Use Forecasting: Designing Fashion Garments for Extended Use

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Abstract This chapter introduces the concept of 'use forecasting' to describe how designers might anticipate and design for the extended use of fashionable clothing. Garment design that supports extended use is one strategy with the potential to mitigate the harmful environmental consequences of disposable fashion. Lifecycle assessment studies of clothing conducted in the UK, have shown that even a modest extension to the use phase of clothing can significantly reduce the carbon, water, and waste footprint [1]. Much like a fashion designer employs 'trend forecasting' to predict future tastes in colors, fabrics, and silhouettes, use forecasting anticipates how a garment will likely be worn and potentially repaired, refashioned, recirculated, and ultimately recycled. Thus, the capacity for future adaptations that may be necessary or desirable can be incorporated into the garment's design. The intention is not to predetermine a singular lifetime for all garments of one style, but rather to enable diverse, alternate futures for individual garments. Including within the garment's design a capacity for modification may help the garment keep pace with the changing needs of the wearer, therefore postponing obsolescence and disposal. Implementing use forecasting within a typical fashion design process is presented in a case study, The Living Wardrobe, within which a series of fashion garments for extended use was prototyped. Strategies for consumer engagement with enduring garments are also discussed.

Keywords Use forecasting · Garment lifetimes · Fashion design · Sustainable fashion · Design for longevity · Clothing practices

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1   Too Much of a Good Thing

Fashion clothing is being produced in excess of consumption. In early 2018, H&M revealed they are carrying US$4.3 billion of unsold stock [2] and Burberry admitted to burning GB£150 million of unsold stock [3]. The fashion industry accounts for 2% of the world's Gross Domestic Product [4], achieving US$1.34 trillion in retail sales per year [5]. These sales figures are projected to grow significantly over the next few years, increasing by 13% in 2021, attributed largely to the growing middle classes in China and India [6]. Yet the value of the market is only anticipated to grow by 8%, indicating an increase in low-value goods, i.e., fast fashion [5]. Over-production directly relates to over-consumption; clothing is being produced in excess of consumption but also the rate of purchasing is being driven in line with the availability of new products. While researchers often recognize fast fashion as the problem, industry solutions focus on adjustments to current industry supply chain practices to meet compliance. A more enduring solution is instead to focus on developing sustainable solutions for implementation within the garment use phase.

Prolonging the use of garments is imperative to reducing the waste problem generated by unwanted clothing. In Australia—where I live—it is estimated that a total of 6000 kg of clothing is dumped into landfill every ten minutes [7]. The charity sector receives one million tons of donated clothing and household goods per year [8], including quantities of unworn overrun production fashion clothing. In the state of New South Wales alone, the Smith Family processes annually 13 million kg of clothing at just one facility. Of this, the highest quality garments (3–4%) are resold locally through their network of charity shops, a further 60% is baled and sold by the ton for export to developing countries [9], and 5–10% is sold for industrial rags. The remainder, estimated to be 30% comprising soiled and worn-out textiles too degraded for recycling, goes to landfill, at a cost to the charity of nearly one million dollars per year [7]. Both the Smith Family and the Salvation Army have noted the diminishing quality of donated fashion clothing, unsuitable for reuse [7, 10]. These "flimsy" garments are the product of the 'fast fashion' system that produces garments quickly and cheaply for short-term use: fashion-forward styles that are relevant to the prevalent tastes for a season or two, then discarded in favor of newer styles. This means that although the consumer behavior is commendable in donating them, the garments are unable to be reused.

Fast fashion is a recent phenomenon that has evolved since the 1970s through improvements to industrial supply chain management (just-in-time manufacturing), the reduction of global trade tariffs, and the rapidly expanding manufacturing capacity of China. The global dissemination of new fashion ideas and products has contracted from a six-monthly cycle of spring/summer and autumn/winter collections, to a continual drip feed of new products into store throughout the year. Trends still trickle down from the haute couture runways but are just as likely to bubble up from the street via social media. As production has increased and retail price points have dropped, the consumption of fashion garments has increased

significantly. The largest group of consumers of fast fashion are women of the 'millennial' generation (born between 1981 and 1996), for whom the definition of fashion 'value' has shifted from quality and durability to bargain pricing [11]. When garments are valued in economic terms over performative qualities, they are more readily discarded.

The negative environmental and social consequences of the fashion supply chain are well known to producers and consumers alike. The production of both natural and man-made textiles depletes natural resources and pollutes the environments in which they are made and into which they are disposed [12–15]. The manufacture of garments has long been associated with the exploitation of workers in developing countries who work long hours for sub-standard pay in poor conditions [16]. Efforts to improve the negative impacts of the fashion sector have primarily focused on the supply chain, for which less harmful substitutes have been sought for existing materials and processes [17]. Supply chain improvements are critical to meeting sustainability objectives as are improved recycling options for discarded products. However, patching the existing linear economic model of 'take, make, waste' is insufficient to solve the planetary impacts of a rapidly growing population with a lust for stuff.

