acceptance of their body image, in some cases because external observers tended to make them feel uncomfortable on wearing an artificial-looking (i.e. uncovered device). These people are therefore within the category that suffers from the stigma of amputation. In this section we will refer to the statements of some users via a random letter to ensure their anonymity.

G and R were two amputees and prosthetic users, who were part of our data collection group of 19 users. Their statements are particularly relevant in order to explain the issue of stigma. G stated that he believes that there is a ‘stigma’ around the idea of amputation, and this is also why some people want to ‘hide’ the amputation behind a realistic leg. In his case, he wears an uncovered device, and he described an episode in which he was walking in a public place in his village, wearing shorts. A person told him that he should hide his leg and not show it to people, as the appearance of the device was ‘not appropriate’. Similarly, R. described an episode where she was going out with a friend in a public place, and how that friend was strongly suggesting that she should either wear long trousers, or wear a cosmetic device, in order not to attract the attention of other people to her missing limb. The opinion expressed by the friend of R did not stop her from expressing a preference for a robotic device. However, her friend’s views had made her understand that her personal choice of a robotic prosthetic would not be welcomed by everyone; displaying a disability can be considered ‘embarrassing’. These episodes suggest that the perception of amputation is still a taboo for some people in western society and that, although it was fortunately not the case in our examples, comments and behaviour of external observers could potentially have a negative effect on the confidence of users in showing their prosthetic devices.

Similarly to the previous examples, we recorded the more extreme position of two other users, M and D, supporting the idea that displaying an amputation is (or was for many years) a strong issue for them. M stated that he needed his prosthesis to look as ‘normal’ as possible, and that he would have been ashamed to show other people his missing limb. This user highlighted that showing an artificial device (i.e. by wearing shorts or no shoes), and therefore exposing his disability, was not an appropriate choice. M stated this point of view not because of his personal attraction to realistic devices, but by focusing on the concern of not making the artificial limb noticeable to external observers.

D affirmed that, since his amputation occurred when he was just in his twenties, for many years he had an issue about allowing people to view his disability. As a person with a “genuine passion for going to the seaside during summer”, he described that it took him many years before returning to the seaside, but when he decided to go there showing his prosthesis, he chose a colourful model – more visible than other options. By that time, he had stopped caring so much about the opinion of others, as the point was to go to the seaside to have fun.

Additionally, D stated that immediately after amputation he had opted for a cosmetic device, despite this model being more uncomfortable for him to wear. He averred that at this stage people attach more importance to the (cosmetic) aesthetic of the device, and at a later stage they are more willing to ‘sacrifice’ the realism of a leg for one uncovered (considered to have more functionality). In the second phase after the amputation (i.e. after many years) He chose an uncovered device, as he felt his knee more “free” – “even if it is uglier to see”.

Despite D developing more conscious acceptance and less “shame” on showing the amputated leg, he stated strongly that apart from the seaside, he chose to wear long trousers to cover the prosthesis all year round.

The last two statements highlight how strong the influence of external observers can be in affecting the confidence of users in showing the prosthetic device, and choosing which device to show. Furthermore, the example of D is evidence that amputees have to face the fact that the very few robotic options available are not aesthetically appealing at all. This issue might further discourage amputees to abandon the idea of using a cosmetic-looking leg, as the uncovered device stands like an ‘ugly’ option to show.

User J showed the opposite case in terms of aesthetic attraction of his prostheses. This user stated that he lost his legs in a car accident...and stated that he “loved his legs!” and “I’d liked to have them back”. He added that realistic prostheses would have been his favourite option as they could have reminded him of the lost limbs. He liked to have “something that copied what I used to have”.

Despite his desire to have realistic legs, his current devices are robotic, an appearance that does not meet his requirements, but he states that “I don’t care as other people like it and say ‘it’s cool, you look like a robot’”. Therefore, despite his statement of not caring about the opinion of others in the choice of his legs, he demonstrates the acceptability of the perceived non-attractive look of his prostheses, as other people say they like his robotic devices.

This last statement supports the idea that, regardless of the appearance of the prosthesis (i.e. cosmetic or robotic), some users are affected by the opinion of other people in choosing the aesthetic of the prosthesis. Most importantly, it shows that robotic devices, despite their different appearance, might gain more acceptance from observers than traditional devices.

