Current Trends of Computer Controlled Routers

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Components of CNC Routers

CNC = computer numeric controlled

CNC routers come in a variety of sizes, shapes, configurations, and price. All routers, however, consist of 3 main components:

- Mechanicals
- Electronics
- Software

Will cover the details of each of these components.
CNC Routers

CNC routers range from $2000 systems to units costing from $500K - $750K.

For years, developers concentrated on making routers faster, more powerful, and more versatile.

Today there is a trend for some manufacturers of routers to make them easier to use and more affordable.
Types of CNC Routers
Machine Centers

Routers
Point-to-Point
Panel Saws

Previously there was a difference – nowadays that difference is often difficult to determine.
Introduction to CNC Routers

Low Cost

$2,000

$2,600

$5,000 - $25,000
Types of CNC Routers

5 Axis Routers
Types of CNC Routers

Specialty Routers
Types of CNC Routers
High End Routers
EXTREME TYPES OF CNC MACHINE CENTERS - ROBOTS

Is gaining popularity due to improvements of design and control software

Does not cut faster but has quicker moves between cuts (cheaper than CNC router?)
<table>
<thead>
<tr>
<th>COMPONENTS OF CNC MACHINE CENTERS</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanics - Base</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>Electronics</td>
<td>Steel</td>
</tr>
<tr>
<td>Software</td>
<td>Composite resin / aggregate</td>
</tr>
</tbody>
</table>
MECHANICS - BASE

CAST IRON
high dampening
more expensive

STEEL
cheaper and lighter
not as good dampening

COMPOSITE RESIN / AGGREGATE
new
not as expensive
compromise
easier to setup
Basic Design Issues - Machine Configuration

Fixed Table Cantilever Arm

Fixed table is more stable – cantilever arm is less stable
Allows for larger table and parts
Basic Design Issues - Machine Configuration

Column Type With Moving Table

Cantilever arm is less stable
Allows for easily entry of parts
Basic Design Issues - Machine Configuration

Fixed Table Gantry Type

Gantry is very stable
Allows for large parts but more difficult loading parts
Basic Design Issues - Machine Configuration

Gantry Type Moving Table

Is a probably the most common configuration for all but those machining very large parts
COMPONENTS OF CNC MACHINE CENTERS

Mechanics – Drive Centers

- Rack and Pinion
- Conventional Ball Screw System
- “Spin the Nut” System
- Linear Motors

Electronics

Software
Drive System Options

Rack and Pinion
- least expensive
- not as accurate (more slop)
- prone to dirt contamination
Drive System Options

Conventional Ball Screw System
- Common system
- Highly accurate
- Prone to screw “whip” at high speeds
- Thicker screw makes too heavy to move at high speeds
Drive System Options

“Spin the Nut” System

• For high speed machining
• Allows for heavier non-moving screw
COMPONENTS OF CNC MACHINE CENTERS

Mechanics – Spindles

Electronics

Software

Steel Bearings vs. Ceramic Bearings

Air Cooled vs. Liquid Cooled

Grease vs. Oil Mist
What is High Speed?

High speed is a relative term.

CNC Routers
20 years ago: 15,000 rpm, 500 ipm (12 meters / minute)
10 years ago: 30,000 rpm, 1500 ipm (36 meters / minute)
today: 30,000 rpm, 2000+ ipm (48 meters / minute)
What are the High Speed Spindle Design Considerations?

