Production planning in automated systems

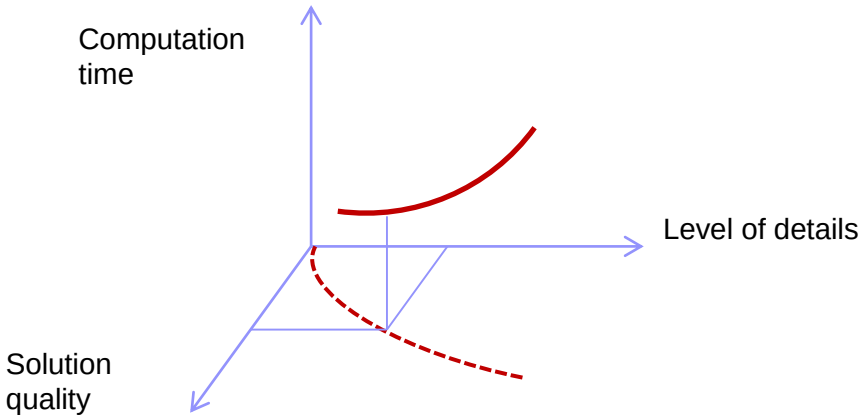
Production planning

- Long-term planning: which products to be placed in the market (strategic level)
- Aggregate or mid-term planning: definition of a master production planning (tactical level)
- Short-term planning: production resources allocation
- Operative control: connection and synchronization of the phases of production process

In case of automated systems, the traditional methodologies don’t support the phases of short-term planning and operative control

Operative planning

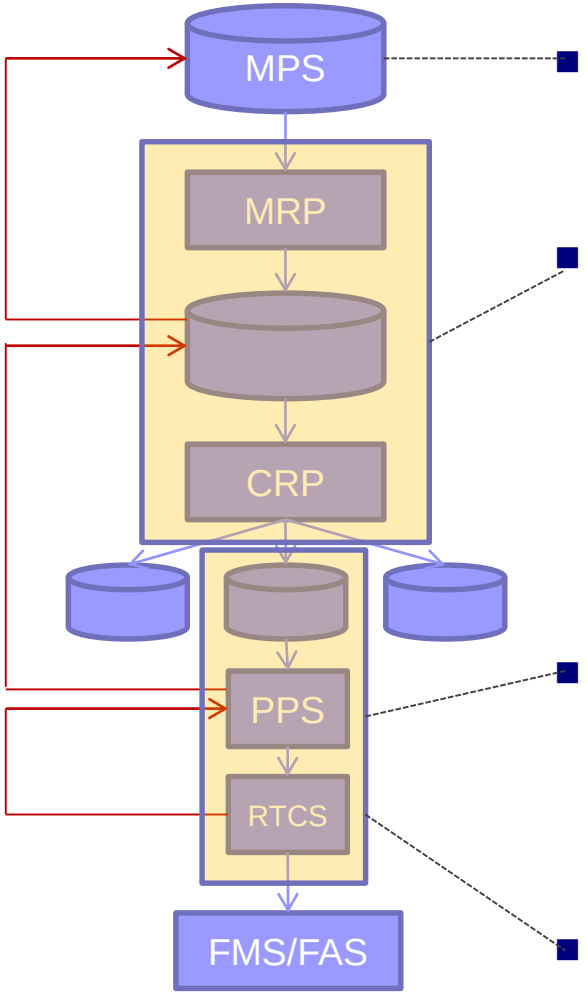
- In automated systems the responses are more predictible (less impact related to human factor)
- Plant supervision system knows the status of machines and work advancement (more available information)
- Level of details vs solution quality vs computation time



