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Structural Intervention and Forming in Woven Fabrics: Structural Weft and Warp Manipulation Methods

Dokuma Kumaşlarda Yapısal Müdahale ve Biçimlendirmeler: Yapısal Atkı ve Çözgü Manipülasyon Yöntemleri

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Abstract

Design diversity in woven fabrics is achieved not only through color, texture, finishing processes, weave structure, raw material properties, and weaving technique, but also through structural interventions that impart relief effects, volume, and dimensionality to the fabric. The aim of the study is to expand the framework that is commonly limited to manipulations applied to fabrics after production through methods such as sewing, dye-printing, bonding, and burning, so as to also include structural manipulations that occur during the weaving process. In the study, the tools and methods of structural intervention are addressed under three categories: mechanical arrangements carried out on the weaving loom and its components, physical interventions applied to the material during the weaving process, and structural shaping processes performed after weaving. In this context, weaving reeds designed in different forms and placed on the loom are observed to stand out. These interventions affect the visual quality of the fabric, the mode of implementing the design, the amount of waste, and the shaping of the product in accordance with its intended function. The studies examined were classified under three categories with the support of visual examples and evaluated in terms of sustainability, waste generation, slow fashion, labor-intensive production processes, and their potential contribution to industrial production.

Keywords: Woven fabric design, fabric manipulation, weaving **forming, structural forming.**

Academical Disciplines/Fields: Textile design, fabric design, weaving design, fashion design, art and design.

Özet

Dokuma kumaşlarda tasarım çeşitliliği; renk, doku, bitim işlemleri, örgü yapısı, hammadde özellikleri ve dokuma tekniğinin yanı sıra, kumaşa rölyef etki, hacim ve boyut kazandıran yapısal müdahalelerle de sağlanmaktadır. Çalışmanın amacı, yaygın anlamıyla tekstilde dikiş, boya-baskı, yapıştırma ve yakma gibi yöntemlerle kumaşlara sonradan uygulanan manipülasyonlarla sınırlı kalan çerçeveyi, dokuma sürecinde gerçekleşen yapısal manipülasyonları da kapsayacak biçimde genişletmektir. Çalışmada yapısal müdahale araçları ve yöntemleri üç başlık altında ele alınmaktadır; dokuma tezgâhı ve parçalarında gerçekleştirilen mekanik düzenlemeler, dokuma sürecinde malzemeye uygulanan fiziksel müdahaleler ve dokuma işlemi sonrasında yapılan yapısal biçimlendirmeler. Bu kapsamda, farklı biçimlerde tasarlanarak tezgâha yerleştirilen dokuma taraklarının öne çıktığı görülmektedir. Söz konusu müdahaleler, kumaşın görsel niteliğini, tasarımın uygulanma biçimini, atık miktarını ve ürünün amaçlanan işleve uygun olarak şekillenmesini etkilemektedir. İncelenen çalışmalar, görsel örneklerle desteklenerek üç başlık altında sınıflandırılmış; sürdürülebilirlik, atık oluşumu, yavaş moda, emek yoğun üretim süreçleri ve endüstriyel üretime katkı potansiyelleri bakımından değerlendirilmiştir.

Anahtar Sözcükler: Dokuma kumaş tasarımı, kumaş manipülasyonu, dokuma biçimlendirme, yapısal biçimlendirme.

Akademik Disiplin(ler)/Alan(lar): Tekstil tasarımı, kumaş tasarımı, dokuma tasarımı, moda tasarımı, sanat ve tasarım.

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GENİŞLETİLMİŞ ÖZET

Tekstil ve moda tasarımında manipülasyon kavramı, yüzey ve yapı düzenleme tekniği olarak geniş bir uygulama alanına sahiptir. Bu çalışma, daha çok kumaşların üretimi sonrasında dikiş, boya-baskı, yakma ve yapıştırma gibi uygulamalarla gerçekleştirilen manipülasyon örneklerine, dokuma sürecinde gerçekleştirilen yapısal müdahaleleri de ekleyerek tekstildeki manipülasyon uygulamalarının çerçevesini genişletmektedir. Çalışmada incelenen manipülasyon uygulamaları, dokuma kumaşların tasarım ve üretiminde kumaşı oluşturan atkı ve çözgü ipliklerinin yeniden yapılandırılması, biçimlendirilmesi ve yeni bir açıdan düzenlenmesi yoluyla gerçekleştirilen uygulamalardan oluşmaktadır. Bu uygulamalarla kumaş yapısı yeniden yapılandırılmakta, yeni bir biçim kazanarak yapısal bir manipülasyon örneğine dönüşmektedir. Bu doğrultuda çalışma, dokuma kumaşlarda atkı ve çözgü ipliklerine yönelik gerçekleştirilen yapısal müdahalelerin hangi aşamada, hangi araç, gereç ve yöntemlerle gerçekleştirildiğini sınıflandırmak, örneklerle aktarmak ve açıklamakla sınırlandırılmıştır. Çalışmada ele alınan bu müdahale biçimleri ayrıca dokuma kumaşların oluşumu, sürdürülebilirlik, atık üretimi ve emek yoğun üretim pratikleri açısından da değerlendirilmiştir.

Çalışmada ilk olarak incelenen manipülasyon örnekleri, literatürde çoğunlukla lif, iplik, renk ve yüzey bağlamında iplik veya kumaş yüzeylerine yönelik gerçekleştirilen uygulamalardan oluşmaktadır. Bu örneklerde görüldüğü üzere manipülasyon uygulamaları, özellikle 1960 sonrasında tekstil ve moda tasarımında kullanılmaya başlanan dekonstrüksiyon/yapısöküm yaklaşımının bir yansıması olarak değerlendirilmiş; geleneksel form ve yüzey tasarımı anlayışını sorgulayan, mevcut kumaş yapısını bozma, yeniden kurgulama ve inşa etme biçimlerinde gerçekleştirilmiştir. Örneğin, Rei Kawakubo, Yohji Yamamoto ve Issey Miyake gibi tasarımcılar, çalışmalarında kumaş ve giysi formunun yalnızca kalıp ve dikişle değil, malzemenin yapısal özellikleri üzerinden de yeniden kurgulanabileceğini başarılı bir biçimde göstererek önemli yüzey ve form manipülasyonları gerçekleştirmişlerdir. Manipülasyon uygulamaları, günümüzde tekstil ve moda tasarımında hâlâ yoğun olarak kullanılan bir tasarım ve üretim yöntemi olarak varlığını sürdürmektedir.

Bu araştırmada incelenen yapısal müdahale ya da yapısal manipülasyon örnekleri, mevcut formun bütünüyle ortadan kaldırılmasından çok, yeniden düzenlenmesi, farklı bir tasarım mantığıyla kurgulanması ve dokuma yapısının yeniden inşasına dayanmaktadır. Bu bağlamda çalışma, dokuma kumaşlarda manipülasyonun yalnızca yüzeysel işlemlerle değil, dokuma tekniği ve araç gereçlerine bağlı yapısal düzeyde de gerçekleşebileceğini ortaya koymaktadır.

Nitel bir araştırma olarak gerçekleştirilen çalışmada, farklı ülkelerden tasarımcı, araştırmacı, sanatçı ve endüstriyel üreticilerin uygulamalarından oluşan örnekler, dokuma kumaşların yapısına hangi aşamada ve hangi araç gereçler yardımıyla müdahale edildiğine bağlı olarak üç başlık altında verilmiş ve değerlendirilmiştir:

- Dokuma öncesi hazırlık ve araç gereçlere dayalı yapısal müdahaleler,
- Dokuma sırasında atkı ve çözgü bağlantılarına yönelik gerçekleştirilen kontrollü fiziksel müdahaleler,
- Dokuma sonrasında kumaş yapısına yönelik gerçekleştirilen kontrollü fiziksel müdahaleler.

