

# INCLUSIVE DESIGN: LEARNING THROUGH REAL-WORLD COMPLEXITY

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## ABSTRACT

Inclusive design in apparel requires not only designing for diverse bodies but also understanding lived experience and embodied variation. Yet engineering and design education continues to rely on standardised body data and idealised sizing models, leaving significant user groups underrepresented. As the fashion sector faces increasing pressure to become more inclusive and sustainable, education must prepare future professionals to address variation as a structural condition rather than a deviation from a norm. This paper investigates how vignettes in case-based learning combined with data-driven design processes can strengthen inclusive product development. Students engage with empirically grounded case vignettes derived from qualitative interviews and paired with three-dimensional body-scan visualisations. The learning sequence foregrounds interpretation before measurement, activating empathic reasoning prior to technical analysis.

The findings show that integrating empathic, professional and systemic reasoning enables students to move beyond garment-level adjustments toward product portfolio-level restructuring. By embedding variation within existing range structures, students reorganised a traditional collection plan around identifiable body clusters without increasing product volume. Fit alignment improved through strategic redistribution of variation. The study proposes a systemic pedagogical framework that bridges design and engineering by integrating qualitative user insight, quantitative body data and organisational decision-making. Inclusive product development is reframed as organised complexity within fashion management systems, achieved through structural integration rather than reactive adjustment

*Keywords: Data-driven product design, design variation, fashion education, Case-based learning*

## 1 INTRODUCTION

Despite advances in digital body-scanning technologies and data-driven product development, the apparel industry continues to rely on standardised sizing systems structured around normative body assumptions. Although three-dimensional scanning has made population-level body variation increasingly visible [1], mainstream range planning remains grounded in statistical averages and proportional grading logic [2]. As a result, many consumers experience fit-related challenges, contributing to dissatisfaction, high return rates and material waste within fashion supply chains [3]. In this context, inclusive design is not only a social objective but also a strategic and sustainability imperative. However, industry responses often focus on extending size ranges or refining measurement rather than reconsidering how variation is embedded within product portfolio strategies. Design education plays an important role in shaping how future professionals address these challenges. Apparel engineering and product design curricula often prioritise standardised systems and inside-out approaches to product development over qualitative user insight. Research in situated and case-based learning suggests that professional judgement develops most effectively when learners engage with authentic, context-rich problems prior to formal abstraction [4]. Empathic reasoning—understood as structured interpretation of lived user experience—has also been shown to support decision-making in design contexts [5]. These findings suggest that pedagogical sequencing may influence whether students understand variation as deviation from a norm or as a fundamental design condition. This study investigates how visual and numerical data from fit and design research [6] can support students' understanding of inclusive product development in apparel education. The framework integrates qualitative user experience data, three-dimensional body-scan data and case-based learning into a cross-disciplinary approach bridging design and engineering. In contrast to traditional curricula that separate fit from design and rely on a single average body type, the proposed model combines design practice,

engineering analysis and user research to address embodied variation as a fundamental condition. Building on theories of transparent customisation [6], the study explores how user insight and body data can inform inclusive product development. Rather than focusing solely on garment-level design, the approach embeds embodied variation within product systems through product portfolio restructuring. The study contributes to fashion design education by proposing a pedagogical framework that connects empirically grounded user narratives with systemic reasoning in product development. By structuring learning as recursive movement between empathic, professional and systemic reasoning, the framework demonstrates how inclusive product strategies can be developed in a more evidence-based and context-sensitive manner.

## **2 METHOD AND EPISTEMOLOGICAL POSITIONING**

This study adopts a qualitative, practice-based research design grounded in interpretive and situated learning perspectives. The methodological approach assumes that professional knowledge in apparel development emerges through engagement with complex, context-rich situations rather than through technical instruction alone. The workshop was therefore designed not to test predefined hypotheses, but to observe how students navigate the relationships between lived user experience, embodied variation and industrial system logic when working with empirically grounded data.

