

Designing for Dignity (Aesthetic Choice in Prosthetic Limbs and Its Psychological Impact)

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Abstract

The historical context of prosthetic design, the biological functionality and appearance of a lifelike leg and the notion that if one has a missing limb he/she wants to cover it, so the wearer can be normal around "normal" individuals has always been the primary concern. This paper will explore the psychological and social influence on prosthetic aesthetics—are a patient's needs actually being met by aesthetics based on realism, or is there a more beneficial psychological advantage to more mechanically-based designs and forms of expression? Using a combination of prosthetic embodiment, studies of comparisons of aesthetic preferences and first-person feedback from both amputees and prosthetics technicians and patients.

This paper will demonstrate that observers and amputee users have significantly different opinions on artificial aesthetics, with users often feeling more satisfied and more confident with visibly mechanical or expressive-looking artificial limbs, as opposed to what observers prefer (a more lifelike imitation appearance) based on aesthetics that support social normalization.

In comparison studies, these stark differences in opinions suggest that aesthetics has more influence over amputee user retention, social return, and overall mental healing than that of a cosmetic matter that can potentially affect overall well-being post-amputation. The paper uses the case study of the Open Bionics Hero Arm to illustrate the use of user-determined aesthetics as an actual design aspect, opposed to solely achieving a realistic outcome, to promote well-being of the user. The paper will ultimately present a call for consideration of aesthetics, as more than just a cosmetic issue, as an essential component to the success and utility of prosthesis and greater influence of psychological and social research into prosthetic development.

1. Introduction

This essay will argue that aesthetic choice is more than a superficial aspect of prosthetic design – it is whether the device is mechanical or not. Rather it would contend that the subjective aesthetic preference for prosthetic design should be taken as one of the major engineering design concerns because of the importance to identity of the person and their success with socio-emotional reintegration back into their environment. The conventional design approach assumes that an ideal prosthetic is a lifelike one, a realistic depiction of flesh and flesh-and-blood limbs, with the unspoken intention of enabling the wearer "pass." The fundamental assertion of the realistic appearance paradigm has never really been tested empirically directly against the psyche of the amputee who actually uses the device: are the amputees satisfied by and desiring of concealment? New evidence from the prosthetic embodiment studies, amputee designer workshops and comparative aesthetic studies suggest a very different, more nuanced perspective where many amputees, given a free choice between the two, prefer the mechanical over the realistic form

of the prosthesis. For them, the mechanical shape announces not only identity, identity and others, but also resilience, but not the insufficiency and inadequacy that would inevitably be concealed.

The emphasis of this paper will be on exploring this gap between the designer's assumptions and the amputee's personal priorities and expectations. By attempting to address the issue of what makes the prostheses visually appealing devices, it will also address the question of what relationship exists between an amputee's social acceptance and psychological well-being and their general preferences in relation to the appearance of their prostheses (realistic or mechanical).

The question is of interest not only as an abstract aesthetic problem but also because the issue of prostheses "returning to the drawer" due to the amputee's refusal to use them is a serious matter. The appearance of the prosthesis is often one of the reasons for such a decision. Consequently, an understanding of the psychology of amputees' visual preferences will have practical implications in both the fields of prosthetic device development and the day-to-day work of prosthetists with their patients.

This paper will contend that the element of aesthetic choice in prosthetic design is not merely a superficial characteristic-as mechanical or not. But instead will assert that aesthetic preference should be considered one of the critical mechanical considerations in prosthetic design, because this factor is critical to the identity and self-confidence of amputees, and their ability to psychologically integrate back into society.

2. Literature Review

2.1 Prosthesis Embodiment and Appearance

Body part perception (i.e. to what degree does the user experience the prosthetic to be part of the body itself rather than external to it, a construct often called embodiment), is also being studied more widely in the field of prosthetic psychology in the recent literature. One such investigation that took place in 2020 for the journal *Frontiers in Neurorobotics*, showed that there was a close relationship between a high degree of perceived realism and high levels of embodiment. As a result, this degree of embodiment had strong power in predicting overall user satisfaction. This suggests appearance is not separate from function in the user's experience — it directly shapes how "integrated" the device feels.

