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Exploring clothing consumption through design fiction

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The wardrobe as a system: exploring clothing consumption through design fiction

Abstract: This study offers a new perspective on clothing consumption by uncovering the systemic nature of the wardrobe. The research builds on systems theory and aims at drawing a map of the wardrobe as a system with particular structure and behaviour. By co-designing fictional “smart wardrobe” services with experts and discussing these services with wardrobe users, we identify characteristics of wardrobe structure and behaviour that give input for a preliminary wardrobe map. Lastly, the wardrobe map provides a basis for discussing sustainable design approaches aimed at reducing clothing demand, in the context of growing clothing production volume and its associated environmental impacts.

Key-words: clothing consumption, sustainable design, systems theory, design fiction, research through design

1. Introduction: clothing volume and the wardrobe as a system

The quantity of clothes in circulation has increased dramatically in the last decades, bringing along negative environmental impacts such as growing resource use, CO₂ emissions and waste volumes. Growth in the quantity of clothes purchased has led to growing wardrobes, and consequently to increasing clothing volumes stored rather than in active use. In the UK, the Netherlands, and Germany, approximately 30% of the wardrobe has not been worn in the last year (WRAP, 2012; Maldini *et al.*, 2017), meaning that we are producing more than needed, and presumably more than we can physically use. Waste management organizations across Europe are struggling to deal with the pace of changes; where more than half of the items discarded are directly incinerated or used for landfill (Morley, Bartlett and McGill, 2009; FFact, 2014; Palm *et al.*, 2014; EcoTLC, 2016). Moreover, international demand of second-hand clothes is dropping together with prices for clothing resales, resulting in higher volume of used textiles that do not find an environmentally-sound destination (Ljungkvist, Watson and Elander, 2018).

In sustainability-oriented literature, clothing volume is usually discussed implicitly under the umbrella of “speed”. That is, fast fashion versus slow fashion and longevity versus premature replacement (see e.g. Cooper *et al.*, 2013; Laitala *et al.*, 2015; WRAP, 2017, 2012). A series of design strategies have been proposed to slow down the cycle of clothing replacement, or to enable more intensive product usage (see Maldini and Balkenende, 2017 for a review). However, based on a series of wardrobe studies, we have argued that clothing consumption does not usually follow dynamics of product replacement (Maldini *et al.*, 2019). Therefore, product longevity may not have a positive effect in reducing clothing demand. Long-lasting garments do not necessarily prevent additional garments to be purchased and produced because other mechanisms, different to that of product substitution, are at play in clothing consumption. Intensive product usage does not lead to reductions in new product demand either, because clothes are purchased for other reasons than mere need.

One limitation of design strategies for reduced clothing volume based on product longevity and intensive usage is that they are based on a simplistic view of clothing consumption. For example, Cooper *et al.* (2013) argue that “if clothes have a longer usable life, they can be replaced less frequently – reducing the volume discarded and meaning fewer resources are consumed in manufacturing”. In expecting a reduction in new product demand on the basis of clothing longevity, these strategies overlook the mechanisms of the wardrobe. They see the wardrobe as a utilitarian collection with permanent volume driven exclusively by need, which is illustrated in Figure 1. From this perspective, the wardrobe is subject to “pull” forces, because incorporation of new garments is based on replacement of unsatisfactory pieces. However, in our previous wardrobe studies (Maldini *et al.*, 2019) we have observed a more complex wardrobe behaviour, which is illustrated in Figure 2. Wardrobes incorporate and dispose of garments for a variety of reasons. New items are often bought

without consideration of those already owned, and owned garments leave the wardrobe because more attractive ones are coming in (“push” forces). Clothing inflow and outflow in the wardrobe can be connected under “pull” and “push” influences, but they can also be independent, meaning that purchase and disposal are not necessarily associated. The independence of inflow and outflow allows wardrobe volumes to grow or shrink over time based on garment clean-ups or accumulation, hence the dashed lines representing flow and volume in Figure 2.

In this study, we explain the contrast between Figures 1 and 2 by the fact that the wardrobe is a complex system; a system constituted by a variety of elements with relations rather than a mere ensemble of objects. Both the structure and the behaviour of the system over time are complex, and that may be one reason why they remain underexplored. Therefore, we aim at answering the following questions: What can we learn about clothing consumption when we look at the wardrobe as a system? How does the structure of this system look like? What system behaviour does this structure promote over time? The objective is to draw a systemic map of the wardrobe (including relevant elements and relations) that can explain its complex mechanisms.

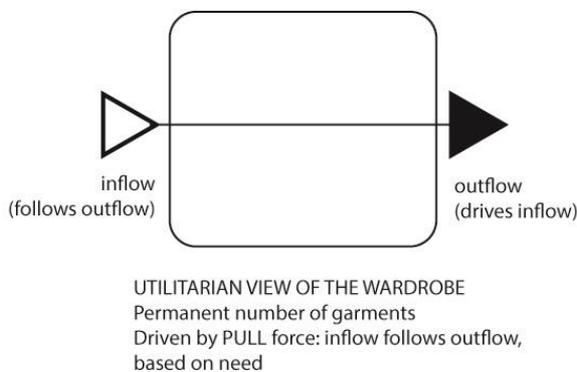


Figure 1. Utilitarian view of the wardrobe, predominant in sustainable design strategies