1.2.2 A Change in the Concept of Prosthetic Devices

The visual appearance of medical products has always been associated with the image of items for ‘solving a problem’, or rather a technical vision of devices as a means of support for a human impairment. The background of the designers of these ‘technical’ products has been exclusively clinical and engineering and accounts for the appearance of a medical device not going beyond its medical function. In other words, these designs completely omit emotional design, often resulting in an unpleasing visual appearance. The appearance of these products often negatively impacts on the interaction of the patient with the medical device, which can be seen as non-user-friendly.

Fortunately, in recent years the design of medical products has improved, with the introduction of more emotionally appealing designs. For example, the bath board launched in 1998 by A&E Design is one of the first positive visually appealing medical designs. Similarly, the KaVO dental unit (**Fig. 1.3a**) shows a pleasing-looking design displaying comforting features and colours, and aims to suggest that going to the dentist can be seen as a positive experience: this design is described by Dan Harden as a product that “looks like it won’t hurt” (Sweet, 1999). By considering the role of orthotic products, the designer F. Lanzavecchia (Vainshtein, 2012) interprets her neck collar design (**Fig. 1.3b**) as an extension of the body and aims to achieve aesthetic comfort for the wearer in different situations by proposing an alternative to the traditional ‘bulky’ neck collar model. Moreover, Pullins (2009) describes how simple everyday orthotic products, such as eye-wear glasses (**Fig. 1.3a c**) are no longer considered a disability, but rather as fashion items. Where people in the past avoided using glasses as it was ‘shameful’ to display a device for visual impairment, nowadays this orthotic product is considered a beauty accessory.

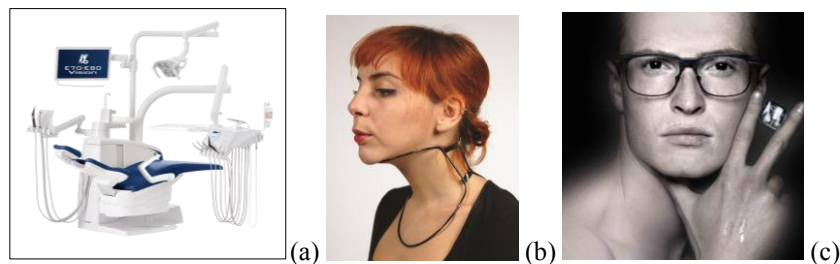


Fig. 1.3 KaVO dental units ‘E80 Vision’ (a), ‘Proaesthetic’ Absent Neck Brace design (Francesca Lanzavecchia - Photocredit: Davide Farabegoli) (b) and Eyewear by Cutler and Gross (c)

As well as the improvement of the design of medical products, the design of prostheses has improved in the years, and innovative theories regarding the understanding of prosthetic devices have been introduced. A point of view from the fashion sector is provided by the amputee and athlete top model Aimee Mullins,

who states that a prosthetic limb no longer represents the need to replace loss, but can be conceived as a fashion accessory. The prosthesis can stand as a symbol whereby the wearer creates him/herself like an architect and continuously changes identity by choosing different models (Vainshtein, 2011) (**Fig. 1.4a** shows the set of legs of the top model). The designer Freddie Robins shows an example of fashion clothing - a knitted wool item - designed expressly for an above limb amputee (**Fig. 1.4b**). The cloth, named ‘at one’, focuses the attention of the observer on the tattoo-style writing, that has a special meaning for the model wearing it, placed on the missing left arm area. The special design with one sleeve missing and the decoration aims to exalt the unicity of the model rather than focusing on ‘something missing’. A second example of design work for revising the vision of above limb amputees is found in the design of a golden prosthetic hand by the sculptor Jacques Monestier. The artist proposed an alternative artistic design that represents a provocative alternative to a realistic hand or a hook design. As Monestier explains “amputees often suffer a loss of self-image. I wanted to transmute what might be considered a disfigurement into something marvellous and exotic. I wanted to create a hand that would no longer cause shame and repulsion. I wanted amputees to be proud to have a prosthetic hand and pleased to look at it. And for the people around them, I wanted the prosthetic hand to be an object of healthy curiosity, a work of art” (page 16, Design Meets Disability).

The topic of perception of prosthetic devices also includes student academic research. For instance, Nguyen (2013) discusses how the prosthetic design should be “more connected to latent needs related to the feminine identity of female amputees” and how they should be connected to the idea of beauty rather than to mere functionality.