Örnekler üzerinden incelendiğinde, dokuma kumaşlarda yapısal manipülasyonun oldukça çok katmanlı ve süreç temelli bir üretim yaklaşımı olduğu görülmektedir. Dokuma öncesi müdahalelerde en belirgin aracın, farklı biçimlerde tasarlanan ve tezgâha sabitlenen özel taraklar olduğu görülmektedir. Tek yönlü veya çok yönlü yelpaze taraklar, ondüle taraklar, V biçimli taraklar ve değişken tarak sistemleri gibi aparatlar, çözgü ipliklerinin yoğunluğunu ve açılarını değiştirerek klasik 90 derecelik atkı-çözgü ilişkisini yeniden kurgulamakta ve kumaş yapısını yeniden inşa etmektedir. Bu sayede, alışılagelmiş olandan farklı olarak dokuma yüzeyinde dalgalı, genişleyen-daralan, üç boyutlu veya form verilmiş atkı ve çözgü bağlantılarıyla yeni yapılar elde edilebilmektedir. Özellikle değişken tarak sistemleriyle tek bir çözgü üzerinde farklı yoğunluk bölgeleri oluşturularak kesimsiz, dikişsiz veya atıksız giysi parçalarının dokuma aşamasında biçimlendirilmesi mümkün hâle gelmektedir.

Dokuma sırasında gerçekleştirilen müdahaleler ise hareketli tarak sistemleri, açık taraklar, raylı taraklar, zigzag taraklar ve leno dokuma teknikleri gibi uygulamalarla çeşitlenmektedir. Bu yöntemler, atkı ve çözgü ipliklerinin birbirlerine bağlanma açılarını ve gerginliklerini değiştirerek yüzeyde dalgalanma, kıvrım, hacim ve üç boyutlu form oluşumuna olanak tanımaktadır. Ayrıca el kontrollü biçimde gerçekleştirilen tansiyon farklılıkları, atkı ipliklerinin bölgesel olarak sıkıştırılması veya gevşetilmesi gibi uygulamalar da yapısal manipülasyonun bir parçası olarak değerlendirilmektedir. Bu noktada özellikle atkı ipliğine yönelik gerçekleştirilen müdahalelerde, en önemli ve eski yapısal manipülasyon uygulamasının tapestry geleneğinde görülen farklı açılı atkı bağlantıları olduğu görülmektedir.

Dokuma sonrası yapısal müdahalelerde ise kumaş yüzeyinde bilinçli olarak bırakılan dokunmamış çözgü alanlarındaki ipliklerin kenarlardan çekilmesi, boşluklu alanların giderilmesi, ipliklerin gruplanması veya bağlanması yoluyla farklı bir yapısal dönüşüm sağlanmaktadır. Bu tekniklerde atkı ve çözgü ipliklerinin bağlantı açıları, sonradan el kontrollü müdahalelerle değiştirilmekte; iki boyutlu yüzey, üç boyutlu bir forma evrilebilmektedir. Bazı örneklerde tüp dokuma veya bölgesel planlama ile dikişsiz, kesimsiz ve atıksız giysiler üretilmiş; kenar iplikleri tasarımın estetik bir unsuru olarak değerlendirilmiştir. Böylece iplik artıkları atık olmaktan çıkarılarak tasarımın bir parçasına dönüştürülmüş; daha çevreci ve yerel üretimlere de referans olan yenilikçi bir uygulama örneği ortaya konmuştur.

Sonuçlar, yapısal manipülasyon uygulamalarının sürdürülebilir üretim açısından önemli bir potansiyel taşıdığını göstermektedir. Dokuma aşamasında kumaşa biçim kazandırılması, kesim ve dikiş kaynaklı atıkları azaltarak sıfır atık yaklaşımını desteklemektedir. Bu yöntemler, küçük ölçekli atölyeler ve yerel üreticiler için uygulanabilir çözümler sunması bakımından emek yoğun üretim ve yavaş moda pratikleriyle de örtüşmektedir. Ayrıca seri üretime alternatif olarak kişiselleştirilmiş, sınırlı sayıda ve özgün tasarımların üretilmesine olanak tanımaktadır. Bazı uygulamalar doğrudan sürdürülebilirlik amacıyla geliştirilmemiş olsa da yapısal özellikleri bakımından atık azaltma ve kesimsiz üretim potansiyeli taşımaktadır.

Çalışma, özellikle tekstil manipülasyonu literatürüne yeni bir alt başlık olarak dokuma tekniğine bağlı biçimde gerçekleşen yapısal manipülasyonları önererek mevcut çerçeveyi genişletmektedir. Atkı ve çözgü ipliklerinin yönüne ve üretim aşamasına göre yapısal manipülasyonları yeniden sınıflandırarak, manipülasyonun dokuma kumaş tasarımında biçim ve form oluşumunun yalnızca bir yüzey etkisi olarak değil, yapısal parametreler üzerinden de ayrıntılı biçimde tanınmasına olanak sağlamaktadır. Verilen görsel ve yazılı örnekler ile yapılan sınıflandırma, gelecekteki çalışmalar için özellikle dikişsiz, kesimsiz ve üç boyutlu dokuma giysi tasarımları bağlamında kuramsal ve uygulamalı bir kaynak çerçevesi oluşturmaktadır.

Sonuç olarak bu çalışma, dokuma kumaşlarda yapısal müdahalenin yalnızca estetik bir tercih olmadığını; sürdürülebilirlik ve emek yoğun üretim biçimleri açısından da yenilikçi bir biçimlendirme ve yapılandırma olanağı sunduğunu ortaya koymaktadır.

1. Introduction

Throughout history, the aesthetic qualities of textiles have been as important as their functional properties. Various designs and methods have been adopted to improve and personalize all types of textiles for aesthetic or functional purposes. In woven fabrics, the applications used to achieve this variety can be purely functional, purely aesthetic, or both functional and aesthetic. The aesthetic and functional diversity of woven fabrics is achieved through the interaction of numerous variables, including "the characteristic features of the yarn or thread" (Berber & Başaran, 2018, p. 57), weave structure, technique, "dye-print and finishing" (Yaşar, 2008), "sud-caustic practices" (Hamamcı, 2023), "pleatings" (Acar, Meriç & Kurtuldu, 2019), colour, "as well as aesthetic perception and design skill" Önlü, 2004). Beyond these parameters, practices requiring direct intervention in the structure of the fabric, such as reconstruction, de-construction, and mixed media, further expand this diversity by enabling novel structural formations.

To achieve diversity, interventions in the fabric structure have been important not only for their visual appeal but also for their effects on volume, size, shape, and form. At present, the concept of deconstruction, which is important in many fields of art and design, significantly influences the restructuring of woven fabrics. The concept of deconstruction provides a perspective applicable not only to woven fabrics but to all textile surfaces.

The understanding of structural intervention reflects a design approach in textile and fashion that questions traditional methods of form-making and enables the reconsideration of existing structures. Since the 1960s, tendencies toward transforming and reconfiguring structures have emerged across various disciplines, later influencing art, architecture, and design; by the late 1980s, these tendencies had become increasingly visible in textile and fashion design.

In fashion design, structural interventions of fabrics first appeared in the late 1970s in the collections of designers such as Rei Kawakubo, Yohji Yamamoto, and Zandra Rhodes. These designers reinterpreted the fundamental elements that constitute garment form, cut, seam, pattern, and surface by handling them in unconventional ways and thereby transforming the structure. In the late 1980s and 1990s, this approach became more apparent not only in garment forms but also in fabric production processes and surface applications.

Structural intervention refers not to the complete destruction of an existing form but rather to its dismantling and reorganization, its reconstruction through an alternative configuration, or its reorganization in a different way. In this process, disruption and construction proceed simultaneously; operations such as unpicking, cutting, fragmenting, displacing, folding, layering, and reassembling become fundamental design tools. As a result, design moves beyond being a fixed and singular structure and acquires a variable, open, and reinterpretable form.

In the context of textiles, manipulation refers to intervening in the surface or structure of fabric to generate new aesthetic and structural qualities. These interventions may include creating deformations in woven and knitted surfaces, altering yarn placement, transforming these surfaces into three-dimensional forms, or intentionally introducing structural variations during the production stage. Each design process is reconsidered with respect to the material properties and the intended form.

