

## Chapter 10

### Co-designing for care: Craft and wearable wellbeing

This chapter examines a less well-understood aspect of personal medical devices (PMDs) as products of complex design processes that function at the intersection between aesthetic and scientific agendas. While these have been the subject of considerable discussion since Simon's (1969) seminal work on design and creativity, the personal element of medical devices highlights more recent developments in design thinking about the relationship between designer, object and user. One approach that has gained significance in recent years has been participative design in which users are brought into the design process to contribute to the designed outcome. In a medical context, patients have tended to be the passive recipients of designed objects and services, with limited engagement in creating a user-centred functionality and aesthetic. However, engagement in the design of medical devices may have positive effects on user motivations to adherence- a better and more inclusive design of PMDs may improve their use and ultimately result in better health. To demonstrate this as a possibility, a case study of participatory design is presented, in which a medical device is conceptualised as jewellery. Participant involvement in the design of an attractive

and personally meaningful product met their desire for more personalised solutions, greater empowerment and enhanced sense of wellbeing. Through situating this case study in relation to design practices and theory, including the design process and ‘good’ design and how meaning is made through design, we open up a new approach to PMDs and medical technology: the importance of considering design. Building on this perspective, we suggest that through a co-design process PMDs might be made more personalised, and that we might find ways in which PMDs, and other health technologies, could be better designed for care through design collaborations.

Good design is essential to both appearance and performance of products. When they are easier to use, fit for purpose and attractive they have motivational qualities; “I want to use it” rather than “I have to use it” invests a degree of ownership in the designed device. However, design refers to both the process and outcome of the activity (Walsh, 1996) and the route to participatory design is an evolutionary one. Explaining design, and what designers do, defines the possibilities for patient engagement through designer problem-solving, ‘know-how’ and the designed outcomes. When design practices combine with an increasing awareness of the importance of person-centred healthcare, they form a compelling focus for research (Golubnitschaja *et al.* 2014).

The argument is extended by the US National Institutes of Health; in order to balance cost reduction with improvements to health and healthcare, medicine must move away from “one size fits all” therapies to become more predictive, pre-emptive, personalized, and participative over time (National Institutes of Health, 2008). The development of service and interaction design but also the proliferation of sophisticated yet affordable personal medical devices contribute to this approach. Some personalised devices have been used for many years, for example glasses and hearing aids, but they increasingly include complex technologies found, for example in blood pressure monitors, that enable patients to

independently monitor their own health. Such devices clearly provide opportunities to gather and communicate personal information. However, it is less clear how the appearance, functionality or symbolic meaning of technologies contributes to a personalisation and an individualised experience.

Within this spectrum of devices, the provision of personal orthotics presents a particular challenge. The correct supply and fit of orthotic devices can be a major factor in the management of a health condition, and in preventative care (HEC, 2009). These are addressed by NHS England's (2015) guidance for understanding patient's needs and the recommendation of a ten-step process. Whilst most of these steps focus on service provision and transformation, others focus on the patient and the device and include the need for the device to be comfortable and provide appropriate support and accurate fit, a choice of high-quality providers; and finally the need to be cosmetically acceptable- an accounting for cosmesis, in particular for image-sensitive younger people. These guidelines point towards a significant change for orthosis provision that improves both patient satisfaction and adherence.

Since orthotics are orthopaedic devices for immobilization, restraint or support of the body (Glanze et al. 1990), personalisation is required to offer the close fit necessary for them to function appropriately, and to allow people to feel an emotional attachment towards them, as they would towards other worn objects, 'wearables' that match their sense of fashion or style. Therapeutic user engagement addresses this challenge through opportunities to develop craft techniques for personalisation and in so doing, highlights the relationship between designers and users, design practices and design thinking.

The crafting of splints in particular has a long historical connection; twentieth century European wars provided the catalyst for the development of both materials and techniques. In the First World War sculptors and woodcarvers applied their craft sensibility to explore the

use of materials such as papier-mâché, leather and textiles to develop new forms of fabrication. (Llewellyn 2010). During the Second World War, furniture designers Eames applied their plywood-forming technology to leg-splint design, further demonstrating how the crafting of materials, methods and anatomical knowledge has contributed to personalised, well-fitting devices. And while craft has influenced splint-making, so the process of splint-making has also influenced craft and design culture (Pullin, 2009).

