DIGITAL FABRICATION: JOINTS

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JOINT FORMS

BASIC PRINCIPALS: Encyclopedia of wood joints

- Not developed for a particular function
- No evident of joint preference in construction
- Adapted in response to change and demand
- Lap joints and mortise and tenon became more complex over time
JOINT FORMS

JAPANESE JOINERY:

- Use of Splicing
JOINT FORMS

SOUTHERN EUROPE:

- Angled Joints
JOINT FORMS

HUMAN HAND

Joints were tested

- clapping
- grasping
- interlocking

- Evolution of joints through Tools
JOINT FORMS

CHARACTERISTICS

- Strength, flexibility, toughness, appearance, etc.
- Derive from the properties of the joining materials
- How they are used
JOINT FORMS: SPlicing

Table Splayed Joint

Gerber Joint

Wedge Locking Joint

Dovetail Joints

Gooseneck Joint
JOINT FORMS: COUNTER

Mortise and Tenon Joint  Bridle Joint  Box/ Finger Joint

Blind Corner Lap  Tongue Joint
JOINT FORMS: EDGE TO EDGE

Rabbeted & Grooved  Lap Joint  Tongue and Dado Joint

Spline Insert  Butterfly Key
JOINT FORMS: TRADITIONAL vs DIGITAL
JOINT FORMS: DIGITAL

Jochen Gros’s 50 Digital Wood Joints project
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JOINT LOGIC: DIGITAL

Jochen Gros’s 50 Digital Wood Joints project
CNC MILL

BASICS

- Allows for perfect joints to be fashioned in substantially less time
- Somewhat difficult to master, but provides endless opportunities
- Requires whole new skill set and way of thinking
- Ideas must be translatable to a computer program
CNC MILL

CONSIDERATIONS

- Setting up your Rhino File
- 3-axis CNC Router (does not under cut)
- Size of Bit
- Inside Corner Problem
- Tolerances
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CNC MILL

Three inside corners are not possible with traditional milling.

One inside corner needs the radius of the end mill.

Relief hole is drilled first, then corner is milled.
CONNECTIONS
Two and Three Piece Linear Connections

Broken down into several categories depending on the angle and orientation of the two pieces

Further broken down by connection appearance desired

  Lap, Mortise and Tenon, Scarf, etc.
Cogged Lap

Provides additional strength, but the pieces do not lie flush

Can be applied as sheet to sheet, frame to frame, or sheet to frame
Crossed Lap

Requires half of the material which limits the strength

Pieces lie flush, allowing wider array of use

Can be applied as frame to frame or sheet to sheet
Mortise and Tenon

Provides additional strength, but the pieces do not lie flush

Can be applied as sheet to sheet, frame to frame, or sheet to frame
Due to the found nature of the pieces used in these explorations, every surface is considered rough and must be milled in order to ensure a tight fit.

seen in many of these joints, the extra bump outs are called dog bones and are created in order to provide the additional allowance needed in order to fit square corners through filleted corners, which are the natural result of the CNC router machining process.

The use of a CNC mill aids in the creation of blind mortises due to the ability to cut any shape to any depth considered pocketing.
In addition to the strengths of a lap joint, the stub tenon provides further resistance to tensile forces.

Can only be applied in frame to frame connections.
Gooseneck Lap

Requires much more length of material to make than the Stub Tenon

Used for its strong tensile force resistance paired with its asthetic appeal

Can only be applied in frame to frame connections
Oblique Scarf

Requires most material but offers the highest strength due to the addition of a third member.

Can be applied in frame to frame or frame to sheet connections.
Notched Lap

Can include many different variations, but provides for connections other than 90 degrees.

Can be applied in frame to frame or frame to sheet connections.
Interestingly, both halves of this joint are identical, and it is the addition of the incline that gives the joint its additional usefulness.

Similarly to the mortise and tenon joints discussed earlier, this series of insets is incorporated in order to assure a flush and tight fit of the members.

In addition to the inclined plane, this joint also explores the use of a double dovetail to increase the tensile strength of the joint.
Effects of CNC on Design

Focus can be moved from the boundaries of individual pieces to where and how the pieces meet

Connection points become more important as the work becomes more about a system of parts than an overall form

Special attention must be directed towards the juxtaposition of perfection provided by the CNC machine and the inherent imperfections of materials
Two and Three Piece Planar Connections
Dovetail

Locks together fairly securely even without adhesives

Easily scaled to any size joint
Finger

Another easily-scaled joint

Not as secure as dovetail

Much simpler than dovetail
Mortise and Tenon

Often mixed with finger joint

Secure in all directions except the direction of insertion
Slotted

Can not create a butt-joint

Good for joints in the middle of members

Not as strong against certain forces
Keys

Can be used to join two boards in the same plane without losing any length

Not as strong

Can be made to be very aesthetically interesting

Can be mobile
Biscuits

Like keys, but hidden

Can be used on any length of joint

No loss of useable length of material
Combinations

Can take advantage of the strengths of multiple types of joint
Combining Planar and Linear
Side-Table

The side-table consists of an endless frame as well as of two shelves that are let in the frame. The individual solid wood parts of the framing timbers are joined at the corners with a Mitre joint with Dovetail Key. The shelves are let in the framing timbers by means of modified Dovetail Tenons. Not only a rigid construction is thus created, but also, depending on the choice of material, a very attractive small piece of furniture.
Finished Examples

Torus Knot Table

Dovetail joint detail is used to create a continuous curvilinear member
Finger Joint - Chair

Finger joints clasp the next member, creating a strong connection while changing axis.
Kundera Chair - Paulo Neves & Alexandre Kumagai

The seat back provides the structure, holding the chair together by tenon joints.
Upright furniture

Linear members are joined using a halved dovetail corner joint, creating a U shape.

The sides are then pushed in using tongue joints on the sides of the linear...
Self-supporting Framework

All the materials have the same profile, but each member is uniquely cut to support the abstract structure.
C...Stool - Jochen Gros

Made to clearly show the work done by the CNC as part of the aesthetic design.

By exposing the Finger Tenons, the process of milling and joinery is made transparent.
Clip Shelf

Crossbars are clipped onto the sides using a Clip Tenon Joint.

The shelves are mortises in the sides by means of Finger Tenons.
Meander Shelf

Designed as a simplified shelf that would slot together without requiring tools, and still have the least amount of trim waste as possible.

The two shelf bearers are shaped in such a way that they can both be produced from the same board by using Slotting Girder Joints as the interlocking shape.
Chest of Drawers

Top shelf and sides are joined by Lapped Finger Tenon Joints, while the bottom shelf is mortised through the sides by Finger Tenons.
Simplizissimus-Table

Designed to be as a simple construction process, all the elements are machined together from the beginning.

The resulting pieces can be put together with no tools using Simple Sotting Joints and Finger Tenons.
Joint Chair

Sebastien Wierwinck Plywood Chair
Frame-Shelf

The wood sides and shelves are bound in place by the linear frame.

The frame members are held by Jigsaw Mitre Joints left exposed for decoration.
Side-Table

Wooden members form an infinite frame joined at the corners by Mitre Joints with a Dovetail Key.

The shelves are added to the frame by Lapped Dovetail Tenons creating a pattern throughout the table edges.
Zoom-Table

Designed to maintain a constant proportion between its length, width, and height; making the number of Lapped Finger Tenons remain the same no matter the size of the table.

The table joints on the side help prevent deflection of the tabletop when loaded.
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