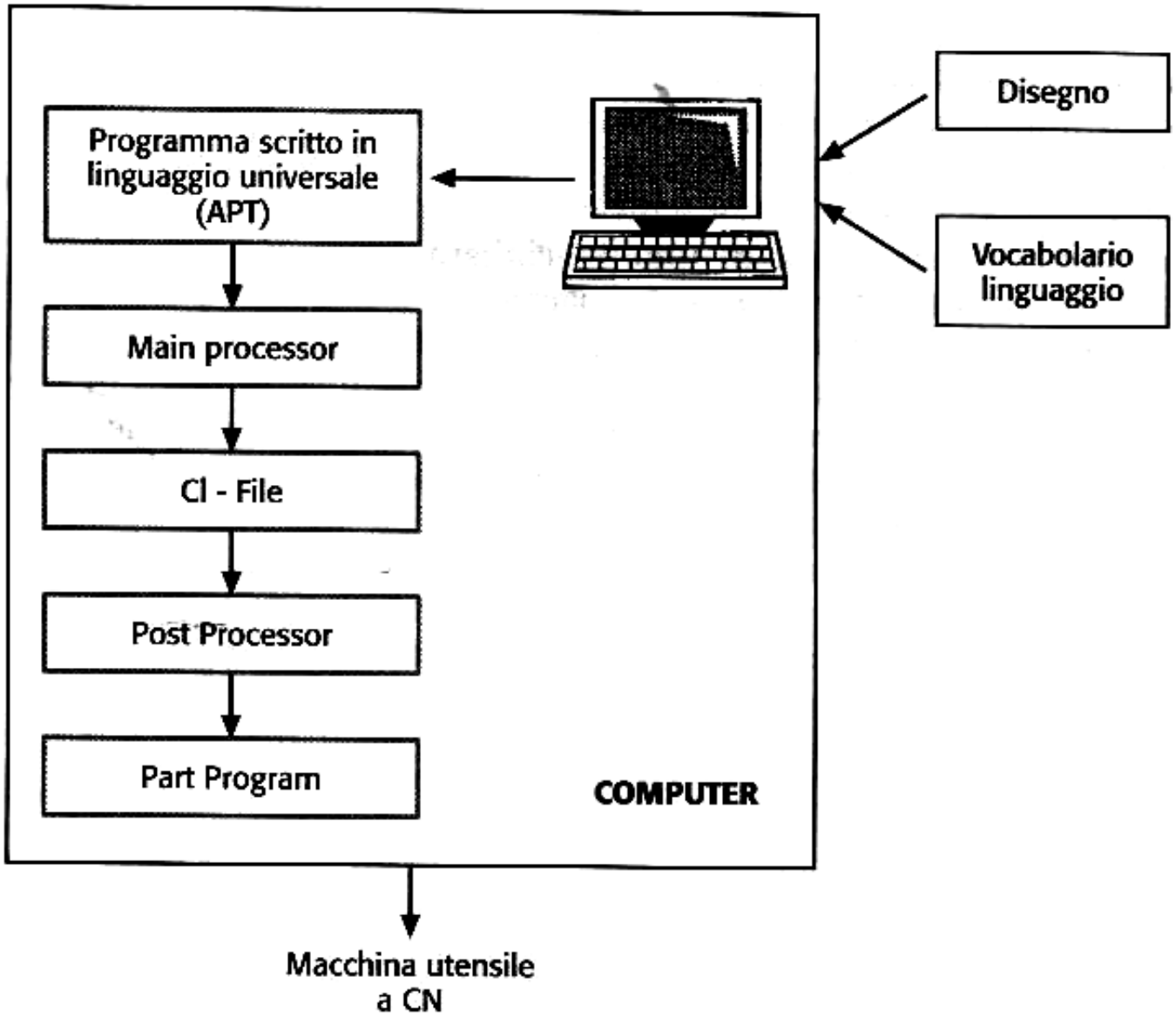
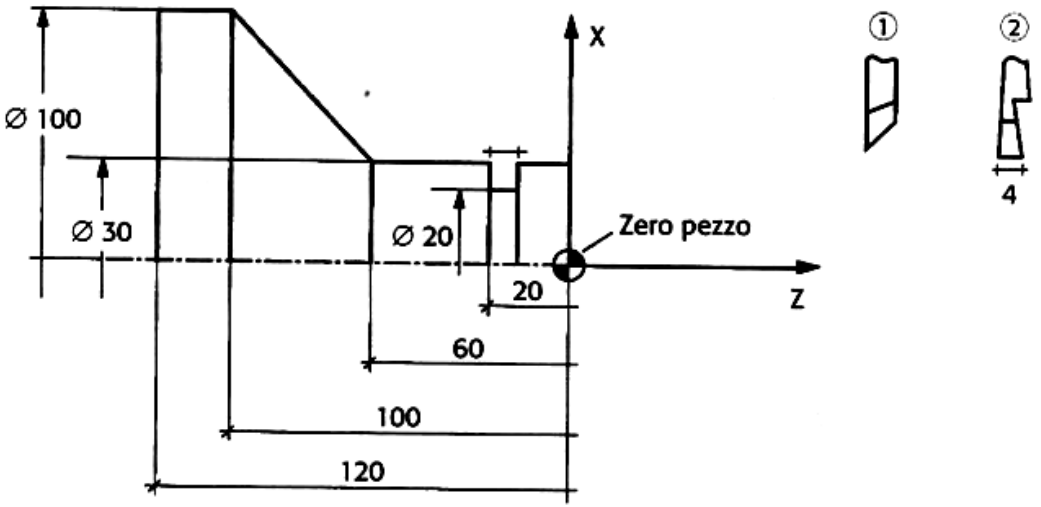
Flexible manufacturing systems

Focus on CNC machines


Programma scritto in linguaggio universale (APT)
Main processor
Cl - File
Post Processor
Part Program
COMPUTER
Disegno
Vocabolario linguaggio
Macchina utensile a CN

Programming elements

- The *part program* provides all information required to execute the machining phases:
  - Regarding the tool trajectory from the part, both related to the geometry and to the moving modes (of advancement, cutting, positioning, …)
  - Regarding the chosen technological parameters (speed, advancement, …)
  - Regarding other auxiliary information, such as:
    - Tool selection
    - Use of cutting fluids
    - Load/unload of pallets
    - …




```
T 101 M 6                          Chiamata utensile 1
G 96 S 100 M4 F2                   Impostazione parametri di taglio
G 0 X Z 1                          Avvicinamento rapido
G 1 Z                              Tornitura profilo
X 30
Z - 60
X 100 Z - 100
Z - 120
G 0 X 150 Z 150                    Allontanamento rapido
T 202 M 6                          Chiamata utensile 2
G 97 S 300 M 4 F.08 M 08           Impostazioni parametri di taglio
                                   e apertura refrigerante
G 0 X 31 Z - 20                    Avvicinamento rapido
G 1 X 20                           Esecuzione gola
G 0 X 31                           Allontanamento rapido
Z 150 M 09                         e stop refrigerante
M 30                               Stop programma e reset
```

An easy program in the language of CNC machines

Machining

- The machining program is loaded in the memory of the governing unit
- The machining program is selected at the moment the parts need to be processed
- Before starting each machining phase, the «zero machine» has to be identified, it is the reference for all handling instructions
- A setup programming cycle (complete or partial) has to be executed in order to verify the presence of any programming error
- Parts have to be positioned
- The program is launched

CAM systems – *Computer Aided Manufacturing*

- CAD systems can be integrated with the related CAM package. They allow to create, starting from the design, the part program. The part program provides all paths of tools to be given directly to the CNC machine to execute machining operations

Numerical Control: conclusions

- The two fundamental and characterizing parameters of a production system are (they are in a trade-off relationship):
  - Productivity: the capacity to process a high quantity of parts in a given time, given defined levels of quality and cost
  - Flexibility: the capacity to quickly adapt to process an high number of parts that have different and changeable characteristics
- CNC machines optimally provide both the aforementioned characteristics, indeed they ensure:
  - Reduced execution times (productivity)
  - Minimal passive times (flexibility)

