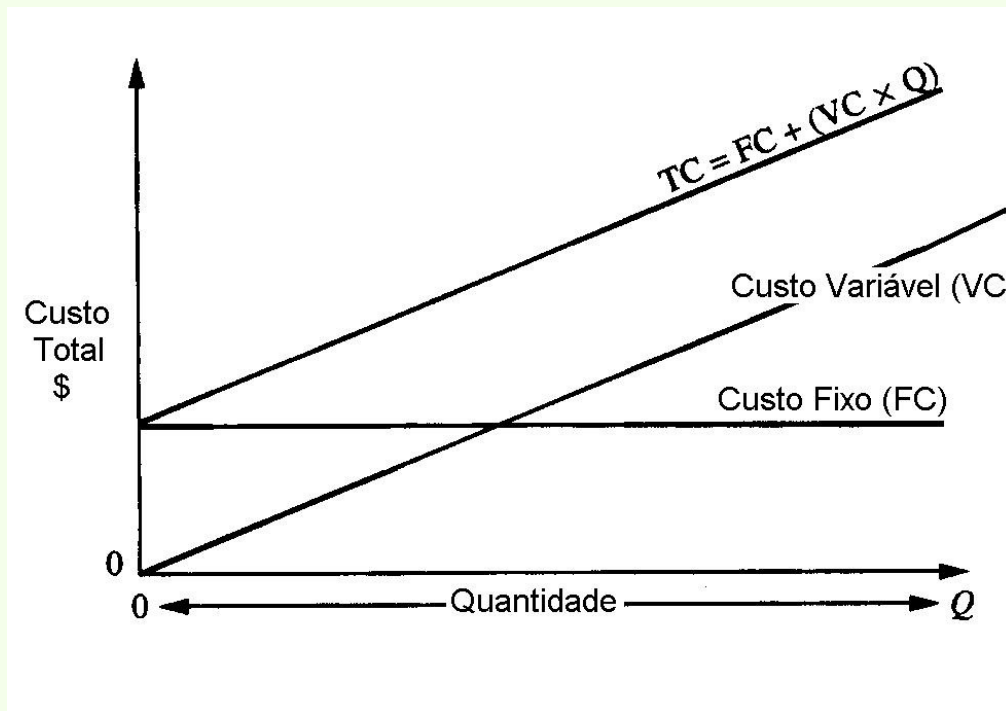


# **APÊNDICE:** **RETAD (*Rapid Exchange of Tools and Dies*)**



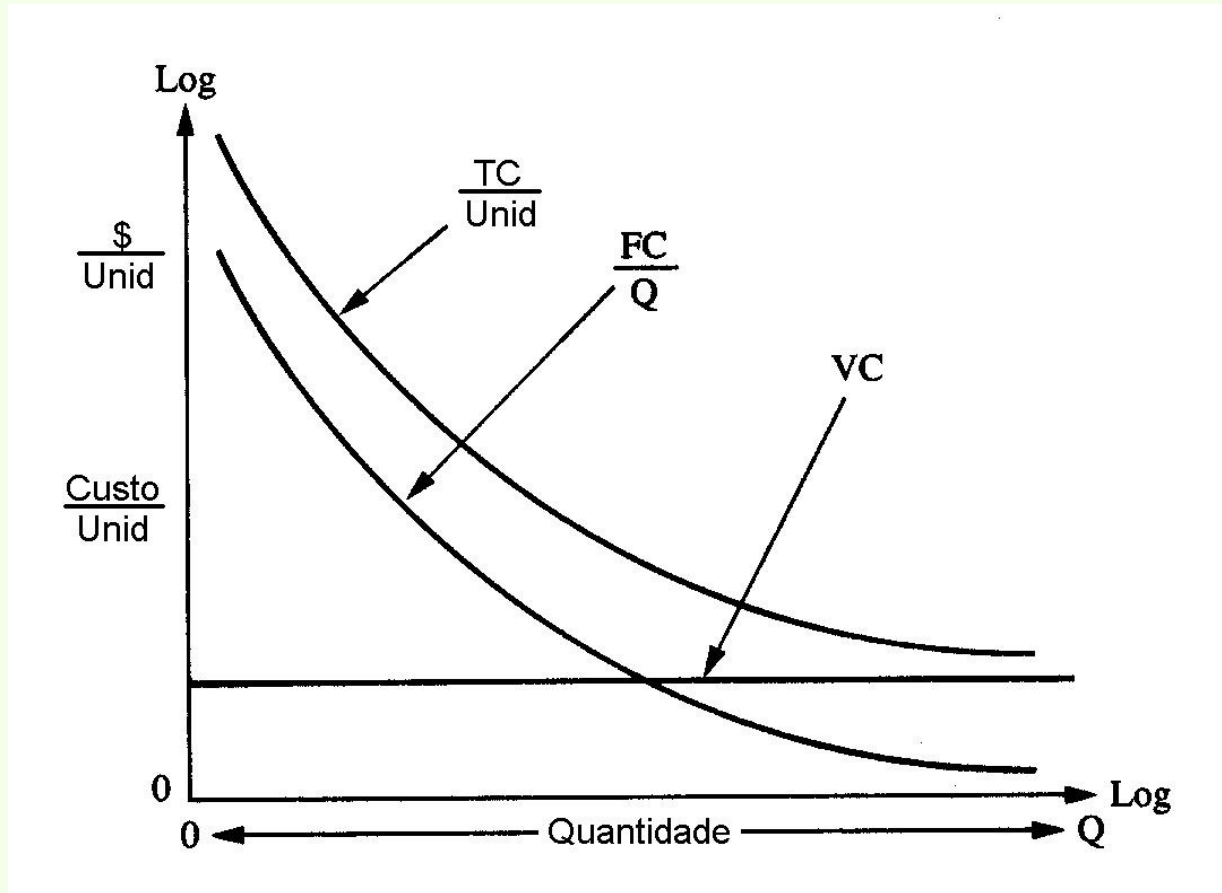
$$TC = FC + (VC \times Q)$$

- onde:
  - TC = custo total de fabricar uma peça
  - FC = custo fixo
  - VC = custo variável por unidade
  - Q = quantidade a ser fabricada

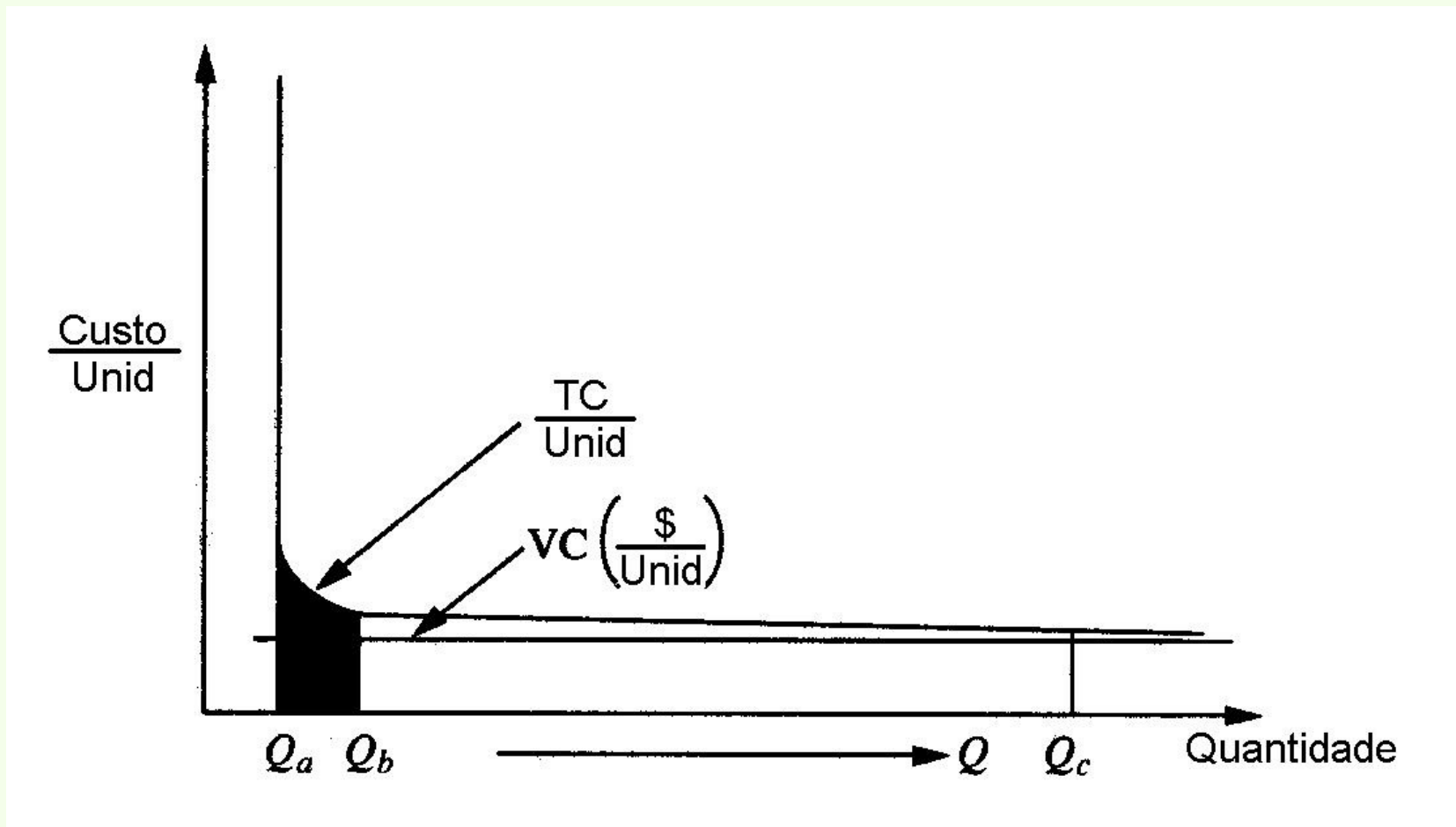


*Representação clássica do custo total versus a quantidade*

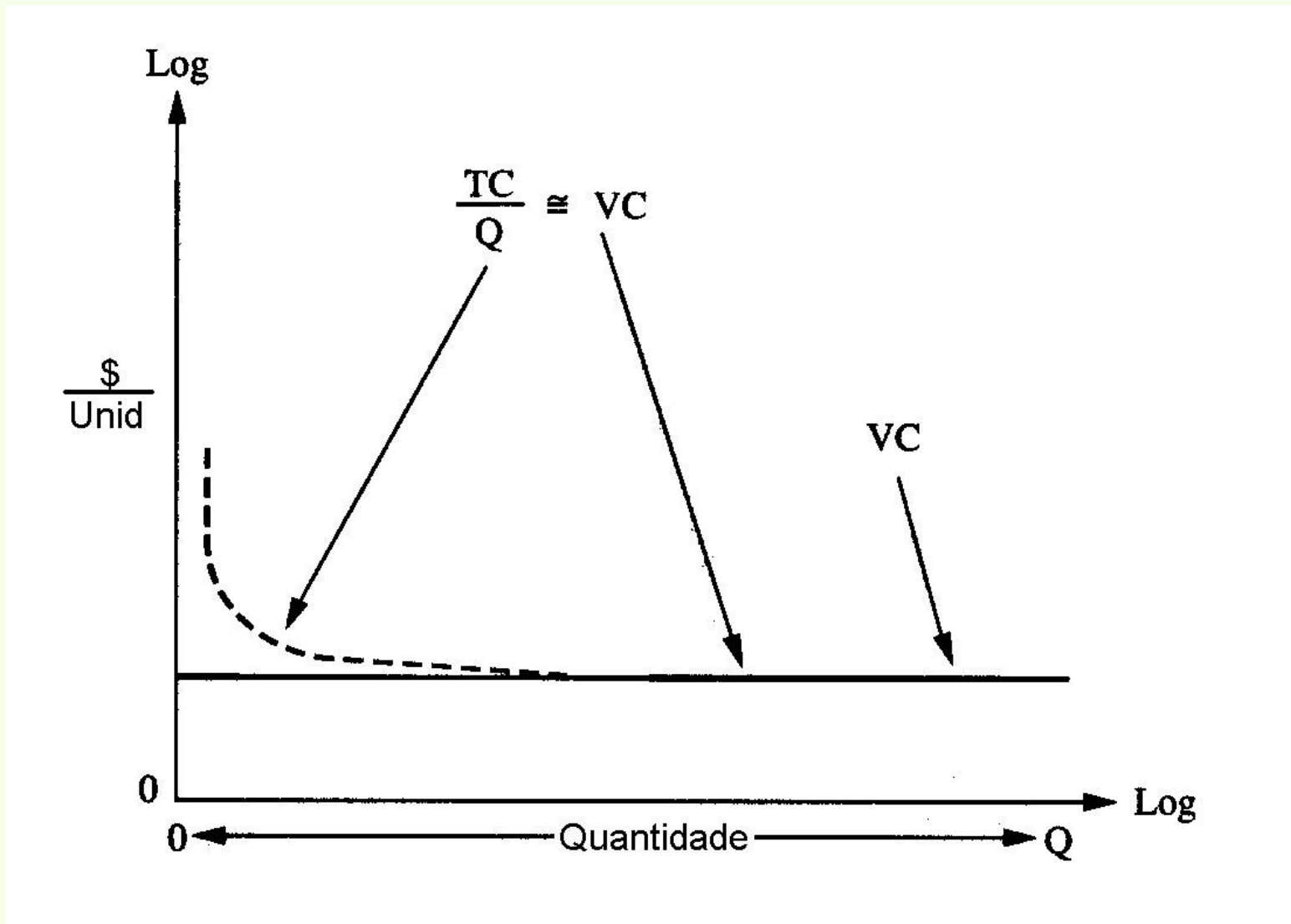
$$\frac{TC}{Q} = \frac{FC}{Q} + VC$$



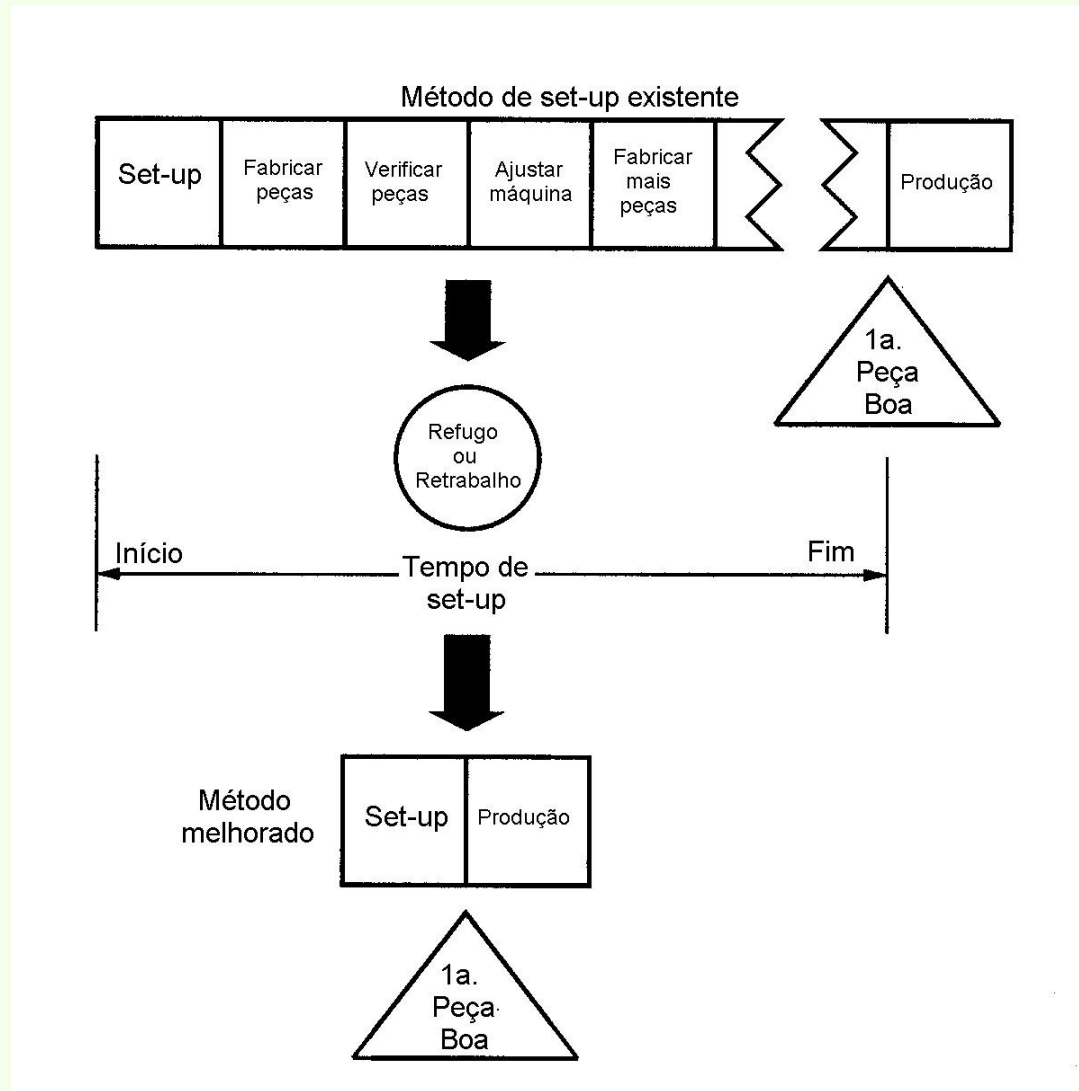
*Modelo do custo por unidade versus a quantidade, plotado em papel log-log ou semi-log*