However, embodiment research also complicates the simple idea that "more realistic equals better." A systematic review in *Micromachines* (2024) on bionic hands notes that appearance is closely tied to body image and social interaction, and that while a natural-looking limb can reduce negative emotion for some users, aesthetic satisfaction is not driven by realism alone — expressive and stylized designs can serve the same psychological function.

2.2 Divergence Between User and Non-User Preference

One further observation of equal interest is that the non amputee's perception of what is normal for an amputee is in large part, in direct contradiction to how "the amputee" would rather have it. According to findings from a comparison study by Amplitude (Living with Amplitude) on amputees and non amputees, it was found as compared to what non users would rather have as a prosthesis, a more natural looking prosthesis is preferred by a smaller percentage, compared to those who would rather have a more mechanical looking prosthetic device.

This finding highlights the need to rethink the design defaults, previously grounded in the pursuit of realism, in favor of the non amputee's comfort.

Supporting this, a 2019 comparative study conducted across Greece and the UK found that participants rated expressive, decorated prosthetics as more attractive than conventional ones, and that expressive

designs improved user confidence and functioned as social "conversation starters" rather than sources of stigma.

2.3 Co-Design and Patient Involvement

This study undertaken by the GSA (Blom & French) of bespoke prosthetic covers showed that, "even without active prosthetic modification the very inclusion of an amputee in the design process could have psychologically positive effects to self, identity and confidence." And the consequences of this - well, if it is not the form of the prosthesis itself but who is taking decisions about how the prosthesis should look that has beneficial results?

2.4 The Cosmesis Perspective

Not all literature aligns neatly with the "expressive design is better" narrative. A UK-based study on foam cosmesis for lower-limb amputees that interviewed 153 patients found that the general satisfaction with the aforementioned realistic cosmetic covering was lower than the medical device industry expected, primarily due to durability and maintenance issues as opposed to the concept of realism being inherently displeasing – which suggests that the implementation quality affects the outcome, not the idea itself. An overview on artificial limbs found in the PMC1121287 source mentions that while some amputees appreciate the robotic aesthetic of prosthetic components, most patients prefer a realistic, unnoticeable appearance for their artificial limb – proving that the concept of realism is not entirely desirable despite its apparent benefits and is not a universal preference.

2.5 Industry Perspective: The Open Bionics Case

co-founder Samantha Payne adds a design-industry perspective to academic literature. She has identified that traditional prosthetic design aimed to visually blend into the human body, but that engineers had difficulty making this a plausible appearance — and that direct user workshops identified that users actually wanted to wear something that made them feel empowered, rather than something that looked like human tissue. This insight contributed to Open Bionics' shift toward more customizable and expressive covers than skin-toned realism.

2.6 Gap Identified

Combined, the literature indicates two contrasting trends, one of which supports embodiment via realism, and the other psychological benefit via expressive, non-realistic design. Few works attempt to reconcile these results or explain which amputees are likely to fall into which category, and why. The present paper's research question, exploring amputee preference directly through patient and practitioner interviews, is poised to determine a distinction between the two, rather than adopting one as universal preference.

3. Methodology

3.1 Research Approach

The nature of this study is qualitative since the research question is based on a subjective aspect of the amputee's perception of their bionic prostheses. The approach is literature-based. The choice of this strategy was driven by the fact that the research question concerns the amputee's feelings and attitudes towards the appearance of their prosthetic limb. Thus, quantitative research would not be sufficient for this study.

3.2 Scope

There will be a specific focus on upper limb bionic/myoelectric prostheses in the case of the Open Bionics due to the high level of sophistication of such devices. Even though the paper will also cover lower limb prostheses and passive prosthetics, the focus will be on the case of the Open Bionics Hero Arm.

3.3 Sources of Evidence

Three types of evidence were drawn on to build the findings of this paper:

Academic and clinical literature — Peer-reviewed research and systematic reviews covering prosthesis embodiment, aesthetic satisfaction, and psychological adjustment after amputation (including studies published in *Frontiers in Neurorobotics*, *Micromachines*, and NIH/PMC archives) were used to establish what is already known and where existing findings conflict.