Numerical Control: conclusions

- It is particularly advantageous for the machining of:
  - Parts with complex shape
  - Parts requiring an high number of tools
  - Continuous control of the cutting speed
  - Exploitation of not highly skilled operators

- Further applications of CNC (in addition to the shaving removal) can be:
  - Robots
  - Measuring machines
  - Centers for the machining of sheet metal
  - Centraper la lavorazione della lamiera
  - Laser cutting systems, *water jet*, …. flat parts systems

- The set of CNC machines constitute a FMS – *Flexible Manufacturing System,* based on the electronic link of single units with a central PC, which manages the allocation of processing activities required on the different machines

Robot

Rossum universal robots (K. Capek), 1920

- In this theatrical drama, for the first time the term *robota* = forced or heavy labor was used

Robotics laws (I. Asimov), 1942

- *A robot may not injure a human being or, through inaction, allow a human being to come to harm*
- *A robot must obey any orders given to it by human beings, except where such orders will conflict with the First Law*
- *A robot must protect ist own existence as long as such protection does not conflict with the First or Second Law*

Main typologies of robots

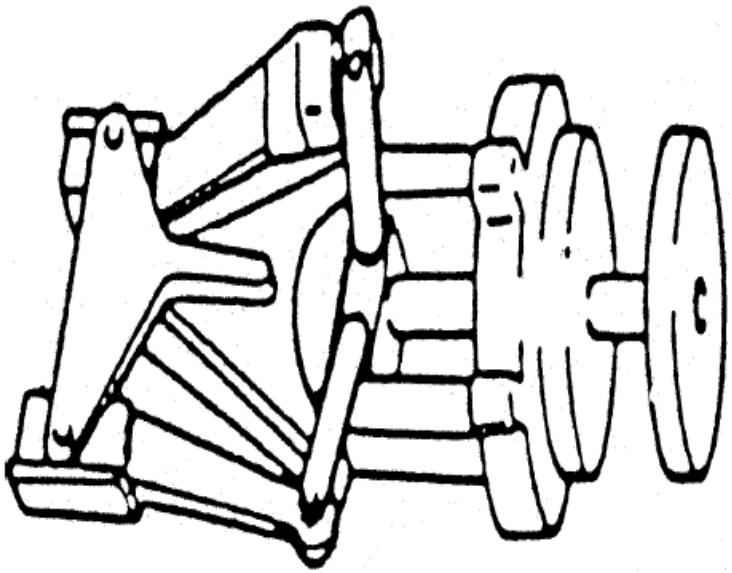
Cartesian

Anthropomorphic

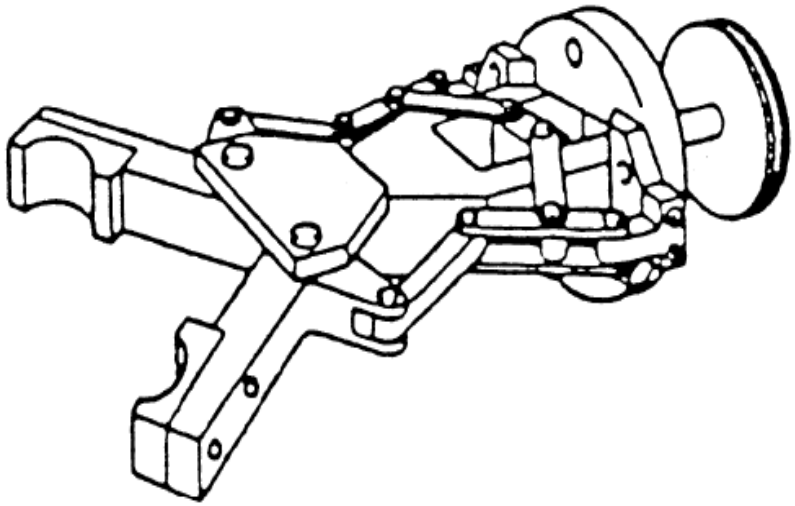
SCARA

Constituent elements of robots: the hand

The hand can execute *gripper functions or end effector functions*



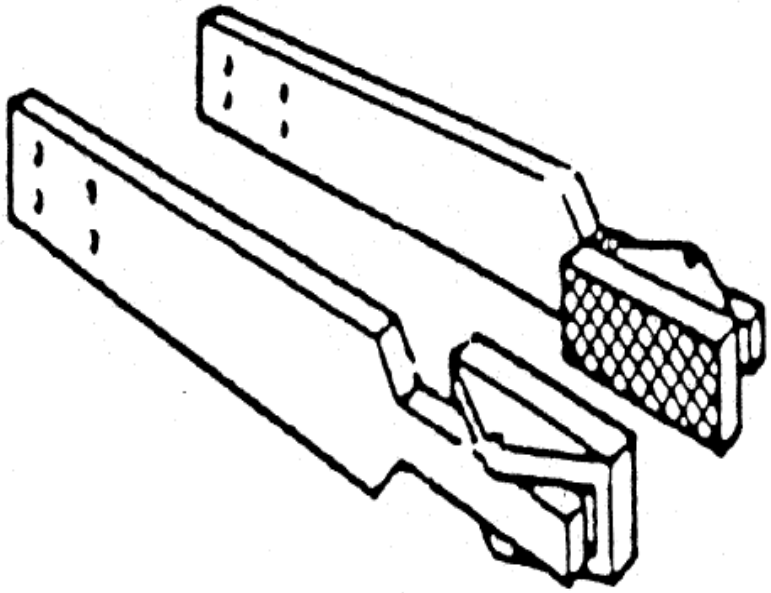
Standard hand



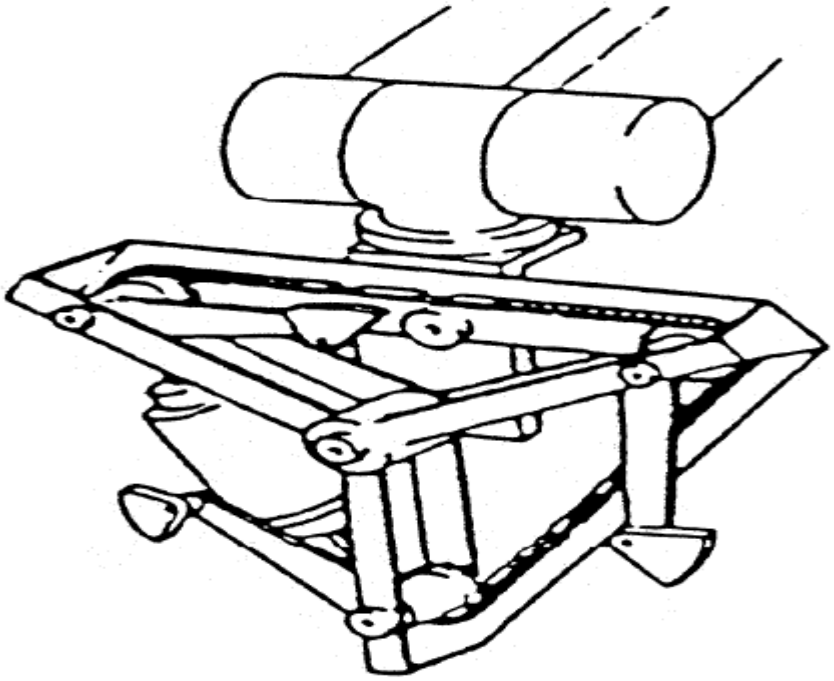
Hand with high opening

Constituent elements of robots: the hand

The hand can execute *gripper functions or end effector functions*



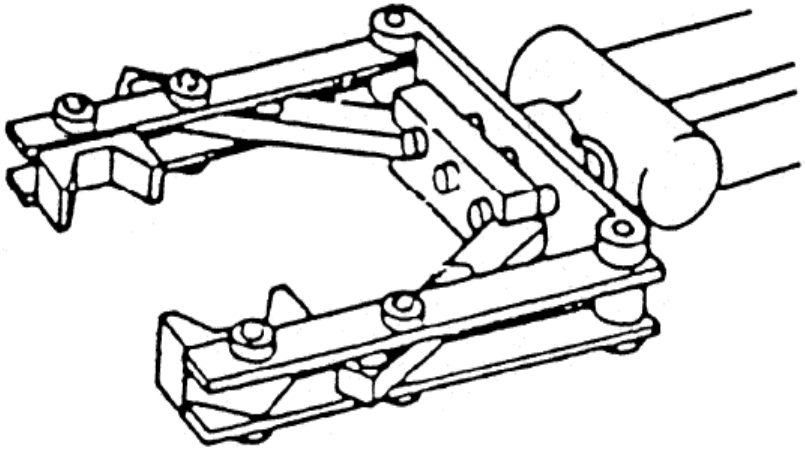
Hand with aligned fingers



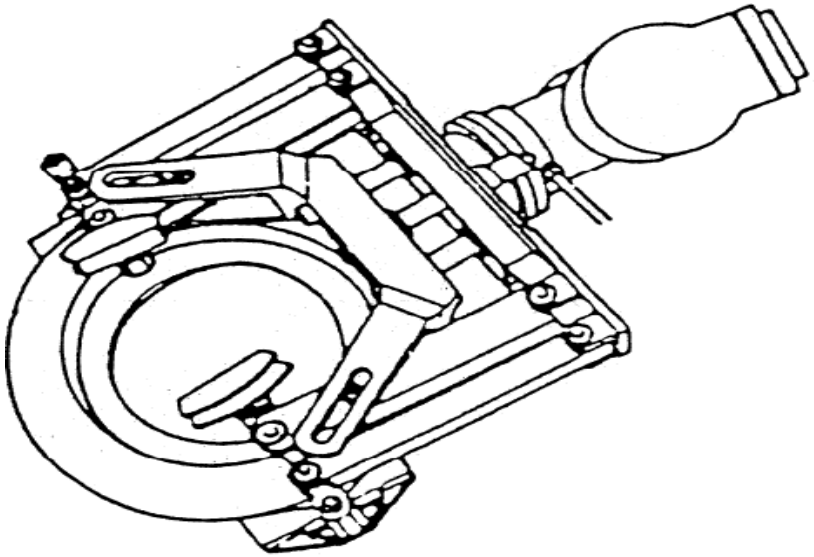
Self-centering hand

Constituent elements of robots: the hand

The hand can execute *gripper functions or end effector functions*



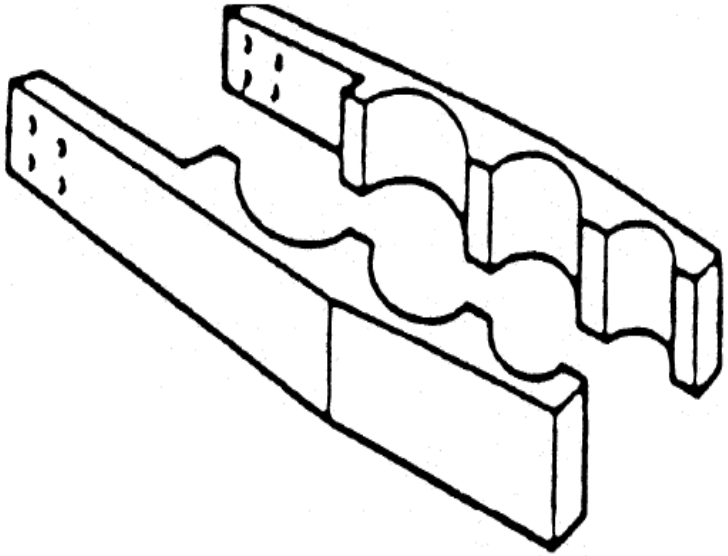
Hand with cams



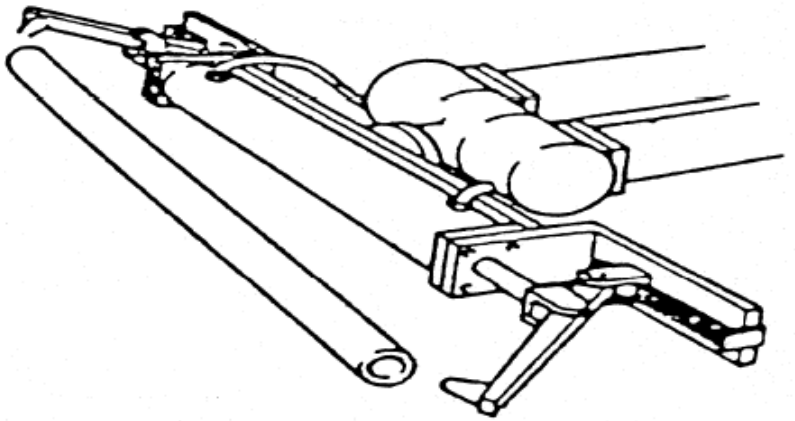
Hand with cams with internal and external jaws

