Experiment and knowledge base: bringing historical textile workers together

The author describes setting up and carrying out of a large scale experiment into spinning. The experiment analysed the possible factors influencing the quality of the thread: weight and moment of inertia of the spindle and the human factor.

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■ **Fig. 1** Group photo of the textile forum participants in Eindhoven

Working in historical textile crafts can be a very lonely affair. While textile in historical times was undoubtedly the most important means to show off wealth and taste – as witnessed by pictures, texts, inventories and surviving textile works – the occupation with textile crafts in modern times has gained a somewhat demeaning reputation. Textile work is often seen as an undemanding pastime for frustrated housewives and the like. This view of textile crafts as something low in both status and material worth is further advanced by today's very cheap mass-produced textiles and clothing. This view is also advanced by a phenomenon regarding historical events, where badly made textile wares, made using inappropriate materials and much simplified historical techniques, can be found on offer for little more than the cost of their materials.

Importance of the preparation process

In direct opposition to this modern view of ancient textile crafts as a simple additional task for women stands the fact that for manufacturing objects like the fine, exacting textile works which still survive today, three things are needed: a very high level of skill, expensive material and massive amounts of time. This is a fact often not made clear when textile works are concerned. While nobody would talk about smelting steel as a basic blacksmith's ordinary task, preparation of fibres – both wool and flax – and the production of spun yarns are often only seen as an aside to a normal woman's housework, even though the yarns are the basis for textile work just like smelted steel is the basis for metalwork. Both the process of preparing and spinning fibre into yarn and the process of preparing ore and smelting it into iron are first steps for a many following processes. Both iron smelting and spinning are not single process, but rather consist of a number of actions requiring knowledge of materials and the best techniques. Before the actual smelting and spinning take place, the raw materials – raw ore or fleece – has to be chosen and processed: the ore broken up into suitably small pieces and then roasted, the fleece sorted by quality, cleaned and carded or combed. These preparatory steps already determine the amount and quality of the iron or yarn respectively.

Of course iron smelting and spinning are not totally comparable: It is perfectly possible to spin during breaks in other occupations, hand spindles are portable and can be used for a short time and put away again – unlike furnaces - and spinning yarn certainly requires fewer tools than the smelting process. However, just like smelting is a very important part of iron work, spinning is a very important part of textile manufacture. Yet spinning as a process has not been a focus of research or of archaeological experiments as much as iron smelting, as an arbitrary example can show. When searching the online bibliography part of the database at www.publicarchaeology.eu, a keyword search with the search term "iron smelting" yields 233 entries, while the search term "spinning" has only one single result (date of search January 18, 2010). In the keyword list, "spinning" is not listed separately, while "smelting" is. These differences in treatment are symptomatic of a very large difference in attention given to spinning compared to other preparatory processes. So what do we know about spinning with a hand-spindle?

A search for experiments comparable to those in the metalwork field quickly shows that there is no large dataset of comparable data for the spinning process. The experiments or tests that have been done cannot be linked to each other to get a larger database, since they are vastly different in setup and aim – different fibres, different preparations, different spindles, different ways of spinning, differing means of documentation and publication. Spinning is often shown and sometimes taught at fairs, exhibitions, events and in open-air museums as an easily demonstrated textile technique, but this is done without even knowing what part of the setup influences the yarn in what way. Is the spindle (or its main part for spinning properties, the spindle whorl) more important than the spinner? Is the fibre a rather large or a rather small influence? How much can thread be influenced by these

■ **Fig. 2** Spindles with clay whorls used in the experiment. Top whorl 52 g and MI 41, bottom whorl 15 g and MI 5 factors? What determines a spindle whorl – is it the weight alone, the moment of inertia (MI) alone, or a combination of both? Is it possible to link the archaeological finds of spindle whorls to the surviving fabrics? There can be no clarity on any of these points without sufficient amounts of comparable data – and since this great ignorance concerns making yarns, the very first step in textile production, our lack of understanding is indeed severe.

To gather good, comparable data, a large-scale spinning experiment was designed, starting with an analysis of the possible factors influencing the thread. The spindle contributes two factors: its weight, usually given in archaeological publications, and its moment of inertia. A spindle's or spindle whorl's moment of inertia determines its rotational properties by definition, since the MI is given by where the main mass of the spindle is in comparison to its axis of rotation. The use of the MI in evaluating and describing spindle whorls was first researched by André Verhecken and published in NESAT X in Strand et al., forthcoming .