In contrast with fast fashion is slow fashion. Emerging from the slow design movement of the mid-2000s, and with parallels to the slow food movement of the 1980s, 'slow fashion' describes fashion produced with alternative values and methods to those of fast fashion. Hazel Clark defines slow fashion as fashion that demonstrates: concern for local resources and distributed economies; transparent production systems with less intermediation between producer and consumer; and sustainable and sensorial products that have a longer usable life and are more highly valued than typical "consumables" [18]. Slow fashion endorses a rethink of fashion as a production system but also as a values system which over the last decade has led to an examination of how the desire for fashion might be satisfied in less materialistic ways [19]. These approaches emphasize the durability of emotional relationships between consumers and products as a means of reducing consumption whilst pointing out the elusiveness of designing products to bring about such relationships [20].

The conception of fashion as the on-going engagement with the garments of the wardrobe, describes fashion as a social practice of wearing clothing to present a fashionable appearance [21]. This is in contrast to the prevalent understanding of fashion as the constant acquisition of new garments (fast fashion). Through actions like buying second-hand fashion and making alterations to garments, participation in fashion extends beyond the adoption of the current trend to include fashion as the capacity of the wearer to create fashion looks [22]. Situating fashion within its social context of daily dressing, highlights the need to design sustainable garments for sustainable wearing: including in the design process anticipated modes of use and reuse and deliberately designing to enable a multitude of possible futures within which garments persist, or are remade as fashion. This too seems at odds with fashion understood as the insatiable thirst for novelty. Alternatively, it suggests a less resource-intensive way to satisfy the same needs by extending the circulation of

fewer garments. Might actions that extend the use of a garment for one wearer reanimate a discarded garment for another?

In line with existing research in fashion and textile sustainability both designers and consumers demonstrate a desire to engage with more sustainable practices. This has led to many and varied models of sustainable fashion practice from design methodologies to consumer-driven approaches. Changes to retail practices and new business opportunities include: up-cycling garments into new fashions [23], reselling/take back schemes for unwanted garments [24], transparency around end-of-life scenarios for returned garments [25], customization [26], clothing swap schemes [27], new sharing services [28], a renewed market for formal wear hire [29], and bespoke made-to-measure [30]. Widespread consumer-led approaches include buying secondhand, recycling and upcycling garments, a resurgence in 'mend and make do' practices of garment repair, home garment production, and clothes sharing and swapping. In turn, this has led to an increase in fashion activism through which consumers are demanding more information about the environmental impacts and labor conditions with which fashion is produced [31]. These initiatives are increasing social engagement with sustainable fashion practices to extend the garment use phase. However, currently garments are not designed for extended use and reuse. This particularly limits their suitability to the various consumer-led sustainable fashion practice strategies listed above. Alongside increasing the original quality of the garment (materials and manufacture), the real opportunity is to begin to design for these practices in the first instance: garment longevity in support of social engagement. This requires a redirection of the fashion design process to design in anticipation of how garments will be used, here presented as 'use forecasting'. Forecasting garment use requires a closer examination of the garment use phase than is usual within the fashion design process typically followed within the industry [32–34].

2 Clothing Use

The nature and duration of use have environmental impacts that might be mitigated through a design process that includes greater consideration of garment use. There is a lack of research into consumer use of garments, but that field is growing. The available data goes some way to detailing the use phase within the garment lifetime by explaining reasons that garments are either kept and worn or discarded [35, 36]. Different garment types, and garments for different occasions, are worn by people of different demographic profiles, are used with varying intensity, and have different life expectancies [37]. The duration of use can be alternatively measured as a number of wears, washes, users or years [38]. Where the latter is used, research indicates widely variable values between garment types, based partly on the different research methods used [1, 39]. In an analysis of why Norwegian women stop using clothing and wish to dispose of them, Klepp identifies that clothing use can be generalized as a series of phases [40]. Klepp describes a phase between acquisition

and first use when the garment is 'on hold'. During 'actual use' it may be rested for a period, then following last time use it remains in the wardrobe 'at mercy' until the decision is made to dispose of it. This model is significant because it highlights common patterns in use despite the complex differences between garment types and the occasions for wear. Klepp's model also enriches our understanding of the phases of the garment life cycle between retail, use, and the grave. Klepp further noted a difference between garments disposed of for reasons of fashion over reasons of wear: fashion garments had a longer use phase, not because they were worn more actively, but remained 'at mercy' for longer before discard [40]. These garments linger in the wardrobe unworn, not because they are physically flawed or no longer fit, but because of changes in taste. That garments are used and rested is important to design in relation to both function and fashion: Where garments are rested because they need dry-cleaning or ironing, might they be designed for less labor-intensive care practices? Where garments reflect the very latest fashion taste, might they be designed to be modular so that components can be removed and interchanged once their moment has passed? Particularly, when a garment is 'at mercy' of disposal, what design strategies might enable tired garments to become fashionable again and return to active use?

