Silent Witnesses: A Groundbreaking Idea in the 1st Millenium BC Changed the Ancient Textile Industry and Laid the Foundation for Modern Clothing Production

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Abstract | Comparable data sets of the excellently preserved textile finds from the 1st millennium BC in Xinjiang, Western China, tell an unusual story: About 500 BC in Xinjiang, the ancient textile industry went through far-reaching structural changes, and the design of the produced clothes changed significantly. What was the reason for this substantial shift? A new scientific method reveals that the seemingly simple but groundbreaking idea to cut into fabric to manipulate its shape swiftly spread in the region. Based on the archived data in the design memory of Xinjiang's excellently preserved textile finds, this article highlights how an innovative design idea restructured the entire craft, pioneered new clothing concepts, and laid the foundation for modern clothing production.

Keywords: Forensic approach, Reverse Engineering, design memory, clothing as data archive

1. Silent Witnesses

Comparable data sets of the excellently preserved textile finds from the 1st millennium BC in Xinjiang, Western China, tell an unusual story: About 500 BC in Xinjiang, unexpected structural changes developed in the ancient clothing production. Also, the design of the produced clothes changed significantly. What was the reason for this substantial shift within the ancient textile industry?

A new scientific method reveals that a seemingly simple but innovative technological idea within the clothing production swiftly spread in the region: the idea to cut into fabric to manipulate its shape. This idea was groundbreaking. It laid the foundation for new, efficient production concepts and restructured the entire craft. Beyond that, it pioneered a new design discipline, which is still essential today: the concept to produce clothes by tailoring them (Beck 2018; Beck and Jess 2021). How could merely one design strategy cause such an immense structural shift? The answer is still preserved in the ancient textile finds.

2. Forensically informed Reverse Engineering and clothing as a data archive

Clothing fulfils practical, communicative and social functions (North 2006, 5; Mentges 2005, 11–39). Additionally, it plays an essential part in economic production processes and is a powerful driving force for trade and the development of new technologies (Beck and Jess 2021). Clothing is deeply interconnected with its cultural, social and economic environment. As a cultural memory, it traces the changing eras and their social structures. Thus, clothes are data archives. Even after several thousand years, they contain the concepts of their design and production techniques within themselves. Specific technological ideas or design strategies are still preserved in the compelling logic of the construction of the garments (Beck 2018; Beck and Jess 2021).

The remarkable change within the ancient textile industry in the second half of the 1st millennium BC in Xinjiang could be demonstrated by a new methodology that uses forensically informed reverse engineering techniques to reconstruct the embodied information in the specific design of the ancient textile finds. The method was applied to significant, and excellently preserved textile finds from the 1st millennium BC in Xinjiang, Western China. In the six consecutive phases of the methodology, the ancient clothes were scientifically reconstructed, analysed, reproduced, and the reconstructions were tested and performed on the human body. The collected primary data were structured into comparable data sets (Figure 1) (Beck 2018, 26-61).

Based on the archived data in the design memory of the excellently preserved textile finds from Xinjiang, this article highlights how an innovative design idea restructured the entire craft, pioneered new clothing concepts, and laid the foundation for our modern clothing production.