From the late 1980s onward, designers such as Issey Miyake, Dries van Noten, Rick Owens, and Martin Margiela demonstrated different forms of structural intervention and manipulation in their work. In particular, the collections created by Rei Kawakubo for Comme des Garçons stand out as significant examples that transformed conventional understandings of fabric and garment construction (Image 1).

In this context, the study addresses manipulation in textiles from the perspective of structural intervention and proposes new approaches that expand existing understandings.

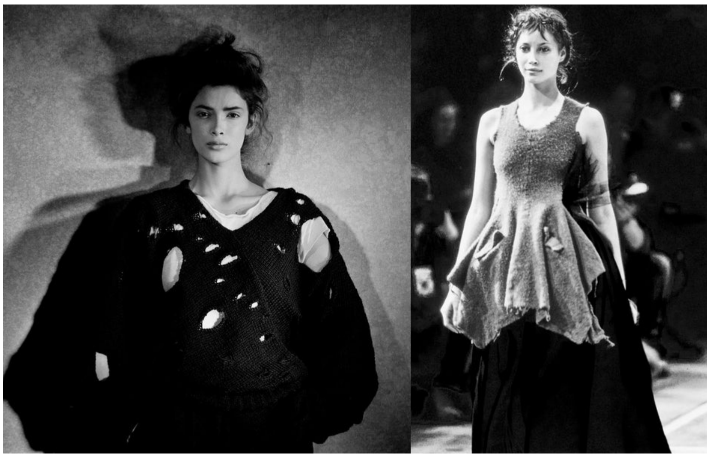


Image 1. Deconstruction reflections in fashion, *knitted sweater,* Rei Kawakubo for Comme des Garçons, 1982, photo by Peter Lindbergh (left), *woven shirt,* Rei Kawakubo for Comme des Garçons Fall/Winter 1994 Ready-to-Wear Fashion (right).

Manipulations of garment forms or fabric surface designs have, over time, been reflected in the stages of fabric production, and construction has also been carried out through techniques such as weaving and knitting. The methods that intervene in and disrupt the conventional structure of woven fabrics and create a new appearance, shape, and form are presented. The study not only presents examples from the existing literature and classifies them into three groups based on their application processes, but also interprets these examples from the perspectives of re-construction and sustainability. Thus, it emphasizes that structural interventions can be applied in future studies of local and personalized fashion, as well as in labour-intensive production contexts.

This study defines structural manipulation on woven fabrics, discusses their applications, and contributes to the field by proposing a new classification. Subsequently, structural manipulations applied to woven fabrics are systematically examined in three groups according to their stage of application, thereby establishing a foundation for future design and application. It can be concluded that designs are no longer produced solely for aesthetic or functional purposes. Structural manipulation applications within a sustainability framework will provide an innovative perspective, particularly in labour-intensive production areas, and attract consumers' attention.

2. Manipulation and Textile Manipulations

A literature review shows that the term manipulation in textiles and fashion encompasses a broad range of meanings. From a common perspective, the manipulation involves the intentional, planned, and aesthetically meaningful alteration or reshaping of a fabric’s appearance. Nevertheless, manipulation is not limited to transforming pre-existing materials; it also constitutes a textile design approach that involves generating structures from scratch. In this regard, manipulative practices are enabled by a creative process that may include the formation of the fabric itself.

Although manipulation of textiles is often associated with post-production interventions, such as stitching, bonding, dyeing, printing, and finishing, the contemporary use of the term has broadened significantly to encompass deeper structural alteration and transformation. As stated by Çağlar Öztürk and Kozbekçi (2023, p. 73), the different manipulation methods employed in textiles are grouped under three headings, “fibre manipulation, colour manipulation, and fabric texture manipulation”, and the authors present a common classification. In this study, that framework is expanded to incorporate manipulation practices employed during the weaving process (Table 1). Accordingly, the concept of textile manipulation now encompasses not only procedures carried out on yarns or fabrics but also textile production stages, such as woven, knitted, and nonwoven structures.

In this context, the primary objective of this study is to analyse the structural interventions applied to warp and weft yarns before, during, and after the weaving process, and to examine the resulting changes in form and configuration. Within this framework, the weaving reed, auxiliary apparatuses, and various applied techniques have been classified. The study is grounded in an extensive field-based investigation, and all available sources identified within its scope have been compiled, contextualised, and supplemented with visual documentation to enhance analytical clarity.

As shown in Table 1, fibre manipulation practices that alter the chemical structure of fibres are presented first. Felting applied to wool fibres; pressing and shrinking applied to synthetic fibres; wet finishing processes applied to fibres such as wool, silk, cotton, and linen; and thermal finishing (thermosetting) applied by dry heat to thermoplastic fibres such as polyester and polyamide all fall within this heading (Kurtuldu Dönmez & Önlü, 2022). The devoré technique, which involves burning fibres of different compositions, may also be considered a finishing technique. Furthermore, manipulation of fibres and yarns may be achieved by directly transforming them into surface structures using interlining or water- or heat-soluble materials. Variations in volume, relief, and shrinkage generated by these processes produce manipulative effects on textile surfaces.

The second category emphasises yarn manipulations, highlighting that yarn structure is as critical as the raw material in determining the outcomes of textile manipulation. Across all textile production methods, such as weaving, knitting, non-wovens, and sandwich structures, the physical structure of the yarn affects the design as much as its chemical structure does. High twist levels, volumetric irregularities, differences in fineness or thickness, transparency or opacity, and tactile qualities, such as softness or rigidity, which stem from raw materials or production techniques, all generate manipulative effects during surface formation. Even the twist direction and intensity, or the combined use of yarns with different twist levels, can create distinct textures, volume, and relief variations on fabric surfaces. In addition to differences in S or Z direction twists, this category can include various yarn production methods, such as highly twisted, ply-twisted, and fancy yarns, as forms of yarn manipulation.

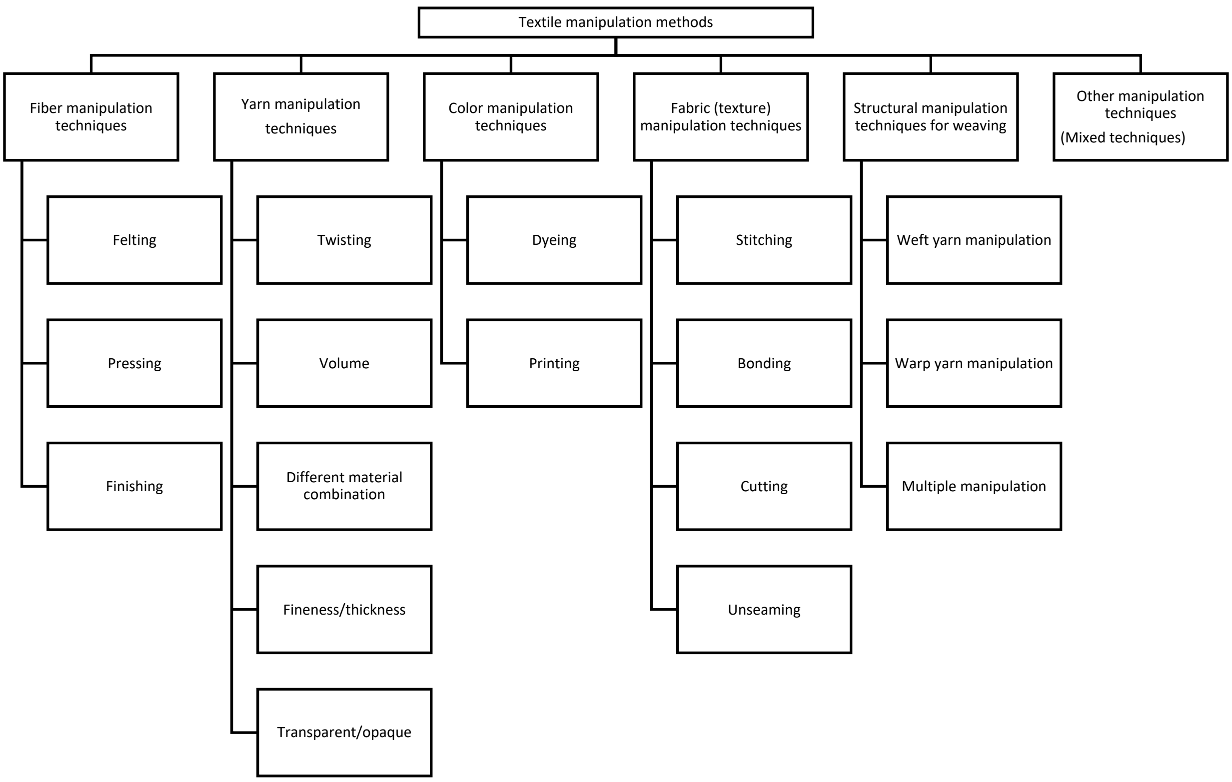
Different structural manipulations can be achieved through dyeing and printing techniques that exploit the material potential of textile surfaces to create colour-based effects. Whether natural or chemical, these methods, carried out according to the raw material, produce marked aesthetic and physical differences across textile surfaces.