The personalisation of orthotic devices, the use of craft techniques and interactive design principles may create a new model for developing effective treatments. Our case study demonstrates how participants with Ehlers-Danlos Syndrome-hypermobility type (EDS-ht)<sup>1</sup> which requires the use of splints, felt about wearing conventional splints, and how engagement in the design of different splints enabled them to create better-fitting and more personally meaningful devices. In order to explore a design-approach to PMDs, we first situate PMDs within design theory, drawing on ideas of what constitutes ‘good’ design, how meaning is made through design, interactive approaches, and how it might be possible to design for care.

## **Design**

The development of orthotics demonstrates how design processes and outcomes themselves are subject to change both in activity and interpretation. Buchanan (2001), reflecting on the development of design, describes places or placements as areas of discovery and invention that characterise the practice of design. They demonstrate new ‘orders’ of practice and research as a way to answer new project and societal demands. Buchanan argues

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<sup>1</sup> Ehlers-Danlos Syndrome is the name of a group of rare inherited conditions that affect connective tissue of which there are a number of variants, hypermobility type is the more common of these and can cause joint hypermobility, dislocations and extreme fatigue (<http://www.nhs.uk/conditions/ehlers-danlos-syndrome/Pages/Introduction.aspx>)

that design's trajectory has moved from 'symbols' (graphic and communication design), to 'things' (product design), 'interactions' (interaction design) and finally 'systems' (environment and system design). These orders are not rigidly fixed, but represent the growing scale and complexity of design interventions. A definition of design that emerges is by no means straightforward but necessarily captures the relationship between the creative process and realised solution, as "the intentional solution of a problem, by the creation of plans for a new sort of thing..." (Parsons, 2016, p.11). In this, design distinguishes itself from craft, which draws on the development of traditional skills and the application of standard rules to materials (Parsons, 2016).

From an object perspective, PMDs can be considered as designed products that demonstrate a relationship between form and function. Functionalism developed the principles of functional aesthetics that emphasized geometry, precision, simplicity, and economy in the design of products. Design should be from the "inside out", so that the form of a product follows from its function, an approach later summarised by Mies van der Rohe, one of modernism's leading proponents as 'less is more'. Arguably in this tradition, functional form was realised as a styling feature, a fashion for nothing, as much as other movements were associated with style through different forms of ornamentation (Lambert 1993). In contrast to this minimal European approach, styling features were very much a part of mid-twentieth century American modernist design. These designers emphasised the product's exterior in response to commercial demands for the creation of product appeal. Raymond Loewy famously pronounced that 'ugliness does not sell' by creating streamlined styles and favouring non-functional, aerodynamic shapes that remained influential to the 1960s (Ulrich and Eppinger 2012). However a defining feature of both approaches is their concern with new materials and with them, the possibilities for design.

Good design came to be explicitly stated in another way, through the practices of industrial design and new product development (NPD). Of enduring influence are Dreyfus's (1967) five critical goals to achieve utility, appearance, ease of maintenance, low costs, and communication, in which the visual quality of products communicate corporate design philosophy and mission. In this way industrial product design came to be considered in two important dimensions. First, ergonomics, which encompasses of all aspects of a product that relate to its human interfaces, and includes novelty of interaction needs, maintenance and safety issues. Second, aesthetics and considerations of whether visual product differentiation is required, and the importance of pride of ownership, image and fashion (Ulrich and Eppinger, 2012). This approach advanced consideration of the user and user needs in respect of products, albeit defined by the designer and the organisational environment.

### **Meaning-Making through Design**

While PMDs can be considered within the product order, the expansion of design into a broader problem solving activity was reflected in the possibilities of design as meaning (Brown, 2008). With this approach, objects are shaped by human intentionality and human-made things are dependent on intention to exist, part of the language that design can create and shape.