2.1 Extended Use

Extended use is most readily understood as continuing to use a product beyond the point that it might typically be discarded. For clothing, the decision to discard a garment can be motivated by a range of reasons. In 2015, Laitala and colleagues published the findings of a wardrobe study in which they analyzed why the women interviewed disposed of particular garments. In summary, the findings show that the longevity of the garments in the wardrobe and their active use is largely determined by physical garment attributes of material properties and fit, over fashionability [41]. These findings are in keeping with research conducted in the UK which found that the majority of clothing was disposed of because it did not fit anymore [1]. Emerging from this research is the importance of garments being kept in 'active' use. Active use describes garments that are being worn regularly or periodically, as distinct from garments stored in a wardrobe but unworn [38]. This is a critical distinction to draw since research also shows that while there has been a reduction in the discard of clothing in recent years, there has also been an increase in overall clothing sales, which points to increased storage of clothing in people's homes [1, 42]. High volumes of clothing in the home suggest that each garment is worn less frequently and/or garments are being stored unworn. Extended use can be further understood as more intensive use. Intensive use has environmental benefits where it mitigates, or at least reduces, the need for additional garments worn for the same occasion or function. For example, increasing the number of wears between washes. This might be achieved by changing the fabric of a garment design from one that is 'dry clean only' to one that is 'gentle hand wash', thus reducing the time

the garment rests, unworn, in the dry-cleaning pile. The cost and the effort required to take garments for dry cleaning are barriers to a garment's more frequent use. Incorporating consideration of the ease of cleaning within the design process when selecting fabrics, is an example of use forecasting.

The growing body of research into clothing use provides fashion designers with considerable information on clothing lifetimes and consumer practices that can be directly applied to the existing fashion design sector, enabling a reorientation of design from design for sustainable *products* to design for the *conditions of sustainability* [43]. It begins to show how designers can influence the use of garments, through a more holistic understanding of the garments' life cycle and the relationality of the design phase within that cycle. Through their design decisions, the designer can contribute to sustainable use practices. It is at the point of design that materials are gathered and manufactured into garment form, comprising decisions on which fabrics and trims to use and where and how to produce it. These decisions affect how the garment can be cared for (dry clean, machine, or hand wash), how long it will last (durability of components and construction), and what end-of-life scenarios are possible (reuse, recycling, and disposal).

3 Use Forecasting

So how might designers approach design for extended use within the typical fashion design process? This question underpinned my postgraduate research study, The Living Wardrobe [44], through which the concept of use forecasting emerged. Prior to the study, I had owned and designed for a boutique womenswear label. Within this commercial practice, I had become concerned with the environmental impact of the materials and production methods I was using, but also the environmental impacts of the model of business in which I was practicing fashion design, particularly the significant amounts of post-consumer waste generated by the seasonal fashion calendar that continually rendered my designs obsolete a few months after they were produced. My fondness for dressing in fashion garments acquired secondhand, suggested to me the potential of design for extended use to enable sustainable fashion by increasing the recirculation of fashion garments. This potential warranted exploration through practice, to investigate how current industry practices of fashion design might be expanded to give greater consideration to use.

3.1 The Living Wardrobe

Within the PhD, I employed creative practice to investigate how a typical fashion design process might be adapted to produce garments better suited to extended use. Research methods of object analysis and literature review were used to expand my

existing professional garment-making skills and develop a repertoire of technical design and construction techniques to use in garment design and specification for manufacture. These were trialed in a series of sample garment designs, framed within the notion of a 'living wardrobe'. A *living* wardrobe emphasizes the use phase of the garment's lifecycle and therefore the study looked beyond the production of the most sustainable fashion garments, to instead explore the potential of fashion design to enable sustainable ways of living with garments [45]. Animism in product design can contribute to stronger subject-object relationships between people and their possessions, potentially leading to more careful and long-term use of products [46–48]. Thus, practically, The Living Wardrobe describes a suite of womenswear garment types that comprise an essential everyday wardrobe, while conceptually, it defines the prototype garments as enduring entities with the capacity of long and active lifetimes.