Within the category of fabric texture manipulation techniques, interventions included stitching, bonding, cutting, and unseaming. These are incorporated into fabric surfaces, where single or multiple fabric structures can be combined (such as sandwich structures). These applications are the most common among textile manipulations.

Structural manipulation techniques for weaving included in the study are explicitly identified as weaving-structure manipulations. Although fibre and yarn connections can be reconfigured relatively easily in knitted or non-woven structures, woven structures impose inherent limitations due to the perpendicular arrangement of warp and weft yarns. For this reason, methods of structural manipulation in the production of woven fabrics require a distinct classification. These interventions are divided into applications that can be carried out in the weft direction, in the warp direction, or in multiple directions. In this study, all manipulation applications classified under this title were reclassified under the following title, depending on the manufacturing stage at which the intervention took place, and were illustrated with visuals.

Finally, the mixed-media manipulations were presented on the same table. This category includes multiple manipulation-based applications that involve different combinations of techniques, which become unique through the aesthetic and technical knowledge of the designer and the artist. In contemporary practice, approaches such as digital imaging, artificial intelligence-assisted methods, and electronic applications are categorized as mixed-media under the heading *other techniques*.

Table 1. Textile manipulation methods with new section suggestions



2.1. Structural Manipulation and Weaving Applications

When structural manipulation applications in woven fabrics are examined, these methods can also be regarded as a re-creation study. At this point, beyond improving an existing design, it is suggested that it be restructured through conscious, controlled planning from beginning to end.

Based on this definition, the weft and warp manipulations in the weaving examples given below are acts of re-creation, re-construction, structural proposition, and re-shaping. Some examples result from manufacturing methods that employ slow, labour-intensive techniques to transmit cultural heritage and promote environmental sustainability, as opposed to the industrial processes of fast fashion, which generate substantial waste from cutting, are unsustainable, and raise ethical concerns. These slow methods aim to reverse these trends. In this regard, manipulations carried out during the design and manufacture of woven fabrics consist of rearranging, structuring, and deliberately disrupting the weft and warp yarns that form the basis of the weaving technique, thereby ensuring the integrity of the fabric.

In its most basic form, the weft and warp yarns, which intersect at right angles to form the fabric, interlace at different angles, affecting the fabric's structure. Rearranging their connecting parts, angles, or densities constitutes reconstruction by disrupting their conventional structures. This method is called structural manipulation. This includes interventions on both weft and warp yarns during weaving: interventions applied to the weft yarn are called weft manipulation, those applied to the warp yarn are called warp manipulation, and those applied to both yarns are called structural manipulation (Kurtuldu Dönmez, 2025). However, this reconstruction, carried out in only one direction, can also affect the yarns in the opposite direction. That is, defining the manipulation by evaluating the entire structure during the final design phase would be more accurate.

Structural manipulations applied to woven fabrics are designed and implemented with regard to both functional and aesthetic concerns. As a result of these manipulations, woven fabrics can, in addition to remaining two-dimensional, become three-dimensional. "This state of redimensioning through structural manipulations provides a sustainable, innovative, and creative perspective on waste formation, particularly for seamless woven clothing designs" (Kurtuldu Dönmez, 2025). These manipulations, which include weaving and manufacturing stages, employ various techniques guided by the principle of destroying the existing order and reconstructing it through new methods.

These different structural manipulation methods on weft and warp yarns in woven fabrics can be grouped under three headings in the study:

- The structural manipulations that occur based on the preparation and the equipment before the weaving,

- The manipulations that occur through physical and controlled interventions on the connections of weft and warp yarns during the weaving,

- The manipulations that occur through physical and controlled interventions on the fabric structure after the weaving.

These manipulation practices aim to implement an innovative manufacturing method that may involve using fewer materials, reducing cutting and sewing waste, and creating either a labour-intensive model or an entirely aesthetic product.

The structural practices of this weaving method enable the creation of woven fabrics, accessories, clothing, interior products, and abstract artistic objects. Through manipulation, objects with zero-cut waste, sustainability, customisability, limited serializability, and even open-source, DIY (do-it-yourself) features can be designed and produced. Another advantage is that they are cost-effective and can be produced by local manufacturers without advanced equipment.

When all the examples presented in the study are evaluated according to reconstruction, it is possible to group them under two headings. As stated in the introduction, some designs and applications encompass both the destruction and the reconstruction of existing structures. Others are created using a new construction method that differs from the traditional structure. Images 1-5 and Tables 2-3 illustrate this configuration with examples. Instead of traditional weaves that connect at a 90-degree angle and whose warp-weft angles change during the stitching stage, they are constructed directly at different angles.

The examples were created using reconstruction and re-design methods, which involve the traditional weaving process at right angles, followed by the manual control of the woven structure. Thus, all manipulations performed using weaving techniques differ in the way they reshape, redesign, or reconstruction.

2.1.1. The structural manipulations that occur based on the equipment and the weaving preparation phases before weaving

The capabilities of the looms and machines used for combed, dobby, or jacquard weaving affect not only the production criteria but also the aesthetic and physical characteristics of fabrics. Examples include material type, colour, patterning capacity, and size, shape, form, and volumetric features of fabrics. Specifically, the positioning of the weft and warp yarns defines the relationships among the yarns in weaving, both within each set and between them. Thus, the fabrics exhibited two- or three-dimensional twisted and wavy appearances and forms, influenced by relief. For example, fabrics can adopt innovative forms owing to rearrangements that result from variations in the density of, or the angle between, warp yarns.

The orthogonal angle between the weft and warp yarns, created by the weaving reed's tucking action, is typically considered a fixed parameter (Ataş, 2009; Cnaani, G. & Sterman, Y., 2024, p. 125). Going beyond standard weaving by rearranging the positions of the weft and warp yarns can enhance design diversity. For example, mechanical adjustments and new arrangements are carried out, particularly on the frame or the looms, before weaving to position the warp yarns at different densities. In this way, a wide range of patterns, textures, structures, colours, and fabric varieties are created, especially on manual weaving looms.

In weaving carried out with a standard loom reed, the 90-degree angle between the weft and warp threads is largely maintained. Generally, weaving is carried out in a way that preserves this angle. However, if intervention in the yarn connections within the fabric structure is desired, it is typically performed manually during or after weaving. Whether applications of angular manipulation are planned for execution before weaving is realised depends on the shape of the weaving apparatus and the reeds used.