Krippendorff's philosophical and semantic background defines design and designers' work as a matter of creating meaning rather than artefacts (Krippendorff, 1989; 2006). In this account, meaning is a cognitively constructed relationship and selectively connects features of an object and features of its context into a coherent unity. Objects must always be seen in a context and the product environment of other things, situations and users including the observer themselves. Thus, meaning not only signifies a product's basic functions and aesthetics; it also carries an emotional and symbolic value, bringing a product message to the

user (Krippendorff, 2006). In a PMD context it is pertinent to consider design as making sense of things: people and very personal items, their relationship to who gave them, and as a reminder of the giver. Wheelchair design offers a unique opportunity to explain design-inspired innovation, meaning, and how a design system functions. In the design process, the wheelchair can be thought of as an extension of the self and a means of self-expression; a physical object but one with implicit messages. The product not only signifies its basic functions and aesthetics but carries an emotional and symbolic value with a set of symbolic meanings for both the user and individuals observing its use. The product acts as an extension of the human body and mind by giving the user both independence and identity. Design is important as it allows for new perspectives from the beginning and through the whole process of product development (Utterback et al. 2006).

### **Interaction design**

Design as form and function in contexts sees products as objects; a meaning-led approach extends its connection with users. Buchanan's third order of design moves from object to interaction, an approach that embraces human-centred design. In these accounts the user is a resource, and design is focused on understanding and delivering what users want. It sees designers as part of a wider group of agents in the process of co-production or co-creation. It also accounts for changes in understanding the process of designing, suggesting that we are constituted in relation to the world not only as thinking subjects but as bodily beings (Schön, 1983).

With interaction design the designer becomes an actor able to listen to users and facilitate the discussion about what to do. This approach can be communitarian, or applied to individual service encounters, for example a patient in a hospital, in which the user is a bringer of capability. In service design, where users are engaged in the design process and

outcomes, the basic function is to find a balance between what designers try to fix and what is to be left free.

To account for this interactivity between design and user, models of user-engaging design have emerged. Sanders and Stappers (2008) defines two mindsets, 'expert' in which users are subjects, reactive informers, and 'participatory', where the users are partners, active co-creators. User-centred design is therefore distinguished from participatory design by the active engagement of the user. Participatory co-design sees designers creating solutions with people from the community and recognises that local value chain actors can leverage local knowledge. It can also lead to innovations that may be better adapted to the context and be more likely to be adopted, since local people have invested resources in their creation (Brown, 2008). With co-creation, users have a proactive role and should be involved at every stage of service development and as early as possible (Keränen et al. 2013).

These perspectives define a design agenda for PMDs. Designing has moved from a focus on the designer's creativity directed towards an object, to a broader range of concerns and activities. The ability to relate form and functionality to products remains an important but not an exclusive aspect of designing. It is difficult to design and appreciate design without attention to its meaning. Moreover the designer as facilitator or force for change, working with users and participants, has expanded the role and possibilities for design. The next section further develops these perspectives on user participation and co-creation, and by focusing on the design of PMDs in the health sector it introduces wellbeing as an objective of participative design.

### **Design for Care**

Contemporary healthcare is characterised by an increasing array of medical devices for diagnosis, prevention, support of the anatomy, monitoring and treatment of disease



(World Health Organisation 2003; EC 2001) and more specifically the management of injuries and control of conception (GHTS 2005). It is posited that wearable medical devices placed on our bodies play a role in our personal and intimate worlds, influencing our everyday lives and self-perception. Faulkner (2009) discusses the depth and reach of their influence, and explains that:

Medical devices enter into our intimate and family relationships, into our understandings of health and disease, our values and beliefs, our practices of looking after our own health, as well as our experience of healthcare systems and healthcare professionals' work (p.27).

As a sub-set of medical devices, wearable medical devices are worn objects. They are characterised as autonomous artefacts, usually non-invasive, and located on the body to perform their medical purpose (Fotiadis 2006). This requires devices to operate in a range of social, non-medical settings for a variety of activities in which the wearer may engage in their everyday lives, and be *wearable* in all these settings.

Further research has focused upon a specific form of wearable medical devices, orthoses, also known as splints, braces and supports (Fess *et al.* 2004). Generally, splints function to immobilise, restrain and support the joint; and are designed by hand therapists and occupational therapists based in hospitals. One important issue affecting the efficacy of a splint is the low rate of patient adherence to their prescribed use. As is true of other PMDs, whilst many people choose to wear these objects as prescribed, for others it is evident that the design of wearable medical devices within the traditional biomedical model creates artefacts that can lead to low adherence and dissatisfaction.

There are a number of reasons for low adherence towards the wearing of splints. Paterson's (2013) review of the literature identified important problems with wearability including inappropriateness for the patient's condition; difficulty to remove and put on; issues

with comfort and fit; hygiene; and perceptions of both impracticality and undesirability. Furthermore the splint may be socially and emotionally unacceptable, while other researchers have reported issues of style, aesthetics and cosmesis affecting patient adherence (McKee and Rivard 2011). In order to address this, McKee and Rivard suggest that an approach which situates health within a biopsychosocial model might be a productive direction for orthotic intervention.