Operative planning

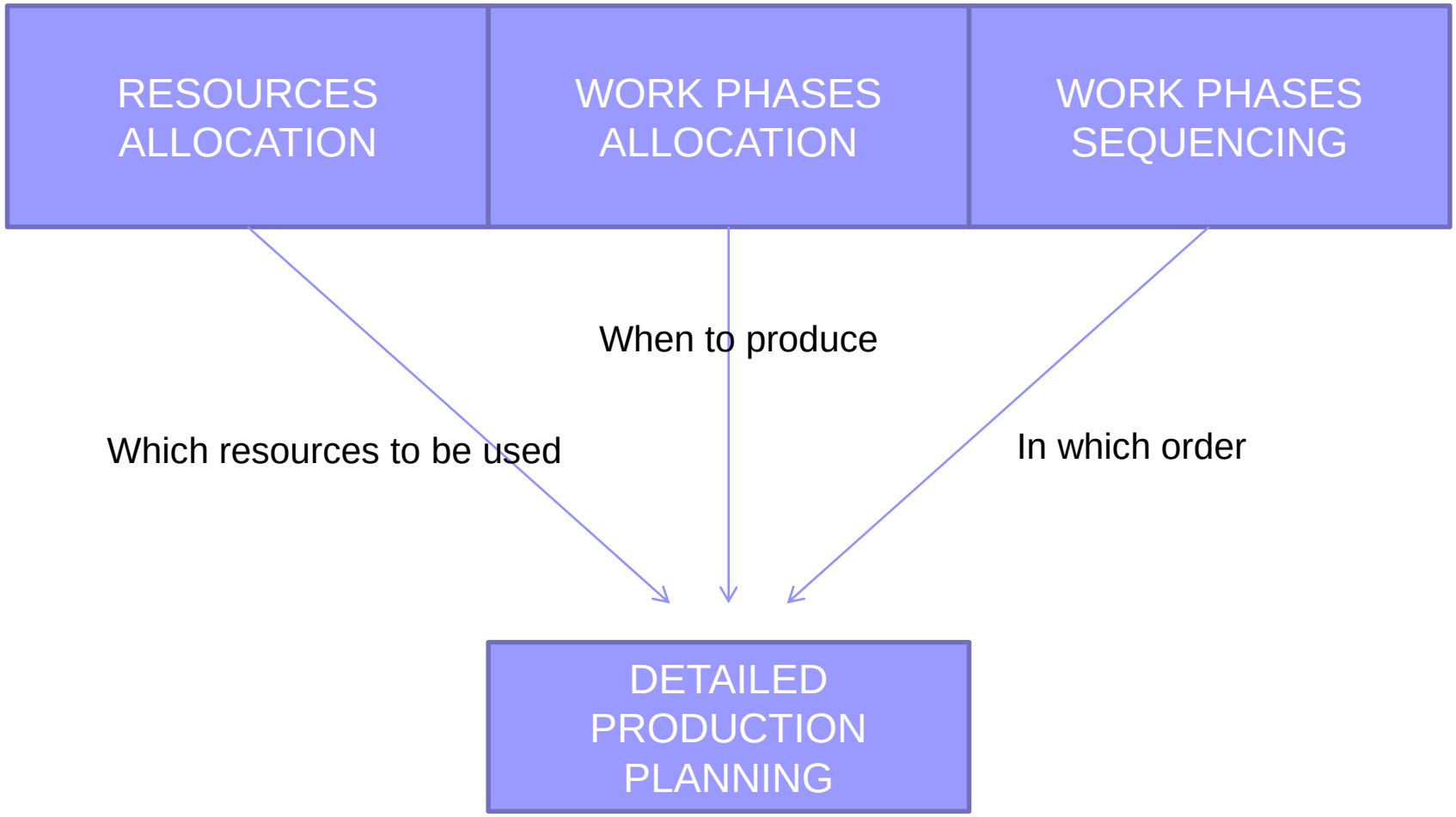
- From problem to sub-problems (phases partition), each of them considers a specific phase with different planning horizons
- It is possible to plan a long time period, without a decrease of performances in terms of computation time and solution quality
- Detailed data with a reduced quantity for time near to production start vs aggregate date for previous time
- With this approach:
  - Better management of modification in orders portfolio
  - Decoupling of phases, which allows a better decision making
  - Different phases means also different algorithms
  - Easy program and easy management
  - Better management in case of problems, because the decisions are taken at the latest, reacting only in the right phases.