*Figura real do custo por unidade versus a quantidade, plotado em coordenadas cartesianas*



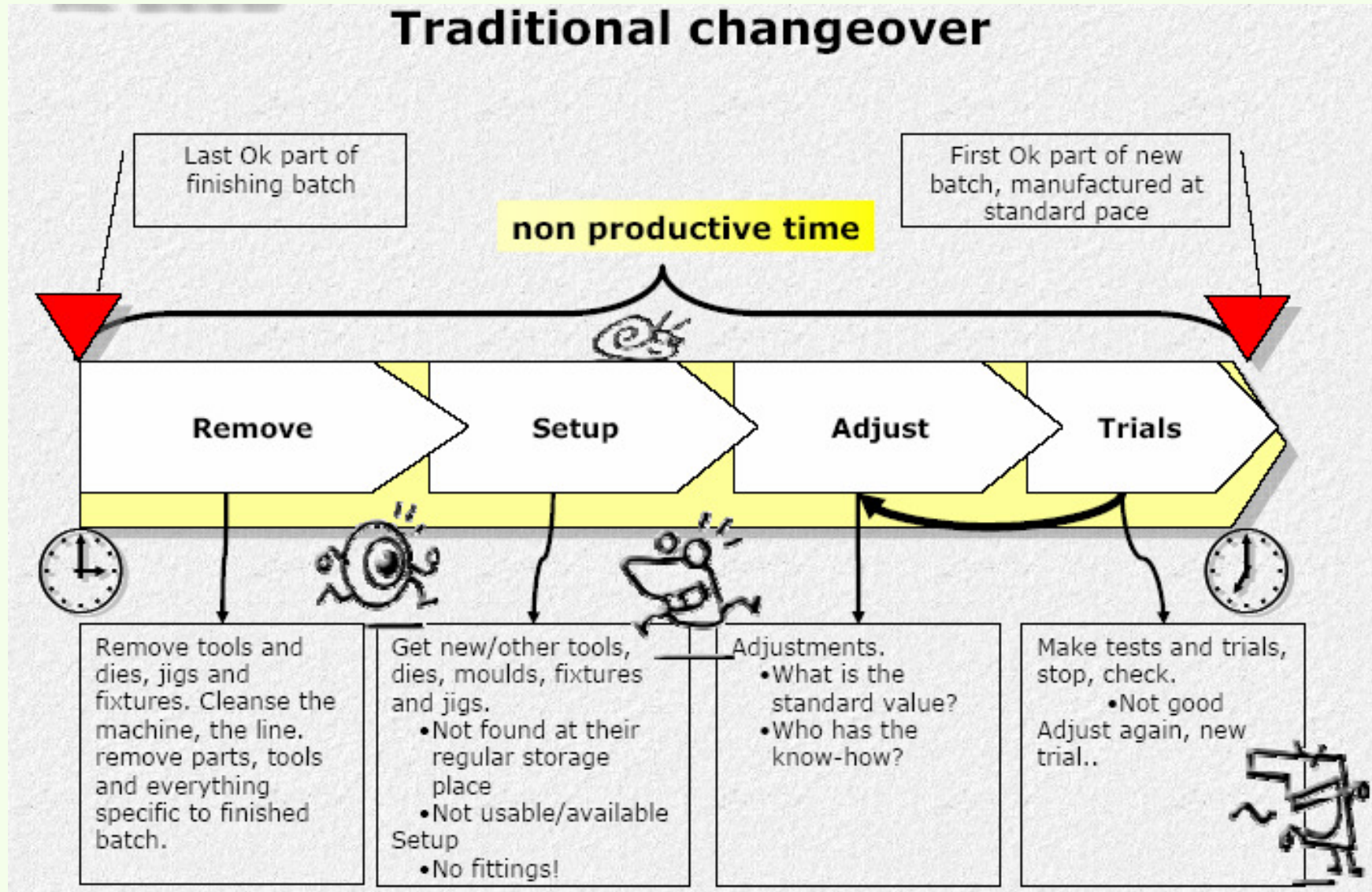
*Efeito do custo de set-up sobre o custo por unidade*



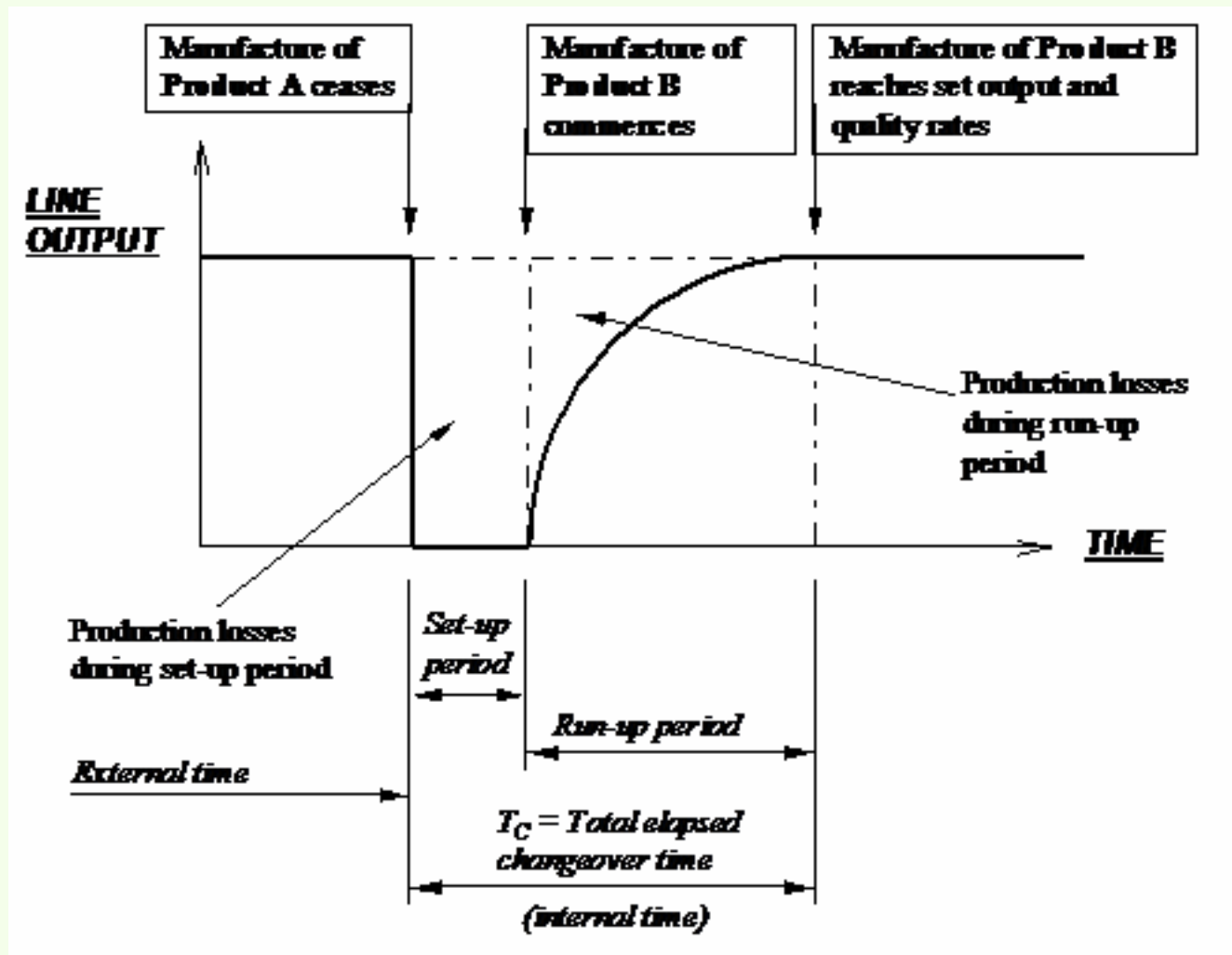
*Método melhorado do set-up reduz o tempo de set-up através da eliminação de elementos desnecessários como o ajuste*



## Traditional changeover







*Set-up time refers to the time taken to physically make the changes to the line in order to run the new product,*

*Run-up time is the time taken to make adjustments to the line in order to produce products of the specified quality at the specified production speed.*

*Changeover reduction simply refers to attempts to reduce the time taken to carry out the changeover process.*

- Tempo de Setup
  - Da última peça do tipo “A” até a primeira peça do tipo “B”, aprovada e liberada para a produção.

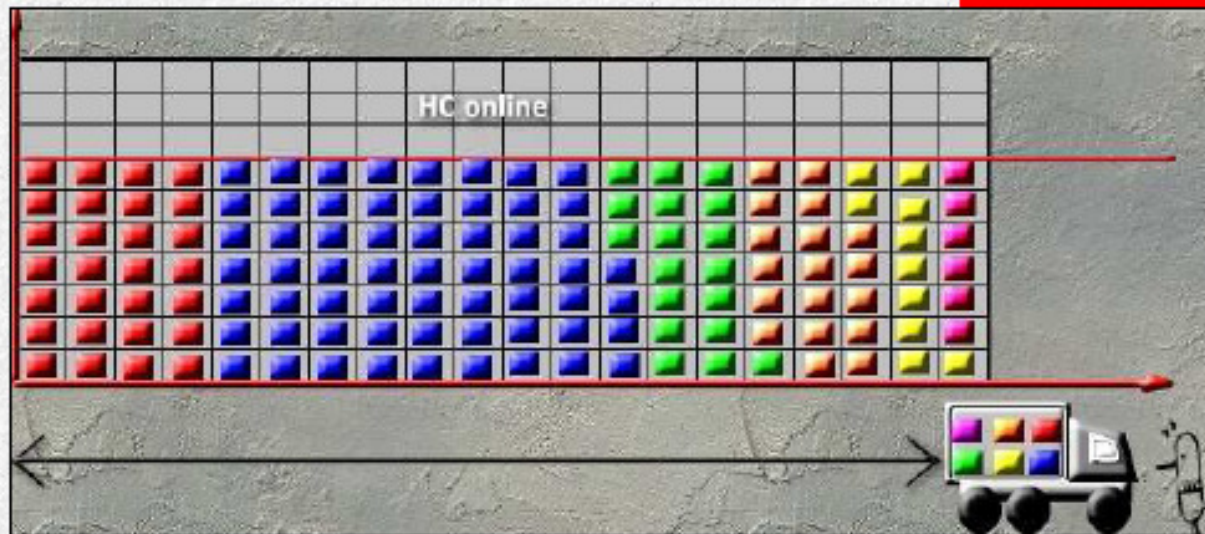
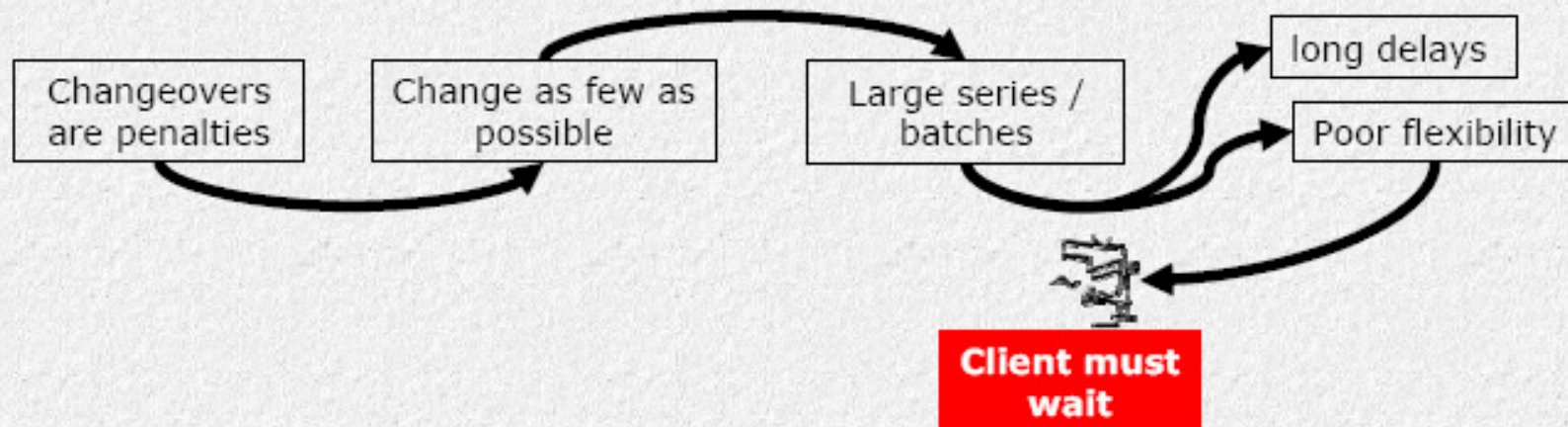
•08:45 •09:00 •09:15 •09:30 •09:45 •10:00 •10:15 •10:30 •10:45 •11:00 •11:15 •11:30 •11:45 •12:00 •12:15 •12:30



- |                  |                  |                      |
|------------------|------------------|----------------------|
| • Parar Produção | • Fixar          | • Fazer Amostras     |
| • Retirar        | • Ajustar        | • Aprovar            |
| • Preparar       | • Fazer Amostras | • Liberar            |
| • Posicionar     | • Reajustar      | • Reiniciar Produção |

