

# *Building Things*

BIOEN 302  
Lecture 3  
October 5, 2009

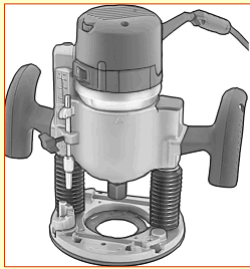
## Cutting tools

- **Band saw**
- Drill
- Milling machine (vs. router)
- Lathe
- Table saw
- Shearing tools (like paper cutter)
- CO2 Laser
- Water jet

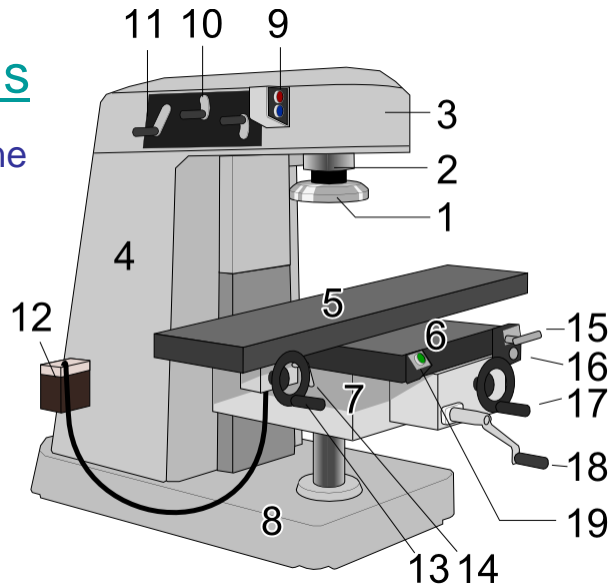


## Cutting tools

- Milling machine  
(vs. router)



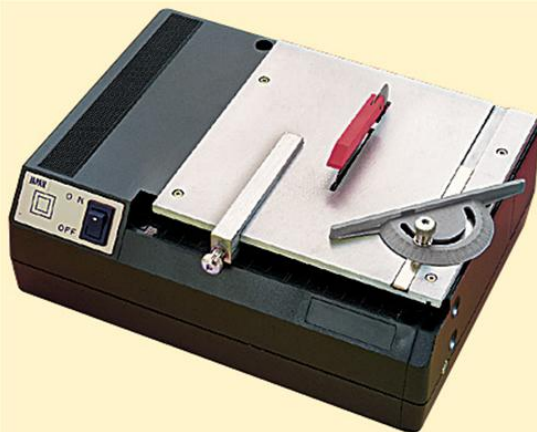
Source: McMaster-Carr catalog



Source: Wikipedia commons  
[http://commons.wikimedia.org/wiki/File:Milling\\_machine\\_\(Vertical,\\_Manual\)\\_NT.PNG](http://commons.wikimedia.org/wiki/File:Milling_machine_(Vertical,_Manual)_NT.PNG)  
Author and uploader: "Tosaka"

## Cutting tools

- Lathe
- Table saw

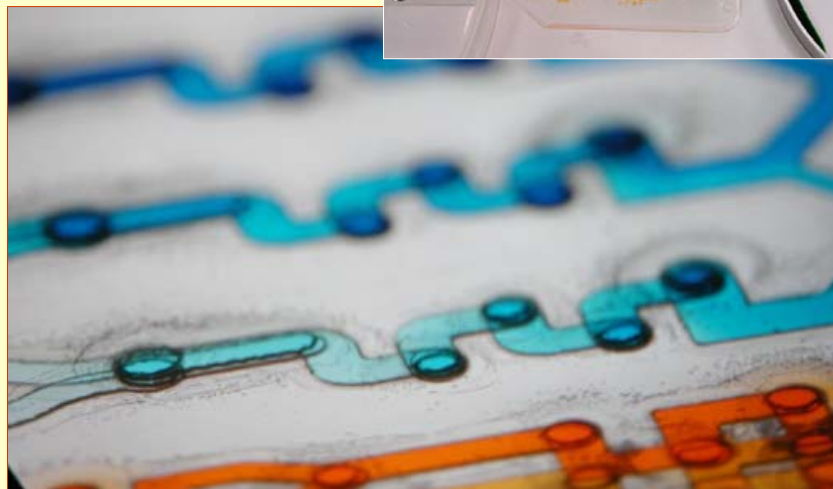
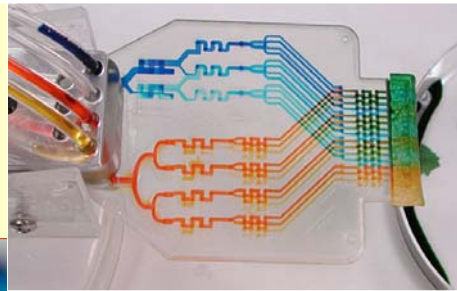


## Laser cutting tools

- CO2 Laser: ULS
  - [http://www.ulsinc.com/english/laser\\_application/view\\_process.html](http://www.ulsinc.com/english/laser_application/view_process.html)
  - [http://www.ulsinc.com/english/medical\\_disclaimer.html](http://www.ulsinc.com/english/medical_disclaimer.html)
- CO2 Laser: Trotec
  - [http://www.troteclaser.com/en-US/solutions/business/Pages/Laser\\_Marking\\_Medical.aspx](http://www.troteclaser.com/en-US/solutions/business/Pages/Laser_Marking_Medical.aspx)
- Good for PMMA and Mylar
- Can cut glass, but jagged
- These models can't cut metal

## Cutting tools

- Laser-cut microfluidic device



## Cutting tools

- Water jet



Source: Flow International, flowcorp.com

Mech E Water Jet Cutting Systems Shop  
EGA 127  
Kevin Soderlund, lead ME instrument maker  
Not part of student shop...?

