Kontakt Information

- **Professor Kenn Steger-Jensen.**

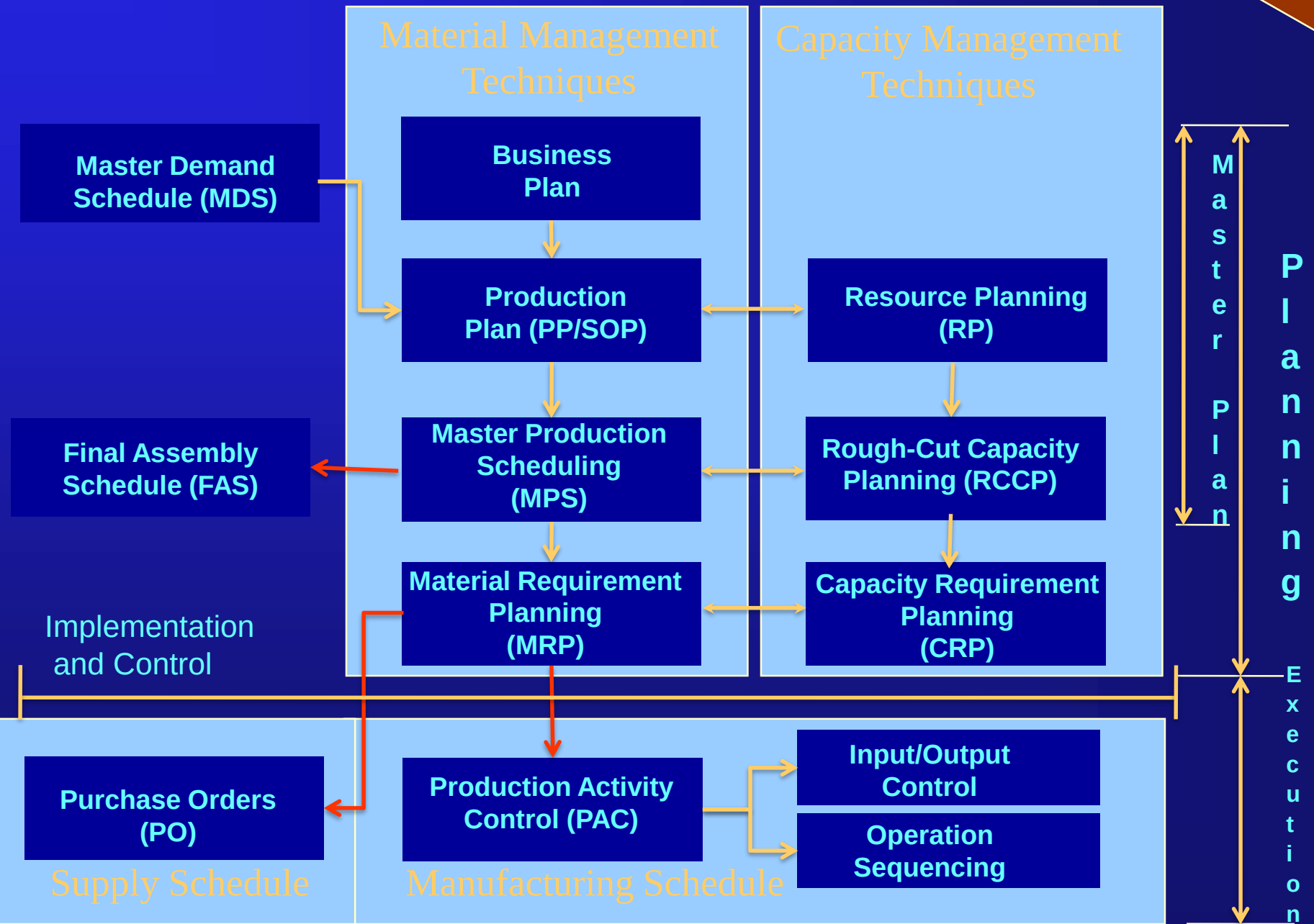
- Har I brug for et servicetjek af din produktionsstyring eller har du brug for sparring, eller hjælp til valg af løsninger, er du velkommen til at kontakte mig.

- **Mobil: (+45) 24 20 50 94**
- **E-mail: kenn@celog.dk & kes@usn.no**

- **Center for Logistik, Aalborg Universitet**
- **Maritime Logistik, Universitet i Sydøst Norge**

Centre for Logistics

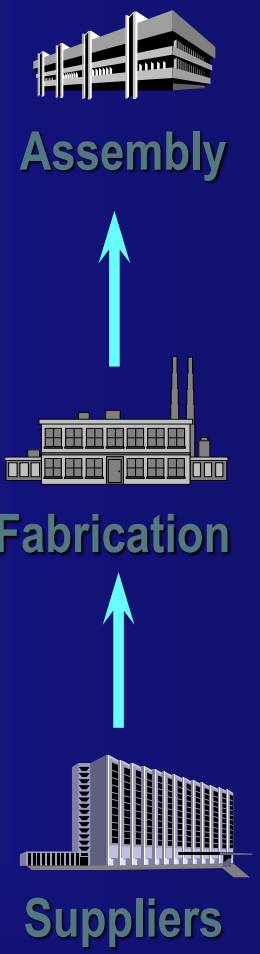
Planning and Control hierarchy



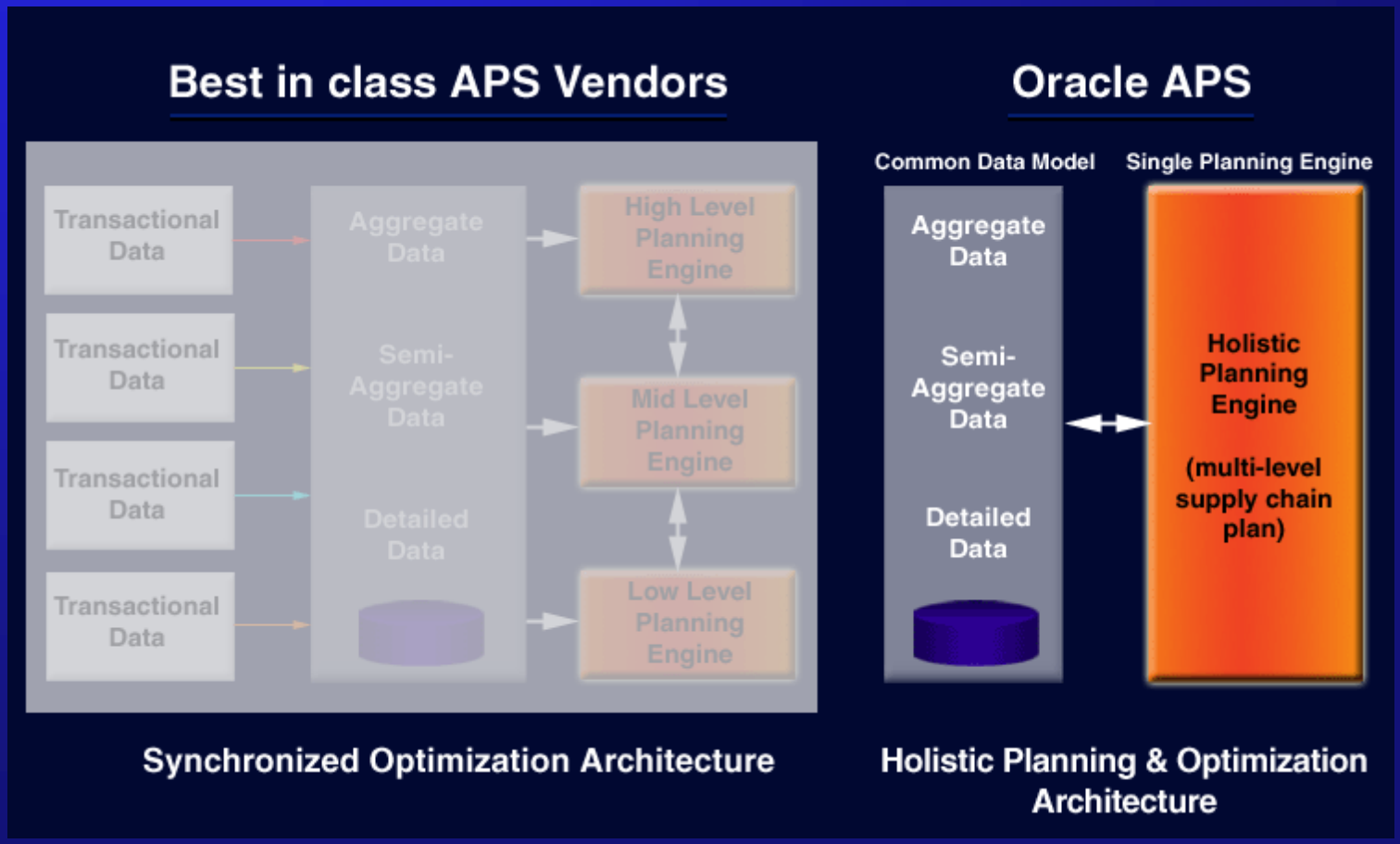
Horizontal Strategy

This traditional model of supply chain planning systems has some inherent weaknesses, which can be summarised as followed:

- Multiple, fragmented plans which must be continuously synchronized with one another
- Long planning lead times resulting from complex and lengthy batch processes
- Poor visibility across the extended supply chain due to a lack of real-time data
- Discrepant planning and execution activities that render most plans obsolete in a short amount of time
- Complex data integration between planning and execution systems.



Common Data Model!



Source: AMR Research

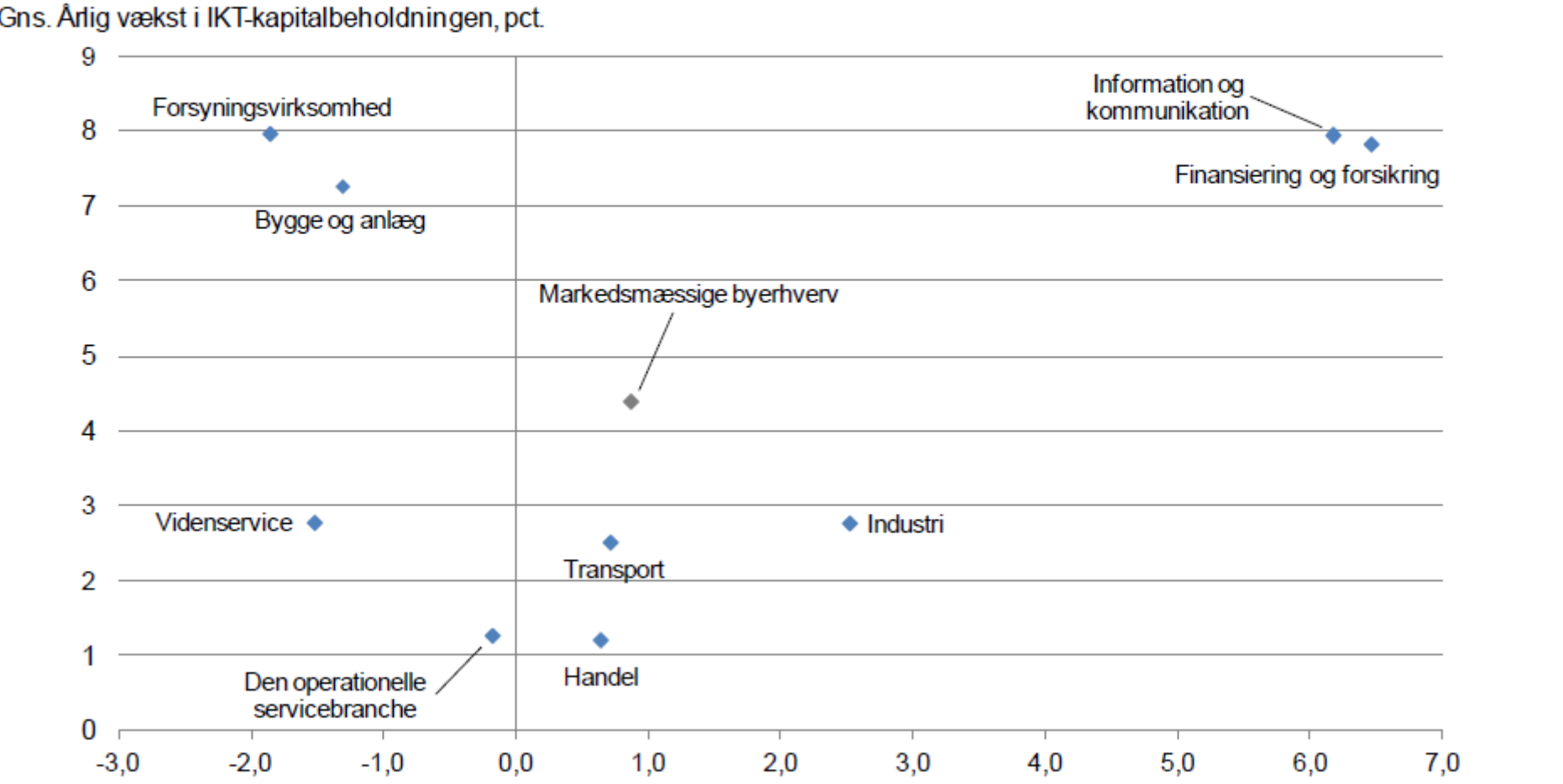
Produktionsstyringsopgavens tre bestanddele

