Design for Disassembly – Exploring A Critical Designer’s Agency through Adversarial Design to Produce Athleisure Clothing in a Circular Economy

Pervez, Wajiha*

*University of Technology Sydney, Sydney, Australia
* wajiha@wajiapervez.com

This research looks at circular economy innovation in athleisure garments, a hybrid of athletic and leisure clothing. The increasing uptake of athleisure garments as everyday clothing contributes to the environmental crisis at a scale that perpetuates the unsustainability of fast fashion due to their extensive use of plastic-based textiles. While the industry might claim to shift towards sustainability and circular economy in athleisure clothing, the approach is predominantly inclined towards perpetual growth and recycling, which promotes recurring cycles of consumption and production.

The research is framed by Adversarial Design theory by Carl DiSalvo which proposes that critical designers use their practice as a generative frame to expose hegemony within the relationships between product, production, and consumption. For example, material design for disassembly and recycling might be popular industrial approaches for designing athleisure garments due to their plastic-based composition; however, adversarial design can provide alternate ways to navigate the concept of labour, waste, and materiality of athleisure garments within a circular economy by confronting users with the complexity and perplexities of these industrial processes.

This research aims to investigate such conceptual applications of design for disassembly through the adversarial design framework by developing functional prototype garments to achieve experimental stretch, fit and moisture management capabilities for exercise and daily task performance in a designer’s studio. By manipulating natural, undyed calico and linen as ubiquitous and relatively sustainable but unconventional materials for athleisure garments, the prototyping experiments work towards the critical analyses of ‘disassembly’ systems that underlie the predominant use of synthetic textiles and their near impossibility for disassembly.

**Keywords:** Circular Fashion; Design for Disassembly; Adversarial Design, Athleisure Fashion.
1. Introduction
This research exercises a practice-based designer’s agency to explore circular economy solutions through a critical design for disassembly methodology in the context of athleisure clothing and its contribution to the rapidly escalating environmental crisis. It uses the Adversarial Design framework by Carl DiSalvo to seek a conceptual disassembly of the hegemonic recycling-based, design for disassembly circular economy narrative that exponentially drives athleisure clothing production and consumption.

First, it introduces athleisure, discusses its historical role in helping a moving female body, its influence on popular culture and the effects of its consumption on the environment. Next, it explains the economic growth motivations to accelerate athleisure clothing production and their incompatibility with sustainability efforts. It then makes a case for a critical design for disassembly approach in this research’s studio practice component. Finally, it experiments with natural materials and slow hand-stitched smocking methods to set the foundation for further research into seeking alternatives for plastic-based stretchable fabrics and fast industrial assembly lines to manufacture athleisure clothing.

2. Athleisure Clothing
2.1. Origins and Influence on Popular Culture
Athleisure clothing is athleticwear-inspired apparel worn for exercise, and everyday fashionable wear (Green, 2017). It follows a long history of designers making clothes to enable active, working women to engage in urban sports and fitness culture (tennis, biking etc.) and look fashionable while doing it (Horton, Ferrero-Regis and Payne, 2016; Wilson, 2018). For example, Jean Patou’s popular looks such as Tennis Chic consisted of a short-knit dress with a white silk skirt and plain white sleeveless cardigan (figure 1 & 2) (Koca & Özsan, 2017).
Present-day athleisure clothing is fitness-inspired but fashionably more versatile such as Adidas x Stella McCartney, Gucci x North Face, Roksanda x Lululemon etc. It is expected to reach USD 549.41 billion in global sales revenue by 2028 (Business Wire, 2022). However, this economically high-performing clothing category comes at a high cost to the earth’s ecosystems due to its environmentally pollutive assembly lines and the predominant use of plastic-based fibres.
2.2. A Broader Problem of Consumption

The United Nations 2030 Sustainable Development Goals identified responsible production and consumption practices essential for sustainable development (United Nations, 2023). But fashion and sustainability are often considered at odds with each other due to their underlying economic, financial, social and cultural complexities (Tham 2020).