<table>
<thead>
<tr>
<th>Speed (rpm)</th>
<th>Bearing Material</th>
<th>Cooling Method</th>
<th>Lubrication Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,000</td>
<td>Steel bearings</td>
<td>Air cooled</td>
<td>Grease lubrication</td>
</tr>
<tr>
<td>30,000</td>
<td>Ceramic bearings</td>
<td>Liquid cooled</td>
<td>Oil mist</td>
</tr>
<tr>
<td>40,000</td>
<td>Magnetic bearings</td>
<td>– not common in the wood industry since is so expensive</td>
<td></td>
</tr>
</tbody>
</table>
COMPONENTS OF CNC MACHINE CENTERS

Mechanics - Base
Electronics
Software

Types of drive motors
Types of drive controllers
Drive System Options

Drive Motors

Stepper Motors
• cheaper
• slower
• not as accurate (many without feedback positioning)

Servo Motors
• more expensive
• faster
• more accurate
Drive System Options

Drive Controllers

**Hardware Controller**
- traditionally more common
- propriety based – “closed architecture” (hard to modify or access)
- fast
- more expensive

**Computer-Based Controller**
- cheaper
- slower since goes through computer bus
- “open architecture”

**Hybrid Hardware and Computer-Based Controller**
- good compromise – in speed, open architecture
Drive System Options

Drive Controllers

“Look Ahead Capability”

• Adjusts acceleration and deceleration based on what lies ahead

• Makes for faster more accurate cuts
COMPONENTS OF CNC MACHINE CENTERS

- Mechanics - Base
- Electronics
- Software
- CAM – computer aided manufacturing
- NBM
- Addons
Mastercam

Mastercam is just one example of a CAM package. It is the largest seller of a CAM package (base = $5K)

The only difference between MC Mill and MC Router is Tabs, Nesting, and the Tool Table

ADVANTAGE OF MC (or similar CAM) is that there are many people trained in it

DISADVANTAGE OF MC is that it is complex and expensive ($5K)
NESTED BASED MANUFACTURING (NBM)

Definition:

**Nesting** – geometric optimization of part(s) made for a panel on a CNC router, milling machine, laser, panel saw, etc. for best yield

**NBM** – A philosophy which is joined with JIT, cellular manufacturing, and CAD/CAM
Other Considerations

Material Hold Down Techniques

Tools and Tool Holdings
Two BROAD Types of Router Types

Stick Manufacturing
• multi part raised panels
• chairs
• 3-D products

Panel Manufacturing
• cabinets
• book cases
• RTA furniture
• upholstery frames

Type affects the hold down technique employed
Types of Hold Down Techniques

- Gaskets
- Mechanical Fastening (nails)
- Manual “Flip” Pods
- Manual Vacuum Pods
Types of Hold Down Techniques

Automatic Clamping

Automatic Pods

For video files shown on this slide, contact Richard_lemaster@ncsu.edu
Types of Hold Down Techniques

High Vacuum System

Roller Hold Down

Combinations
Types of Hold Down Techniques

SUMMARY

Inexpensive
- Gaskets
- Manual “Flip” Pods
- Manual Vacuum Pods
- Mechanical Fastening (nails)

Most Expensive
- Automatic Pods
- Automatic Clamping

Most Expensive to Operate
- High Vacuum System

• Roller Hold Down
Other Considerations

Material Hold Down Techniques

Tools and Tool Holdings
TYPES OF TOOL CHANGERS

• Multi-Spindle

• Turret Head

• Type Writer Head
TYPES OF TOOL CHANGERS

- Changing Rack
- Rotary Changer
- Piggy Back
Aggregates

- Changing Direction, Speed, etc
Machine Interface – Tool Changers
Tool Holders and Chucking
Tool Holders and Chucking
Collet Nut
Tool Holders and Chucking

Hydraulic Clamping

Hydro Clamping

Source: Leitz Lexikon
Tool Holders and Chucking

Heat Shrink

Diebold-ThermoGrip®-Schrumpftechnik  ThermoGrip® Shrink FitTechnologies
ThermoGrip® frettage

Eigenschaften der Schrumpffutter:

- 20°C
- 45°C
- 94°C
- 131°C
- 168°C
- 205°C
- 243°C
- 280°C
- 317°C
- 355°C
Tool Holders and Chucking

Tribos

SCHUNK TRIBOS
compared with heat shrink chucks

SCHUNK Spann- und Greiftechnik