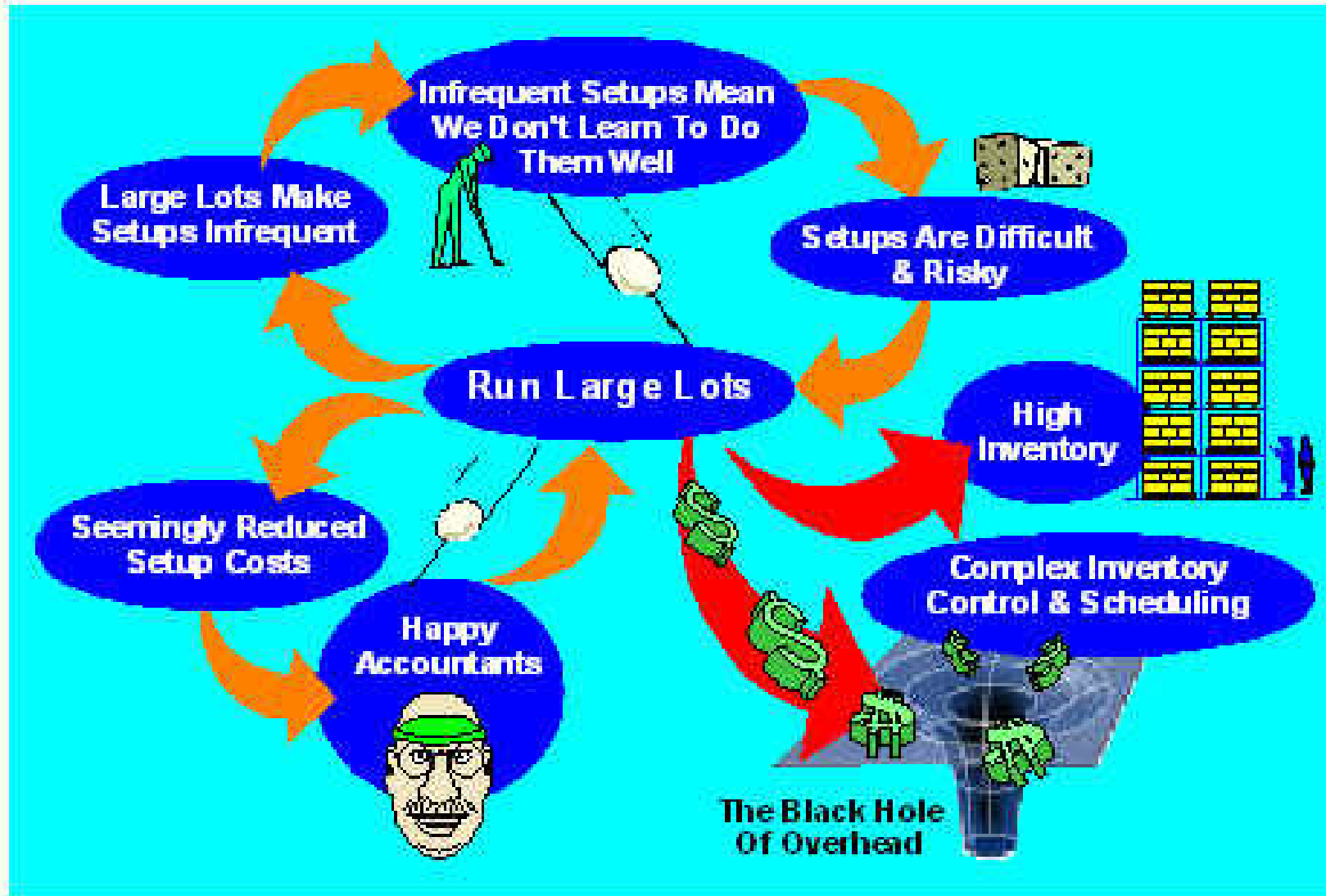
- Setup Interno - São todas as tarefas que, para serem executadas o equipamento deve estar parado
- Setup Externo - São as tarefas que podem ser realizados enquanto o equipamento ainda está produzindo o lote anterior

## Consequences of lengthy changeovers

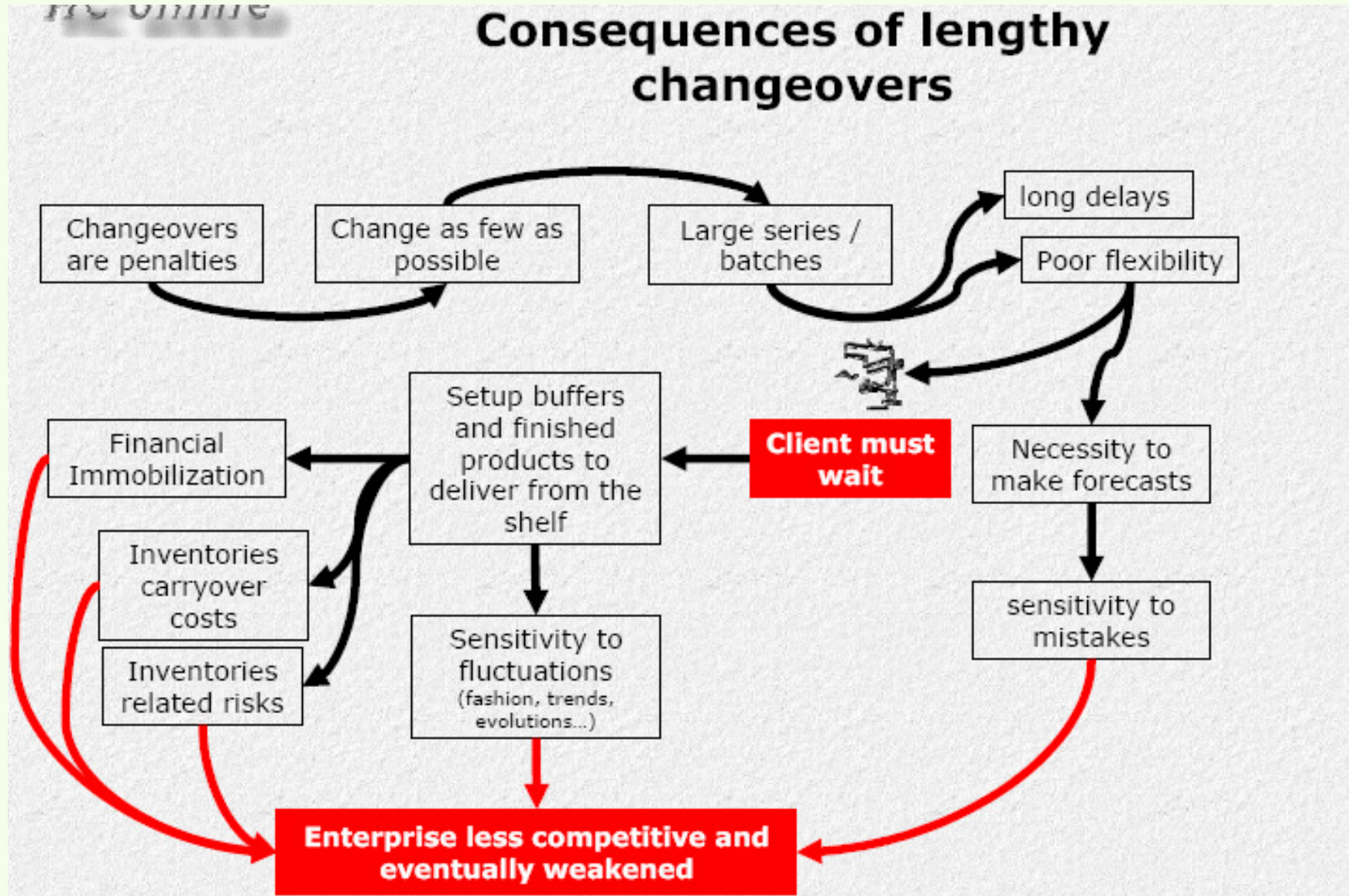


### Example of delay

One column represents one working day of seven hours (lines).  
To get a mixed batch of six different references, the client has to wait 20 days (delivery free of charge), while time really necessary to manufacture this order is 6 hours.