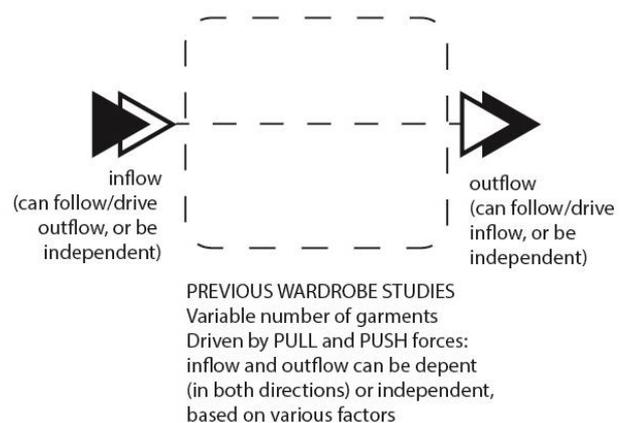


Figure 2. Wardrobe flow observed in previous wardrobe studies

Both wardrobes and systems have been the object of study in previous fashion and clothing scholarship. The wardrobe is receiving increasing attention in ethnographic studies of clothing consumption (Woodward, 2007; Klepp and Bjerck, 2012; Fletcher and Klepp, 2017), but these are often focused on a selection of garments at a specific moment, rather than on the behaviour of the wardrobe as a whole and over time. Another stream of design-focused fashion scholarship has used systemic thinking to develop new Product-Service-Systems and business models for environmentally-sound production and consumption (see e.g. Armstrong, 2013; Armstrong et al., 2015; Fletcher, 2010; Fletcher and Grose, 2012; Niinimäki and Hassi, 2011). However, these have not been nourished from systemic analysis of clothing consumption, including the practices of purchase, storage, use, maintenance, and disposal, and the connections between them.

In an early study about the process of clothing consumption, Winakor (1969) already acknowledged that its logic is different to other product categories. The author proposes a simple descriptive model of this process describing some of the characteristics of wardrobe flow illustrated in figure 2. Still, such model does not explain what elements of wardrobe structure promote this specific behaviour. More detailed perspectives of the wardrobe as a system acknowledging its networked-like nature

constituted by dynamic and mutually influential elements are much needed. A more comprehensive overview of the system structure is particularly necessary for designing new ways of intervention.

In mapping the elements and interconnections of the wardrobe as a system, we hope to promote the emergence of design strategies for lower clothing volume that consider the complexity of clothing consumption. A second level of contribution is to understand if design can be helpful to enable systemic perspectives. Is doing design useful to trigger systemic thinking among designers? Can design artefacts elicit systemic perspectives of the wardrobe when displayed to users?

With the purpose of exploring these questions, this study builds on systems theory and takes a Research-through-Design (RtD) methodological approach. The method includes developing fictional “smart wardrobe” functions and services together with a team of designers, and discussing these provocative pieces with wardrobe users. This path allows not only to develop the much-needed wardrobe map, it is also helpful to analyse the contribution of design to enable systemic perspectives of the wardrobe.

2. Theoretical framework: thinking in systems

In their interdisciplinary book *The Systems View of Life: A Unifying Vision*, physician and chemist Capra and Luisi identify a paradigm shift across contemporary sciences, one that builds on systems as a perspective of the world.

At the forefront of contemporary science, we no longer see the universe as a machine composed of elementary building blocks. We have discovered that the material world, ultimately, is a network of inseparable patterns of relationships; that the planet as a whole is a living, self-regulating system (...) This new conception of life involves a new kind of thinking – thinking in terms of relationships, patterns, and context (Capra and Luisi, 2014)

This phenomenon is not restricted to the natural sciences but has emerged in a variety of fields. Within design, scholars have too announced a “systemic turn” in the field, defining systemic design as one that “affirmatively integrates systems thinking and systems methods to guide human-centred design for complex, multi-system, and multi-stakeholder services and programs across society” (Jones, 2017, p. 157). However, the limitations of the systemic perspective in the field have also been acknowledged. The focus has been on creating new systems evading a systemic analysis of the issue at stake. “So far, we have addressed many macro-level problems in emerging technology, social change, policy and governance, climate change, and bio-ecosystems with superficial approaches” evaluates systemic design scholar Peter Jones, “(a)s designers, we often see well-formed design solutions for large-scale problems that target an envisioned need without understanding the complex social ecology of use” (Jones, 2017, p. 158). In fact, as already mentioned, we recognize this limitation within the sustainable fashion field, meaning that systemic solutions for clothing consumption volumes are developed with no previous systemic analysis of the wardrobe.

Donella H. Meadows (2008) defines systems as “a set of things - people, cells, molecules, or whatever- interconnected in such a way that they produce their own pattern of behaviour over time” (Meadows, 2008, p. 2). They are constituted by three kinds of things: elements, interconnections and a function or purpose, the later meaning that a system is more than the sum of its parts. In order to illustrate the behaviour of a simple system over time, Meadows uses a combination of three features: stock, inflow, and outflow (see Figure 3). Inflow and outflow are represented as faucets to indicate their role as system regulators. The presence of stocks, which have variable volume, allows inflow and outflow to be independent from each other. Moreover, both external and internal elements can influence inflow and outflow, the later operates via feedback loops. Feedbacks do not only help to

maintain flows stable (balancing feedbacks), they can also increase or decrease inflow or outflow (reinforcing feedbacks).