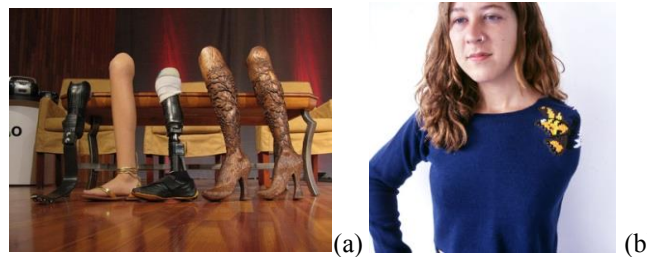


Fig. 1.4 The set of prosthetic legs of the amputee top model Aimee Mullins – screen shot located at https://www.ted.com/talks/aimee_mullins_the_opportunity_of_adversity accessed 01.12.15, (Aimee Mullins, 2009) (a), Catherine Long wears ‘at one’ knitted wool (Freddie Robins, 2001) (b)

In the past few years, media and fashion campaigns have aimed to positively raise awareness of the concept of showing and performing with amputation. The popular Paralympic games are the first major example. By referring to the London Paralympic 2012 and acknowledging the Commonwealth Games in Glasgow

2014, the BBC⁵ stated that “More than two-thirds of people believe attitudes towards disabled people have improved since the Paralympic Games in 2012, a survey has suggested”.

Prosthetic users K and G agree with this finding, and they reported that “for so long amputation and disabilities have been hidden behind closed doors”, but thanks to the media influence of the Paralympic games, people are becoming generally much more accepting of the phenomenon of amputation, and used to the idea of a prosthetic device. Accordingly, in 2012, the McCann Worldgroup released a poster campaign to promote ticket sales for the London 2012 Paralympic Games (Fig. 1.5a and b). The campaign included Paralympic stars and emphasised the power and physical performance of the athletes, making them appear less disabled, and almost like super heroes.

A campaign by Debenhams chose the long jump silver medal winner Stefanie Reid as model for a dress which leaves the legs uncovered (Fig. 1.5c). As reported by the Daily Mail⁶ regarding this choice, “the aim is to further challenge perceived norms of the fashion industry showing that a broader range of body and beauty ideals is a good thing”. Similarly, Kenneth Cole chose in the ‘We All Walk in Different Shoes’ Advertising Campaign, a series of 11 emotionally arresting photographs that celebrate diversity. By including the amputee top model Aimee Mullins, it was stated that “the hope is to dispel all forms of social prejudices while also exemplifying diversity”⁷.

A more provocative example demonstrating the emerging visual role of amputees is found in the model and singer Viktoria Modesta (Fig. 1.5d). Through music videos, modelling and shows, she demonstrates the use of robotic prosthetic devices as a strength point of her artistic image rather than as a weakness.

The singer states: “the time for boring ethical discussions around disability is over. It's only through feelings of admiration, aspiration, curiosity and envy that we can move forward”⁸.

These examples represent only a small selection of the media communications encouraging the elimination of stigma for amputees, and in most cases, they encourage the display of robotic devices and not hiding the ‘disability’. These works have probably helped the acceptance of external people towards the idea of amputation and alternative (i.e. non-realistic looking) designs.

⁵ <http://www.bbc.co.uk/news/uk-28175349>

⁶ <http://www.dailymail.co.uk/femail/article-2304574/The-Paralympian-amputee-glamorous-gran-size-18-swimwear-model-stars-new-Debenhams-campaign.html>

⁷ <http://www.prnewswire.com/news-releases/we-all-walk-in-different-shoes-56807927.html>

⁸ "Modesta kāju zaudējusi Latvijas ārstu nolaidības dēļ" (in Latvian). Delfi.lv. December 16, 2014. Retrieved January 16, 2015



Fig. 1.5 McCann Worldgroup a poster campaign for the Paralympic Games London 2012 (a) and (b) (located at https://adsoftheworld.com/blog/london_2012_paralympic_games_campaign, accessed 01.12.2015, McCann Worldgroup, 2012), the amputee athlete Stefania Reid for the fashion campaign of Debenhams (located at www.dailymail.co.uk/femail/article-2304574/The-Paralympian-amputee-glamorous-gran-size-18-swimwear-model-stars-new-Debenhams-campaign.html accessed 01.12.2015, Debenhams, 2013 (c), and the model and singer Viktoria Modesta (Jon Enoch photography) (d)

Despite the existence of these realities promoting a change in the perception of the standard model of amputation, more advances have to be achieved in the understanding of prosthetic product designs. Despite the fact that perception of disability and amputation has positively improved in the past few years, there is still room for improvement to be made. The issue of an old, traditional and incorrect vision of amputation, viewed as something to be ‘hidden’ and being ‘ashamed’ to show to others, is still present. The consequence of this view is little interest in the design of prostheses as aesthetically appealing models.