### **2.1 Empirical Foundation of the Vignettes**

The vignettes were derived from prior doctoral research on apparel fit and sizing. The broader dataset comprised 150 qualitative interviews with women, field observations and 350 three-dimensional body scans [7]. The original research examined lived experiences of fit, sizing challenges and embodied variation across diverse body profiles. Qualitative and numerical data were statistically and thematically coded into recurring categories related to fit and style preferences, body shape variations and purchasing behaviour. From this dataset, two interview transcripts representing recurring and structurally distinct fit-related challenges were selected and developed into narrative vignettes. These cases were chosen because they illustrated identifiable patterns observed across the larger dataset while reflecting different embodied configurations. To complement the narrative material, 30 anonymised body scan visualisations were selected to represent a wide range of body forms, including the two interview participants. However, students were not informed which scans corresponded to the vignettes. This ensured that interpretation preceded confirmation and prevented direct matching between narrative and body data.

### **2.2 Participants and Workshop Structure**

The workshop involved 40 Bachelor-level design students in their fifth semester across two educational locations. Both sessions followed an identical structure to ensure consistency. The workshops were audio recorded and photographically documented to capture discussion processes, clustering activities and visual mapping outcomes.

The workshop was organised into three sequential phases. In the first phase, students individually read the two vignette narratives and identified statements they considered relevant, surprising or unclear. Each observation was written on a separate note, making individual interpretations visible and allowing emerging themes to develop. In the second phase, students worked in groups of four to compare and cluster their observations thematically. Each group assigned descriptive headings to their clusters, articulating perceived patterns of embodied challenges. In the third phase, groups were presented with 30 body scan visualisations. No numerical measurements or contextual information were provided. Students were asked to discuss whether and how the bodies appeared to align with or deviate from prevailing normative sizing assumptions. Based solely on visual analysis, the students organised the scans into clusters according to perceived similarities and differences in body shape.

### **2.3 Analytical Focus**

The sequencing of narrative interpretation prior to visual classification, and visual classification prior to technical measurement, was intentional. It was designed to activate empathic reasoning before analytical abstraction. This structure allowed observation of how students moved from qualitative interpretation to pattern recognition and, subsequently, toward systemic reconsideration of range planning strategies.



Figure 1. Photos from workshop session

## 2.4 Vignettes as Pedagogical Instruments

Within this study, vignettes function as structured narrative accounts of lived user situations that foreground meaning before measurement. Each vignette presents a condensed, context-rich account of a user's experience with clothing, fit and embodied variation without initially providing technical explanation or quantitative data. This deliberate withholding of metrics encourages students to engage in interpretive reasoning prior to analytical assessment. In case-based learning, such narrative constructions serve as entry points into situated understanding [8,9]. When encountering a lived dilemma, students must first interpret what is occurring, what forms of discomfort or exclusion may be present, and what knowledge is needed to understand the situation more fully. This process activates empathic reasoning and supports professional problem framing [10,11]. In the context of inclusive apparel design, the vignettes are not fictional anecdotes, but empirically informed constructs derived from qualitative interviews and user experiences. The pedagogical role is not to present data directly, but to generate the need for data. When later paired with 3D body-scanning information, they enable students to connect embodied narratives with morphological and quantitative analysis. In this way, the vignette functions as a bridge between user narratives and data-driven design development, supporting an approach in which body variation is anticipated and embedded within product development systems.

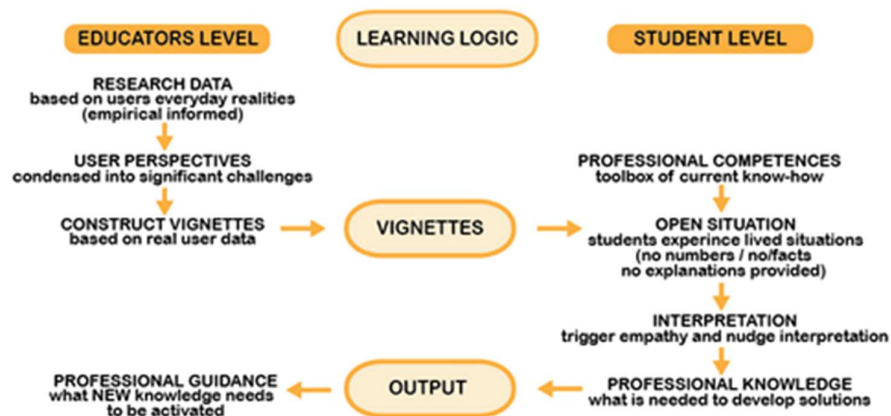


Figure 2. Vignette's dual structure

Figure 2 illustrates a dual structure that is data-informed in construction and interpretation driven in pedagogy. Educators construct vignettes based on empirical user data and condensed user perspectives, while students engage with open-ended situations without predefined solutions. This encourages students to mobilise prior knowledge, interpret user needs and identify which forms of information and data are relevant to the situation. The interpretive process may create productive uncertainty, generating

a self-identified need for further knowledge. Measurement and analysis therefore emerge as responses to identified challenges rather than as starting points, supporting a more empathic and user-centred design process.

