

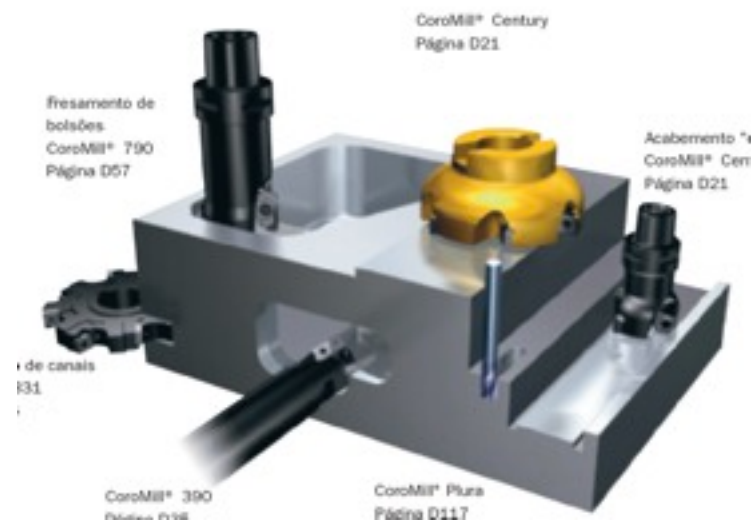


Ferramentas Multicortantes CNC

Lab 2 - 2013 / 1

Algumas operações de usinagem que utilizam mais de uma aresta simultaneamente:

- Fresamento
- Furação
- Alargamento
- Rosqueamento



Fresamento

- Informações gerais (v_c , f , a_p , etc)

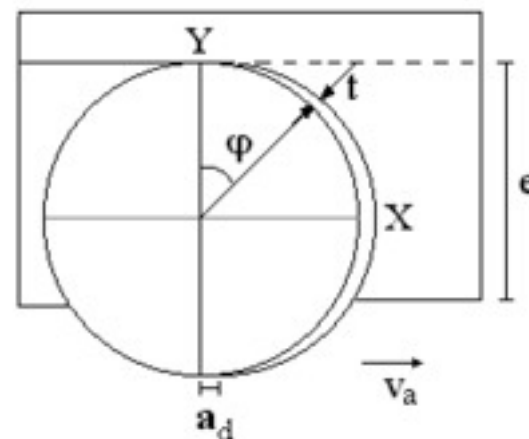
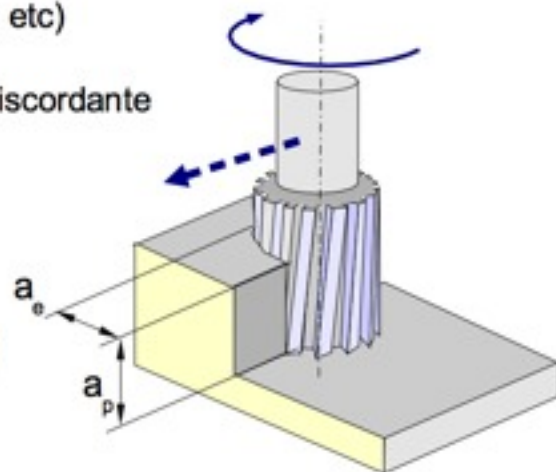
- Fresamento concordante / discordante

- Diâmetro da fresa

- Número de dentes (Z)

- Penetração de trabalho (a_e)
(Largura de corte)

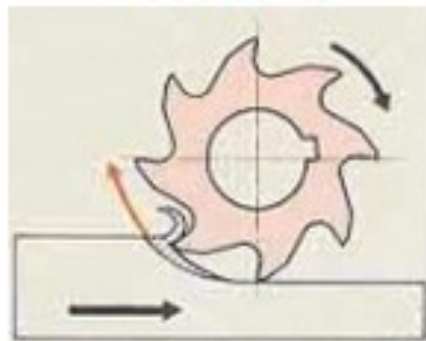
- Avanço por dente (f_z)



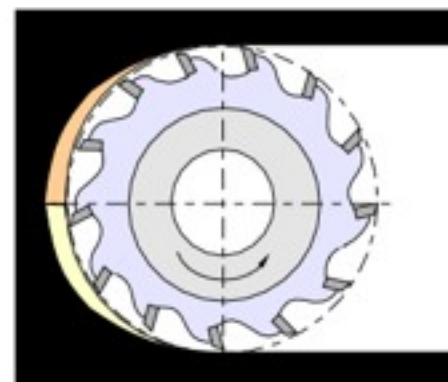
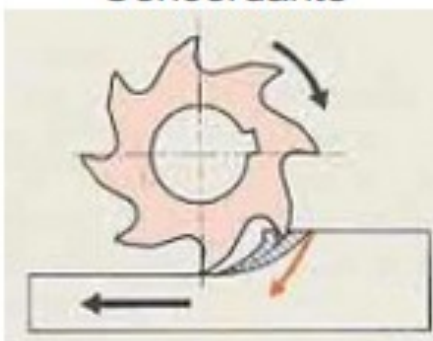
$$t = a_d \text{ sen}(\varphi)$$

Fresamento Concordante / Discordante

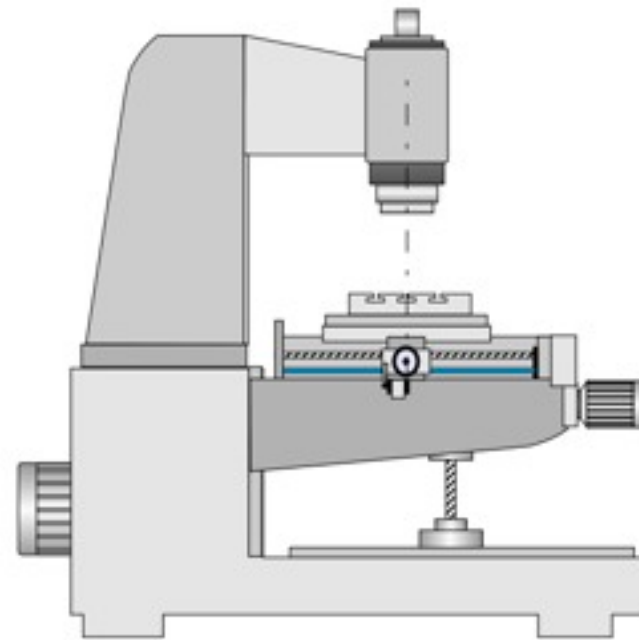
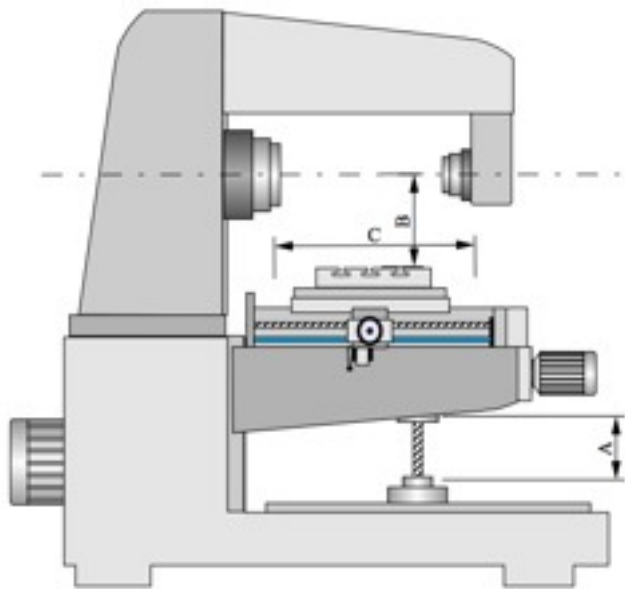
Fresamento Cilíndrico
Discordante



Fresamento Cilíndrico
Concordante

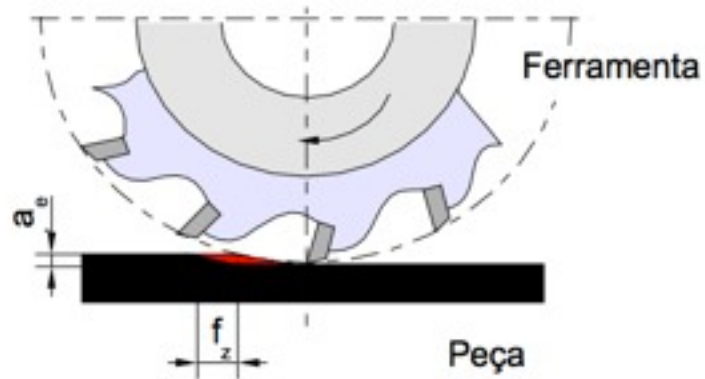
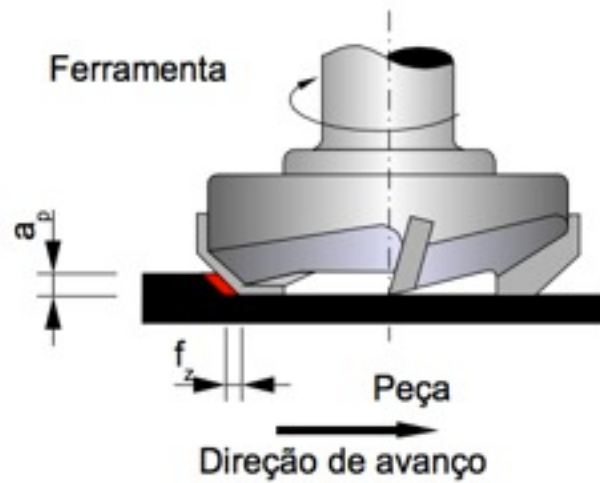


