Business Administration

Lecture No. 11: Delivery and Process Management

1. Concept of Delivery
   (delivery, production volume, inventory, backlog)
2. Concept of Process Management
3. Scheduling
4. Material Requirement Planning (MRP)
5. Man-Hour Planning and Capacity/Burden Analysis
   (CRP and MRP II)
6. Production Instruction

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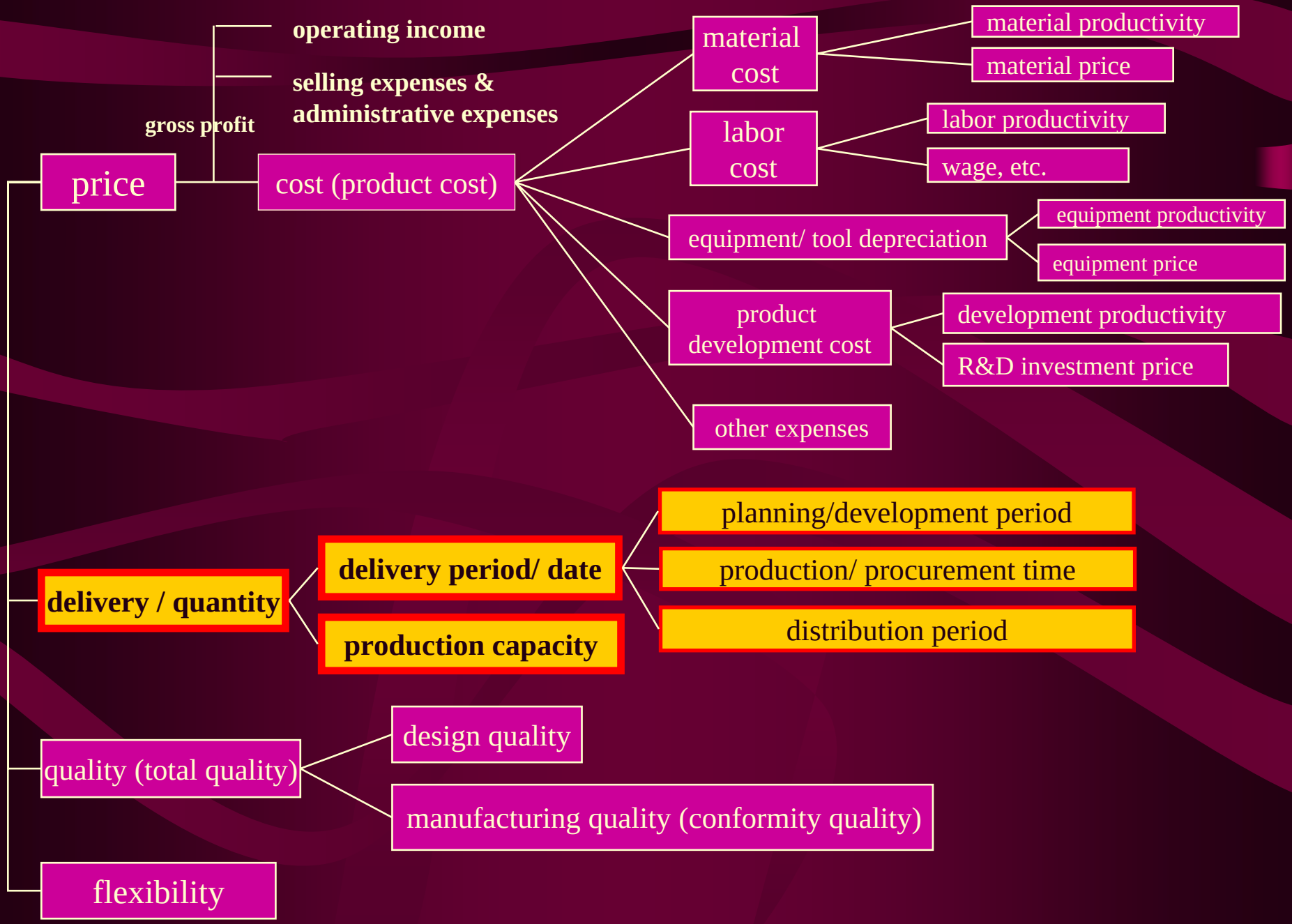
Main Factors of Product Competitiveness



1. Concept of Delivery
(delivery, production volume, inventory, backlog)

Delivery

= date set for delivery (point in time to be in someone's possession)

or

= delivery period (period from order placement to possession)

Target of delivery depends on how long customers can wait.

Differs by products.

What does Delivery (= delivery period) include?

--- up to type of production

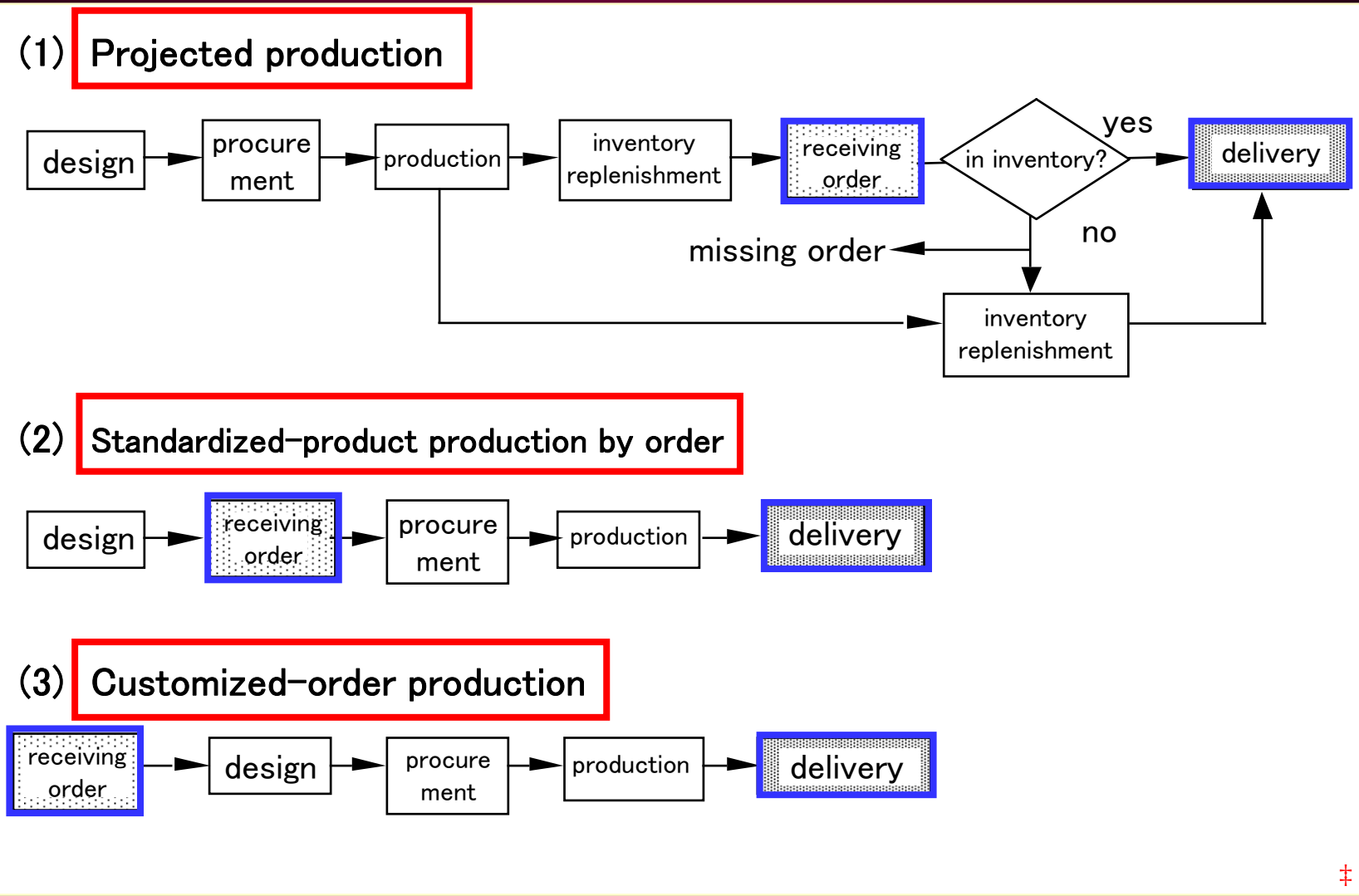
(1) Projected production (stock production)

(2) Post-order production (order production)

(2a) order production of standardized products
(projected design, order production)

(2b) customized-order production
(order design, order production)

Projected Production and Production by Order



"Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (I p172 figure.6.1) "

Delivery/Production volume/Inventory/Backlog

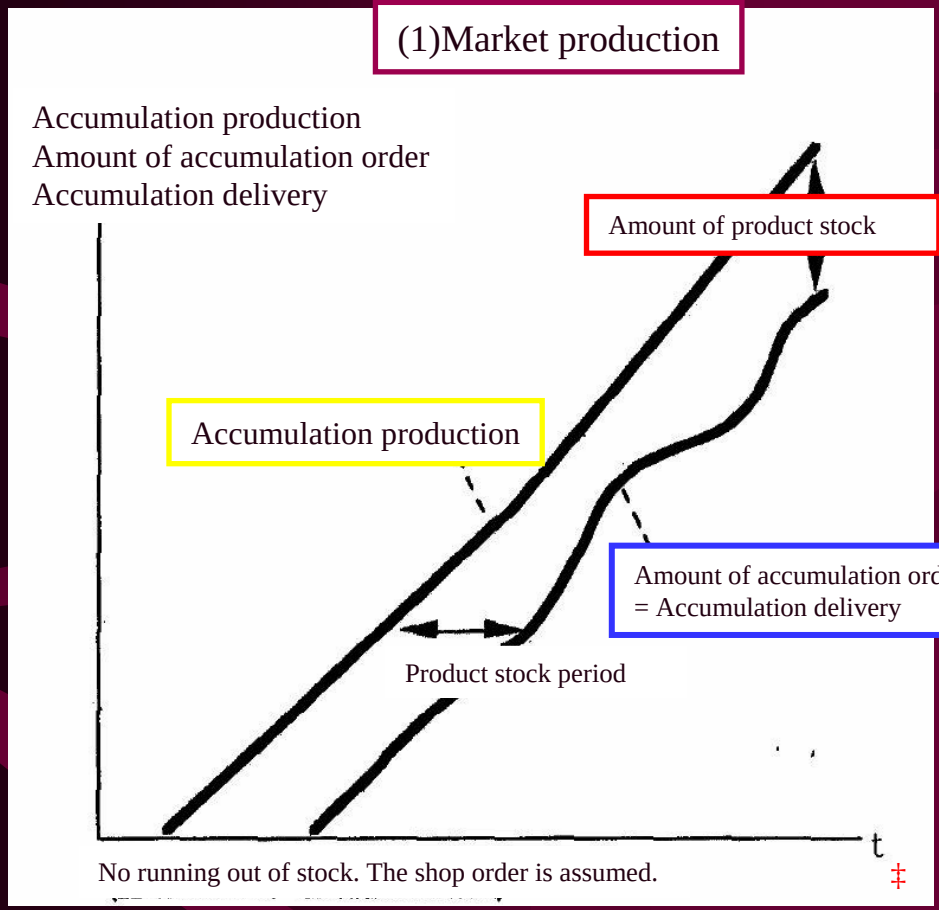
Delivery and production volume are linked through inventory and backlog.