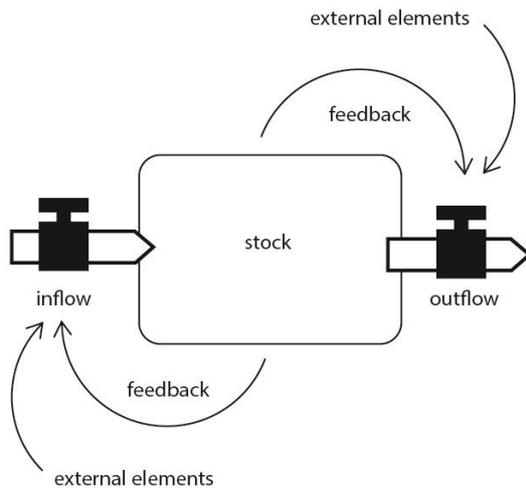


Figure 3. A simple system (Meadows, 2008). The system’s flow is illustrated in thick arrows and the thin arrows are influences affecting inflow and outflow.

This simple description of the components and behaviour of systems over time is of straight-forward application to the wardrobe. Inflow and outflow are independent, but they can influence each other through balancing and reinforcing feedback from internal elements. Moreover, the volume of stock is variable. Lastly, external elements can be of direct influence on flow via the system regulators (inflow and outflow). Therefore, Figure 3 provides a solid foundation for a preliminary wardrobe map, to be further completed with elements, interconnections, and purposes emerging in this study.

3. Methods and initial results

3.1. Design fiction for knowledge generation

A main objective of this study is to uncover relevant elements and interconnections of wardrobe structure that can explain its behaviour over time. We do this by (a) co-designing fictional “smart wardrobe” services with designers and experts, and (b) using the proposed services as provocation for discussion about clothing consumption with wardrobe users.

By working with fictional services, we build on previous studies in the field of Human-Computer-Interaction (HCI), which use critical, speculative or fictional designs to provoke discussion. They differ to mainstream design practice in that they do not propose a “solution” to the issue at stake but rather integrate the tensions and critical aspects of this issue in the artefact, purposely preserving their complexity (Bleecker, 2009; Bardzell and Bardzell, 2016; Blythe *et al.*, 2016). Although these streams of design practice were not explicitly developed for research purposes, they have proven to be successful in bringing key aspects of a critical issue to light. They do it by, for example, incorporating extrapolation, irony, ambiguity or magic, with a focus on the future (Blythe and Encinas, 2016). The fictional character of these artefacts and their future temporality free designers and participants from the constraints of present technology and encourages the emergence of visions, values and prejudices about the present. One reference used in this study is the IKEA catalogue (Brown *et al.*, 2016); a publication created to confronting readers with dilemmas that digitalization and big data could bring about. A key element of the fictional products and services offered in the catalogue is to show trade-offs. The publication offers technological solutions for the household that come at a cost to privacy or ownership, making tensions between utopian and dystopian futures visible.

In this case, the fictional “smart wardrobe” services are used to discuss clothing consumption from a systems perspective. In broader terms, the approach builds on Research through Design (RtD), a stream of research that uses design as a way to generate transferable knowledge (see e.g. Frayling, 1994; Koskinen et al., 2011; Stappers and Giaccardi, 2017). Stappers and Giaccardi (2017) point out several ways in which this is done. One is by creating prototypes that can be observed, measured, or used to inform and provoke discussion. Another one is to reflect during the process of creating these prototypes. In this study, we do both. We harvest insight both from the design phase and from a subsequent discussion group with wardrobe users, where the proposed services are used as provocation. The specific methods are described in the sections below.

3.2. Co-designing “smart wardrobe” services

The design of the services starts with a creative session at Delft University of Technology. The session involves six students following the Master Programmes Strategic Product Design and Design for Interaction, one wardrobe consultant, one Internet of Things researcher, one sustainability researcher and one professional designer working on technological solutions to enable better clothing reuse. To open the session, we share background information similar to the one presented in the introduction of this article and we discuss the concept of design fiction.

The specific objective is to create provocative “smart wardrobe” services with emphasis on the systemic nature of the wardrobe. These concept ideas should embed and elicit discussion about dynamics of clothing consumption. The protocol of the creative session includes input for designers at three different levels, namely fictional technologies, issues of discussion, and companies (see Table 1). Designers are expected to use the input as starting point for the creative process. The fictional technologies aim at connecting wardrobe activities. These are chips and sensors with various functions that can be placed on clothing and wardrobes, enabling “smart” systems. The issues of discussion are aspects of clothing consumption to be used for provocation. These are pairs of opposites aimed at promoting ambiguity in the ideas. Finally, we propose a list of companies that can play the role of service providers, stimulating system-level thinking.

FICTIONAL TECHNOLOGIES sensors and chips able to:	ISSUES OF DISCUSSION		COMPANIES Possible service providers
Store information on brand, materials, size, model etc. for each garment	Small wardrobe	Big wardrobe	Zara: a fast fashion brand
Map garment ownership through the personal wardrobe	Slow wardrobe	Fast wardrobe	Lena: a local fashion library
Map clothing usage, including records of garments worn together in an outfit	Need	Desire	Zalando: an online retailer
Connect usage data with the calendar, weather information, and the user’s personal agenda	Pull force	Push force	Sympany: a local collector and sorter or post-consumer textiles
Connect all the previous information with the user’s network, companies, or making it publicly accessible	Clothes in use	Clothes stored	Greenpeace: an activist organization for environmental conservation

Table 1. Three levels of input provided to the design team.