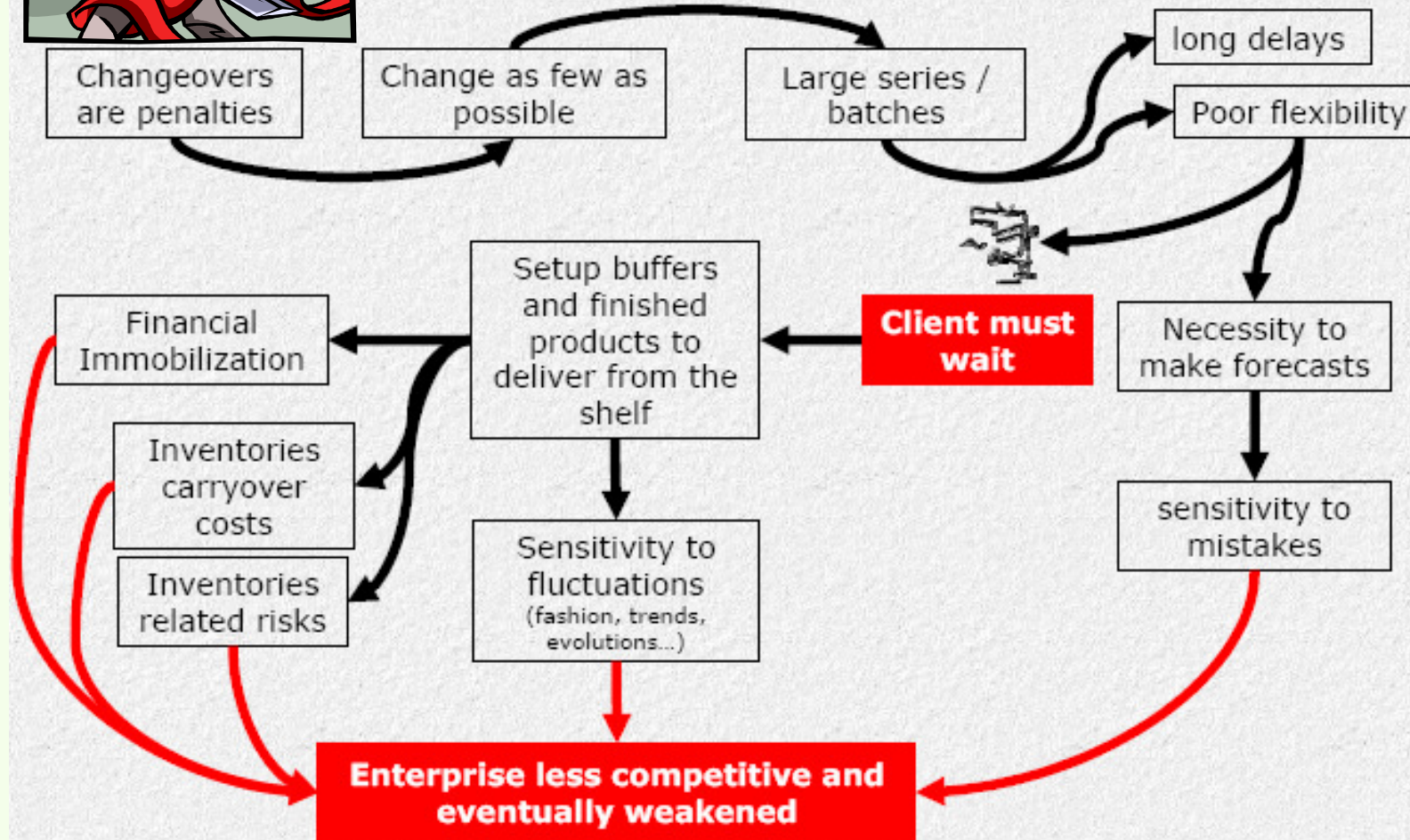








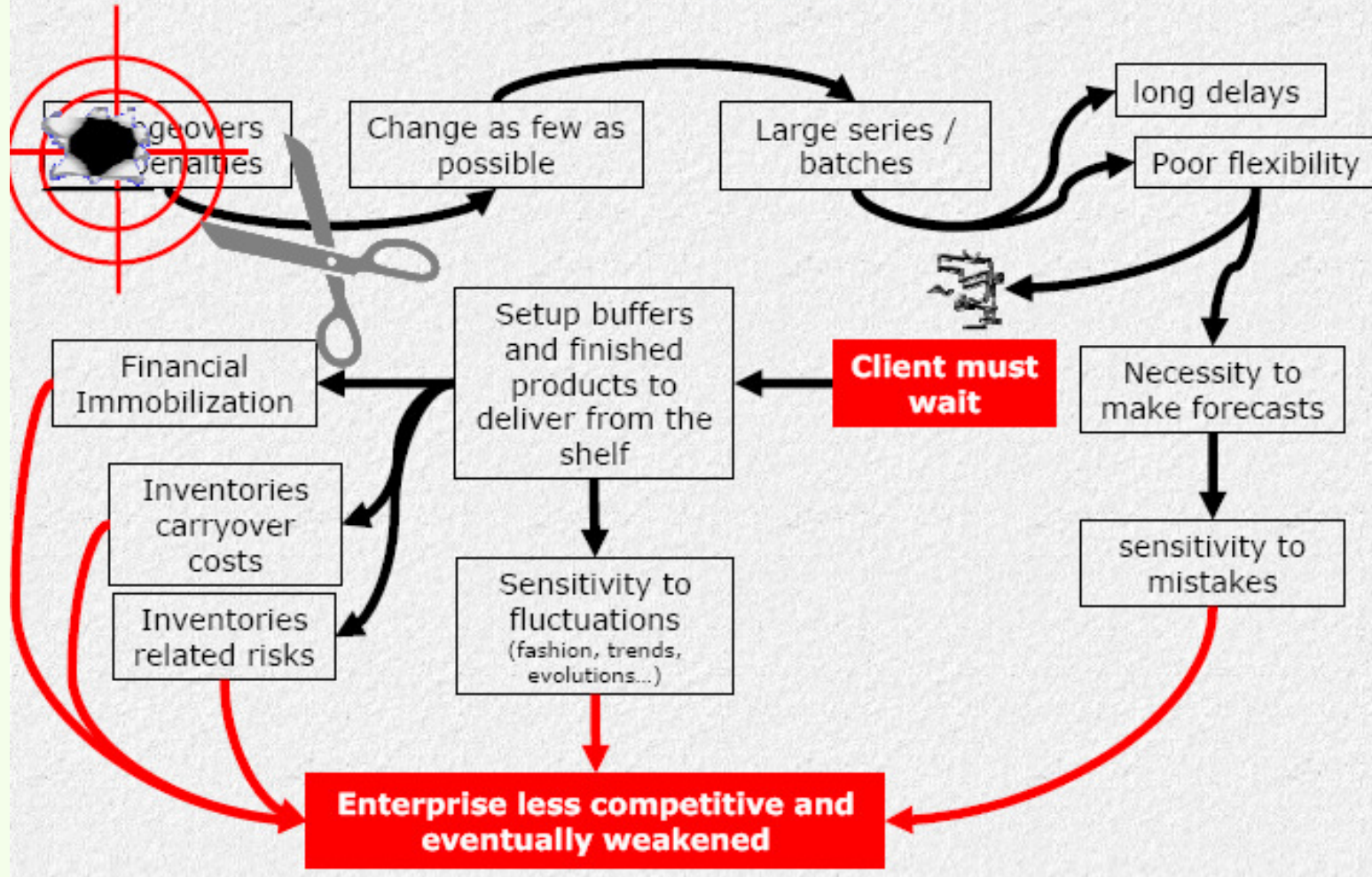
## Consequences of lengthy changeovers

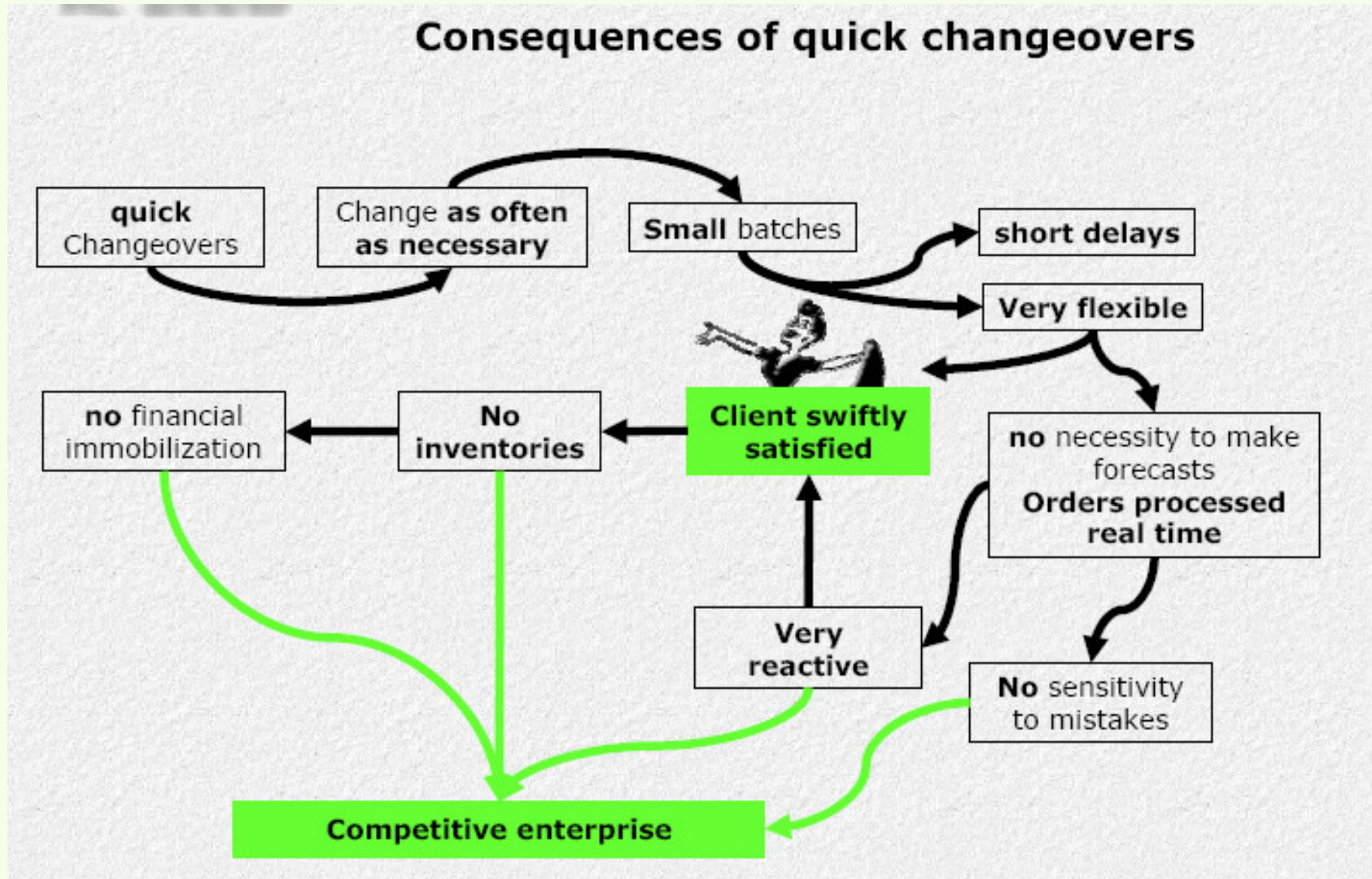


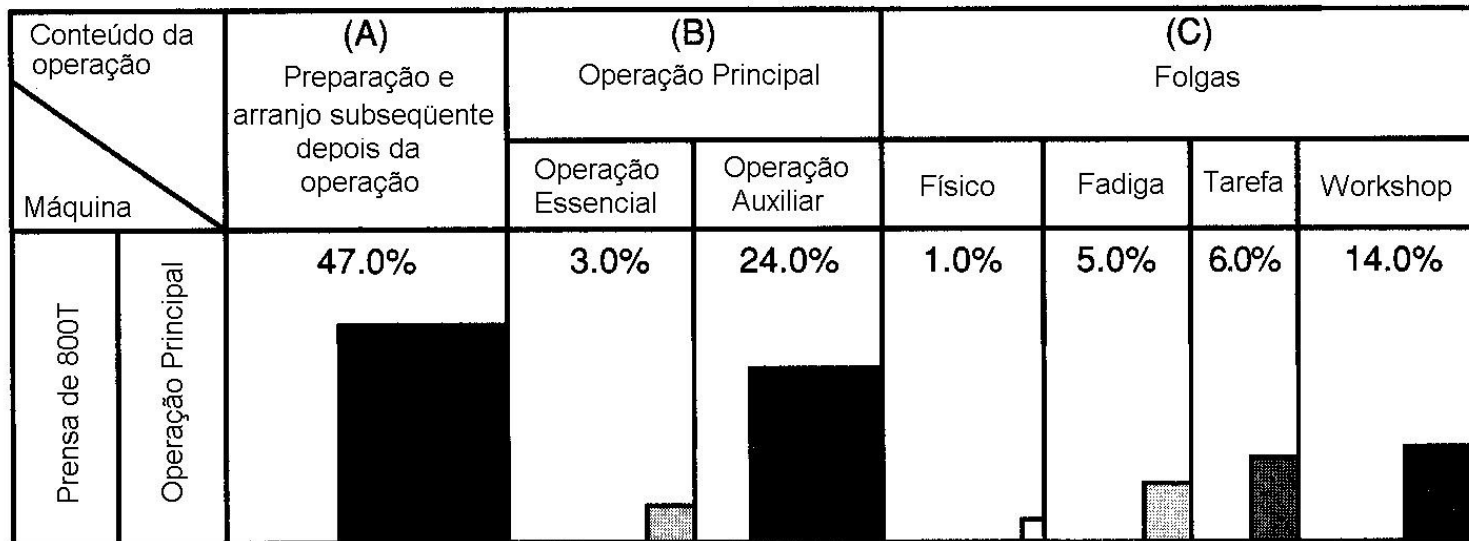


Single Minute Exchange of Dies

# Implementing **SMED** is cutting the chain of **negatives** consequences



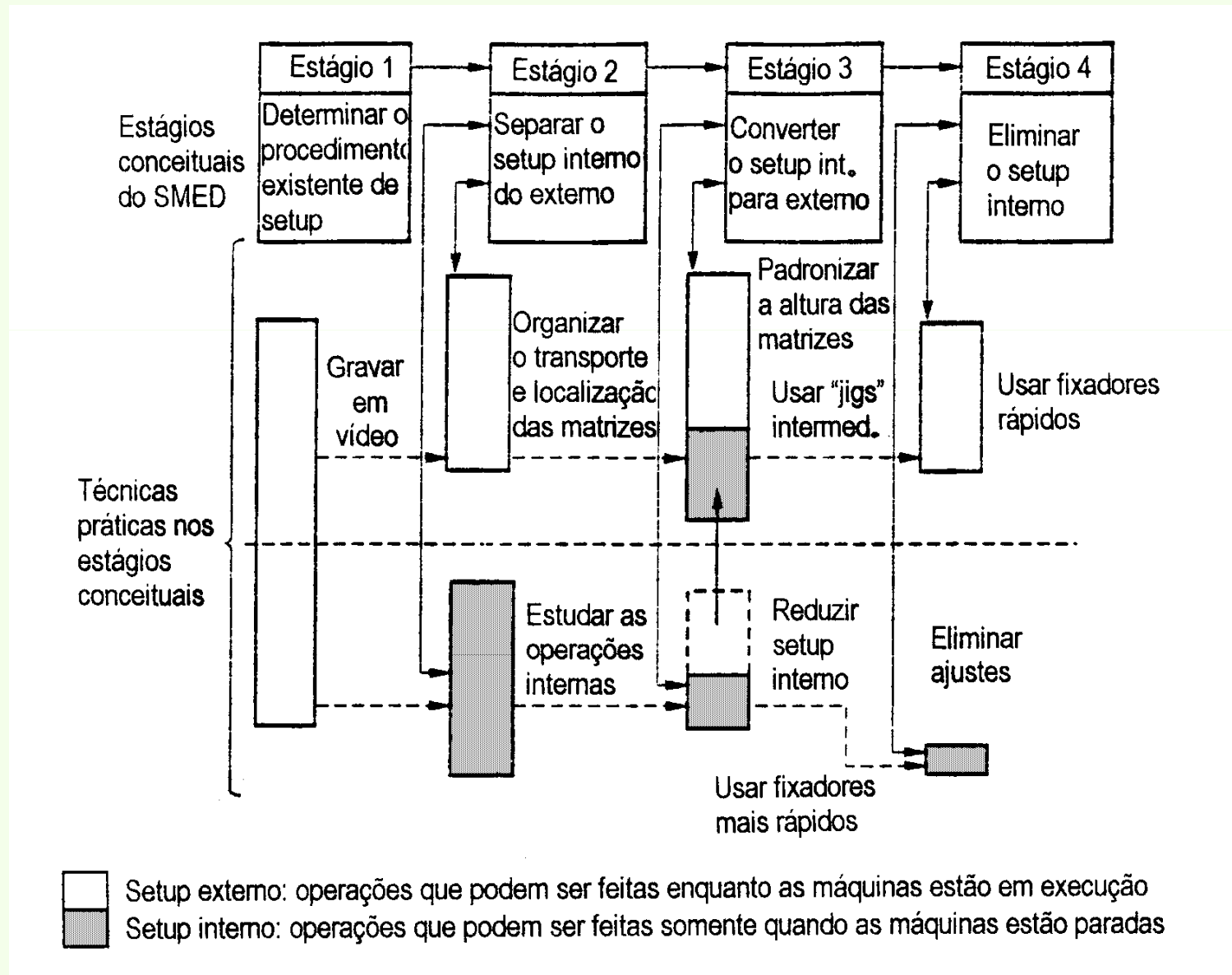




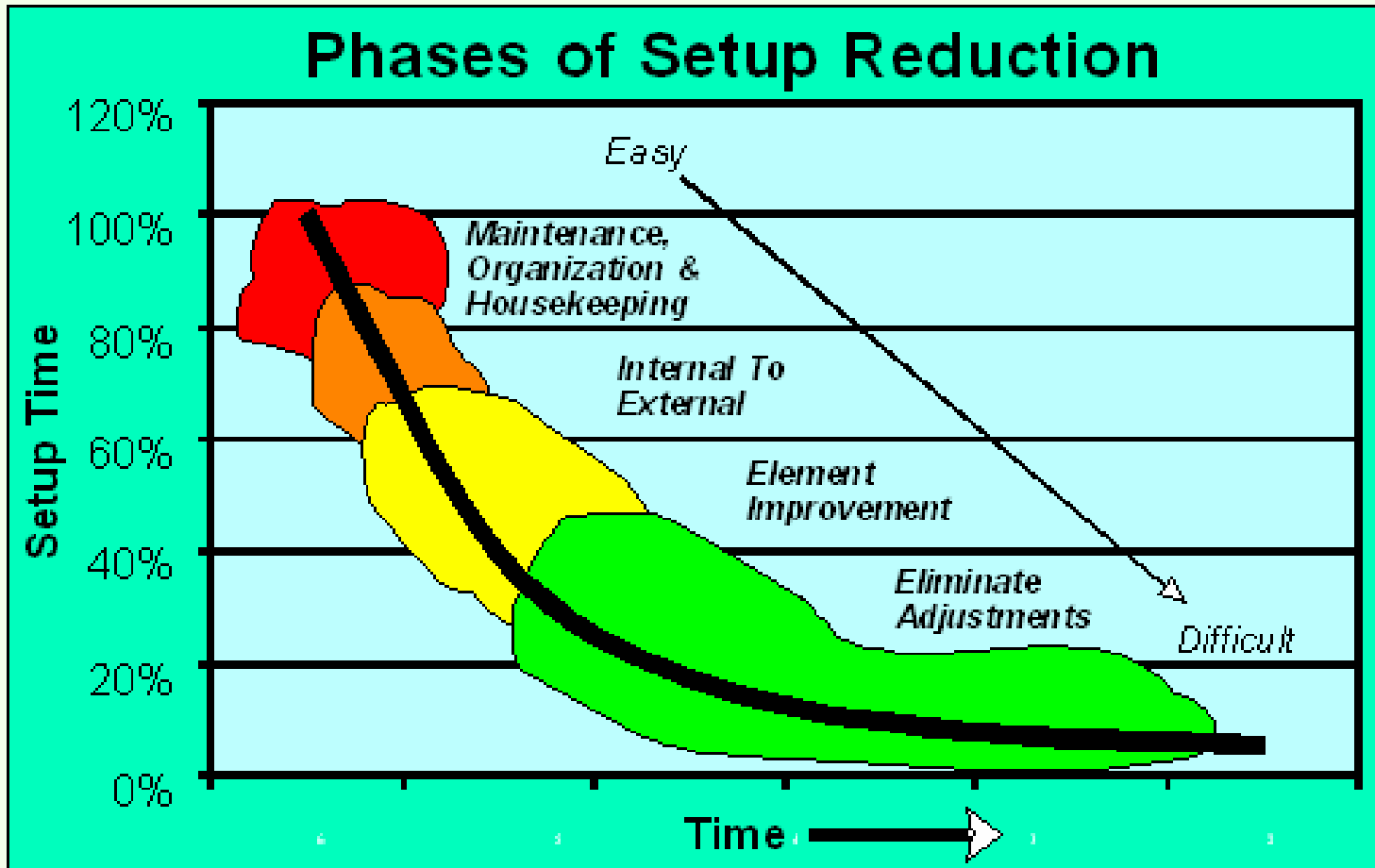
Elementos que compõem (A)		
	sec.	%
transporte da matriz	869	3.5
fixação da matriz	2940	11.7
ajuste	5475	21.7
remoção da matriz	1789	7.2
miscelâneos	610	2.4
		<u>47.0</u>