The biopsychosocial model of health (BPS, Engel 1977) encompasses psychological, social and biological factors; in addition we might think of health as an ability to adapt and to self-manage (Huber et al. 2011). More specifically health requires “the sufficient competence of a person to cope through self-regulation with any stressful disturbance on every system level” (Egger 2013, p.26). In these ways it challenges the dominant Biomedical Model, with its focus upon the biological body (Fox 2012). By adopting a personalised treatment approach towards the patient, the BPS model provides versatility for design for care and opens up a broader consideration of wellbeing within the design process.

These understandings are also taken up in participatory medicine- a form of co-operative healthcare where patients, healthcare professionals, caregivers and other stakeholders are actively involved in the management of an individual’s health (Gruman & Smith 2009). In this model, an important factor is the relationship between the healthcare professional and patient and the sharing of decision-making with the aim of patient concordance rather than compliance (Mullen, 1997). This move towards participatory, personalised medicine is similar to the shift of focus from object-centred to experience-centred design (Buxton 2007; Sleeswijk Visser 2009). It highlights a design for care approach and its effectiveness through participation in the design of new services and medical devices (Jones 2013).

McKee and Rivard (2011) propose fifteen guiding principles to undertake such a design process (Table 10.1). These support McDonagh's (2006) assertions that there is a need for a balanced approach to both functionality and supra-functionality, which is achieved by designing with rather than for people (Weightman and McDonagh 2003).

TABLE 10.1 HERE

Although these principles are far reaching, they do not consider the fundamental reasons why people choose to wear objects on their bodies. In this respect a craft sensibility firstly provides insights into understanding the cultural and personal significances of wearing objects, through the exploration of material and process (White and Steel 2007). Secondly, this approach extends the understanding that the experience of wearing a medical device is similar to the experience of wearing jewellery:

...the sensation of touch on the body is pre-eminent, but movement and gesture, signal and message also become active participants in a web of visual, physical and psychological elements (Watkins 1999).

This intimate relationship between the worn object and the wearer's sense of identity and wellbeing is often overlooked by research into wearable medical devices. For George Simmel, the jewellery-object performs or communicates the wearer's identity to others, by singling "out its wearer, whose self-feeling it embodies and increases at the cost of others." (Simmel *et al.* 1977, p.207). Whilst personal identities and their maintenance are integral to individual wellbeing (Bostrom and Sandberg 2011), the implications for wearable medical

devices and patient adherence are considerable and deserve further consideration, and contemporary jewellery provides a framework in which to locate and investigate their design.

Contemporary jewellery design is a movement from the 1950s onwards that considers and challenges the themes and properties of jewellery (Skinner 2013). It acknowledges that the relationships between object, maker, wearer and viewer provide continual communication and interpretation of aspects such as identity and cultural values through semiotics and material use (Mazumdar, 2014). As a craft, contemporary jewellery can be presented as an approach and an attitude (Adamson 2007); and it is posited that this approach provides a new direction for co-design and design for care creating the therapeutic jewellery solutions described in the case study later in the chapter.

The similarities of jewellery and wearable medical devices begin with their characteristic of being worn or carried on the body, where they can play “an active part in constituting the particular experience of the self, in determining what the self is” (Miller 2010, p.40). Whilst jewellery is crafted to appear distinctive and (in the case of bespoke pieces) also crafted to the needs and desires of the individual client, the wearable medical device is designed with a medical aura that only considers the medical needs of the client. The value of the medical device is measured by its ability to restore or maintain the biomedical health of its wearer, whereas it is the emotional and material value of jewellery that is often the focus of wearability and meaning for the wearer.

Between wearable medical objects and jewellery lies an intersection in which therapeutic jewellery is located. This space enables the creation of therapeutic jewellery, a hybrid object that applies a craft approach to develop wearable objects; which are aesthetically pleasing and emotionally engaging, and so lead to improved adherence. In this respect, biomedical considerations are still important but the psychosocial aspects of wellbeing are also incorporated into their design. This therapeutic approach embraces a

holistic consideration of what it means to be human and to wear objects on the body, alongside medical objectives.