During the creative assignment, designers worked in three groups and shared intermediate outcomes with each other (see Figure 4). All participants commented on all concepts in order to refine or develop them further. The researchers did not take an active role in the creative process, we rather provided general guidance and documented the intentions behind participants' ideas recorded in audio and video.

The input provided and the challenge of creating fictional proposals sparked creativity in the design teams. They came up with a variety of ideas by connecting the three levels of input with their own experience as wardrobe users, their perception of how clothing companies work or could work and their previous knowledge on innovative technologies and services in this and other sectors. We note that not all elements in Table 1 were included in designers' proposals, they rather played a role as communication starters and mutated during the creative session as designers considered them (ir)relevant for their fictional services. Several proposals were based on a broad notion of the wardrobe, linking purchase, use, maintenance and disposal, and acknowledging its systemic nature. The session resulted in six highly relevant service ideas. In the discussion section (section 4) we will reflect on the implications of this session and resulting proposals for our research questions.



Figure 4. Creative session participants working in groups

Following the creative session, the proposed ideas are further developed by the researchers in collaboration with a graphic designer, giving shape to six graphic advertisement pieces. The graphic pieces had to meet certain conditions. Firstly, they had to be easy to make and fast to read. Secondly, there should be certain level of clarity and ambiguity in the message (i.e. the general service concept should be easy to understand but the abstract issues embedded should preserve their provocative aspect). Lastly, they had to elicit reactions stemming from participants' daily experiences and values during the next research phase (discussion group). In line with these conditions, we used a poster format and the familiar and convincing tone employed usually in popular advertisement.

This process resulted in six posters, depicted in Figures 5 to 10. The services offered in the posters are:

- *Zalando use-value*: a discount programme for garments that offers products similar to those worn frequently at a reduced price (Figure 5).
- *Gucci lifestyles*: a subscription service including four different plans where clients receive a personal package with garments to be worn every week (Figure 6).

- *Wardrobe surfing*: a social media platform suggesting new paths for unused clothes (Figure 7).
- *Ikea hide & pick*: a physical closet assisting choice for the day's outfit, which uses artificial intelligence to display a selection of garments suitable for current weather, agenda, and user's mood (Figure 8).
- *Social Responsibility Europe pay-as-you-wear programme*: an alternative payment system for garments where users pay per use (Figure 9).
- *Sympany worn-out pile manager*: A system that assists users in repair decisions and activities, and finds replacement items in the market for products beyond repair (Figure 10).

zalando
USE VALUE

Share your clothing usage data and become a smart shopper. We identify your favourite clothes and offer discount on similar items.

Tartan Plaid BLUE shirt
PURCHASED APRIL 2021
52 USES SO FAR
9 USES LAST MONTH

Congrats! You have reached **discounts** in the following similar pieces:

Gingham shirt GREEN € 22.00 € 25.99 15% off for you!	Gingham shirt YELLOW leather € 31.40 € 34.99 10% off for you!	Madras shirt RED € 20.70 € 25.99 20% off for you!
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We don't sell clothes, we empower your wardrobe! The more you wear your clothes, the bigger the discount on similar items. Zalando gives you the opportunity to make the best out of your purchase. Get more of what you like and what you will actually use. Strengthen your style!

Figure 5 Zalando use value.
Original shirts photo credits: mrsiraphol / Freepik

GUCCI Lifestyles:
fresh outfits always at your door.

Participate in our subscription program. Wear a different GUCCI outfit every day and be part of the GUCCI community.

Forget about washing and taking care of your clothes. Get a GUCCI wardrobe delivered weekly to your home and share your outfits in social media. If your style contributes positively to GUCCI's image, you get access to better subscriptions and to brand events. Co-create the GUCCI lifestyle!

The options for subscription plans are (price per week)

PREMIUM 300,-	Clothes are brand-new and coming out of the latest collection.	FAIR 70,-	Clothes launched two years ago, with signs of previous use. Get a great quality-price relationship, be stylish and do not bother about care.
QUALITY 150,-	Clothes are as-good-as-new and in line with the latest trends. Differences between PREMIUM and QUALITY subscriptions will be mostly unnoticed by others.	WANNABE 35,-	Clothes are somewhat worn-out and may include pilling areas, holes or repairs. Wear the same that you have seen celebrities wearing only 3 or 4 years ago, and be part of the GUCCI community – for little money!

Figure 6 Gucci lifestyles.
Original doors photo credits: Christian Stahl

WARDROBE SURFING
A PLATFORM BUILT BY THE Couchsurfing COMMUNITY

WHY KEEP CLOTHES THAT YOU NEVER USE?
GET OUR AI WARDROBE MANAGER, LINK IT TO YOUR SOCIAL MEDIA,
AND FIND THE BEST DESTINATION FOR YOUR FORGOTTEN CLOTHES.

Remember me? I am getting bored of this dark wardrobe. I haven't been used for 2 years!

Have you tried me with your new red shirt? Maybe for the bike tour next week?

Did you know that Max wears pants like me every day? May I spend a couple of months in his wardrobe? I'm feeling like a short break...

It seems like you've moved on with your style... I estimate your friends would offer € 5-10 for me. Try it on! I'm ready for a new life!

SHARING IN ORDER TO MAKE THE BEST OUT OF WHAT WE HAVE,
THAT IS WHAT DRIVES THE COUCHSURFING COMMUNITY.

