Operations Management I

Manufacturing Resource Planning – MRP II

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Manufacturing Resource Planning – MRP II

A Framework for Planning and Scheduling

Overview

MRP II Hierarchy

- Long-Range Planning
- Intermediate Planning
- Short-Range Planning

Extensions

ERP, SCM, etc.

Hopp and Spearman, 2008, **Factory Physics**, McGraw Hill. **(Section 3.2)**

MRP II

Overview

Problems of MRP

- Capacity infeasibility (infinite capacity)
- Long and fixed planned lead times
- System nervousness

→ Manufacturing Resource Planning (MRP II)

An integrated manufacturing management system
(all planning and scheduling activities)

<---- A framework for planning and scheduling in manufacturing systems (MRP II hierarchy)

<---- MRP + Additional functions

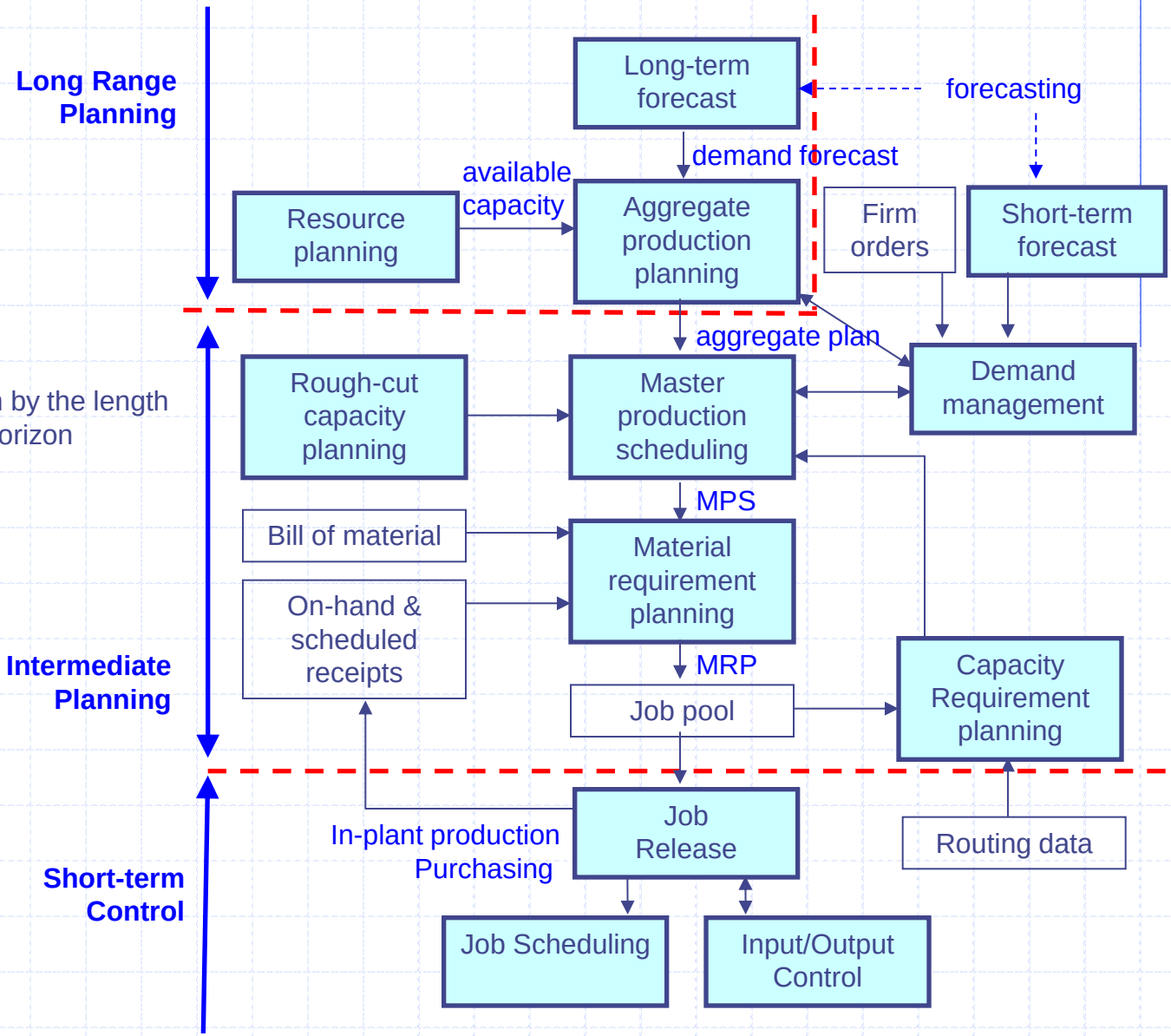
- ✓ Demand management
- ✓ Forecasting
- ✓ Aggregate production planning
- ✓ Master production scheduling
- ✓ Capacity planning, etc.