- Inden for produktionsstyringen tales om tre hovedmål:
  - Leveringsevne og kort leveringstid.
  - Kapacitetsudnyttelse.
  - Kapitalbinding i lagre og i varer i arbejde

DI produktivitetsområdet*

Centre for Logistics

Gns. årlige produktivitetsvækst relativt til årlig vækst i IKT-kapitalbeholdningen, 2000-2010



Kilde: Særudtræk fra Danmarks Statistik samt DI-beregninger

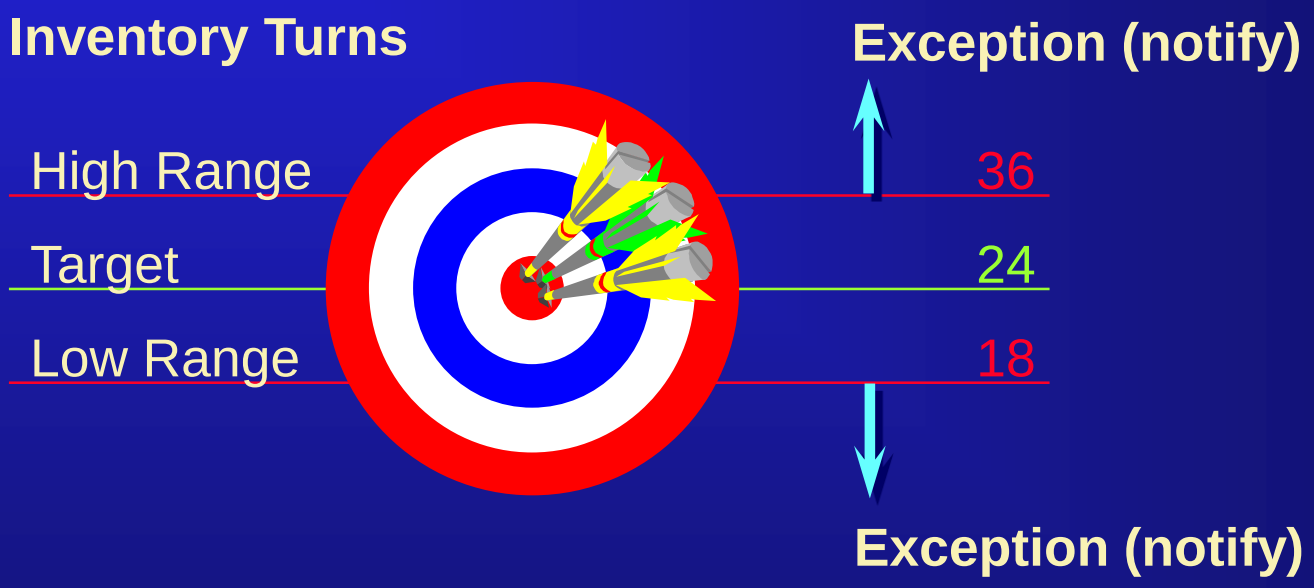
Her er - Produktiviteten !

- Danske virksomheder, der har digitaliseret udvalgte interne processer f.eks. lagerstyring, bogføring, distribution eller produktionsstyring, har en markant højere værditilvækst pr. medarbejder end virksomheder som ikke har.

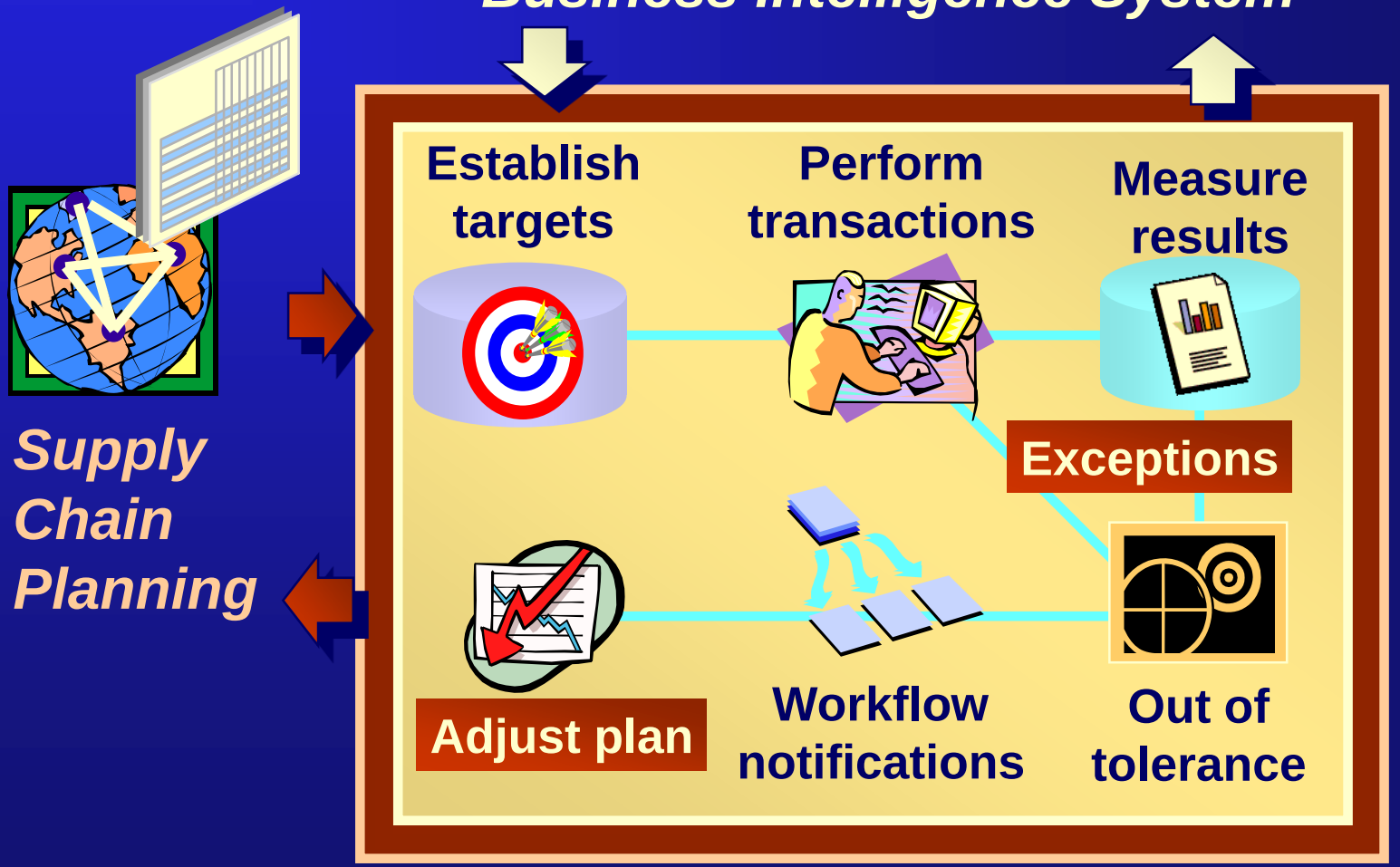
- Effekterne er særligt udtalt i de virksomheder, hvor der samtidig er sket en tilpasning af organisationen og arbejdsgangene med henblik på at udnytte de digitale muligheder*

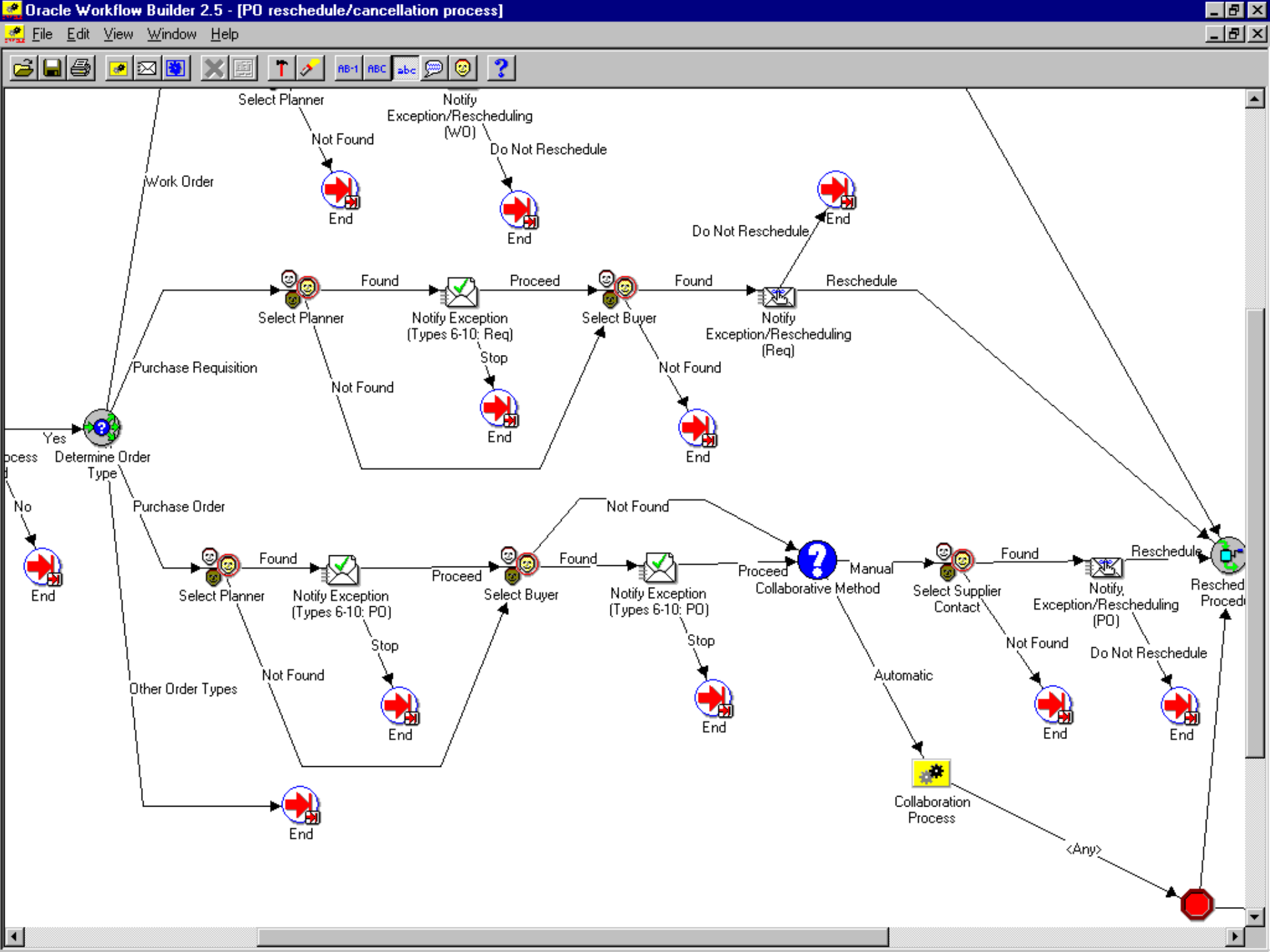
* CEBR,"Digitalization and Productivity", 2011. I rapporten fremhæves det blandt andet, at en ét procentpoint større andel af virksomheder der har digitaliseret mindst én intern proces, øger bruttoværditilvæksten i erhvervslivet med mellem 2,6 mia. kr. og 6,5 mia. kr. årligt.