A synergy of design approaches is therefore proposed that encourage the wearer to adhere to their prescription. These are embedded within the biopsychosocial model in which biomedical diagnosis is just one aspect and participatory design is an integral part. This model is interwoven into a design for care approach - where craft is acknowledged as a vehicle to construct meaning and offer dignity to people's lives. We locate the participatory and craft design of splints and other wearable medical devices within in a contemporary jewellery framework that focuses on the exploration of the richly human aspects of health and wearability. The impact of wearable medical devices on the wearer can then be considered through the identification of the qualities and associations of both jewellery and wearable medical devices thus highlighting the limitations of traditional medical device design. Here, a third approach, co-design for care is developed to create therapeutic jewellery, hybrid objects incorporating the philosophies of craft and medical knowledge. As Jones (2013) explains:

Designing for care brings a holistic and systemic design perspective to the complex problems of healthcare. Services have been already improved by designing better artefacts, communications, and environments. What is missing is the mindset of professional care in designing for people, practitioners, and societies (p. 8).

Consequently these design approaches incorporate a caring design ethic (Jones 2013) towards health-promoting artefacts. The ethic requires designers to adopt the role of healthcare professionals, and to consider how design processes and outputs best promote all

aspects of a patient's wellbeing. This ethic is promoted through the selection of participatory and empathic design research methods to increase an understanding of people's everyday lives. Empathic design enquires about lived experience, with the aim of understanding the authentic perspective of people (McDonagh 2006). By using methods that develop empathy, the designer is able "to become closer to the user through respectful curiosity, genuine understanding, and suspension of judgment" (McDonagh et al. 2009, p. 310). Participant engagement in generating design solutions arises from the personal crafting of objects. Their qualities, functionality, comfort and so on combined with their meanings provide exemplars of processes and outputs that are readily accessible to others. Furthermore data regarding the supra-functional needs of the user, which include the emotional, spiritual, social aspirational and cultural aspects of relationships with products, are collected that allow for designs of objects to enable people to engage with them at both rational and emotional levels (Chapman 2005).

These participatory processes help to overcome problems of self-selection bias, where the decision to participate can be perceived as an opportunity to promote awareness of interests, activism or 'setting the record straight'. The use of craft techniques focuses participants on the creative and aesthetic qualities of the designed orthotic object, as a means of engaging with the process of personalisation rather than its verbalisation. Further they overcome problems of tokenism, perfunctory engagement with a small number of patients. Participative design necessarily requires small groups and purposive sampling techniques that can be applied to specific medical conditions.

These perspectives also demonstrate how healthcare is evolving through the adoption of a design for care ethos. The growing acceptance of the patient as an equal partner creates an environment for design interventions and enables the holistic design of medical objects. In the context of wearable medical devices, therapeutic jewellery is a co-designed

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person-centric health device. These aspects are explained more fully in the following case study that demonstrates generative design methods to inform and inspire their design, and meets the needs of patients.

### **Case study: The Craft of Wearable Wellbeing**

The case study is a practice-based project to research the design of therapeutic jewellery, and was informed by the designer-researcher's experience of wearing orthoses to manage EDS-ht. These orthoses were worn long-term to manage pain, and to immobilise the joints after dislocation or soft-tissue injury. Orthotics are commonly used by EDS-ht patients to manage the condition, alongside a prescribed physiotherapy regime. This entails wearing a range of different orthoses for the affected joints throughout the day and night and over a lifetime, for the range of acute and chronic issues that the EDS-ht patient experiences.

The research hypothesised that designing within the biomedical model results in wearable medical devices with a medical register and low patient adherence. Consequently a biopsychosocial design model was proposed for the design of a new hybrid artefact: therapeutic jewellery that promotes all dimensions of the wearer's wellbeing.

The case study synthesises design approaches, using principles of generative design, participative design, contemporary jewellery design and digital fabrication within a framework of the biopsychosocial health model. The aims were to explore methods, practices and artefacts that support design for care processes in order to improve the design and services of these objects. This account highlights/focuses upon three aspects of the design process: the development of co-design methods for this PMD; implications for design arising from a hybrid design approach, the conceptualisation of a cco-designed orthosis.