Direção de avanço

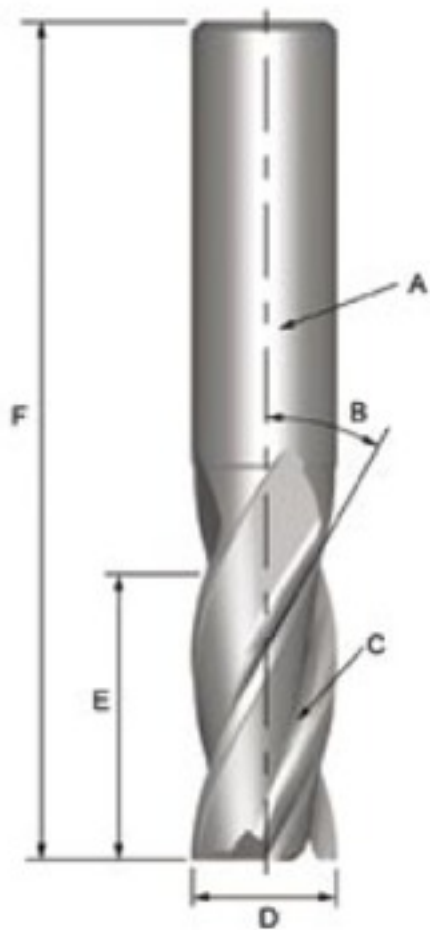


Fresamento Frontal

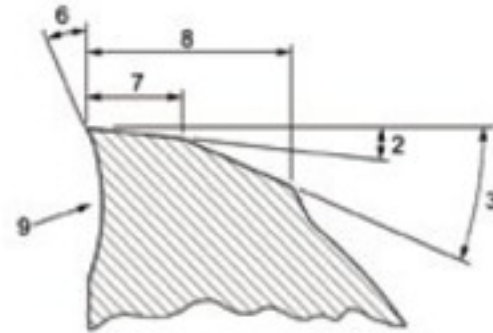
Fresamento Periférico



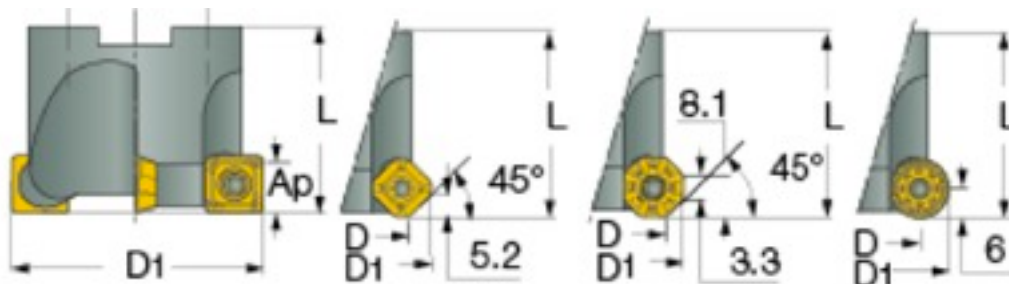
Fresa de Topo Inteiriça



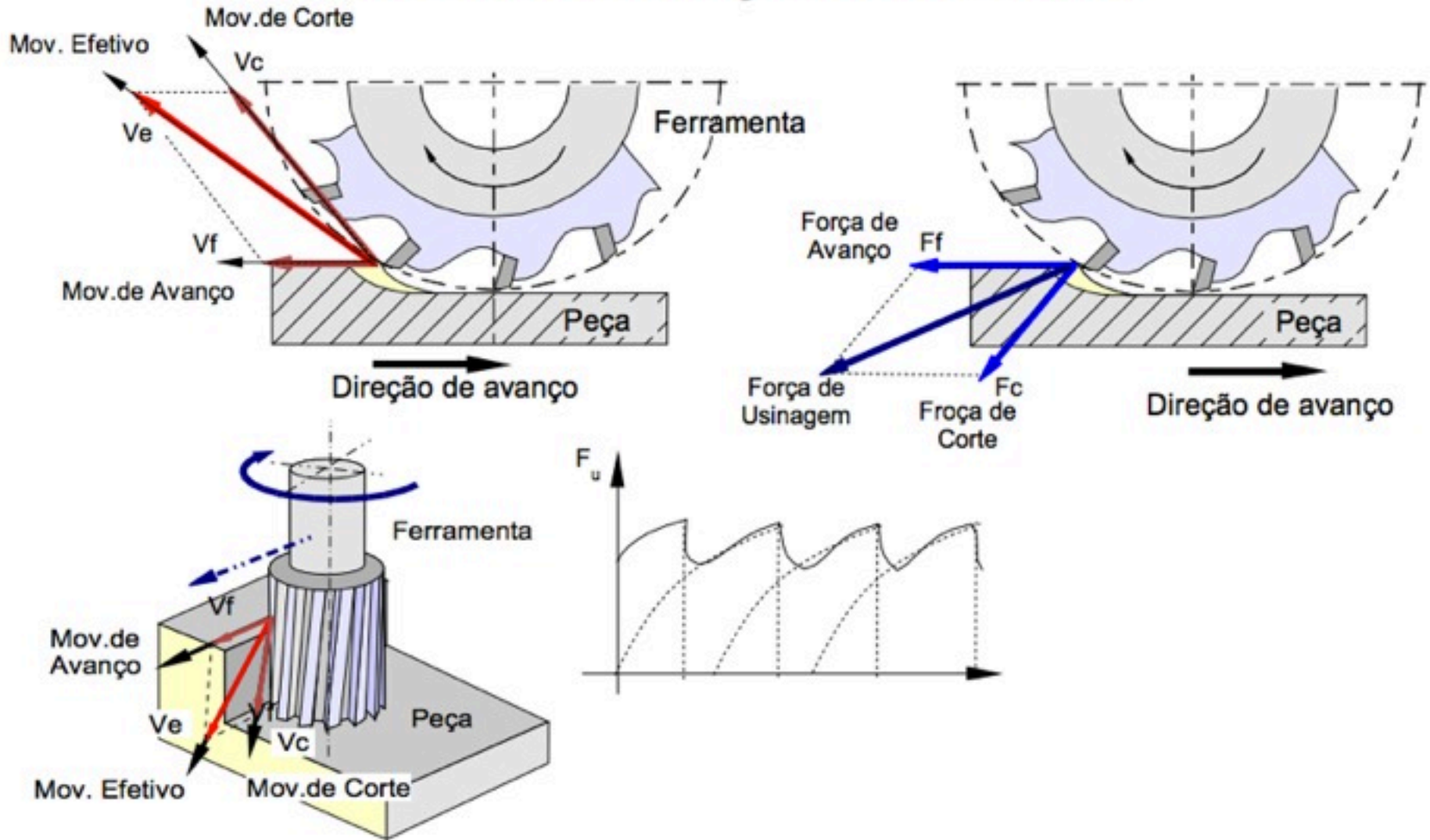
- A Haste
- B Ângulo da Hélice
- C Canal
- D Diâmetro Externo
- E Comprimento de Corte
- F Comprimento Total