MRP II

- **Overview**

  MRP II Hierarchy

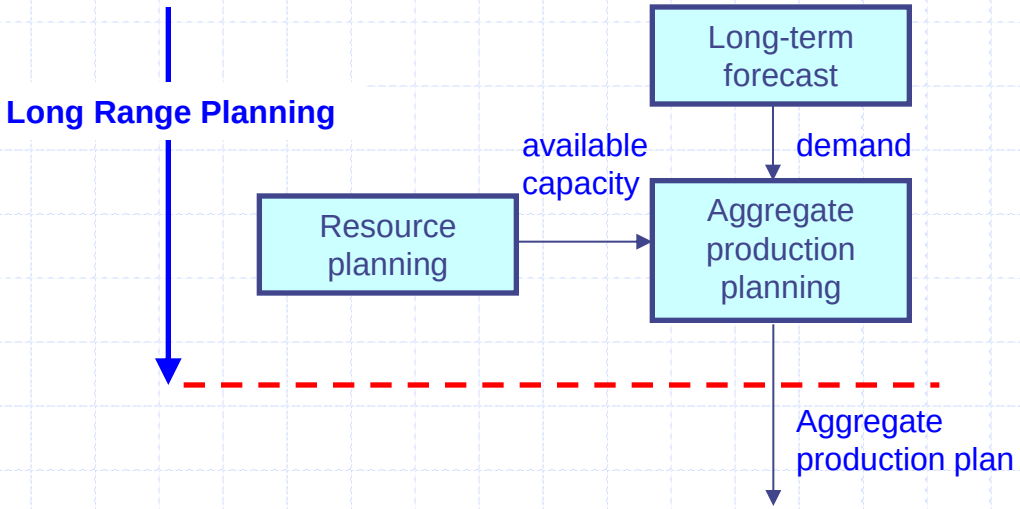
  - Classification by the length of planning horizon



MRP II

MRP II Hierarchy

Long-Range Planning – Overview



- Length of time horizon
  - ✓ 6 months to five years
- Frequency of replanning
  - ✓ Once per month
  - ✓ Once per year
  - ✓ Two or four times per year, etc.

- Degree of details
  - ✓ Product family level

Grouping of end items having similar demand and production characteristics (aggregate units)

e.g., small sized automobiles, large sized automobiles

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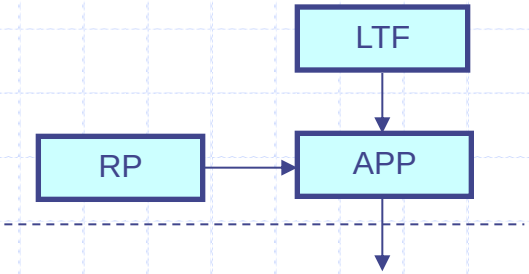

MRP II Hierarchy

Long-Range Planning – Details

- Resource Planning
  - ✓ Process of determining capacity requirements over long-term (capacity determination, facility layout, equipment requirements, etc.)

    Example (equipment requirements for batch production)

projected available capacity over the long-term planning horizon

- Forecasting (long-term)
  - ✓ Predict demand in the future (Determine capacity, tooling, and personnel requirements)
  - ✓ Forecast for part families (for aggregate production planning)

Long-term demand forecast

- Aggregate Planning
  - ✓ Determine levels of production (regular/over time), workforce, inventory/backlogging, and subcontracting over time
  - ✓ Levels of details
    - ➢ Part families (aggregate units)
    - ➢ One or two years planning horizon

