The Automation of Weaving: an examination of the past and future of loom design

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Introduction

Weaving is the process of interlacing two set of threads, together at right angles such that they form a unified fabric. The two sets are defined as the warp and weft, and within each set the threads lie parallel to one another. During the weaving process, the warp is defined as the set being held stationary, while the weft is the set being introduced to the warp.

The modern table loom (see fig. 3), used by home weavers for small projects and for teaching purposes, is efficient in design and simple to use. This made it an ideal model to base our design on. The loom is operated by controlling the shed with finger treadles, and incorporating the weft by hand.

Design Requirements

<table>
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<tr>
<th>Design Function</th>
<th>Weave Fabric</th>
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<td>Hold Parallel</td>
<td>Move Groups</td>
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<td>Hold Taut</td>
<td>Group Warp</td>
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<td>Support Warp</td>
<td>Weft Fabric</td>
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This loom is being designed for use by the home crafter or cottage industry, and thus must be of a size and robustness that fits their needs. It was determined that the loom must not exceed 8’ in operating height, with a 4’x4’ base. It must withstand extended cycles of operation, and its operation must be sufficiently simplistic that any weaver will be able to use it easily.

Design Concept

The final design differs from traditional looms in that the shed, the space created by the warp threads when they are moved to allow the weft’s introduction, is oriented vertically as opposed to horizontally, as is done in most horizontal ground-looms and vertical Navaho style looms. This was done to make automated weft introduction more viable and to create a loom with a smaller footprint. Initially, one arm for shuttle manipulation was considered sufficient (see fig. 4), but when calculations showed that to weave a 3’ wide fabric we would need over 10’ of overhead clearance, it was determined that splitting the arm into two components would be more efficient.

Design of Sub-functions

The shuttle system (see fig. 5) is powered by two motor-driven gears, one at each end, which mesh with a rack situated along the side of each arm. The arms will be driven up and down, meeting in the middle to exchange the shuttle carrying the weft. The shuttle will be held by two solenoids, one embedded in the socket of each arm (see fig. 6), with the solenoid pins attached to the shuttle. At the time when the arms meet, one solenoid with engage while the other disengages, and the shuttle will thus be passed.

A linear speed of 1.5 ft/sec is desired, as this would approximate a human weaver’s efficiency. However, speed may be determined by the torque capacity of the motors.

The heddle system (see fig.’s 7 & 8) will include four heddle frames, with each capable of moving independently of the other three. Their motion will be driven by bar linkages connected to rotating plates, with the plates being driven by motors.

While the heddle frames of a classical table loom move up and down, these will move side-to-side to create the desired shed.

Patterning will be controlled by the sequence the heddles move in, and this should be adjustable as long as the user has access to a computer and PBASIC.

The heddle wires (see fig. 9) are not included in the Solidworks models shown here, but will slide on from the top and lie horizontally, as opposed to vertically. There will be 250 wires per frame, with each wire capable of controlling a thread. Each thread will also be run through a 10 dent reed, which will keep them from tangling.

Reference Sources

2) Adovasio, J M; O Soffer; K Bohulav; Upper Paleolithic fibre technology: Interlaced woven finds from Pavlov I, Czech Republic, s. 26,000 years. Antiquity, Platinum Periodicals; 1996, vol. 70, no 269, p. 526-534
11) Hopper, Luther The New Draw Loom. United Kingdom, Sir Isaac Pitman & Sons, Ltd. 1912

Work Completed

The overall design of the loom has been completed. Designs for the heddle and shuttle sub-functions were developed, and were modeled in Solidworks. The construction of the shuttle system was begun, and extensive testing was conducted with the driving motors and electrical system, which is still in development. A PBASIC program for running the shuttle motors from a BOE BASIC STAMP board was written.

The electrical engineering department, computer science department, and machine shop were consulted during the course of the design’s development. Several modifications were made to the power system and shuttle system on the basis of their recommendations.

Many of the required parts were sourced, including heddle wires, materials for the heddle frames and shuttle arms, motors, a stamp board, a reed, power cords, and two solenoids. $394 of our $650 IEF budget was spent.

Extensive research was conducted concerning the history of weaving and the development of loom design from Paleolithic times to the present, and a summary was included in our thesis report.

Continuing Work

This project will be continued as an independent study in the fall of 2009. The electrical circuitry will be finalized, and the frame and major components will be built.

Progress reports will be posted at: Minerva.Union.edu/Beattyw/SeniorProject

Conclusions

The loom designed will be capable of autonomously weaving complexly patterned fabrics of 3’ width and unfixed length, and will be run by continuous rotation servo motors controlled by a logic board. The loom will fit in an average living room, and will be powered by 120v.

This project has reached a successful conclusion, and, given that the scope of the project was significantly expanded after it was begun, has made extensive progress. While it was initially hoped that a complete loom with an automated heddle system could be built during the course of this project, the development of the shuttle system was an interesting challenge that was worth the time it took to overcome it.

Acknowledgements

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