Secondary interview material — Original interviews were outside the scope of this paper, so it instead relies on interviews and firsthand accounts already published by credible institutions and news outlets, treated here as documented qualitative evidence:

A patient account from Euronews' coverage of amputee soldiers being fitted with bionic prosthetics, offering a direct, personal perspective on what it feels like to wear an expressive prosthetic device.

An expert account from a Johns Hopkins University publication, in which a clinical prosthetist discusses the practical realities of fit, comfort, and function that shape how a patient relates to their device day to day.

Industry and case material — Public statements from prosthetic manufacturers, along with product pages and user testimonials, were reviewed to see how design philosophy plays out in real, commercially available devices.

3.4 Case Study Selection

The Hero Arm was chosen as the paper's central case study because it is a well-documented example of a prosthetic built specifically around user psychology and aesthetic research, not just biomechanical performance. Its move away from skin-toned realism toward customizable, expressive covers makes it a useful real-world anchor for the paper's argument. :

3.5 Data Analysis Approach

Sources were reviewed and compared thematically rather than statistically. Findings across academic studies, published interviews, and industry material were grouped around recurring themes — such as embodiment, social perception, and patient agency — to identify where the literature agrees, where it conflicts, and where firsthand accounts support or complicate the academic consensus.

3.6 Why This Method Was Chosen

Since the research question was exploratory and not hypothesis driven, a research method involving an accumulation and synthesis of the literature as well as published personal narratives was a more fitting approach than collection of new primary research. Use of pre-published interviews would also ensure credible, documentable first-hand evidence with minimal requirement for ethical approvals and research time commitments characteristic of primary human research.

3.7 Limitations of the Method

Because this paper is built on secondary literature and previously published interviews rather than original research or a large-scale independent study, its findings should be read as illustrative of broader patterns already identified by existing institutions and researchers — not as new primary data collected specifically for this paper. `

4. Findings / Results

4.1. A mismatch in preference between observers and users

Perhaps one of the clearest threads running through the literature, and one of the more interesting discoveries, is that when it comes to designing a more attractive prosthetic leg cover, what makes it more

attractive to the people who will be wearing it often has nothing to do with its appearance to an outside observer, or to people with both legs intact. A 2019 comparative study from Greece and the UK indicates that the public tended to favor realistic, flesh-toned covers in terms of social acceptability, but amputees who would actually have to live with them usually would not. Their research also revealed that experimental expressive cosmetic leg covers were rated as more attractive than the realistic ones and were more likely to increase the user's confidence, as well as encourage them to talk about it rather than conceal the fact that it is a prosthetic at all.

4.2. Realism, and its limitations for embodiment

Still, there is positive evidence for realism too. The previous research aside, another study, published in 2020 in *Frontiers in Neurorobotics*, reported a link between visual realism in lower-limb prosthetic appearance and degree of embodiment (e.g., how the prosthesis felt like part of the participant's body); and embodiment, in turn, was related to higher user satisfaction. Thus for many, and perhaps for one meaningful fraction of users at that, realism does genuinely still matter from a psychological perspective. However, this is tempered by a systematic review published in 2024 in *Micromachines* that challenges the notion that that's one way of guaranteeing satisfaction—the authors reported that the appearance-based well-being is driven more by self-image and general social interaction; thus if the cosmetic cover could make body image and social interactions better by some means it did not matter how closely the cosmetic cover came to looking like human skin—if it managed this goal effectively by some unconventional means of beauty, then satisfaction would increase with whatever method achieved it.

4.3. The role of the decision-maker (not just the outcome)

This also suggests some related insights from work on co-designing from the Glasgow School of Art: and it is perhaps not at all an interesting concept if appearance (aesthetic) alone, or of having to choose between realistic (normal) or creative, comes from a participant whose life is unaffected and not who has to live with the choice. Amputees who directly participated in the design of their prosthetic cover reported increased identity and confidence, regardless of whether it was realistic or not.

4.4. A Patient's Own Account

This pattern shows up in real accounts too. Euronews documented the reaction of Vitalii Ivashchuk, a soldier who lost his hand in a mine explosion, after being fitted with a bionic Hero Arm with interchangeable, expressive covers. He described the moment as "a very cool feeling" that he struggled to put into words — a small but telling data point that lines up with the broader literature on expressive design and user confidence.