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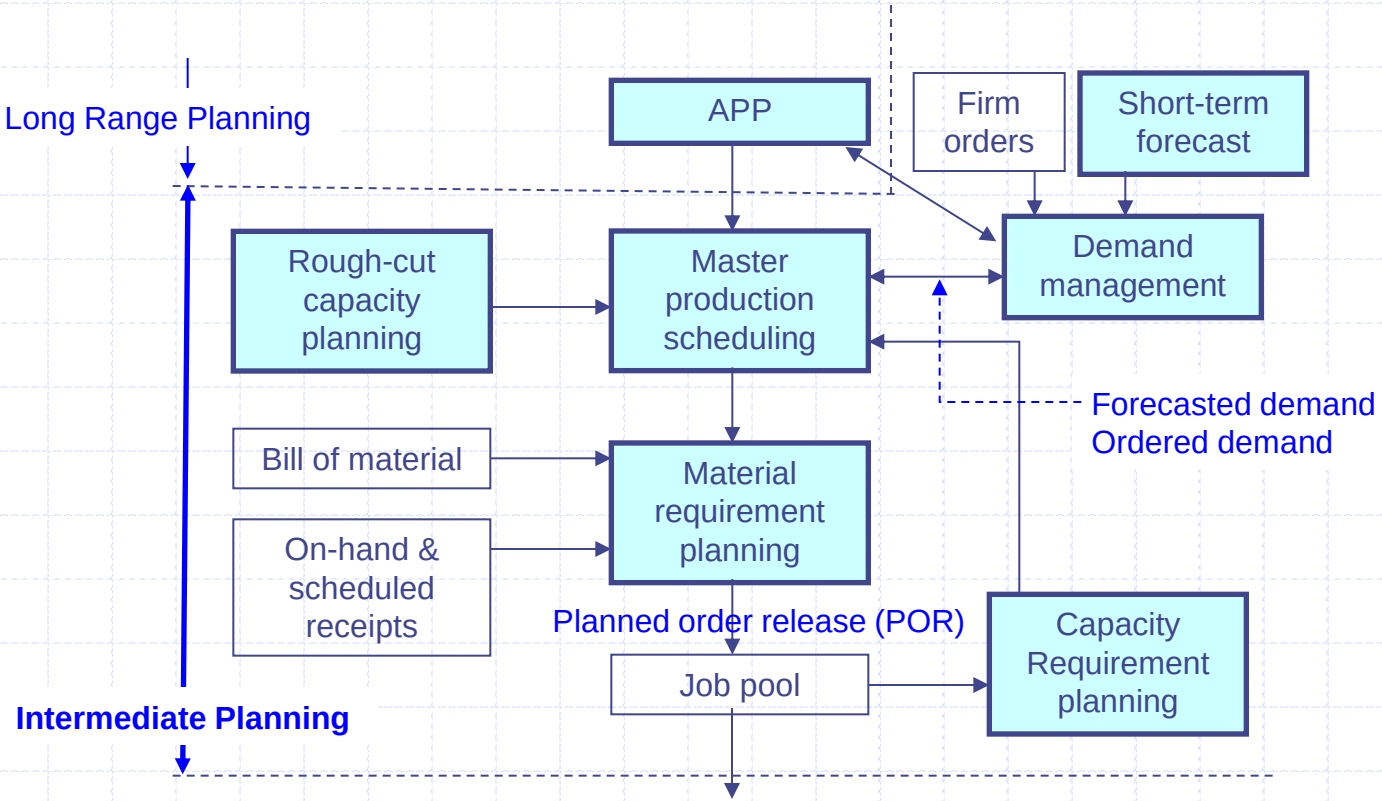
- Degree of details:
  - ✓ End-items (MPS)
  - ✓ Parts/components (MRP)
- Length of time horizon
  - ✓ 1 week to several months

MRP II Hierarchy

Intermediate Planning – Overview



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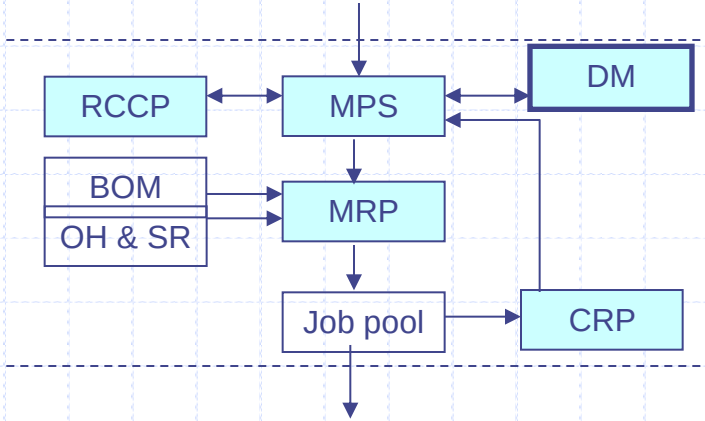
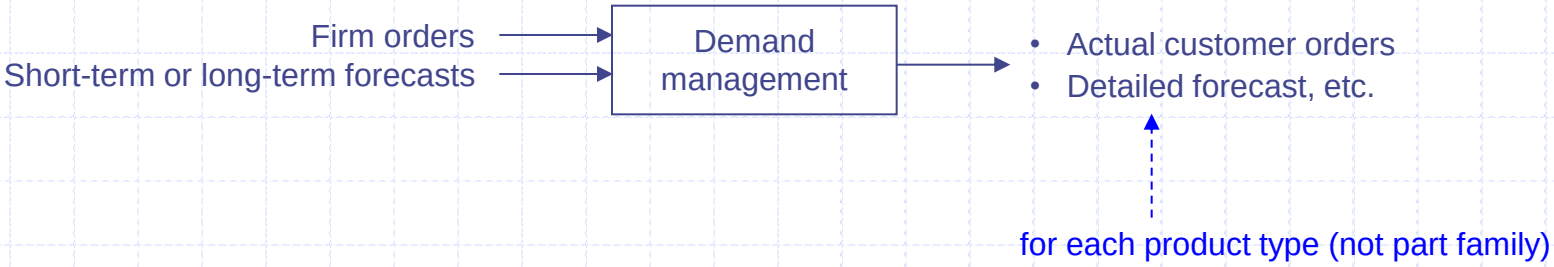