Figure 7 Wardrobe surfing.
Original jeans photo credits: mrsiraphol / Freepik

LET DATA PICK YOUR STYLE TODAY

Thursday, 27th March 2025
18° ☀ max 23°, low 14°
10:00 meeting Tim
11:30 work in the article
19:30 cocktail party

Mood tuner
COMFY RISKY

0,322 BTC
Hide & Pick wardrobe

Our Hide & Pick wardrobe helps you find the best outfit based on your agenda and weather conditions. Only the relevant clothes are displayed and your outfit decision is faster and simpler.

We help you to know your wardrobe better and to keep head-space to what is important. Be prepared for your day, do not lose time in making decisions about your outfit and be aware of what you actually like to use. Enjoy the benefits of a truly data-driven life!

Feeling like playing safe? Choose the **comfy** setting in the mood tuner focusing on the clothes used often.

Feeling adventurous? Then choose the **risky** setting, your wardrobe will display the items more rarely used.

IKEA

Figure 8 IKEA hide & pick.
Original wardrobe photo credits: larkandlarks.co.uk

PAY-AS-YOU-WEAR AND CONTRIBUTE TO A RESPONSIBLE EUROPE



Buy clothes that you will actually use and be a more responsible consumer. At Company Social Responsibility (CSR) Europe we developed a programme to help companies and customers understand each other better, to encourage clothing usage, and to reduce textile waste.

Ask for the "pay as you use" programme at your regular shop.

This is how it works:

no use	FREE	} discounted from customer's bank account and distributed in supply chain
1st use	€ 20,	
2nd	€ 10,	
3rd	€ 5,	
4th	€ 2,5	
5th	€ 1,25	
6th	€ 0,60	
7th	€ 0,30	
8th	€ 0,15	
9th	€ 0,07	
10th	€ 0,03	
11th-50th	€ 0,01	— paid by CSR Europe and distributed in supply chain



SYMPANY Worn-out pile manager

We help you find the best repair option for your clothes, and the best replacement for items beyond repair.



PILLING?

Clothes are periodically picked-up and donated to Sympany. You get a replacement garment at home, which you can send back free of charge or keep and pay, including Sympany's service fee.



ZIPPER BROKEN?

To be repaired, it pays off. Clothes are periodically picked-up and sent back directly from repair shops. The bill includes Sympany's service fee.



BUTTON OUT?

Repair it yourself. Manager helps you finding a good spot in your agenda.

Figure 9 CSR Europe pay-as-you-wear programme. Original dress photo credits: mrsiraphol / Freepik

Figure 10. Sympany worn-out pile manager. Original woman and clothes photo credits: katemangostar / Freepik

3.3. Discussion group

In a second phase of knowledge generation, the six graphic pieces are used in a discussion group with participants (see Figure 11). Invited participants are respondents from previous wardrobe studies. They have been previously sensitized about wardrobe flow by counting all their garments (including those in use and stored) and registering all garments coming in and going out of their wardrobe over a six-month period (wardrobe turnover). This process included a brief description of the reasons behind each of their wardrobe turnover decisions. The group includes six people (four women and two men, aged 29 to 58 whose wardrobes include between 164 and 272 garments).

The discussion group takes place at the Amsterdam University of Applied Sciences and lasts three hours. Participants introduce themselves, briefly describing their wardrobe and sharing their experience during the wardrobe study. The researcher explains the background of the study and requests participants to react to the six advertisement pieces. The intentions behind the ads are not disclosed to participants. They are requested to indicate if (a) they would like/resist/be indifferent to each service, and why; and (b) how would they use it? how would it affect their lives? These are indicated individually in writing.

Later, all reactions are shared and discussed. The discussion group is audio and video-recorded, following a focus-group-like dynamic aimed at considering the fictional pieces as if the services were available on the market. However, their fictional nature is mentioned at the start of the session to avoid discussion on their technicalities.



Figure 11. Discussion group supported by provocative graphic pieces

During the session, participants reacted to the posters with interest and curiosity, they understood the basic service ideas relatively quickly and asked for some clarification. While discussing the services offered, they acknowledged differences in their wardrobes' structure and behaviour. For example, one participant said she would pick up garments left by others in the street to try and use them later, and another one acknowledged a tendency to keep unused clothes in the wardrobe for very long time. The systemic attributes of the wardrobe were present in the service proposals and they dealt naturally with the elements and interconnections embedded in them. In line with their provocative purpose, the

posters elicited discussion about participants' consumption habits, that of other people, and the role of clothing companies, advertisement, and post-consumer textile collectors. When asked their opinion as possible clients of the services offered, participants seemed interested about specific features or for specific garments and situations, but they were rather critical to the service as a whole. In the next section, we reflect on the implications of this and other issues discussed for our research questions.

4. Discussion

Coming back to the questions posed in the introduction, the methods above led to findings at two levels, which are discussed separately in the subsections below. Firstly, we discuss wardrobe structure and behavior: what characteristics of the wardrobe emerged when participants considered it as a system? Secondly, we reflect on the methods level: how did the framing help to enable systemic thinking about the wardrobe, both during designing and discussion?