Some people could argue that the importance of the aesthetic of prosthetic devices should not be considered, as prosthetic users could simply cover the prostheses under long trousers. However, we recorded many male amputees who stated that they wanted to display their prostheses to others, and not to have to hide their amputation. As a matter of fact, it was not rare for us to meet amputees wearing shorts in winter, or, in one case, we met a user wearing a special pair of trousers which displayed only the artificial leg and covered the healthy leg. In the case of women, the possibility of wearing skirts or shorts was also a matter of importance; they did not want to renounce to their femininity, and they wanted the option to

wear a sporty comfortable look at the gym. Tastes in which prostheses for females to display could have been either a very realistic device or, more often, a nice and unique robotic design.

The issue of the appearance of the prosthesis seemed to be relevant also for users who were wearing long trousers. Most of the people we spoke to stated that they did not feel comfortable wearing an uncovered device under their long clothing, due to incompatible anatomy. The result of wearing this model is the uncanny effect of a skeletal leg when the trousers fold on the prosthesis. Similarly, most of the users disliked the idea of wearing a ‘bulky’ cosmetic model. They stated the preference for a robotic device, even when the device was not visible to other people. Our idea is that a prosthesis responding to the needs of the user can provide confidence to the wearer, even when not directly visible to external observers.

1.3 APD: From Medical Product to Appealing Work of Design

The works mentioned in the previous section propose examples of a change ongoing in the understanding of medical and prosthetic devices. Following this current of thought, we aim to go beyond the traditional meaning of prostheses and re-discuss the conventional vision of amputation. Our point of view is that the aesthetic of prostheses is an aspect playing an important role in prosthetic design and should be not undervalued. Specifically, we believe that the aesthetic of the device affects both the self-body vision of the amputee and the impression that the external observers and society have of the product and the understanding of disability of the wearer.

1.3.1 Overcoming the Stigma: From Disability to Super-Ability

The thought of some prosthetic user interviewees is that, if a device has to be noticed, they would much prefer to attract the attention of external observers for the beauty of the prosthetic design, rather than for an uncovered device or a bad mimicry of their lost leg (i.e. cosmetic device).

Our aim is to promote the beginnings of a different perception of amputation and of prosthetic devices. The objective is to move from a negative old-style phase where the prosthetic device is viewed as a matter of disability, or worse, something to be ashamed of; to an appealing robotic-looking device, that stands for ‘super-ability’ (**Fig. 1.6** Manifesto ‘Super Ability’ - University of Strathclyde Images of Research, May 2015 - Manifesto promoting this concept) rather than ‘disability’. For instance, the device can stand as something that the amputee is confi-

dent to wear and to show to others, i.e. it can have appealing futuristic features, it can look modern and robotic, or it can look feminine and graceful. The idea is that the device should represent a skilled work of design, or a fashion accessory, something to be seen to creatively play to the user's own identity. In return, the attention of external observers would switch from noticing a missing limb to noticing an appealing product, and therefore to change the approach to the understanding of the 'disability'. The person noticing the limb would for instance be willing to provide a comment like 'this design looks cool!' rather than 'how come the limb loss occurred?'

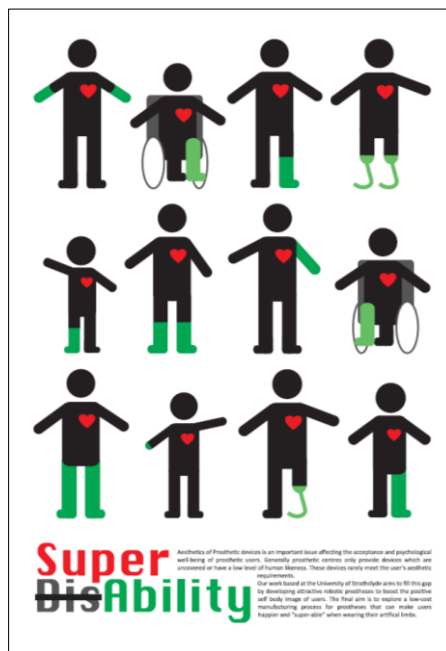


Fig. 1.6 Manifesto 'Super Ability' - University of Strathclyde Images of Research, May 2015