Various weaving apparatuses equipped with splints, pins, punches, and staples for making smaller weavings allow warp yarns to be arranged at angles and densities different from those used in conventional vertical and parallel warp planning. Using these devices, the weft and warp yarns are manipulated to produce zero-waste woven products in non-rectangular shapes. These weaving apparatuses can be manufactured in a variety of shapes, sizes, and orientations and designed as two- or three-dimensional forms. Examples of such manipulations, carried out by weaving designers or collectives from many countries, can be observed, with the specific manipulations depending on the design of the weaving apparatus. These manipulations, carried out according to the shape of the weaving apparatus, are also known as shaped weaving.

Woven accessories or textile products can be produced using weaving apparatuses available in various shapes and sizes, which allow manipulation of weft and warp threads (Image 2). These practices also provide a user- and consumer-centered experience, particularly when implemented through DIY kits. From a sustainability perspective, they are feasible even when produced from leftover yarns and exemplify an environmentally responsible approach, since they generate no warp yarn waste.

Image 2. Weft-warp manipulation application samples on different weaving kits (A Yarn Story, 2025) (left), (The Loome, 2025) (right).

The primary tasks carried out during pre-weaving planning are weaving reeds into various shapes. These differently shaped reeds ("single fan-shaped reed" (Faber, 2002; Anderson, 2005), "multiple fan-shaped reed" (Seidl & Kellenberger, 1993; Ahmad, Sun & Hussain 2023), "ondulé reed" (Smayda & White, 2017), fan reed, special fan reed, and hybrid reed) are fixed and do not exhibit comb movements during weaving. Before weaving, they are positioned at desired angles and shapes; the warp yarns are tied to the loop, and weaving begins.

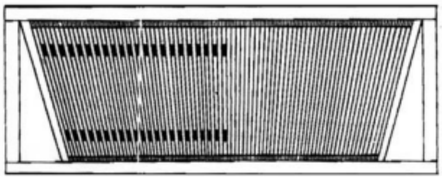
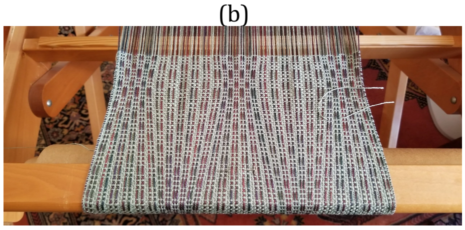
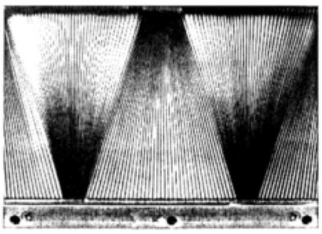
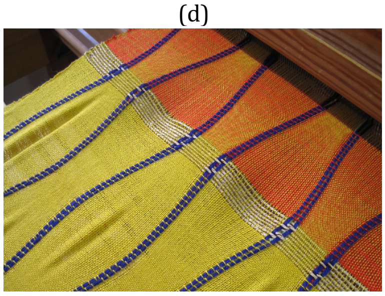
In single- and multiple-fan-shaped reed configurations, reed combs are fixed, allowing the reed to be woven at desired angles. While the density between the combs on a single fan-shaped reed is fanwise in a single direction (Table 2-a), the density is arranged in multiple fan-shaped reeds or ondulé reeds (Table 2-c). Images of the fabrics woven with these two reeds are shown in Table 2b and Table 2d, respectively. Thus, weaving was carried out at different warp densities. By raising and lowering the combs on an ondulé reed, the designer can change warp yarn densities on the fabric surface (Arafat, 2019; Willemoes-Wissing, 2011). By providing variable warp density, even within a single weave, this capability offers a wide range of design opportunities.

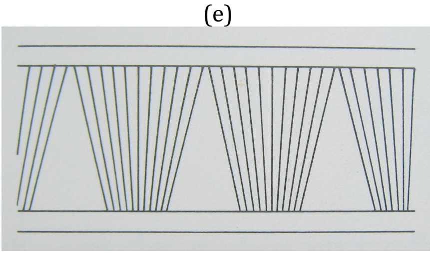
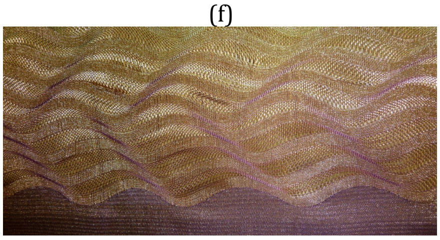
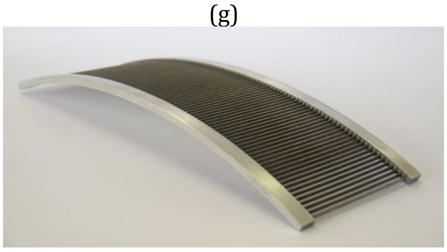
Another reed was developed from the fan reed (Table 2-e). This special fan-shaped reed has fixed combs that open in a single direction, with triangular spaces between them. During weaving with single and multi-directional fan reeds, the weft yarns, held in place by the sley beat, intersect the warp threads at different angles and densities, thereby creating structural modifications on the fabric surface (Table 2-f).

Originally, the curved reed was designed to prevent hard yarns (such as jute) from breaking due to tension differences between the center and the edges of the fabric during weaving (Table 2-g). Subsequently, it became a tool for structural manipulation that could affect the surface appearance by varying the warp and weft angles in fabrics, and it was used with different yarns. These fixed, combed reeds are adjusted by the designer during the weaving process, thereby altering the warp density and the weft-fixing angle. Thus, both visual and physical recontructions occur on fabrics.

Examination of the images presented in Table 2 does not explicitly indicate that the works were carried out with a zero-waste objective or a sustainability-oriented approach. Nevertheless, these practices can prevent cutting waste when materials are intended for transformation into products, such as garments. Furthermore, when analysed from a design perspective, the studies presented in the same table suggest that variations in weaving-reed structures may offer an innovative approach to labour-intensive production areas typically associated with slow fashion.

Table 2. Reed samples and weaving applications that allow intervention in the connections of weft-warp threads before weaving process

Reed samples	Woven fabrics views
(a)  Single fan-shaped reed, Faber 2002; Anderson, 2005.	(b)  Weaving with single-fan shaped reed, Arafat, 2019.
(c)  Multiple fan-shaped reed, Seidl & Kellenberger, 1993; Anderson, 2005 and Ondulé reed, Smayda, N. & White, G. 2017.	(d)  Weaving with multiple fan-shaped reed, Willemoes-Wissing, 2011.

(e)  Special fan reed, Osterkamp, 2011.	(f)  Obi woven with special fan reed, Osterkamp, 2011.
(g)  Curved reed/jute reed, 2017.	

2.1.2. The Structural manipulations that occur depending on the connections of the weft and warp yarns during weaving

Practices that manipulate the angles of yarns during weaving are not new. Although the term *structural manipulation* is relatively new, the oldest known applications of structural manipulation were, in fact, in tapestry weaving. As is well known, the word *tapestry* is of French origin and denotes a depiction produced by weaving. In this method, instead of the weft threads extending along the fabric and connecting to the warps, they are connected locally, in the direction indicated in the drawing. Importantly, the weft yarns are woven manually or wound on small bobbins and do not require the weaver's shuttle. Although in traditional tapestryweft yarns are tied to the warp at a 90-degree angle, when a corner or different motif is desired, they are tied without creating a 90-degree angle (O'Callaghan, 1980, p. 49) (Image 3). In contemporary applications, they largely enable structural manipulation associated with various circular and cyclical angles. Images 2 and 4 illustrate the potential for utilising leftover yarns and minimising cutting waste (Bunting, 2020). Moreover, it represents an innovative approach to slow fashion within labour-intensive, artisan-based production, highlighting how sustainable practices can be integrated into hands-on textile processes without compromising either aesthetic or functional quality.

Image 3. Wedge weaving samples, O'Callaghan, 1980, p. 49.

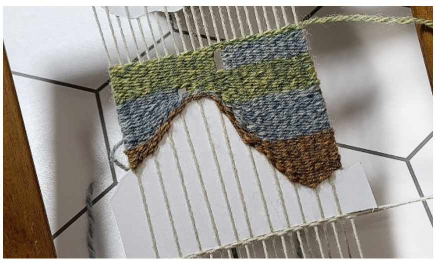


Image 4. Warped fibers, tapestry samples as the first samples of structural manipulation on weaving, Bunting, 2020.