MRP II Hierarchy

Intermediate Planning – Details (1)

- Demand Management
  - ✓ Process of converting the long-term aggregate forecast to a detailed forecast while tracking individual customer orders
    - ⇠---- Filtering and adjusting customer orders into a form that produces a manageable master production schedule
  - ✓ Inputs and outputs



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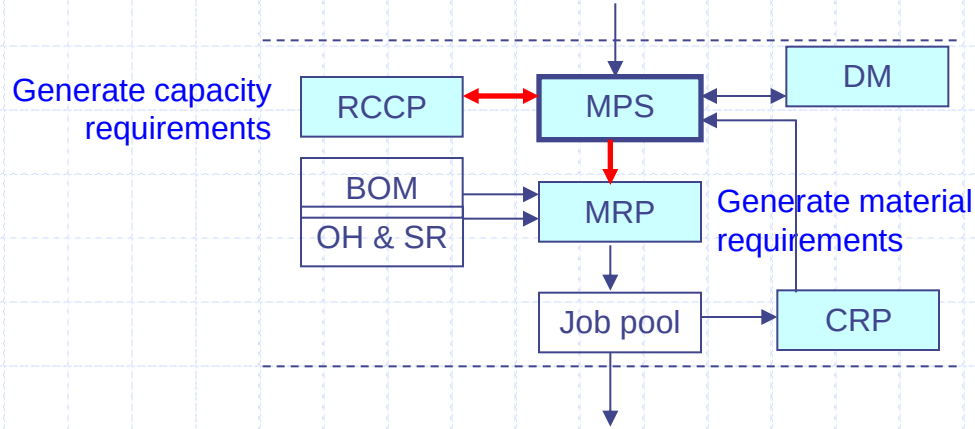
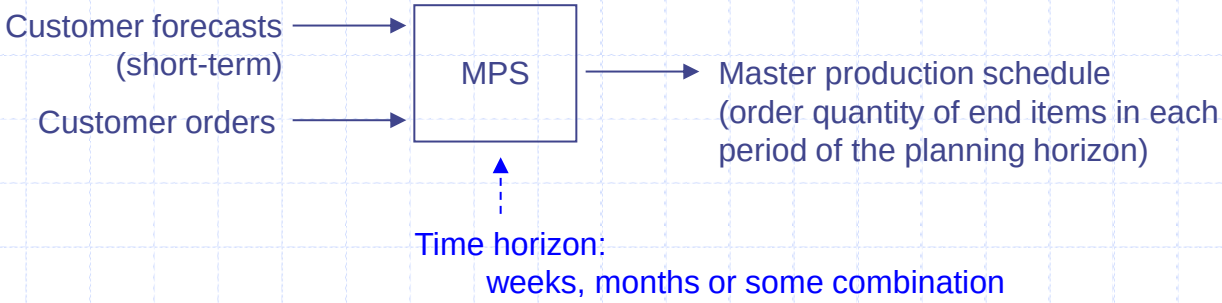


MRP II Hierarchy

Intermediate Planning – Details (2)

- Master Production Scheduling
  - ✓ An anticipated schedule of end items or groups of items with independent demand (order quantity in each time bucket)
  - ✓ Key functions
    - ➢ Translate aggregate plans into specific end items (APP → MPS)
    - ➢ Evaluate alternative master production schedules
    - ➢ Effectively utilize capacity ⟵ rough-cut capacity planning (checking capacity for a few critical resources)
  - ✓ Inputs and outputs



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MRP II Hierarchy

Intermediate Planning – Details (3)