Exception Notification



Integrated Performance Management




Oracle Workflow Builder 2.5 - [PO reschedule/cancellation process]
File Edit View Window Help
Select Planner
Not Found
End
Notify Exception/Rescheduling (WO)
Do Not Reschedule
End
Work Order
Do Not Reschedule
End
Found
Select Planner
Proceed
Notify Exception (Types 6-10: Req)
Found
Select Buyer
Reschedule
Notify Exception/Rescheduling (Req)
Stop
End
Not Found
Not Found
End
Purchase Requisition
Yes
Determine Order Type
No
End
Purchase Order
Found
Select Planner
Notify Exception (Types 6-10: PO)
Proceed
Select Buyer
Found
Notify Exception (Types 6-10: PO)
Not Found
Proceed
Collaborative Method
Manual
Found
Select Supplier Contact
Reschedule
Notify Exception/Rescheduling (PO)
Resched Proced
Stop
End
Not Found
Other Order Types
Not Found
End
Stop
End
Automatic
Not Found
End
Do Not Reschedule
End
Collaboration Process
End
<Any>

New KPI s for the Future Supply Chain

Current KPIs

Availability to consumer (percent in-stock)

Cost reduction

Financial KPIs

- Return on investment (ROI)
- Gross Margin Return on "X" (GMROX)
- Return on brand equity
- Inventory

Traceability

Sustainability KPIs

Energy consumption

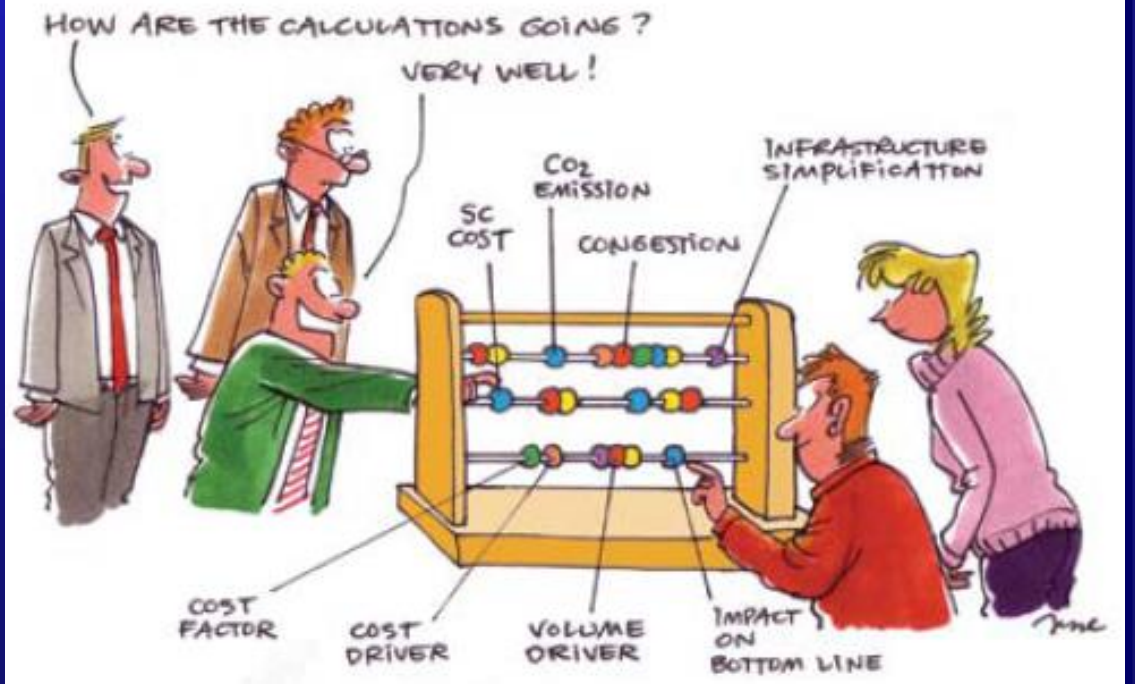
CO_2 emissions (greenhouse gases)