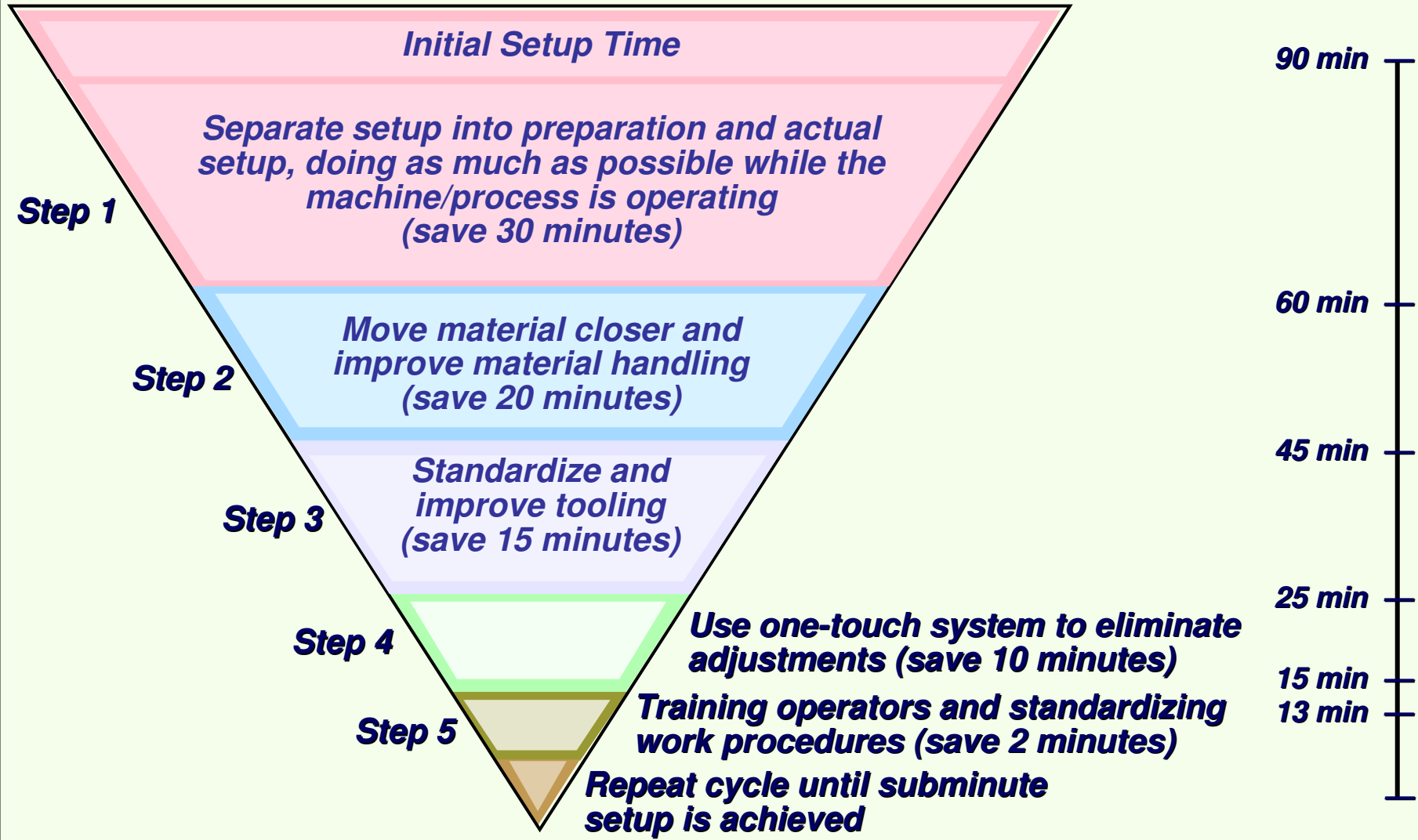
*Análise das operações numa prensa de 800 toneladas*



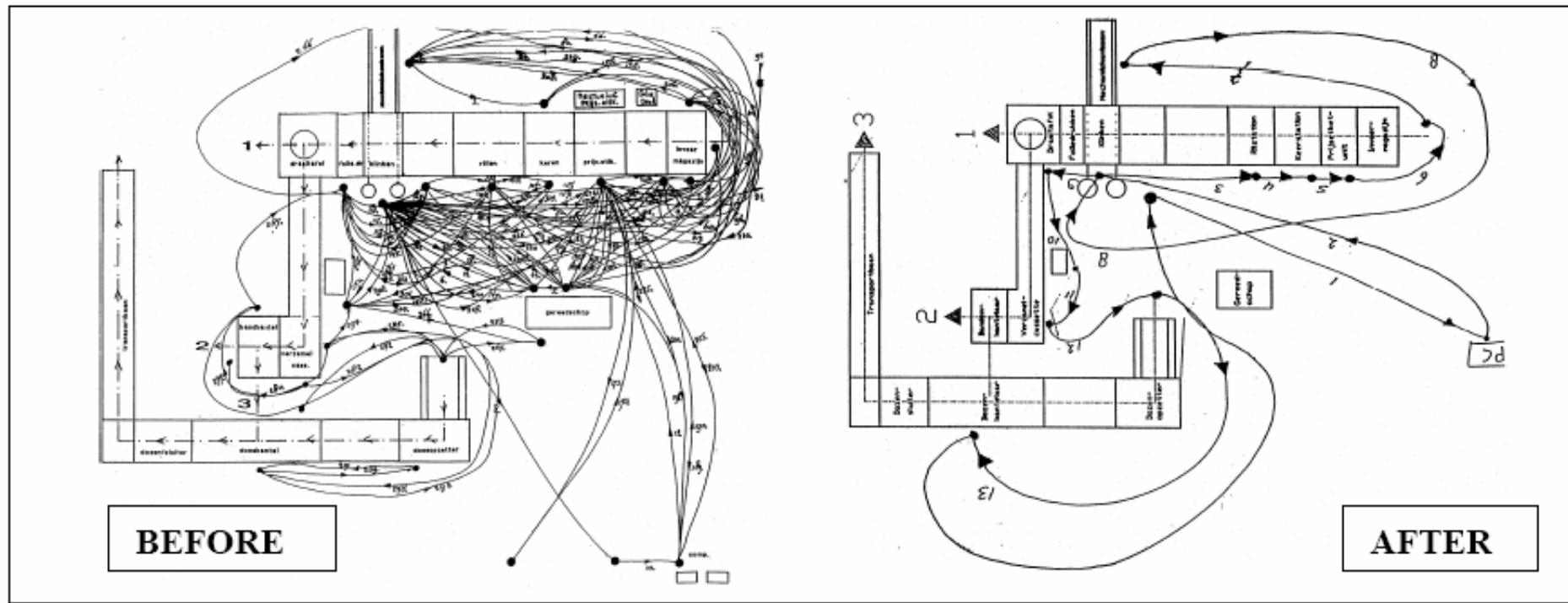


Estágios conceituais e técnicas práticas do sistema SMED (desenvolvido por S. Shingo, 1985)







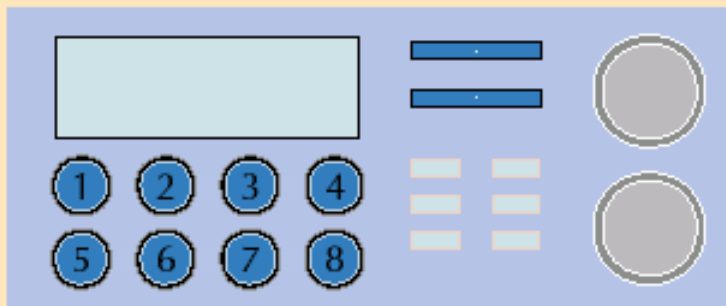


*Routing diagram before and after changing the order of activities. The 'before' picture was an actual set-up as performed by one person in an office supply factory.*





Preset desired settings



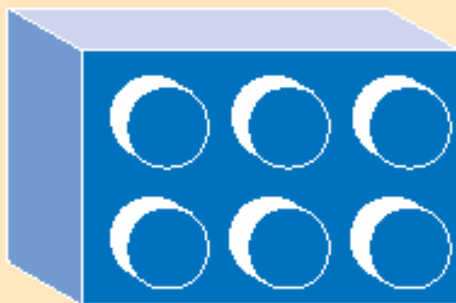
... like the stations on your car radio.

Use quick fasteners



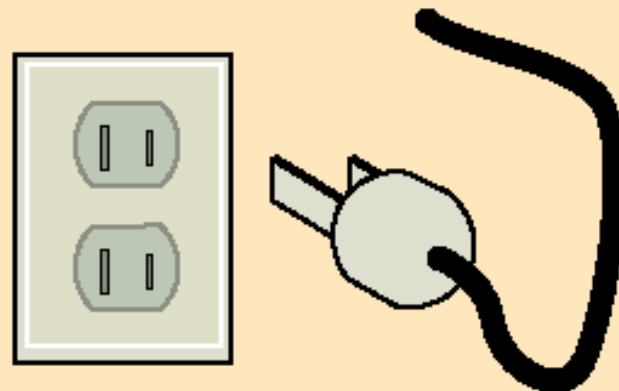
... like key rings that allow keys to be added easily.

Use locator pins



... like Lego blocks

Prevent misalignment



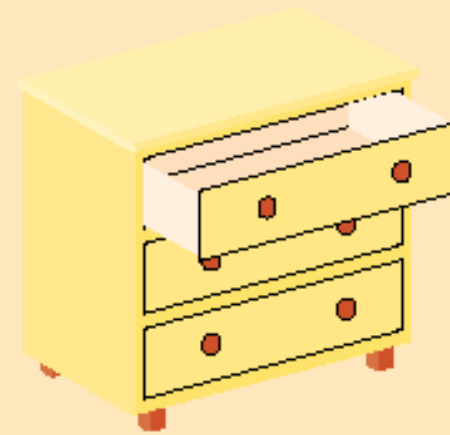
... like electrical plugs with one longer prong

Eliminate tools



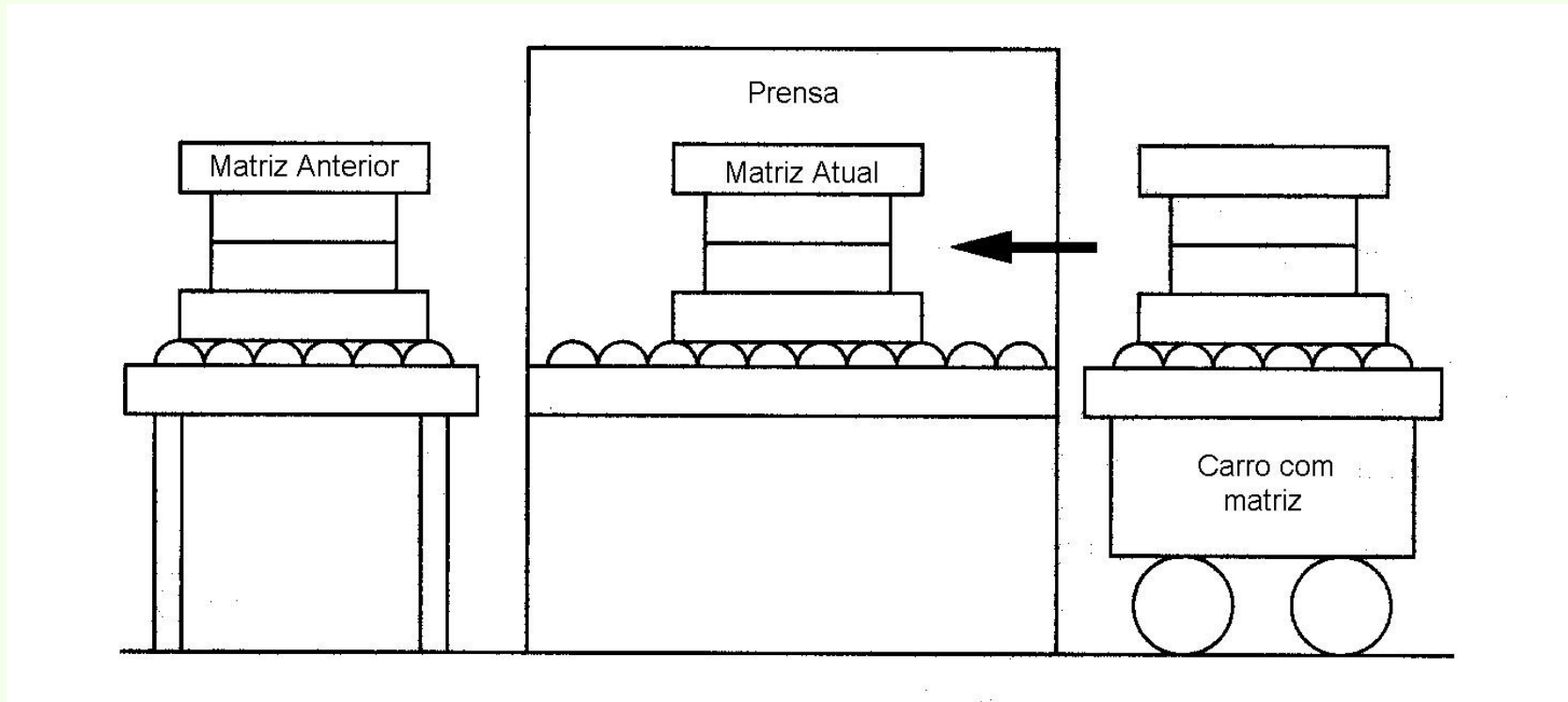
... like snap on connectors for computers.

Make movements easier

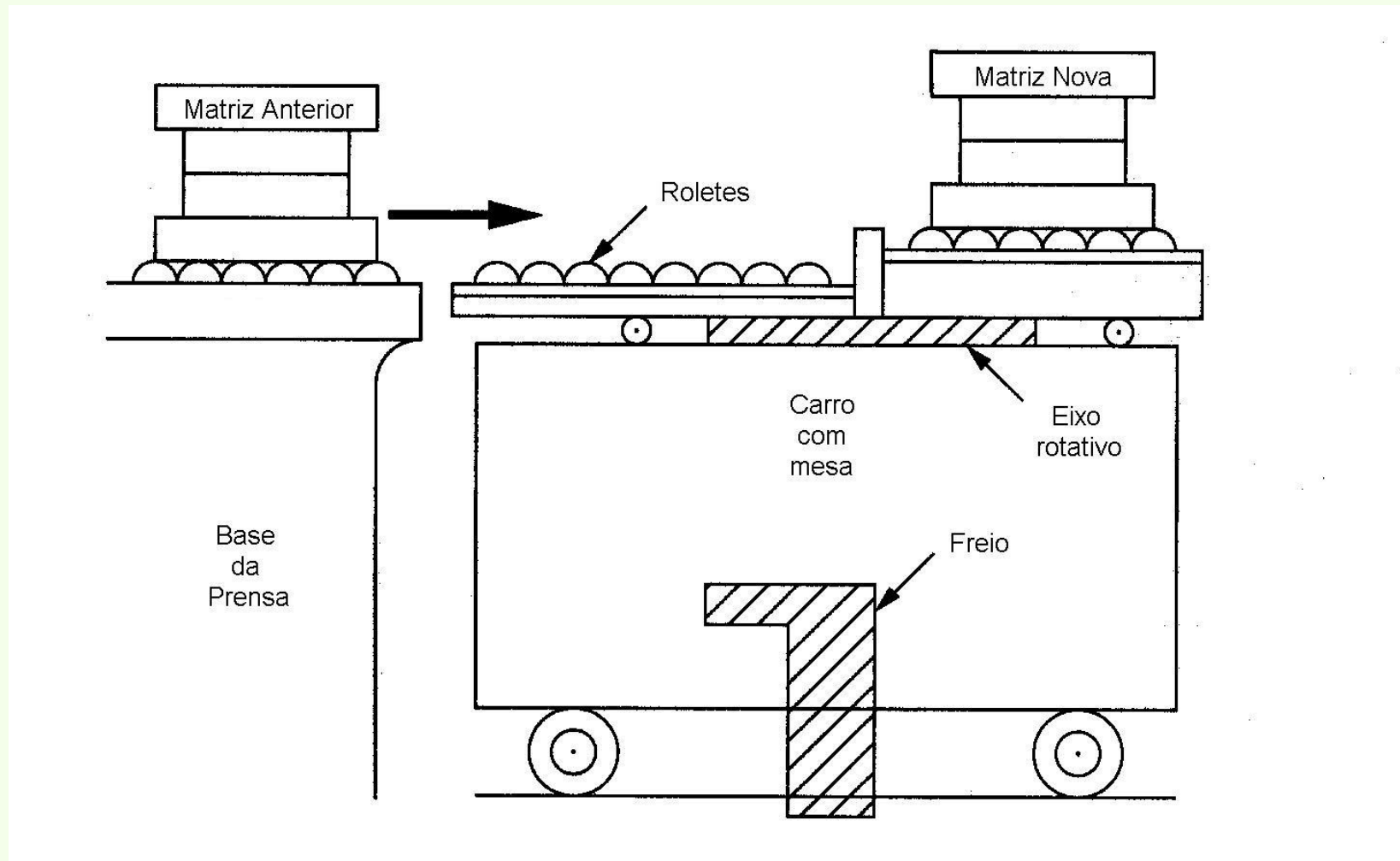


... like exchanging the drawers in your dresser.