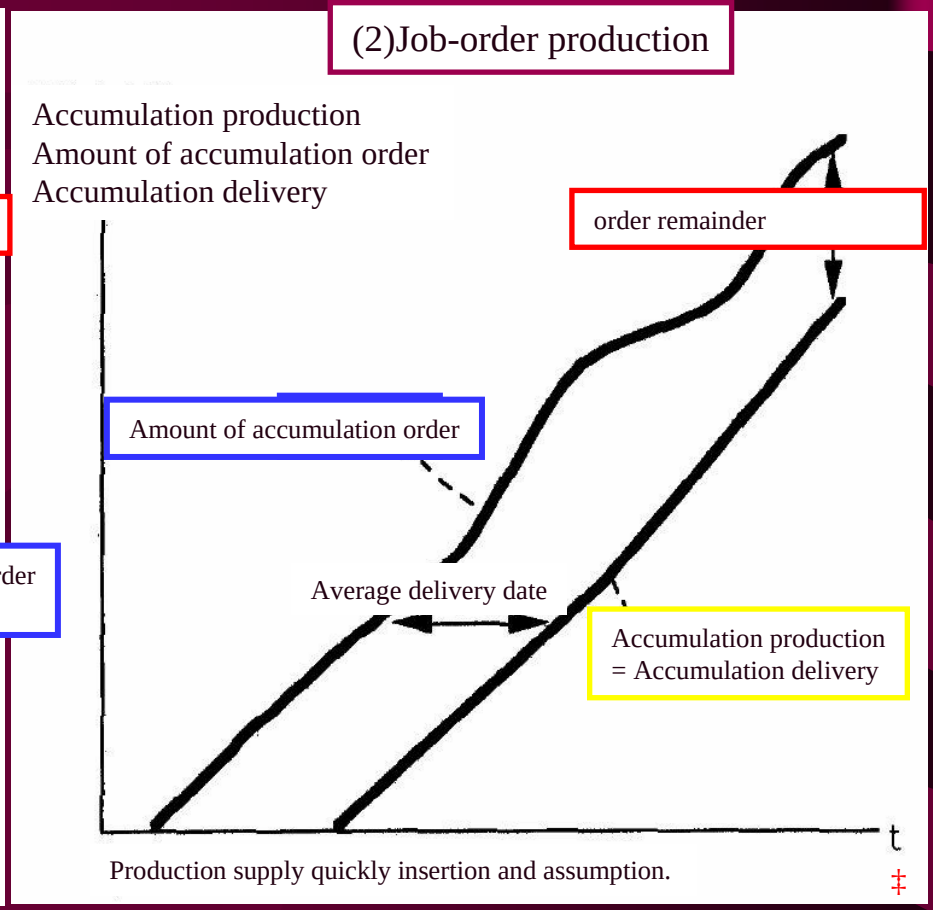
Analyze by rheogram curve (cumulative curve)

(1) case of stock production (having inventory)

(2) case of order production (having backlog)

Relationship Among Delivery, Production Volume, and Inventory (rheogram curve)





Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (Ⅰ p173 figure.6.2)

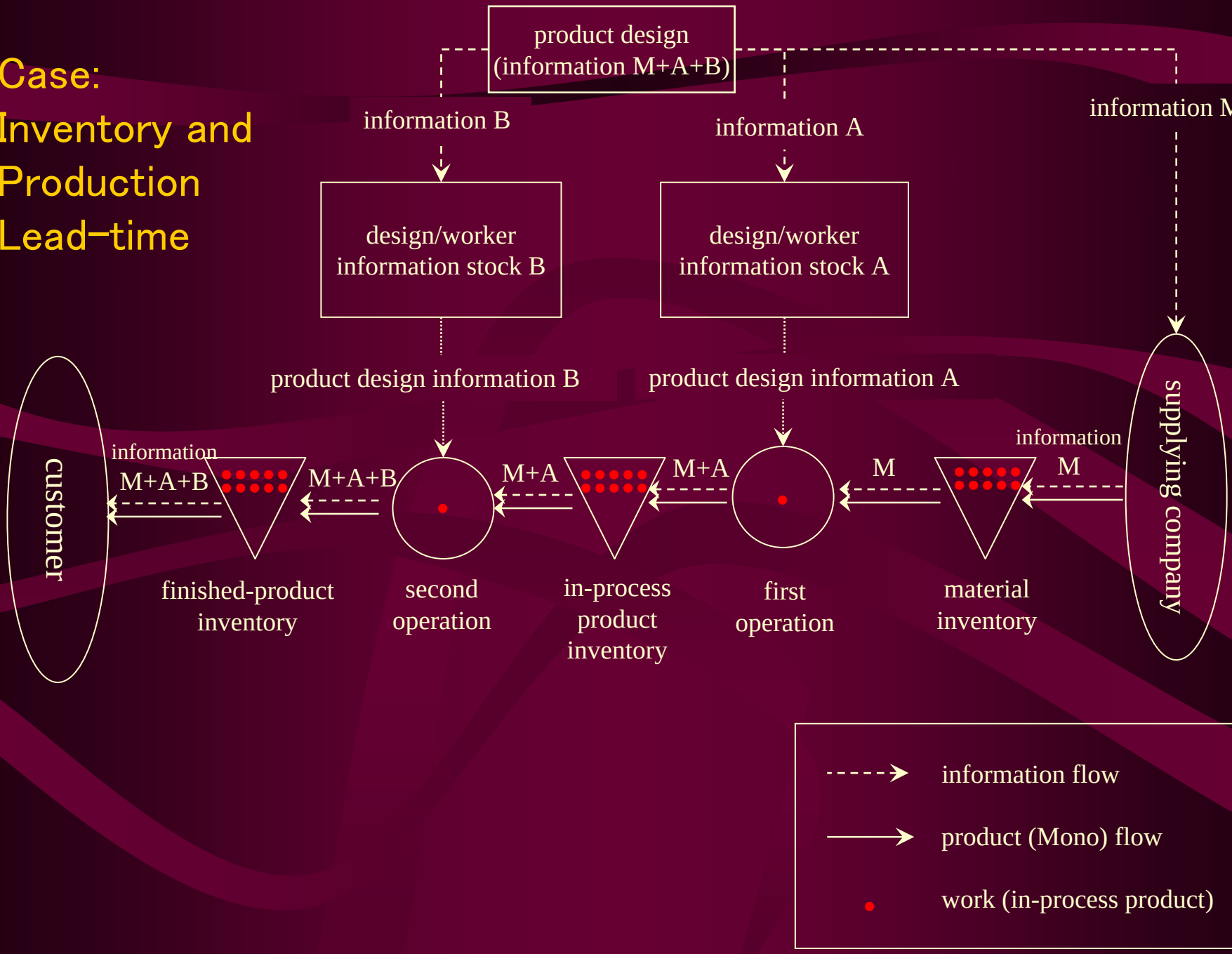
2. Concept and Content of Operation Management

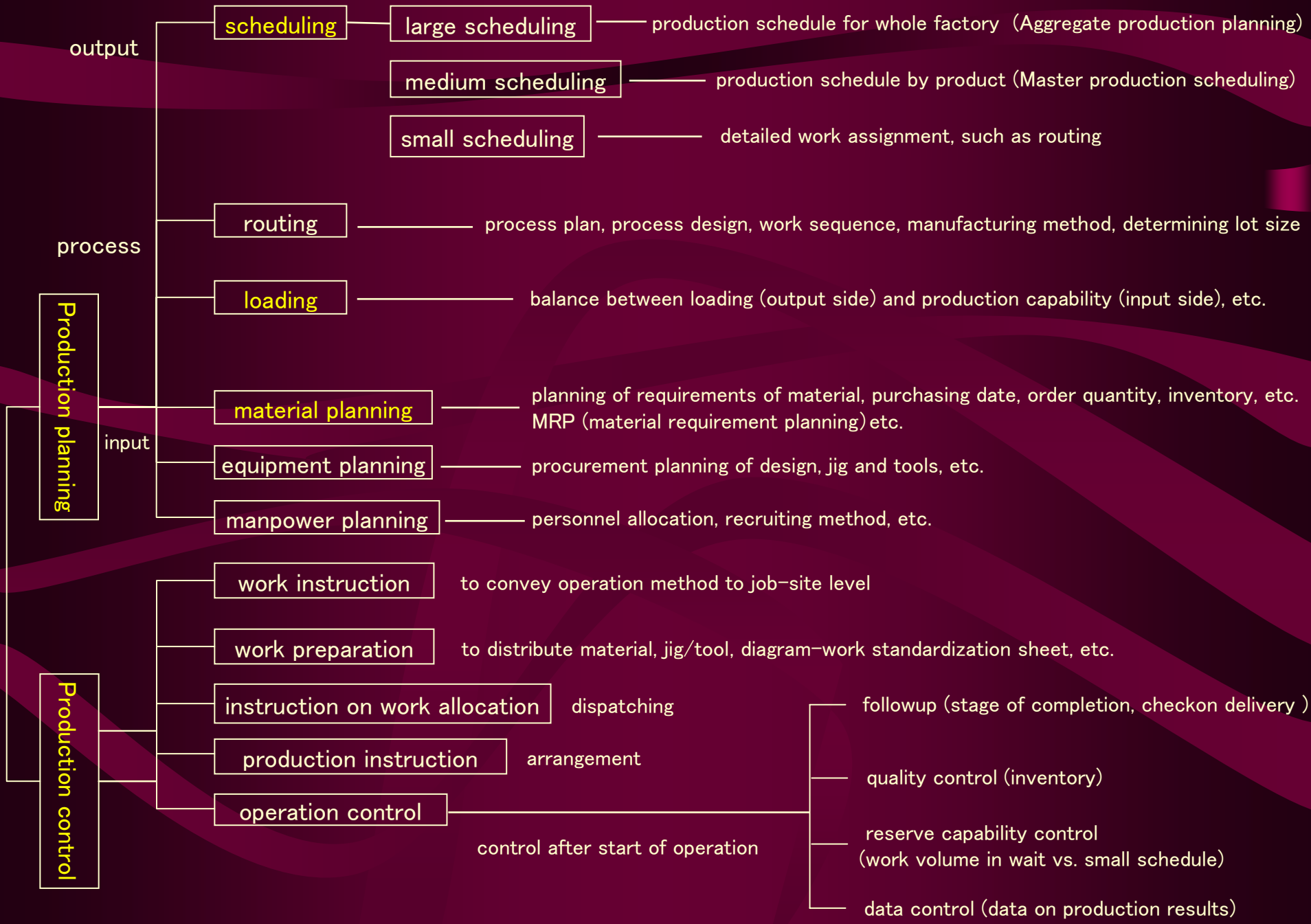
Operation management :
to plan and control production activity from the aspect of delivery and quantity. (It is not called “delivery management”)

(1) Order production :
Key is to shorten production period.
No problem with product inventory.

(2) Stock production :
Keyes are demand projection and inventory control.
Effect of production period is indirect (projection accuracy)

Case: Inventory and Production Lead-time





Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (Ⅰ p175 figure.6.3)

Content of Process Management

(1) Production Planning

Scheduling (output plan)

Material planning (input plan)

Capacity requirement planning (input plan) etc.

(2) Production Control

order release, production control, etc.

3. Scheduling (case of Stock Production)

In case of stock production, demand projection becomes the basis of production planning.

(1) Large Scheduling (aggregate production planning):
tabulation by main product category; by-month indication;
planning period of 1 year unit

(2) Medium Scheduling (master production schedule):
classification by item; by-day indication;
planning period of 1 month

(3) Small Scheduling (final assembly schedule), etc:
classification by variation
indication by cycle time (sequence plan);
planning period of 1 day

Genre of Scheduling

Planning factor / Type of Planning	Planning period (Horizon)	Unit of time frame (Increment)	Frequency of planning adjustment	Product category	Target of plan	Purpose
① Aggregate Production Planning (Large Scheduling, overall production schedule)	6 months – 1.5 year	month – week	revision by month	product by group	all factory	・base of manpower plan production level (Pt) inventory level (It) labor power level (wt)
② Master Production Schedule (Medium Scheduling, standard production schedule)	1 – 3 months	season – day	every month – every 2 weeks – every season	by specification (major division)	division (process)	・settlement of product production volume by category ・capacity requirement planning, material requirement planning
③ Final Assembly Scheduling, etc. (Small Scheduling, sequence, schedule)	1 – 10 days	day – minute (include . cycle time)	every season – everyday	by specification (subdivision)	every station (worker)	・settlement of production sequence ・allocation of operation on each station

Note: While Aggregate Production Planning and Large Scheduling, Master Production Schedule and Medium Scheduling, do not possibly match in strict terms, the basic concepts are considered close, thus explained here in bundle.

Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (Ⅰ p178 table.6.1) ‡

Method of Large Scheduling

Linear programming

Lagrange method

Cut and try method ---- a general method

Graphic cut and try using rheogram (cumulative curve)

Basic Policies on Large Scheduling

(1) Demand chasing pattern

(2) Production equalization pattern

(2a) inventory pattern

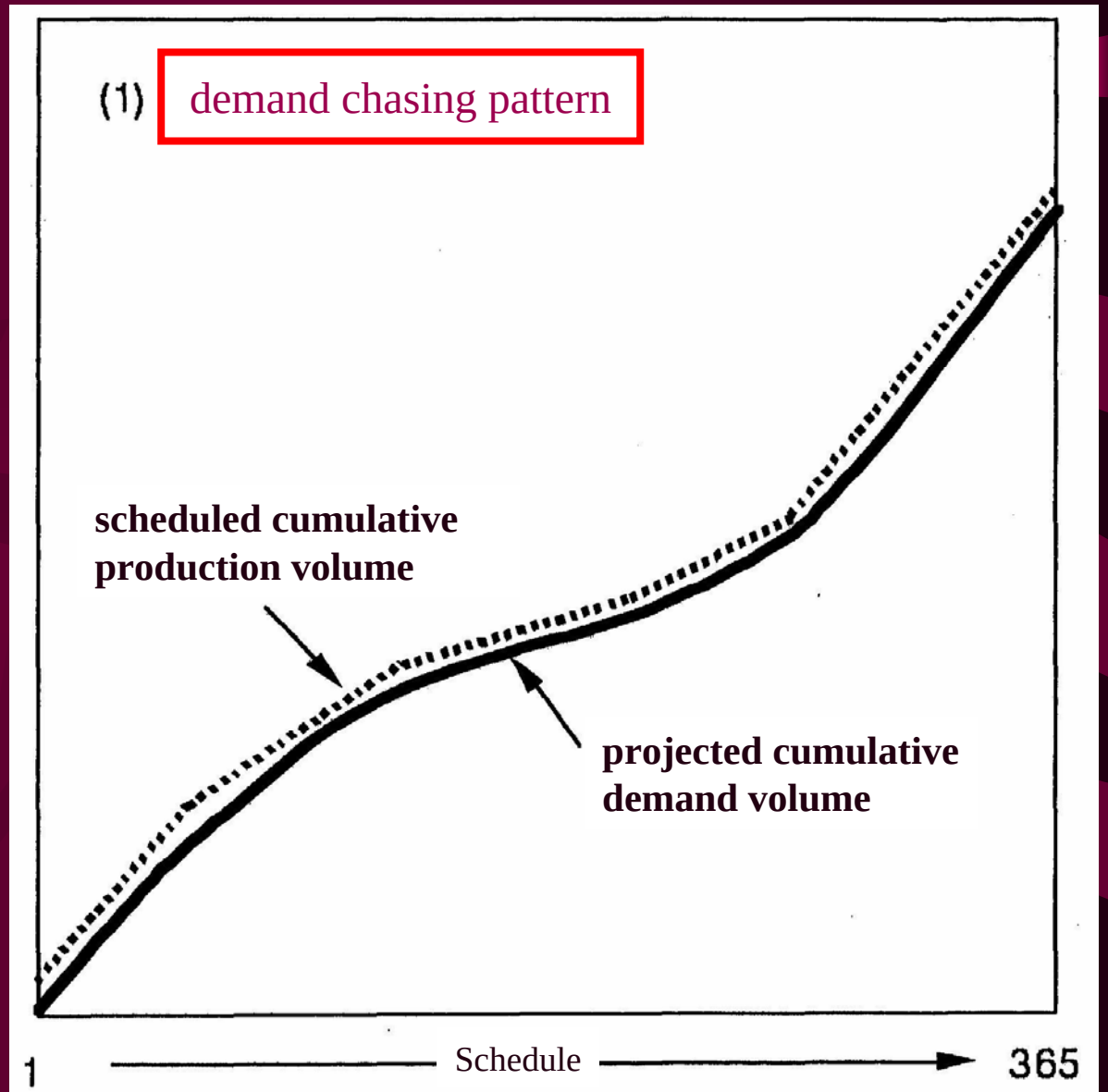
(2b) under-production pattern

(2c) balanced pattern

For each, compare basic wage, recruiting expense, lay-off expense, overtime allowance, inventory cost, out-of-inventory opportunity cost, etc.

Drawing Large Scheduling

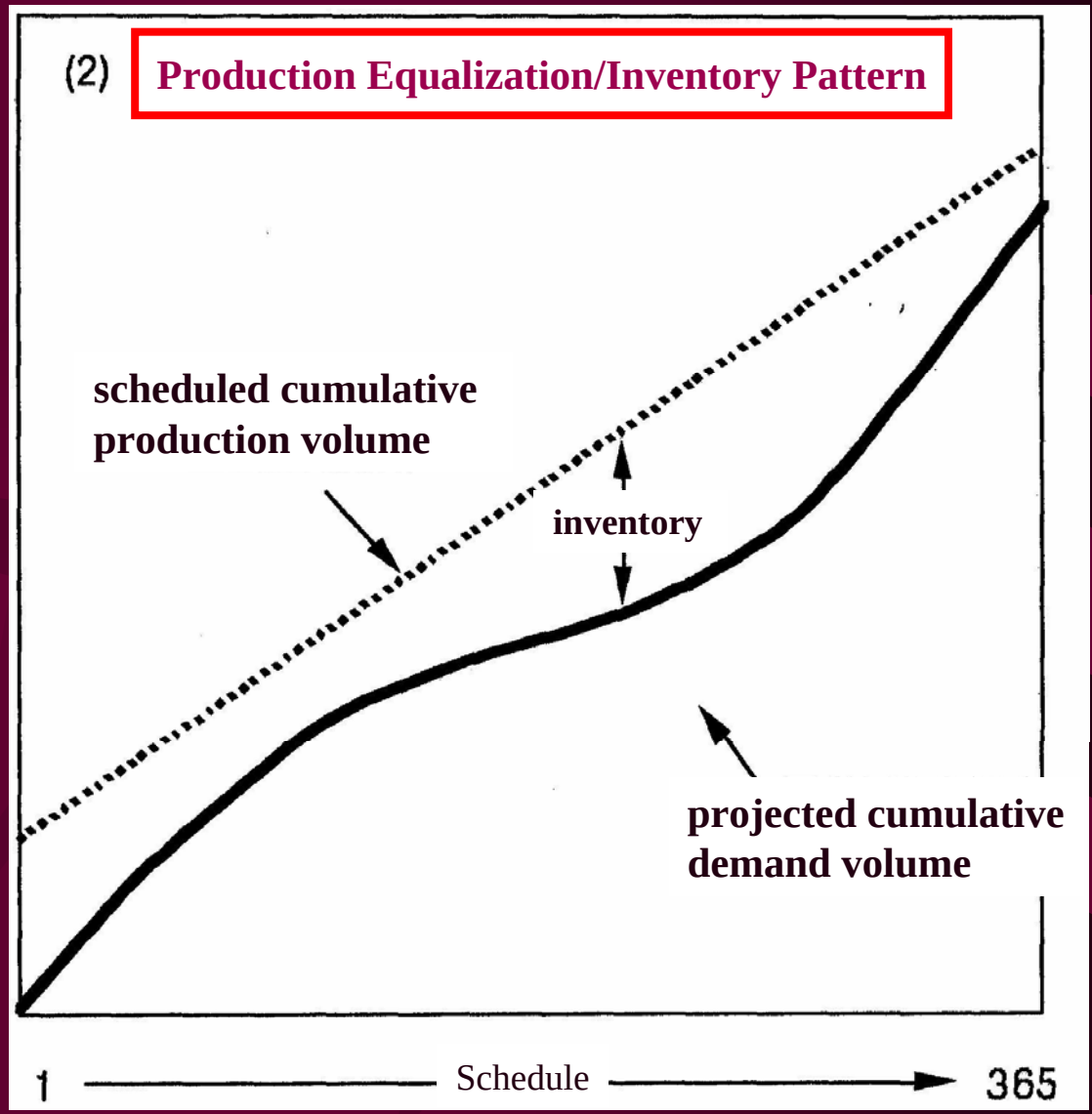
Cut & Try Method Using Rheogram



"Takahiro Fujimoto
'Introduction to Production Management'
Nihon Keizai Shimbun, Inc. 2001
(I p179 figure.6.4) "

Drawing Large Scheduling

Cut & Try Method Using Rheogram



Takahiro Fujimoto
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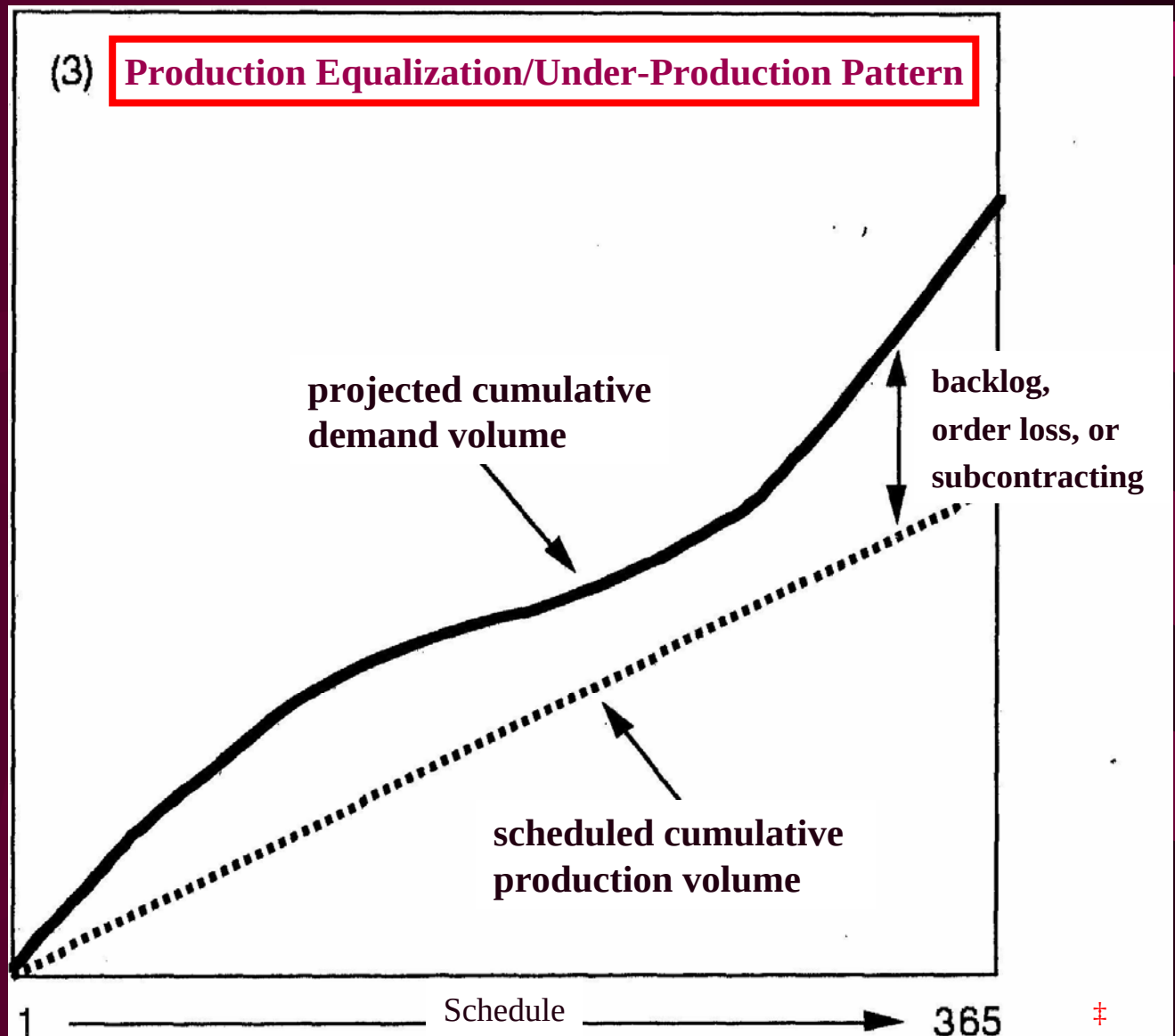
Nihon Keizai Shimbun, Inc. 2001
(Ⅰ p179 figure.6.4)