Constituent elements of robots: the hand

The hand can execute *gripper functions or end effector functions*



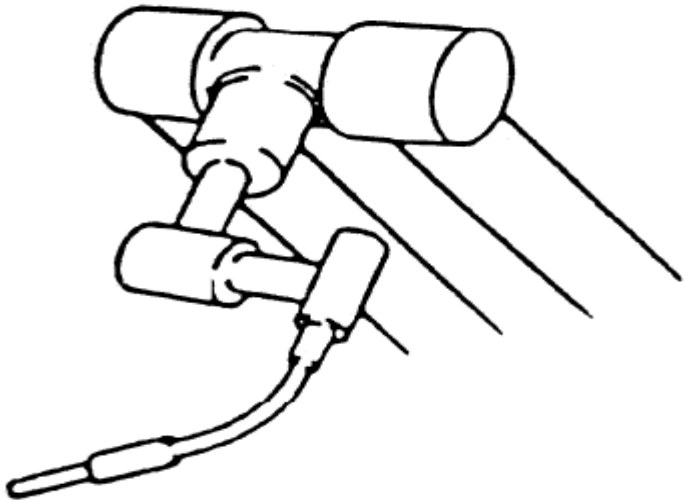
Hand for parts with different sizes



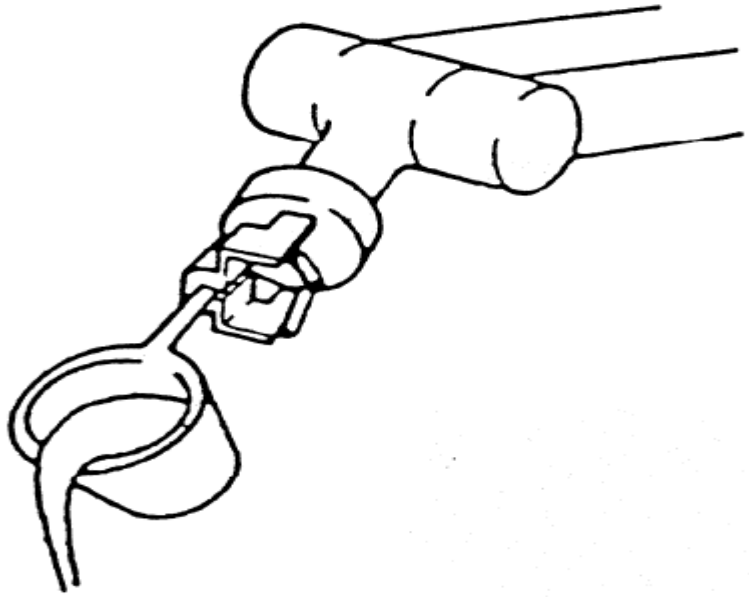
Special hand for glass tubes

Constituent elements of robots: the hand

The hand can execute *gripper functions or end effector functions*



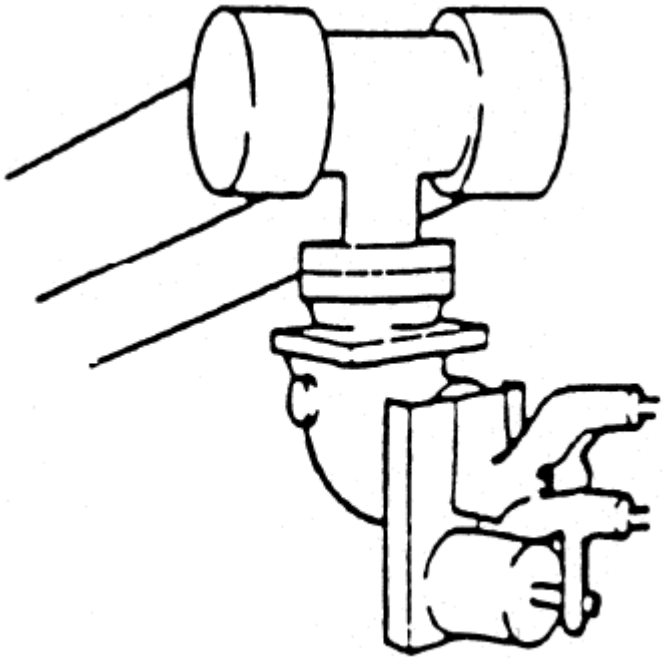
Flashlight for arc welding



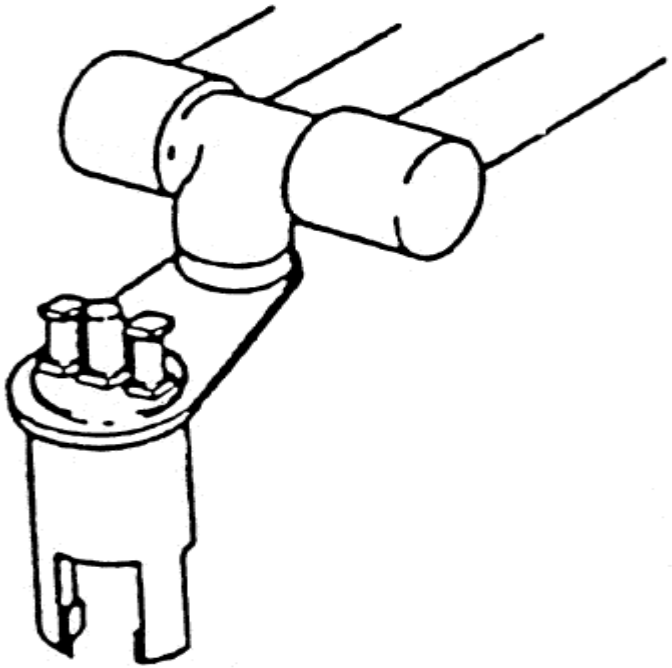
Hand with ladle

Constituent elements of robots: the hand