In addition to these two values, which may possibly influence the thread, the fibre material is the third possible influence. Fibre type, coarseness and fibre preparation can be vastly different, resulting in different approaches to spinning the fibre into yarn and variations in the yarn. Last, but in no means least, the spinner himself or herself will influence the yarn type and thickness.

This influence of the spinner also constitutes the main difficulty in designing and running an experiment about spinning with drop spindles. However, a simple, well-defined task like spinning wool on a drop spindle is excellent for showing how large the influence of the individual worker can be. For any archaeological experiment, the "human factor" constitutes a problem, since individual humans will handle tools differently, act differently and work more or less efficiently and accurately depending on their personality, background and the practice they have in the particular field of work. And since fitness levels may vary from day to day, even engaging the same experimenter with the identical set-up again will not necessarily lead to the same experiment outcome.

		weights	variance
15/41	(reference, clay)	15,4 - 15,9 g	0,5 g
5/41	(plywood)	5,1 - 5,5 g	0,4 g
15/188	(plywood)	15,7 - 16,8 g	1,1 g*
15/5	(clay)	14,2 - 14,5 g	0,3 g**
52/41	(clay)	51,0 - 52,4 g	1,4 g

■ **Table 1** Variances in weight between the single whorls of each category (*heavier/**lighter than aimed for)

Setting up the experiment

For an evaluation of the four factors determining the spun yarn, the experiment has to yield enough data for a comparison between different spindle weights, spindle MI values, different fibres and different spinners, requiring a large-scale experiment setup.

The two spindle factors, weight and MI, can be isolated easily by calculating/designing and manufacturing different spindles. As the reference point, a spindle whorl from a London find, dated 1125-1150, was chosen. The spindle whorl is a ceramic cylinder with an MI of 40 and a mass of 16 grams. This whorl was chosen because clay is still easily available today, its weight and MI lie more or less in the middle range of whorl finds from Britain in the 12th century, and because different MI and weight combinations are easily calculated for cylindrical forms. In addition, the author thought that cylindrical clay whorls would be quite undemanding to manufacture.

Around this reference whorl, four other experimental whorls were designed, two of those with the same MI but different weights and two with the same weight but different MI. With this isolation of the two defining factors, it is theoretically possible to show the influence of weight and MI on the resulting yarn.

After calculating the whorls, some test pieces were formed freehand and fired to indicate the shrinkage of clay and variances in the whorls. It soon became very clear that the variation between hand-formed whorls, even if trying to make exact cylinders, was huge, owing to the rather slim but tall, tower-like form of the designed whorls. In addition, shrinkage and final density of the clay would vary with slight changes in the wetness of the clay. After some tests, manufacturing identical whorls from clay without help of any specialised tools proved to be quite impossible. As a solution, special tools slightly resembling cookie cutters were made from copper-alloy metal and those were used to cut out the whorls during one single session, using clay from a fresh factory-prepared batch. More than 20 spindle whorls from each type were made and whorls were then sorted by weight to remove any outliers. This procedure kept the variances between the single whorls used in the experiment quite low (see **table 1**).

To allow for the very low weight compared to a high MI in two of the experimental whorls, these were cut from plywood, which posed fewer problems. Variances in wood density, however, also led to small irregularities in weight.

All spindle whorls were glued to bamboo chopsticks, with the bottom of the spindle whorl in the same position on the spindle stick. Each spindle was given an ID number. For the experiment runs, each spindle was pre-wrapped with a starter yarn from bright red wool and weighed including this starter thread. A second weight measurement was taken after the spinning session to give a first impression about the amount of fibre spun and, in comparison to before and after measurements of the fibre handed out to the spinner, to show if any fibre was lost due to discards during the process (and if yes, how much). Fibre for spinning was handed out in portions of approximately 10 grams. In case one portion was not sufficient, spinners received additional fibre packages.

To pinpoint influences on the thread by the fibre, two different kinds of wool were chosen, a fine long-staple wool, carded and combed (Merino) and a medium coarse wool, carded (Tyrolean Bergschaf). Both wools were prepared industrially to eliminate differences in preparation that might influence the spinning procedure. The preparation as carded and combed top (all fibres aligned in one direction) and carded batt (fibres not all perfectly aligned) are the usual preparations for Merino and Bergschaf wool. Two different wool fibres were chosen so as to have two kinds of fibre similar enough to each other for comparison – since differences between the fibre categories linen, silk and wool are huge – and because most modern hand spinners have only or mostly experience with spinning wool.