Drawing Large Scheduling

Cut & Try Method Using Rheogram



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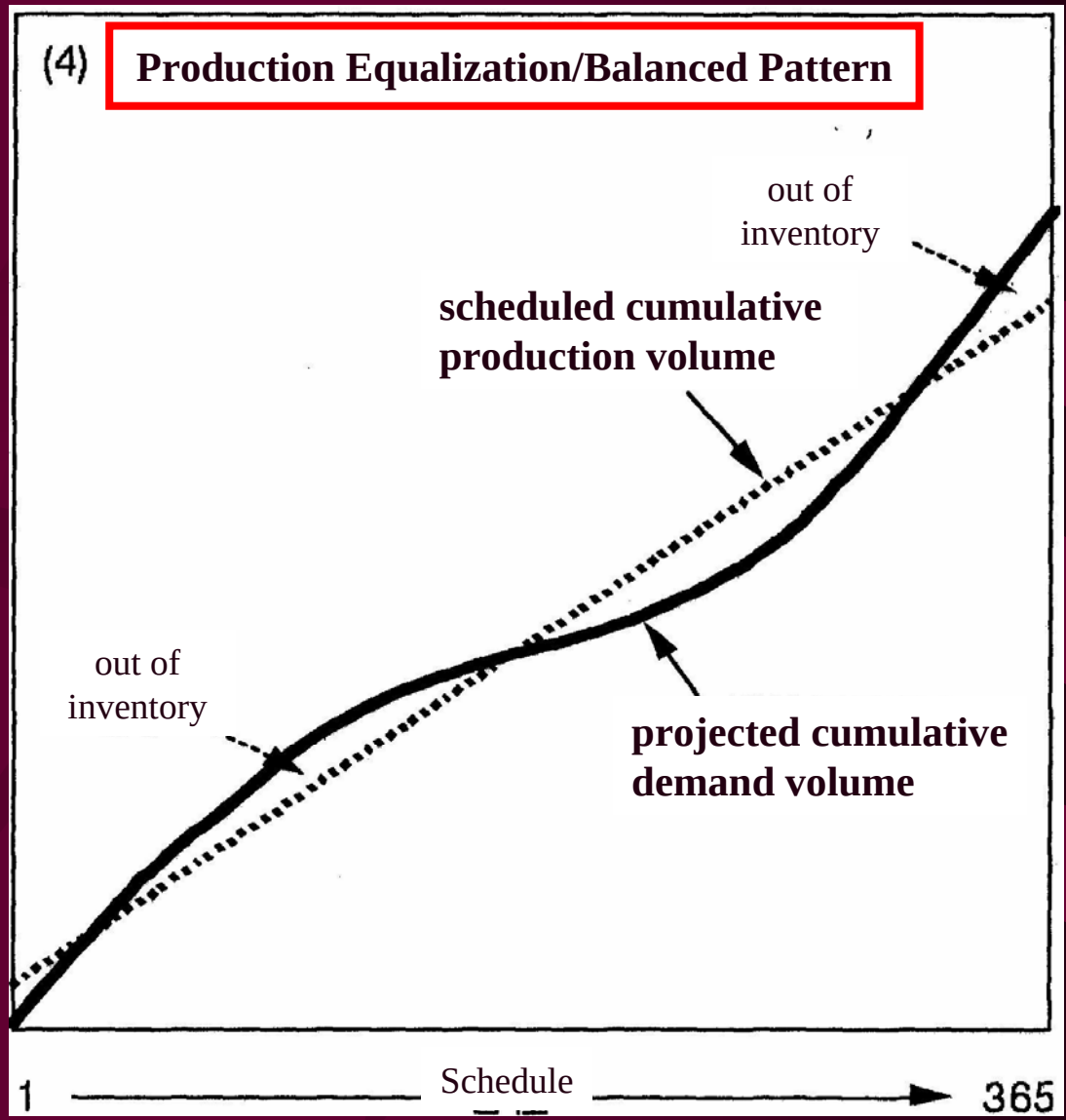
(I p179 figure.6.4) "

Drawing Large Scheduling

Cut & Try Method Using Rheogram



Takahiro Fujimoto
'Introduction to Production Management'
Nihon Keizai Shimbun, Inc. 2001
(Ⅰ p179 figure.6.4)

Strategies of Aggregate Production Planning

Assuming there is no capacity limit, following are strategies to draw Large Scheduling (Aggregate Production Planning): Find out most suitable ones by Cut & Try method.

(○ advantage ● disadvantage ◑ rather advantage)

Production Volume (Pt)	Labor (Wt)	Inventory (It)	Basic salary	Stock expense	Lay off expense	Overtime expense	Evening shift expense	inventory expense	Stock out	Subcontract expense
①Fluctuate : cummulative demand ≒ cummulative production Chasing Demand	Fluctuate number of workers. Absorb by **recruit and layoff** .	Stable at low level		●	●		●			
② Fluctuate: cummulative demand ≒ cummulative production Chasing Demand	Fix number of workers. Absorb by **overtime, early leave**, etc.	Stable at low level	◑			●				
③ Stable: cummulative demand ＜ cummulative production Level: High	Stable on number of workers, working hours	Absorb by **inventory** fluctuation	●				●			
④ Stable: cummulative demand ＞ cummulative production Level: Low	Stable on number of workers, working hours	**Backlog**, or refuse order entry	○						●	
⑤ Stable: cummulative demand ＞ cummulative production Level: Subcontract	Stable on number of workers, working hours	Absorb shortage by subcontracted production	○							●
⑥ Stable: cummulative demand ≧ cummulative production Level: Middle	Stable on number of workers, working hours	Mix of above 3 types						◑	◑	◑

Critical Fractile Method

Compare marginal dead-stock cost and marginal stock-out cost.

Marginal dead-stock cost
= inventory cost, appraisal loss of inventory, etc. = L

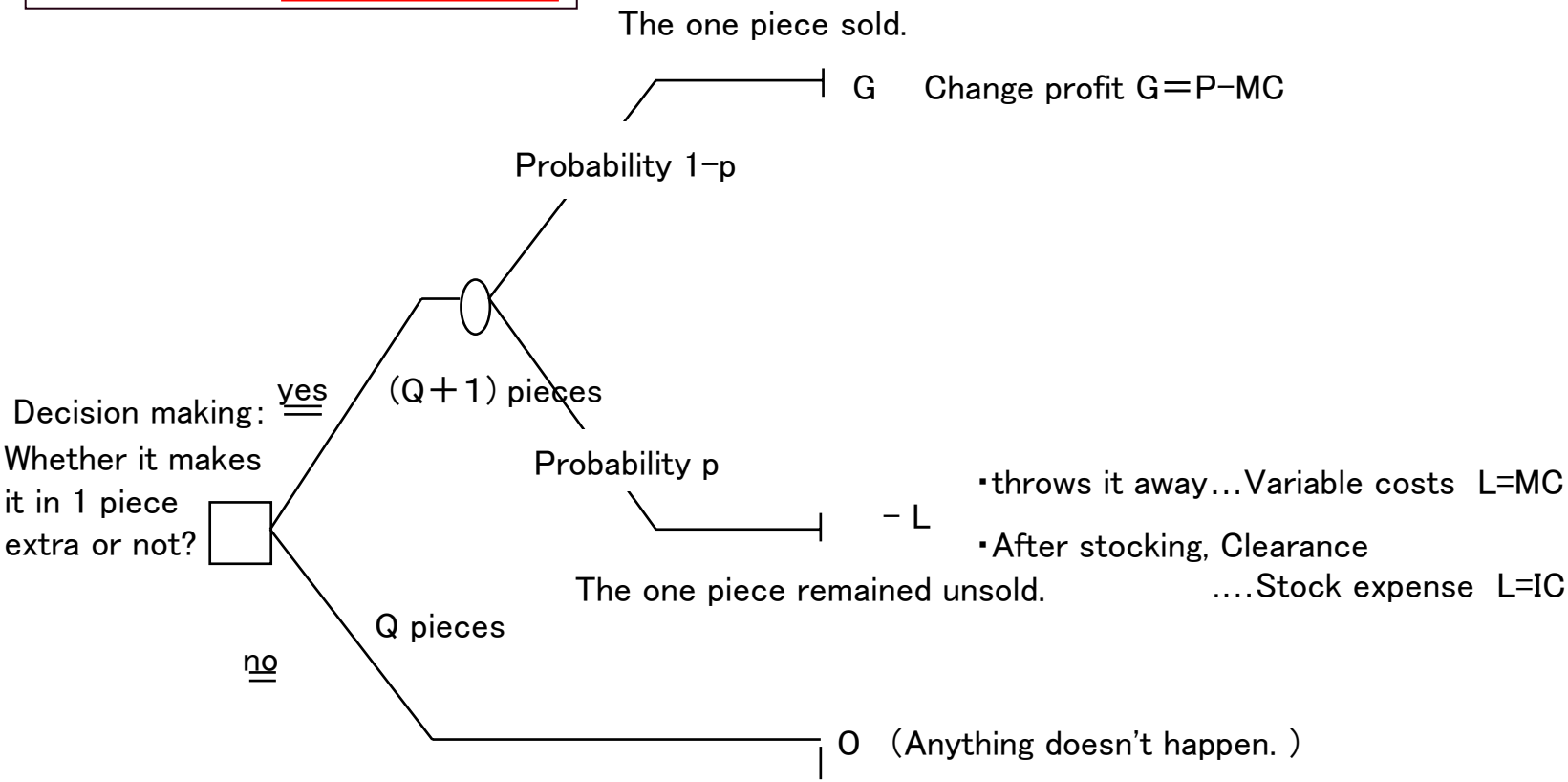
Marginal stock-out cost
= marginal profit = stock-out opportunity cost = G

Subjective probability on dead-stock = p

Here, an appropriate volume for production is: $p = G / (G + L)$.