Traffic congestion

Water consumption

Security compliance

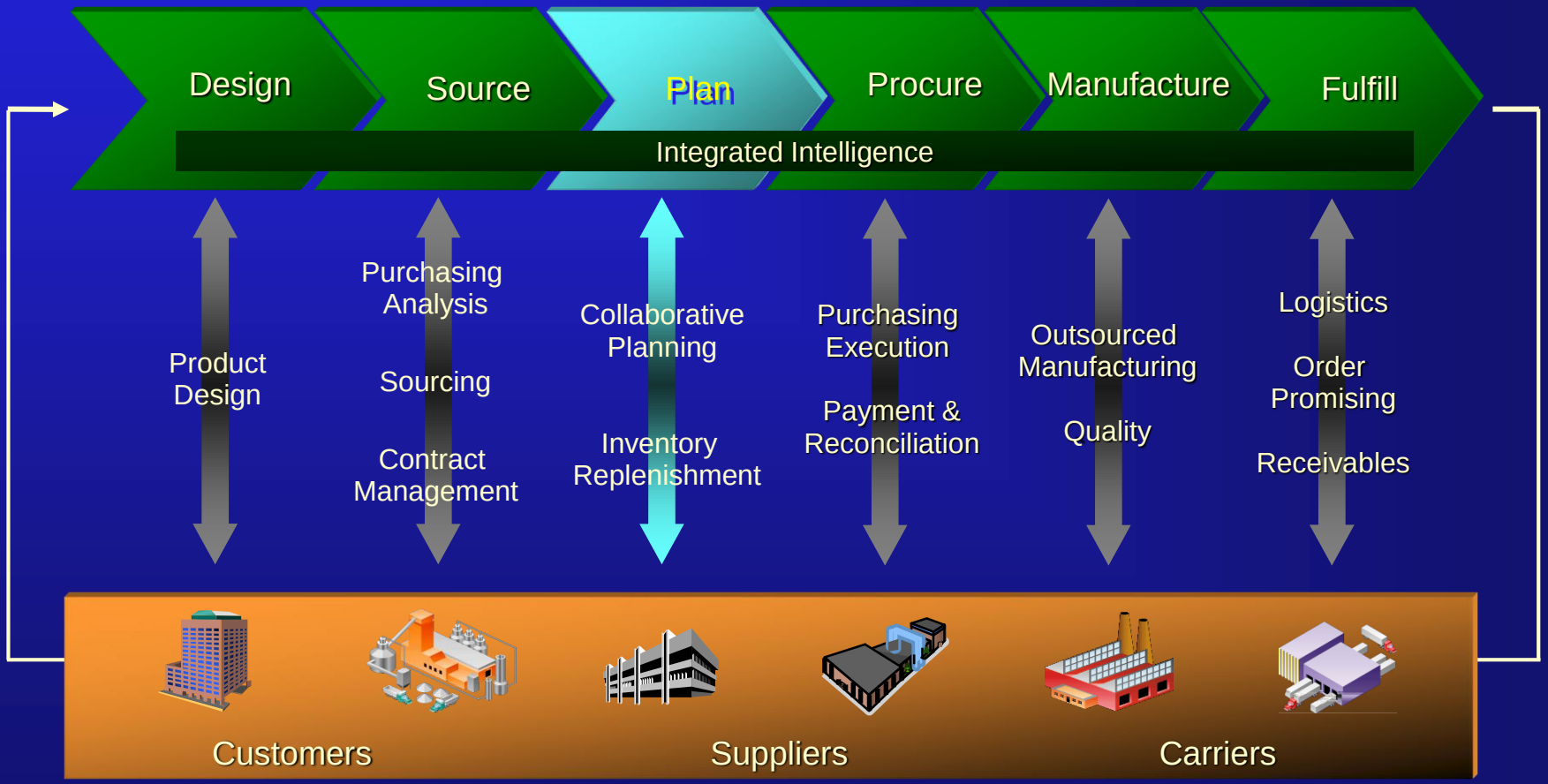
Infrastructure simplification



Centre for Logistics

Oracle Supply Chain Management

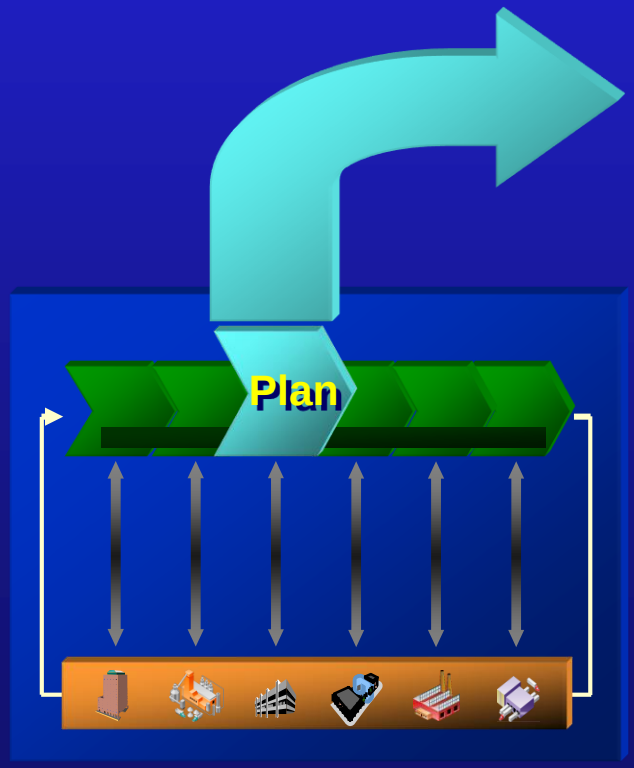
Complete collaboration solution

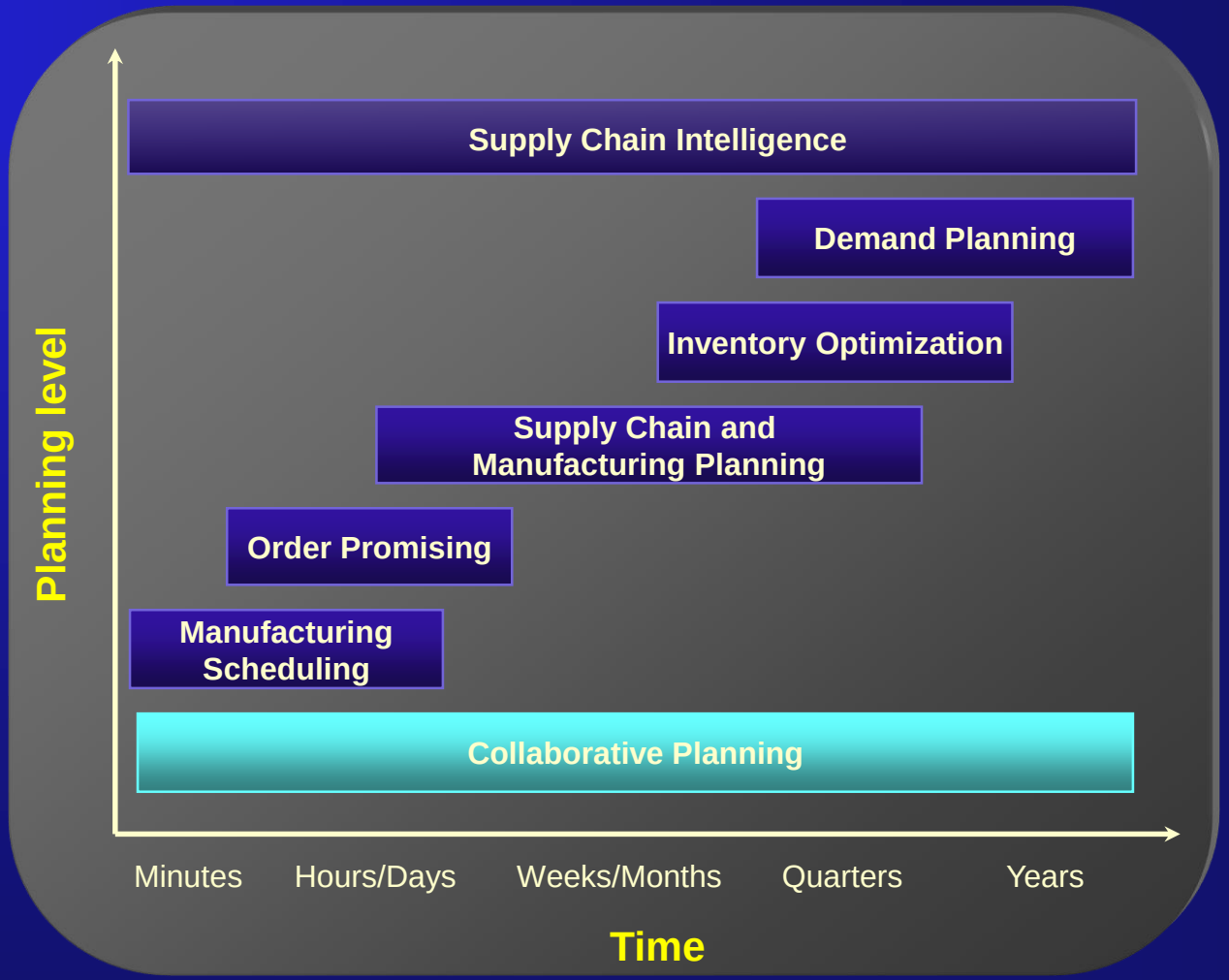


Centre for Logistics

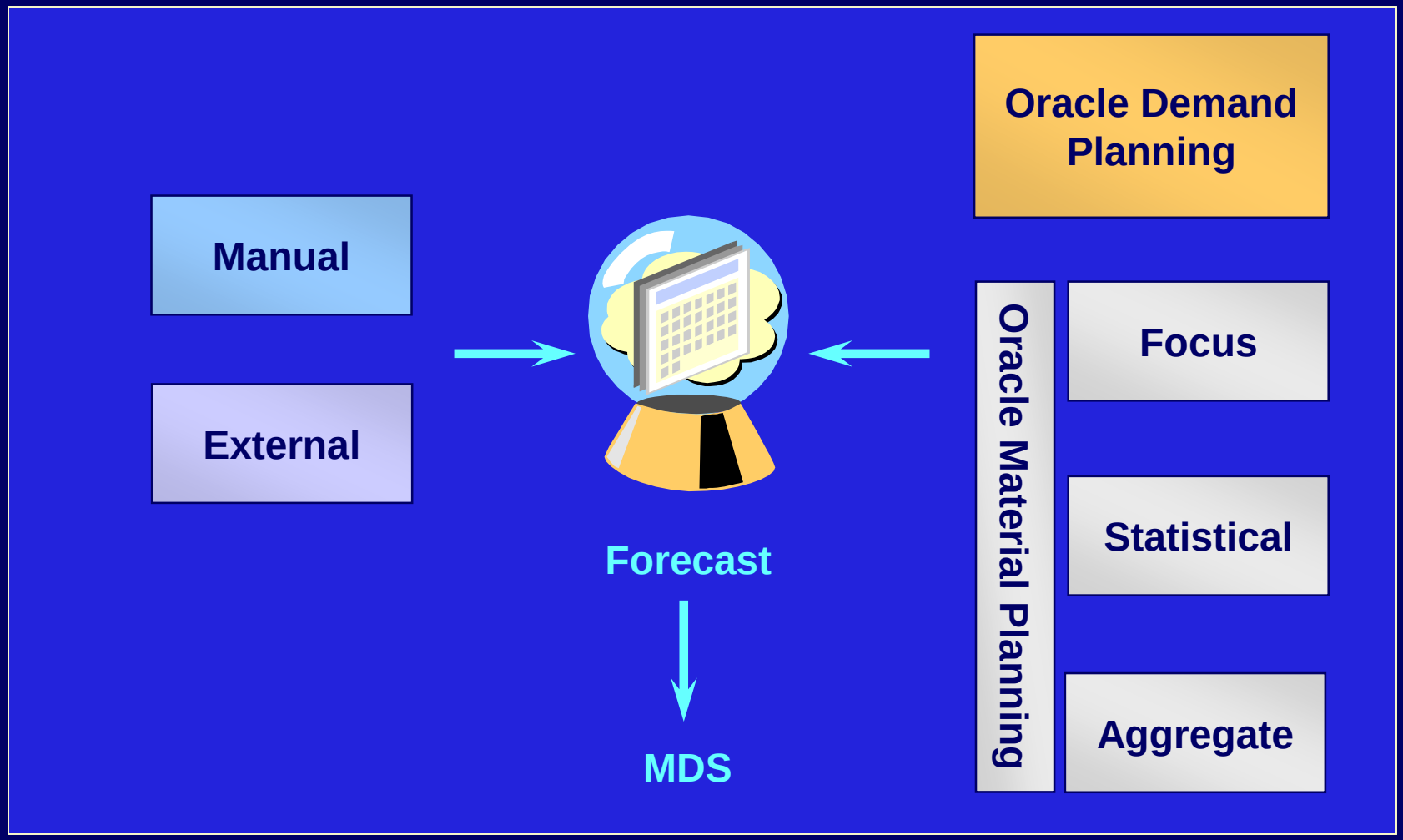
Advanced Planning and Scheduling

e-business planning solution

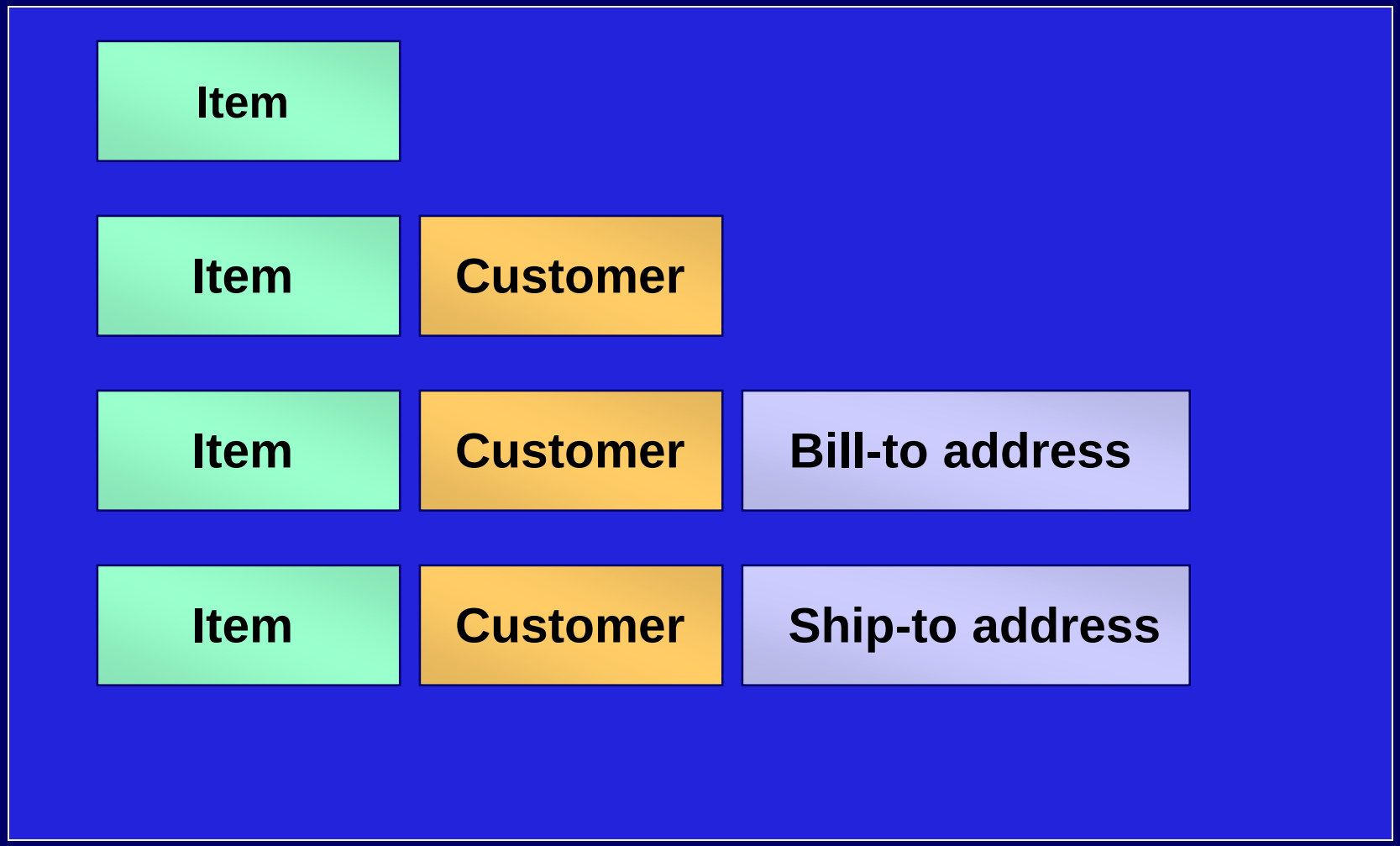




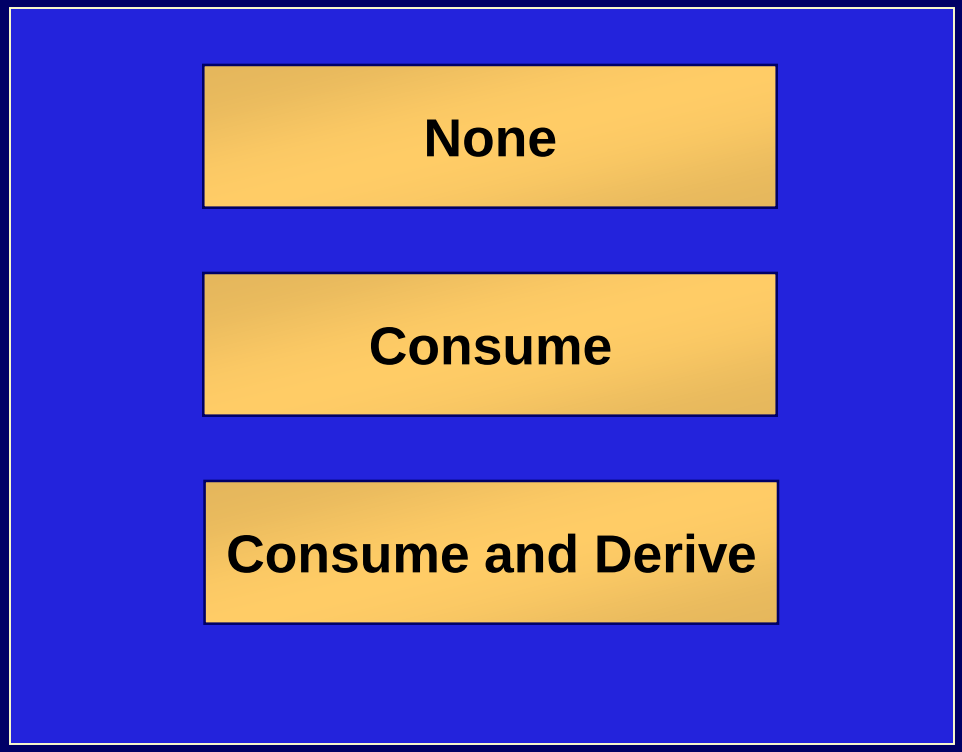
Forecasting Alternatives



Forecast Levels

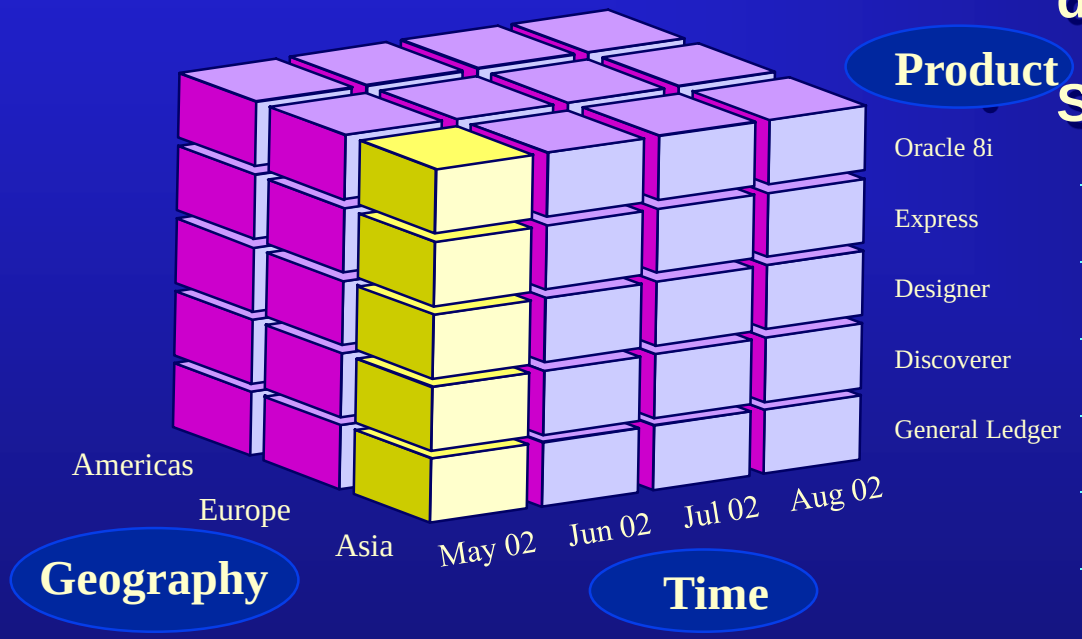


Forecast Control



Decision Support and Analysis

Slice and dice along multiple dimensions



- **Analyze data from different perspectives**
- **Seeded dimensions**
  - **Time**
  - **Product**
  - **Geography**
  - **Sales channel**
  - **Shipping location**
  - **Sales representative**

MDS Summary

- Load MDS to consolidate independent demand
  - Sales orders
  - Demand forecast
  - Interorganization planned orders
- Loading an MDS requires a process that is similar to that of loading a forecast

- Master Data
- Sales Order
- Purchase Order
- Receiving Goods
- Follow up
- Pre-Booking
- Order Pick