The garment prototypes that comprised The Living Wardrobe were developed iteratively, each one contributing new knowledge to the research study by testing and refining practical approaches in designing fashion for extended use. In total, six different garment types were produced: dress, skirt, coat, top, culottes, and trousers; archetype garment forms considered to be typical womenswear 'wardrobe staples'. The transition from one garment type to another, necessitated changes to usual industrial pattern-making and construction methods in consideration of fit and fabric requirements typical to those garment types. The fashion design methods developed from prototyping these garments draw on techniques of professional dressmaking and tailoring and domestic practices of garment repair and reuse, where the former seeks to enable the latter. Forecasting likely use and possible use informed how these techniques were incorporated into new designs; directing the design development process to account for future use scenarios that enable sustainability, where sustainability is not located within the 'sustainable' object but instead is the outcome of the relationship between people and things, in their context of use. These prototypes revealed the critical role the garment artefact might play in the transition from fast, disposable fashion to enduring, slow fashion. A garment designed with provisions for extended use, might contribute to new habits of garment care in use by making sustainable clothing care practices available to wearers.

3.2   Use Forecasting as a Method

Use forecasting is a suitable descriptor for the activity of designing for use because it aligns new practices to familiar methods, echoing 'trend forecasting.' Trend forecasting is a typical stage of the fashion design process that comes early in the overall design process. By forecasting trends, a designer (or design team) seeks to preempt what styles will appeal to the target consumer at the time the collection being designed will be on sale. Trend forecasts predict favored silhouettes, colors, fabrics, textures, and details to inform garment design development. Because trends

emerge through collective cultural consciousness (the 'zeitgeist'), generalized trend forecasts for consumer markets are developed by trend forecasting agencies for sale to product developers who in turn adapt the forecasts to their target market.[1] Importantly, new trend forecasts build on previous trends and market behaviors, offering updates and alternatives to existing looks. Traditionally, trend forecasts were released bi-annually, in keeping with the fashion calendar of spring/summer and autumn/winter. However, given the collapse of seasons within the fast fashion system and the move from print publications to online subscription platforms, trend information is now produced and shared continually in support of time poor designers seeking aesthetic inspirations for the dozens of collections they produce per year. The easy accessibility of these mass trend directions (provided for download as technical drawings of garment design concepts, color and fabric palettes) contributes to the homogenization of mass market fashion because everyone is working from the same trend material. This begs the question whether trend forecasting preempts or predetermines future trends.

Use forecasting shares some similarities to the above description trend forecasting: generalized patterns of use can be applied to specific garment designs and target markets. Similar to trend forecasting, use forecasting is undertaken early in the design process, and the findings applied to the development of each garment's design, informing fabric choices, construction methods, garment styling (silhouette, fit, fashion features), and details (fastenings, trims, embellishments). The data required to inform use forecasting has some similarities to trend forecasting also, in that past sales data, particularly customer feedback, can inform the use forecast. A range of lifecycle assessment tools now exist to assist designers to evaluate the potential environmental impacts of products in development (for example, Ecoinvent [49]). Therefore, as research into clothing use patterns deepens, it is feasible that in the future, quantitative measures may be developed to assist designers predict likely garment use. Brands will be able to develop proprietary use forecasting guides on the specific methods suitable for their range of products and target market, therefore streamlining the process.

Use forecasting should not be understood as a means of *predetermining* use, rather, by preempting likely use, desirable futures can be amplified, and undesirable ones designed out. Thus, the view of the future forecast is broad and considers intended and unintended consequences. For example, fabric choice can dictate cleaning methods for a garment, design details can render a garment obsolete beyond a particular point in time. This view stretches the forecast in keeping with the idea 'back-casting', a method of designing 'from the future to the present' [50]. From this perspective, trend forecasting can be seen to enable fast fashion, while use forecasting enables slow fashion.

The design of fashion garments for extended use necessitates an approach to design that pays greater attention to the practical side of how garments are worn and cared for, not merely what they look like on the body [51]. Under pressure to

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[1]See, for example, Worth Global Style Network (WGSN) https://www.wgsn.com.

rapidly produce constant novelty, fashion designers are frequently more concerned with garment aesthetics than clothing functionality [13]. Garment designs in production may undergo a fit-test to trial the garment style on a live model who is representative of the target market. This test checks the fit and design features of the style on the body. Rarely does this test involve actual users; instead, professional fit models are employed. Garment use has limited consideration within the conventional fashion design and production process: materials and trims are carefully selected to ensure the washing/ironing advice provided on the care labels is suitable for all garment components. However, the durability of the garment is not so consistently addressed. The physical durability of the garment being designed varies with the target market profile and price point, which determines the acceptable fabric quality (pilling, holes, fading) and construction (seam and stitching strength, interlinings, and linings), to avoid faulty returns during the expected garment lifetime. High-quality garments may be designed with some provisions for alterations in fit and will include spare materials to assist with repairs. The popularity of fast fashion has resulted in consumer acceptance of poorer quality make and materials, given the short fashion life expectancy of garments. There is little or no perceived need for repair of such garments which will wear out as they go out of fashion. While recycling is an option for these worn-out garments, reuse is preferable [1].