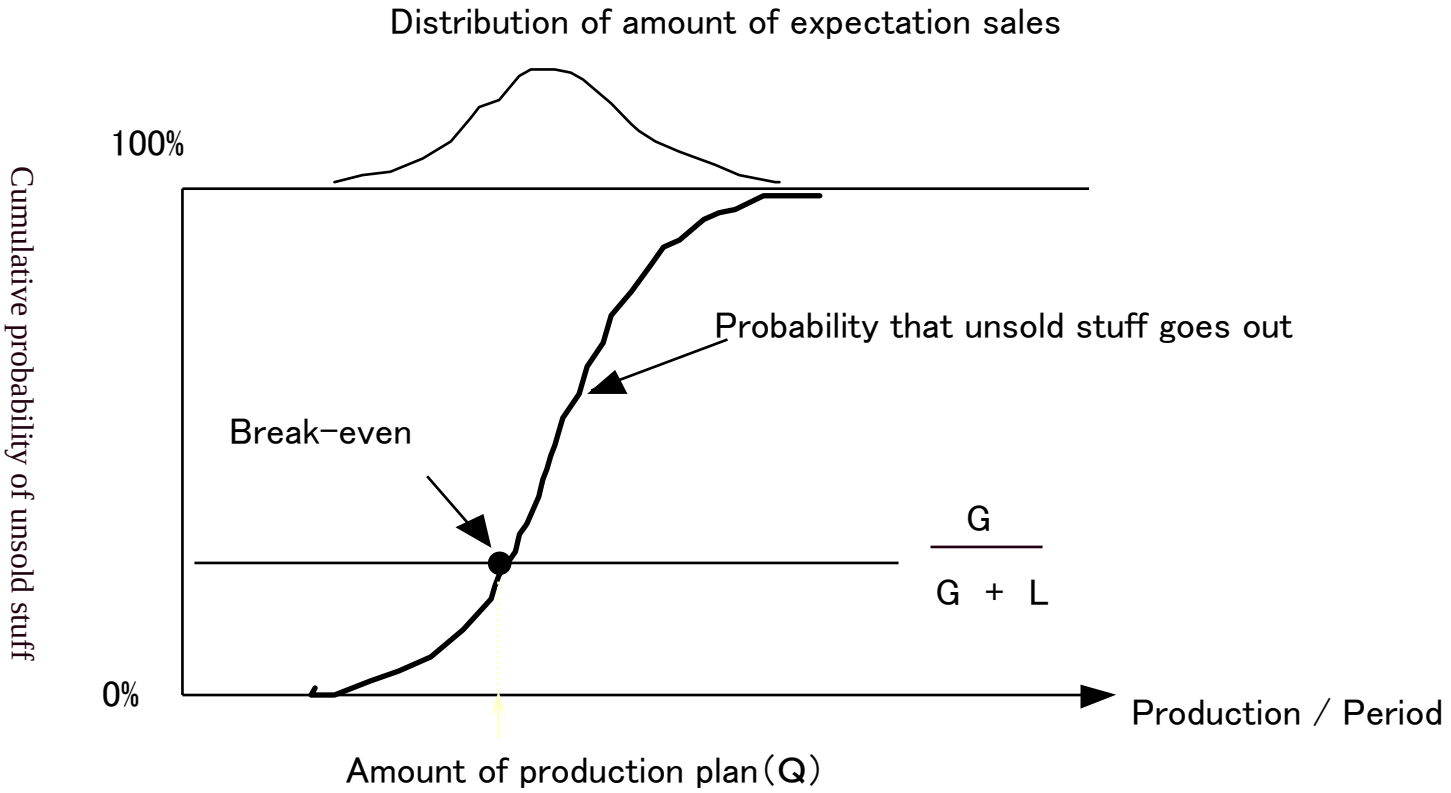
Decision of production according to Criticalfractail method （1）

thinking with the decision tree



Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (Ⅰ p181 figure.6.5)

Decision of production according to Criticalfractail method （1）



Equilibrium point (Break-even)　…　(1 － p) G + p (－ L)=0

∴ G ＝p (G ＋ L)

∴ It only has to choose the amount of the production(Q) plan that becomes

unsold stuff probability in equilibrium point　$p = \frac{G}{G+L}$

Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (Ⅰ p181 figure.6.5)

(2) Medium Scheduling (Master Production Schedule)

Classification by item.
by-day indication; planning period of 1 month

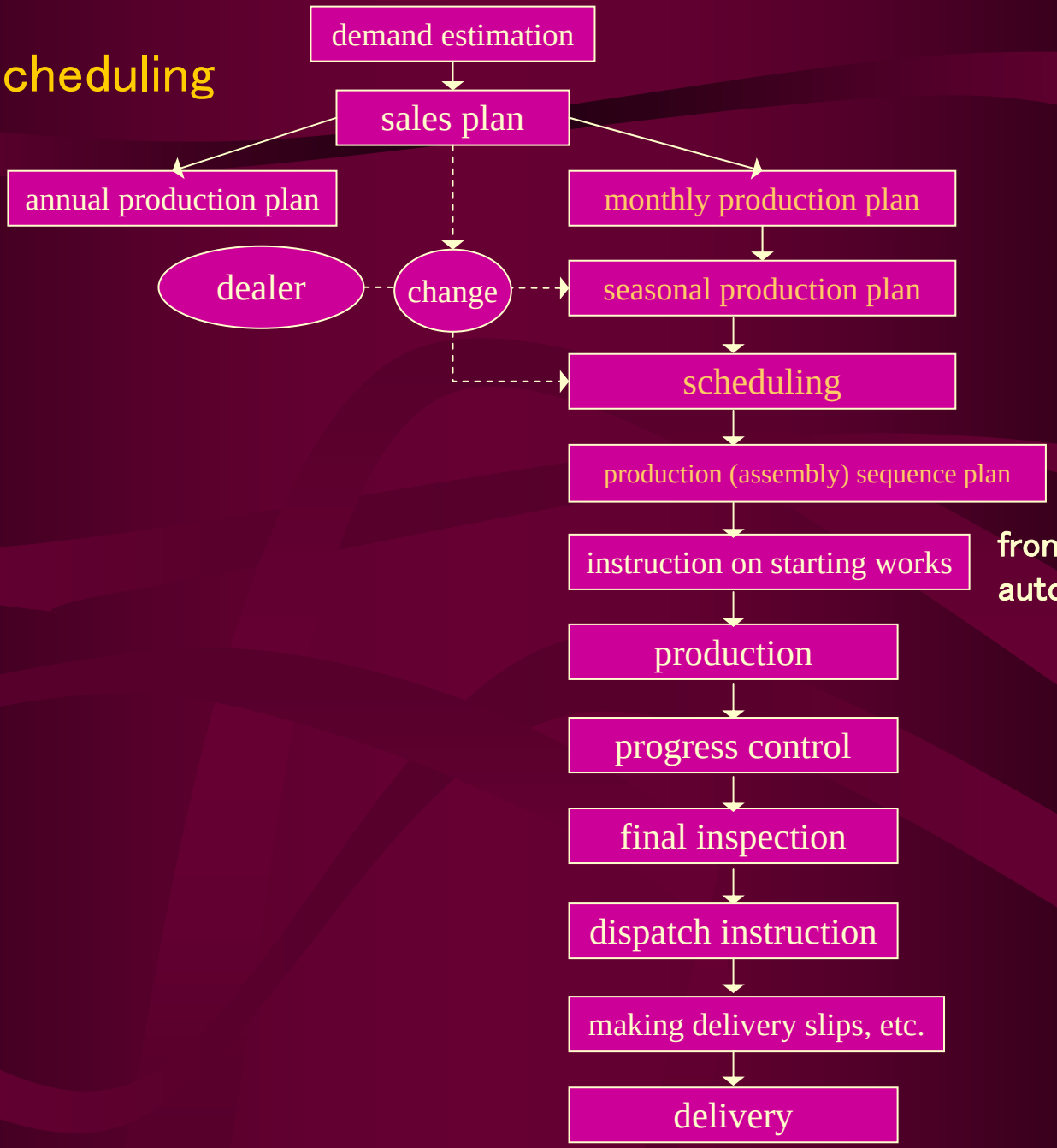
Important scheduling to constitute a starting point
for MRP (to be described later)

(3) Small Scheduling (Final Assembly Schedule, etc.)

Classification by variation.
indication by cycle time (sequence plan); **planning period of 1 day**

Starting point of sequential supply/production of parts.

Toyota's Scheduling



Yasuhiro Monden, Taichi Ono 'New Development of the Toyota Production System' Japan Management Association 1983 ‡

Toyota's Scheduling

Annual production planning (≒ aggregate production plan)

↓

Monthly production planning (≒ master production schedule)

(N — 2, N — 1, N month)

↓

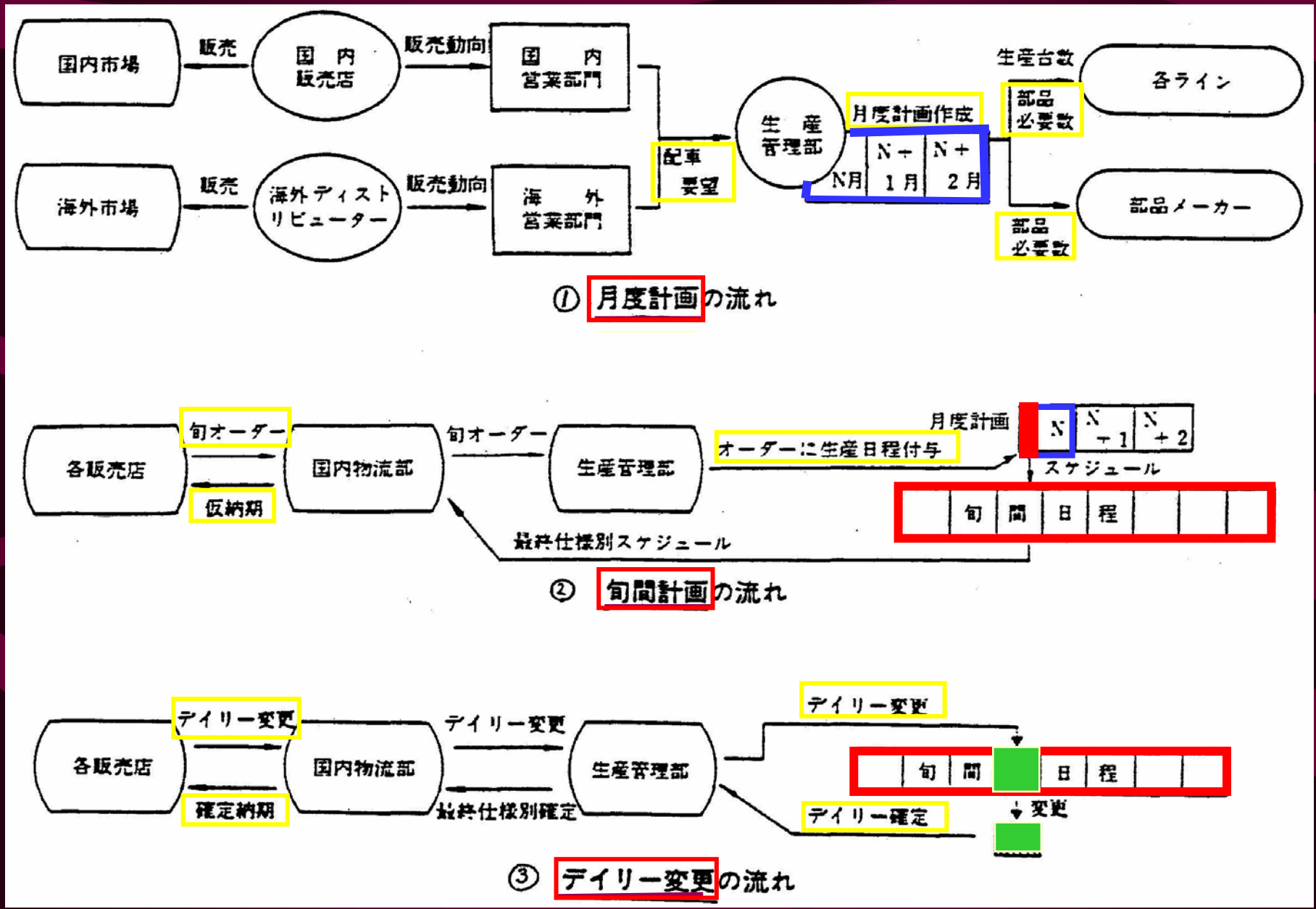
Seasonal production planning

Production (assembly) sequence schedule (≒ final assembly schedule)

Gradually enhance scheduling accuracy.