4.1. Wardrobe structure and behaviour

During the creative session, the fictional technologies introduced to designers as input encouraged them to quickly consider the wardrobe as a system. By using these technologies, they connected the practices of purchase, storage, use, maintenance, and disposal of each garment, acknowledging relations between garments, and the influence of external factors. Moreover, the issues of discussion introduced as second level of input were successful in starting conversations about wardrobe structure and behaviour, which were in turn integrated in the service proposals. For example, *Sympany worn-out pile manager* automatic replacement of garments (Figure 10) and *Zalando use value* persuasive discount programme (Figure 5) embed tensions between “push” and “pull” influences in wardrobe flow. Conversations about “clothes in use vs. clothes stored” contributed to *Wardrobe Surfing*, *IKEA Hide & Pick*, and *CSR Europe pay-as-you-wear programme* (Figures 7-9), where use (in)frequency of garments gains visibility. Implicit in *Gucci lifestyles* subscriptions, based on temporary clothing access, were discussions about wardrobe size (Figure 6).

In providing a starting point for the creative process, these issues brought about other elements of wardrobe structure and behaviour that were not introduced by researchers. In line with the aims of the study, these other aspects of clothing consumption that emerged during the creative process are useful to draw the much-needed wardrobe map. The importance of market prices and the power of sales as a driver for purchases was core in the development of *Zalando use value* which offers discounts in clothes similar to those worn more often. Another central issue of discussion was the relationship between use and exchange value of garments, implicit in this and other services, for example *CSR Europe pay-as-you-wear programme*, in which users pay per use. In this fictional service, product prices rise but prices per use fall as items are worn more often. Designers acknowledged users' limited control of the wardrobe and the presence of involuntary inflow (for example, when receiving clothing as a present) and outflow (when items are lost). This conversation contributed to *Sympany worn-out pile manager* automatic replacement of garments and *Gucci lifestyles* subscriptions, where wardrobe inflow is controlled by companies rather than by users. Personal identity and social performance were discussed in relation to what the wearer allows, or not, in the wardrobe and the look of the day. Personal style was identified as a restricted but flexible aesthetic zone, and such ideas were embedded in *Wardrobe Surfing* and *IKEA Hide & Pick*.

These and other internal and external elements playing a role in the wardrobe as a system gave input for a preliminary wardrobe map depicted in Figure 12. See, for example, the presence of involuntary inflow and outflow illustrated in arrows with no faucets, since they can bypass users' system regulation. A series of external elements with direct influence in voluntary inflow and outflow emerged. For instance, “social environment” and “price of garments outside stock” are of direct influence in voluntary inflow, and “allocated storage space” and “value of garments in stock for

others” are of direct influence in voluntary outflow. However, it was during the discussion with users in the second phase of the research that the centrality of “purpose of stock elements” and the variety of purposes emerged explaining, at least partially, the structure and behaviour of the wardrobe as a system.

While the design team had embraced the concept of “smart wardrobe system”, which helped them visualizing and connecting different elements or clothing consumption, the user group mostly resisted the connections of elements embedded by designers in the fictional services. They found the services helpful for specific garments, but restrictive if the service would apply to the wardrobe as a whole. For instance, one participant said he would only appreciate discounts offered by *Zalando use value* for his white T-shirts, another one would profit from *Sympany worn-out pile manager* replacement function for her favorite woolly sweater that unfortunately shrank in the washing machine, yet another respondent would benefit from a service such as *Gucci lifestyles* but only for clothing to be used in special occasions. When reacting to each service as a whole, participants rejected *Zalando use value* services for lacking “sense of adventure and evolving taste”, they thought *Sympany worn-out pile manager* replacement function would take away their “chance to try something new”, and resisted *Gucci lifestyles* because they “did not want to be hip”.

We explain the reactions of respondents by the fact that flow-related decisions are garment-specific; however, the services proposed wardrobe-wide functions. The automated services oversimplified the networked structure of the wardrobe to an unwelcomed unidirectional structure. Moreover, each service emphasized specific aspects of clothing consumption playing an important role in the behavior of some items, but not in others. As a result, when respondents contrasted these services with their actual wardrobes, they saw more limitations than opportunities. At the same time, this contrast made the complexity of the system, its flow, and its stock, visible to us researchers. We could see the wardrobe as a system, but a much more complex system than the fictional services propose. As we will explain below, a central aspect of its complexity is the variety and organization of stock.

In simpler systems, the stock may be clearly classified in stable categories; for example, the stock of a gas station classified according to kinds of gasoline. But in the wardrobe, the stock is structured according to several overlapping classifications; namely, garment type, colour, use context, performance in specific weather, etc. (see Figure 12). The kind of organization is comparable to that of a virtual music collection with categories such as artist and genre overlapped by different playlists. Every item in the wardrobe stock belongs simultaneously to different categories, in a unique combination that is rarely shared by another item. Consequently, items respond to very specific sets of purposes, which can change over time and in relation to other items. For instance, the presence of a purple velvet skirt in stock may respond to the purpose of diversifying outfits to be worn at work in a cold day in combination with lighter colour sweaters, communicating sobriety and livelihood. The specific role of this item in the system and its purpose leads to a very specific behaviour of the item over time, which differs from all other items in stock and their possible substitutes. These findings came up from the discussion group, as a reaction of wardrobe users to the fictional services.

Since each item responds to specific purposes, and the system has its own general purposes altogether, discrepancies between purpose of items in stock and the overall purpose of the system lead to feedback loops and ultimately to inflow and outflow (Figure 12). However, unlike simpler views of the wardrobe suggest, the varied nature of items in stock leads to specific garments trajectories, and feedback loops are unpredictable. Delaying disposal of one sweater does not mean that purchase of another sweater will be delayed. The presence of dresses suitable for high use frequency or providing emotional fulfilment does not stop the inflow of other dresses either. The trajectories of items in stock, and their interdependence, are more intricate than that. Feedback loops are mediated by a variety of internal and external elements and the influence of each item in stock on overall system behavior is limited and indirect.