In this tapestry example, manipulations during weaving result from manual interventions and modifications to the loom's tools. The most pronounced differences arise from the movement of the reeds during weaving. The reed examples presented in Table 2, consisting of combs arranged and fixed in a fan-shaped configuration, have been updated over time to reflect evolving needs. Thus, the movement of reed combs during weaving increased the variability of warp densities.

Variable movable reeds (Table 3), such as warping (zigzag), open, rail, stepping, and V-shaped reeds, allow modification of woven fabric structure during weaving by changing the density and angle of the warp yarns. Thus, manipulations can be carried out by moving both the weft and the warp yarns.

First, among these reeds, the warping/zigzag reed is the most advanced (Table 3-a) because its combs are grouped in a zigzag arrangement, allowing the teeth to be adjusted to the desired width. This reed was designed to be widened or narrowed during weaving. The density of warp yarns can be adjusted during weaving. When tied to warp yarns at varying angles, weft yarns create a wavy weave structure. The example on the right shows a weaving sample using a template that acts as a warping reed. As shown in this example, weft and warp yarns are tied together, forming a zigzag pattern (Table 3-b). The designers of this fabric stated that, after being removed from the loom, the fabric takes on a 3D form as its tension is relieved (Canaani & Sterman, 2024, p. 132).

On the other hand, open-reed combs are arranged in fixed positions on the reed frame (Table 3-c). However, they are not fixed to a frame on the upper side and therefore remain open. To change the density of the warp yarns during weaving, adjustable Velcro straps or elastic bands are used to bring the reed combs closer together on the open part of the reed (Başaran & Bekiroğlu, 2023, p. 193). Thus, structural manipulations are achieved by altering the angles of the weft and warp yarns on the fabric surface. Warp yarn density can be adjusted using different combinations. Therefore, it is apparent that it is a preferred reed, especially for artistic and authentic works. In the example of weaving made with an open reed by Rachel Snack and Suzi Ballenger (2014), manipulations involving single-directional or multidirectional curvatures can be applied at the desired angles (Table 3-d).

The rail reed consists of comb groups that are fixed to the reed frame with screws (Table 3-e). This reed operates on the principle of a channel that forms the reed's upper and lower frames, and screws that allow the reed-comb groups to move within the channel, thereby decreasing or increasing the spacing between the teeth. Like the open reed, this reed offers variety in the creation of artistic weavings. Table 3-f shows one of Kadi Pajipuu's designs created using a rail reed. The wavy appearance observed in this study was oriented vertically.

Pajipuu (2022) named the new reed "stepping reed", which he developed by adding weighted, movable steppers to the upper part of the weaving loom's reed, in addition to the rail reed (Table 3-g). These steppers create a wavy weft-compression action during the sley beat, providing structural manipulation. Thus, versatile manipulations are carried out on both weft and warp yarns. These weighted, movable steppers can be placed on the rail at specified intervals and activated as required during weaving. In Table 3-h, the waviness produced by the moving steppers was oriented horizontally.

Next, as illustrated in the example, a reed with a curved profile can be opened and closed into a V shape by screws at its center. The V-shaped reed divides the warp-yarn densities symmetrically at the midline, producing a mirrored arrangement (Table 3-i). Thus, it enables the weaving of a fabric that widens or narrows toward the centre. Although it allows manipulation through interference with the warp yarns, it does not provide additional opportunities for movement. However, this reed can be used to weave shaped fabric pieces. In the fabric example on the right, woven by Canaani & Sterman (2024, p. 126), the same result is achieved by a pattern developed with a V-shaped reed (Table 3-j). The designers stated that the fabric takes on a three-dimensional form after being removed from the loom. This form also provides a seamless, form-fitting effect as an alternative to applying darts, particularly in garment design.

At this point, the variable reed, the most innovative of the reeds and a tool used to separate and space the warp (the lengthwise yarns held in tension on a loom), was developed from the V-shaped reed (Table 3-k). The weaving is produced on a single warp using multiple sets of reeds arranged at gradually varying angles. Reeds with comb angles ranging from the lowest to the highest are used. In this technique, weft refers to the crosswise yarns woven into the warp. By gradually increasing warp density within a single fabric, cut-free abstract weavings with different starting and finishing features can be produced. Cnaani and Sterman, designers of the reed, stated that they developed the reed specifically to produce cut-free skirt pieces (2024). Furthermore, owing to this reed, they achieved a zero-waste outcome by producing a seamless double-layered A-form skirt (Table 3-I). This method, defined as the system of grouping warp yarns and interfering with the linear structure of both weft and warp yarns, produces multidirectional manipulation throughout the fabric structure.

Another example of structural manipulation, apart from these reeds, is leno, which may be performed manually or by the weaving reed. "Woven surfaces, also known as leno, hem-stitch, crossing, or topstitch, are textile structures that are loosely woven yet structurally strong, created by the up-and-down and crosswise movements of the warp yarns" (Yavaşçaoğlu, 2012, p. 23). These movements produce structural modifications by disrupting the right angle between the warp and weft yarns during weaving. Leno weavings can be produced by single-rotating, double-rotating, or reversed-rotating power; by different arrangements in reed transition; or by changing the number or direction of weft and warp yarns, which can produce weaving manipulations (Doğu, 2019).

Table 3 presents examples of structural manipulation (s); hand manipulation (m, n) (Greenlaw, 2019; Greenlaw, 2025); frame control (o, p) on a single-frame loom; and a reed, Posileno (r), that operates with rotary power.

Another work by Peggy Osterkamp, known for her work with the special fan reed (Table 3-u), serves as an example of structural manipulation during weaving (2011, p. 1). In this work, she said that she was inspired by methods for manipulating yarns without using a reed, such as those used by Peter Collingwood, Ann Sutton, and Diane Sheean. However, she did not explain in detail how she carried out her work. Eyring stated that designers can achieve such weavings by changing the tension of the warp yarns (2020, p. 89). Examination of Osterkamp's fabric shows that the weft yarns are not incorporated into the weave smoothly or neatly. Taking this information into account, he is thought to have used one of these applications to create the fabric.

- Manually tightening up the weft yarns locally with a comb, which is used for combed weavings,

- Carrying out the sley movement manually with a weaver's shuttle or stick,

- Changing the tensions of warp yarns locally during weaving.

The linen tapestries in Peter Collingwood's exhibition Angle-fell feature undulating weft yarns (Image 5). Collingwood (1964) explains that he achieved this series by constantly changing the tension settings of the warp yarns, causing the weft yarns to fluctuate between the warp threads in a controlled manner. A tension difference can occur only if at least two different warp beams are used. Thus, as the tension of the warp threads, tied in groups to different beams, is varied, the wavy areas in the weavings change, producing a pattern. Using this method, Collingwood carried out a weaving manipulation. Although Collingwood's studies do not explicitly address issues of sustainability or waste management, they underscore that weaving production is inherently labour-intensive and artisanal. This perspective highlights the significant manual effort, skill, and craftsmanship involved in traditional textile production, positioning such practices within a framework that aligns closely with the principles of slow fashion. By focusing on artisanal weaving, he implicitly highlights the potential of these practices to support sustainable approaches, even though sustainability is not directly discussed.