A popular industrial circular-economy suggestion for manufacturing athleisure clothing is using recycled plastic-based fabrics so they can be disassembled and reformulated into yarn at the end of their useful life (Yip, 2020). While recycling is a big component of achieving sustainability in fashion, it does not solve the overarching problem of over-production and over-consumption of athleisure clothing. In fact, the proliferation of terms like eco, green and conscious to market the use of recycled plastic-based fibres greenwashes the complexities and environmental footprint of their derivation from finite fossil fuel resources, energy-intensive recovery, energy and chemically intensive reformulation, and labour-intensive assembly processes. This greenwashing makes it harder for consumers to know their buying decisions’ actual social and ecological footprint including the problems of landfills and environmental degradation (Webb, 2021).

![Figures 4 & 5. Growing Clothes Mountain in Alto Hospicio, Iquique, Chile (Skyfi, 2023)](https://www.skyfi.com/blog/skyfis-confirms-massive-clothes-PILE-in-chile)

3. Research Question

Although sustainability and circular economy in fashion are mostly discussed as environmental concerns, ethnographic research into fashion’s consumption patterns reveals that sustainability gains through long-term use and repair are highly dependent on changed user behaviour and consumption patterns (Muldoon, 2006). These patterns are influenced by underlying social, political and experiential dimensions, not just material innovations and design choices (Fletcher, 2012). Thus reducing athleisure clothing’s impact on the planet needs to be paired with materials, procedures and questions that probe changes in sociocultural consumption patterns.
Through the studio practice in this research, I have investigated the gap between environmental and socio-cultural dimensions affecting the design and consumption of athleisure clothing within a circular economy through the design for disassembly methodology by asking:

What are the opportunities for making critical athleisure garments within a circular economy, made with 100% natural fabrics through hand-stitched fabric manipulation techniques such as smocking and pleating? What are the implications for elasticity and moisture management when the garment is worn by a moving female body? ‘Natural’ in this context refers to fibres grown through agriculture, such as cotton and linen.

4. Adversarial Design & Fashion and Textile Designer’s Agency

In fashion, designers are perceived as major decision-makers at various stages of the apparel production process. In reality, it is a conflicted position. On the one hand, designers are applauded for their creativity. But on the other, they are also held responsible for being a part of environmental and social degradation (Blomfield 2002; Tham 2020). Contrary to popular belief, it is a complicated position, and designers exercise limited agency under the influence of corporations, investors, suppliers, collaborators, buyers, law, shareholders, production facilities etc. throughout the garment lifecycle (Walker, 2010). None of them has equal agency, and the power keeps fluctuating as one gains leverage over another under the fashion democracy (Busch 2019).

An in-depth investigation of fashion means seeing it as a bubble where numerous specialised fields converge to make products and services that are later sold to consumers. The model comes from Andries Van Onck’s MetaDesign framework, which describes nested levels of products, systems and paradigms in which new forms of collaborative design can take place to catalyse changes at a behavioural level (figure 6) (Tham 2020; Giaccardi 2005). Understanding this hierarchy is vital to trace the approach towards sustainability and circular economy. In the mass athleisure clothing industry, a designer’s agency is contained inside the product bubble using the tools, materials, policies, and parameters of economic growth and maximum financial profits. Even if designers are aware of the problems of athleisure clothing overproduction and overconsumption, they have to collaborate at a systemic level to implement the changes. Systems are a subset of the larger economic growth-based paradigm, and designers are rarely part of the decision-making at this level. However, adversarial design inquiry into athleisure clothing production and consumption methods enables designers and researchers to use their agency from within the product bubble to design products that label the hegemonic sites and problematic situations.
Figure 6. A designer’s agency under the fashion bubble (Tham, 2020)

Adversarial Design is theoretically framed by Carl DiSalvo to challenge beliefs and values around what is taken to be a fact (DiSalvo, 2012). Adversarial Design is expanded in detail elsewhere, an excerpt is provided here (Pervez, 2022). Adversarial design, in the form of services, events, products, and process abandons the idea that there is one absolute solution, it seeks alternatives. It helps to question conventional sustainability claims and design assumptions through agonism — a political theory developed by Chantal Mouffe that informs the adversarial design framework and emphasizes contestation as foundational to democracy (Mouffe, 2005). Contestation under adversarial design is not a radical shift in design but a new lens to look at how things could be if certain systematic, material, financial, and aesthetic restrictions do not exist (DiSalvo, 2012).

This research acknowledges that athleisure clothing is made on a mass scale, in a complex design and supply chain system with underlying sociocultural and environmental implications. It plays with the agency of those variables through the adversarial design framework in the design practice section to extend the boundaries of the circular economy. Investigating two critical political aspects of athleisure clothing, i.e., the female body and movement and labour and time lies at the heart of the studio practice component of this research.