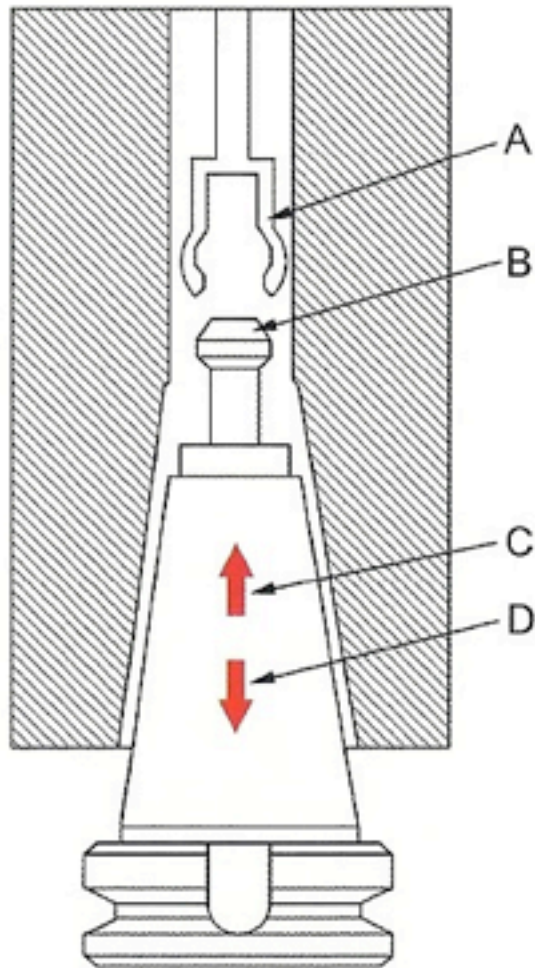
Pastilhas Intercambiáveis



Movimentos e Forças no Fresamento



Porta-Ferramenta



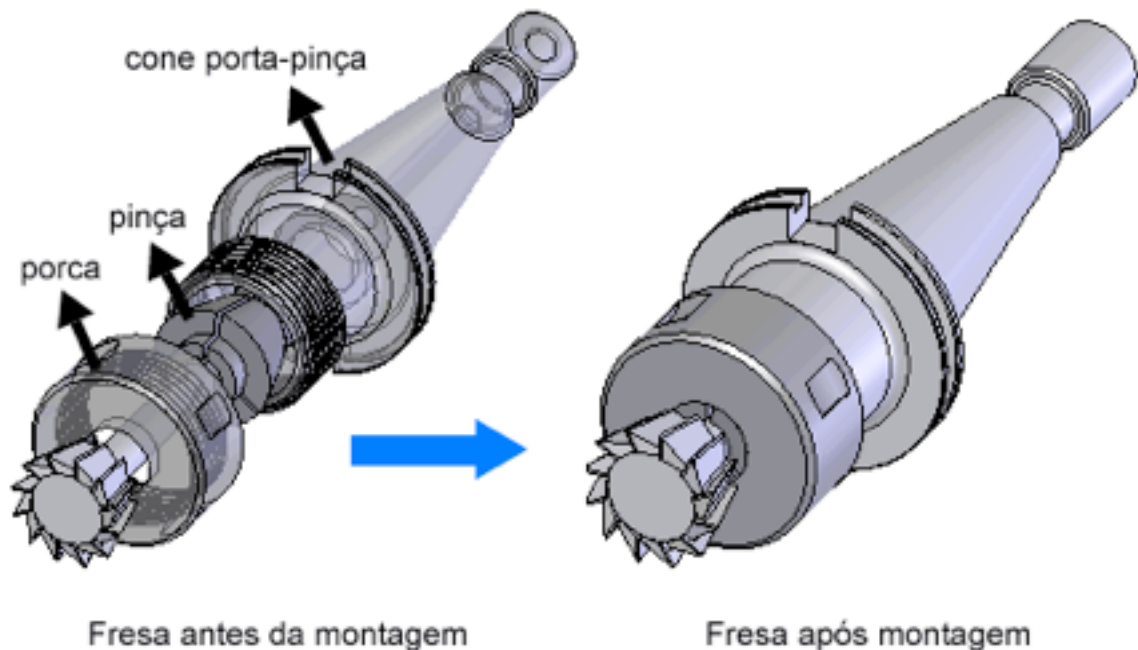
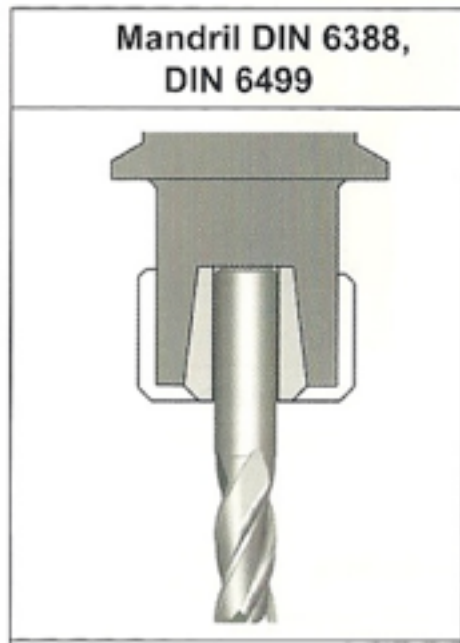
- A Barra de tração com trava
- B Pino de tração
- C Fixação
- D Liberação

Fixação da Ferramenta

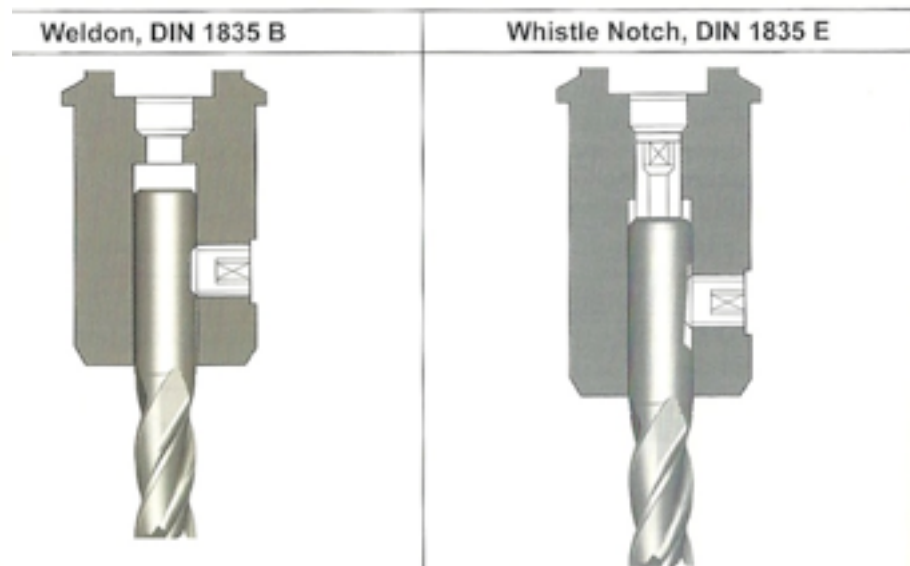
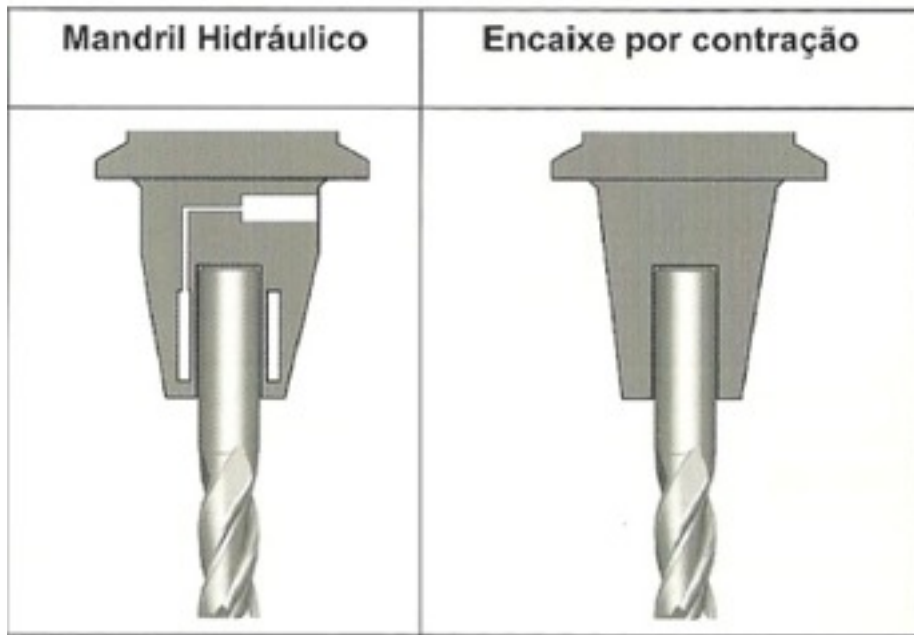
SISTEMAS DE FIXAÇÃO

Existem quatro tipos diferentes de sistemas de fixação para as ferramentas:

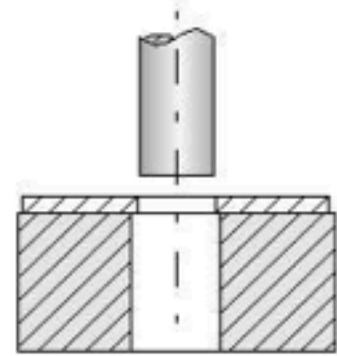
1. Mandril DIN 6388 e DIN 6499
2. Mandril Hidráulico
3. Encaixe por contração
4. Weldon e Whistle Notch (Lingüeta de arraste)



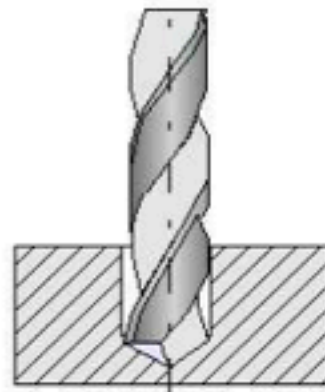
Fixação da Ferramenta



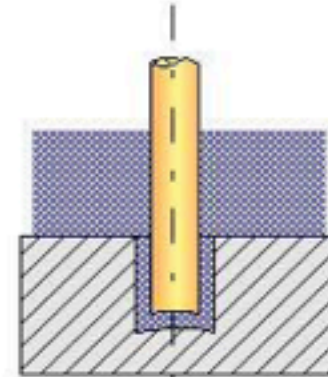
Para mandris Weldon e Whistle Notch, um parafuso radial fica em contato com a ferramenta e a mantém no seu lugar. A ferramenta necessita ter uma área plana retificada na haste.