- Packing
- Dispatch papers
- Final Booking
- Delivery

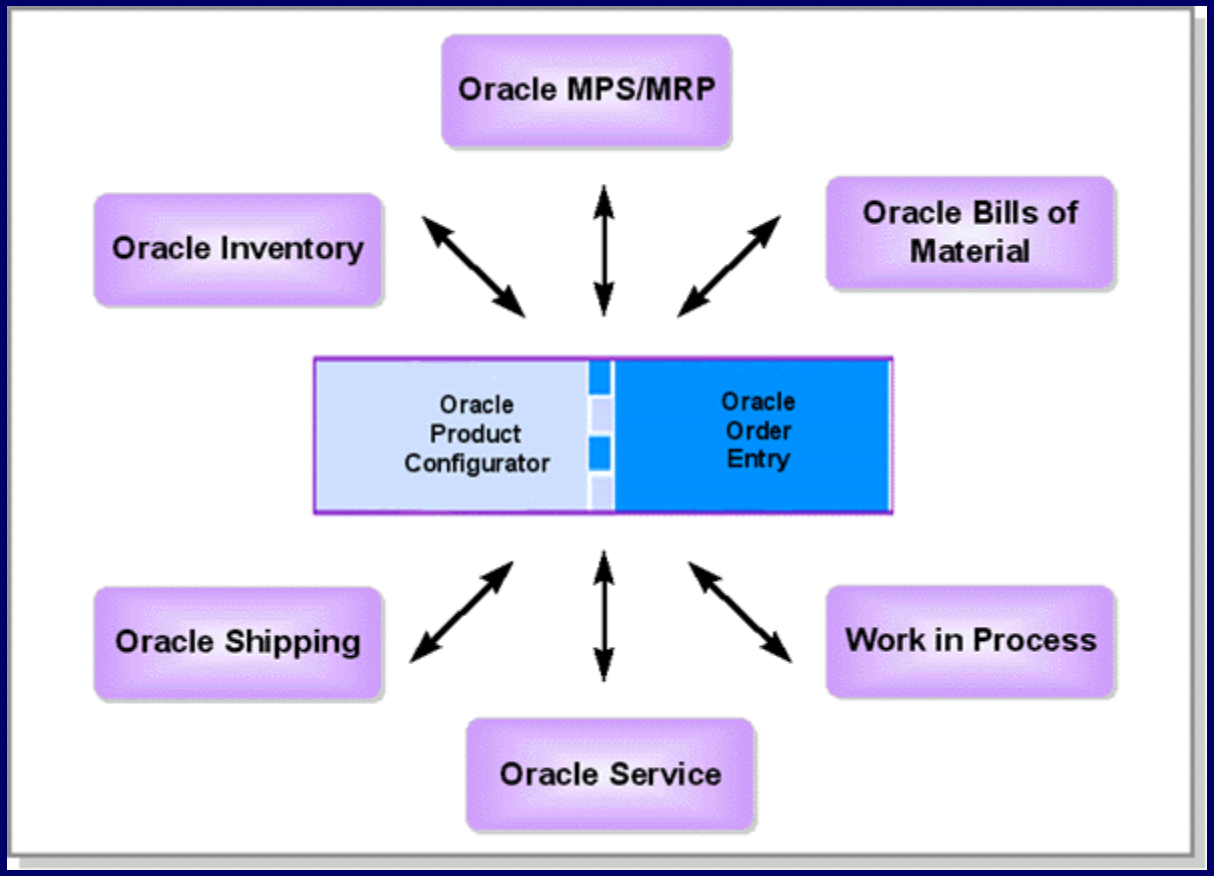
Master data management is important for a lean logistic process to the marked.

Validated

- Dimensions
- Weight
- Volume
- Type of goods
- HS (Tax) codes
- Country Duty codes
- Places of origin
- Dangerous goods

are necessary for pre-booking, freight estimate and customs clearance for shipping the cargo!

Product Configuration



Remember PLM and CAD Cam Integration

Item Attributes, Lead Time

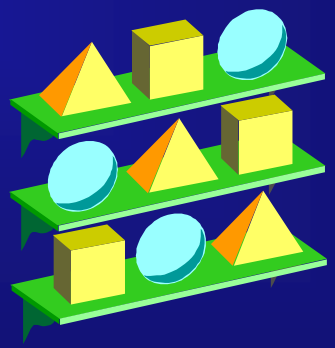
MPS Stability

- Too many changes in the MPS are costly in terms of reduced productivity. However, too few changes lead to poor customer service level and increased inventory

- MPS stability is normally achieved by
  - Firmed Order
  - Frozen time periods for the MPS
  - Time fences (Planning and demand times) to establish clear guidelines for the kinds of changes that can made in various periods.

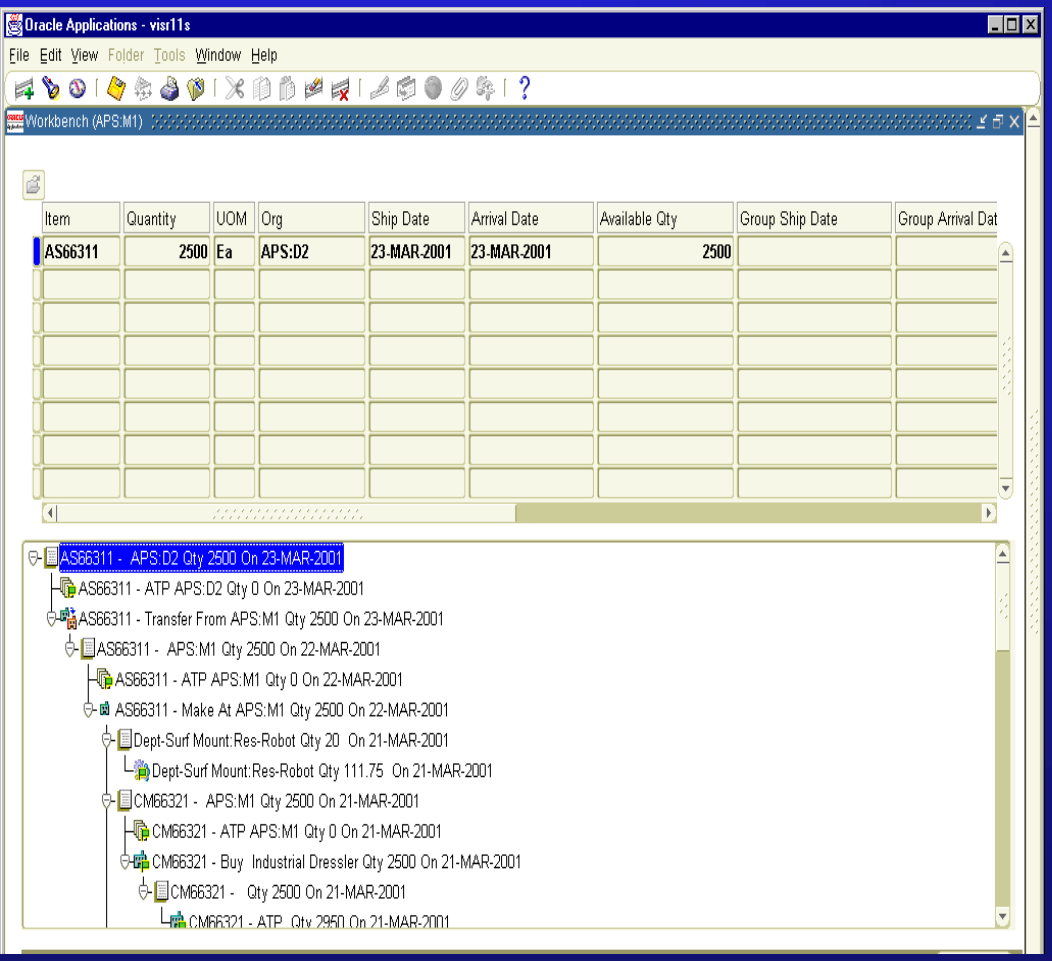
ATP

- Uncommitted inventory plus planned production
- Inventory position based on scheduled production and planned lead times
- Does not consider capacity constraints
- Supply considered
  - On-hand inventory
  - Planned production