4.1. The Female Body and Movement
Athleisure clothing has established specific visual and material standards of working and active female body representation (Craik, 2019). However, its flawless factory-made look mimicking the shine and finesse of premium natural materials leaves less room to think about the material’s origins, the human element involved in its construction or the environmental impact of its various stages of production. Therefore, the primary premise of the studio practice is to stay true to the original domain of athleisure clothing where designers put the female body, movement, and light fitness activities at heart while making athleisure clothing. But also, make athleisure garment prototypes without internalising the plastic-based materiality as an enabler of movement and comfort.
4.2. Labour and Time
Dressing up the active female body has been a task that designers have historically taken up to break the existing visual, material and social dress codes (Poplin, 2020). Therefore, the studio practice component of this research will utilise time-intensive stretch-enabling hand-stitched fabric manipulation techniques such as smocking and pleating for making athleisure garments for a moving female body. Secondly, it will disassemble the notion of speed in favour of slower, more reflective athleisure prototype garments. Behind this approach is the idea from science philosopher Thomas Kuhn, whose concept of the paradigm shift (1962) states that there is no probability of solving a problem within the paradigm that created it (Kuhn, 2012). The dominant paradigm driving the popular athleisure clothing business model is speed and exponential economic growth, i.e. producing millions of products predicted by forecasted growth numbers, then marketing them as a necessity and newness to sell more (Leach, 2021). The motivations behind this paradigm are reflected in the approach towards sustainability and the circular economy efforts to support it, i.e., making more plastic-based fabrics with a combination of recycled and virgin plastics using fast or mechanical labour to match the desired economic growth metrics and positioning excessive recycled clothing consumption as a step towards sustainability.

5. Studio Practice
The studio tests and garment prototypes in the following section correspond to the practice of forming an agonistic collective and exploring the relationalities corresponding to the female body and movement and labour and time. In adversarial design, “the tactic of articulation constructs linkages between objects, people, and actions that transform them into an agonistic collective — an open space of contest in which the elements gathered together are able to act out a plurality of conflicting practices, values, and beliefs” (DiSalvo, 2012, p. 96). The practice of articulating an agonistic collective under adversarial design doesn’t just address dominant political issues but also creates open spaces of contest where conflicting practices can be carried out and expressed on a scale that is accessible, eligible to be experienced and participated in by people. The agenda is not to assert a particular point of view but to suggest alternatives as prototypes and proof of concepts and leave them open to interpretation and further contest (DiSalvo, 2012, p. 114).

5.1. Forming an Agonistic Collective – A collaboration between The Female Body and Movement + Labour and Time
The athleisure garment prototypes produced in this research serve as devices of articulation that connect craft, time and natural fabrics to experience an athleisure alternate that otherwise does not exist. Further to these devices of articulation, I also decided to partner with a dancer and yoga practitioner, a photographer, and a stylist to use and interpret these garments via a collaborative photoshoot so that these devices of articulation could be tested. This step was necessary for forming an agonistic collective through an adversarial design process because products designed under adversarial design do not merely show that the alternatives exist. Instead, they provide spaces and environments to interact with the products made with adversarial design intention.
5.2. Ideation

While designing garment prototypes for this research, I kept the primary purpose of athleisure clothing in focus where the designer puts the female body, movement, aesthetic appeal, and light fitness activities at the heart of the athleisure clothing design process without internalising a specific materiality. Additionally, the design does not compromise on comfort, visual appeal, and wearability.