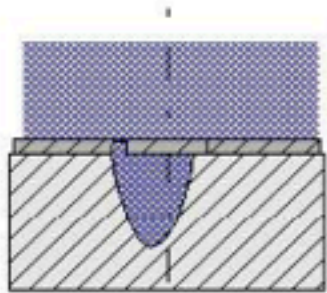
punções



brocas helicoidais



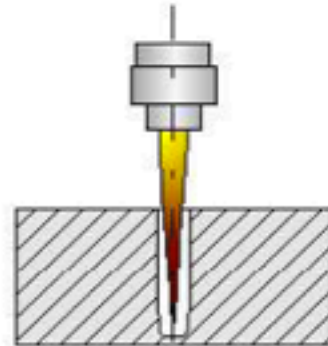
eletro-erosão



remoção química

Furos

outros



feixes de energia



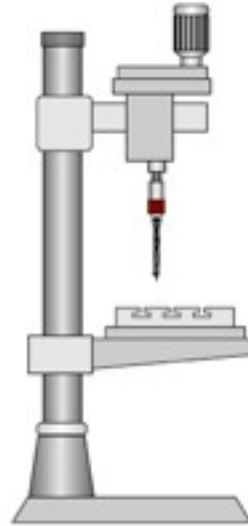
Furadeiras



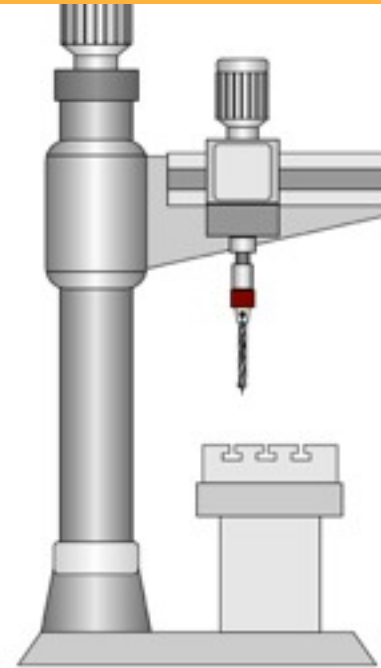
Furadeira manual



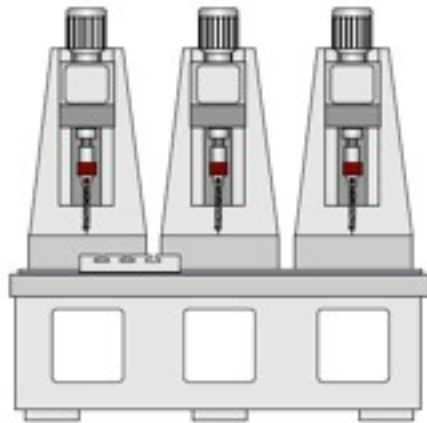
Furadeira de bancada



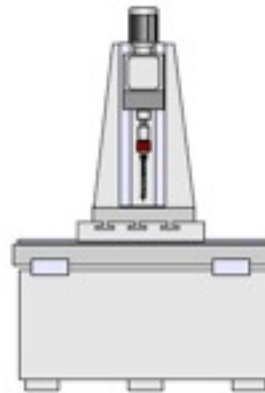
Furadeira de coluna



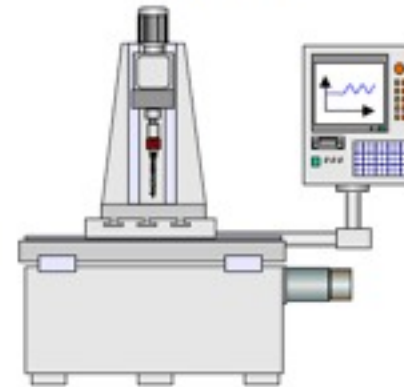
Furadeira de coluna radial



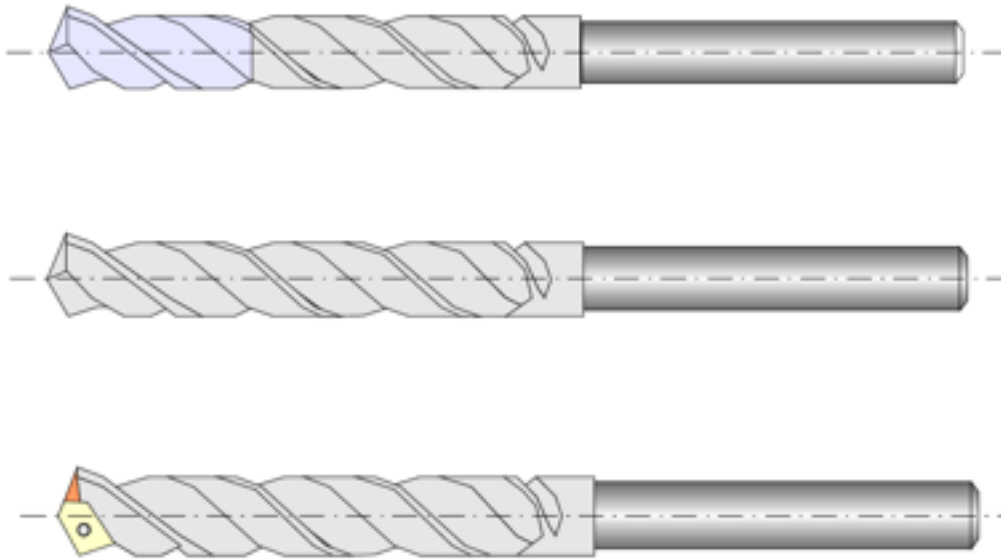
Furadeiras em série



Furadeiras de coordenadas



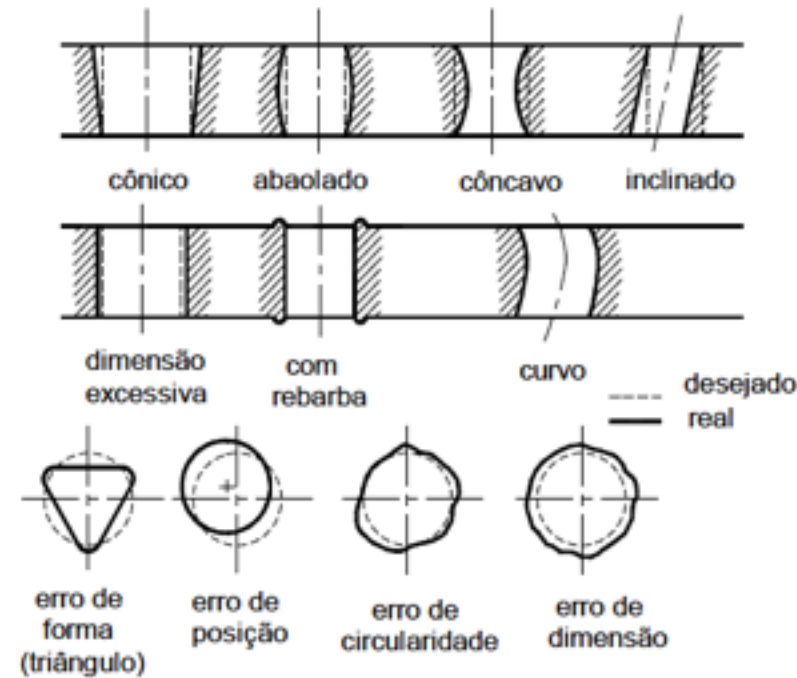
Furadeiras de comando numérico



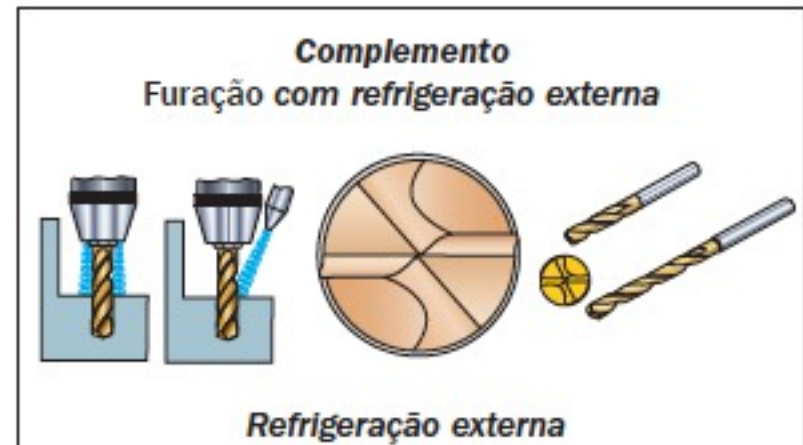
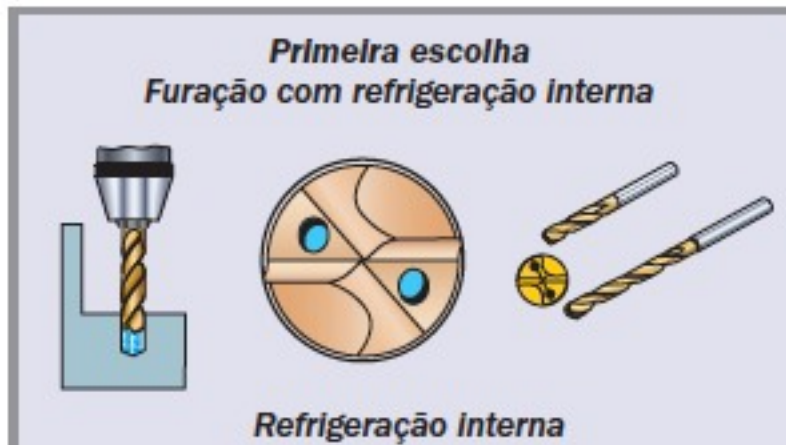
| ISO/ANSI | |
|------------------------|----------|
| Aços | P |
| Aços inoxidáveis | M |
| Ferros fundidos | K |
| Materiais não-ferrosos | N |
| Ligas de titânio | S |
| Material endurecido | H |