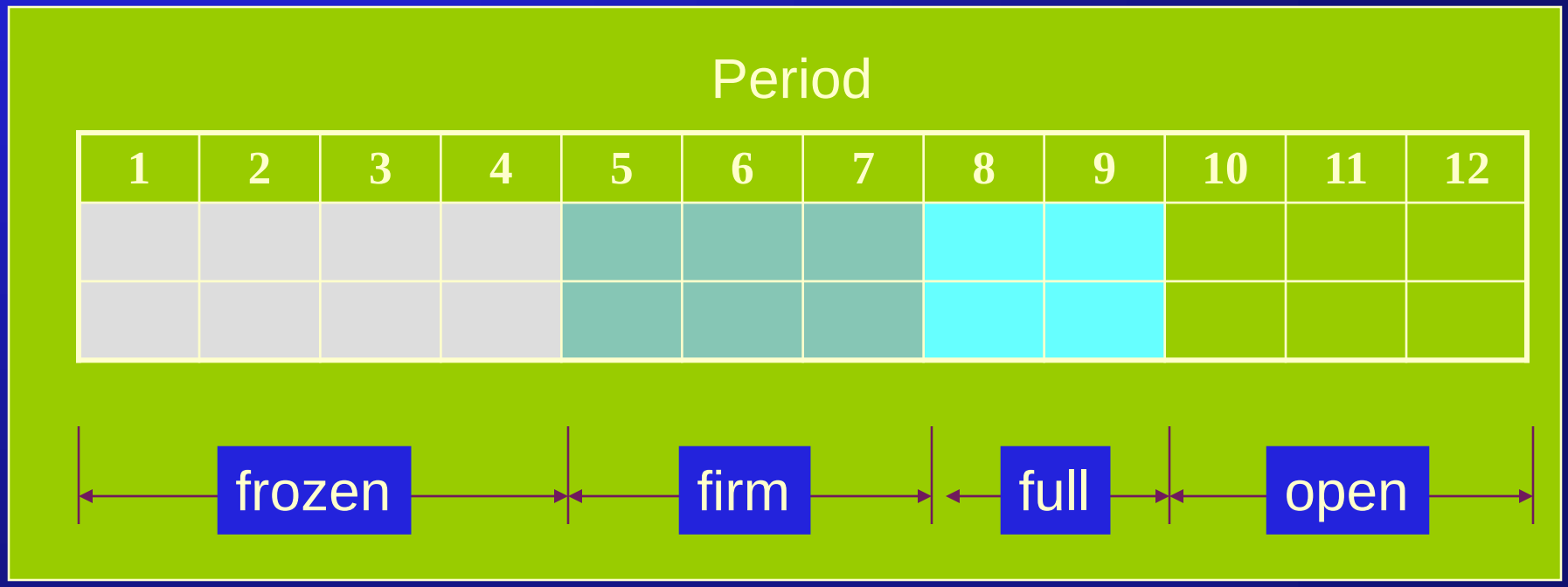
Promise Orders More Accurately

Accurately communicate your capabilities to customers



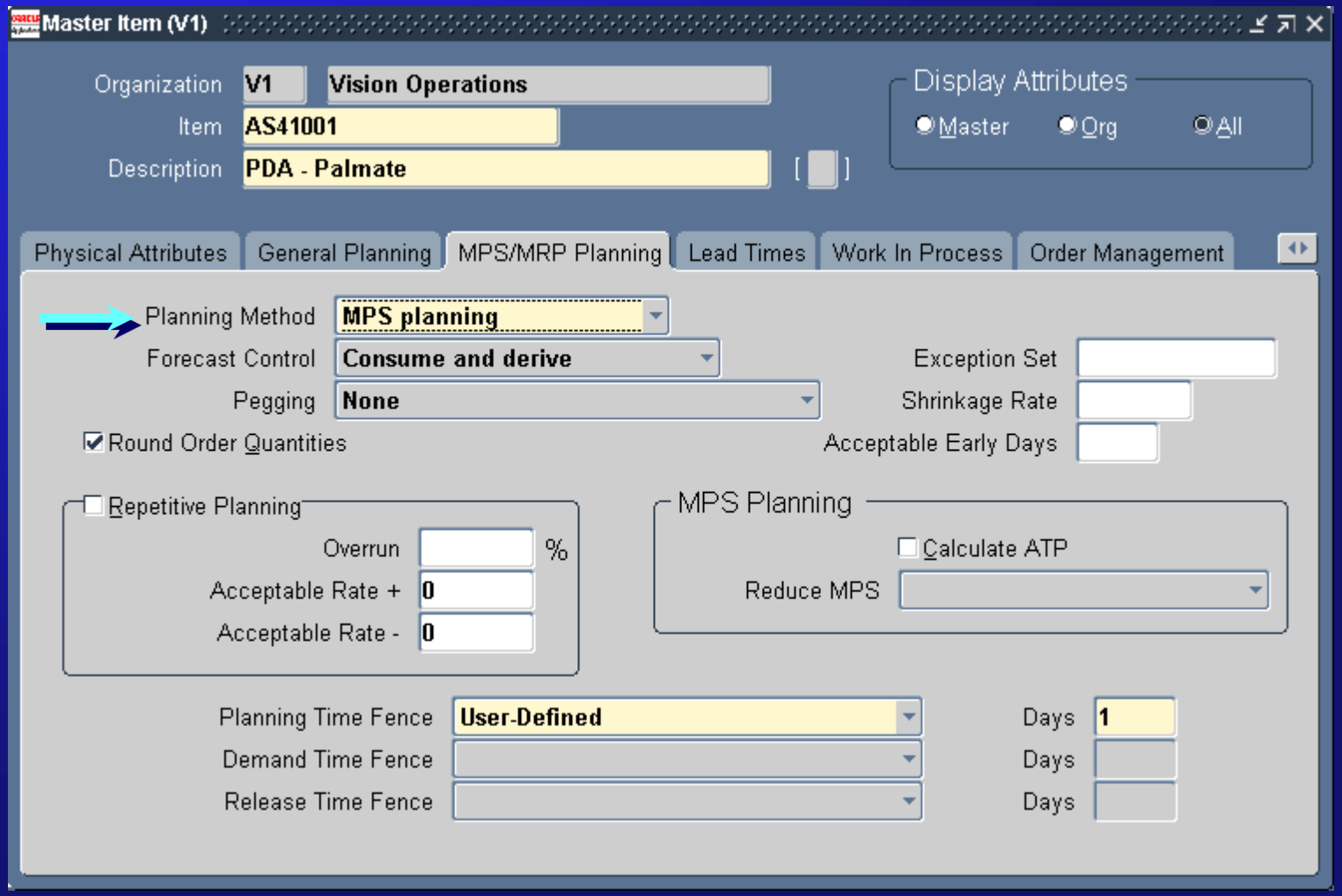
- **Promise orders based on:**
  - **Material availability**
  - **Manufacturing capacity**
  - **Supplier capacity**
  - **Transportation capacity**
- **Global statement of availability**
- **Promise across your supply chain**

Time Fences



Do your company use planning and demand time fences?

Item Master — MPS/MRP Planning

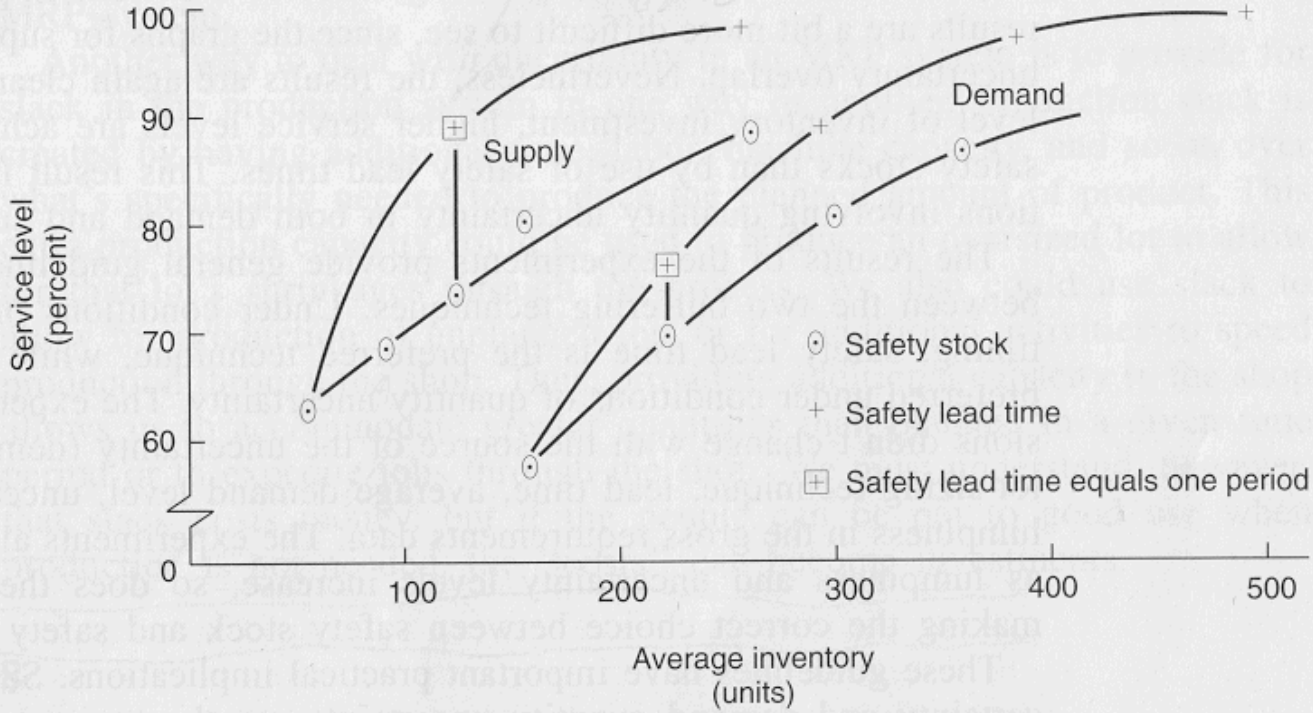


Categories of Uncertainties

Type	Sources	
	Demand	Supply
Timing	Requirements shift from one period to another	Orders not received when due
Quantity	Requirements for more or less than planned	Orders received for more or less than planned

Buffer on times or quantity?