This concept applies, for instance, to other less severe forms of disability. For instance, some people with no visual impairment, in order to play with their image and look, wear fake glasses with an appealing frame. This example is put forward as an explanation of how that concept of visual 'disability' has changed over time, from something to 'hide' to something to be socially accepted and considered as a standing for fashion. On the subject of prostheses, when Oscar Pistorius was hosted by the University of Strathclyde in November 2012 as a guest speaker, he was told by someone in the audience that, after seeing him running at the Olympic and Paralympic games, his 5-year-old son asked for prosthetic running blades as a Christmas present. The child, a non-amputee, was seeing the devices as cool and as desirable to wear. He was not imagining the prostheses as supports for allowing

an amputee to run, but viewing these devices as a symbol of Super-Ability, as something to be proud to wear in front of his friends.

Will prosthetic devices be perceived as a product to be proud to show off and as a design work? This question is linked to the fact that prosthetic users need to feel proud and confident in using their artistic prosthetic devices. Our aim is to encourage this image of the use of prosthetic devices, and therefore improve the image of amputation. What we want to suggest is to change the image of amputation from the perception of a stigma and a disability to a super-ability – in other words, to view a device as a new and appealing part of the body, to be connected to the image that the user wants to promote.

1.3.1. Emotional Design for Prosthetics

Until a few years ago, the product design process was mainly focused on the functionality of the product and did not place much importance on the visual appeal. However, nowadays the concept of product design has completely changed. Consumers do not require only functionality in products, they also seek an emotional impact; they wish the product to communicate something to them. However, we question why a large number of everyday products with a shorter term of usability are endowed with a high emotional aesthetic appeal, whereas a special and intimate product, such as a prosthetic device, is designed and conceived as either a poor copy of the previous limb, or an unpleasant looking ‘skeletal’ device. We assert that the robotic prototype should be considered as the best design for promoting a different image of amputees and prosthetic devices.

The vision that the visual appearance of prosthetic devices is a matter of importance for the user is a novel field of investigation, as both the academic and industry interest in the field has been limited until now. Examples of authors interested in the subjects can be found in the research of Murray (2005; 2002) and Nguyen (2013).

Academic research specifically focused on robotic models as a way of revising the concept of prosthetic devices has been narrow. Influential researchers investigating this field can however be found i.e. in Vainshtein (2011) and Pullins (2009). The first author explored the role of prosthetic devices as a fashion accessory and a way of creating a new identity. Similarly, Pullins investigated the new role of prosthesis as more than a medical device. The author states “within design for disability, where terms still tend to come exclusively from clinical and engineering backgrounds, the dominant culture is one of solving problems. A richer balance between problem solving and more playful exploration could open up valuable new directions”. A few companies have been interested in the design process of robotic devices by proposing aesthetically elaborated carbon fibre pros-

thetic covers - like the US companies Unyq⁹ or the The Alternative Limb Project¹⁰.

However, the examples mentioned are only partially relevant and do not fully cover the theme of the revision of the concept of prostheses for the well-being of the users.

The most relevant research around the topic of image of prosthetic devices can be found in the Simple Limb Initiative of San José State University. By uniting prosthetists and the works of university design students, the project aimed to design robotic prostheses for the elimination of the social stigma for children of developing countries.

The Simple Limb Initiative is a project initiated in 2013, under a collaborative design project between Prof. Leslie Speer from San José State University (SJSU) and Prof. Gerhard Reichert from the Fachhochschule Schwäbisch Gmünd (HfG SG). Together, they and their students worked on conceptualising affordable prosthetic designs that focused on aesthetics without compromising function. It is the belief of the project that people, amputees or not, wish to be surrounded by and look at beautiful objects in their environment, including the objects they wear and see others wearing. Celebrating one's 'disability', through positive association, assists the amputee with everyday reactions from the public and as a result provides confidence and pride in themselves and their abilities.