Precisão do Furo

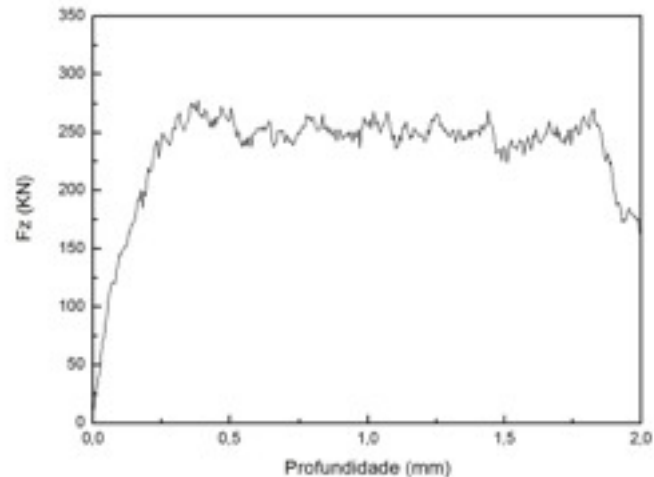
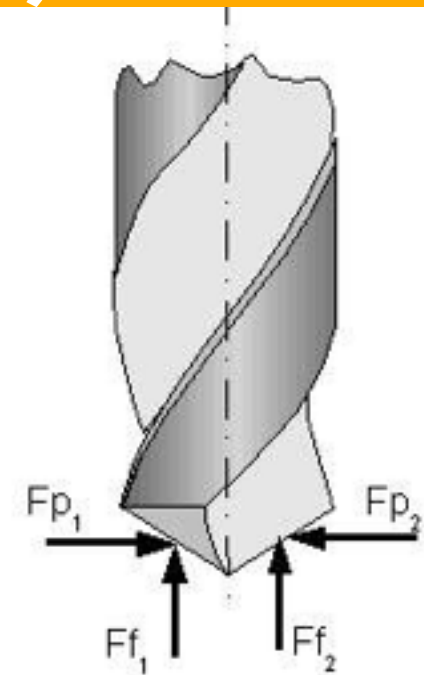
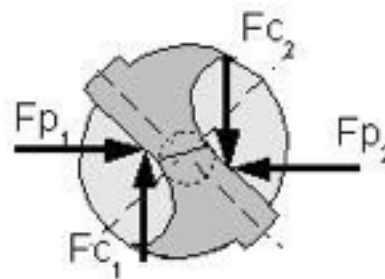
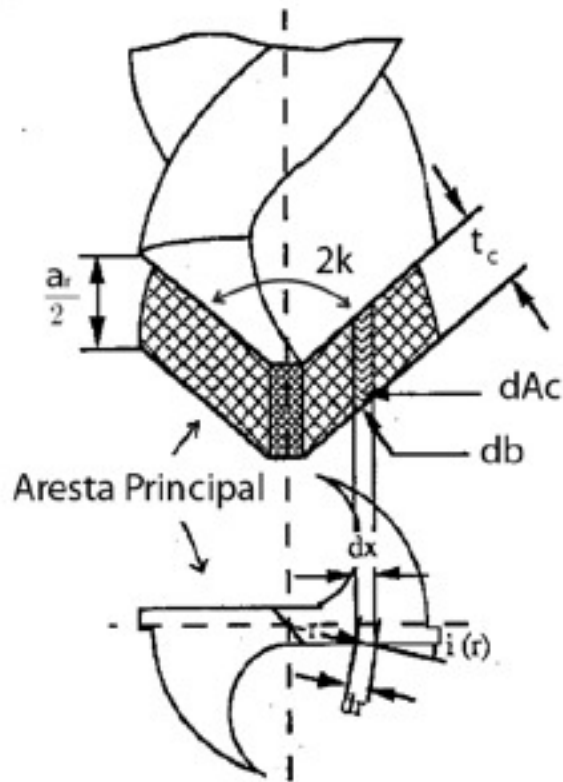
| Diâmetro do furo | | 3 - 6 | | 6 - 19 | | 19 - 38 | |
|--------------------------------|-----------|---------|---------|---------|---------|---------|---------|
| condição | Erro [mm] | tamanho | posição | tamanho | posição | tamanho | posição |
| Sem furo de centro e sem bucha | 0,08 | 0,18 | 0,15 | 0,20 | 0,20 | 0,20 | 0,23 |
| Com furo de centro e sem bucha | 0,08 | 0,10 | 0,08 | 0,10 | 0,10 | 0,10 | 0,13 |
| Com bucha | 0,05 | 0,05 | 0,08 | 0,05 | 0,10 | 0,10 | 0,08 |



Lubrificação



Forças na Furação



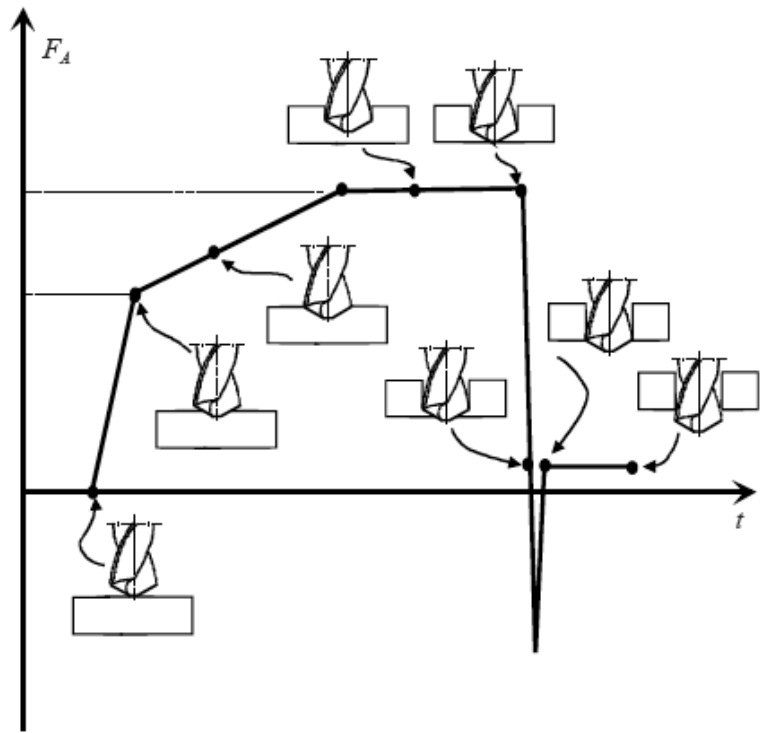
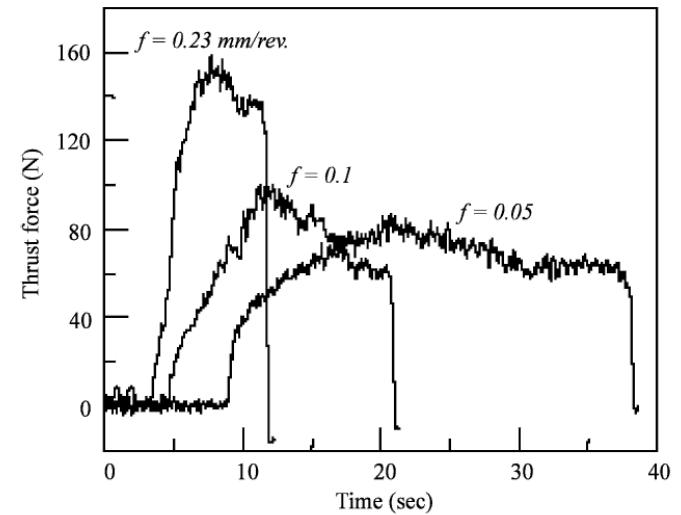
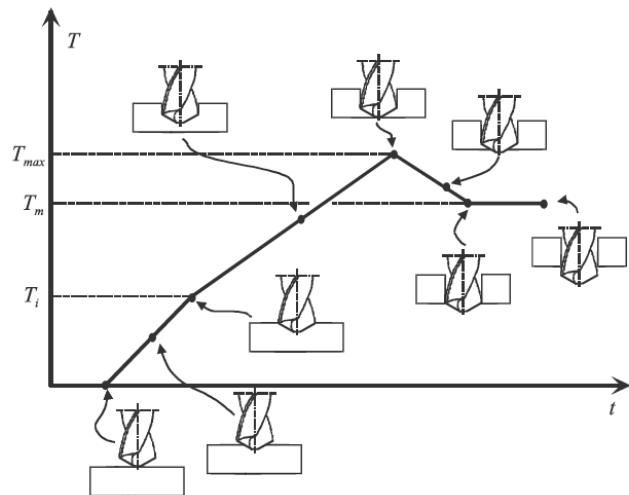
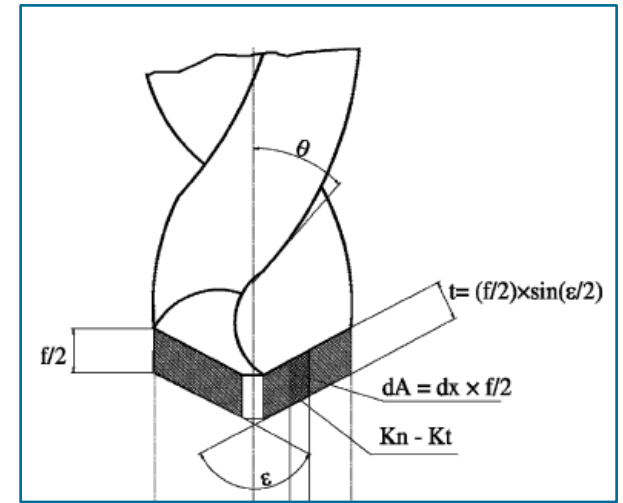
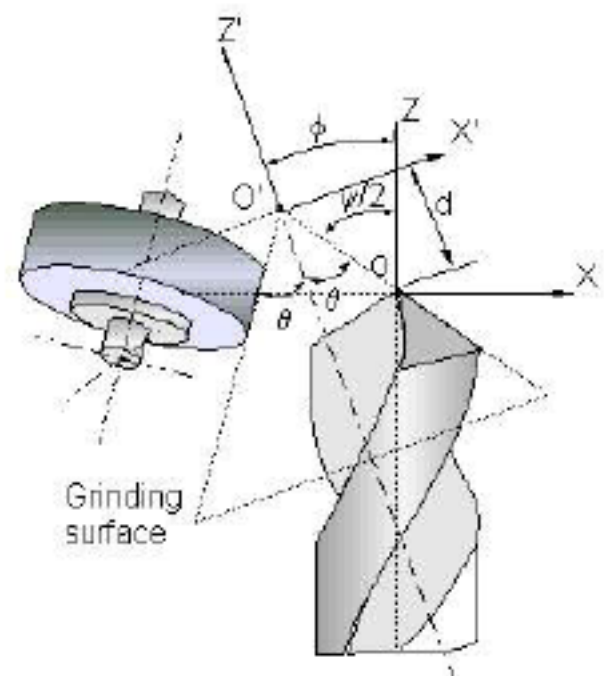
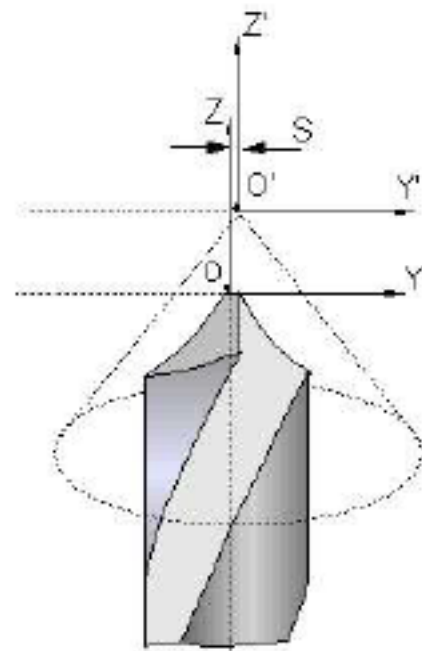
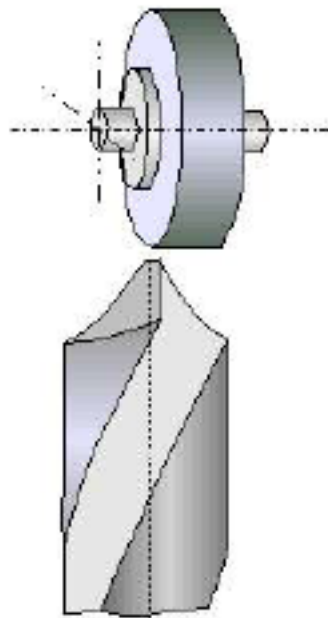
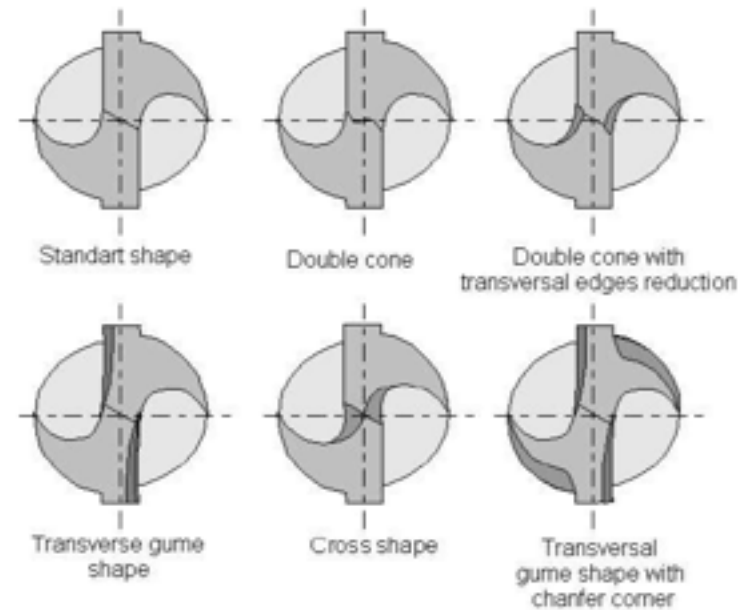
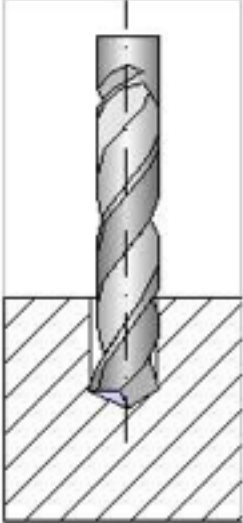
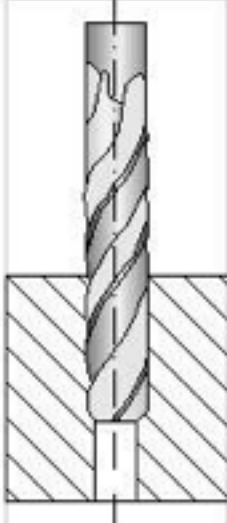
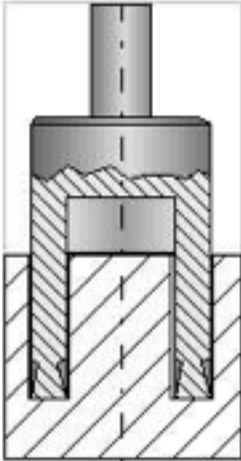
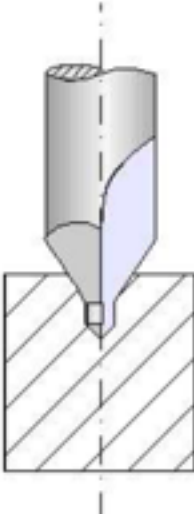
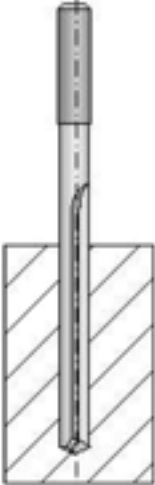
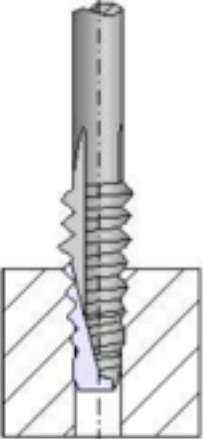