For the initial tests, I decided to experiment with smocking natural calico fabric to discover various options to create directional stretch provisions for the body. Smocking refers to a craftsmanship and embroidery technique that controls fabric fullness and enhances elasticity in garments by creating gathers (Hall, 1999). I chose calico for several reasons; first, it has a symbolic meaning for fashion practice because it provides the starting point for experimental patternmaking. Second, it is made from raw and breathable woven natural cotton. It is free from colour, prints and textures that communicate or inspire a potential use for fabric. Moreover, most of the calico cotton in the world is produced in the global East using renewable resources such as rain and greywater (Lanfranchi & Cline, 2021). Therefore, it is more likely to disintegrate naturally after its useful life if not mixed with plastic and other contaminants in waste streams. Third, unlike plastic-based materials, calico is a woven material that does not stretch and using it puts limitations around the intended studio practice. It compels alternative strategies for creating stretch qualities through fabric manipulation. Last but most important, utilising a seemingly inappropriate material is an important agonistic endeavour for the practice of adversarial design because it asks why certain elements, actors or materials have been excluded, and how the inclusion of a certain condition or material draws attention to a hegemonic process. (DiSalvo 2012, p. 64). Cotton in knitted and blended percentages is included in the industrial athleisure clothing ecosystem. However, using this specific form of cotton is agonistic because it confronts the intrinsic belief that woven calico cotton cannot be used for athleisure clothing production because it is not capable of providing stretch and fit capabilities instantly.

Figure 7 & 8. Sample 1 – Cushion Wave Stretch (two-directional diagonal stretch)
Based on the stretch and fitting allowances provided by the smocking experiments in calico and several other lightweight materials such as linen, I started to visualise how a completely smocked athleisure garment would look and function. I decided to make the final garment prototypes in linen. The fabric was perfect for my needs. It was lightweight, natural, breathable, undyed, had a good length to shrink, had a nice bounce, and smocked very well. So, I decided to keep the next set of garments simple, predominantly using crosshatch weave and pairing it with other smocking variations in an experimental piece to construct three separates – a crop top, a pair of pants, and a wraparound jacket. All of them could be worn separately or together to assemble different looks.
5.3. Planning
I decided to start with a crop top and then work my way up towards a pair of pants and a wrap-around jacket. The jacket/wrap-around piece was intentionally the most experimental. I made it as one long piece that could be draped around and played with. I then randomised the entry points into the jacket by adding seven sleeve and collar options because I wanted to give agency to the wearer in the use stage. The plan was to let the wearer (in this case the model) decide the wearability. To provide maximum flexibility for that wearability, I provided a network of drawstrings that could control the garment.

The first challenge for any garment made with the smocking process is to plan it well. As the technique is inherently zero waste, one has to be careful about utilising the entire width of the fabric and marking the length that would shrink down to the desired outcome. For example, I marked double the width and length of each panel for the crop top and then smocked it down to the required size (figure 7). An amusing component that I repeatedly observed while designing with smocking is that even though two fabric panels have the exact dimensions and the same smocking patterns, the result is never the same. The final size can vary and shrink beyond the expected result and has to be planned as a tolerance in the pattern. Hence, a pattern becomes a guide rather than an exact blueprint, and sizing becomes a range of numbers where the garment can fluctuate rather than an exact number.

Another important point to consider as more layers start to overlap and the fabric starts bunching up, is to offset the seams slightly from the body’s curves so that the fit stays close to the body. By doing so, the garment sits well next to the skin around the shoulder and torso, and the seams do not feel lumpy. The biggest challenge perhaps could be to balance the density, length, and weight of the smocked textile panels at the front and back since the fabric gets heavier with smocking.
Figure 12 & 13. Crop top front and back details

Figure 14. Finished Pants
5.4. Wearability
In the testing/photoshoot collaboration between the stylist, the photographer, the model and myself as the designer, the top fitted well, was comfortable, soft to the touch, enabled the body to move freely, was stretchable and allowed good airflow. The wearability was easy and intuitive. It was adjustable when the model switched between posing, her yoga flow and stretches. All collaborators observed that though the top itself is free of any colours or printed patterns, it looks interesting due to the smocking. Smocking, therefore, provided functionality, but also pattern, texture and ornamentation to the garments. It was important to note that though this research started with using smocking for its technical advantage, its aesthetic quality is also valuable and adds to the visual appeal of the garment.
As intended, the wrap-around garment turned out to be the most playful of the prototypes. It could be worn through the sleeves and tied up to encase the body or used in other creative ways as desired by the collaborators (figure 18). I observed that it took considerable time for the pants to dry after intense sweating due to the amount of fabric and layered smocking. There were suggestions to make the pants more tapered and fitted from the bottom in the subsequent iterations. That is a skill that I have to develop as the research advances forward through my design practice PhD work in the future. In my research so far, I have only experimented with symmetrical smocking. It is promising and exciting that more fit variations can be explored by enhancing my knowledge of smocking or exploring more techniques in the future.
Figure 17. The wrap-around jacket’s wearability
Figure 18. The wrap-around jacket’s wearability variations
6. Conclusions - Critical Reflection of Adversarial Athleisure Garment Prototypes