3.3 Fashion Design for Reuse

Fashion designed for extended use will likely be worn by more than one owner sequentially or concurrently. To meet the various needs of different wearers over an extended garment lifetime, research into consumer clothing practices emphasizes the need for garments to be modifiable, to adapt to changes in the wearer's body, changes in their attitudes to themselves, and notions of fashion over time [52]. Ideally, the design of fashionable garments should open the garment to many possible future acts of reuse. Building on Klepp's research into patterns of clothing use [40, 53], Fig. 1 maps the disposal and reuse options for an unwanted garment. The options and pathways presented in the diagram have been determined through literature review and practice-based research, as outlined above. In preference to final disposal into the waste stream, garment use can be extended by various consumer actions of renewal to reinstate it to active use, or by recirculation for others to use. Currently, garments are largely repaired, recirculated, repurposed or refashioned in spite of their design and manufacture. For example, most garment types are typically mass manufactured with narrow, densely stitched seams that prohibit easy intervention to adjust the fit of a leg or sleeve, or to replace a broken zip or perished elastic from a waistline. Instead, if each of the outcomes in the diagram in Fig. 1 are anticipated at the design stage, decisions can be made on material choices and construction methods that facilitate extended use which itself can be conceived through a number of concepts addressed in this section.

Repair. A damaged garment might be repaired and then worn anew. Repair extends on typical garment care (washing and ironing) to describe acts of garment
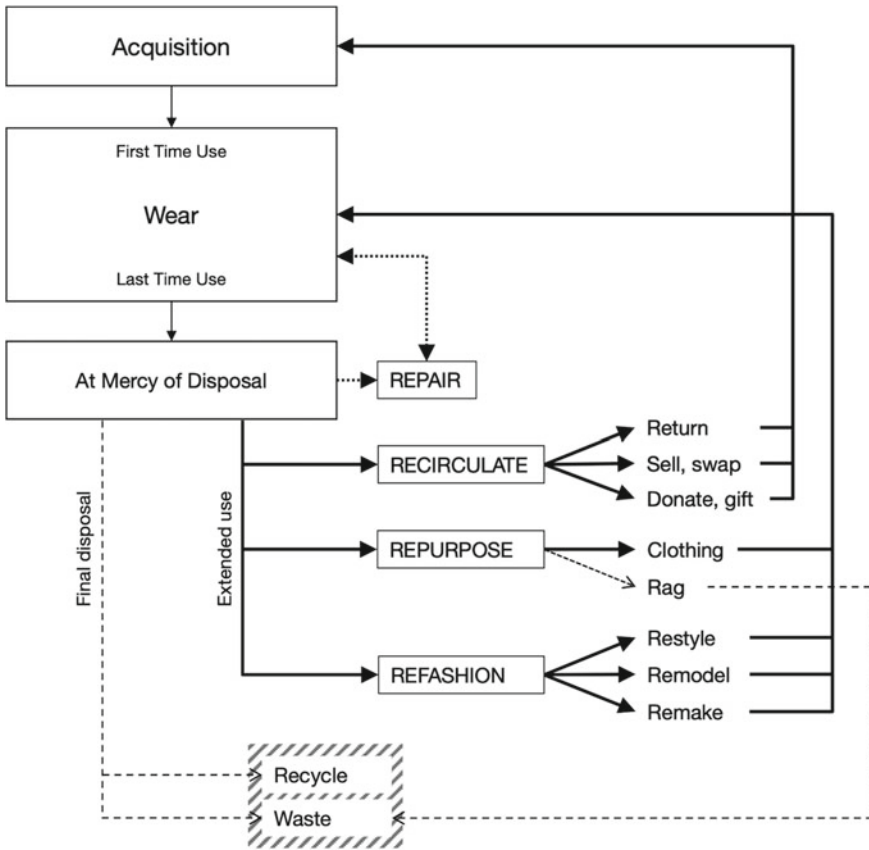
Fig. 1 Disposal and reuse options for discarded fashion garments. *Source* Prepared by the author

maintenance like reattaching a button, restitching a seam, patching, and darning holes to restore the garment to its original appearance and function. While invisible mending is a practiced craft, a search of the hashtag #visiblemending on the social media platform Instagram, returns thousands of colorful, decorative repairs that conceal garment flaws with eye-catching embellishment. The need for repair is anticipated for some garments which are sold with spare buttons and sometimes thread, beads or sequins. This provision for future repair can be extended with the inclusion of deep hem turnings for example, that make available excess fabric for patching. Other design considerations can assist repairs beyond the provision of spare materials: the construction methods used can assist or hinder actions of repair, so too fiber and fabric choice. Garments are assembled from cut pieces of fabric, trims and fastenings in a general order of assembly [54]. For example, one of the early steps in manufacturing a pair of trousers is to insert the zip, following which pockets, fly shields, the waistband, and top stitching details are added. This order of