Figure 6.7. General trend of the thrust force as a function of drilling time

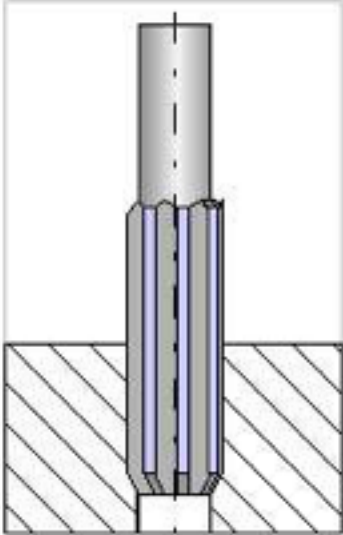
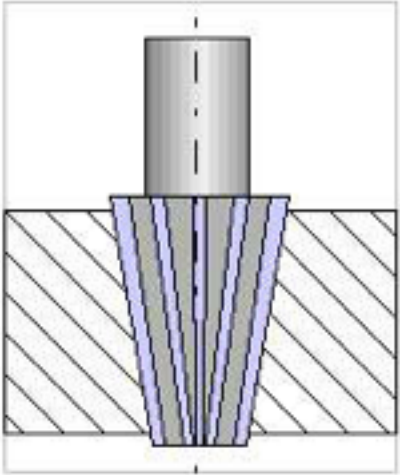
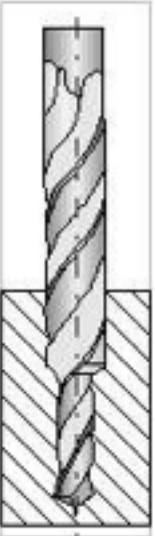
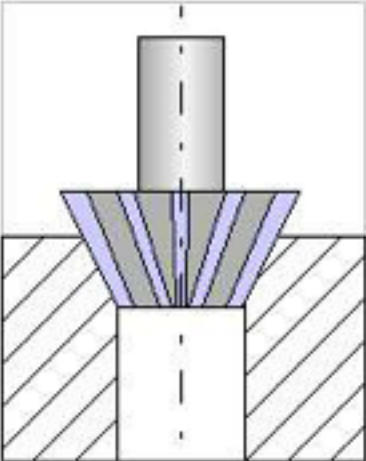


Afiações



| | | |
|--|--|--|
| <p>Furação em cheio</p> | <p>Furação com pré-furo</p> | <p>Trepanação</p> |
|  |  |  |
| <p>Furação de centro</p> | <p>Furação profunda</p> | <p>Rosqueamento</p> |
|  |  |  |



| Alargamento cilíndrico | Alargamento de perfil |
|--|---|
|  <p>A cross-sectional diagram showing a cylindrical drill bit with a double-flute design cutting into a workpiece. The bit is positioned vertically, and the cutting action is shown at the tip, creating a cylindrical hole in the material.</p> |  <p>A cross-sectional diagram showing a drill bit with a profiled cutting edge cutting into a workpiece. The bit is positioned vertically, and the cutting action is shown at the tip, creating a hole with a specific profile shape.</p> |
| Furação de perfil em cheio | Rebaixo de perfil |
|  <p>A cross-sectional diagram showing a drill bit with a profiled cutting edge cutting into a workpiece. The bit is positioned vertically, and the cutting action is shown at the tip, creating a hole with a specific profile shape.</p> |  <p>A cross-sectional diagram showing a drill bit with a profiled cutting edge cutting into a workpiece. The bit is positioned vertically, and the cutting action is shown at the tip, creating a hole with a specific profile shape.</p> |

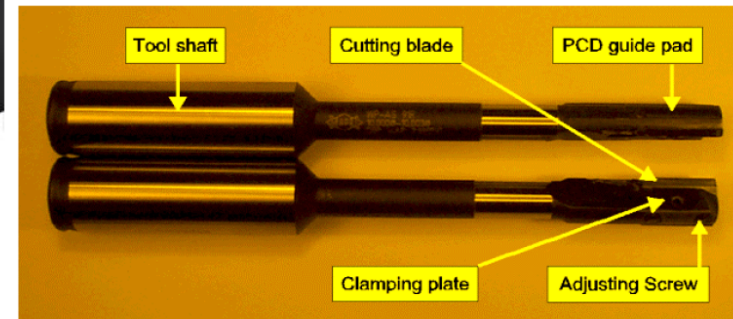


Alargadores (Reaming Tools)

Furação – Desbaste: Tolerância: ISO IT11 à IT14

Alargadores de Desgaste: Tolerância: ISO IT 8 a IT 9

Alargadores de Acabamento: Tolerância: ISO IT 7

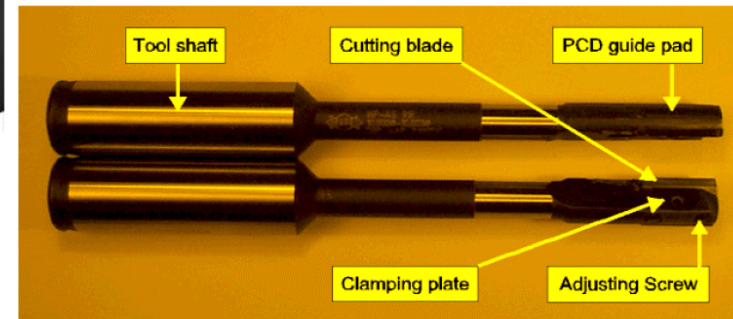


Alargadores (Reaming Tools)