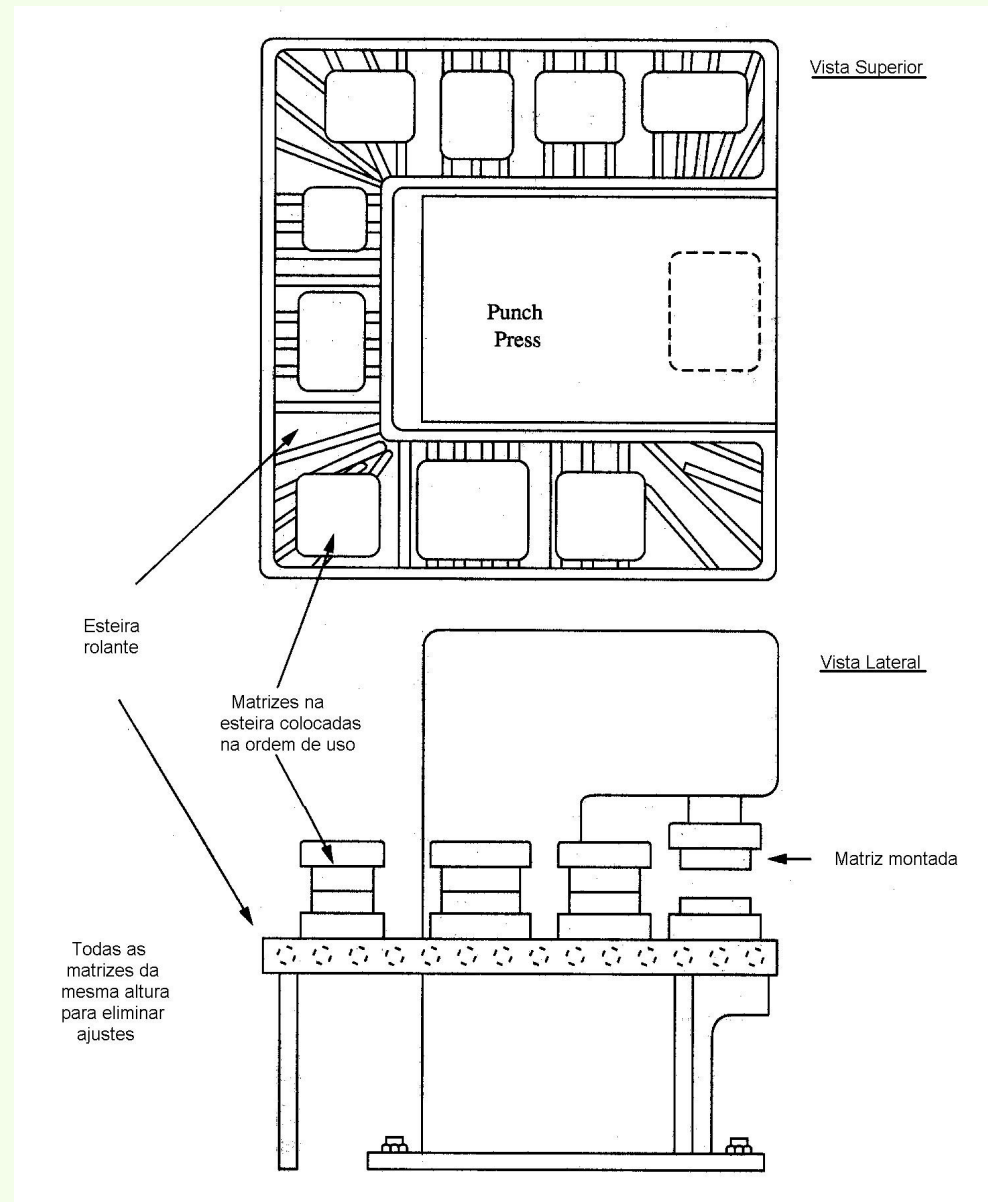




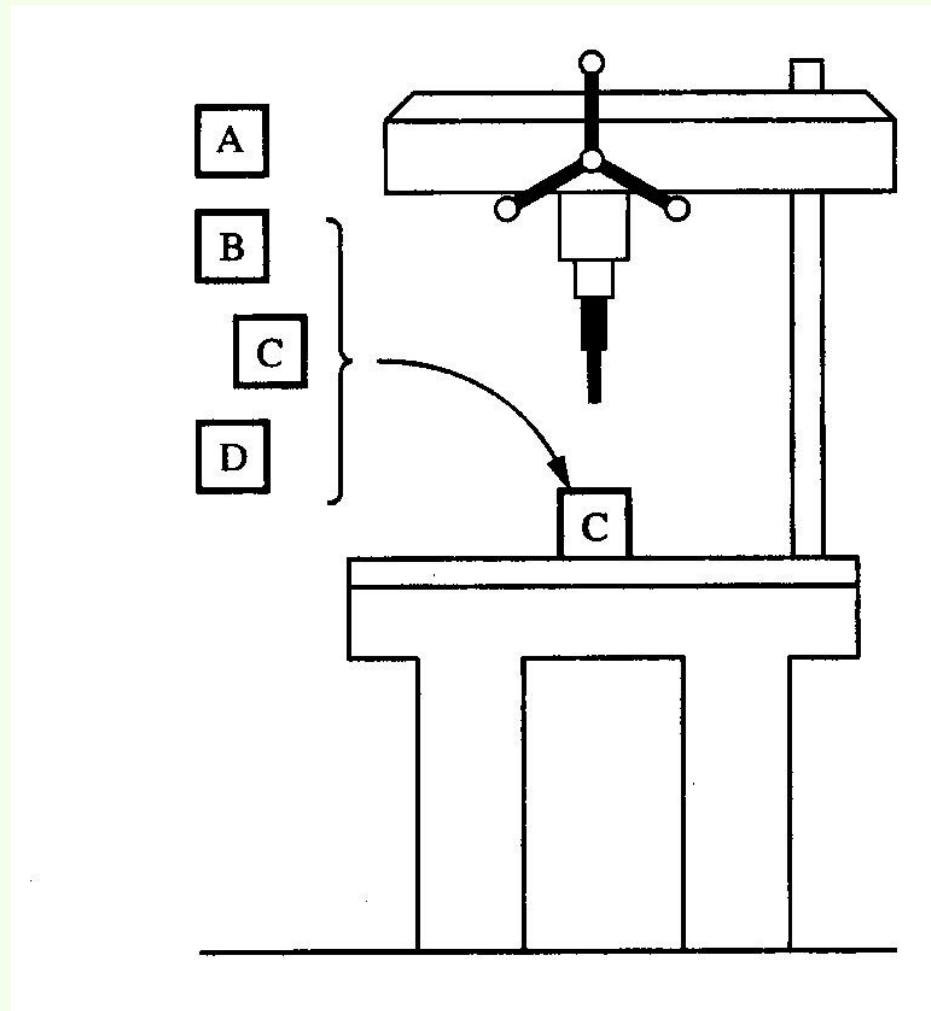
*Roletes podem ser usados para trocar matrizes visando reduzir o tempo de set-up interno*



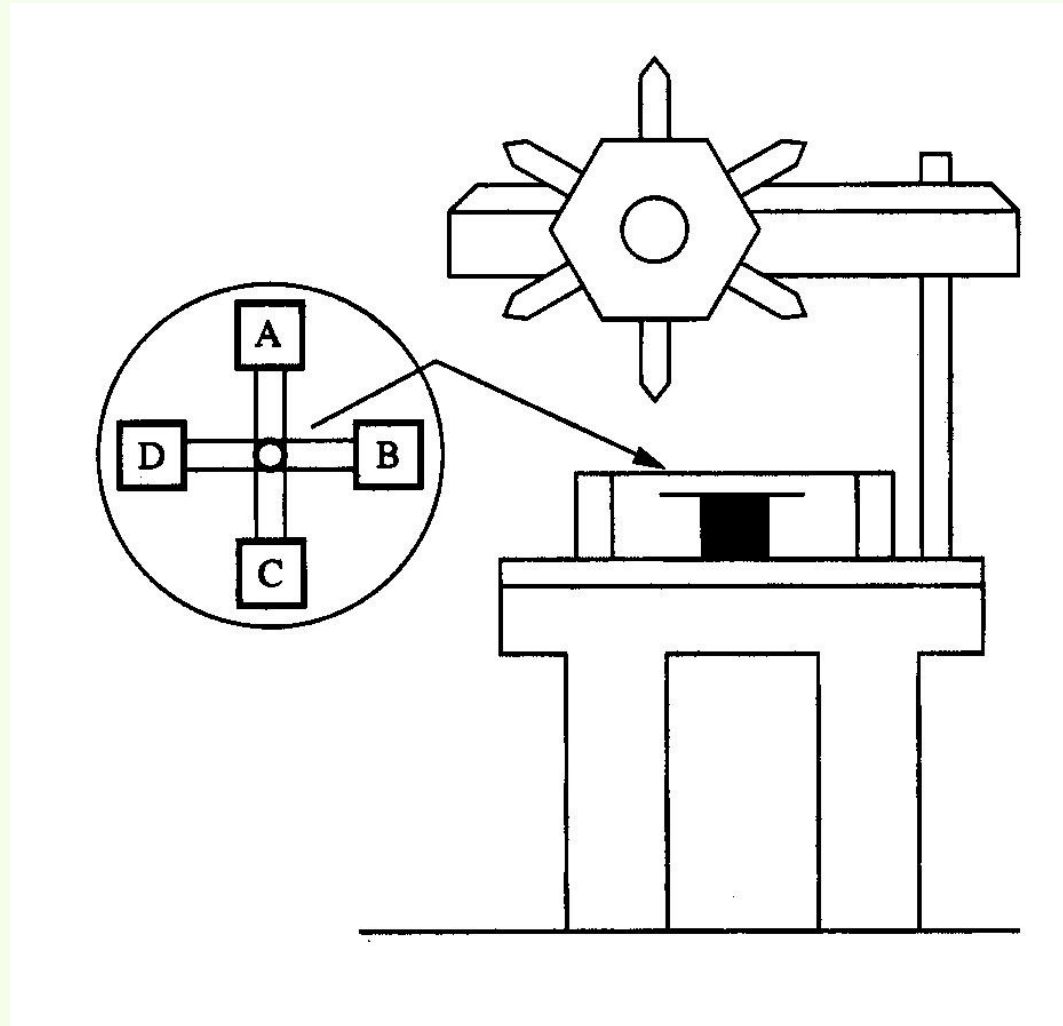
*Um carro para troca de matrizes que comporta tanto a matriz anterior como a atual numa mesa giratória, adicionando flexibilidade ao processo de troca de matrizes*



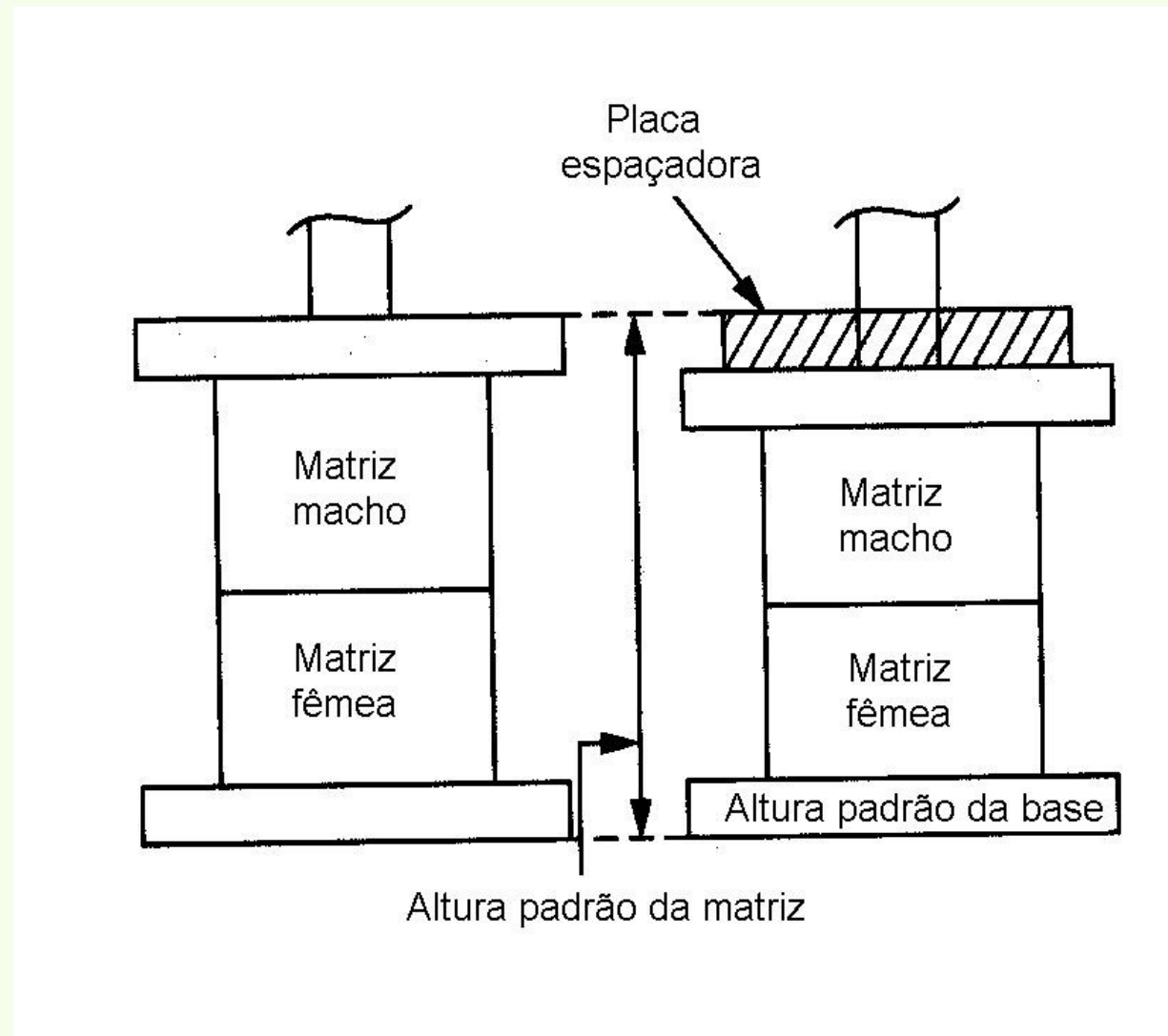
*Prensa equipada com uma esteira rolante para a troca rápida de matrizes*