- Master Production Scheduling
  - ✓ Computation

Offsetting:
Lead time = 1 week

Fixed order quantity (150)
Initial inventory (55)

	Week							
	1	2	3	4	5	6	7	8
Forecasts	30	30	30	30	35	35	35	35
Customer orders	38	27	24	8	0	0	0	0
Ending Inventory	17	137	107	77	42	7	122	87
MPS	**0**	**150**	**0**	**0**	**0**	**0**	**150**	**0**
MPS (after offsetting)	150	0	0	0	0	150	0	0

requirement
= max { forecast,
customer order }

If (initial inventory – requirement) > 0

- ending inventory = initial inventory – requirement
- MPS =0

e.g., 55 – max {30, 38} > 0

→ Ending inventory = 55 – max {30, 38} = 17
MPS = 0

If (ending inventory (at previous period) – requirement) < 0

- MPS = lot size
- ending inventory = ending inventory (at previous period) + MPS – requirement

e.g., 17 – max {30, 27} < 0

→ MPS = 150
ending inventory = 17 + 150 – max {30, 27} = 137

MRP II

Fixed order quantity (150) Initial inventory (55)	Week							
	1	2	3	4	5	6	7	8
Forecasts	30	30	30	30	35	35	35	35
Customer orders	38	27	24	8	0	0	0	0
Ending Inventory	17	137	107	77	42	7	122	87
MPS	0	150	0	0	0	0	150	0
MPS (after offsetting)	150	0	0	0	0	150	0	0

MRP II Hierarchy

Intermediate Planning – Details (4)

- Master Production Scheduling

✓ ATP inventory ◄---- ATP (available-to- promise)

Quantity of end items that marketing can promise to deliver on specified dates

◄------ Negotiating customer due dates (of independent make-to-order demands)

➢ Example

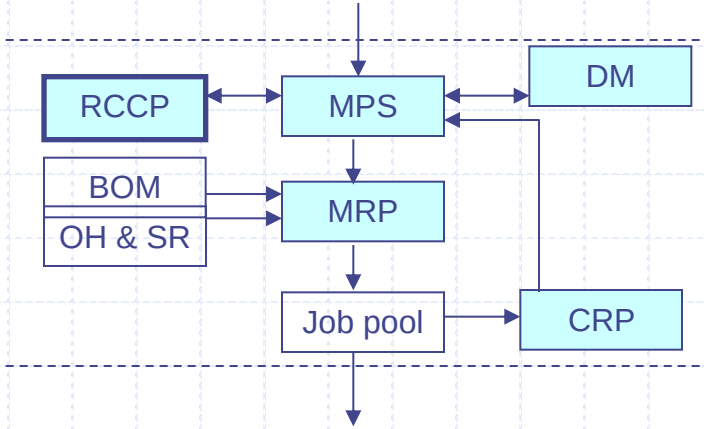
- ATP inventory at period 1
  = initial inventory + MPS – sum of customer orders until the next MPS
  = 55 + 0 – 38 = 17

- ATP inventory at period 2 (periods 2 through 6)
  = MPS – sum of customer orders until the next MPS
  = 150 – (27 + 24 + 8 + 0 + 0) = 91◄--------

150 units scheduled for completion in period 2, 91 units are uncommitted, and total new orders up to that quantity can be promised for delivery as early as period 2

- ATP inventory at period 7 (period 7 or 8)
  = 150 – (0 + 0) = 150

MRP II



MRP II Hierarchy

Intermediate Planning – Details (5)

- Rough-Cut Capacity Planning (for MPS)

  Quick capacity check of a few critical resources
  to ensure the feasibility of the master production schedule

  ✓ Bill of resources (for each end-item)

  Number of hours required at each critical resource to build a particular end item

e.g., Part A with components A1 and A2, Part B without components

Processing times at process center 21 (critical resource)

- Part A: 1 hour / unit
  Component A1: 0.5 hours / unit
  Component A2: 1 hour / unit
  } 2.5 hours/unit
- Part B: 2 hours / unit

Process center	Part A	Part B
21	2.5	2.0

MRP II

MRP II Hierarchy

Intermediate Planning – Details (6)

- Rough-Cut Capacity Planning (for MPS)
  - ✓ Example (Parts A and B at process center 21)

