

PIECEWISE: An Evolving Inventory of Remixable T-Shirt Parts for Repeated Upcycling

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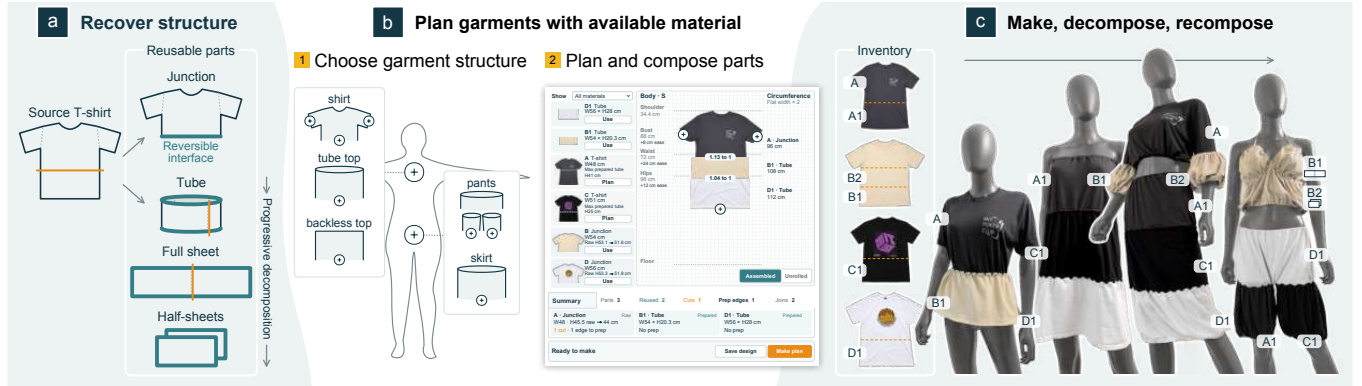


Figure 1: PIECEWISE treats T-shirts as an evolving inventory of remixable parts. (a) A parts abstraction captures reusable T-shirt structure, while reversible, mismatch-tolerant interfaces join parts without standardizing their dimensions. (b) Garment structures describe how these parts compose around the body; an inventory-aware studio supports co-planning part decomposition and garment recomposition before cutting and making. (c) Parts are remixed into new structural roles across successive designs.

Abstract

PIECEWISE introduces a compositional framework for repeated T-shirt upcycling through an evolving inventory of remixable parts and assemblies. It identifies junctions, tubes, and sheets as reusable parts and defines garment structures that describe how these parts can be recomposed around the body. A reversible threading interface joins parts without standardizing their dimensions, while supporting post-assembly adjustments to fit, shape, and drape. An inventory-aware studio supports co-planning decomposition and recomposition: makers revise proposed parts and their assignments across garment designs before cutting, then update the recorded physical inventory as transformations are committed. Formative workshops suggest that makers with limited garment-construction experience can use the framework to design new garments from unwanted T-shirts. Our results demonstrate how modular capabilities can be retrofitted onto existing garments for systematic reuse across sizes, styles, and functions.

CCS Concepts

• **Human-centered computing** → **Interactive systems and tools.**



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Keywords

garment upcycling; textile reuse; reconfiguration; modular design

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1 Introduction

Garment upcycling extends clothing's useful life and reduces textile waste. Existing garments vary widely in construction, dimensions, materials, and surface appearance. While this diversity offers rich opportunities for creative reuse, exploring these possibilities is often technically demanding and ad hoc, requiring makers to envision feasible transformations given source-specific constraints. Repeated upcycling compounds this challenge: each intervention changes what remains available. By contrast, domains such as electronics use standardized components and interfaces to support systematic, inventory-based reuse and repeated recomposition [Lu et al. 2025, 2023; Mandel and Ju 2023].

