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Appendix: Expanded Experimental Design

This appendix expounds upon the reasoning motivating each decision within the experimental design. These details may also provide the basis for replication by another practitioner, or as a basis for enhancement or expansion of the experiments presented herein. In keeping with the goals outlined within the SMART methodology designed by Malcolm-Davies (2023), this serves as a reference to ensure sufficient clarity within a written form. Ideally, future contributions will allow for widely available video submission as well.

Materials

The presence of chalk-based textile tools in the material record necessitated using this as a material for replicating spindle whorls. Given how rare it is in the archaeological whorl assemblages worldwide, it would contribute usefully to textile studies more broadly. Chalk was recovered from Wiltshire (around Swindon, UK) and Hampshire (Winchester, UK) without any prior selection criteria. It was anticipated to make up to three complete whorls, of various sizes, so at least six blocks of chalk would be required. Eight were gathered for this experiment and photographed in their unaltered state.

Clay whorls were also noted in the archaeological record, but there was some doubt by the original investigators whether the smaller ones were instead beads, and if the oblong shaped whorls (Whorl F) might be something else entirely. Since there was doubt regarding the spindle whorl categorisation made by the original excavators, they were selected to feature in this experiment to provide a practical reasoning to recategorization, if pertinent. To create a balanced view of spindle whorls in the Danebury assemblage, it was important to replicate three complete clay whorls of research interest. DAS®, an air-dry clay, was used for the creation of experimental clay whorls as it has been used by the author in previous experiments (see footnote 2), and there was an understanding of shrinkage expectations.

Craft dowel sticks were used for the creation of spindle sticks and widely available for purchase. These were made of the same type of easy to carve wood, either balsam or pine, which were already of the required parameters of the experiment, in terms of diameter and length. It was possible to source finely made, lathe-turned spindle sticks, but due to costs, an alternative was sought. Each archaeological whorl selected had different perforation sizes, so multiple sticks would have been required. The additional benefit of having hand carved spindle sticks was that it might reveal insights into the experiential component of spinning with rough-hewn versions, and it might create visible wear marks inside of the perforation of each whorl—the chalk would be an ideal material to show this type of wear.

The selection of wool relied on two factors, the first being cross over from the experiment conducted by Kania (2015). The participants were given two types of wool, bergschaf and merino. They used carded batts for the bergschaf and combed for the merino, but stated they should have used one preparation only or both methods for each wool type (Kania, 2015). This decision was made to replicate the experience of using each type of wool in an experimental capacity, and to contribute additional insights regarding the suitability of this wool selection. Given the retrospection provided by the author, it was also decided to create consistency in fibre preparation as well. Both wools were found at World of Wool (www.worldofwool.co.uk) as combed top preparation.

A third wool was selected, North Ronaldsay, following in concept from the approach adopted by Ryder (1981). Soay has been used as an acceptable choice for prehistoric textile experiments, given their long lineage in the region and without significant breeding schemes focussing on genetic improvement. In the same vein, North Ronaldsay has a similar acceptability for these types of experiments and has a significant presence in the prehistoric record (Balasse, et al., 2019). Due to its double coated nature, it may also deliver insights that the woolly breeds, bergschaf and merino, cannot provide. This comprised the second factor for achieving a more actualistic approach to the experimental design. As well, it would provide relevant results to the few examples of archaeological evidence that does exist in the UK for this period (see Beamer, 2022, pp.23-30, and it could be a useful comparison with well-known assemblages, like that of the Hallstatt mines (Grömer, 2016).

The staple length of each wool used was approximately 5 in (12-13 cm), though North Ronaldsay had more variation (some locks as short as 3 in/8 cm). This is generally regarded as a short wool, since long wools—such as Leicester long wool, Lincoln long wool, or teeswater—can have a typical staple length of 10 in (as well, they may also be shorn twice a year). This particular length is extremely versatile to a hand spinner, being suitable for both combing for worsted preparation and spinning, and carded for rolags and woollen spinning. Preparation was not specifically targeted in this experiment, but it is worth stating its importance in the spindling technique and how the yarn appears and behaves throughout the subsequent steps of the *chaîne opératoire.*

Preparation Methodology

For all whorls, the archived parameters—that recorded on the microfiche—and the published illustrations were consulted (see Beamer, 2022). Though it was not possible to make completely accurate versions, all efforts were made in replicating the parameters exactly. In both the chalk and clay, this was feasible. The chalk versions look visually dissimilar, emphasising the potential that surface wear may have changed they looked over time, but they still reflected the

measurements recorded in the archive and it would not interfere with the results of this experiment. As well, it afforded the opportunity to assess how well chalk whorls wear. Since the chalk whorls were made through a reductive process, beginning with a well carved specimen should reveal any wear damage over the course of the experiment. A utility knife, putty spatula, and steel awl were used to carve each whorl, being weighed periodically throughout the process to create an accurate replica.