Bill of resources

Process center	Part A	Part B
21	2.5	2.0

Master production schedule

Week	1	2	3	4	5	6	7	8
Part A	10	10	10	20	20	20	20	10
Part B	5	25	5	15	10	25	15	10

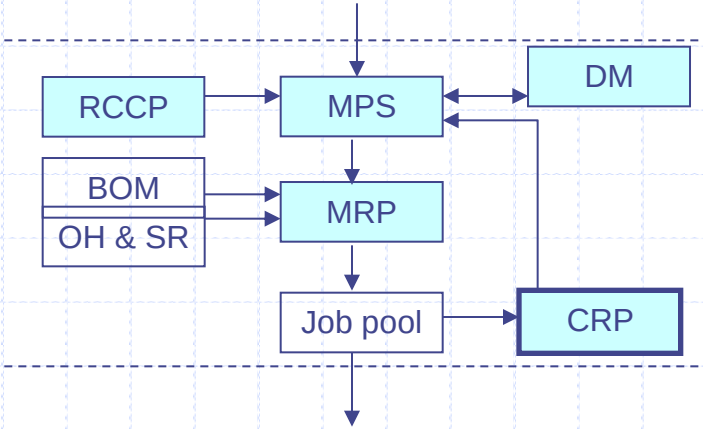
Week	1	2	3	4	5	6	7	8
Part A (hour)	25	25	25	50	50	50	50	25
Part B (hour)	10	50	10	30	20	50	30	20
Sum	35	75	35	80	70	100	80	45
Available	65	65	65	65	65	65	65	65
Over(+)/Under(-)	**30**	**-10**	**30**	**-15**	**-5**	**-35**	**-15**	**20**

no idle time
→ optimistic estimates

Feasible in the planning horizon (total required = total available = 520)

Infeasible in each period
- Adjust MPS by changing due dates
- Adjust capacity by adding or taking away resources, using overtime, or subcontracting

MRP II



MRP II Hierarchy

Intermediate Planning – Details (7)

- Capacity Requirement Planning (for MRP)
  - ✓ Detailed capacity check on MRP generated production plan (more detailed than RCCP)
    1) Predict job completion times for all process centers, using given fixed lead times, and then computes a predicted loading over time
    2) These loadings are compared against the available capacity. (No correction is made for an overloaded situation.)
  - ✓ Inputs and outputs

manufacturing lead time at each process center

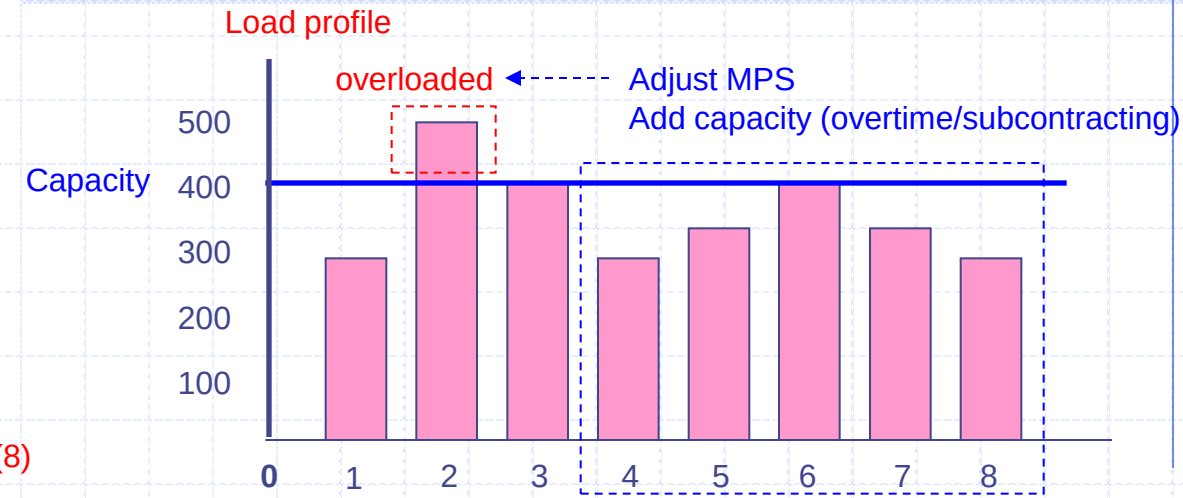
All planned order releases (from MRP)
Routing data (from process planning)
Existing WIP positions
Capacity and lead times for all process centers

Capacity Requirement Planning

capacity feasibility at each process center

Infinite forward loading for all process centers

MRP II



MRP II Hierarchy

Intermediate Planning – Details (8)

- Capacity Requirement Planning (for MRP)
  - ✓ Example

A process center
(lead time = 3 days, capacity = 400 parts/day)

Orders that have been released

- 400 units have been released into the process center at the start of the current day.
- 500 units have been there for one day
- 300 units have been there for two days
- Planned order releases (5 days from the current day)

Day	1	2	3	4	5
Planned order release	300	350	400	350	300

MRP II

MRP II Hierarchy

Intermediate Planning – Details (9)

- Capacity Requirement Planning (for MRP)
  - ✓ Limitations
    - ➢ Voluminous and deterministic data

      Time to go through the process center does not change
      (not a good predictor of load condition except in the very near term)

      ←------ fixed lead time
    - ➢ No correction

      Only tells the planner that there is a problem (it offers nothing about what caused the problem or what can be done to alleviate it.)