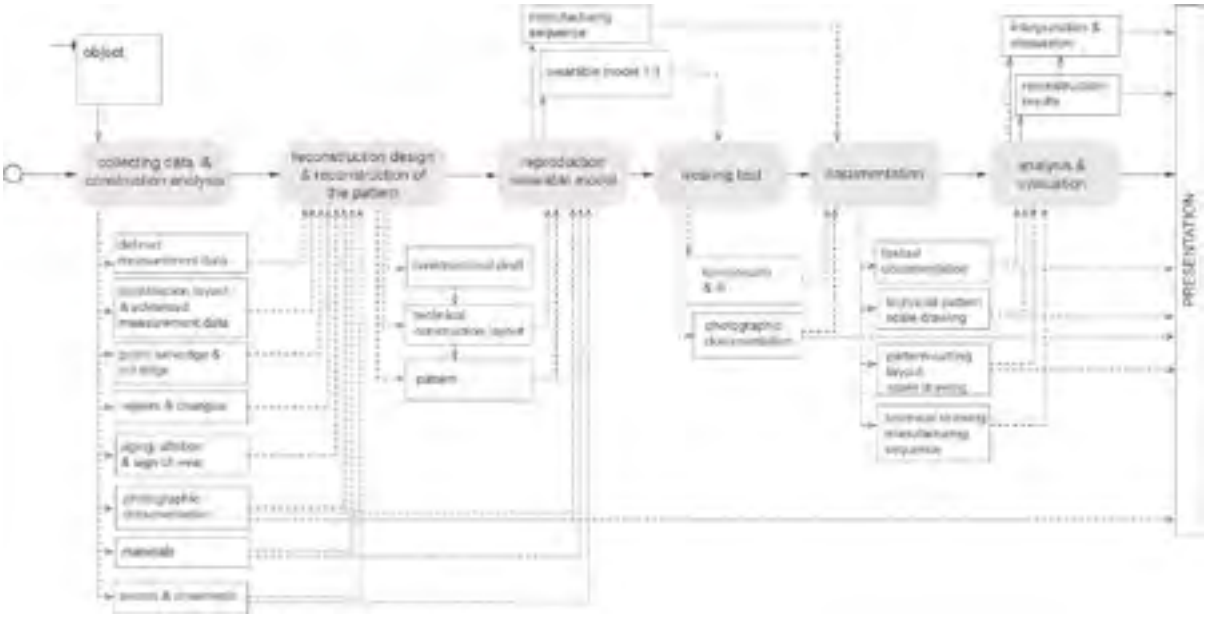

Figure 1. Diagram of the six consecutive phases of the methodology: grey areas visualise actions executed within the method, framed boxes representing the acquired research results (Methodology and diagram: Ulrike Beck)

3. The highs and lows of ancient clothing production directly on the loom

At the beginning of the 1st millennium BC in Xinjiang, garments were directly woven on the loom. For this purpose, each separate construction piece of a garment was already shaped during the weaving process (Beck et al. 2014, 224–235; Beck 2018, 62–75, 78–88, 154–222). Thus, for example, to produce a pair of woollen trousers, both trouser legs and the crotch piece were right from the beginning woven on the loom into the right shape and size and only then sewn together to produce the final garment (Beck et al. 2014; Beck 2018, 62–75, 78–88, 154–222; Beck and Jess 2021).

This time-consuming approach required considerable planning and foresight: While weaving the fabric, all the desired details and requested shapes and measurements had to be adequately included in the textile to ensure that the design and construction of the three-dimensional garment would function properly (Beck et al. 2014; Beck 2018, 154–263; Beck and Jess 2021). Therefore, the different phases of the production process – the weaving, the construction and the fashioning of the garment – were completely interconnected disciplines and could not be processed independently. Thus, the entire manufacturing process was likely realised either by one person or in close cooperation on one production site. (Beck et al. 2014; Beck 2018, 62–75, 78–88, 154–222.; Beck and Jess 2021).

A remarkable advantage of this technique was the possibility to decorate the clothes with complex ornaments and patterns that could be directly woven into specific positions of the final garment. Nevertheless, this method also had two significant disadvantages: By weaving the clothing shapes directly on a loom, the entire concept and planning of the garments had to be done right at the beginning of the manufacturing process. Once started, the craftsman had to strictly maintain the initial concept to ensure the final garment would function. Possible construction mistakes in the various garment pieces were only verifiable when the pieces were finally put together to the finished product, but not separately during the weeks or even months-long time-consuming weaving process (Beck et al. 2014; Beck 2018, 214-215; Beck and Jess 2021).

Furthermore, the loom as a tool is best suited to producing two-dimensional textile surfaces. Thus, for technological reasons, the form weaving offered only a few simple options for the three-dimensional construction of the garments (Beck 2018,156–159; Beck and Jess 2021). Consequently, those garments only consisted of a few basic geometric shapes (Figure 2) and their aesthetic was primarily created

through sophisticated patterns and ornaments (Beck 2018, 78–88, 156–159; Beck and Jess 2021).