Operative planning



- Level 1. Master Production Schedule (12-24 months)
- Level 2. Plant level (3-12 months)
- Level 3. Short term planning
- Lvel 4. Real time scheduling

Production planning system (PPS)



Production planning system (PPS) - Goals

- Machines saturation;
- WIP minimization;
- Changes minimization;
- Delivery date keeping;
- Flow time minimization;
- Tardiness minimization;
- Makespan minimization;
- A combination of the previous goals.

Production planning system (PPS) - Contraints

- Equipment availability;
- Availability of raw material and components;
- Production capacity (the number of jobs to be planned cannot exceed production capacity, without delay);
- Physical capacity (space) or system capacity;
- Delivery date;
- Cycles (availability of CAD\CAM cycles in archive).

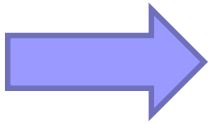
Real Time Control System (RTCS) - Activities

- LOADING, composed of two phases:
  - loading: which part has to be loaded into the system;
  - timing: when the part chosen has to be loaded into the system.
- OPERATION SEQUENCING, composed of two phases:
  - routing: which physical machine has to work a specific part, given a set of alternative machines;
  - dispatching: which parts has to be chosen from the queue of a machine, in order to be worked on it.

Real Time Control System (RTCS) – Loading rules

- BL1

$$IB_j = \frac{\sum_{i=1}^{m} F_{ij}}{max\left\{F_{ij}\right\} \times m}$$



Choose j in order to:

$$IB_j = max\left\{IB_j\right\}$$

- i = 1,..., m: machine index
- m : number of machines;
- j : job index
- C_i : Current workload on machine i ;
- T_{ij} : Work time of job j on machine i;
- $F_{ij} = C_i + T_{ij}$: workload on machine i after introducing job j into the system.

Real Time Control System (RTCS) – Loading rules

- BL2

$$IB_j^* = \sum_{i=1}^{m} \left[\frac{Cs_i}{max\{Cs_i\}} - \frac{F_{ij}}{max\{F_{ij}\}} \right]^2$$

Choose j in order to:

$$IB_j^* = min\left\{ IB_j^* \right\}$$

  - Csi is the workload on machine i related to a certain time horizon.

Real Time Control System (RTCS) – Loading rules

- BL3

$$IB_j^{**} = \sum_{i=1}^{m} \left[\frac{Cs_i}{max\{Cs_i\}} - \frac{F_{ij}}{F_j} \right]^2$$

Choose j in order to:

$$IB_j^{**} = min_j \left\{ IB_j^{**} \right\}$$

  - Fj is the workload, after introducing job j, on the machine which has the maximum workload in the time horizon, (machine j with Csi= max).

Real Time Control System (RTCS) – Dispatching rules

- SPT (Shortest Processing Time) or SIO (Shortest Imminent Operation): the job to be dispatched is the one with the minimum work time on the considered machine.
- LPT (Longest Processing Time): the job to be dispatched is the one with the maximum work time on the considered machine.
- TSPT (Truncated SPT): use SPT, but when the waiting time for a job exceed a limit (to be defined) use FIFO rule (see in the following).

Real Time Control System (RTCS) – Dispatching rules

- LWKR (Least Work Remaining): the job to be dispatched is the one with the minumum total work time on the machines not yet visited.
- TWORK (Total Work): the job to be dispatched is the one with the minumum total work time (sum of all the work times of a job).
- MSUT (Minimum Setup Time): the job to be dispatched is the one with the minumum setup time on the specific machine.

Real Time Control System (RTCS) – Dispatching rules

- FIFO (First In First Out)
- LIFO (Last In First Out)
- FISFS (First In the System First Served)

Real Time Control System (RTCS) – Dispatching rules

- FROP (Fewest Remaining Operations): the job to be dispatched is the one with the minumum number of operations to be executed (nearest to end).
- MROP (Most Remaining Operations): the job to be dispatched is the one with the maximum number of operations to be executed.
- EDD Earliest Due Date
- Slack
- Slack per operations