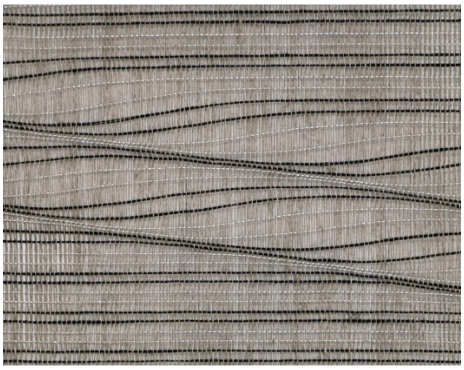


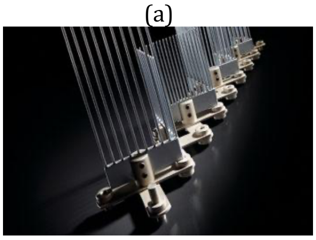
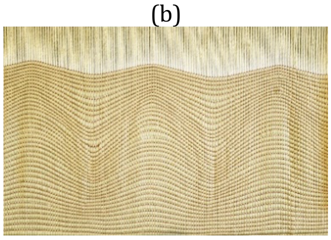
Image 5. Anglefell, wall-hanging (detail), Peter Collingwood, 1964.

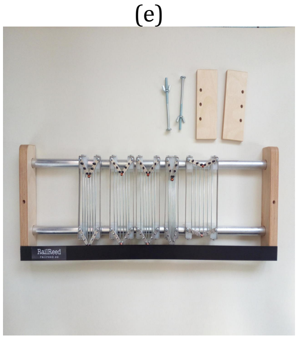
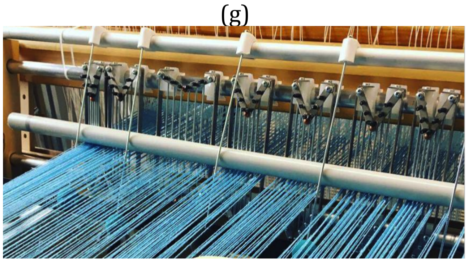
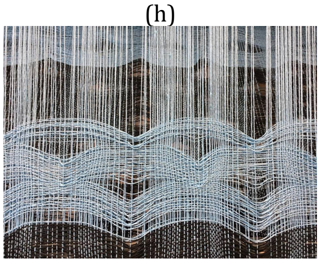
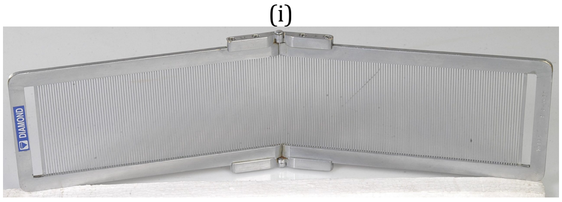
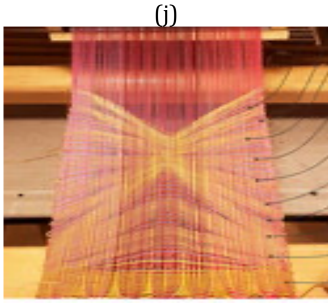
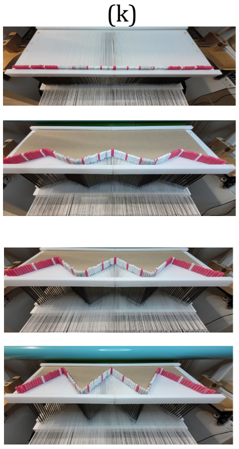
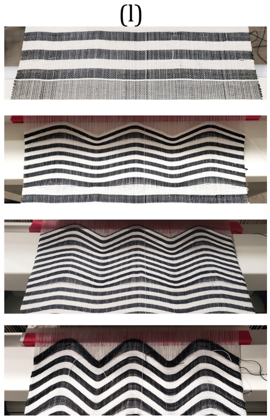
As with Collingwood, Ann Sutton conducted work in 2008 that involved manually manipulating warp yarns under different tensions and grouping them at varying angles on the fabric surface (Image 6). Sutton (2008) emphasizes that weaving is a highly labour-intensive practice both as an art and as a craft.

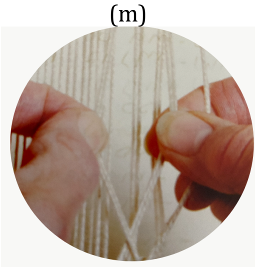
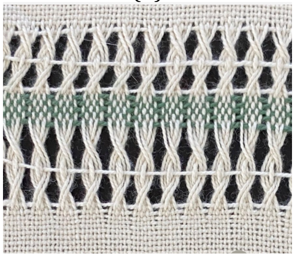
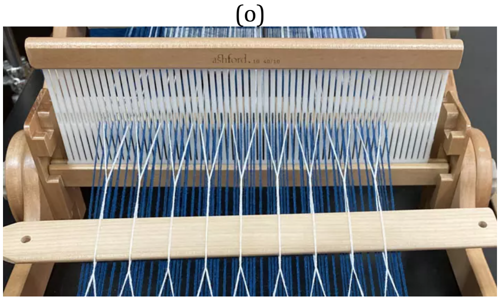
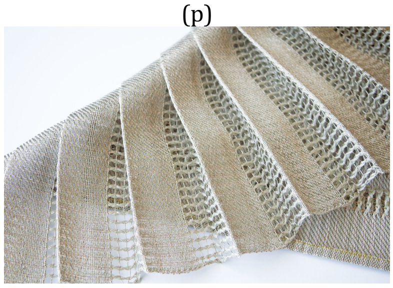
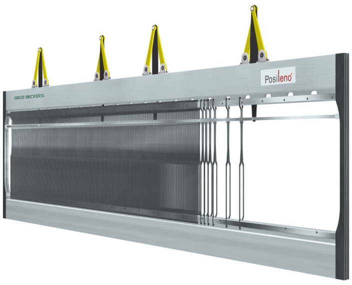
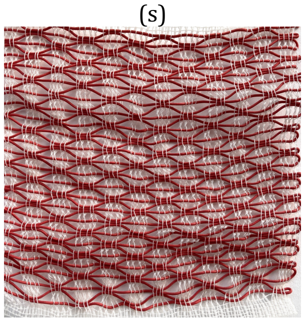
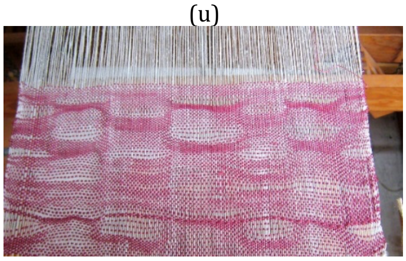
Image 6. Experimental Piece, woven fabric, Ann Sutton, 2008.

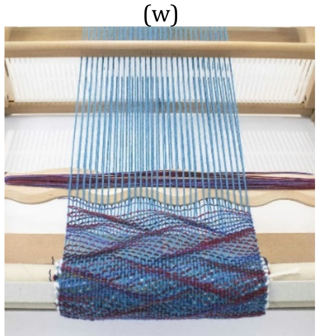
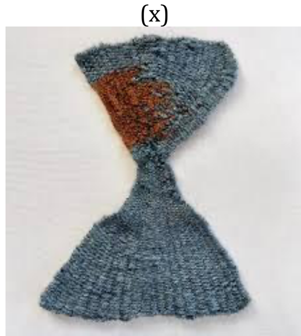
Table 3-v shows examples of wavy shuttles. The right-hand picture illustrates a weaving created with this wavy weaver's shuttle rather than with a reed (Table 3-w; Evans, 2022). In this weaving method, the wavy shuttle performs the sley movement that the reed would normally perform. This shuttle modifies the process by tying the weft yarns to the warp yarns at different angles. This weaver's shuttle appears to have been used in Osterkamp's reedless (i.e., those requiring no reed) wavy weavings, as described in the previous example. The structural manipulation example, formed in a waste- and cut-free manner on a small handloom during weaving, is shown in Table 3-x. Weft-yarn angles also vary depending on how they are tied to the warp yarns. This method, developed by Adgate (2019), produces multi-directional structural manipulation through direct intervention in both the weft and the warp yarns. The manipulation, carried out manually, is a technique that can be implemented and varied according to the designer's aesthetic taste and design criteria. Thus, it is accepted as a practical method in artistic practice. It also has a feature that enables seamless, cut-free, and waste-free manufacturing.