Furação – Desbaste: Tolerância: ISO IT11 à IT14

Alargadores de Desgaste: Tolerância: ISO IT 8 a IT 9

Alargadores de Acabamento: Tolerância: ISO IT 7



Qualidade de Trabalho

| | IT01 | IT0 | IT1 | IT2 | IT3 | IT4 | IT5 | IT6 | IT7 | IT8 | IT9 | IT10 | IT11 | IT12 | IT13 | IT14 | IT15 | IT16 |
|--------------|------------------------|-----|-----|-----|-----|-------------------|-----|-----|-----|-----|-----|------|--------------------|------|------|------|------|------|
| Eixos | | | | | | | | | | | | | | | | | | |
| Furos | mecânica extra-precisa | | | | | mecânica corrente | | | | | | | mecânica grosseira | | | | | |

Tolerâncias fundamentais ISO até 500 mm

Grupo de dimensões em mm (milímetros) – valores da tabela em μm (microns)

| qualidade | Até 1 | > 1 ≤ 3 | > 3 ≤ 6 | > 6 ≤ 10 | > 10 ≤ 18 | > 18 ≤ 30 | > 30 ≤ 50 | > 50 ≤ 80 | > 80 ≤ 120 | > 120 ≤ 180 | > 180 ≤ 250 | > 250 ≤ 315 | > 315 ≤ 400 | > 400 ≤ 500 |
|-----------|----------|------------|------------|-------------|--------------|--------------|--------------|--------------|---------------|----------------|----------------|----------------|----------------|----------------|
| IT 01 | 0,3 | 0,3 | 0,4 | 0,4 | 0,5 | 0,6 | 0,6 | 0,8 | 1 | 1,2 | 2 | 2,5 | 3 | 4 |
| IT 0 | 0,5 | 0,5 | 0,6 | 0,6 | 0,8 | 1 | 1 | 1,2 | 1,5 | 2 | 3 | 4 | 5 | 6 |
| IT 1 | 0,8 | 0,8 | 1 | 1 | 1,2 | 1,5 | 1,5 | 2 | 2,5 | 3,5 | 4,5 | 6 | 7 | 8 |
| IT 2 | 1,2 | 1,2 | 1,5 | 1,5 | 2 | 2,5 | 2,5 | 3 | 4 | 5 | 7 | 8 | 9 | 10 |
| IT 3 | 2 | 2 | 2,5 | 2,5 | 3 | 4 | 4 | 5 | 6 | 8 | 10 | 12 | 13 | 15 |
| IT 4 | 3 | 3 | 4 | 4 | 5 | 6 | 7 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
| IT 5 | 4 | 4 | 5 | 6 | 8 | 9 | 11 | 13 | 15 | 18 | 20 | 23 | 25 | 27 |
| IT 6 | 6 | 6 | 8 | 9 | 11 | 13 | 16 | 19 | 22 | 25 | 29 | 32 | 36 | 40 |
| IT 7 | 10 | 10 | 12 | 15 | 18 | 21 | 25 | 30 | 35 | 40 | 46 | 52 | 57 | 63 |
| IT 8 | 14 | 14 | 18 | 22 | 27 | 33 | 39 | 46 | 54 | 63 | 72 | 81 | 89 | 97 |
| IT 9 | 25 | 25 | 30 | 36 | 43 | 52 | 62 | 74 | 87 | 100 | 115 | 130 | 140 | 155 |
| IT 10 | 40 | 40 | 48 | 58 | 70 | 84 | 100 | 120 | 140 | 160 | 185 | 210 | 230 | 250 |
| IT 11 | 60 | 60 | 75 | 90 | 110 | 130 | 160 | 190 | 220 | 250 | 290 | 320 | 360 | 400 |
| IT 12 | - | 100 | 120 | 150 | 180 | 210 | 250 | 300 | 350 | 400 | 460 | 520 | 570 | 630 |
| IT 13 | - | 140 | 180 | 220 | 270 | 330 | 390 | 460 | 540 | 630 | 720 | 810 | 890 | 970 |
| IT 14 | - | 250 | 300 | 360 | 430 | 520 | 620 | 740 | 870 | 1000 | 1150 | 1300 | 1400 | 1550 |
| IT 15 | - | 400 | 480 | 580 | 700 | 840 | 1000 | 1200 | 1400 | 1600 | 1850 | 2100 | 2300 | 2500 |
| IT 16 | - | 600 | 750 | 900 | 1100 | 1300 | 1600 | 1900 | 2200 | 2500 | 2900 | 3200 | 3600 | 4000 |

Fabricação de Roscas

Tipos de macho de roscar



**Machos
Manuais**



**Machos
Máquina**



**Machos
p/ porcas**



**Machos
p/ tubos**



**Machos
especiais**

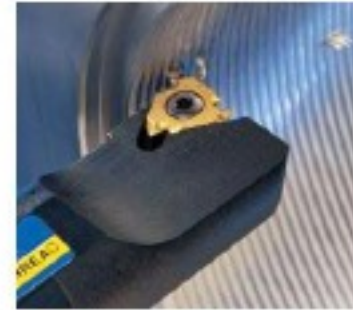
- Velocidade de Avanço



Cossinete



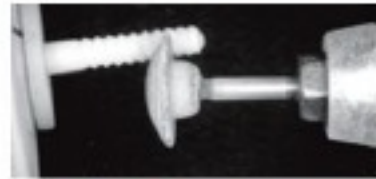
Macho



Torneamento



Turbilhoador

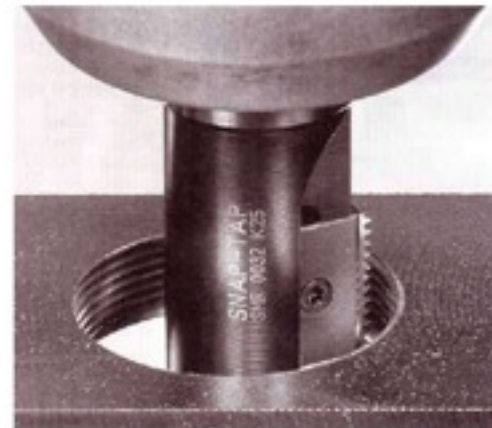
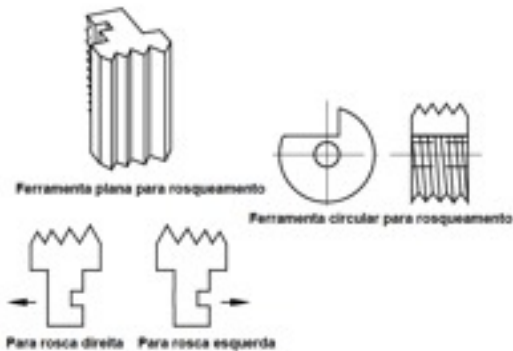


Retificação



Fresamento

Pentes de rosqueamento



Máquinas Ferramentas

- Máquinas Convencionais
- Máquinas Automáticas
- Máquinas de Comando Numérico
 - 3 eixos
 - 4 eixos
 - 5 eixos



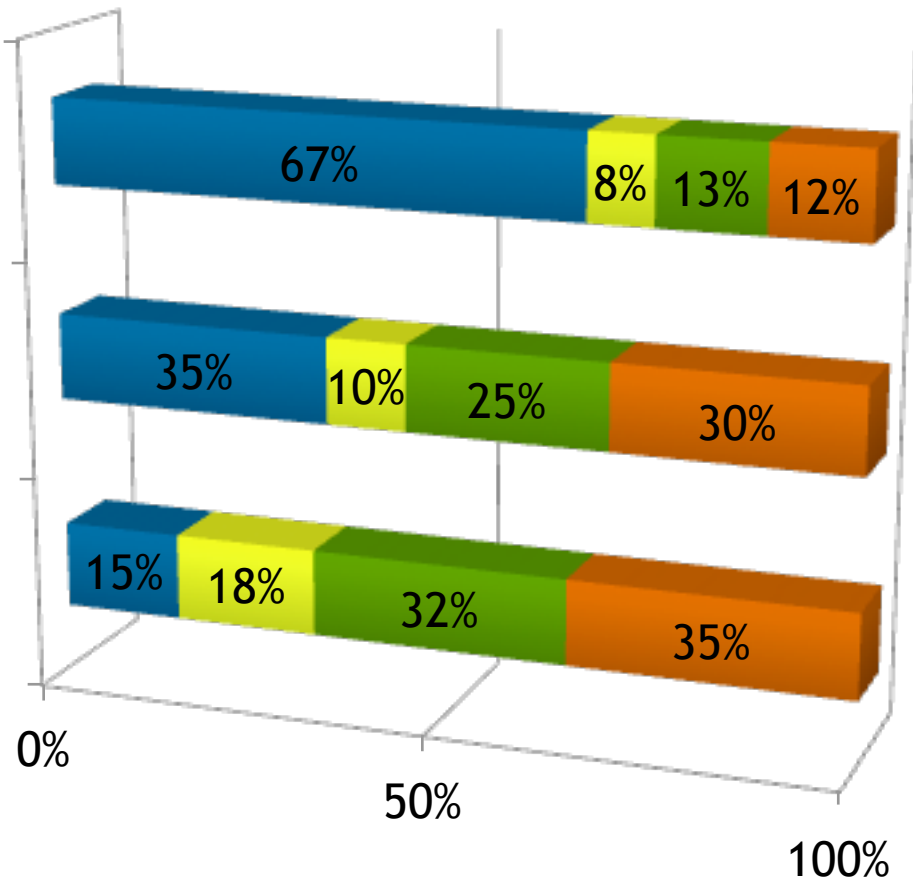
(Haas Automation)