construction inhibits the easy replacement of a broken zip as these other garment parts must be unpicked to access the zip for removal and replacement. Beyond construction methods, fabric choices impact how readily a garment might be repaired. Durability is important to long-term use in the first instance, but fabric construction and fiber content also impact how well a garment design responds to repair. In some fabrics, stitch lines visible once a seam has been undone may disappear when ironed, or an all-over print may negate the need for repair by concealing minor damage like a stain. Fabric testing can be undertaken as part of early design development to determine performance properties in relation to these qualities. Fabric producers could include such data with the fabric specifications they currently provide. A complementary design approach to facilitating repair is prevention of repair by predicting and reinforcing areas of likely wear. For example, the reintroduction of underarm shields into contemporary, conventional garment manufacture would not present any challenges to manufacturers and go a long way to extending the use of upper body garments susceptible to perspiration stains.

Recirculate. The simplest life extension option for an unwanted garment is to pass it on to someone who wants it. Clothing rental, subscription, and take-back services are growing in popularity, enabling consumers to return unwanted clothing to its provider for redistribution to subsequent wearers until its final disposal (ideally through appropriate recycling streams). Alternatively, unwanted clothing recirculates through the secondhand market, where discard channels comprise gifting to friends and family, donating to charity, swapping informally or at organized clothes swap events, and selling to resale boutiques or to peers via online platforms such as eBay, and depop. Recirculation recommences the cycle of acquisition/wear/disposal. The subsequent use period of a garment is estimated to be approximately half its initial use period [1]. Different recirculation methods are likely to require different capacities for longevity in garments. Clothing recirculated through clothing rental and subscription services can be expected to be used more intensively by more wearers than clothing that is gifted to family, donated to charity, or resold in the secondhand market. To withstand intensive use, garments need to be more physically durable: hard wearing fabrics, construction, colorfast prints and dyes. It can be anticipated that these garments will have an overall shorter lifespan in years, and therefore enduring visual appeal (a 'timeless' style) may be less relevant. However, for garments passed on through secondhand channels of gifting, donating, or selling, where the likely lifespan is longer, the capacity for the garment to be updated in keeping with new trends is more important. Also of importance in the secondhand market is the capacity for the garment to be altered to fit an individual figure. When first purchased, a garment is one of many of the same style, available different sizes. In the secondhand market, that garment is unique: it sits within the eclectic accumulation of the vintage boutique, charity shop on online resale platform. While it may appeal to a new wearer, it may not fit. Incorporating methods of variable sizing and flexible fit into the garment design can overcome some of the issues standardized sizing presents.

Repurpose. Within the hierarchy of reuse, repurposing is the lowest level, suitable for garments that are worn out, ideally having passed through several

cycles of reuse through other means. For example, a business shirt formerly worn to work is worn when gardening. The recategorization of the shirt within the wardrobe from "work" to "gardening" is the only action needed to extend its lifetime. While repurposing extends the use of the garment, it does not mitigate the purchase of a replacement garment, as there is now one shirt fewer to wear to work.

Refashion. Restyling, remodeling, and remaking present the greatest opportunity to refashion a garment and thus extend its use by maintaining its original value as a fashion garment. For the purposes of designing sustainable fashion, 'to refashion' is here defined as to reinstate a garment to a fashionable status (to make fashionable again). This definition extends the conventional connotation of refashion meaning "to remake, alter" [55], to describe the outcome of those actions. A garment may be refashioned through remodeling, by removing last season's ruffles. Through remaking, the fad fashions of five years past can be reworked to suit the prevailing tastes. The capacity for garments to be refashioned is critical to the longevity of fashion garments, as opposed to other types of clothing. Garments purchased to participate in current trends, to be fashionable, need to maintain pace with changing tastes if they are to be worn beyond the seasons for which they were created. Therefore, refashioning a garment is distinct to repurposing one, where the fashion garment is reused for its clothing, rather than fashion value.

Refashioning a garment draws together a number of design strategies with the potential to either return a discarded garment to its former fashionable status or to keep the garment in fashion throughout a prolonged period of use. These strategies speak to the emotional, rather than physical durability of the garment, and concern primarily the context within which the garment exists. The garment's capacity to connect the wearer to the prevailing taste of their surrounding culture changes with time and with the wearer's evolving needs and attitudes. Although the motivations for refashioning garments can seem intangible, the design strategies applicable can be particularly technical.