The hand can execute *gripper functions or end effector functions*



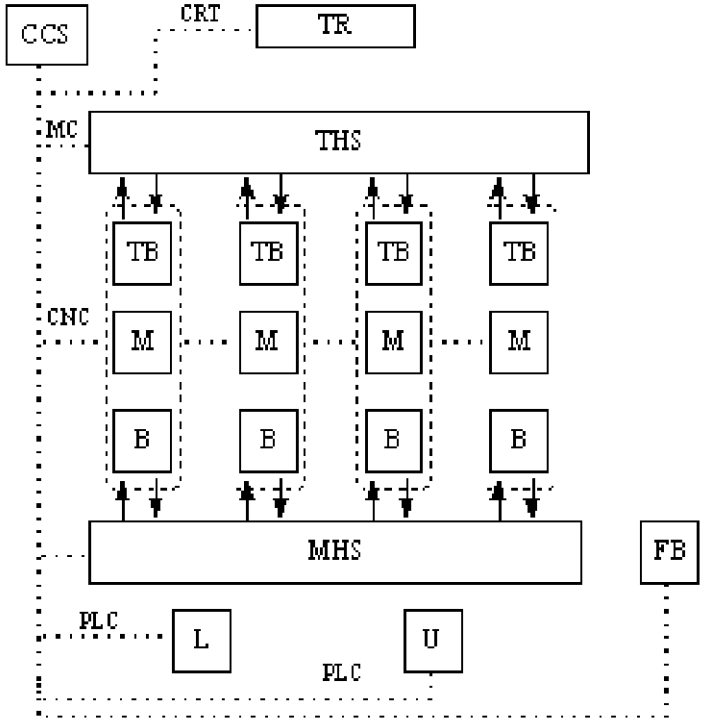
Gun for points welding



Pneumatic iron

FMS – Conceptual schema and examples

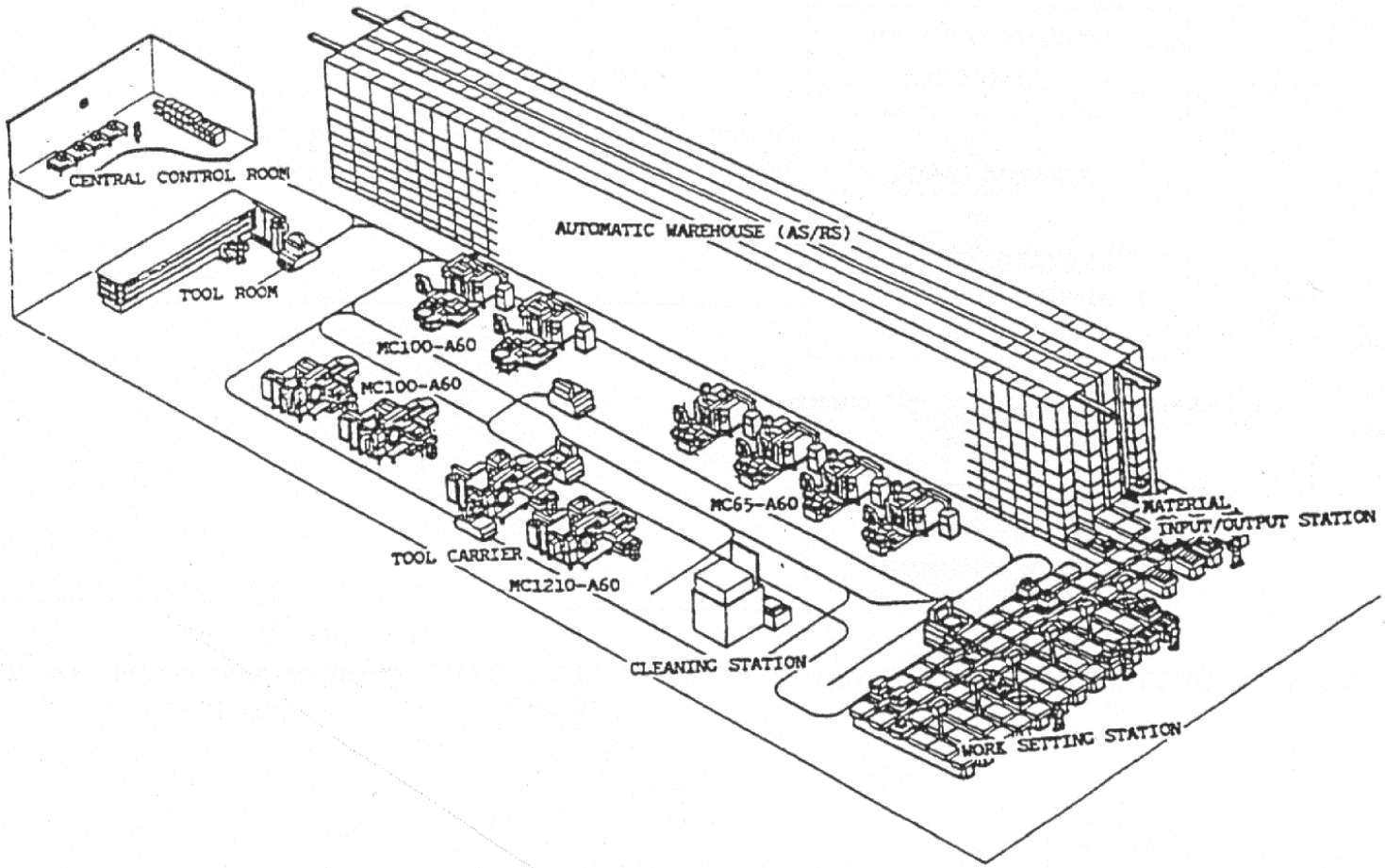
LOGIC SYSTEM OF A FMS



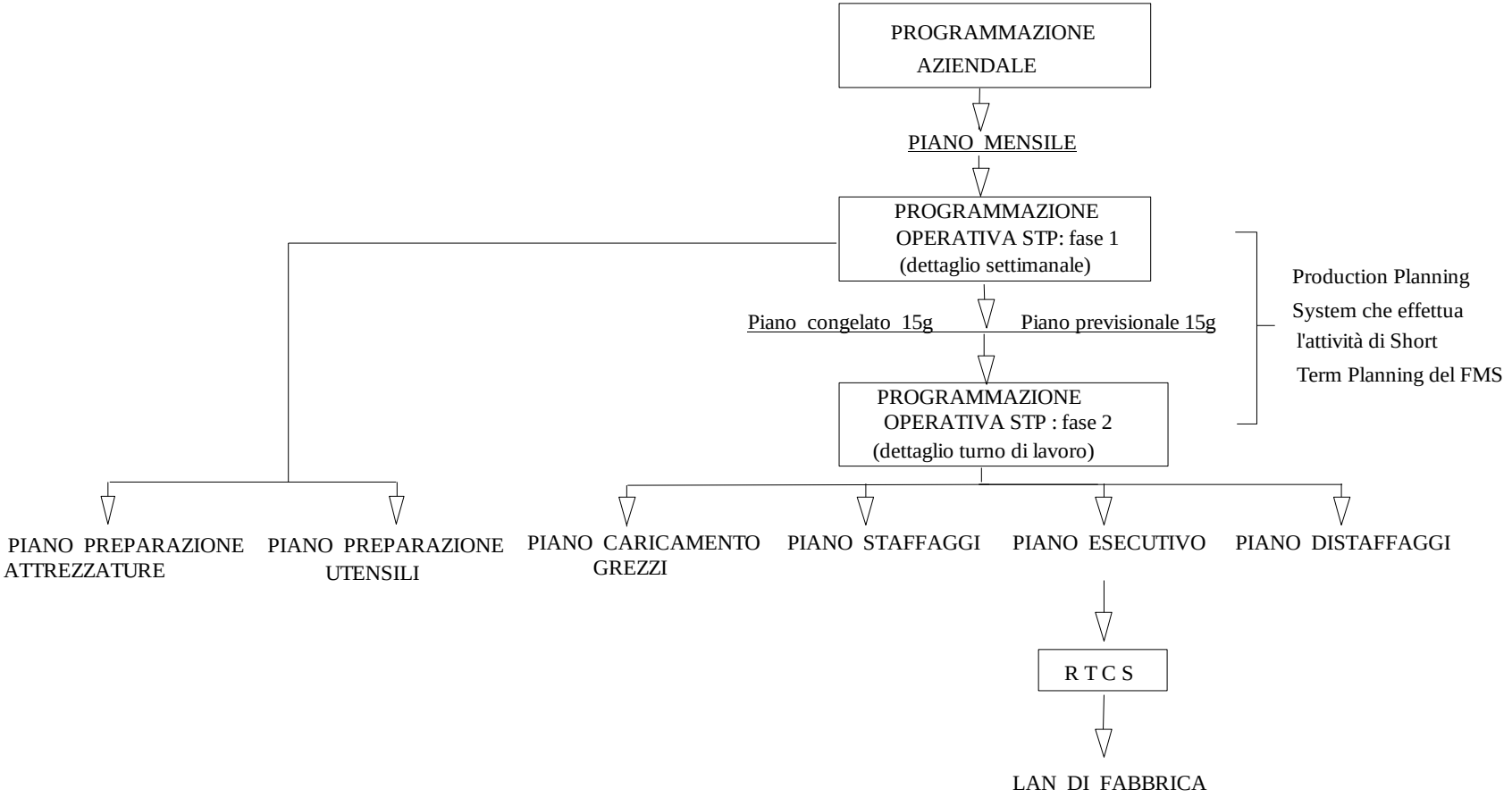
Legenda

M	= NC Machine	TB	= Tool Buffer
MHS	= Material Handling System	L	= Load
B	= Buffer storage	U	= Unload
WS	= Work Station	FB	= Fixture Buffer
TR	= Tool Room	CCS	= Computer Control System
THS	= Tool Handling System	.....	= Data Network