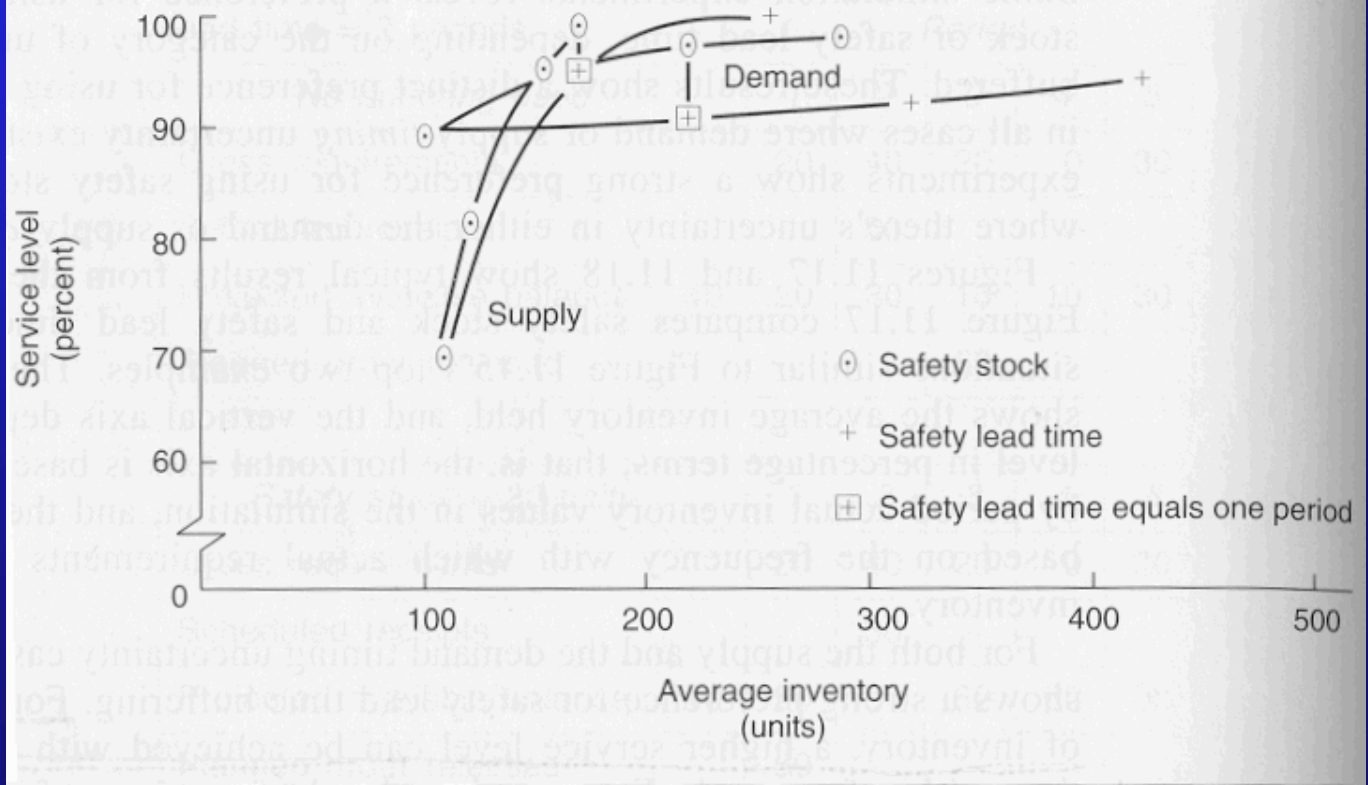
FIGURE 11.17 Experimental Results: Average Inventory versus Service Level with Timing Uncertainty



Source: D. C. Whybark and J. G. Williams, "Material Requirements Planning under Uncertainty," *Decision Sciences*, October 1976, p. 602.

Buffer on times or quantity?

FIGURE 11.18 Experimental Results: Average Inventory versus Service Level with Quantity Uncertainty



Source: D. C. Whybark and J. G. Williams, "Material Requirements Planning under Uncertainty," *Decision Sciences*, October 1976, p. 603.

Materialedisponering

Ved materialebehovsberegning er der to disponerings-metoder for materialerne:

- Startdato for operationen
- Startdato for produktionsordren

Centre for Logistics

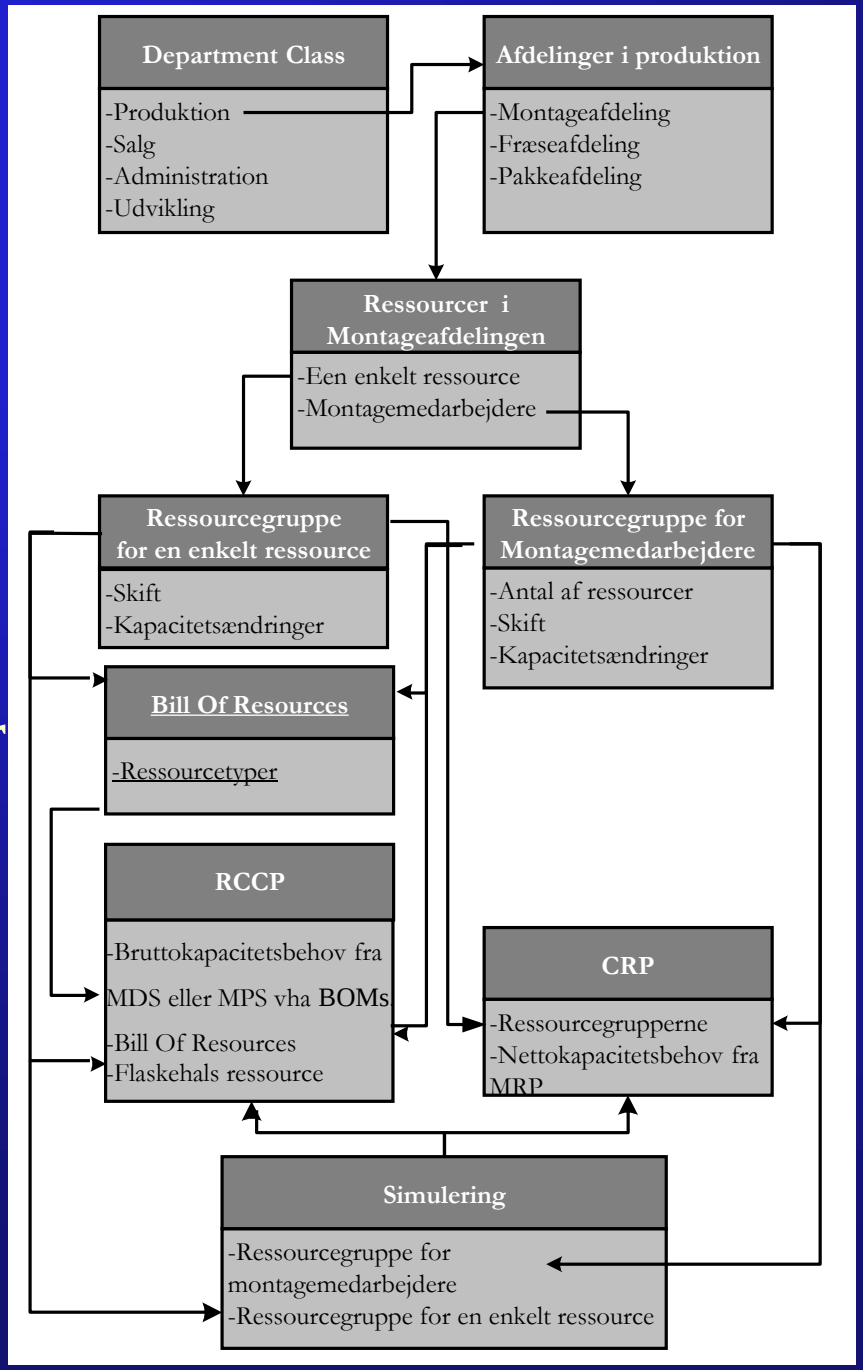
Afdelingsstruktur

Ressourcetyper

Ressourcestruktur

Ressourceplaner

Kapacitetsniveau



Overview of Capacity Planning

- **Rough Cut Capacity Planning (RCCP)**
  - Rough Cut Capacity Planning (RCCP) to validate your master schedule
- **Capacity Requirements Planning (CRP)**
  -Detailed Capacity Requirements Planning (CRP) to validate your MRP plans
- **These two capacity planning approaches supports two levels of capacity planning:**
  - **Rate-based (Production line) manufacturing**
  - **Routing-based (Resource) manufacturing**

Scheduling terms & Definitions

- **Loading -The assignment of jobs to processing centres**

- **Infinite loading -Jobs are assigned to work centers without regard to the capacity of the work center**
- **Finite loading -Jobs are assigned to work centers taking into account the work center capacity and the processing time**

- **Vertical loading (work center focus, idle) -Loading jobs at a work center, job by job, usually according to some priority criterion, *using infinite loading***
- **Horizontal loading (Job focus, priority) -Loading each job on all work center it will require, one at the time, according to some priority, *using finite loading***

Insight in Scheduling Rules

One-machine case

Make-span independent of sequence
e.g 3 jobs (1,8,5) total time =14

However min. the average flow time
Sequence jobs in ascending order (SPT)

E.g. average time each jobs spends in the system is (1+6+14)/3=7 and reverse order (8+13+14)/3=11,67

Scheduling Terms & Definitions

Baker [1974] distinguishes between local, global, static, and dynamic priority rules.

- A rule is ***local*** if it bases the priority of an operation on features of the jobs in the waiting queue before the given machine only. E.g FCFS, SPT and EDD.
- It is ***global*** if features of other jobs and machines may be used. E.g CR, S/RO
- Moreover, a rule is **static** if the relative priorities of the operations do not change over time, and ***dynamic*** otherwise.