Figure 2. Scientific reconstruction of a pair of woollen trousers (2003SYIM21:19) and a woollen poncho (2003SYIM21:4/1) from Yanghai, manufactured around 1000 BC in Xinjiang. Both garments consist of only a few basic geometric shapes directly shaped on the loom during the weaving process. Left and middle: wearing test with the reconstructed models; right: construction layout of the garments (Reconstruction and technical drawing: Ulrike Beck, photographs: Martin Jess, model: Juan Felipe)

4. A remarkable idea leads to the division of labour, specialisation in the craft and trade with intermediate products

Nevertheless, an unexpectedly clever idea replaced this time-consuming and static clothing production on the loom: the idea to cut the handwoven fabrics. This idea was exceptionally innovative because it intended to destroy an exquisite, handmade product to manufacture it into something new. Furthermore, the concept of manipulating the fabric's shape after the weaving process by cutting it into a new pattern would revolutionise the entire craft (Beck 2018; Beck and Jess 2021).

For the concept, new trimming techniques were needed to stabilise the cutting edges of the handwoven fabrics. Those developed in only a short time and were quickly implemented in a wide range of variations (Beck 2018, 163–167; Beck and Jess 2021). In the second half of the 1st millennium BC in Xinjiang, the separate construction pieces of a garment were already cut out of larger fabrics. Thus, the new approach to separate the weaving from the three-dimensional construction of the clothes had already started. Consequently, shape-neutral materials could now be produced independently and eventually processed further as required. Accordingly, a piece of fabric was no longer just one defined part in an already planned garment. Instead, a fabric had potentially many different functions and could be processed and changed as needed (Beck 2018, 167–170).

The new strategy started seemingly simple but evolved quickly. For example, around 500 BC in Xinjiang, a woollen tunic was produced out of one single six metres long fabric with only three cuts, and the four pattern pieces were trimmed and sewn together (Figure 3) (Beck 2018, 165–167). Only 600 years later, in the 1st century AD, complex woollen and silk garments were already produced in the region. They consisted of at least 15 and up to more than 30 differently designed construction pieces (Beck 2018, 154-211). This new concept was a pioneering strategy to manufacture clothes.

Separating the weaving process from the three-dimensional construction of the garments laid the foundation for division of labour and specialisation in the craft. Textile craftsmen were now able to focus on just one of the two areas within the clothing production. Consequently, they could develop and refine their skills, cooperate in the production process, and open up space for differently oriented production sites. As a consequence, trading with intermediate products such as various fabrics or yarns became beneficial. Since loom-shaped construction pieces were so explicitly produced for a particular garment, it is improbable that they have been traded. Instead, it was preferable to manufacture and finish the entire garment on one production site. In contrast, with the new strategy, the trade with exquisite fabrics and yarn between different production sites seemed very enriching. Moreover, it would increase the variety of the materials, patterns and shades used for clothing production and lead to an exchange of knowledge (Beck 2018,167-187; Beck and Jess 2021).

Figure 3. Scientific reconstruction of a woollen tunic (86HWM-NN-1) from Wupu, produced around 500 BC in Xinjiang. The tunic was produced out of one single six metres long fabric with only three cuts. Left and middle: wearing test with the reconstructed model; right: construction layout of the garment (Reconstruction and technical drawing: Ulrike Beck, photographs: Martin Jess, model: Frederike Doffin)

5. A new fast and dynamic strategy pioneers the way from decorator to architect

This new strategy had another entirely different advantage: It accelerated the design and construction process from the initial concept of a garment to the finished product in a groundbreaking way. Construction concepts could now be verified and adopted much faster because the garments were constructed and produced from finished fabrics. Whereas by shaping the textile pieces on the loom, weeks or even months passed, with the new strategy, a design idea could be implemented within just one day, a fraction of that time. Furthermore, discrepancies could be verified during the construction process already because the separate garment pieces could now be adjusted or cut again. Consequently, the design concept of a garment could be implemented, tested, and optimised more quickly. As a result, a design idea could be further improved while still being realised (Beck and Jess 2021). Thus, the production process became significantly more dynamic and adaptable. These different strategic components pioneered a new distinct design discipline: the three-dimensional construction of the garments as an art form (Beck 2018, 154-211; Beck and Jess 2021).