*Co-designing for care*

Generative design research is carried out at the front-end of the design process (Sanders & Stappers 2012). The project comprised of a series of elements, and the objectives and rationale behind each activity are outlined in table 10.2. An initial scoping exercise was promoted by HMSA to its membership, where they were directed to respond to via social media: email; twitter and a facebook project page open to comments. This generated data from respondents that supported the research hypothesis, and which informed the design of a sensitising pack and a workshop. The aim of the sensitising pack was to allow participants to explore the scope of the topic, and consisted of a workbook with short daily tasks that included taking photos of objects and settings, and describing aspects of their personal splint use.

This process was subsequently developed in a workshop, where participants become co-partners with the designer-researcher. A group of between four to eight participants enables the workshop facilitators to pay attention to every individual. (Sleeswijk Visser *et al.* 2005). Seven women were recruited for the workshop with the support of HMSA (Hypermobility Syndromes Association), they all have EDS-ht and long-term experience of wearing orthoses. They were motivated to take part due to their dissatisfaction with wearing orthoses and their desire to engage with the design process in order to create ones with more wearability. The workshop was women-only, in order to focus on wearable solutions that incorporated notions of adornment for women, and to create a safe space for women to discuss sensitive issues (i.e. body image). At the time of the workshop, half of the participants were working; whilst the other half were medically retired due to EDS-ht; and their ages ranged from twenties to early sixties. This research was seen as the opening trial for a series of studies positioned to research into the experiences of patients, with different medical conditions who wear wearable medical devices; and to investigate patient involvement throughout the design process.



The principle behind generative techniques is to allow people to make designerly artefacts, and individually share stories about their objects (Sleeswijk Visser *et al.* 2005). Two exercises were organised for the workshop, both using craft-based representational strategies, with participants individually creating a collage and a 3D model that they then shared with the group. It employed a craft approach with the view that craft and art practice allows for the ideas of participants to be embodied and given form in the model-making process (Sullivan, 2006) and that “by connecting people on emotional and visceral levels, artistic forms of representation facilitate empathy” (Leavy 2009, p.14). The qualitative data generated was then analysed to inspire and inform the concept design of orthotic wrist splints.

*TABLE 10.2 ABOUT HERE*

The first exercise generated data regarding participants’ experience of their own wellbeing and illness. Participants made an individual collage, in a cardboard box form, and from a collection of 100 images and 20 words, to describe their own feelings and experiences towards wellbeing. On completion, they shared their models and personal narratives with the group. Collage is a well-used technique for qualitative research (Leavy 2015), helping the collage-maker access intuitive knowledge and enabling communication on a metaphorical level (Butler-Kisber & Poldma 2010). The second exercise entailed participants considering their ‘dream health device’ and producing a 3D model, and again sharing their models with the group. This enabled them to explore solutions for orthoses and accessed their tacit knowledge (Polanyi, 2002) regarding these artefacts.

*Implications for design from the participatory workshop*

Themes identified in the scoping exercise and sensitising pack, were supported through analysis of the data generated by the participants' 3D models of splints within the workshops. This data included the transcripts of participants' discussions regarding their models and the researcher's visual analysis and assessment. In discussions, participants demonstrated their expertise of wearability by identifying the design factors that influence the wearability of orthoses. These were identified as: fit; function; style; aesthetics; materials; method of making; emotional engagement and meaning (fig. 10.1). Each of these impacts upon the wearer's adherence to the device and needs to be addressed if wearability and adherence is to be improved.

Participants felt conflicted between wearing orthoses and feeling that these artefacts were socially undesirable, as one respondent commented:

I don't want to be defined and judged by 'granny beige' splints and surgical looking supports... I am a young woman who happens to have a disability - that's a side note. I also happen to have a very definite sense of style and that WILL translate to the very things that are meant to make my life easier and better, so help me!

Participants were very clear about the effect of wearing orthoses, one commented on finding a device that she could wear to a social occasion: "For two hours I regained my 'mojo' and felt like me". Whilst another summed up the negative experience:

Generally very little thought goes into them in my experience, for people who have to wear them constantly. Sure if you break your wrist and need to wear a

splint for six weeks you can put up with it being hot and sweaty and looking horrible, but not if you have to wear it day in and day out.

Their awareness of material properties, worn on the body, highlighted issues of breathability and thermoregulation, with many comments mirroring one participant's observation that "the material not being hot and clammy would be good, making it look more like an accessory than a splint, and breathable". Aesthetic qualities were commented on, and Velcro though useful was also disliked because it "...catches on things, ruining the splints or other clothing and scratching skin".