During the discussion group, participants acknowledged differences in the behavior of garments in the wardrobe. For instance, one respondent noted “I always thought my wardrobe was moving slowly because I have clothes older than ten years, but then I noticed that other clothes come and go very fast”. In Figure 12 we have intended to explain this and other aspects of wardrobe behavior over time by drawing a preliminary picture of wardrobe structure. The elements and relations included in this map are those emerging from the creative session and discussion group, but many other elements and relations influence actual wardrobe behavior. Additional limitations of this study are the small number of participants included and their relatively homogeneous cultural background. However, despite these restrictions and the incompleteness of the model, this basic map illustrates aspects of clothing consumption that are of use while designing solutions to the challenge of growing clothing volumes. Further implications of this wardrobe structure for sustainable design strategies are discussed in the conclusion.

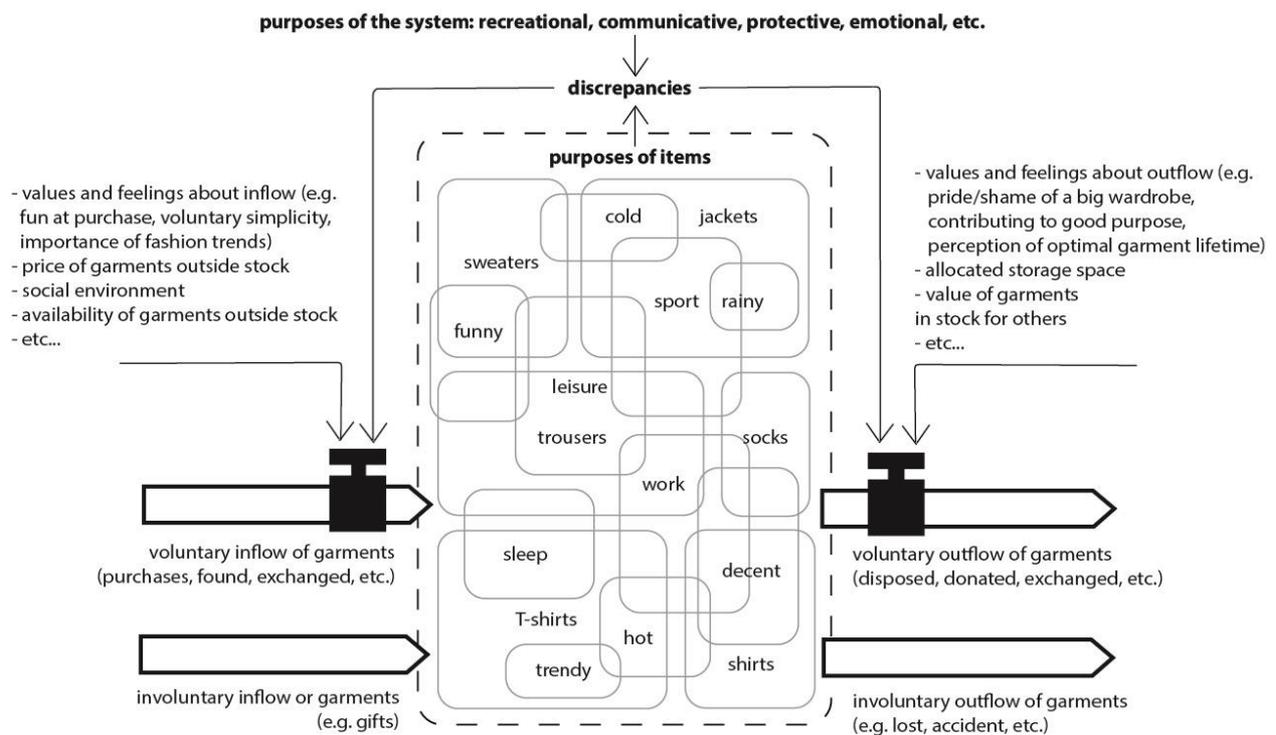


Figure 12. A systemic map of the wardrobe including elements, interconnections and purposes emerging from this study.

4.2. Enabling systemic perspectives of the wardrobe through fictional services

A second purpose of the study was to evaluate how doing design and being confronted with design fiction artefacts enabled designers and users to see the wardrobe as a system. During the research, both participants of the creative session and discussion groups dealt naturally with the systemic nature of the wardrobe. The proposed activities helped them to overcome the notion of the wardrobe as a static piece of furniture to include a variety of elements at play and the interconnections between them.

The design assignment helped designers to conceptually connect elements of clothing consumption directly and indirectly related to the wardrobe. For example, in the replacement function offered by *Sympany worn-out pile manager*, they acknowledged the difficulty of keeping a specific garment in

the wardrobe through time by recurring purchases, due to the seasonality of collections. Moreover, in *Gucci lifestyles* they stressed the ever-changing nature of the wardrobe by offering a subscription programme delivering a new personal wardrobe every week. In designing both services, participants naturally connected inflow and outflow, and they linked these with other relevant issues in clothing consumption; in this case “time”.