In the 1st century AD, the garments in Xinjiang already showed an extraordinary degree of abstraction in their design. Also, the three-dimensional construction of the clothes had developed enormously (Beck 2018, 170–177). The dynamic production process and the verifiability of the design concepts lead to a significantly better adaptation of the clothes to anatomy and motor function. Consequently, the human anatomy was now clearly reflected in many different details in the three-dimensional constructions of the garments. Thus, the functionality of the clothes achieved an entirely new quality and exquisite balance and fit when worn (Figure 4) (Beck 2018, 177–188, 195–198; Beck and Jess 2021).

While using shape weaving, the aesthetic of the clothes was achieved through colourful patterns and ornaments. Instead, now, with the new strategy, the construction concepts themselves became a distinct form of expression. Beyond the exquisite fit and functionality of the clothes, the garment's three-dimensional construction was also used to play with different shapes. Now, cascading woollen tunics would elongate the human silhouette (Beck 2018, 130-152, 189-198). Also, elaborately composed and finely lined narrow cuffs and standing collars were included in the design of the garments (Beck 2018, 184-198). Heavy woollen skirts with hemlines folded in hundreds of delicate pleats would float in slow undulations around the body and change direction with every step (Beck 2018, 192-195; Beck forthcoming 2021). Translucent silk fabrics would artfully cascade around the body and move like a fine mist. Even functional seams between different construction pieces were used to draw subtle lines into the fabric, like delicate leaf veins in overlapping silk petals (Figure 4) (Beck 2018, 184-188, 195–198; Beck and Jess 2021).

Caused by all the improvements in the production process, in the 1st century AD in Xinjiang, the exquisite design of the garments already embodied the idea to design clothes explicitly for motion (Beck 2018, 195-198; Beck and Jess 2021). This concept was an advanced step in clothing production: It was the idea to utilise the strictly logical construction of the garments as an independent, sculptural art form of expression. Furthermore, it was the idea to design for the intimate interaction of the garment with the moving human body. Although it originated as a consequence of a technical and structural shift in the production process, this new concept marked the beginning of craftsmen in Xinjiang's construction of clothes as an advanced art form, and as we know and use it today in modern clothing production (Beck and Jess 2021).

Figure 4. Scientific reconstruction of a silk blouse (95MN1M5-23) and a silk wrap skirt (95MN1M5-18) from Niya, produced in the 1st Century AD in Xinjiang. Both garments were cut and constructed of different delicate silk fabrics and illustrate an extraordinary degree of abstraction in their design. Above: wearing test with the reconstructed models; below: construction layout of the garments (Reconstruction and technical drawing: Ulrike Beck, photographs: Martin Jess, model: Deva Schubert)

6. Conclusion

The seemingly simple idea of cutting into a fabric to manipulate its shape had profound effects and consequences far beyond the textile craft that are still essential today.

This idea laid the foundation for new, efficient production concepts in the ancient textile industry and restructured the entire craft. It was crucial to improve and replace the static and time-consuming clothing production on the loom used in Xinjiang at that time.

By separating the weaving process from the three-dimensional construction of the garments, cutting fabrics laid the foundation for division of labour, specialisation in the craft and trade with intermediate products. On top of that, it accelerated and enhanced the design and construction process in a groundbreaking way: design ideas could now be further improved while still being implemented. Thus, clothing production became significantly more dynamic and adaptable. The dynamic production process and the verifiability of the design concepts lead to a significantly better adaptation of the clothes to anatomy and motor function.

Furthermore, the three-dimensional construction concepts themselves became a distinct form of expression, and the intimate interaction of the garment with the moving body became a crucial design element.

Even though presumably designed to change and reorganise a production system, this groundbreaking innovation in ancient clothing production laid the technological and the intellectual foundations for a new design discipline, which is still essential today: the concept to produce clothes by tailoring them.

Clothing has been central to humanity for many millennia and is deeply interconnected with the cultural, social and economic environment. This remarkable phenomenon from the ancient textile industry in the 1st millennium BC in Xinjiang highlights how profound and far-reaching the effects of changing a design strategy and reorganising a production system can be for society. Understanding clothing and its interdependency on our society are crucial to reinvent ourselves consistently and break new ground by designing our future.

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Ulrike Beck leads the BMBF-funded research project InnoTexGes at the University of Arts Berlin. She interlinks design and textile research with data science and applies innovative scientific methods on material culture to reveal new insights into clothing production strategies.

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