6.1. Informing Sustainability and Ethical Factors
Making redefined athleisure clothing prototypes under adversarial design parameters and extending them to collaborators for experience completes the process of articulating an agonistic collective. But, more importantly, it demonstrates and gives practical evidence that it is possible to develop athleisure garments free from the politics of geographically disconnected supply chains and the hegemony of plastic-based fibres, toxic chemicals and a multiplicity of factors that destroy earth’s ecosystems. As adversarial design is never a finished process, this research will continue to develop further through both practice and theory towards a PhD to test the elements that can be exchanged for circular economy efforts between practice-based research and the mass athleisure industry for research and collaboration.

Figure 19. Forming an agonistic collective: Extending critical adversarial design garment prototypes to collaborators for experience.

6.2. Slow Making
These athleisure garment prototypes made me appreciate the value of slow progress and reflection, which is often lost in the mass athleisure industry because of its’ scale and the practice of producing multiple collections a year. The smocking complications such as balancing the weight of the garment with each step, challenged my assumptions of productivity and speeding up the process through sewing machines or doing more with my time. I had to embrace the pace of the process and trust that it would be completed in its own time. Although many of my design choices were guided by their functional capacity, they emerged as aesthetic qualities in the garment.
Another important point to consider while discussing slow making is that the garments made in an industrial setting have seasonal deadlines and profit margins to consider and this slow pace might not be of any use while working with such limitations. But, I would argue that there are still lessons to be learnt through this practice. This intentional method of athleisure production can also be vital in achieving sustainability gains in the mass athleisure industry in addition to slow making such as care. Limiting overproduction and degrowth - a concept whereby material and energy throughput of the economy is reduced to bring it to balance with the living world while fairly distributing income and resources (Hickel, 2020, p. 204).

6.3. Durability
Even with hundreds of hours spent smocking, my expectations of the durability of the final prototypes were low. I assumed that the garments would tear during use because of the fragile nature of smocking stitches. I had a repair plan ready with smocked repair patches, but the garments turned out to be stronger than I expected. As evidenced in the wearability test with my collaborators, they tend to enable and withstand workouts, yoga flows and dance to some extent.

6.4. Contribution to the Field- A Research-Based Designer’s Agency under Adversarial Design
A new technology or material often steals all the limelight in mainstream athleisure clothing, and the labour done by designers to reach that output gets lost in the background. Shifting the commercial imperative of athleisure clothing design from product to process creation under adversarial design allowed me time to slow down, reflect on my practice and prototypes and engage critically with aspects of the supply chain that are not always made prominent to achieve a collective circular economy (figure 20).

Throughout making these prototype garments, I have experienced and observed things that I might never have experienced if I had focused on coming up with the next technology to mitigate athleisure clothing waste problems. I know from my professional experience that labour problems are not just limited to assembly lines or factory workers. These problems affect designers as well. Ultra-fast turnover timelines allow less time for reflection and personal well-being. As a result, designers often suffer from burnout and work dissatisfaction. Sustainability and circular economy also become questions of emotional health because designers’ moral values may clash with corporate values. Hence, the next insight from this adversarial design research is that to sustain the athleisure clothing industry - which is built on the idea of a strong female body that is active, confident, well-rested and is able to convey that strength through clothing choice - designers must likewise attempt to make choices that not only positively impact design, systems and paradigms, but also nurture healthy minds and inspiring designers that have been given enough time to rest and reflect on their practice.

Lastly, I aim to extend this research further into my PhD and develop more athleisure garments rooted in the recent research on the potential for seamless knitting to mitigate waste during the garment production process (McQuillan, 2020). The new athleisure garments will be intended towards degrowing the industry through exercising a designer’s agency by using place-based materials and mindfully developing only the desired quantities based on user feedback.
Figure 20. A designer’s agency and potential for a circular economy under adversarial design

References


**About the Author:**

**Wajiha Pervez:** Wajiha Pervez is an experimental textile designer, artist, and academic. She researches apparel, materials, systems, and cultural practices in the context of environmental sustainability and circular economy. Her work celebrates the collaboration between materials, technology, and craft to create products for a sustainable future.