We note that a key element of success in this respect was that of proposing services as the object of design during the creative session. This trigger led participants to consider the interconnections of actors at play, including users and their social networks, retailers, service providers, and garments. Moreover, the aim of creating provocative, fictional services rather than straight-forward solutions encouraged discussion of key issues of clothing production and consumption that are less likely to emerge in a solution-based design process. For example, while giving shape to *GUCCI lifestyles*, designers were aware that most users would not be tempted to leave clothing ownership aside, relying on a single-brand temporary wardrobe. However, they proposed a service where “instead of owning clothes the customer belongs to the brand, to the identity they are selling”. This proposition emphasized the designers’ perception that “all major brands are focusing on customer experience and identity rather than products”. The fact that these were fictional propositions led them to explore and expose this issue further.

During the discussion groups, the ads played a similar role. They were very effective in setting the stage for discussions about clothing consumption in the broad sense, in a short time, and in a somewhat playful environment. Participants easily understood the services’ operation through the ads, they could personally react to the idea of the wardrobe as a system and reflect on their own clothing practices by imagining the effect these services would have in their lives. Moreover, the posters were central in revealing the complex and varied nature of actual wardrobe’s structure and behavior. As already mentioned in the previous section, participants could recognize specific situations or garments where the services offered would be beneficial, but they reacted rather negatively while imagining the services applying to their wardrobe as a whole. It was through the ads that participants could imagine a fictional, oversimplified wardrobe behavior and contrast it with their own.

One difference between the creative session and the discussion group was in the role played by companies and technology in conversations about the wardrobe. While in the former they helped to easily connect the dots of the wardrobe as a system in order to come up with relevant service ideas for this study, in the later they tended to divert discussion from the main focus of the research. Participants of the discussion group reacted to the relationship they had with the companies providing the fictional services, the probable use of data collected by technological devices and their concerns about privacy, and other controversial issues that were also embedded in the ads, but do not necessarily contribute to uncover the structure and behavior of the wardrobe as a system.

For example, one participant argued that she would resist all services because of their “creepy” use of personal data and because of the connotations of the companies behind them. She associates IKEA with “uniformity” and GUCCI with “emptiness”, therefore she reacted negatively to the ads, leaving all discussion about her wardrobe aside. These statements point out to specific design constraints when artefacts are to be used as triggers of discussion. Especially when research is not only explorative and aims at answering specific questions. The ambiguity of artefacts, and specially of provocative fictional pieces, can be effective in breaking the ice and eliciting personal reactions related to the object of study, but these may not always contribute to the intended knowledge outcomes.

In any case, the design process and artefacts of this study enabled designers and users to see the wardrobe as a system. From this perspective, designers participating in the creative session could pinpoint elements and interconnections of wardrobe structure. Such structure explains some aspects

of wardrobe behavior over time. Moreover, despite the difficulties just mentioned, the discussion group brought forward the complexity of wardrobe stock and diverse behavior of the items within it. Arguably, asking these participants about elements at play in their clothing consumption practices would not have the same results in providing a new systemic perspective of the issue at stake.

5. Conclusions

The introduction of this study highlighted the importance of understanding clothing consumption dynamics better, in order to develop sustainable design strategies that help reducing clothing demand. Moreover, it pointed out the limitations of promoting product durability and intensive usage to this end. The relationship of clothing durability and intensive usage with reduced product demand is based on a simplistic view of the wardrobe. A more comprehensive understanding of the wardrobe, we argue, is needed to develop effective strategies. Therefore, we built on systems theory to propose a systemic perspective of the wardrobe. Looking at the wardrobe as a system helped to uncover its basic structure and consequently to understand its behavior over time.

In order to identify elements and relations of wardrobe structure, we conducted a creative session with designers and experts to co-create fictional “smart wardrobe” services, and a discussion group of these services with previously sensitized wardrobe users. These research activities provided input for a preliminary map of the wardrobe as a system (Figure 12). The findings explain some characteristics of clothing consumption that were observed in previous wardrobe studies and that are not considered in utilitarian views of the wardrobe (see differences between figures 1 and 2 in the introduction).

This map pictures the wardrobe as a complex system with a variety of purposes, where inflow and outflow are independent but can be connected by feedback loops. Inflow and outflow in the wardrobe can be voluntary or involuntary, and they are influenced by internal and external elements. The system stock includes a variable number of distinctive items with specific purposes. These items are organized in overlapping categories.

In line with the initial purpose of the study, the structure described above helps to consider design strategies aimed at reducing new product demand with a more comprehensive picture of the wardrobe in mind. The blurry inner structure of stock, and the variety of items included, makes the system very difficult to control; both by users and by others wanting to influence wardrobe behavior. Reducing overall wardrobe inflow by promoting inflow of specific garments (e.g. long-lasting garments, multifunctional garments, etc.) is unlikely to have a positive effect, because the influence of each item in stock on the others is intricate and limited. Strategies at a material level can have direct effect only in specific cases (e.g. avoiding outflow in garments that age prematurely and are usually purchased by replacement). On the other hand, strategies operating at a symbolic level are more likely to have an overall effect. Acting upon perceptions of overall “system purposes” and “values and influences about inflow” seems particularly promising. This is due to their straight-forward influence on inflow (or demand) and their impact on the entire stock.

The design field has proven successful in stimulating consumption through material and symbolic elements. Nonetheless, a central challenge remains since the early days of green and eco-design; that of providing effective solutions to draw limits to ever-growing levels of production and consumption in line with our finite world. In this context, understanding the complexity of consumption dynamics is central. The systemic perspective of the wardrobe developed in this study contributes to this line of inquiry. The map in Figure 12 not only explains why it takes more than designing long-lasting garments to reduce clothing demand, it can also help in developing other strategies that take the complexity of clothing consumption into account.

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