Restyle. To restyle a garment is to find a new way to wear it. Ethnographer Sophie Woodward discusses how fashionability is achieved through assemblage: the combination of new fashion garments with the existing wardrobe to create an outfit that is in keeping with the current fashions [21]. Restyling offers a way to renew the appeal of a garment by pairing it with different items in the wardrobe; perhaps newer garments and accessories, or those purchased for a different occasion. It does not require any modification of the garment. For example, layering a sleeveless dress over a long sleeve top. The 'shop your wardrobe' concept encourages consumers to reduce their consumption of new fashion garments by finding different ways of wearing garments they already own [56]. Garments with more versatility built into their design offer greater capacity to be restyled if, for example, waistlines can be cinched in or released. Innovations in modular garment design could build on the inherently adaptable material qualities of clothing by offering more ways to wear a garment.

Remodel. Remodeling describes alterations required to replace or conceal wear and damage, accommodate changes in fit, or to change part of the garment that dates it to a past moment in fashion. In contrast to repair which remedies damage to

the garment, remodeling modifies the existing garment form in a subtle or substantial way. For example, darts may be released to give comfort to an expanding waistline, a maxi skirt hemline shortened to a mini skirt as fashions cycle. As for repair, often the way a garment has been designed and manufactured makes such alterations difficult. In the early-mid twentieth century, garment remodeling was a common household practice. Dressmaker manuals from that time explain an extensive range of approaches to garment care, mending, making, and remaking clothing to ensure maximum lifespan [57]. They are methods that might be employed within existing industrial production processes and within contemporary domestic environments. For example, the inclusion of wide seam allowances typical of men's tailored trousers can be transposed to women's trousers to permit waistline alterations [58].

Remake. While remodeling does not fundamentally change the form or function of a garment, remaking describes a garment that is deconstructed and reassembled into a new form, often in combination with components from other garments or the addition of new fabric. In the language of contemporary sustainable garment design, remaking unworn garments into new forms is frequently termed 'up-cycling', to signal that the value of the original garment is maintained throughout the process. Remaking as a practice of sustainable fashion has been adopted by brands [59, 60], but also embraced by the online do-it-yourself (DIY) community [61, 62]. Within the huge online craft, sewing, and dressmaking community, users share both the methods and outcomes of remaking projects they have undertaken. For example, posts on the blog *Japan Couture Addicts* [63] describe projects completed from the book *Cool Couture Remake Dresses*, demonstrating possibilities to the wider community, inspiring and encouraging participation [64]. The popularity of up-cycling suggests considerable scope for brands to design garments in anticipation of their remaking.

Within these methods of refashioning, a hierarchy of difficulty is apparent. With little effort, a wearer can refashion a garment by finding a new way to wear it. Remodeling requires some degree of intervention by the wearer to adjust a garment to suit new circumstances. Refashioning a garment by remaking it into a new form requires the greatest effort on the part of the wearer to either carry out the remaking themselves or access a service to do so. Restyling, remodeling, and remaking are not mutually exclusive and can be approached within design as complementary and/or cumulative. Further, garment attributes that enable refashioning can support recirculation if a newly acquired secondhand garment can be adjusted to fit.

Recycling and Waste. All of the above garment life-extension strategies postpone final disposal of the garment into the waste stream. With few textile recycling systems yet available to consumers, dropping a garment into the rubbish bin is the most convenient action to take with an unwanted garment [42]. The main challenge to recycling clothing is the mix of materials typically used in one garment. Fabrics often contain blended natural and/or synthetic fibers, to which plastic and metal fastenings are attached. Internal structures like fusible interlinings, padding and boning contribute further material types. Currently, recycling systems for garments require material separation to effectively reclaim and recycle the different fibers into

good quality yarns for reuse. Therefore, to support this emerging technology, designers can reduce their material palette to as few different materials as possible and employ construction methods that more readily permit the separation of garment components at the end of the garment lifetime. The challenge here is ensuring durability of the garment is not compromised before that point.

Mapping the various reuse pathways for the extended use of a garment provides a suite of future use scenarios for which designers can plan. Within The Living Wardrobe study, as the prototypes were developed, each extended use scenario was considered in relation to the garment type being developed. For example, what are the likely reuse pathways for a dress compared to trousers? How do the design features, fabric, fastenings, construction impact those likely futures? While each garment type and design style warranted a response specific to its form and assembly of materials, a general suite of design principles for extended garment could be determined:

- Design for durability: reinforce areas of wear, use durable fabrics and trims, robust construction
- Design for adaptability: allow for changes in size and style
- Design for easy intervention: use simple production equipment and methods so later changes are easy to perform
- Design for easy replacement of parts: use a combination of fabrics within garments such that replacement with contrasting fabrics is suitable
- Design opportunities for renewal through remaking
- Design for a range of aptitudes: consider the skill level of the wearer in making repairs and modifications, offer simple as well as advanced options