Clay objects are produced through an additive process, but since there would be a reduction of mass through the drying process, all whorls were made with a 30% weight buffer. While the mass was overcompensated for, the measurements were not. This was due to the behaviour of air-dry clay and not needing to fire it as a final step in the process, which can change other metrics. The final clay whorls appeared remarkably similar to the original versions.

Following the retrospection by Kania (2015) regarding the preparation of the wool samples, it was decided to create carded batts of all experiment wool. The sourced bergschaf and merino wool were made into prepared combed top via an industrial milling process. This involves industrial straightening processes with water/steam and rollers to flatten the natural crimp. To revive the natural crimp of the wool, and to make it more similar to hand processing a fleece, the combed top wools would be washed in warm soapy water, dried, and carded into batts. The North Ronaldsay was processed by hand, with an attempt to scour it sufficiently to resemble the level evident in the commercially processed versions.

Wool batts were sectioned into strips for easier handling during the spinning process. All wool samples were portioned prior to spinning, pre-drafted, then spun according to the yarn grist and spindling method. This produces a semi-worsted yarn where individual fibres have been separated from neighbouring fibres and air incorporated during the process to ensure a lighter, loftier yarn than what would be possible from a commercial combed top preparation. Though distaffs may have been used in the prehistoric past, it did not seem practical to incorporate this tool in the spinning of samples because production times were not considered as part of the overall project.

Recording Methodology

In an endeavour to make accurate and sufficiently complete records, each phase of the project was recorded with photographs, and video where sensible. Photographs were taken from the initial state of raw materials, such as chalk blocks that had been quarried, and after each progressive step of the operational sequence. Much of the process of experimental archaeology is fluid, therefore the making of whorls and the spinning process were given additional recording

protocols, for example, video. Some of the processes were recorded twice, once for the creation of a technical record, and other which would be used for social media outreach.

A written log was created for the real time recording of actions taken throughout the experiment. This aided in the specific design of the experiment and any thoughts, experiences, or modifications were written in an expositional style. This document also assisted in the writing of this article to ensure sufficient transparency in approach and outcome so that it may be repeated and/or expanded.

All spun samples were wound onto black cardstock. It was important to keep the spun samples under tension as this could change the grist measurement. These yarns were measured digitally through the programme Gimp, using the measurement tool and archaeological scale. Black cardstock gave enough colour contrast to show the fuzzy halo surrounding the exterior surface of the yarn, another important feature to record. Following Kania (2015), the later third of the sample was used for the creation of a reference collection. This collection offers guidance on how to interpret the archaeological assemblage when specialist knowledge is inaccessible.

No samples were washed in this experiment. This decision was made to keep the number of variables to a minimum and to avoid complications from arising in future experimentation where finishing techniques have not yet been explored. As a new direction for experimentation, however, exploring finishing techniques and their impact on the final grist is an important endeavour. Again, to keep the project within a reasonable scope, and to align it with previous experiments, there was no further processing of the samples after having been spun.

All metrical data from the replica spindle whorls were recorded in accordance with the practice of the original Danebury post-excavation team. This amounted to a ruler and a scale that measures to the tenth of a gram. Though it was possible to use callipers and scales using tenth of a gram, the concern was that it could yield too specific data that would not be as useful when comparing this reference collection to those already archived. As well, this rationale simplified the shapes into two typological categories, discoid and biconical, simplifying moment of inertia calculations too.

Excel was used to create a calculator for efficiently calculating moment of inertia and angular momentum. For the turn tests, angular momentum calculations were performed for each discrete iteration and recorded in a table. For consistency with Grömer (2005), the ‘turn test’ was broken into two approaches, the first showing the number of twists with multiple activation actions, and the second uses a single activation and recording the number of twists before the spindle begins to back spin.

Spindle Construction

Whorls

For each whorl, the chalk blocks were first planed by using a wide putty knife to create the two flat surfaces for the discoid shape. Since the creation of chalk whorls was a reductive process, a small margin of error was kept during the rough shaping in case the chalk began to flake or chip. The perforation was counter-drilled with a steel awl and widened to the dimensions of the archaeological whorls. This resulted in a biconical shape reminiscent of the originals. The disc-shape was cut by the utility knife into a rough, symmetrical shape based on the diameter of the complete whorl. The whorls were weighed periodically from this point to ensure the final whorl would be comparable in all metrical points as the artefactual example. Minor adjustments were made to compromise the shaping process to remain as specific to the original shape—discoid—rather than making each experimental whorl look aesthetically identical to the archaeological whorl.