Simple Limb Initiative's ongoing research with amputees has shown that there is a desire for attractive and beautiful prostheses that can augment their physical appearance in a positive way (Fig. 1.7). Through the project it was found that both prosthetists and engineers who work in the clinics need convincing as to the value of beauty in these types of products. Engineers, quite rightly, believe that functionality is primary and that the amputee wishes to have something to replace the missing limb that visually replicates a human appendage. As discussed earlier in this chapter, the Uncanny Valley is experienced by onlookers and this can result in a kind of isolation for the amputee. This suffering and isolation is what has prompted the Simple Limb Initiative to do the work they are doing.

The project was supported by Prosthetic Solutions in Santa Clara, California and Mahavir-Kmina in Medellin, Colombia, where multiple products have been designed and are undergoing user testing. Each round improves upon the previous and the most recent results are visually appealing, have a variety of aesthetic choices, function well, and all cost under \$30USD in parts to manufacture. Materials used were sourced in multiple locations around the world, are common and easy to obtain, and in many of the solutions rely on local craft industries to fabricate.

⁹ www.unyq.com

¹⁰ www.thealternativelimbproject.com/

During the projects, student teams designed products that would be used in Colombia. This geographic focus gave student teams the opportunity to develop solutions that addressed visual and aesthetic preferences in a specific region. This also gave them the ability to expand their material choices by actively finding a wider variety of material and fabrication resources. Trying to find the aesthetic/functional/cost balance for such a demanding product is an ongoing challenge, and was faced during the final part of the student project prosthetic. The acceptance of the aesthetic of the legs will be tested to assess whether the patients actually are interested in prostheses that are beautiful and functional.

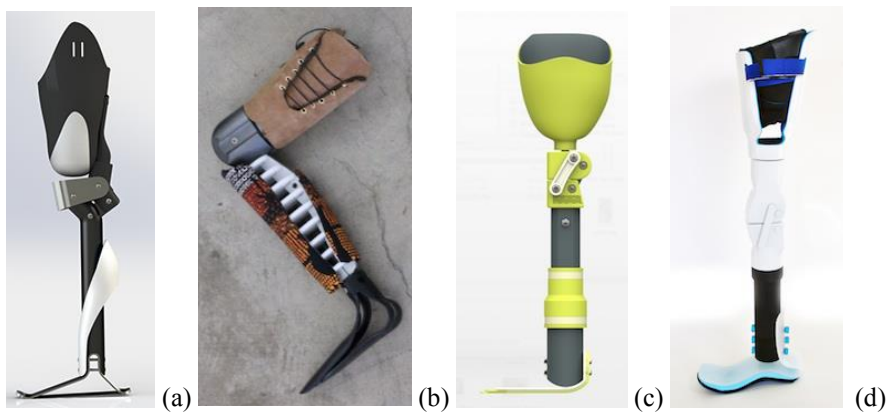


Fig. 1.7 Simple Limb Initiative Transfemoral Prototypes Round 2 (Left to Right: A: Natalie Mukhtar; B: Richard Lotti; C: Adam Fujihara; D: Eskady Haile)

The students' work has resulted in a number of insights. Finding aesthetic solutions that purposely avoided the Uncanny Valley, yet incorporated aspects of cultural identification through form and detail proved challenging, but over the three rounds have evolved and resulted in positive reactions from amputees. The inspiration for the project has been centred on a culture (region) and the art, architecture, fashion, and design that is native to that region. Finding opportunities to incorporate the talents of local artisans and materials was helpful in focusing aesthetic efforts.

Future explorations for the Simple Limb Initiative will include research activities working with amputee partners to gain insights into their aesthetic preferences, and both positives and negatives will be engaged. The results of this research will feed into the next round of prototyping and will drive discreet component design, along with overall aesthetic.

1.4 Conclusion

Our research aim is to offer a different perception of the medical product – and, specifically, of the prosthetic device; as a way to promote in users and external observers a different image of disability and to encourage the perception of the device as a good looking design item rather than a visually unattractive medical device. We propose the use of robotic devices for allowing amputees to wear a personalised and attractive ‘new part of their body’, and present this design for allowing both users to gain a positive self-body vision and external observers to view the concept of disability under a new, positive light. By using a unique and artistic robotic replacement of the limb, amputees should perceive themselves and be perceived as ‘super-abled’ rather than ‘bearer of stigma’.