The workshop generated a range of insightful data that demonstrated this group's negative perceptions regarding the wearability of orthoses and the accompanying negative impact this then had on their sense of wellbeing. Through participants' accounts, current orthoses emerge as 'ugly', 'sweaty', 'unstylish', impractical and difficult to use over the long term. Both cosmetic aspects and the comfort of day-to-day use are through such understandings, and these made participants unenthusiastic about, and less likely to use, the medically prescribed orthoses they had been given. While these medical orthoses may 'work' physiologically to support the joints, if their poor design negatively impacts on wellbeing and frequency of use, their overall success in improving health might be more questionable. The feedback from participants points to a need for design to develop devices that people can easily engage with emotionally and that they can perceive as meaningful in their lives. To this end, designers need to consider how it looks and feels on the body; to focus on how it makes the wearer feels and how it fits into their world. Materiality is key in this respect, with the need for materials that perform well on the body and do not create the sweatiness and smell that some complained about. Whilst people want the device to function

appropriately and fit well, the important design aspects for these artefacts are those more intangible wearability factors of personal style, emotional engagement and meaning, and it is in these areas where contemporary jewellery design can propose stylised solutions. Orthosis design should be considered in the context of self-identity and style. Consumer behaviour in fashion retailing demonstrates not only instrumental intentions to purchase but also emotional ones, in which choice, contemporary styling and endorsement through many media have major roles. In brief, the findings highlight the importance of holistic solutions and a transdisciplinary approach to orthotic design.

#### *Developing co-designed orthoses*

The research then moved into the conceptualisation phase (Sanders & Stappers 2012) generating a series of relevant concepts inspired by the research insights. The designer-researcher approached the design of therapeutic jewellery in an emergent manner, engaging with the source material through a reflective practice that explored design through drawing, models, and the investigation of material qualities. She began by creating a collage using those images and words most used by the participants. The themes of “freedom” and the ability to choose paths was important to workshop participants, and suggested their desire for a range of choices when it came to orthoses available for them. It was decided to explore how technologies could best be employed for this purpose whilst addressing the layers of wearability and importantly considering how these artefacts could promote the emotional engagement and meaning that jewellery creates in the wearer.

The two popular images that participants used in their collages were Amazon Warrior and Wonder Woman, and the frequent use of the word “strength” were in direct opposition to

the feelings of loss, chaos and feeling broken that participants experienced. These were used playfully by the designer researcher to inspire and generate designs, to be worn by these two archetypes in the twenty-first century. The image of a gift proved popular, and the maker considered how the orthoses could be considered, similar to jewellery, as gifts. These approaches to the data demonstrate craft functioning as a vehicle to construct meaning, whilst offering substance and grace to people's lives (Metcalf 2002)

A series of wrist splints as therapeutic jewellery were then devised that embraced a range of digital and analogue technologies used in contemporary jewellery making. As a creative and craft process, the designer employed 3D technology along with collaborations with silversmiths and a cabinetmaker, to achieve designs using 3D printing materials alongside a collection using silver and wood. Techniques include measuring the wrist dimensions and fabricating the device using traditional bench techniques, where silver is manipulated using rolling mills and hammers. Digital technologies included scanning the wrist into a CAD programme and designing the device directly onto the wrist model, and then 3D printing the device. The first collection of designs was fabricated by a desktop 3D printer (fig 10.2), to demonstrate the possibilities of using domestically available technologies; whilst a second collection used SLS 3D technology. A third collection was created using traditional jewellery materials such as silver (fig 10.3) and wood through collaborations with silversmiths and a cabinet-maker. The devices were custom-fit to the designer-researcher's own wrist, this ability to provide a perfect fit by digital and analogue methods demonstrated the ease by which personalised orthotics can be fabricated.

INSERT FIG 10.2

Fig 10.2 Fresh Embrace - desktop 3D printed orthosis (material: red PLA )

In addition, a digital health project was proposed, offering a web-based service for wearers of orthoses. Open designs will be displayed within a digital library on this site for others to access for printing and to further develop the designs. The project would work as an open design project where the designer becomes “a database designer, a meta-designer, not designing objects, but shaping a design space in which unskilled users can access user-friendly environments in which they can design their own objects” (De Mul 2011, p.36). The approach includes the use of scanning technology, to scan the body part and import the data into a CAD programme. Designs can be then adjusted for an exact fit for each person with the wearer also choosing from a range of materials and finishes.