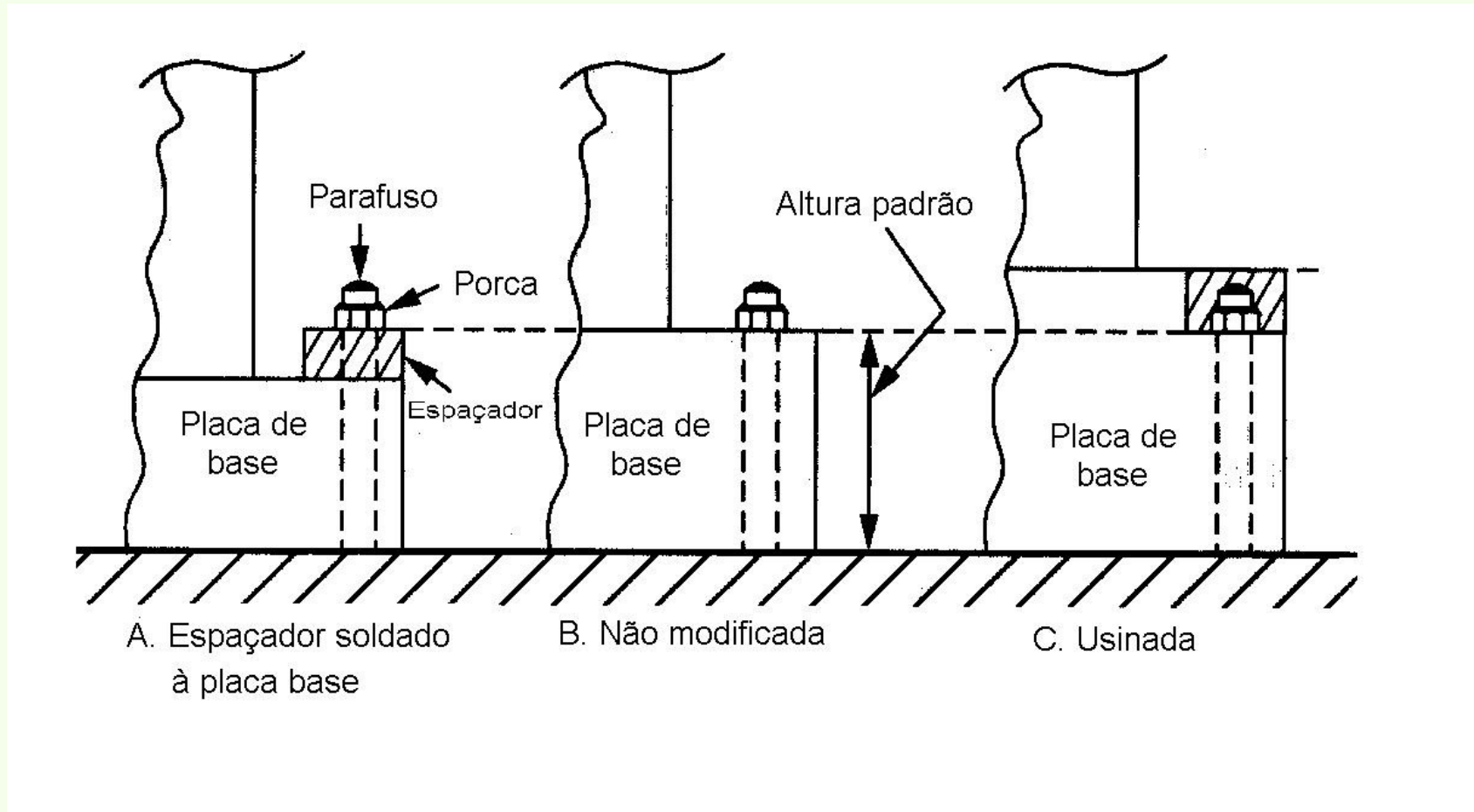
*Situação em que uma máquina tem quatro tarefas com quatro dispositivos de fixação diferentes, que demandariam quatro fixações diferentes, cada uma consistindo da troca de dispositivos e do alinhamento da ferramenta com a peça*



*Com o reprojeto, os quatro dispositivos são montados numa mesa e alinhados rapidamente. Um castelo revólver substitui a árvore e um dispositivo automático de avanço para baixo substitui a haste manual*

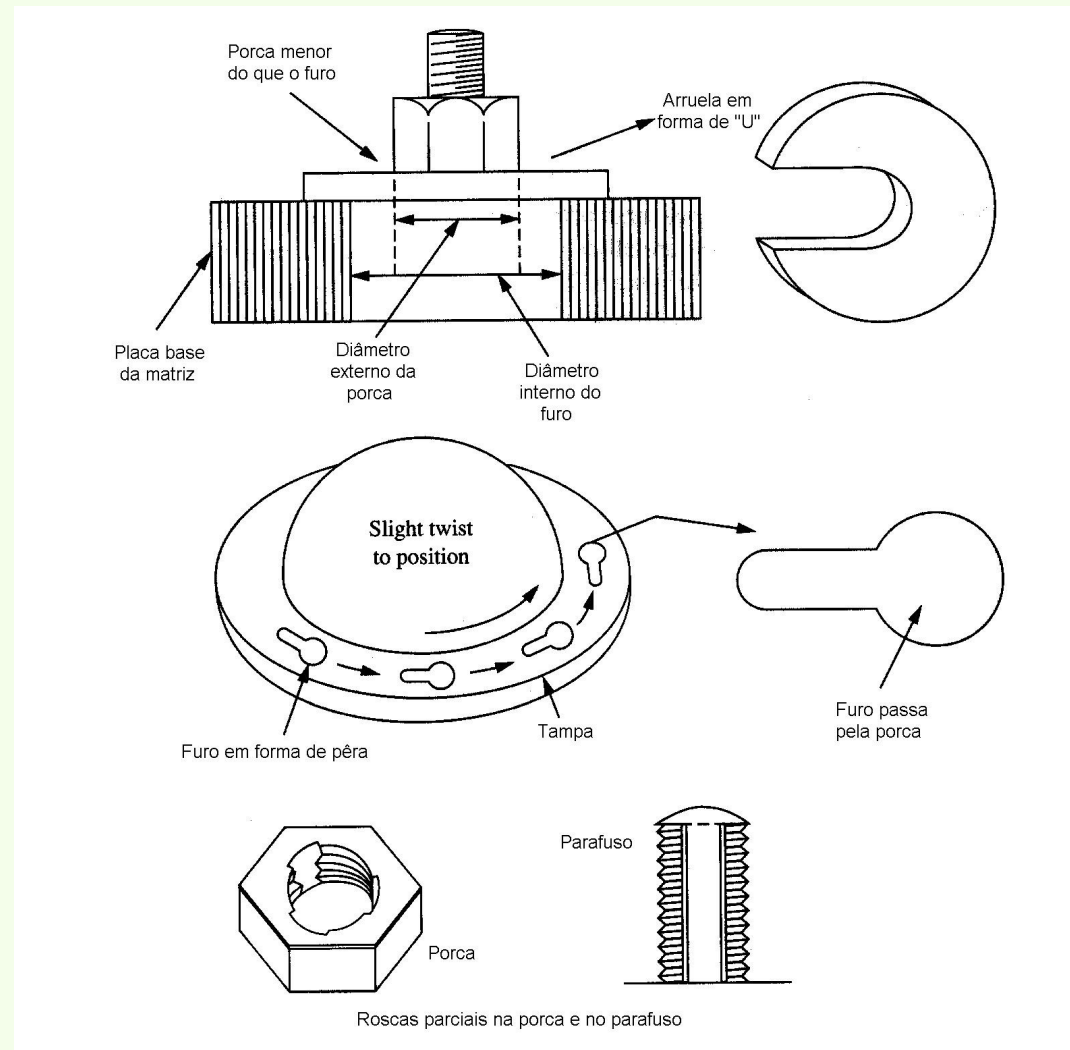


*Uma placa espaçadora pode ser usada para padronizar a altura da matriz*

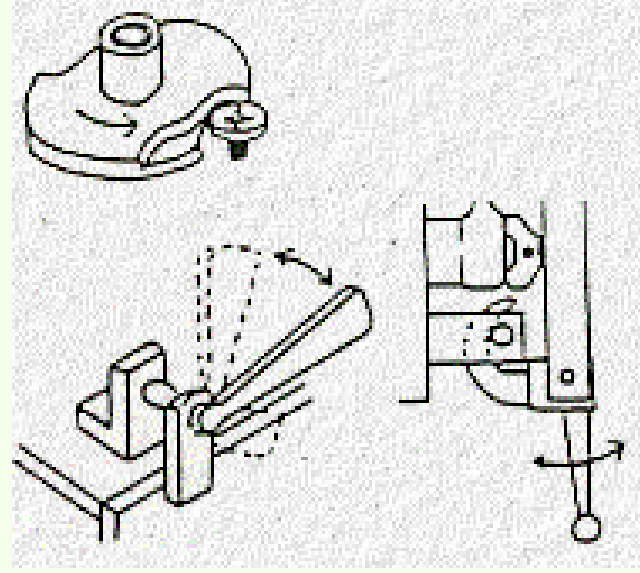
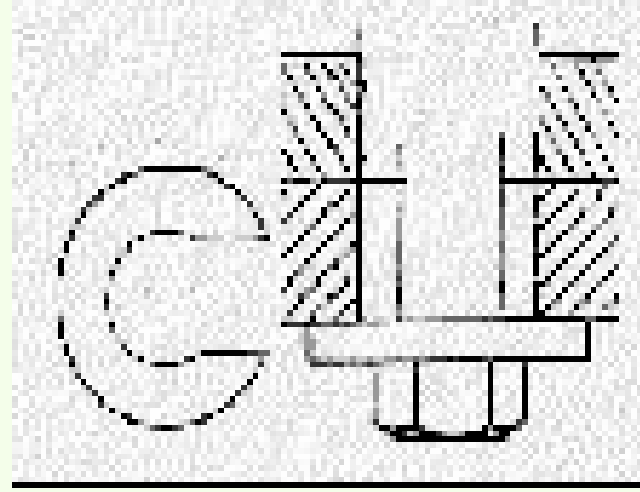
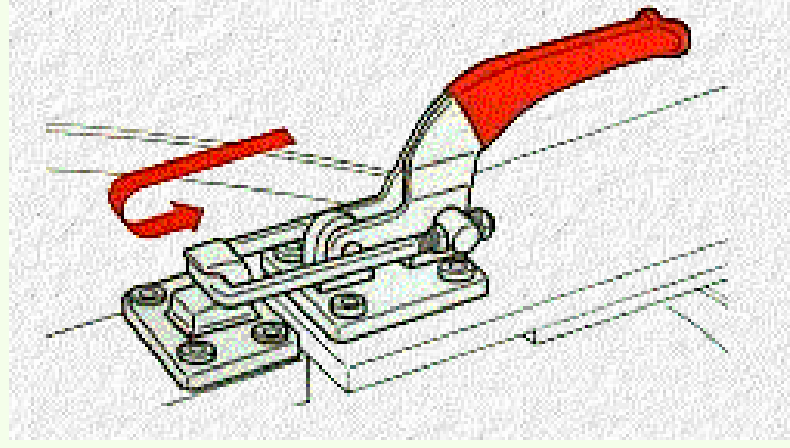
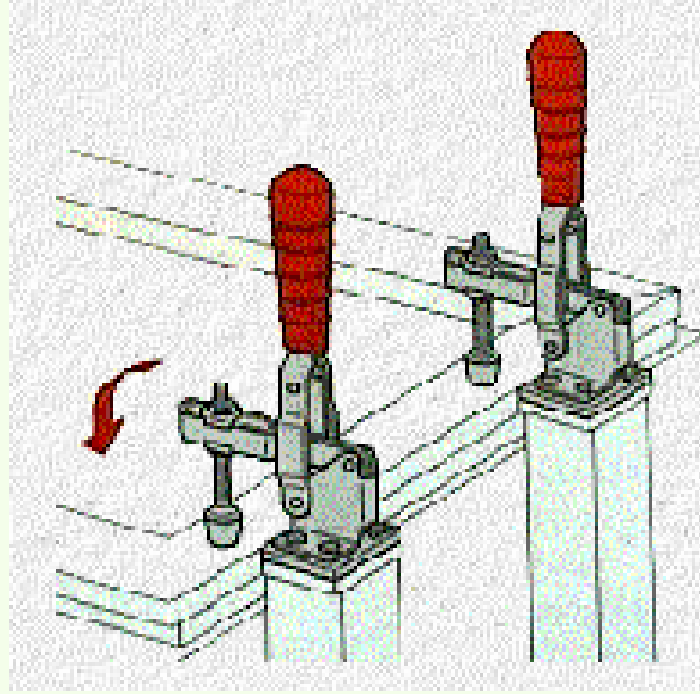


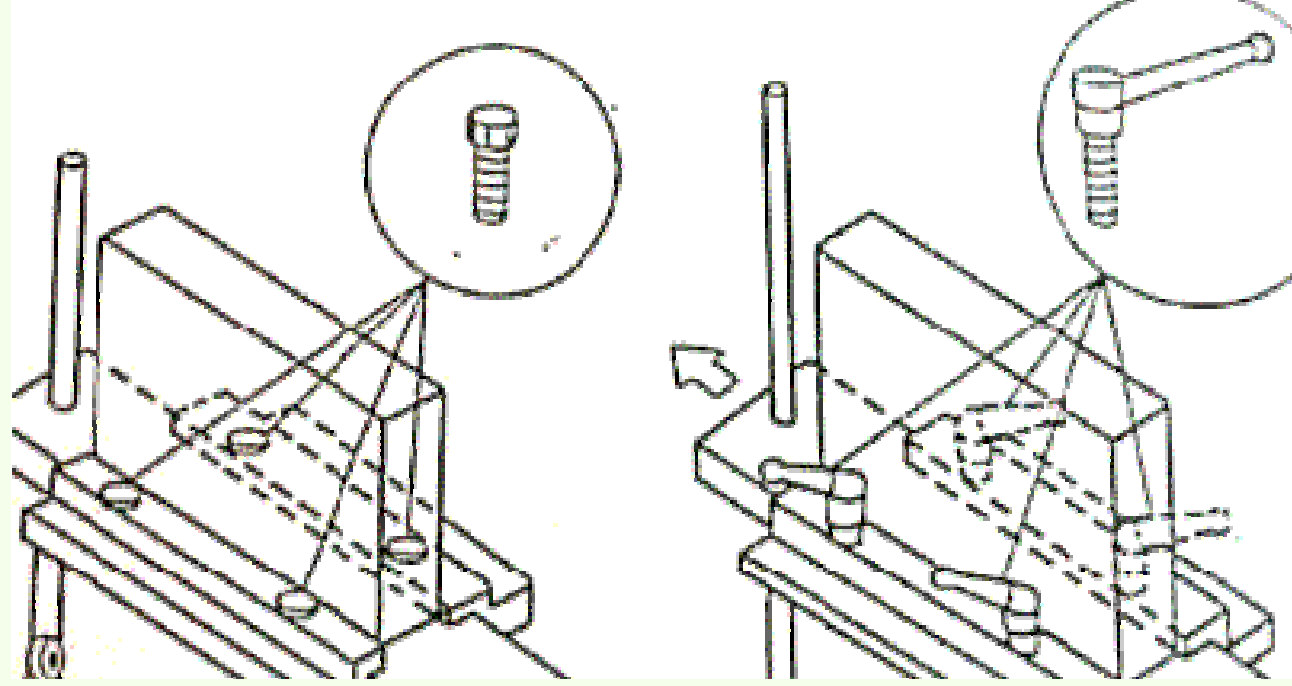
*Padronizando-se a altura da placa base reduz-se a necessidade de parafusos de diferentes comprimentos*