## 2.5 Learning through Real-World Complexity – A Systemic Model

Based on insights generated through the workshops and analysis of the students' learning processes, we identified three interconnected and equally significant forms of reasoning. These insights enabled us to formalise the observed practices into a systemic learning model for inclusive product development situated within fashion management systems, illustrated in Figure 3. The model conceptualises learning as a dynamic and relational process in which user insight, industry systems, data and case-based learning interact to support inclusive product strategies. Rather than presenting product development as a linear sequence, the framework positions interpretation, analysis and strategic structuring as mutually informing processes. At the centre of the model, data functions as an integrative mechanism connecting user insight, industry systems and case-based learning. User insights represent lived experiences and embodied challenges derived from qualitative and quantitative research, while industry systems represent the organisational and strategic structures through which products are developed and evaluated.

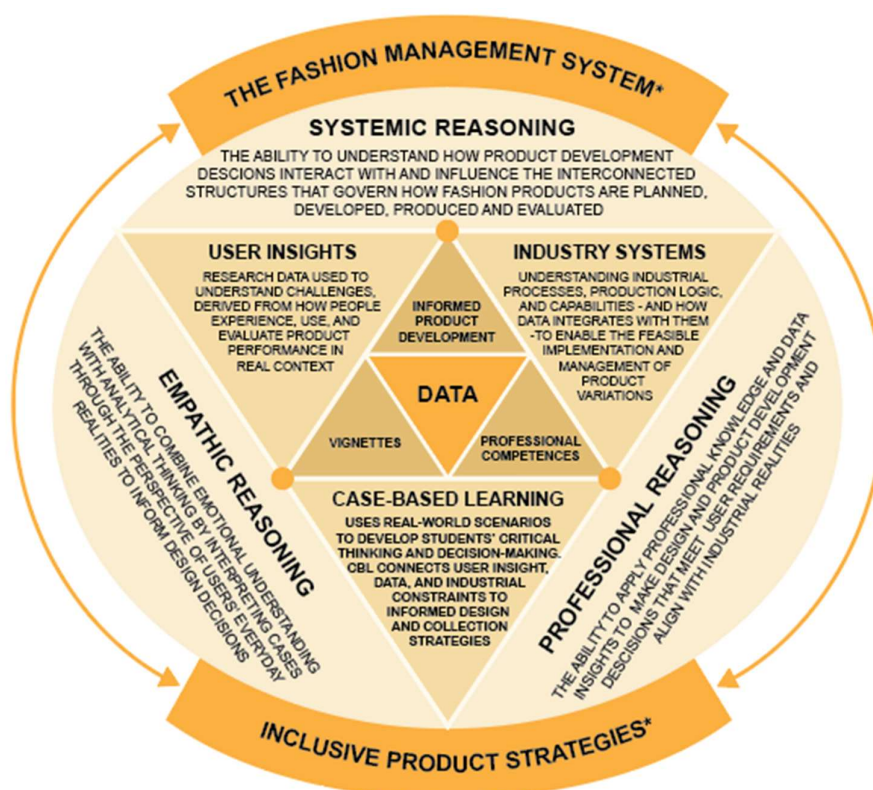


Figure 3. Learning Through Real-World Complexity – A Systemic Model

Case-based learning functions as the pedagogical domain in which these forms of knowledge are translated into situated learning processes through empirically informed vignettes. The vignette functions as a mediating mechanism that transforms experiential knowledge into contextualised scenarios that activate interpretation. Data supports analysis and implementation, but gains meaning through interpretation and professional translation. The outer frame\* represents the fashion management system as the structural context within which all decisions are embedded.