■ **Fig. 4** Different stances and different methods to hold the fibre supply when spinning with the reference whorl

To get comparable data, each of the participating spinners used the same spindle type and fibre combination at the same time. This was because of the possible influence of the spindle type sequence on the results (including changes in yarn output due to practice), but also to avoid frustration arising if spinners with a less efficient spindle compared their yarn output to that on more efficient spindles. Thus the number of spindles from each of the five types had to be sufficiently large. To eliminate fluctuations in yarn output due to short-term problems (like "clumsy streaks"), spinning time with each spindle/fibre combination was long enough to give each spinner the chance to get used to the spindle and still get a reliable, more or less average output. With an estimated ten to twenty minutes for acquainting oneself with a new spindle, minimum spinning time after this should be thirty minutes to get reliable data. As a compromise between very long spinning time for each spindle for good, reliable data and short spinning time, making it easier to find enough spinners willing to participate, one hour spinning time was chosen.

■ **Fig. 3** One spinner giving additional twist to the spindle while spinning during the experiment

Since the magnitude of the human factor in the spinning process had not yet been determined, the experiment was designed to accommodate up to 20 spinners spinning simultaneously. A full experiment run with 20 spinners and each of the two different fibres on each of the five spindle types results in 200 data points from 200 person-hours spinning time – ten for each spinner, one hundred for each fibre, forty for each spindle; allowing comparison between the yarn samples to pinpoint the influence of each of the four factors if that is possible at all.

These basic requirements for the experiment design result in logistical problems. For the experiment, a large enough location to accommodate up to twenty spinners was needed, including space to store the equipment for spinning and documenting. The biggest logistical problem, however, concerned the participants. While a professional spinner in the Middle Ages may have been used to spinning for several hours each day, this is not the case for today's part-time spinners. To ensure approximately the same quality in the spinning process, the daily spinning time for the experiment was limited to two hours, with a break between the two one-hour spinning sessions. This means that the total time of ten hours is spread over five consecutive days.

Because the experiment only delivers viable data if all spinners work with all spindle/fibre combinations, and since best results can be expected if the spinners already have some experience with spinning, spinners had to be competent enough to spin a reasonably even thread over two hours of consecutive spinning time. Thus the main problem was getting enough competent spinners together for five days.

European Textile Forum

To solve this problem, the concept of a meeting for historical textile crafts persons and scientists was developed and named the European Textile Forum. To entice both professionals and Living History enthusiasts working with textiles to come, the Forum was designed as a six to seven day event, with a combination of evening lectures from professionals working with historical textiles (both analysing historical textiles and reconstructing or recreating them), free time to exchange tips, tricks and techniques or hold a small workshop for colleagues and a weekend market to buy tools and materials for historical textile crafts. This combination of possibilities and activities does not only make running a large-scale experiment feasible, but also aids in networking and as a knowledge base. Exchange between people working the crafts and scientists analysing surviving specimens allows both sides to profit from each other's knowledge.

■ **Fig. 5** Spindles with clay and plywood whorls used in the experiment. Top reference spindle, whorl 15 g and MI 41, middle whorl 5 g and MI 41, bottom whorl 15 g and MI 188

To make the most of the knowledge base and knowledge exchange, the Forum was designed as an open event, meaning that everybody interested in historical textile crafts would be welcome. This included, for example, living history participants, artists working with historical techniques and also the general public. The evening lectures were very well received and offered a variety of topics, including theories and structures of weaving, report on extant garments and garment fragments that are currently analysed and evaluated, and experiments concerning textile tools and crafts.

Without doubt, the perfect venue – if not the only possible type of venue – for such an event is an archaeological open-air museum, and the Historisch Openlucht Museum Eindhoven kindly offered the opportunity to run the Forum in September 2009. This first Forum was a complete success, making the first large-scale spinning experiment possible. Fifteen spinners participated in the experiment, giving enough samples of spun yarn to attempt an interpretation of the type and amount of influences.

