Computer Assisted Woodworking

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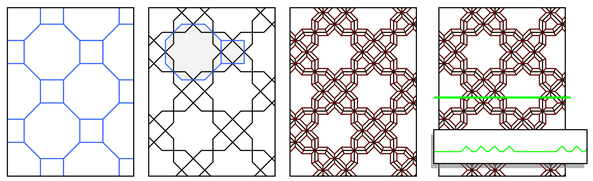
Abstract

Using computer software, an artist can design a wide variety of objects and patterns. Sometimes, the final art piece will be a print of the graphical image. At other times, the artist may want a different physical embodiment of the work. In this poster, we present a paradigm that makes the flexibility of Numerically Controlled (NC) machining available to the non-technical woodworker. We propose a machine architecture and suite of software tools that together offer a simple way of realizing computer art in wood.

To make computer-aided machining practical for home woodworking, we must provide a simple, inexpensive NC machine. The specialized machine will require custom software for generating appropriate toolpaths, and design tools that target the machine's capabilities. As an example, we built an NC lathe with a single computer-controlled axis. We then developed a set of software tools for designing Islamic star patterns and turning them into toolpaths for this lathe.

Designing Islamic star pattern



(a) (b) (c) (d)

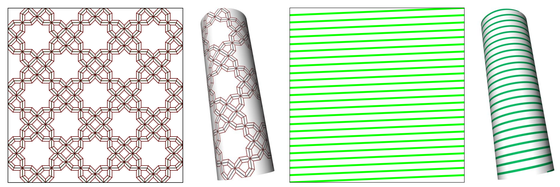
(a) A tiling of the plane by octagons and squares

(b) Motifs copied to yield a star pattern

(c) Pattern expanded in a beveled design

(d) Toolpath to machine design

Converting to cylindrical NC toolpath



(a) (b) (c) (d)

(a) Planar pattern

(b) Wrapped onto cylinder

(c) Planar wrap-around toolpath

(d) Cylindrical toolpath

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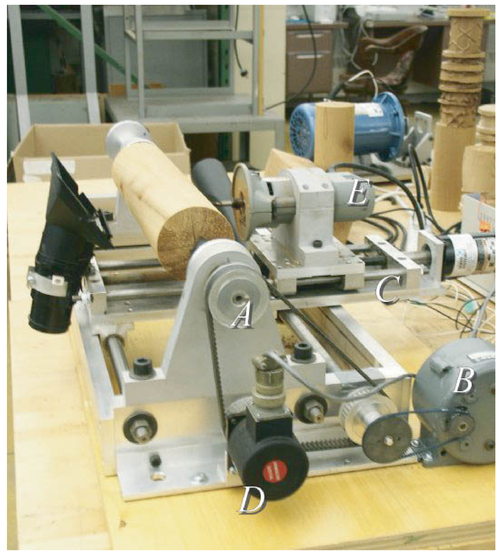
New machine architecture

Our machine mechanically links two of the three axes of an NC machine.

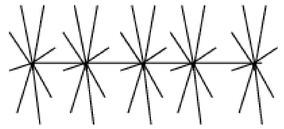
- Tool forced to follow a fixed trajectory:
  - Either by manually turning a handle or with a DC motor.
  - Machine controller does not control movement along this path.
- Controller manages only one axis of motion in response to movement along path.



Labeled in the lathe photograph are the spindle (A), a DC motor (B) driving the tool carriage (C), the encoder (D), and the router (E).

Simulation

To preview the result, we use a variant of the "mow the grass" technique, with vectors emanating radially from a line rather than from a plane.



Test Piece

Simulation

Machined part

Tool path: 38,590 tool positions.

Simulation details: cylindrical height field, 50 samples around radial axis, 1300 along linear axis.

Simulation time: 18 minutes on 866MHz Pentium III, NVIDIA GeForce 4 Ti 4200.

Machining time: 2 hours.