Within this framework, each case activates recursive engagement with three interdependent modes of reasoning: empathic, professional and systemic. These modes do not operate sequentially but relationally. Empathic reasoning foregrounds lived and embodied realities and challenges normative assumptions. Professional reasoning translates interpretive insight into technically structured analysis through disciplinary knowledge. Systemic reasoning situates emerging solutions within the broader architecture of fashion management, including range planning, production frameworks and product

portfolio configuration. The learning logic emerges through iterative movement between meaning, data and implementation. Rather than reducing complexity to predefined variables, students are required to navigate the dynamic relationships between users, visualised embodied variation and production systems. Inclusive product strategies therefore emerge not as isolated product solutions, but as outcomes of systemic organisational change.

### 3 DISCUSSIONS: RETHINKING TRADITIONAL COLLECTION DEVELOPMENT

In Danish education and mass-market fashion, Collection Development (CD) is traditionally structured as a portfolio of product categories organised through design variations aligned with a brand's DNA and developed within a standardised sizing system. Target customers are typically represented through an average body model constructed through standard grading and limited fit variation within a push-to-market strategy. As illustrated in Figure 4, the traditional range plan consists of six product categories and 92 styles designed for a single standardised body type. Students were informed that only 12.8% of 350 body scans matched this standard (Terkildsen, 2020). To address this limitation, students worked with three predominant body shape categories identified in the study. While the number of product categories and styles remained unchanged, design variations were strategically redistributed to accommodate these body variants, shifting the focus from size variation alone toward integrated shape and design variation.

| PRODUCT CATEGORY | PRODUCT VARIANT | Bodytype STANDARD | STYLES | TOTAL |
|------------------|-----------------|-------------------|--------|-------|
| TOPS             | Sweat Shirts    | ●●●●●             | 5      | 25    |
|                  | T-Shirts        | ●●●●●             | 5      |       |
|                  | Shirts          | ●●●●●             | 5      |       |
|                  | Tunics/blouses  | ●●●●●             | 5      |       |
|                  | Knit            | ●●●●●             | 5      |       |
| TROUSERS         | Volume          | ●●●●●             | 4      | 20    |
|                  | Straight        | ●●●●●             | 4      |       |
|                  | Relaxed         | ●●●●●             | 5      |       |
|                  | Jeans           | ●●●●●             | 5      |       |
|                  | Shorts          | ●●                | 2      |       |
| DRESSES          | Bodycon         | ●●●●●             | 5      | 15    |
|                  | Volume          | ●●●●●             | 5      |       |
|                  | Regular         | ●●●●●             | 5      |       |
| SKIRTS           | Volume          | ●●●●●             | 4      | 12    |
|                  | A-line          | ●●●●●             | 4      |       |
|                  | Straight        | ●●●●●             | 4      |       |
| BLAZERS/JACKETS  | Formal          | ●●●               | 3      | 10    |
|                  | Casual          | ●●●●●             | 4      |       |
|                  | Functional      | ●●●               | 3      |       |
| OUTERWEAR        | Formal          | ●●●●●             | 4      | 10    |
|                  | Casual          | ●●●●●             | 4      |       |
|                  | Functional      | ●●                | 2      |       |
|                  |                 |                   | 92     |       |