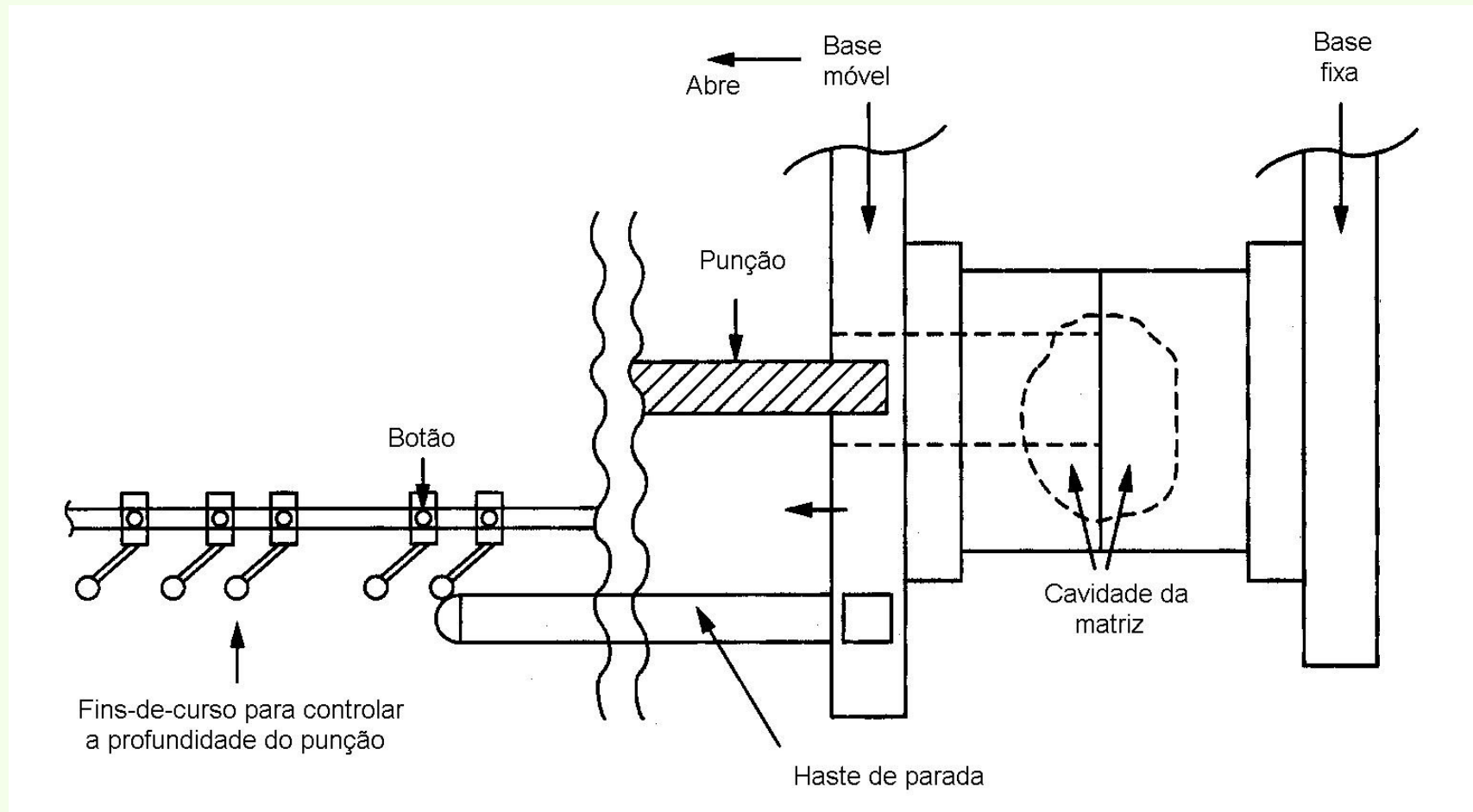




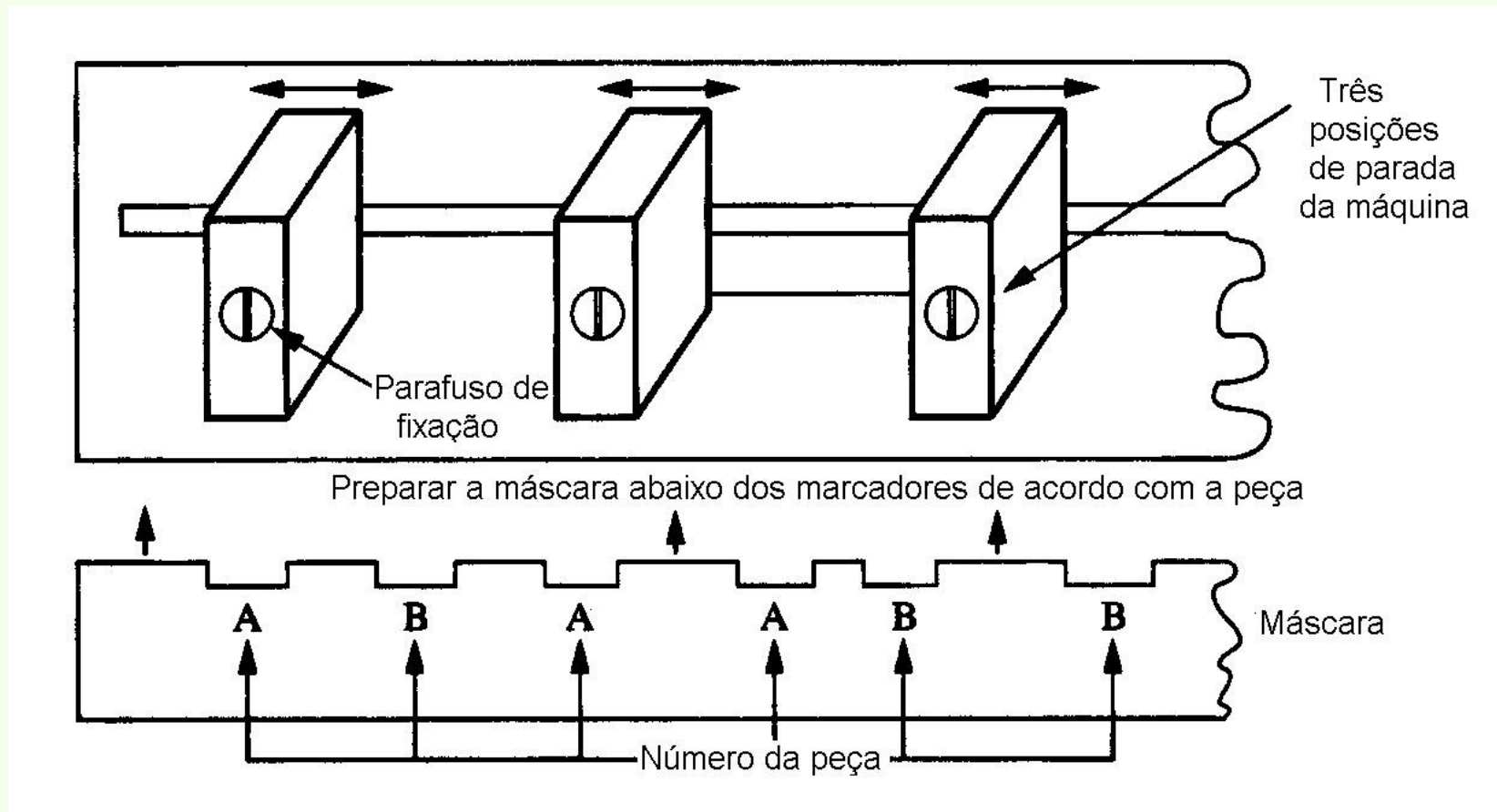
*Três fixadores que atuam de maneira rápida, reduzindo o tempo de set-up interno: (1) arruela em forma de "U", (2) furos em forma de pêra, (3) porca e parafuso com porções usinadas para que estes elementos tenham roscas parciais*







*Instalando-se fins-de-curso em todas as posições necessárias  
elimina os ajustes do posicionamento do punção*



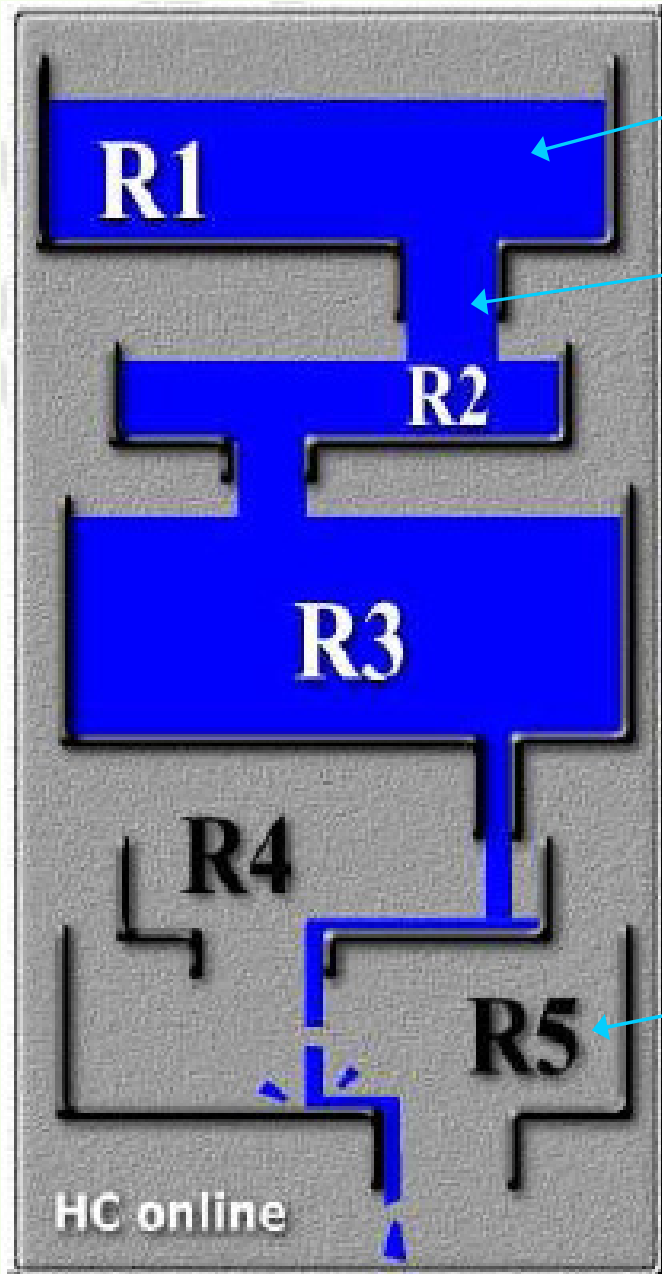
*Uma máscara pode ser usada numa mandriladora para acelerar o posicionamento dos limitadores da máquina*



<i>Tempo de set-up</i>	1976	1977	1980
60 minutos	30%	0	0
30-60 minutos	19%	0	0
20-30 minutos	26%	10%	3%
10-20 minutos	20%	12%	7%
5-10 minutos	5%	20%	12%
100 segundos - 5 minutos	0	17%	16%
100 segundos	0	41%	62%

***Redução no tempo de set-up numa empresa real***

Industry	Equipment	Before	After	%
Assembly	Adhesive Applicator	12:09:00	0:21:00	97%
Assembly	Air Cleaner Assembly	2:00:00	0:00:00	100%
Brake Mfg	Briquette Press	1:05:00	0:12:00	82%
Brake Mfg	Drill Machine	0:35:00	0:05:00	86%
Brake Mfg	Segment Drill	12:00:00	1:12:00	90%
Cosmetics	Capper Machine	0:09:36	0:03:21	65%
Electronics	PCB Inserion-ICs	0:13:30	0:05:56	56%
Electronics	PCB Insertion-Axial	0:05:18	0:04:18	19%
Electronics	PCB Insertion-Radial	0:54:12	0:05:06	91%
Foundry	Molding Machine	0:10:00	0:06:12	38%
Metal Cutting	Casting Drill	1:00:00	0:09:00	85%
Metal Cutting	CNC MILLING	2:00:00	0:00:00	100%
Metal Cutting	FADAL HMC	1:45:00	0:15:20	85%
Metal Fab	40 Ton Press	0:48:00	0:04:00	92%
Metal Fab	750 Ton Hyd Press	2:10:00	0:42:00	68%
Metal Fab	800 Ton Press	6:00:00	0:10:00	97%
Metal Fab	Aluminum Extruder	1:09:00	0:02:12	97%
Metal Fab	Brake Press	0:37:00	0:04:00	89%
Metal Fab	Draw Press	1:30:00	1:00:00	33%
Metal Fab	Edge Trim Press	0:24:00	0:04:00	83%
Metal Fab	Pilot Change-Muffler Press	0:07:00	0:00:15	96%
Packaging	Flex Packaging Line	3:00:00	0:10:00	94%
Paper	Sheeting	0:03:00	0:00:36	80%
Pharmaceutical	Centrifuge	0:12:00	0:02:12	82%
Plastics	250 Ton Injection Molder	1:06:00	0:09:12	86%
Plastics	Injection Molder	2:30:00	0:06:00	96%
Plastics	Injection Molder	2:00:00	0:03:00	98%
Printing	Kidder 6-Color Web Press	4:20:00	1:10:00	73%
Printing	Press Make Ready	9:30:00	4:20:00	54%
Wood	Router	0:09:00	0:01:18	86%



*Matéria-Prima*

**Bottleneck Resources and  
Non-Bottleneck Resources  
(TOC)**

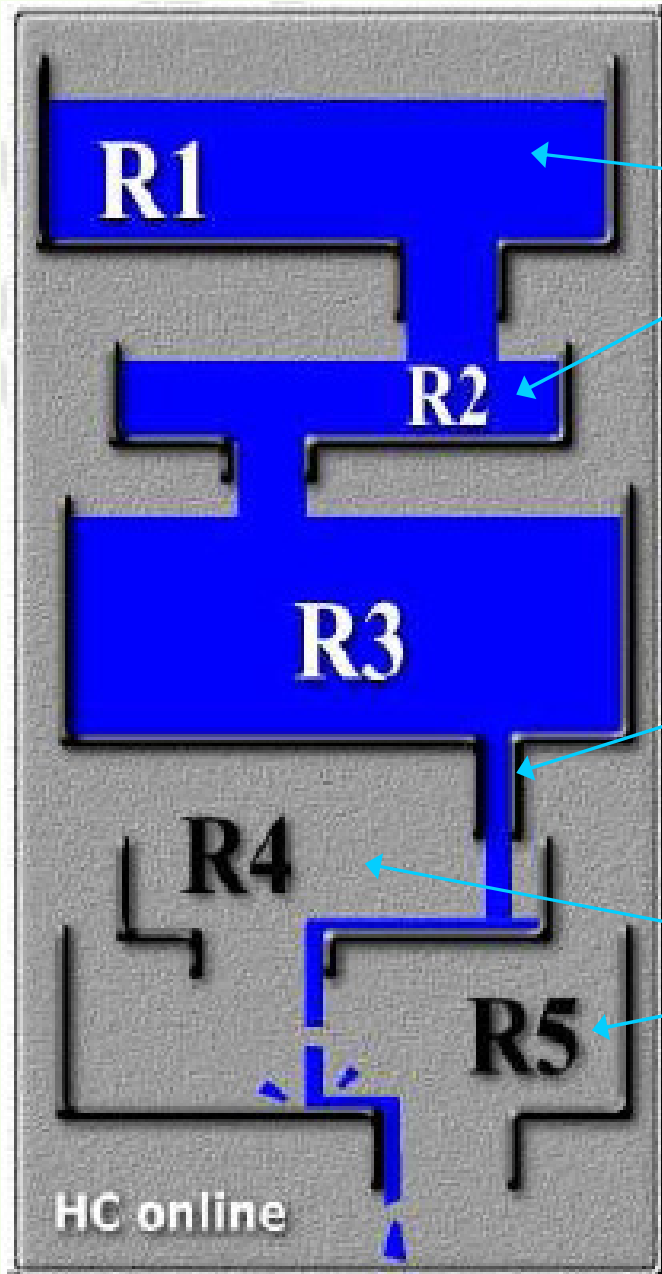
*Capacidade*

**Gargalo?**

*Produtos Finais  
(satisfaz o  
mercado,  
teoricamente)*

**Pitfall! Pitfall!**

**Don't deploy TPM and SMED everywhere! Don't deploy TPM and SMED everywhere!  
Focus efforts!**



Devo melhorar R1 e R2?  
WIP ↑

Gargalo = Foco

Devo melhorar R4 e R5? (Por exemplo, aplicando SMED)

**Bottleneck Resources and Non-Bottleneck Resources (TOC)**

**Pitfall! Pitfall!**

**Don't deploy TPM and SMED everywhere! Don't deploy TPM and SMED everywhere! Focus efforts!**