Source: CEC Master Shop, [www.cec-waterjet.com/](http://www.cec-waterjet.com/)

## Other forming methods

- Forging: shaping solid pliable material
  - Rolling
  - Stamping: cut out or bend sheet material
  - Peening: impact with rounded tool
- Extrusion: passing semisolid or liquid through aperture (die) of specific cross-section
  - <http://enr.bd.psu.edu/pkoch/plasticdesign/extrusion.htm>
- Casting
  - Liquid poured or injected into a mold
  - Metals cast in *foundry*
  - Polymers for microfab (PDMS, Polyurethane)
    - <http://faculty.washington.edu/afolch/FolchLabResearchProjects.htm#>

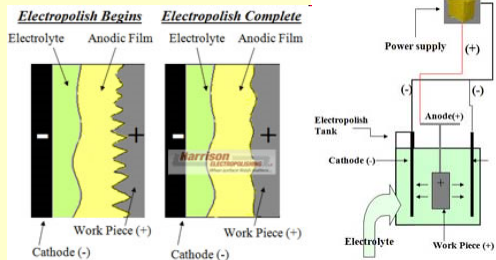
## Finishing steps

- Sanding (belt or disc sander)
- Electropolishing
- Anodizing / electroplating
- Plasma treatment

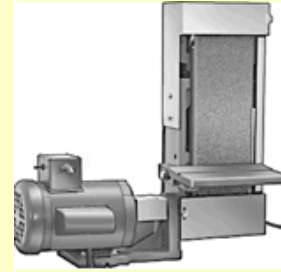
- [Astp.com](http://www.astp.com)



Alloy Tech,  
<http://www.atep.com/a.htm>



Harrison Electropolishing,  
[www.harrisonep.com](http://www.harrisonep.com)

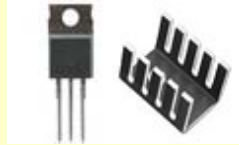


## Joining methods

- Soldering: ✓
- Brazing: Soldering with bronze @ higher temp.
- Welding
  - Metal: melt material at joint, optional addition of material
  - Plastics: dissolve material at interface
- Hot isostatic press (HIP)
- Plasma treatment (silanes/silicone-glass)
- Ultrasound / vibration

## Joining methods: glue

- PMMA (super glue)... very stiff, sticks to skin
- Epoxy (resin + hardener, mixed)... sets without air contact
- Heat sink compounds
  - Silicone does not harden
  - Another type (?) does
- Hot glue not good where dimensional accuracy or temp. resistance is important
- Advantage of glue: no holes to drill, no heating
- Disadvantage of glue: can't take it apart, need to hold it during hardening



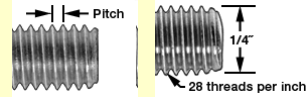
## Joining methods: Machine screws

- Dimensions
  - Thread shape precisely defined
  - UNF (fine), UNC (coarse)
  - Numbered 00 through 12 and 1/4" up for diameter
  - Second number for threads/inch
  - Metric uses mm diameter with standard thread count
- Preparation
  - Drill, then tap a hole, *or*
  - Make a through hole and use washer & nut

## Joining methods: Machine screws

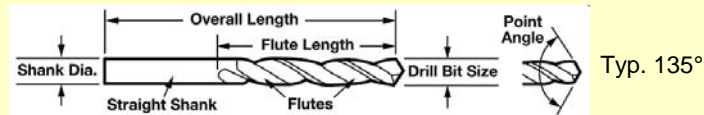
- Dimensions

- Thread shape precisely defined
- UNF (fine), UNC (coarse)
- **Numbered 00 through 12 and 1/4" up for diameter**
- Second number for threads/inch, e.g. 4-40
- Metric uses mm diameter with standard thread count



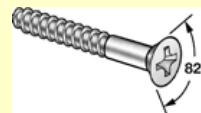
- Preparation

- Drill, then tap a hole, *or*
- Make a through hole and use washer & nut



## More about screws

- Sheet metal screws
- Wood screws
  - Note 82° countersink angle
  - Not equal to drill tip angle



- Screw driver type

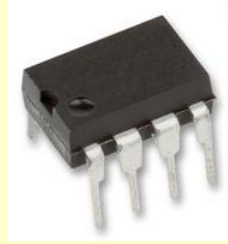
- Phillips good!

- Head shape

- Pan, flat, oval, fillister

## Circuit assembly

- Two package types:
  - DIP = Dual Inline Package



- SOIC: Small-outline integrated circuit  
one type of surface-mounted device

- Conversion