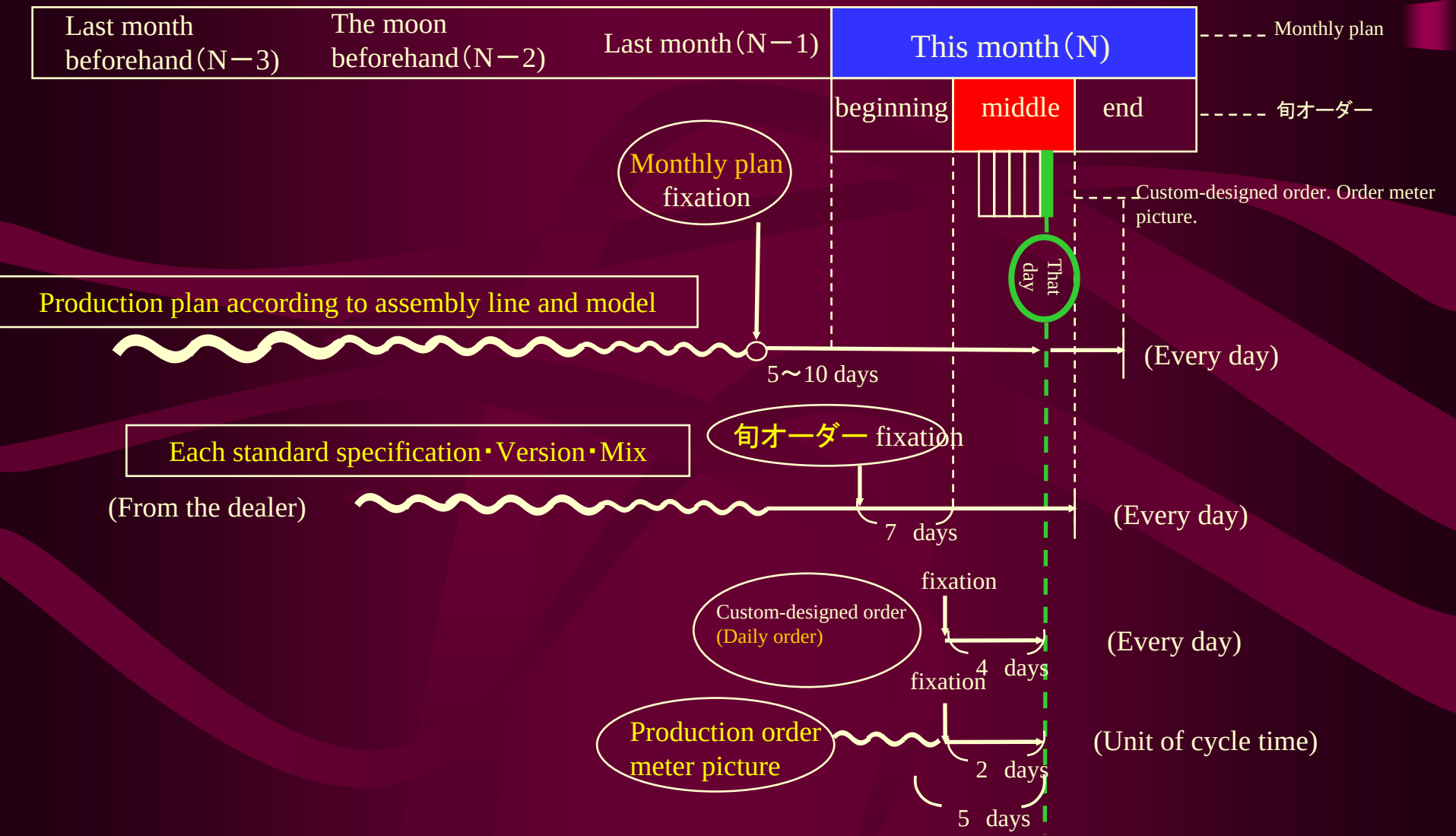
Gradually fine-tune way of designating products.

Toyota's Scheduling



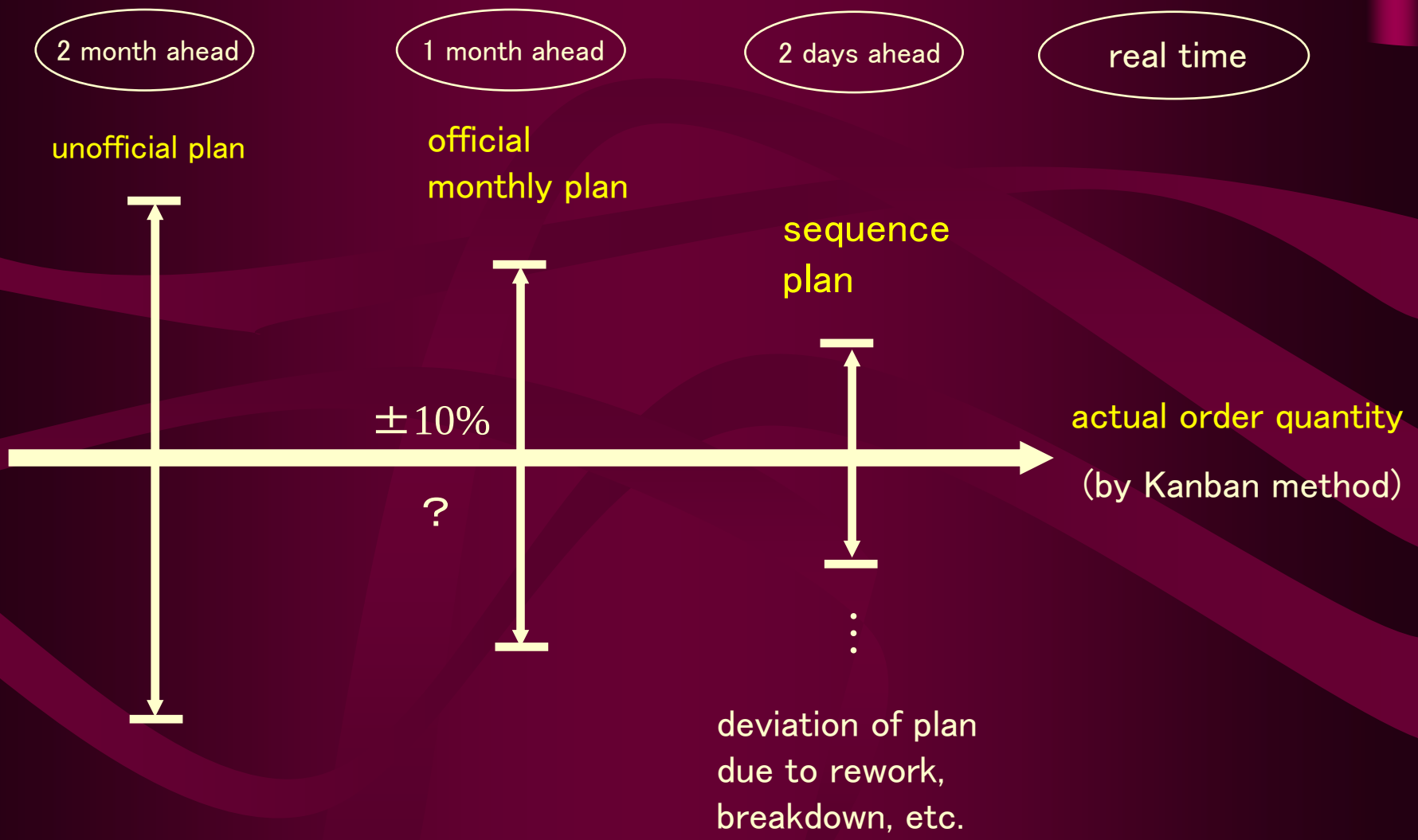
Toyota's Production Planning System (Summary)

Toyota's production planning employs a method to gradually narrow down the range of production category (model → standardized specifications→ customized-order specifications), time unit (month→ season→ day→ cycle time), and planning precision thereof. In short, the method is gradually converged by repeating schedule revisions and accuracy advancements.



Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (Ⅰ p184 figure.6.6) ‡

Advancing Accuracy on Parts Order Volume (specification mix)



4. MRP (Material Requirement Planning) (= deployment planning of input)

System to provide job sites with an order release and an instruction on material procurement, based on computed results in an upstream of each step regarding to material variety requirement, volume requirement, and timing requirement, through a series of calculation process which is consistent to a master schedule (basic production planning).

(1) Aggregate requirement calculation: parts' expansion of master schedule

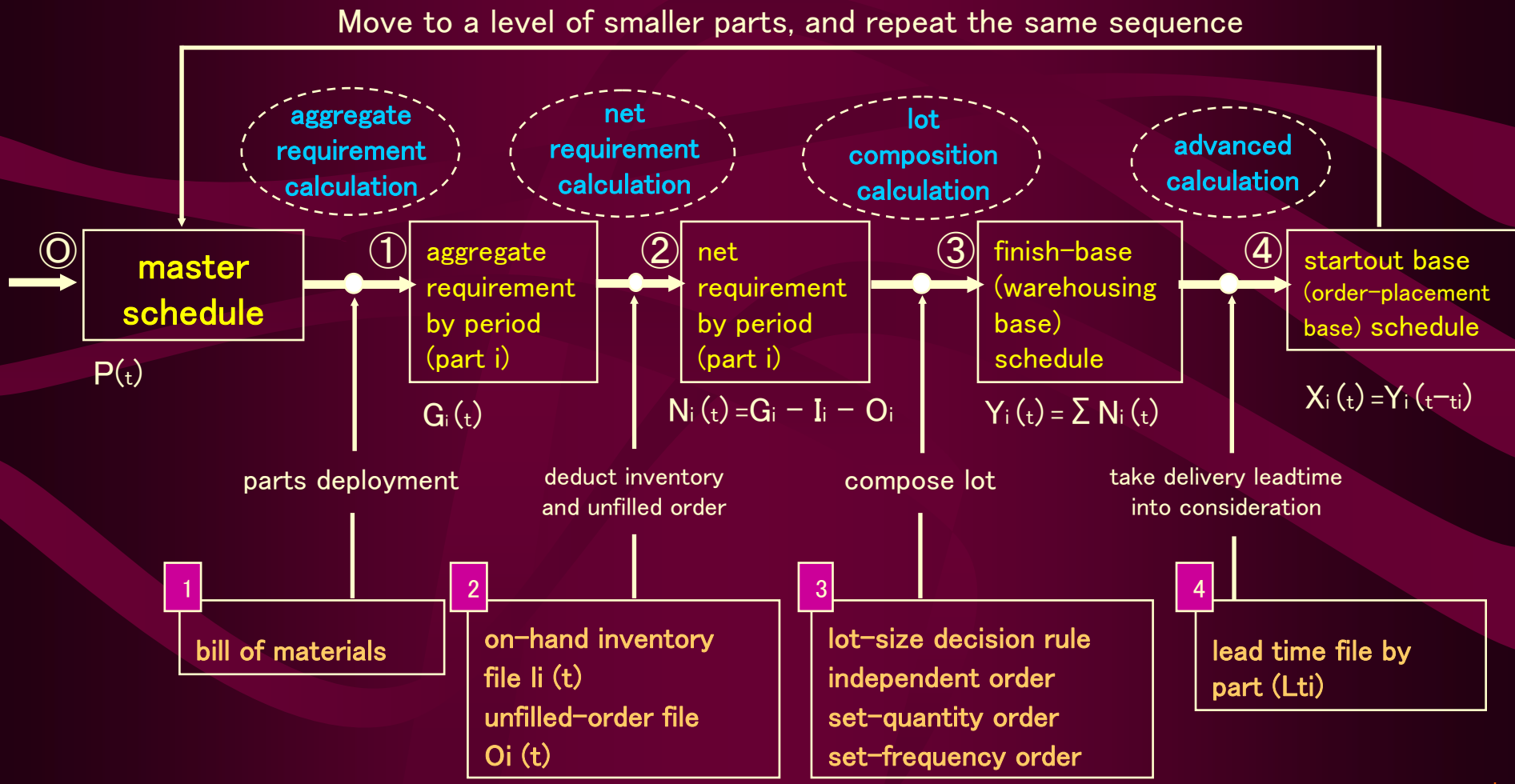
(2) Net requirement calculation: deduct inventory and backlog