The human factor

Though the laboratory analysis will be needed for the full results, some preliminary results can already be presented. First of all, the weight of the whorl only determines the strength of the thread, and this is the case only if the spindle is not supported (held in the hand of the spinner or set into a bowl or onto a surface); there is no direct connection between the thickness of the thread spun and the weight of the spindle. In contrast to that, the ratio between MI and weight of a given spindle seems to be connected to a tendency for the spinners to produce soft and thick yarn (for a high ratio) or hard-spun thin threads (for a low ratio). However, what might be the most important preliminary result is that the yarn samples do show that every individual spinner has a certain range of thread types and thicknesses that can be called the "comfort zone". The size of this comfort zone can vary; a spinner with a very small comfort zone will have a severely limited thickness range and more or less just one type of thread, while a spinner with a large comfort zone may produce very different threads, even with the same tools and fibres. Influencing a spinner to drop out of that comfort zone by supplying an unusual spindle is very hard and takes a seriously unwonted spindle that will behave very differently from the spinner's normal spindles. Even with the very unwonted spindles that were supplied, like the spindle with an MI of only 5 and a weight of 15 g, most of the spinners tried to find a way to cope with the spindle while still producing thread inside their comfort zone instead of making a different yarn that might be better suited to the spindle supplied.

Thus, while different spindles might influence a spinner depending on that individual craftsperson's comfort zone, it became quite clear during the experiment that the spinner is the element with most influence in the experiment setup. Thread thickness or type could not be foreseen from a given spindle-fibre combination. Spinners with a larger comfort zone would produce a larger range of threads, while those with a small comfort zone or less easily influenced by the tools would produce almost the same thread on each of the spindles. Furthermore, the spinners adapted very well to even the most extreme experimental spindles with very high or very low ratios of MI to weight.

Full analysis of the thread samples will show the influences of spindle, fibre and spinner more clearly, also giving evidence for the efficiency of each spindle-fibre combination for the individual spinners. From the results of this first spinning experiment, follow-up experiments can be designed to shed light on more aspects of fibre, spindle and spinner during the spinning process.

With the success of the first Forum, the European Textile Forum will be held again in the future. The aim is to turn it into a yearly event, alternating between different venues in Europe to give people from all over Europe a chance to attend once in a while without having a very long trip. Information about the Forum can be found on the website www.textile-forum.org. The organisers, Sabine Ringenberg and Katrin Kania, can be contacted via this website as well.

Summary

Experiment und Wissensbasis – Historische Textilexperten kommen zusammen

Die Autorin beschreibt die Vorbereitungen und die Durchführung eines umfassenden Experiments zum Thema Spinnen. Die Untersuchung analysierte die möglichen Einflussfaktoren, welche die Qualität von Fäden beeinflussen: Das Gewicht, das Trägheitsmoment sowie den menschlichen Faktor. Fünfzehn Textilexperten nahmen an dem Experiment teil und arbeiteten innerhalb eines festgelegten Zeitrahmens mit identischen Sortimenten von Spindeln. Die vorläufigen Resultate zeigen, dass es keine direkten Beziehungen zwischen der Stärke des gesponnenen Fadens und dem Gewicht der Spindeln gibt. Das Verhältnis zwischen dem Trägheitsmoment und dem Gewicht scheint aber dann einen Einfluss auszuüben, wenn ein weicher und dicker oder ein hartgesponnener dünner Faden hergestellt werden. Am wichtigsten ist jedoch die Feststellung, dass die hergestellten Garnstücke aufzeigten, dass jede individuelle Person beim Spinnen eine bestimmte Spannbreite von Fadentypen und Dicken herstellen konnte, welche als ihre jeweils bevorzugte „Komfort-Zone" bezeichnet werden mag. Die einzelnen arbeitenden Menschen haben damit den größten Einfluss auf das Resultat.

Expérience et savoir-faire - Confronter le travail des spécialistes des textiles historiques

L'auteur décrit le déroulement d'une expérience à grande échelle sur les techniques de filage. L'objectif était d'analyser l'impact de différents facteurs sur qualité du fil : le poids et l'inertie du fuseau et les facteurs humains. Quinze fileurs ont participé à cette expérience pour laquelle ils avaient les même délais et des séries de fuseaux identiques. Les résultats préliminaires démontrent qu'il n'y a pas de lien direct entre la finesse du fil tissé et le poids du fuseau. Le ratio entre la phase d'inertie et le poids semble agir sur la rugosité du fil. L'échantillonnage des différentes fibres obtenues démontre surtout que chaque fileur obtient sa propre gamme de fil, que l'on peut considérer comme sa "zone de confort", ce qui signigie que le facteur humain est le plus influent sur la production.

■ **Katrin Kania** studied Archaeology of the Middle Ages and Early Modern Time at Bamberg University, specialising on textiles and clothing in connection with experimental archaeology. After writing her phd thesis about garment construction in the Middle Ages, she now works as a freelancer, offering workshops on historical textile techniques and custommade garment reconstructions.