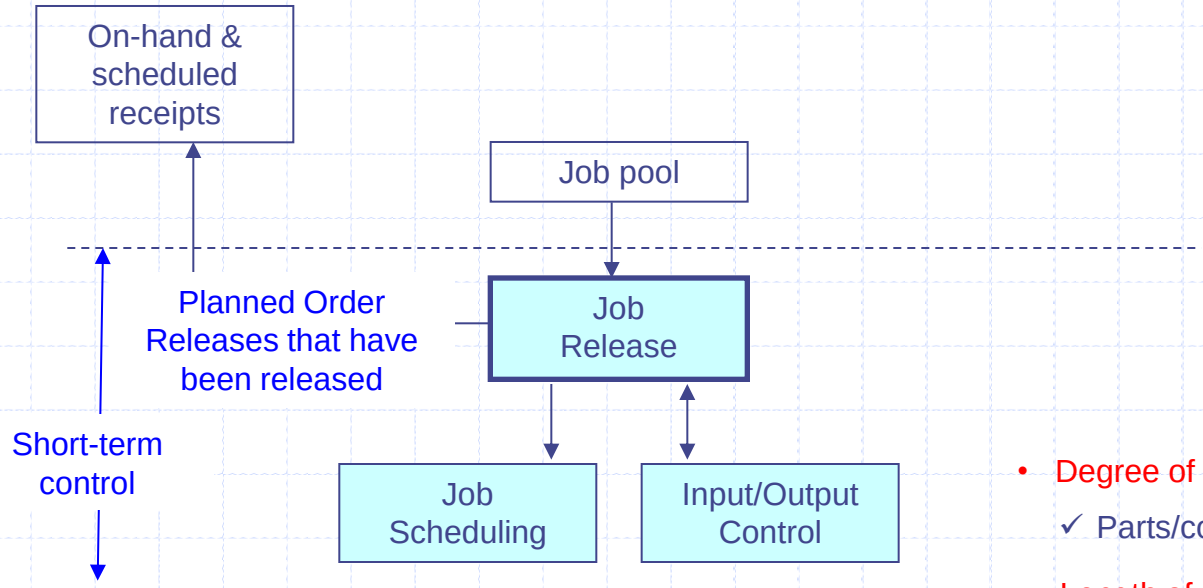
      ←------ The planner should find the resolving methods by himself/herself.
    - ➢ Infinite capacity

      Infinite forward loading for all process centers
      (→ finite loading)

MRP II

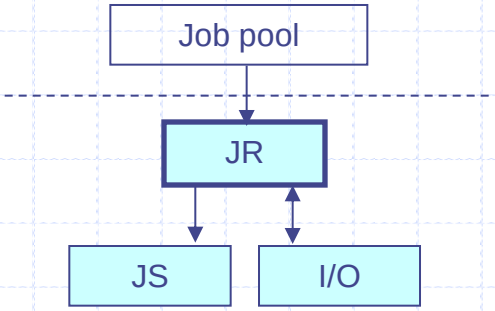
MRP II Hierarchy

Short-term Control – Overview



- Degree of details
  - ✓ Parts/components level
- Length of time horizon
  - ✓ Day to week

MRP II



MRP II Hierarchy

Short-term Control – Details (1)

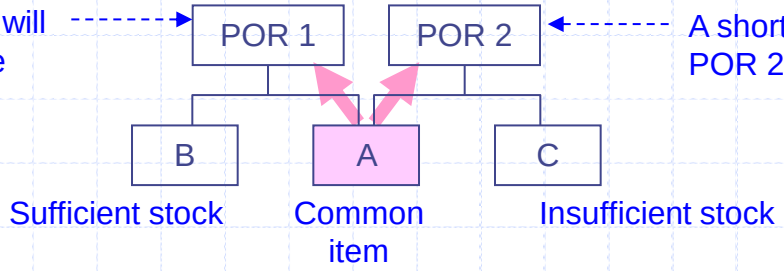
- Job release
  - ✓ Converts planned order releases to scheduled receipts (real release to shops)
    - ➢ Allocation

      Resolution of conflicts when there is an insufficient quantity on hand in the case of several high-level items using the same lower-level part

      Example

      Sufficient stock for either POR 1 or 2 (but not for both)

Job release function will allocate the available stock to POR 1.