| PRODUCT CATEGORY | PRODUCT DESIGN  | Bodytype x<br>Bodytype BX<br>Bodytype BXD+xD | Bodytype<br>x | Bodytype<br>BX | Bodytype<br>BXD+xD | STYLES | TOTAL |
|------------------|-----------------|----------------------------------------------|---------------|----------------|--------------------|--------|-------|
| TOPS             | Sweat Shirts    | ●                                            | ●             | ●              | ●                  | 4      | 27    |
|                  | T-Shirts        | ●                                            | ●             | ●              | ●                  | 4      |       |
|                  | Shirts          | ●                                            | ●             | ●              | ●                  | 4      |       |
|                  | Tunics/blouses  | ●●                                           | ●             | ●              | ●                  | 5      |       |
|                  | Knit            | ●●                                           | ●             | ●              | ●                  | 5      |       |
| TROUSERS         | Volume          | ●●                                           | ●●            | ●●             | ●●                 | 5      | 27    |
|                  | Straight        | ●●                                           | ●●            | ●●             | ●●                 | 6      |       |
|                  | Relaxed         | ●●                                           | ●●            | ●●             | ●●                 | 6      |       |
|                  | Jeans           | ●●                                           | ●●            | ●●             | ●●                 | 8      |       |
|                  | Shorts          | ●●                                           | ●●            | ●●             | ●●                 | 2      |       |
| DRESSES          | Bodycon         | ●●                                           | ●●            | ●●             | ●●                 | 5      | 15    |
|                  | Volume          | ●●                                           | ●●            | ●●             | ●●                 | 4      |       |
|                  | Regular         | ●●                                           | ●●            | ●●             | ●●                 | 6      |       |
| SKIRTS           | Volume          | ●●                                           | ●●            | ●●             | ●●                 | 4      | 11    |
|                  | A-line          | ●●                                           | ●●            | ●●             | ●●                 | 2      |       |
|                  | Straight        | ●●                                           | ●●            | ●●             | ●●                 | 5      |       |
| BLAZERS/JACKETS  | Formal bodycon  | ●●                                           | ●●            | ●●             | ●●                 | 5      | 10    |
|                  | Casual loose    | ●●                                           | ●●            | ●●             | ●●                 | 3      |       |
|                  | Functional      | ●●                                           | ●●            | ●●             | ●●                 | 2      |       |
| OUTERWEAR        | Formal          | ●●                                           | ●●            | ●●             | ●●                 | 3      | 7     |
|                  | Casual          | ●●                                           | ●●            | ●●             | ●●                 | 3      |       |
|                  | Functional      | ●●                                           | ●●            | ●●             | ●●                 | 1      |       |
|                  | Targeted Styles | 15                                           | 24            | 8              | 19                 | 5      | 92    |
|                  |                 |                                              | 15-24+8       | 15-19+(8+5)    | 15-21+5            |        |       |

Figure 4. Traditional range plan vs Body Inclusive range plan (Terkildsen, & Pedersen (2023))

The figure compares a traditional range plan with a body-inclusive alternative, where each dot represents a style or style variation. The traditional range plan (left) is based on a singular proportional sizing system in which variation is primarily created through style differentiation, while body diversity is addressed solely through grading. This reflects a conventional inside-out approach centred on lean production and standardisation. In contrast, the body-inclusive range plan (right) integrates multiple body variants into the product portfolio structure. Rather than relying on one dominant fit standard, the collection is strategically distributed across identified body variation clusters, enabling a more targeted and inclusive range plan without increasing product volume. The model illustrates a shift from singular standardisation toward managing embodied diversity through micro-standards within fashion management systems.

At the conclusion of the workshop, students analysed a traditional range plan and discussed which variations were necessary to accommodate different body variants. They recognised that each product category posed distinct fit and design challenges and that variation could not be distributed evenly across the portfolio. Drawing on professional knowledge, students evaluated which body variants could share designs and where additional variations were required. The exercise demonstrated that a significantly larger proportion of customers could be accommodated through strategic redistribution of body-shape variation. Students reframed inclusion not as product expansion, but as strategic reorganisation of the existing product portfolio. This shift expanded the discussion from isolated fit adjustments toward

systemic consideration of how variation can be embedded within fashion management and collection planning systems, expanding students' understanding of their professional role.

#### 4 CONCLUSIONS

This study has demonstrated that inclusive product development can be approached as a systemic capability rather than as an additive adjustment to standardised collection structures. By integrating empirically informed vignettes with a systemic learning model, the framework enables students to move between empathic insight, technical evaluation and organisational reasoning. Learning is structured as recursive engagement across interpretive, analytical and strategic domains.

The workshop findings indicate that implementing inclusive range planning increases organisational complexity, as it requires coordination of multiple body standards rather than reliance on a single normative model. However, this complexity does not necessitate increased product volume. Instead, it requires strategic redistribution of variation across existing product portfolio structures, enabling a significantly larger proportion of customers to be accommodated without increasing the number of styles brought to market. Importantly, the workshop shifted student discussions from isolated product solutions toward systemic decision-making. Although the curriculum predominantly centres on product design, students demonstrated strong engagement with systemic and empathic reasoning, particularly when reflecting on how product portfolio structures, production frameworks and strategic planning shape the feasibility of inclusive design. The findings suggest that inclusive design competence extends beyond aesthetic sensitivity and technical adjustment to encompass the ability to embed variation within fashion management systems.

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