(3) Lot composition calculation: order rule → finish-base schedule order

(4) Advance calculation: lead-time for preceding process → startout-base schedule order

Configuration for Calculating MRP (Material Requirement Planning)

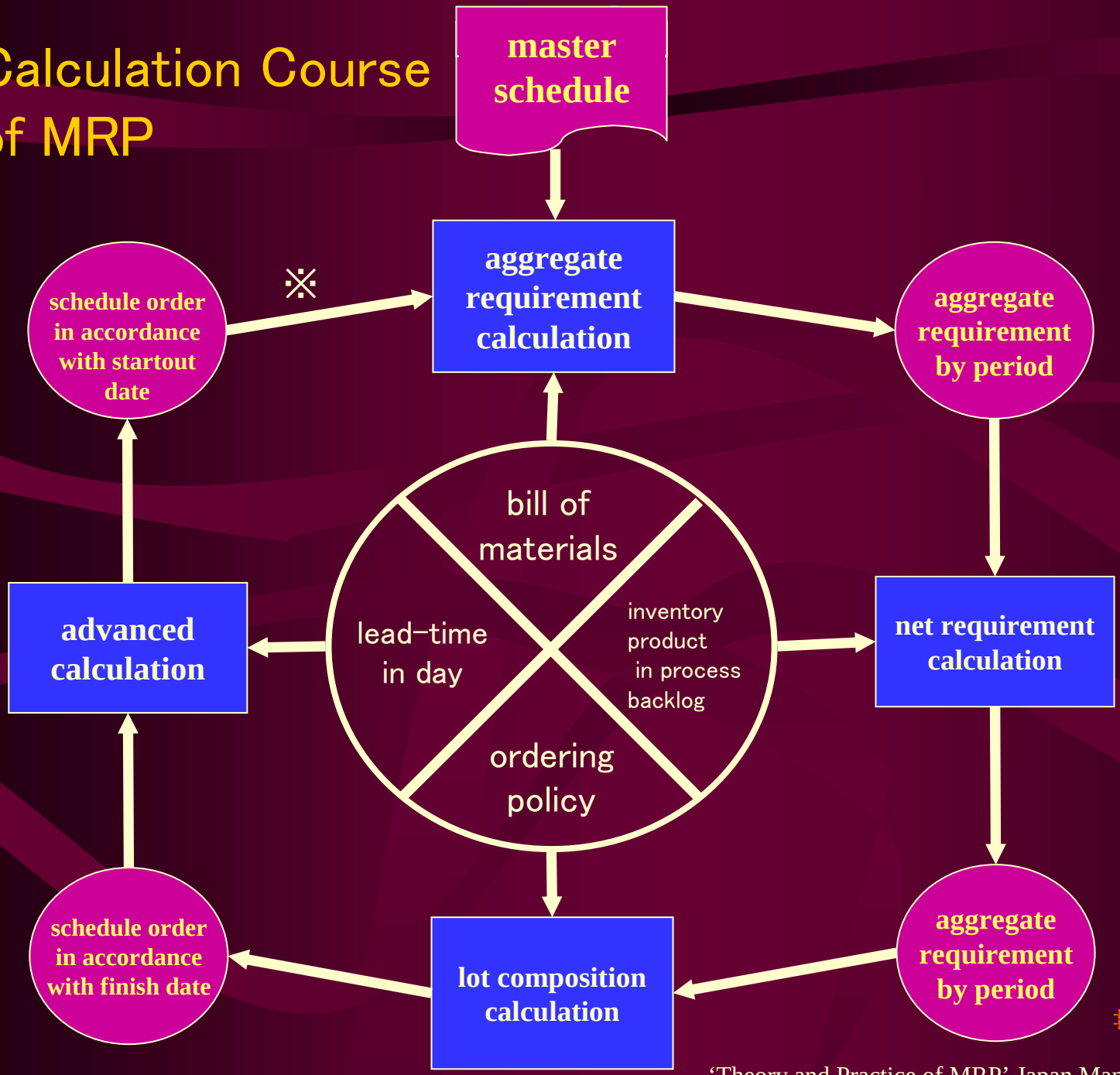
Based on Master Schedule as the input, MRP produces an information on manufacturing instructions with respect to Bill of Materials to all steps of a multi-stage production process.



Author making (reference: Smith Rayton 'Theory and Practice of MRP')

Reference: Takahiro Fujimoto 'Introduction to Production Mmanagement' Nihon Keizai Shimbun, Inc. 2001 (I p188)

Calculation Course of MRP

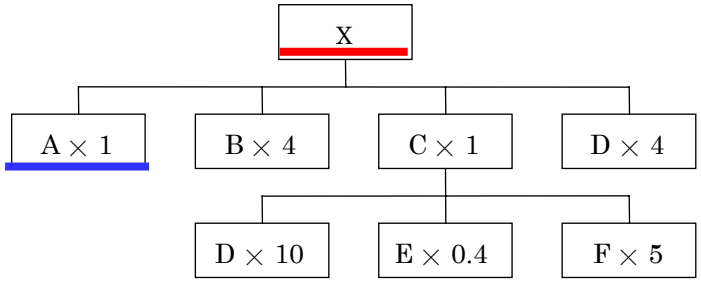


※Move to calculate an aggregate requirement volume at lower levels, and further down to an item at the lowest on Bill of Material, when MRP the calculation gets completed.

‡ Smith Rayton, Yoshiteru Kojima, Masakatsu Mori
'Theory and Practice of MRP' Japan Management Association 1977

MRP’ Numerical Example（1）

Data（1） **Composition part table**



Data（2） **Standard production plan**

		Instruction day ××年××月××日				
me of artic	Plan amount(following during week)				
	1	2	3	4	5
X	300	100	100	200	200
Y	–	200	200	100	–
Z	50	50	50	150	–

Data（3） **Information related to parts**

Name of articles	Unit	Invento	the Number	Order policy	Lead time	Vessel
A	pieces	250	–	in each case	2 weeks	Purchased part
B	pieces	600	1,050	in each case	2 weeks	Purchased part
C	pieces	40	300	Regular (2 weeks)	1 weeks	Assembly part
D	pieces	1,000	5,000	Constant (5000)	3 weeks	Purchased part
E	pieces	50	100	Constant (100)	3 weeks	Coil part
F	pieces	400	4,700	Regular (3 weeks)	5 weeks	Purchased part
X	pieces	–	300	As it’s a production	1 weeks	Finished product

Smith Rayton, Yoshiteru Kojima, Masakatsu Mori 'Theory and Practice of MRP' Japan Management Association 1977

MRP’ Numerical Example（1） — Calculation of Part A

Parts A(purchased part) are 1 piece use used in the assembly line of X, and it only has to disburse the following amount from the warehouse according to the assembly plan of X(start).

A	Disbursement plan	1	2	3	4
		100	100	200	200

The number of present inventory figures is 250, and the expectation stock at the end of each week is

A	Stock(250)	1	2	3	4
		150	50	?	

A	Delivered plan	1	2	3	4
		—	—	150	200

It is necessary to order from it ahead to make the trader deliver goods. The lead time of parts A is from data (3) to 2 weeks. The number of purchasing agents is 150 to the first week, and it only has to order 200 pieces on the week second.

A	Order plan	1	2	3	4
		150	200	–	–

The MRP calculation is as follows

	1	2	3	4
Total necessary amount	100	100	200	200
Order that has been instructed.	–	–	–	–
Stock (250)	150	50	–	–
Pure necessary amount	–	–	150	200
Plan order (start)	150	200	–	–
(Recommendation order) Order 150 pieces. The delivery date is the beginning of the third week.				

‡

Smith Rayton, Yoshiteru Kojima, Masakatsu Mori 'Theory and Practice of MRP' Japan Management Association 1977

MRP’ Numerical Example（2）

Table 6－2 Numerical Example of MRP Calculation

	2000/12	2001/1	2001/2
Master schedule.	5000台	6000台	4000台
Total necessary amount of lamp.	10000個	12000個	8000個
Number of orders that has been instructed.	0個	0個	0個
Stock of the end of the term.	13000個	1000個	0個
Pure necessary amount of lamp.	Uncertainty	0個	7000個
Amount of order plan.	0個	7000個	Uncertainty

The under line shows already-known data.

Takahiro Fujimoto ‘Introduction to Production Management’ Nihon Keizai Shimbun, Inc. 2001（Ⅰp190 table.6.2）

Effect and Limitation of MRP

Perfect as a logic ––– but in reality?

- It does not contain in itself a mechanism for revision when an actual production deviates from the plan.
- Same problem with a case where a lead-time is off the plan, as no revisal mechanism is contained.
- Rigid in status quo. Not in promoting improvements.
- System was high-priced in days of large computers.
- Assumption of "Production capacity is unlimited" is unrealistic.
  → CRP, MRP II

Compare with Kanban system (to be explained later)

5. Man-Hour Planning and Capacity/Burden Analysis (CRP and MRP II)

Man-hour planning = planning of production capacity

production capacity − burden = reserve capacity

"Number Indication" or "Time Indication"

→ analysis by "Manpower Loading Chart"

〈Reminder〉

- Consider conforming item (yield rate)
- Consider product mix (capability per what?)
- Consider set up time, down time (time for machine trouble, etc.)

Production Capacity of Number Indication

① daily production capacity = operating hours (H) / day × $\frac{\text{net working hours}}{\text{operating hours}}$ × $\frac{\text{gross production volume}}{\text{net working hours}}$ × yield of conformity product

② burden = conforming product requirement per day (converted to particular product mix only)

③ reserve capacity = 1 − (burden / daily production capacity) (uniform product mix only)

Production Capacity of Time Indication: To exhibit the same context in Time Unit

Machine capacity when plural machines are placed in a line is:

①A [daily production capacity]
= [number of machines] x [operating hours (H) / day] x (1 down time)

in case of human capability, in consideration of worker's skill level, attendance rate:

① B [daily production capacity]
= [number of persons] x [actual work period / day]
x [proficiency conversion coefficient] x [attendance rate]
x [direct hours / actual working hours]

Proficiency conversion coefficient is an weighted average at an office, setting a standardized capacity as 1.