A shortage notice will be generated for POR 2. (remains in the job pool)

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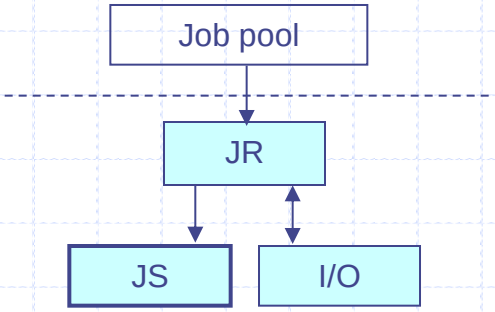

MRP II Hierarchy

Short-term Control – Details (2)

- Job scheduling

✓ Definition

Allocation of resources over time to perform a collection of tasks

e.g., machine scheduling

assigning each operation of each job start time and completion time

- ➢ Resources ≡ machines
- ➢ Tasks ≡ jobs (set of operations)

✓ Approaches

➢ Theoretical approach

Optimization problems
(one-machine, parallel machine, flow shop, job shop, etc.)

<---- Various OR techniques
(branch and bound, integer programming, heuristics, etc.)

➢ Practical approach

Job dispatching
(Arrange the queue in front of each workstation)

<---- Dispatching rules (with simulation technique)

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MRP II Hierarchy

Short-term Control – Details (3)

- Input/output control

✓ Definition

Way to keep lead times (or completion times of jobs) under control

✓ Method

① Monitor the WIP level in each process center

Changing the MPS

② If the WIP goes above a certain level, the current release rate is too high, so reduce it.

③ If the WIP goes below a specified lower level, the current release rate is too low, so increase it.

④ If it stays between these control levels, the release rate is correct for the current condition

e.g., lot release control in wafer fabrication

MRP II

The roots are in planning.

MRP

↓

MRP II

↓

Extensions

ERP (Enterprise Resource Planning) ⟷ PDM (Product Data Management)
PLM (Product Lifecycle Management)

The roots are in product.
(Concurrent Engineering)

- Definition

  A unification of business processes through integrated enterprise applications and centralized data

- Goal
  - ✓ Integration of all facets of a business (production, marketing, personnel, accounting, finance, etc.)
  - ✓ Linking information together in ways that make it much easier for upper management to have a more global picture of operations in almost real time
- Various software packages
  - ✓ SAP R/3
  - ✓ Oracle/Appl
  - ✓ Uni ERP, etc.

MRP II

Extensions

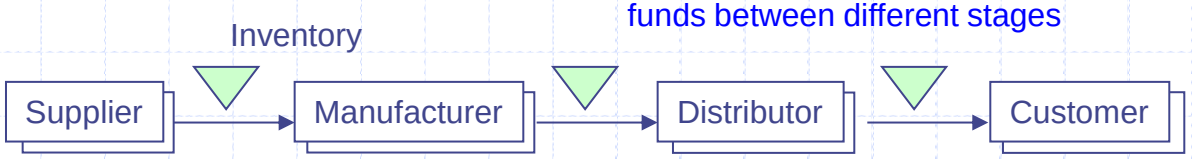
SCM (Supply Chain Management)

- Definition

  All stages involved, directly or indirectly, in fulfilling a customer request (primary purpose: satisfy customer needs)

  ✓ Typical stages

constant flow of information, product, and funds between different stages

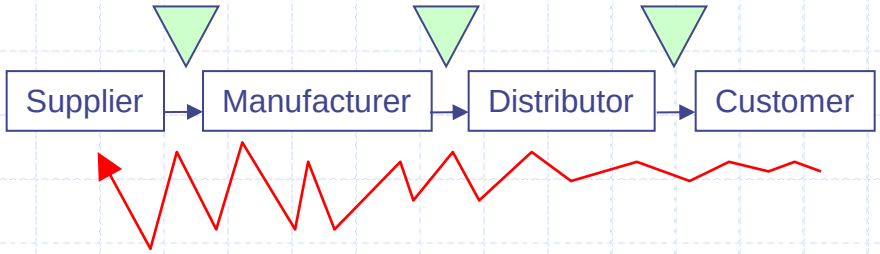


- Why SCM?

  ✓ Bullwhip effects

Decision (in IE view point)

- Inventory
- Facility
- Transportation
- Information



Fluctuations in orders increase as they move up the supply chain from customers to distributors to manufacturers to suppliers