By acknowledging the personal differences in users for their tastes and their ideal device, and deeper psychological dynamics for their body vision, we believe that times are right for encouraging a more matured vision of amputation and a different approach in prosthetic design is needed as a first step in this matter. The majority of prostheses currently produced are designed to mainly address the pragmatic needs of the user and, by following an old traditional prosthetic form, do not take into account their emotional requirements. Our assumption is that a change in the image of disability is needed and that significant help can be provided by revising the image of prostheses to meeting the expectations of users based on how they would prefer their appearance to be.

We recognise as a limitation of our work the fact that our principles might not apply to all people and in all the cases. For example, there are people that might have little or no concern on the visual aspect of their prostheses and are happy to use an uncovered device, or users who are more comfortable to wear a realistic-looking device rather than artificial-looking one, or others that might be happy to wear different designs for different occasions (i.e. realistic prostheses for formal occasions). Additionally, we recognise that the topic of disability and amputation is a wide and complex psychological process, and the issues of acceptance and well-being is a delicate course, and cannot to be reduced to the design of the prostheses only.

Our work hopes to promote a new design system in which a user has the option to choose an attractive robotic prosthesis and to feel comfortable to wear it in a public place. The idea is for the amputee not to attract attention of people for his disability, but for the visual appeal and originality of the prosthetic product.

Our hope is that the understanding of disability will be more positively perceived in the near future and that our research could inspire people involved in the prosthetic design process – i.e. prosthetic users, prosthetists, prosthetic designers, external observers – to change their views of prostheses in terms of improving prosthetic designs for meeting the prosthetic users expectations. The core motiva-

tion of this process is the users' general well-being and to promote more critical knowledge in the field of aesthetic of prosthetic devices.

1.5 References

- Cheetham, Marcus, Suter, Pascal, & Jäncke, Lutz. (2011). The human likeness dimension of the 'uncanny valley hypothesis': behavioral and functional MRI findings. *Frontiers in human neuroscience*, 5.
- Hahl, Jill, Taya, Minoru, & Saito, Makoto. (2000). Optimization of mass-produced trans-tibial prosthesis made of pultruded fiber reinforced plastic. *Materials Science and Engineering: A*, 285(1-2), 91-98. doi: 10.1016/s0921-5093(00)00720-6
- Klute, Glenn K, Kallfelz, Carol F, & Czerniecki, Joseph M. (2001). Mechanical properties of prosthetic limbs: adapting to the patient. *Journal of rehabilitation research and development*, 38(3), 299.
- MacDorman, Karl F., Green, Robert D., Ho, Chin-Chang, & Koch, Clinton T. (2007). Too real for comfort? Uncanny responses to computer generated faces. *Computers In Human Behavior*, 25(3), 695-710.
- Mak, A. F., Zhang, M., & Boone, D. A. (2001). State-of-the-art research in lower-limb prosthetic biomechanics-socket interface: a review. 38(2).
- Mori, M. (1970). The Uncanny Valley. *Energy*, 7(4), 33-35.
- Murray, C. D. (2005). The social meanings of prosthesis use. *Journal of Health Psychology*, 10(3), 425-441.
- Murray, CD, & Fox, Jezz. (2002). Body image and prosthesis satisfaction in the lower limb amputee. *Disability & Rehabilitation*, 24(17), 925-931.
- Nguyen, Debbie Diem. (2013). *The beauty of prostheses: designing for female amputees*. Massachusetts Institute of Technology.
- Pullin, G. (2009). *Design meets disability*: Mit Press.
- Rybarczyk, Bruce, Nyenhuis, David L, Nicholas, John J, Cash, Susan M, & Kaiser, James. (1995). Body image, perceived social stigma, and the prediction of psychosocial adjustment to leg amputation. *Rehabilitation Psychology*, 40(2), 95.
- Sansoni, Stefania, Wodehouse, Andrew, McFadyen, A, & Buis, Arjan. (2015). The aesthetic appeal of prosthetic limbs and the uncanny valley: The role of personal characteristics in attraction. *International Journal of Design*, 9(1), 67-81.
- Sweet, F. (1999). *Frog Design: Form Follows Feeling*: Crown Publishing Group.
- Vainshtein, O. (2011). Being Fashion-able: Controversy around Disabled Models.
- Vainshtein, O. (2012). 'I Have a Suitcase Just Full of Legs Because I Need Options for Different Clothing': Accessorizing Bodyscapes. *Fashion Theory-the Journal of Dress Body & Culture*, 16(2), 139-169. doi: 10.2752/175174112x13274987924014