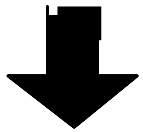
② [burden per day]
= (conforming product requirement x standardized man-hour / conforming product rate)
+ [set up time]

③ [reserve capacity] = [capacity (H)] — [burden (H)]

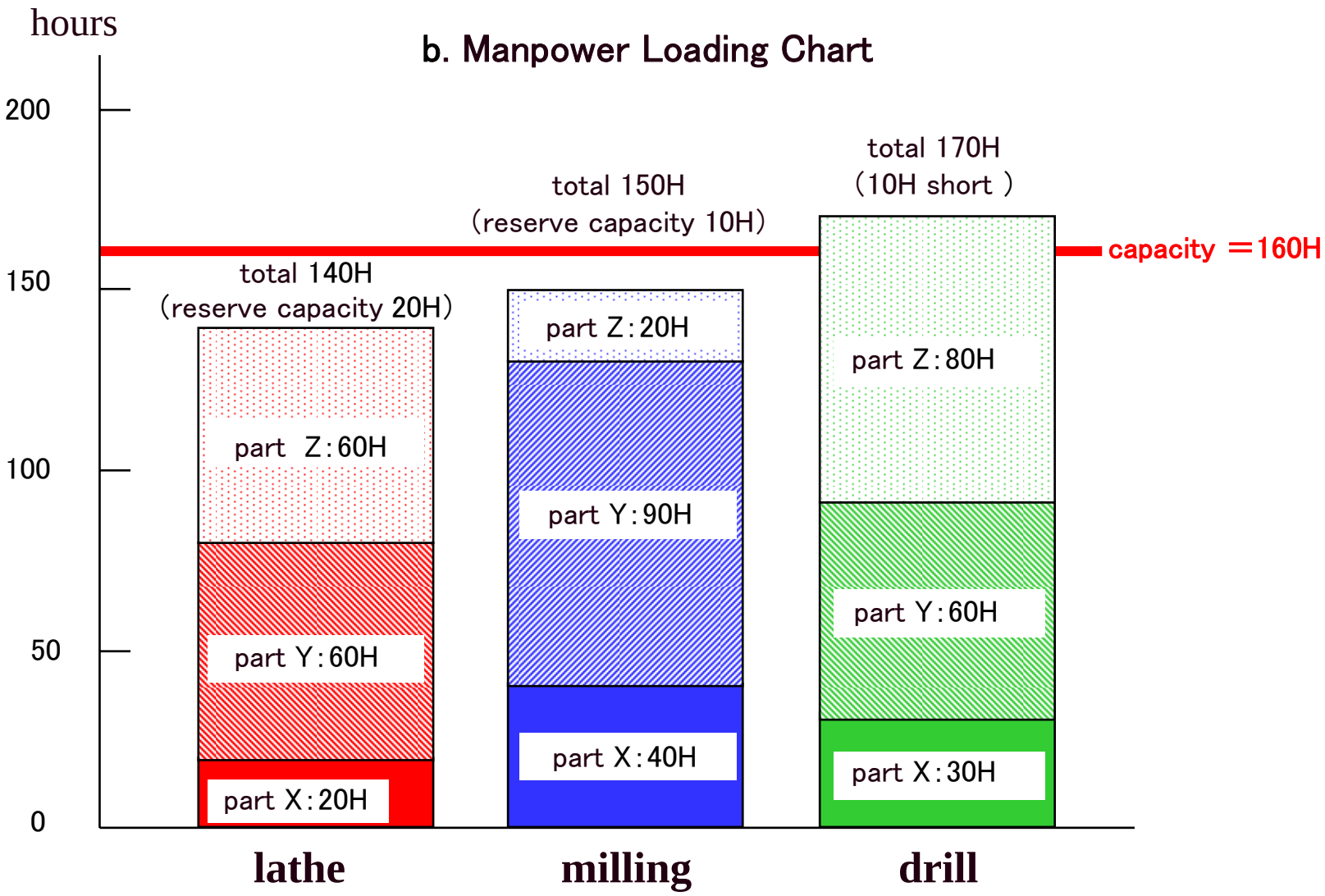
Chart 6-9 Manpower Loading Chart (Numerical Example of Manufacturing Process)

a. Burden by Product

product	process	production volume (A)	standardized process (B)	burden (A × B)
part X	lathe	1000 unit	0.02H/unit	20H
	milling		0.04H/unit	40H
	drill		0.03H/unit	30H
part Y	lathe	3000 unit	0.02H/unit	60H
	milling		0.03H/unit	90H
	drill		0.02H/unit	60H
part Z	lathe	2000 unit	0.03H/unit	60H
	milling		0.01H/unit	20H
	drill		0.04H/unit	80H



Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (I p199 figure.6.9)



Takahiro Fujimoto 'Introduction to Production Management' Nihon Keizai Shimbun, Inc. 2001 (I p199 figure.6.9)

CRP and MRP Ⅱ

CRP (capacity requirement planning)

= man-hour planning system to be linked with MRP

Closed-loop MRP = MRP + CRP

MRP Ⅱ (manufacturing resource planning)

= MRP + CRP + other input planning
(wages, manpower, etc.)

System which integrates material requirement planning and man-hour planning , and further tucks feedback in from work sites.

Chart 6-10 CRP (Capacity Requirement Planning)

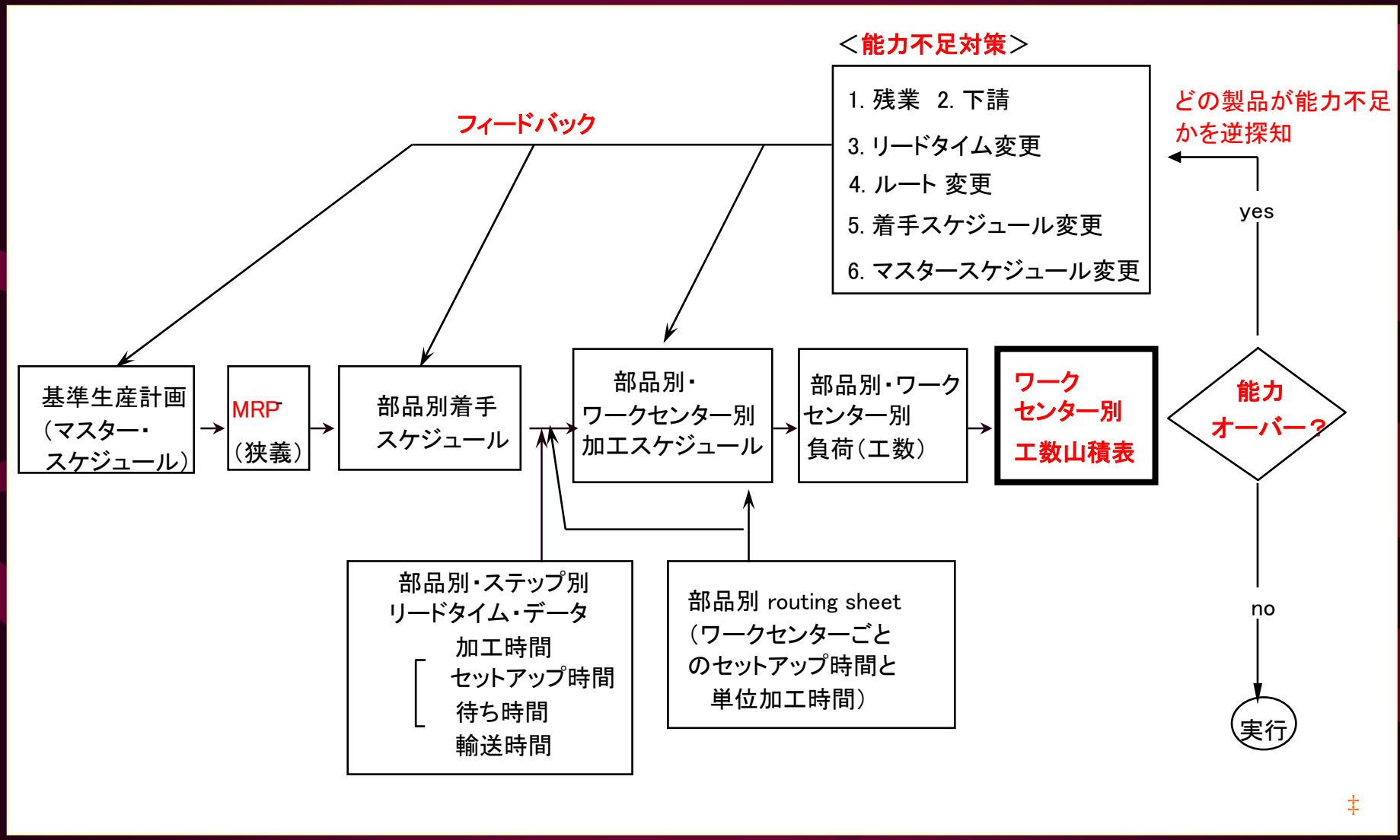
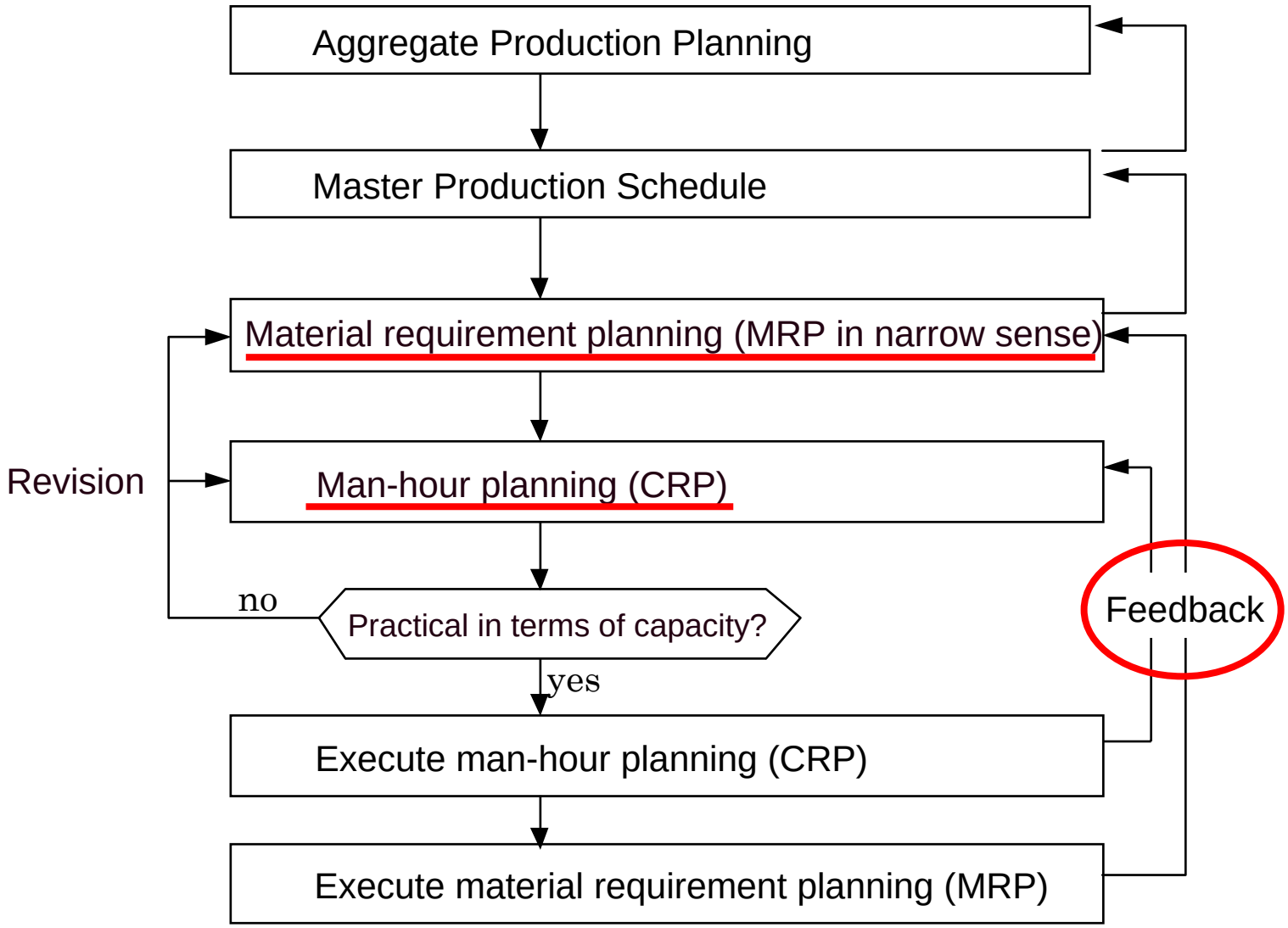


Chart 6-11 Basic Structure of Closed-Loop MRP



Author making (reference: Chase, R. and N. Aquilano 'Production and Operations Managemment, Irwin')
Reference: Takahiro Fujimoto 'Introduction to Production Mmanagement' Nihon Keizai Shimbun, Inc. 2001 (Ⅰ p201)

6. Production Instruction

Production instruction (order release)

(1) "Master Arrangement" by batch

→ work preparation, work allocation, work instruction

(2) "Individual Arrangement" (instruction on starting actual work)

As compared to the case of job shop, a mare complicated system for production instruction is required.