Table 3. Reed samples and weaving applications that allow intervention in the connections of weft-warp threads during weaving process

Reed, kit, module, technique samples	Woven fabrics views
(a)  Warping reed/ zigzag reed, Bluereed, 2020.	(b)  Weaving with warping reed, Canaani & Sterman, 2024.
(c)  Open reed, Başaran & Bekiroğlu, 2023.	(d)  Weaving with open reed, Snack & Ballanger, 2014.

(e)  Rail reed, Pajupuu, 2018.	(f)  Weaving with rail reed, Pajupuu, 2021.
(g)  Stepping reed, Pajupuu, 2022.	(h)  Weaving with stepping reed, Pajupuu, 2022.
(i)  V shaped reed/ V shaped comb reed, 2019.	(j)  Weaving with v shaped reed, Canaani & Sterman, 2024.
(k)  Variable reed module, Canaani & Sterman, 2024.	(l)  Weaving with variable reed module, Canaani & Sterman, 2024.

(m)  Finger manipulated/ hand controlled manipulation with leno weaving, Greenlaw, 2019.	(n)  Finger manipulated/ hand controlled leno weaving, Greenlaw, 2025.
(o)  Loom controlled manipulation with leno weaving, Shtrik, 2021.	(p)  Leno weaving manipulation, Bernstein, 2014.
(r)  Weaving leno reed, Posileno, 2010.	(s)  Leno weaving with posileno, Dunne et al., 2023.
(t)  Different tensions of warps, Eyring, 2020.	(u)  Wavy wefts without fan reed, Osterkamp, 2011.

(v)  Different wavy stick shuttles, Woolery, 2024.	(w)  Zigzag patterns with wavy shuttle, Evans, 2022.
	(x)  Weft shrinking on the loom, Adgate, 2019.

2.1.3. The manipulations that occur through physical and controlled interventions on the fabric structure post-weaving

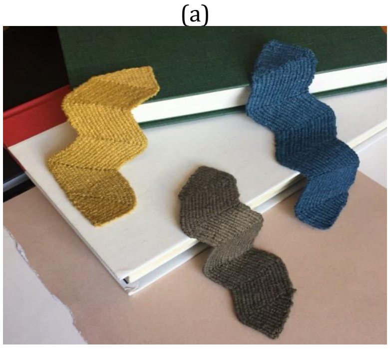
In weaving applications, the weft and warp yarns can form a surface that combines woven and nonwoven areas, as in tapestry weaving. Areas where only the warp yarns are visible and not tied to the weft yarns, forming a hollow structure, can be removed by controlled physical manipulations of the fabric structure after weaving. Today, these applications are mostly carried out manually. The studies presented in Table 4 indicate a structural intervention in both the weft and warp yarns. After the manipulation was applied, a structural transformation occurred as the angles of both the warp and the weft yarns changed.

Adgate (2015) describes a weave in which thicker weft yarns are woven over thin warp yarns in groups of triangular and rectangular pieces, with unwoven areas between them that contain only warp yarns (Table 4-a). Woven and nonwoven surfaces converge, as in tapestry weaving. This weaving, removed from the weaving apparatus or the combed weaving loom, is produced by manually pulling the warp yarns and tying the weaving groups together so as not to disrupt the density of the weft threads. Although Adgate describes her work as warp manipulation, the action occurs in both directions. This technique, as used in the woven bookmark, offers a wide range of product variations and authentic design opportunities by bringing together woven groups into distinct shapes. She highlights that this technique does not generate waste in either the warp or the weft yarns.

Campbell, who creates woven accessories similarly to Adgate, also performs structural manipulations by assembling triangular woven surfaces into a circular shape (Table 4-b). When attributing the origin, she uses the term "pulled warp tapestry" in her work (2019). An Analysis of Campbell's works shows that she, unlike Adgate, is concerned with incorporating warp yarns into the design rather than removing them. By integrating leftover warps aesthetically into the weaving process, they ceased to be regarded as waste.

A woven fabric design example by Kurtuldu Dönmez (2017) uses thin warp and thick weft yarns. The right and left sides of the weaving show warp yarns drawn toward the middle of the fabric through regional planning, and weft threads are separated from their right-angled connections to the warp and incorporated into the design as fringe along the fabric edge (Table 4-c). Based on this design, an example of waste-free, cut-free weaving was demonstrated by manipulating the fabric removed from the loom. The other seamless, cut-free, waste-free, and sustainable woven garments by Kurtuldu Dönmez (2025) are presented in Table 4-d, which also serves as an example of manipulations carried out on the weft and warp yarns after weaving. No warp- or weft-yarn waste was present in this sample. The edge yarns were included in the design for aesthetic reasons. Her designs employ manipulation techniques to produce waste-free, cut-free, seamless woven garments using tubular weaving, which does not require any shrinking yarns or techniques. The weaving action was created by combining different shapes designed to fit the human body and non-woven areas. The warp threads in the unwoven areas of the fabric; which was taken off the loom after weaving; were pulled toward its edges, giving it volume and dimension. This example demonstrates that the warp threads are pulled to one side, leaving the opposite sleeve without fringes. Thus, an asymmetrical appearance was observed. Unlike Adgate and Campbell's manipulation practices, this study makes the third dimension visible.

Table 4. Structural manipulations that take place through physical and controlled interventions into the weft and warp yarns after weaving

(a)  Hand controlled manipulated weavings, Adgate, 2015.	(b)  Hand controlled manipulated weavings, Campbell, 2019.
(c)  Hand-controlled manipulated weaving, Kurtuldu Dönmez, 2017.	(d)  Hand-controlled, manipulated seamless, cut-free, wasteless woven garment, Kurtuldu Dönmez, 2025.

Results

Applications of manipulation in textiles encompass a wide range of techniques. Thanks to advances in technology, design opportunities, aesthetic perception, and design skills, existing practices have also improved. Structural manipulations are processes that combine disruption and construction on fabrics.

In this study, manipulations performed according to the weaving structure and grouped under three headings are classified by their direction. The weaving reeds, shuttles, and apparatuses, which have varying characteristics as illustrated by the examples, can be further developed and diversified.

Suggested as a subheading for manipulation applications in textiles, structural manipulation practices illuminate innovative, both industrially and artistically, sustainable, seamless, cut-free, and waste-free manufacturing methods. Recent examples of work also reflect this approach.

In this study, taking into account contemporary fast-moving consumer habits, weaving manipulation practices expressed in both written and visual forms are regarded as a field of production that can shed light on labour-intensive production styles. Given its innovative and experimental nature, the application is expected to yield significant results, particularly within do-it-yourself practices that exemplify slow fashion.

Exemplary, readily applicable methods were presented as a sustainable and innovative example of customized design to preserve local hand weaving, promote its adoption, and ensure aesthetic diversity.

Structural manipulation, proposed as a subheading within textile manipulation applications, sheds light on a production approach that is open to industrial and artistic innovation and that is sustainable, seamless, cut-free, and waste-free. Recent examples of work in this direction illustrate this point.

From a reconstruction perspective, applications of weaving manipulation involve re-design of the woven structure. Furthermore, it has been suggested that these methods be considered within the scope of textile manipulation.

Considering the fast-consumption mindset that characterises contemporary society, this study demonstrates that textile manipulation practices articulated through written and visual documentation constitute a productive field for highlighting labour-intensive modes of production. Because of their innovative, experimental nature, such practices are expected to generate noteworthy outcomes, particularly in DIY initiatives that embody the principles of slow fashion. A set of illustrative and readily applicable methods is presented as a sustainable and innovative model of personalised design to support aesthetic diversity and to contribute to the preservation and continued relevance of local hand-weaving traditions. Therefore, textile manipulation techniques may also provide an attractive application method for consumers in labour-intensive production areas, such as slow and sustainable fashion.

Hence, this study contributes to the literature by including, among textile manipulations, structural interventions on weft and warp yarns in woven fabrics, and by providing examples from existing studies that can be passed on to future research. This study, which examines the concept of manipulation as a holistic process extending from pre-production to post-production in woven fabric structures, continues with applications carried out by the researcher from a sustainable and zero-waste perspective, using the examples provided.

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