By reevaluating design and construction methods for their capacity to enable future modifications in addition to economic viability (being quick to produce in a mass manufacture setting), garment use may be prolonged with little, if any cost to production. However, such changes can incur aesthetic costs: different design and construction methods can change the look of a garment, thus design for extended use potentially creates its own visual fashion language, as has mass manufacture. However, each style prototyped within The Living Wardrobe seeks to demonstrate that the design of living garments need not result in garments that look substantially different from the prevalent taste. Rather, sustainability through extended use can be incorporated into contemporary, conventional women's daywear design. Aesthetic similarity to conventional fashion is potentially a significant method of making sustainable fashion practices more accessible. Figure 2 shows a modular garment from The Living Wardrobe, comprising three interchangeable parts: the collar and sleeves are separate units worn over a singlet. The garment units can be swapped for others to restyle the look, and each unit has been constructed to enable easy repairs, remodeling, and remaking. In this case, the sustainable garment looks familiar, but enables practices of extended garment wear and care as a result of a

Fig. 2 Outfit from the living wardrobe: modular top and adjustable culottes. *Source* The author

design process connected to the use phase of the garment life cycle. This goes some way to making practices of sustainable fashion easy to adopt, if wearers are not expected to substantially change their look to suit their ethics.

3.4 Enabling Extended Use

A garment designed with affordances of extended use outlined above, including provisions for repair and refashioning, might contribute to new habits of garment care in use by making sustainable clothing care practices available to wearers. While the Living Wardrobe garment prototypes investigated how design can make sustainable clothing practices available to wearers within the garment artefact, they also revealed that those practices, including the invitation to interact, also need to be designed. That is, even if a garment is designed and manufactured for extended use, its enduring capacities may be entirely overlooked if they are not clearly signaled to

the wearer. While some of the enduring capacities of The Living Wardrobe garment prototypes are self-evident (wide seam allowances), others require explanation and instruction, or risk being overlooked (that components are designed to be replaced). Further, that once the invitation to keep the garment in use is accepted, the wearer may need assistance to do so. Therefore, the aims of the garment prototypes became to produce garments that contained within them both their 'futuring' capacities [50] and the means to communicate and facilitate access to those capacities. This resulted in prototyping of both garments and resources to support those garments: Quick Response (QR) code labels that link the garment to a website of resources that explain what the garment does and further guides the wearer in taking those actions. The embroidered QR code garment label embeds within each garment of The Living Wardrobe, a durable hyperlink to a website that might be accessed at any stage in the garment's lifetime. A website of resources for enabling wearer interaction with the garment offers a potential solution to the challenge that wearers may have limited garment literacy to read the futuring capacities or the know-how to act on those capacities. There is potential for this information to evolve as the garment ages, initially supporting sale and first wear, then refashioning for subsequent wear and finally recycling. This presents new possibilities for counteracting the fashion cycle if garment styles produced years prior can remain contemporary through the ongoing discourse that surrounds them online.

4   Conclusions: Reconceptualizing the Garment Lifetime

At the heart of this chapter is a challenge to the cliché of giving your clothes a second life (Fig. 3). Describing an extended life as a subsequent life mis-represents the actual garment lifecycle that is, in fact, a *single* lifetime *inclusive* of the garment being modified or changing hands, before final disposal. The idea that a garment lifetime is synonymous with ownership undermines the value of the garment artefact: the garment does not "die" when it is discarded and is not "resurrected" by subsequent ownership. Reconceiving ownership of clothing as garment 'custody' would help support the extended use of fashion, if possession of a garment is understood as merely one phase in the lifetime of the garment. Custody implies a duty to take care of the garment so that others may use it in the future. Therefore, it warrants fashion design strategies for sustainability that look beyond the initial use phase, to design for the possibility of subsequent use phases.

Currently, clothing is not designed for recirculation within secondhand markets. As the secondhand market grows, fashion brands will need to change how they produce and promote their clothing to foster longevity in the market. Brand value in the secondhand market will become increasingly important. Already, reselling platforms routinely promote top sellers to customers [65]. Fashion reseller ThredUp publishes their highest performing brands in their annual report [66]. Research into what qualities of garments and brands persist in the secondhand market would assist

Fig. 3 Clothing donation bin at a suburban supermarket in Melbourne. *Source* The author

in determining what percentage of secondhand success is due to garment qualities, to brand reputation, or to other factors.

If fast fashion describes the constant acquisition and discard of fashion garments, then slow fashion might be defined as garments produced for extended use. Future impacts of current fashion industry practices are well understood: the pollution generated across the production supply chain and the post-consumer waste problem caused by excessive consumption. These issues are becoming increasingly hard for designers and producers of fashion to ignore, raising the issue of responsibility: who should take it and how. To mitigate the impacts of textile waste on the environment, enabling the various actions of reuse and recirculation described above, must be the priority for sustainable fashion design. Use forecasting is an essential tool for designers to contribute to a circular fashion system.

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