- Usinagem
- Regulagens e Posicionamento
- Troca de Ferramenta
- Troca de Peça

M.F. CNC com troca de pallet e ferramenta

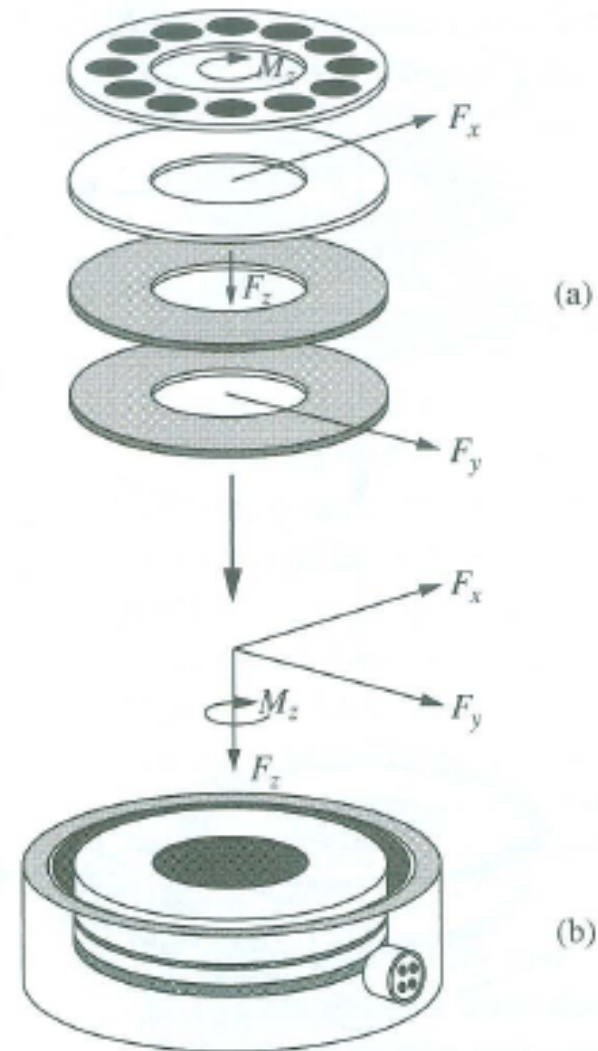
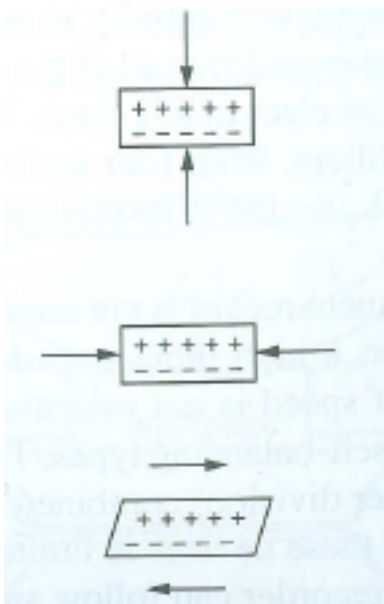
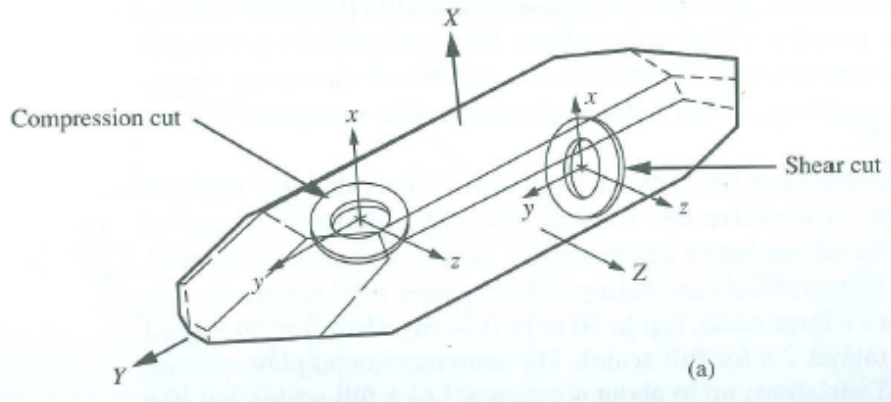
M.F. CNC

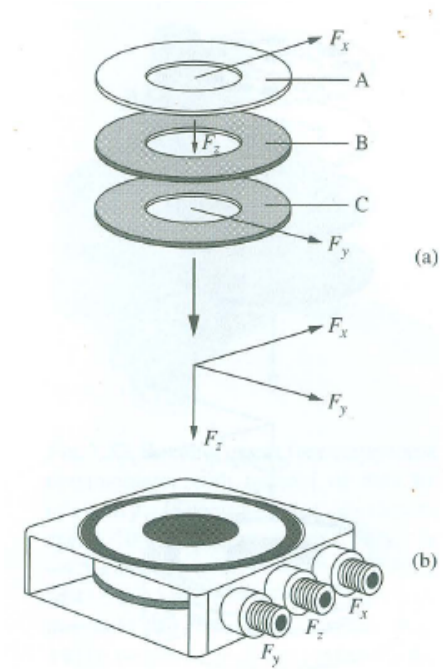
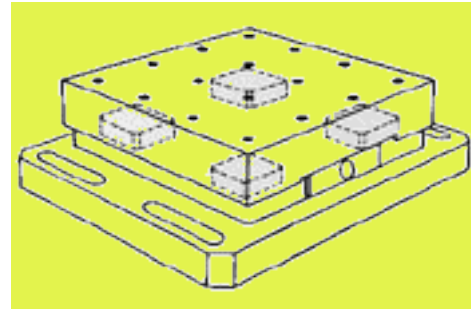
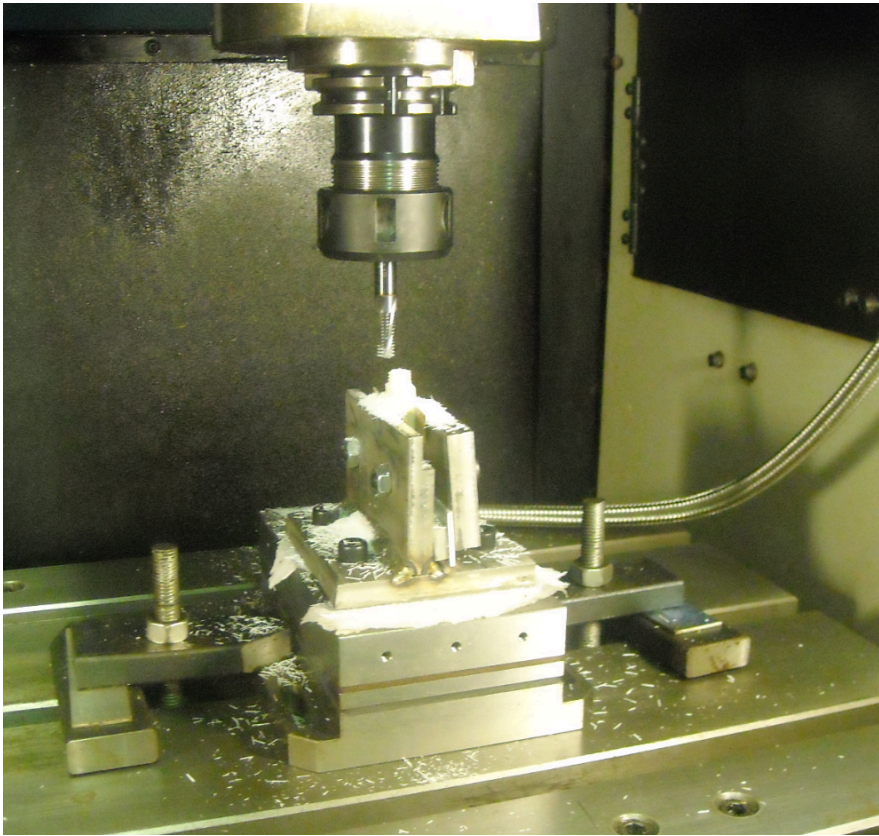
M.F. Convencional

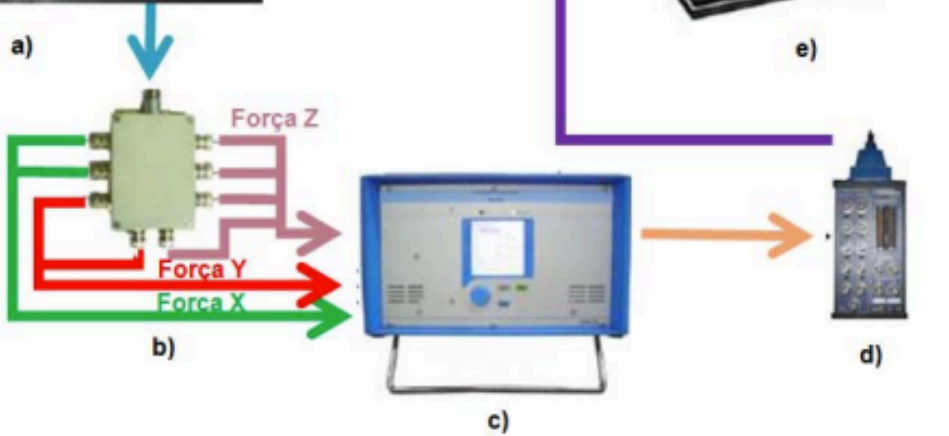
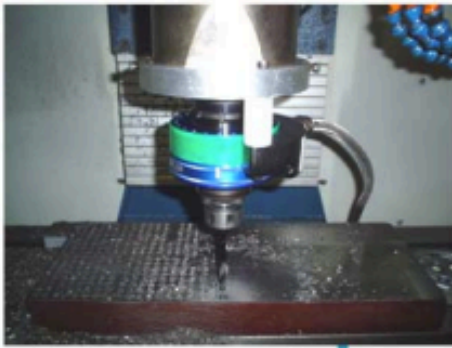


Dinamometria (Sensor Piezoelétrico)

Cristal de Quartzo







Dinamômetro

Condicionador
de Sinais

Placa de
Conversão
Analógica-
Digital

Computador
(Matlab,
Origin, etc)