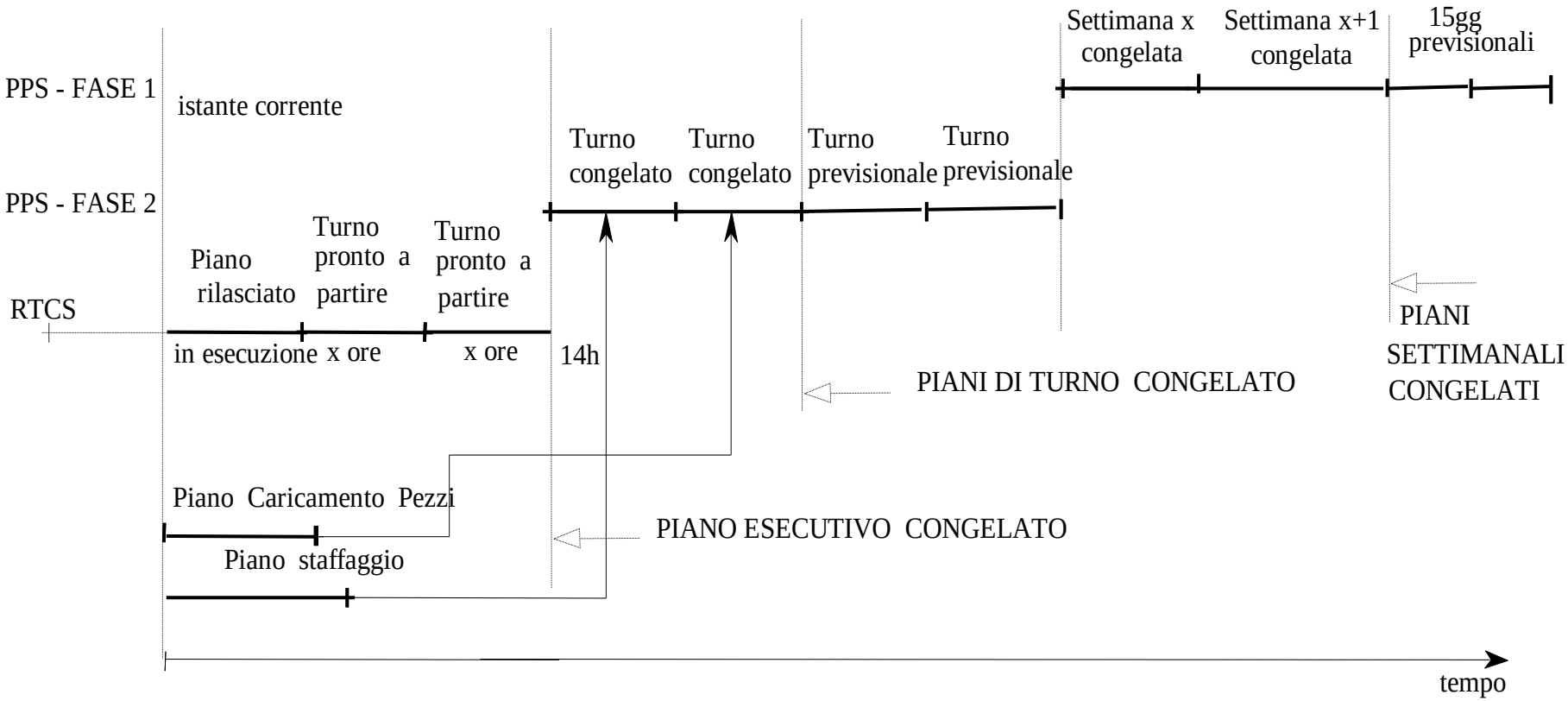
MAX MAKINO SYSTEM



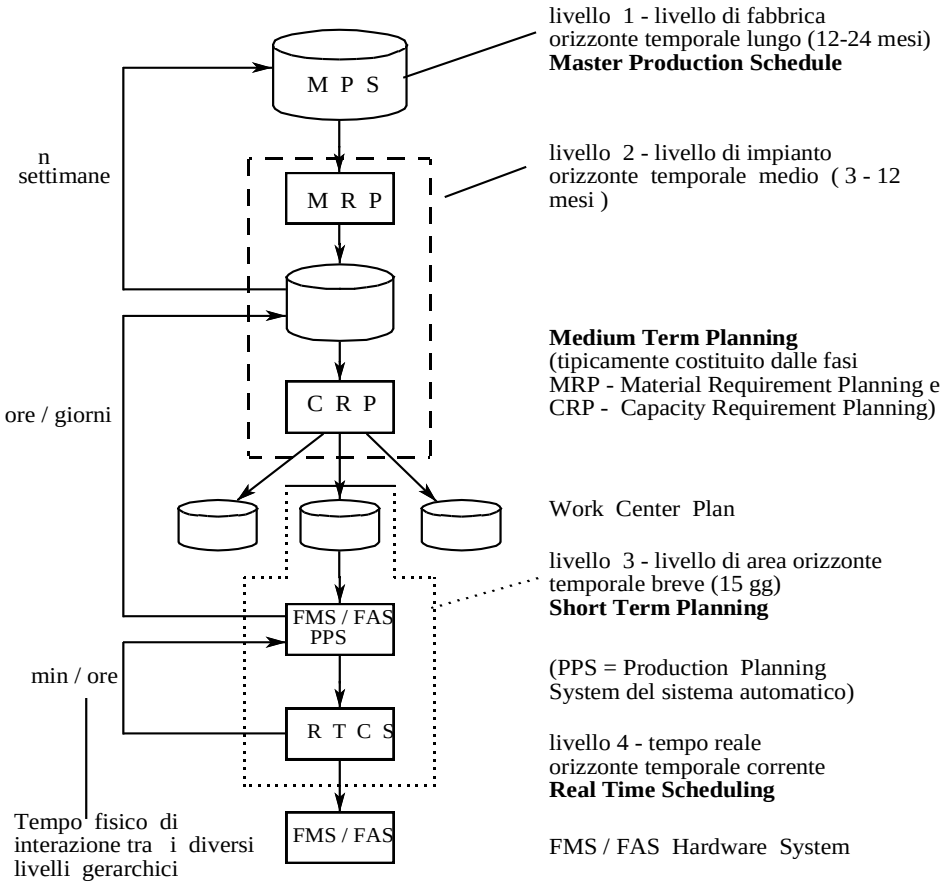
SHORT-TERM PROGRAMMING ACTIVITY



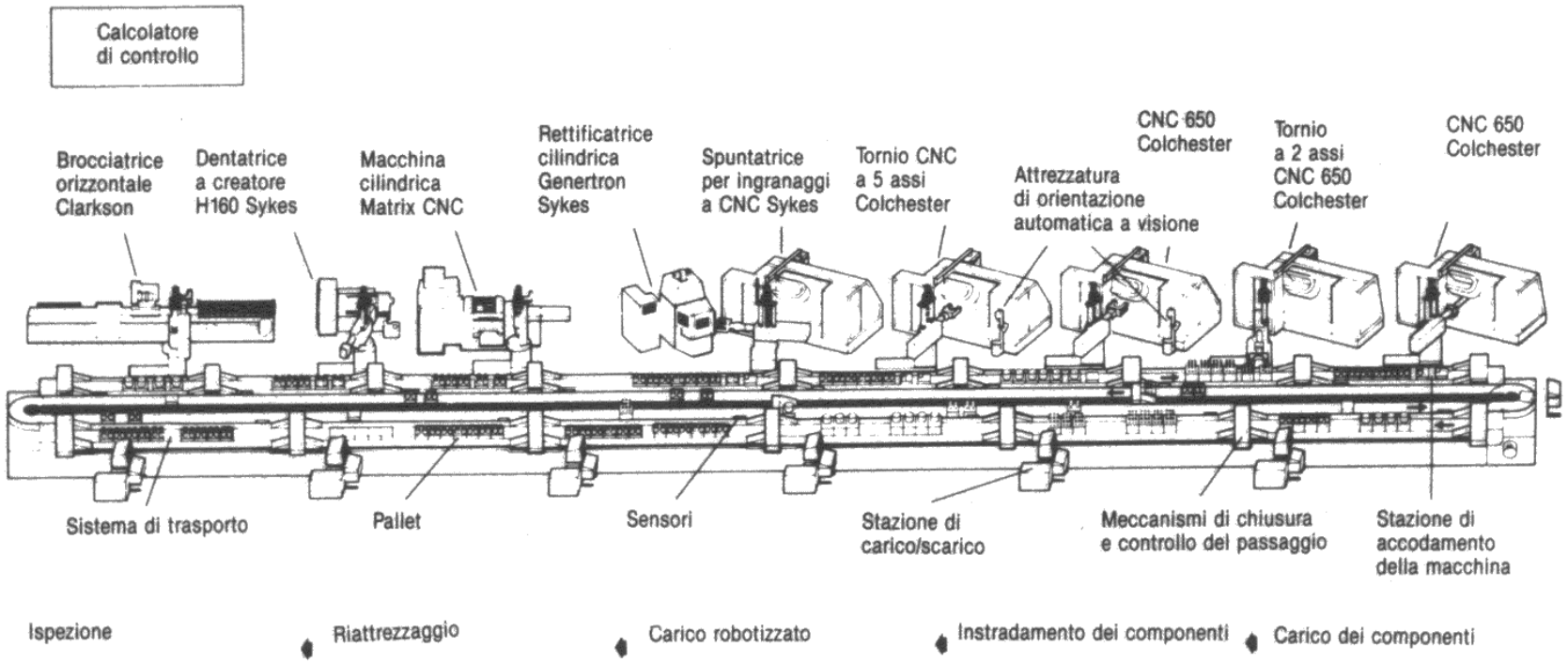
PLANNED TEMPORAL HORIZONT