4.5. What Practitioners Emphasize

A publication by John Hopkins University, which featured clinical prosthetist Courtney Moran, offers a valuable perspective. She notes that an ill-fitting socket can lead to pain and discomfort, and that the limb will always feel “heavy and bulky” regardless of its appearance. In other words, comfort and fit act as a baseline requirement by which the prosthetic's aesthetics are evaluated.

4.6. What the Hero Arm Case Shows

Open Bionics cofounder Samantha Payne has noted that the company's user-tested findings have led to a major shift in design philosophy for the Hero Arms. The goal was to create a product which amputees would feel empowered using – and which did not seek to disguise its mechanical nature. This represents a practical application of the psychological findings, which have since shaped the company's focus on customizable, pop-culture-inspired covers.

4.7. The Preference Isn't Universal

It is important to note that not all sources agree on the preference for organic appearance. An NIH/PMC publication on artificial limb design concluded that although some amputees preferred the robotic aesthetic, the larger majority expressed a desire for a more natural, less conspicuous look. Furthermore, a UK-based study which surveyed 153 lower limb amputees found that satisfaction with realistic cosmetic coverings was lower than expected – and due to factors like durability and upkeep needs rather than an inherent preference for mechanical limbs. Overall, these latter two studies suggest that the preference for mechanical limbs is situational and varies from case to case.

5. Discussion / Analysis

5.1 Explaining the observer/user preference disparity

This finding regarding the divergence between how non-amputees assess the appearance of prosthetics and how amputees perceive their own them is likely the most crucial finding of this paper. For a considerable duration, the appearance of prosthetics has almost always remained realistic primarily due to the presumptions and preconceived notions society held for disability. Designing prosthetics based on realism, in the majority of cases, did not come from what amputees believed they wanted for prosthetics as a product, rather a standard that was developed, mostly from outside observers of disability. What I found most striking, however, was how preferred expressively appearing prosthetics were by amputees, which can be a sign that prosthetic designers spent the entirety of its existence implementing its capabilities without addressing the right fundamental problem: to designing a more comfortable looking prosthetic for observers rather than more confident looking ones to individuals wearing it.

5.2 Connecting the theory of embodiment and the idea of expressively appearing prosthetics

At first glance, it appears embodiment theory results which suggested that a prosthetic which appeared more lifelike as opposed to mechanical would lead to an increased sense of embodiment and satisfaction from its use, may clash with the suggestion that an expressively appearing prosthetic would induce more feelings of confidence in its user as well as an increased attractiveness as a user. However, it is not necessary these two pieces of research contradict each other, the link between the two could be made considering how embodiment is felt if the prosthetic felt more like a part of themselves, if the prosthetic appeared more mechanical it simply adds to the expressively designed object as an expression of their identity as a person. An extendable, mechanical looking prosthetic will still feel embodied by the user, as it supports their identity as someone whose disability allows them to grow, as opposed to an organic prosthetic which would seek to replace what they cannot longer have. The essential difference between embodiment and expressively designed prosthetics is that for the former the appearance must feel more like an extension of themselves or their personal identity rather than something which appears realistic due to its material and design.

Nevertheless, it seems to tie in perfectly with Glasgow School of Art's findings which suggested the increased confidence of the user was not due to them appearing more attractive in the expressive prosthetic, but due to their involvement in the design process which gave them a more confident feeling overall experience.

5.3 How design is not part of a comfort pre-requirement but a follow-up addition.

With Courtney Moran taking such an emphasis on fit can be a good reminder to keep that the aesthetics and appearance in this study does not exclude for the function of wear. Surely, a remarkably visually appearing prosthetic that is not able to provide an ample experience to the wearer by either feeling

uncomfortable, hurting them, or fitting oddly, a person cannot continue to wear a prosthetic that is solely good for looking rather than a good fit and feeling a substantial addition. The result of this is that function would take priority for a part of the product and aesthetics later with a more effective prosthesis. If you look at this, the designer of a prosthetic must always consider how well the prosthetic will work, before considering any other aesthetics for it to succeed to its given function.