The design of these artefacts, with craft sensibility, looks to provide functionality along with an ability to express human values (Risatti 2007). As such, the crafted object is both theorised and personalized through a radical and innovative process (Yair et al. 2001; Adamson 2010), and embraces a definition of contemporary jewellery in which ideas are served by materials and skills (Skinner 2013). Furthermore, the digital health project empowers patients co-create personalised artefacts, while engaged in the design and production process.

Reviews of the collections has been positive with The Orthotics Campaign (2016) commenting that the work is “exciting and creative”. When the 3D printed work was exhibited, viewers recorded how “stylish” “funky” and upbeat” the devices were, with some asking if they could be worn without a medical prescription. Healthcare professionals such as occupational therapists also responded positively, recognising the potential for transdisciplinary design teams with the hope that the project will be further developed.

The original research respondents and participants were invited to review the collections, and their comments endorsed the potential of such devices. One commented:

Having some sort of control over the devices, choices, supports etc. that help improve my quality of living daily gives me back a sense of self and sense of respect and, if people have that, they are less likely to become depressed and spiral downwards physically and mentally.

Whilst another observed that the personalised approach was empowering:

Thank you so much for this, I'm a HUGE advocate of empowering people through choices and being a disabled young woman, I have felt 'weak' and 'visible' (and also 'invisible' at times) when out and about in what can sometimes seem like a huge, flashing 'look at me' set of NHS beige-ness.

This above comments are representative of the positive feedback that was received. Indeed the only negative comments were regarding personal tastes and device needs, which only further support the need for a person-centric approach that incorporates the full range of wearability factors. This reflects the need for a shift in perspective for orthosis design away from a medical model to a social model of prescription (Pullin 2009).

### **Co-design for care**

The design for care process, employed by this research, develops a therapeutic design approach that becomes a new and powerful addition to co-design. It presents possibilities for patient agency in their healthcare by enabling them to articulate their expertise in wearing medical objects; and through its ability to engage participants in applying tacit knowledge to craft objects that address the eight layers of wearability (table 10.2). Creating objects, that incorporate qualities of jewellery such as preciousness and desirability, may be particularly attractive to women, but its focus on detail and the opportunities to create personalized and meaningful objects that people want to wear, has an appeal across the genders. Therapeutic design provides new processes for participation, building upon the co-design approach, by foregrounding the importance of wellbeing as an outcome. This approach offer solutions to achieving the service criteria defined by the Associate Parliamentary Limb Loss Group (2011) for comfort, choice and cosmesis. Since research respondents were concerned with the lack of a fast and efficient access to ‘right first time’ devices, a service provision that employs cheap and effective digital technologies available to fabricate personalised solutions could well address these issues and is supported by the Orthotics campaign (2014). Interestingly, there are developments in the private sector, such as Andiamo (2016), set up by e-patients, who aim to deliver a 3D printed medically effective orthosis within one week, alongside an advanced clinical service.

PMDs provide a valuable focus for the exploration of design principles and practices, demonstrating an established commitment to functionality, while increasing understanding of engagement with the user. Design aesthetics have been discussed in terms of form, in particular for products and their relationship with functionality. In commercial design, products must always have a sales appeal; appearances are targeted at a market of potential consumers who have awareness of a very wide range of well-designed products. PMDs can draw on this commercial appeal, not least as publicly funded healthcare gives way to more



mixed models of private-public partnerships. Nevertheless they challenge form and style and design as process and outcome, to stimulate reflection on the increasingly diverse processes of design. Creating or facilitating meanings of PMDs by their users is an important and neglected consideration in their design. It extends the designer - object relationship, into one of co-creative processes with users. Established models of PMD design contribute to reduced wearer adherence; consequently alternative approaches are desirable. The case study demonstrates how a biopsychosocial model can be used to contextualise new ways of designing orthotics with positive outcomes. It highlights the personal experience of the medical device, how it is sensed and its contribution to social wearability and identity. As a result, participation in the design of PMDs enables patients to be more aware of their wellbeing, adhere to the use of devices and more engaged in the personalisation of their healthcare. We suggest that design, as well as use, allows individualised health technologies to become 'personal'.

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