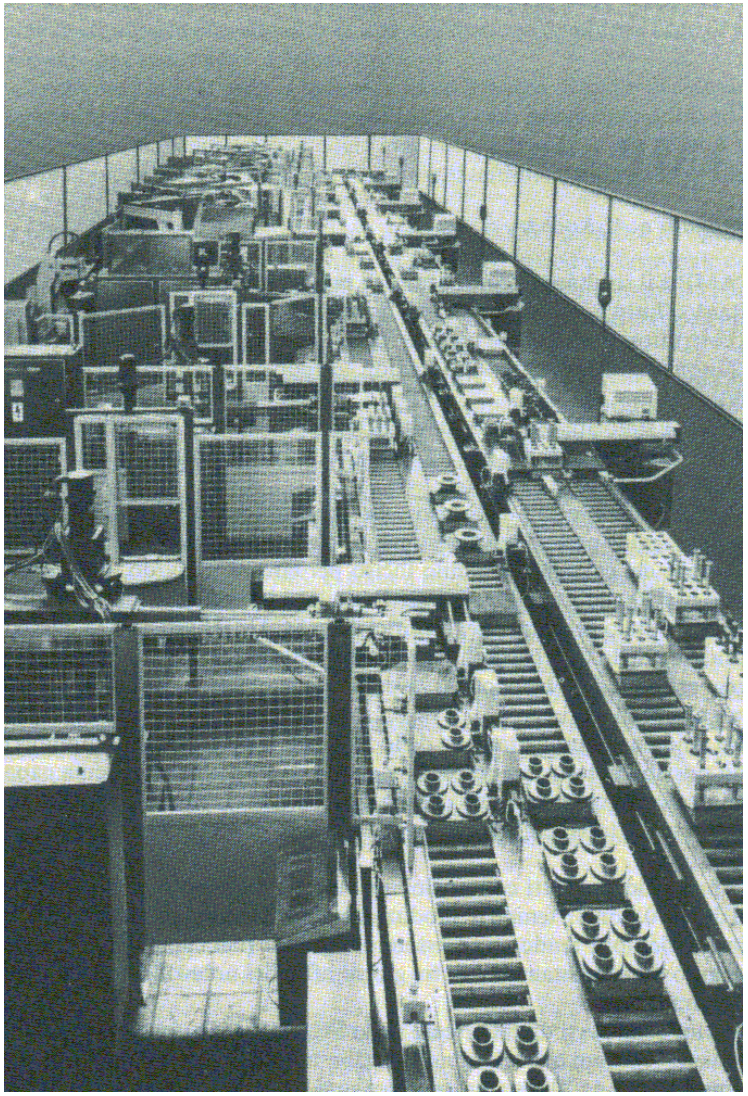
Architecture of the management system



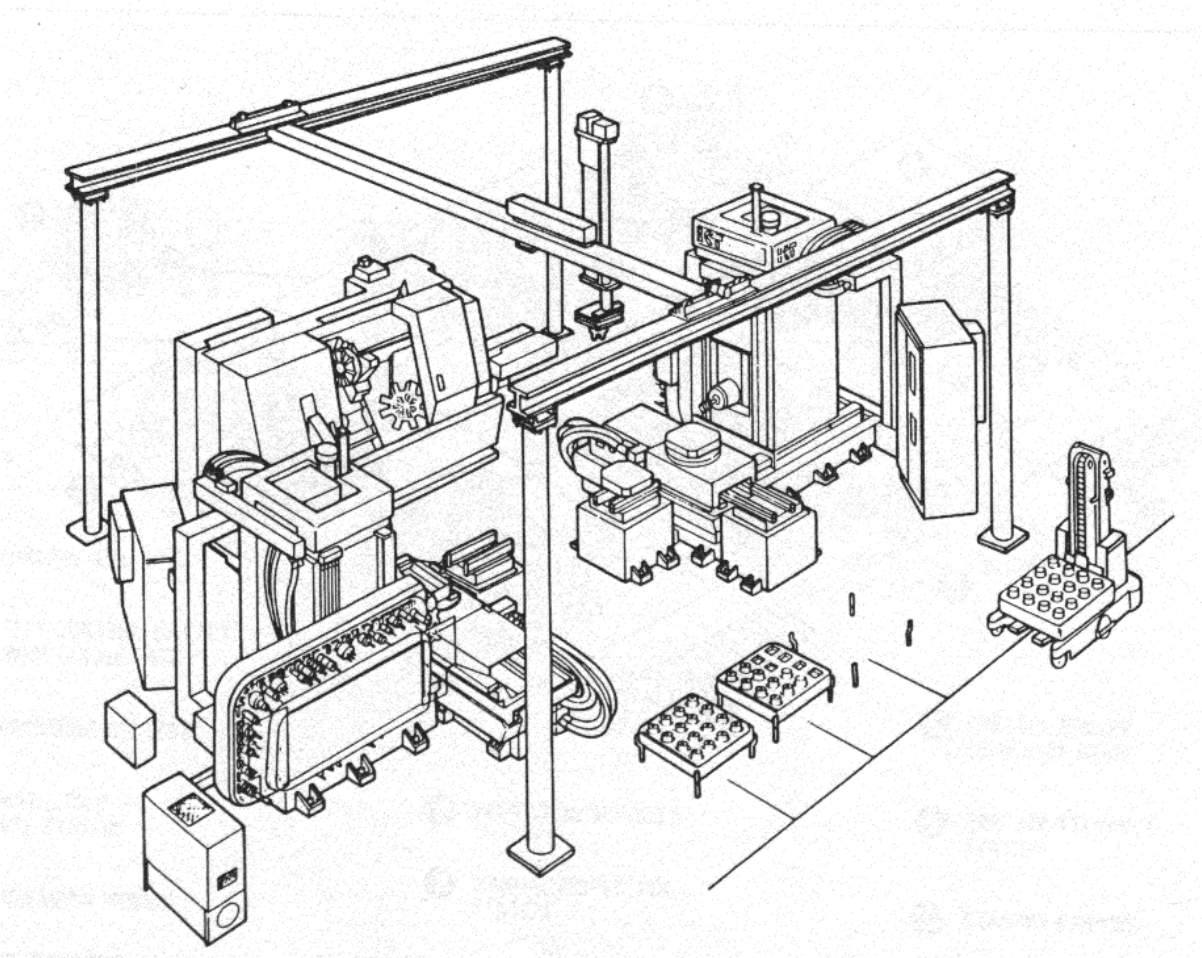
SCAMP system



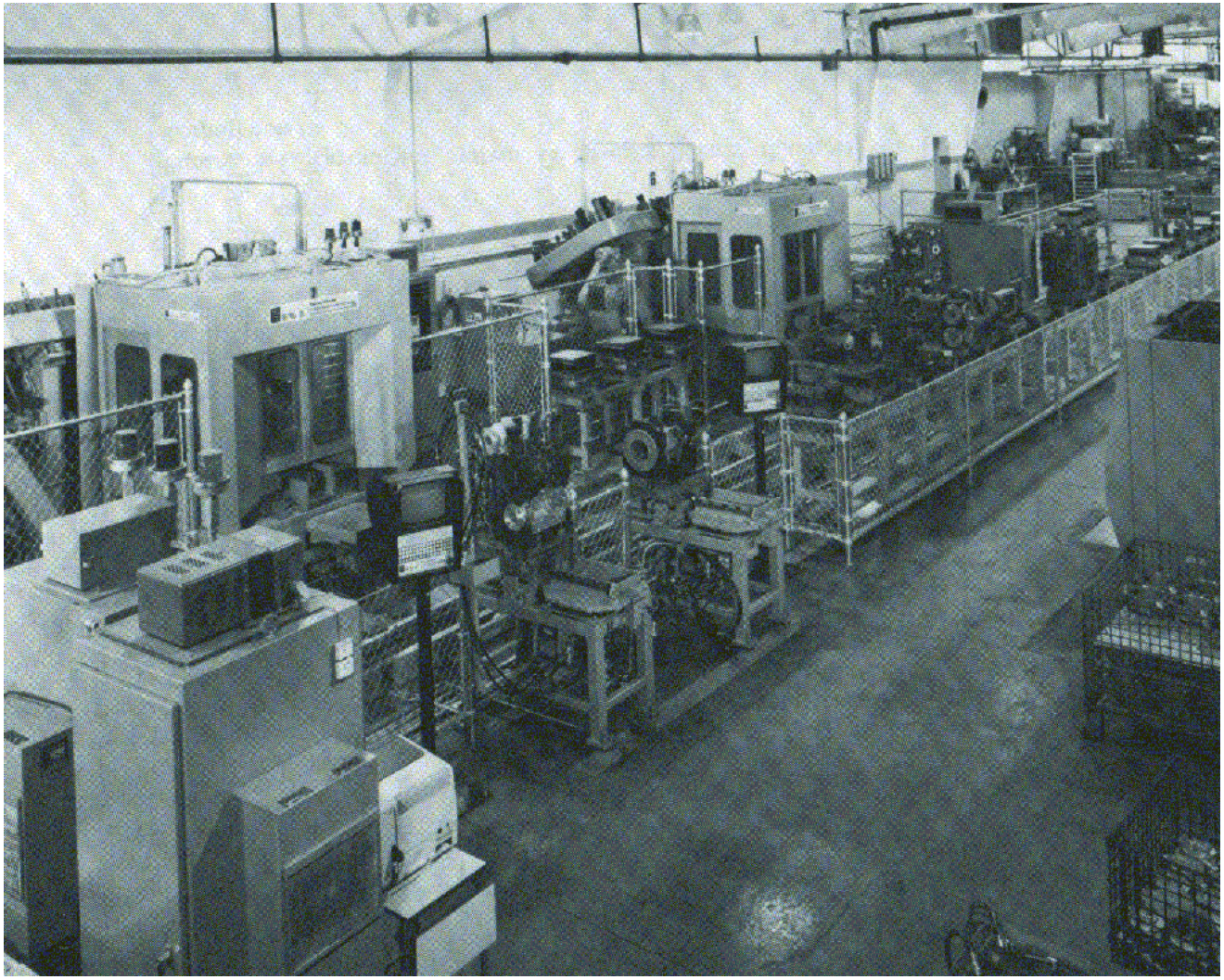
SCAMP system



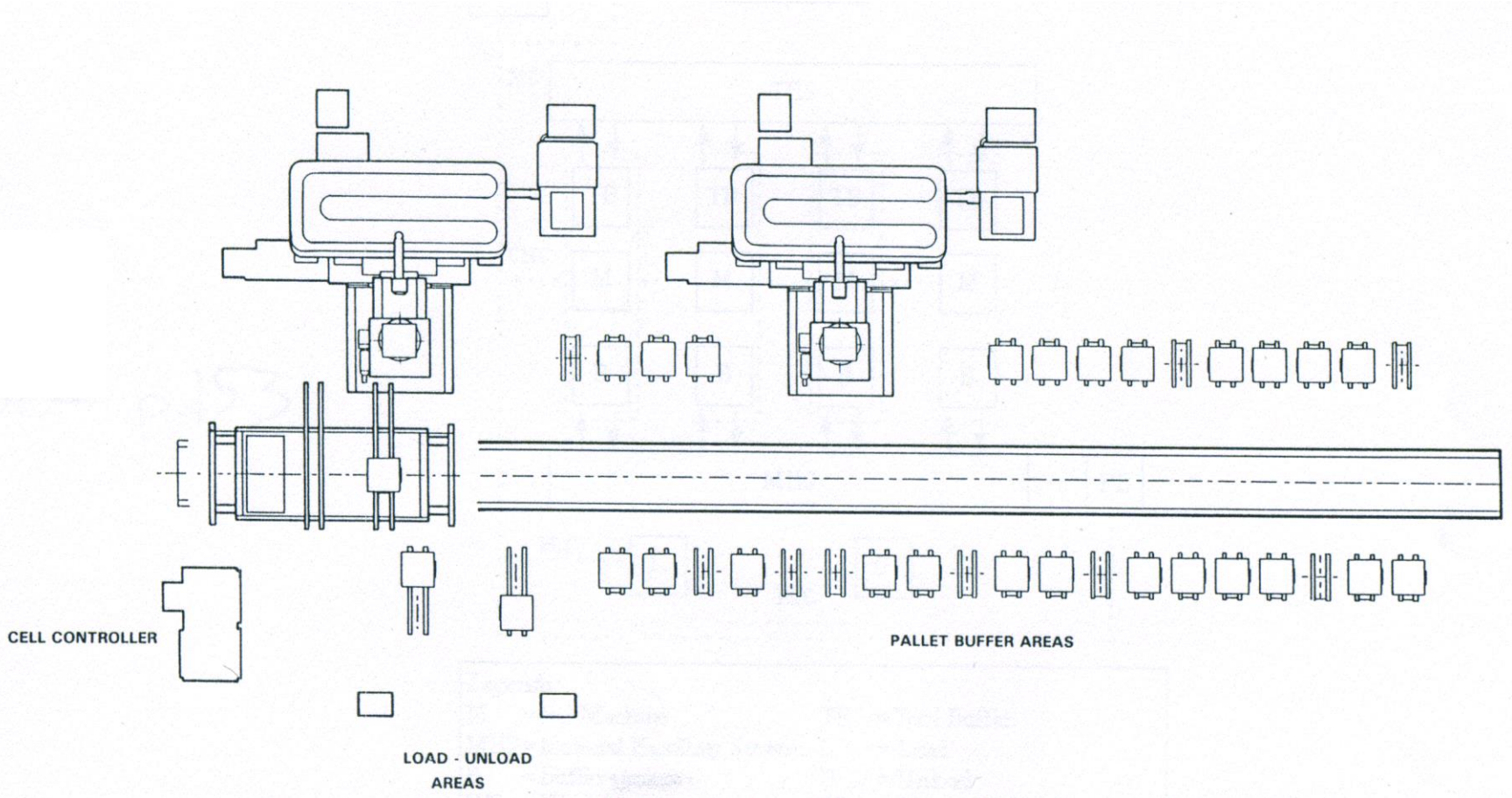