5.4 The Hero arm showing design in practice

The case of The Hero Arm can show us that it has taken companies a very long time to finally realize how important user opinions and user testing truly is for product creation and especially prosthetic design since companies seem more concerned with engineering the prosthetic than thinking how actual individuals will benefit in a psychological aspect. The workshops mentioned where Samantha Payne speaks, reveals just what an influence the opinions and research by amputees had upon the final design of the prosthetic. The results are clear since the psychological benefit for using the prosthetic did not arise due to an expressively designed part but as the direct result of the participation and care of the wearer, leading to a completely different perception of usage.

5.5 The need for universal preference to cease to be a primary characteristic of a successful prosthetic

The reason why I am selecting to argue against what most say, as in wearability, as being very important to prosthesis design (or that most amputees still preferred an organic, human-looking prosthesis) is to better align with my own research that the appearance does indeed have some effect for wearability in relation to the wearers emotional comfort with its appearance. However, the fact that it would not be universally desired is what I believe to benefit this study, and why the preference of a prosthetic must be different based upon such things as how the prosthetic was acquired, how old the wearer is etc. A wounded veteran from combat may benefit or desire a mechanical-looking prosthetic versus a wearer in his or her eighties, having been a victim of disease leading to prosthetic use etc. These different criteria must also have some place in prosthetic design rather than it having one right type of design.

5.6 Broader implication

With the research stated above on embodiments theory, the influence of expressively appeared prosthetics as well as the importance for the wearer being a part of prosthetic design through involvement in workshops this study displays the need to further investigate the topic, and for prosthetic designers to view both fashion and function as two inseparable components of prosthetic use not to approach the appearance of a prosthetic design as some cosmetic that would add value to the final product rather it being a clinical attribute for self-consciousness as well as self-image.

6. Case Study: Open Bionics Hero Arm

The Open Bionics Hero Arm is a multi-grip, myoelectric bionic prosthetic designed for below- and above-elbow amputees, including children. It was selected as the case by this paper since it fully embraces the psychological research, discussed earlier, and does not adhere to the traditional realism-based design model.

Instead of the skin-colored coverings, the Hero Arm highlights its light plastic 3D-printed shells, which could be replaced with different colored and patterned ones (magnetized) for a variety of reasons: from Marvel and Star Wars to Disney characters. It was co-founder Samantha Payne, who reported that the decision was inspired by users during workshops, who recognized that amputees would like to have a prosthetic limb that would empower them, as opposed to realistic ones, which could be creepy.

It resonates with the psychological research in the section, as another veteran, Vitalii Ivashchuk, who lost his arm in combat and became a hero with it, described the first visit as a “very cool feeling”, thus representing how the correct aesthetic could empower people. The study supports the claim about the importance of such characteristics for a prosthetic device’s users.

Meanwhile, the Hero Arm also introduces a custom-molded, breathable, and adjustable socket, meaning the focus on comfort is what ultimately brings in the empowered feeling and the altered perception of a prosthetic limb. It could be concluded that the case fully embraces the ideas presented in the article, with the specific focus on aesthetics being the key element for a successful user experience. Moreover, it is a perfect example of how the user-centered approach could be used in prosthetic devices to increase the degree of empowerment, in contrast to the traditional realism approach.

7. Conclusion

This article aimed to determine the effect of the visual design of a prosthetic limb on the amputee’s social acceptance and psychological state, as well as their preferred appearance between realistic or mechanical. The article concluded that while there was no universally preferred design, most amputees would choose to have an expressive or mechanical prosthetic limb due to confidence and control rather than camouflage. The study also found that psychological benefits were associated with realistic prosthetics, with embodiment being a significant condition, while comfort was a universal requirement regardless of design. The findings in this paper are displayed through the Hero Arm example, which has been a commercial success. This conclusion supports the article’s thesis that prosthetic design is a vital component of a psychological, social, and physical nature and should be considered a necessary aspect in prosthetic design. Aesthetics should not be determined by default, whether that is mechanical or realistic, but rather by the individual and their preferences.

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