PIECEWISE characterizes reusable T-shirt parts at a granularity between whole garments [Qi et al. 2025] and textile scraps [Kono et al. 2025; Leake and Daly 2024; Mei et al. 2025], and garment structures composed from them. It supports their recomposition through a reversible, mismatch-tolerant joining interface and an inventory-aware software studio. Whereas prior work enables reconfigurable fashion through a predefined, standardized kit [Lin et al. 2025], PIECEWISE adapts to existing garments, recovering

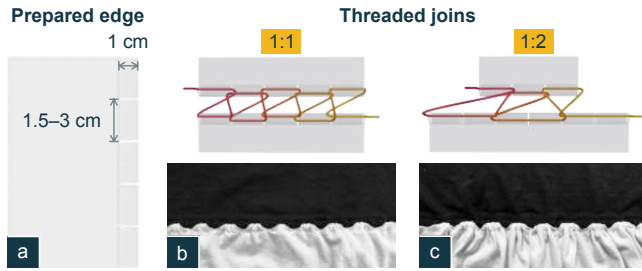


Figure 2: Reversible, mismatch-tolerant joins by standardizing interfaces, not geometries. (a) Hemmed edges are cut into loops and threaded (b) one-to-one or (c) one-to-many.

parts on demand without requiring standardized geometries. Building on existing T-shirt refashioning practices [BlueprintDIY 2023], PIECEWISE formalizes reusable structures, standardized interfaces, and composition rules as a foundation for repeated reuse and future computational design of upcycled garments.

2 A Compositional Framework for Reuse

PIECEWISE identifies neckline-and-armhole *junctions*, torso *tubes*, and open *sheets* as reusable T-shirt parts (Figure 1a). Progressive decomposition preserves seams, hems, and openings until a design requires their release. Part types decouple structure from function: a tube can become a sleeve, a trouser leg, or a skirt. Tubes stack vertically to extend coverage; two or more sheets can join side by side and close to create wider tubes. *Garment structures* organize parts into coverage and branching around the body (Figure 1b).

PIECEWISE standardizes part interfaces, not geometry. Edges are hemmed, and loop positions are located by repeated subdivision at 1.5–3 cm spacing, supporting integer-to-one correspondence across unequal boundaries. T-shirt yarn recovered from offcuts joins edges and gathers excess material (Figure 2), reducing waste by putting scraps to use; unthreading releases parts for reuse.

Threaded edges act as drawstrings, making fit and volume distribution adjustable design parameters after assembly without re-making. Increasing effective yarn length resizes the same dress from XS to L (Figure 4a–b); gathering creates ruffles and ruching (Figure 4e–f). Threaded intervals and suspension around the body shape drape, for example through varied necklines (Figure 3b) or fabric wrapped around the back or hanging freely (Figure 3c).

3 Inventory-Aware Co-Planning

The studio separates physical inventory from tentative designs, letting makers draft parts before cutting. Parts are harvested as



Figure 4: Fabricated outcomes: (a–b) a tube dress that can be resized from XS to L; (c) a graphic-bearing top with unequal tier heights; (d) a hood attached at a prepared neckline; (e) a ruffled maxi dress; (f) an outfit with trouser-leg ruching.

designs develop: the shorter white tier in Figure 4c illustrates how makers tailor tube heights to their intended proportions rather than applying a fixed dimension. On a body-scaled canvas, makers first choose a garment structure specifying coverage and branching (Figure 1b, step 1), then extend its available openings by appending parts. The studio presents existing parts alongside other sources from which new parts can be harvested (Figure 1b, step 2), accounting for edge-preparation allowances and checking coverage against body measurements and ease. If coverage is insufficient, makers can open tubes into sheets and join them side by side; the studio automatically records and reports required operations.

Across drafts, makers co-plan decomposition and recomposition by revising proposed parts and assignments for different outfits. Revisions update garment drafts and projected inventory; makers review cuts, preparation, and joins before committing physical changes. Completed assemblies remain available for reuse, intact or separated into parts.

4 Examples and Findings

Two formative workshops with eight participants suggested that makers with limited garment-construction experience could reason about and design new garments with the framework (Figure 4a–c). Our fabricated examples bring modular capabilities to existing garments (Figures 3 and 4d–f).

Progressive decomposition let us explore finer-grained combinations as our fluency in recomposition and fabric manipulation grew (Figure 4), suggesting an accessible entry point with room for increasing design complexity. Our process also shifted from seeking material for intended designs to asking what available parts



Figure 3: Progressive decomposition of one T-shirt: (a) two tubes; (b) upper tube opened into a sheet; (c) half-sheet and remaining tube. Threading routes vary suspension and drape, as shown by the necklines in (b) and back styling in (c).

could become. Longitudinal studies could examine how inventory, material understanding, and design co-evolve.

Building on these explorations, extending the design language to threading routes, gathering, partial-edge joins, layering, collars, and hoods (Figure 4d) could support structured search and procedural garment generation under upcycling constraints.

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