The same general principle applied to the creation of clay whorls, with two exceptions. Efforts were made to sculpt the whorls to appear as identical to the original, forming the whorls to precise measurements—apart from mass. As clay dries it loses mass—in previous experiments using DAS clay, this was expected to be approximately 30% shrinkage. To compensate, 30% mass was added to the starting amount of DAS clay. This resulted in a slight discrepancy in the final clay whorls, but still considered a reasonable compromise for the overall experiment. The compromises made throughout the whorl construction protocol were deemed to be appropriate for this experiment.

Spindle shaft

All whorls had customised spindle sticks. Round craft dowels were used for convenience and expediency in the project, as well as reducing the cost of the experiment. Apart from Whorl C, which required a custom order (2.4 cm at the widest point, 0.6 cm at the smallest point), the remaining whorls had sticks constructed from the same diameter dowels (0.6 cm diameter). A utility knife was used to gently shape the two ends of the dowel into points, where the centre thickness was designed to one end rather than in the middle. All sticks were shaped and test-fitted with the whorl they were created for, and ranged in length from 28-30.5 cm. Though it was likely that prehistoric whorls were moved from spindle stick to stick as each was filled with yarn, it was irrelevant to make several spindle sticks for this experiment. As Hudson (2014, p.7) correctly indicated, spindle shaft length can impact the handling of the spindle during the experiments and can be a facet reviewed in future replications.

Spindles

For this experiment, all spindles were assembled with the whorl placed on the lower portion of the spindle stick. This aligned with the previous experiments and reduced the number of variables investigated. Future experiments may explore whorl placement and how this might impact the turn tests in particular, and the resulting yarns more generally. Scrap leader yarns were attached to all spindles for ease of use, though not explicitly necessary, again to align with previous experiments. This did not contribute negatively to the overall experiment.

Spindling techniques

All supported spindling methods were coordinated with one hand turning the spindle and the other hand drafting the wool supply. The yarn was formed by drafting against the twist, where extra rotations of the spindle built up more twist than was necessary, then the opposite hand spread the prepared wool into a drafting triangle to manage the grist. This resulted in a stop/start approach, where one hand managed the twirling of the spindle while the other hand pinched the twist from entering the wool supply, then when extra twist had accumulated, holding the spindle and drafting the built-up twist into the newly drafted fibres.

The long suspension method was used for all suspended spun samples. A half-hitch loop was used to facilitate this process as it meant that the same spindle sticks could be used for both spindling techniques. It was decided to use a long suspension method, where the spindle operated at a distance from the hand, to differentiate it from short suspension or in-the-hand suspension (often associated with medieval spindling) and to align with previous experiments. This approach also ensures that the spindle bears the full weight of the apparatus and freshly spun yarn, thereby testing the experiment objectives without interference of the spinner. The spindle was flicked into rotation, then allowed to free hang while both hands manipulated the rising twist and drafting triangle.

Wool was managed in the hand rather than on a distaff as it was irrelevant to the research questions. Each wool sample was pre-drafted and picked clean of errant vegetable matter and nepps during the spinning process. The final samples had variable mass due to this process, but which otherwise had no bearing on the results.

Turn tests

The original turn tests used unknown yarns for the process; linen was chosen for this project since it is a fibre which is usually spun commercially in the s-direction (anti/counter-clockwise), making it a straightforward choice for z-spun yarns. Since the samples were all spun in the z-

direction (clockwise) for the experiment, no new variables would be introduced into the hand gestures used. This strategy is also helpful for replication purposes where modern handspinners may use different tools for spinning (spindle) and plying (wheel or e-spinner), so the skillset may be considered more uniform throughout the process.

Two contrasting yarns were used in the tests to differentiate the plies for counting purposes. An unbleached linen (12/1) and silver dyed linen (16/1), spun to exacting standards of grist, served this purpose and were bought online at www.minefineweavingyarn.co.uk. Ideally, they should have been the same grist but they were available from other weaving experiments performed with the Danebury loomweight assemblage replicas. They were deemed suitable for this part of the experiment because their fine grist was unlikely to cause problems for the tests, though they were not as suitable for Whorl D as imagined. Still, it proved to be insightful in the experiment.