AN EXAMPLE OF MANUFACTURING CELL



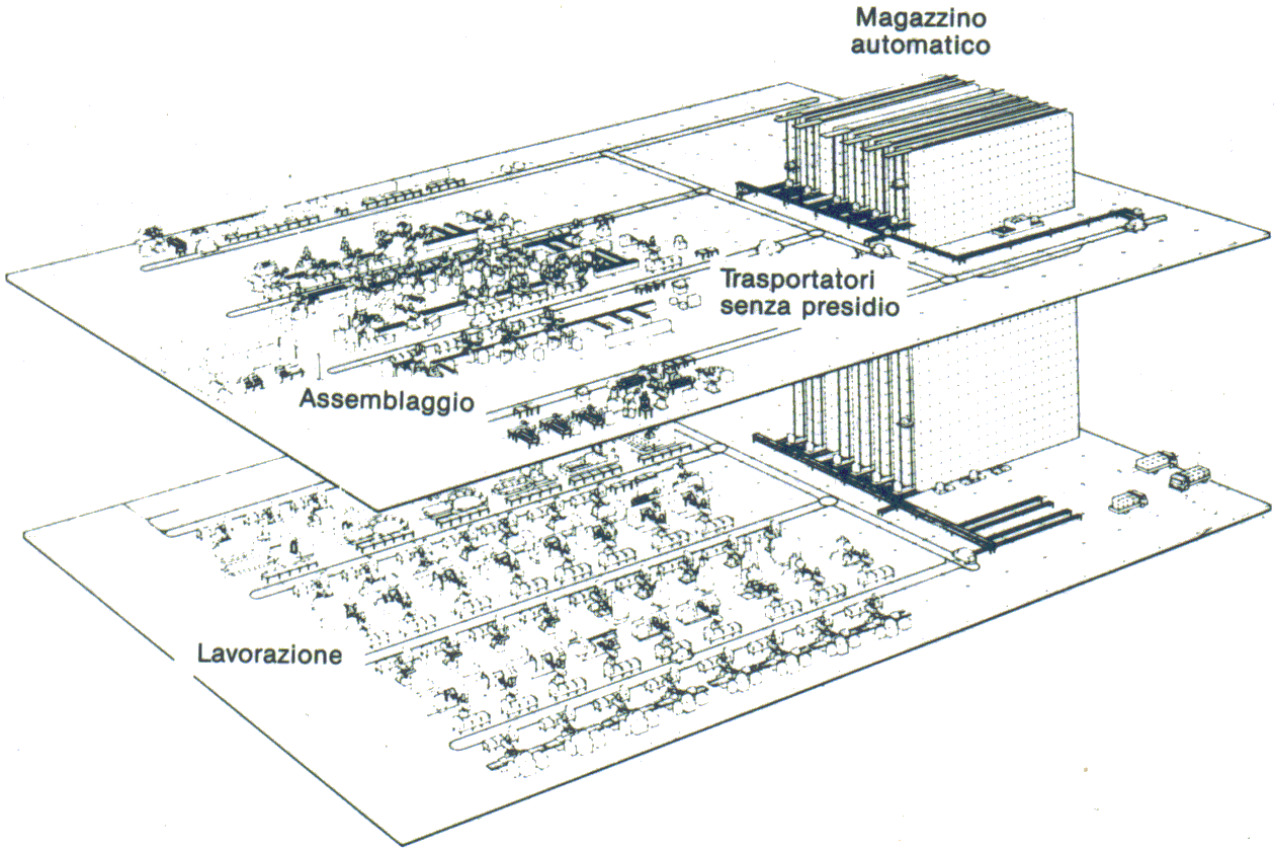
Badger Meter CELL



Badger Meter CELL



FANUC FMS


Magazzino
automatico
Trasportatori
senza presidio
Assemblaggio
Lavorazione