Detailed Scheduling
Eksempel på anvendelse af styringsattributter til planlægning

Centre for Logistics

Aktiviteter ved en operation/ressourcesekvens

I et ERP-system er det muligt at anvende følgende aktiviteter ved en ressourcesekvens eller operation:

- ”Kø” (*’Queue’*) er ofte den første aktivitet ved en operation og anvendes i styringen af materialernes bevægelse mellem de enkelte operationer. Når en vare står i kø venter den på at blive forarbejdet eller på at blive afhentet
- ”Under udførsel” (*’Run’*) er den aktivitet, hvor der udføres en bearbejdning af varen
- ”Bevægelse” (*’To Move’*) er en aktivitet, som angiver, at varer er færdigbearbejdede og er i venteposition og klar til at blive transporteret til næste operation
- ”Afvisning” (*’Reject’*) anvendes til at styre varer, der f.eks. er blevet afvist ved en intern test og efterfølgende vil blive repareret eller kasseret
- ”Kasseret” (*’Scrap’*) anvendes for varer, som ikke kan anvendes i de efterfølgende operationer

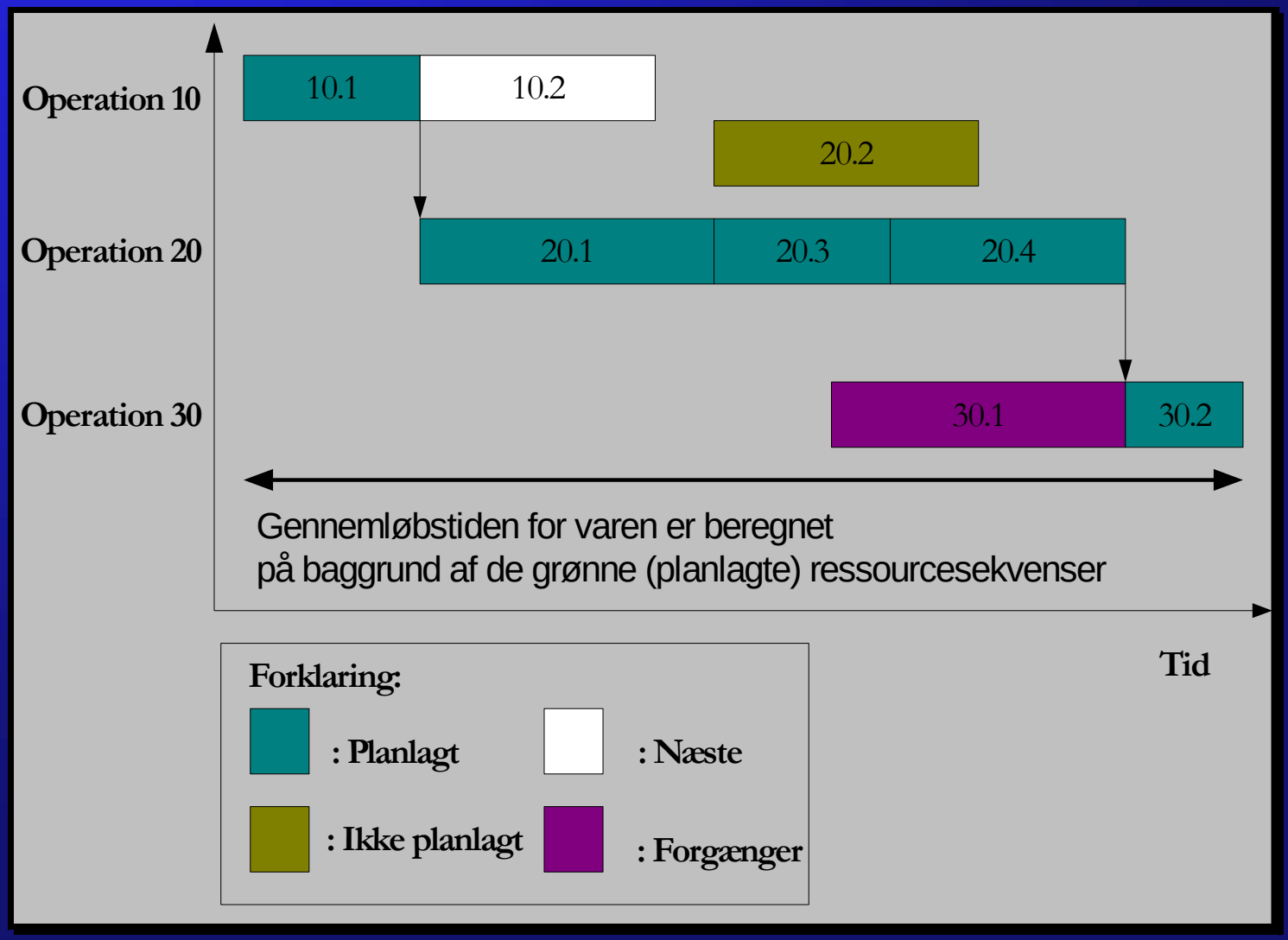
Detailed Scheduling 1000 stk.

Eksempel på anvendelse af styringsattributter til planlægning

Opr.	Res. Seq	Ressource type	Basis	Stk. pr. time	Aktivitet	Plan. metode	Antal res.	kap. behov
10	10.1	Presse	Vare	0,1	Run	Ja	1	100
	10.2	Presse	Serie	1	Nedtagning	Næste	1	1
20	20.1	Kø	Serie	4	Kø	Ja	1	4
	20.2	Arbejder	Vare	0,05	Montage	Nej	3	0
	20.3	Boring	Vare	0,05	Run	Ja	3	50
	20.4	Inspektion	Vare	0,01	Kvalitet	Ja	1	10
30	30.1	Slibning	Serie	1	Opstilling	Forgænger	1	1
	30.2	Slibning	Vare	0,01	Run	Ja	1	10

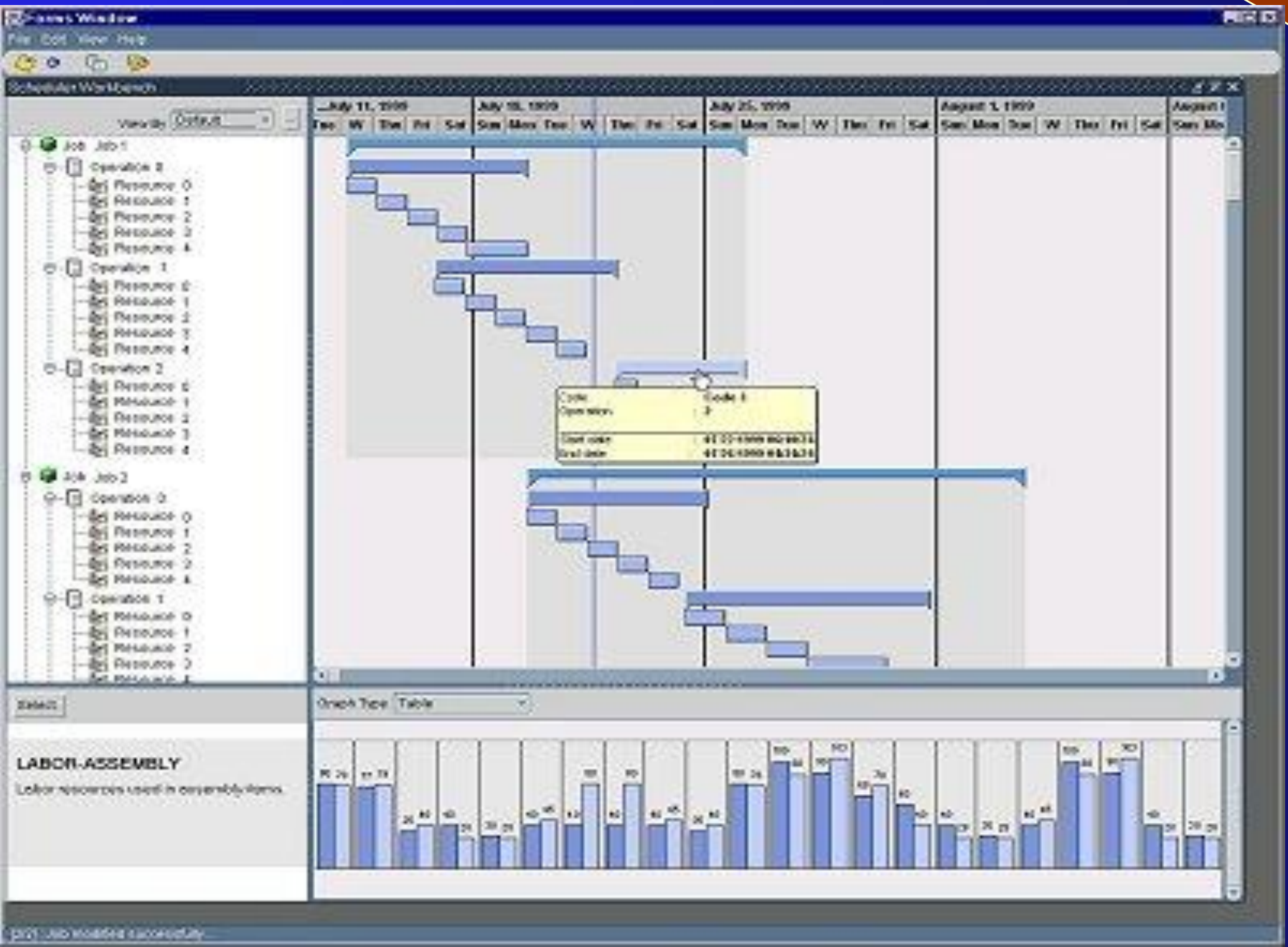
Detailed Scheduling

Eksempel på anvendelse af styringsattributter til planlægning



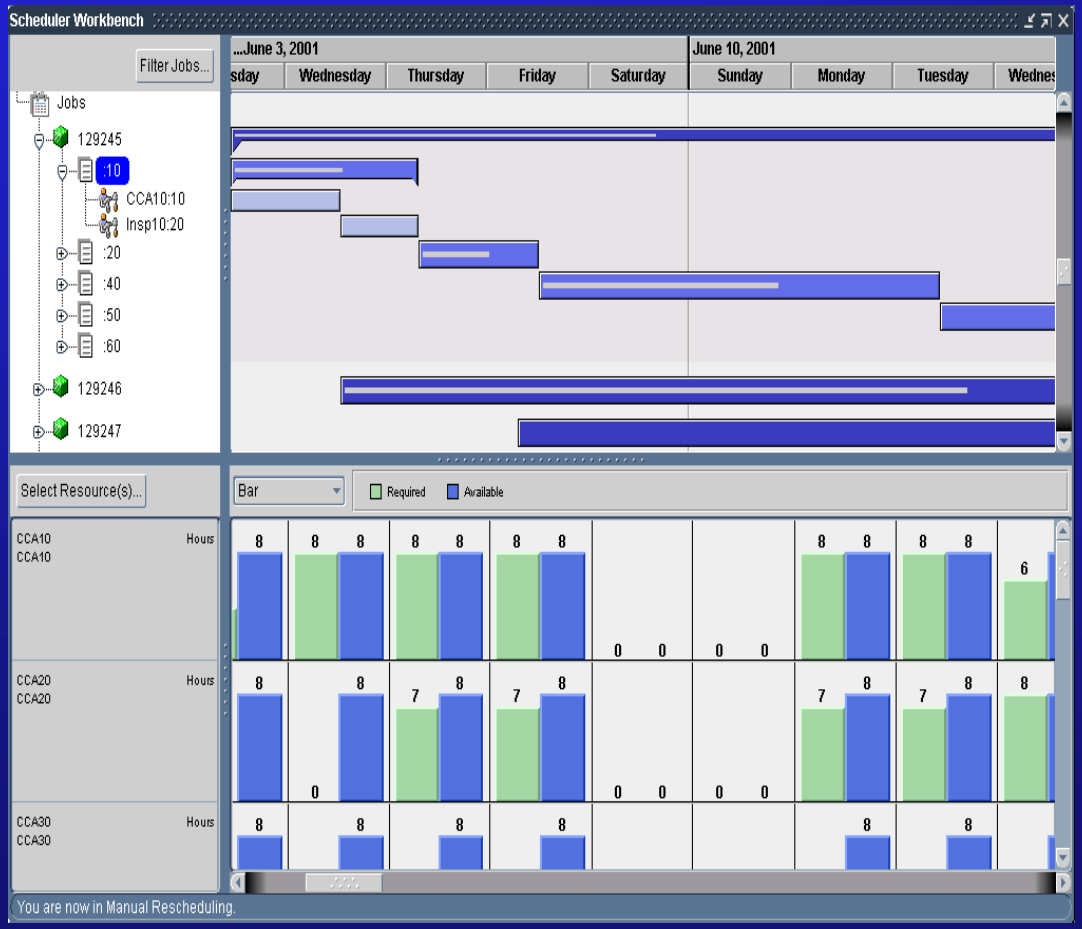
Manufacturing Schedulingb

Centre for Logistics



Manufacturing Scheduling

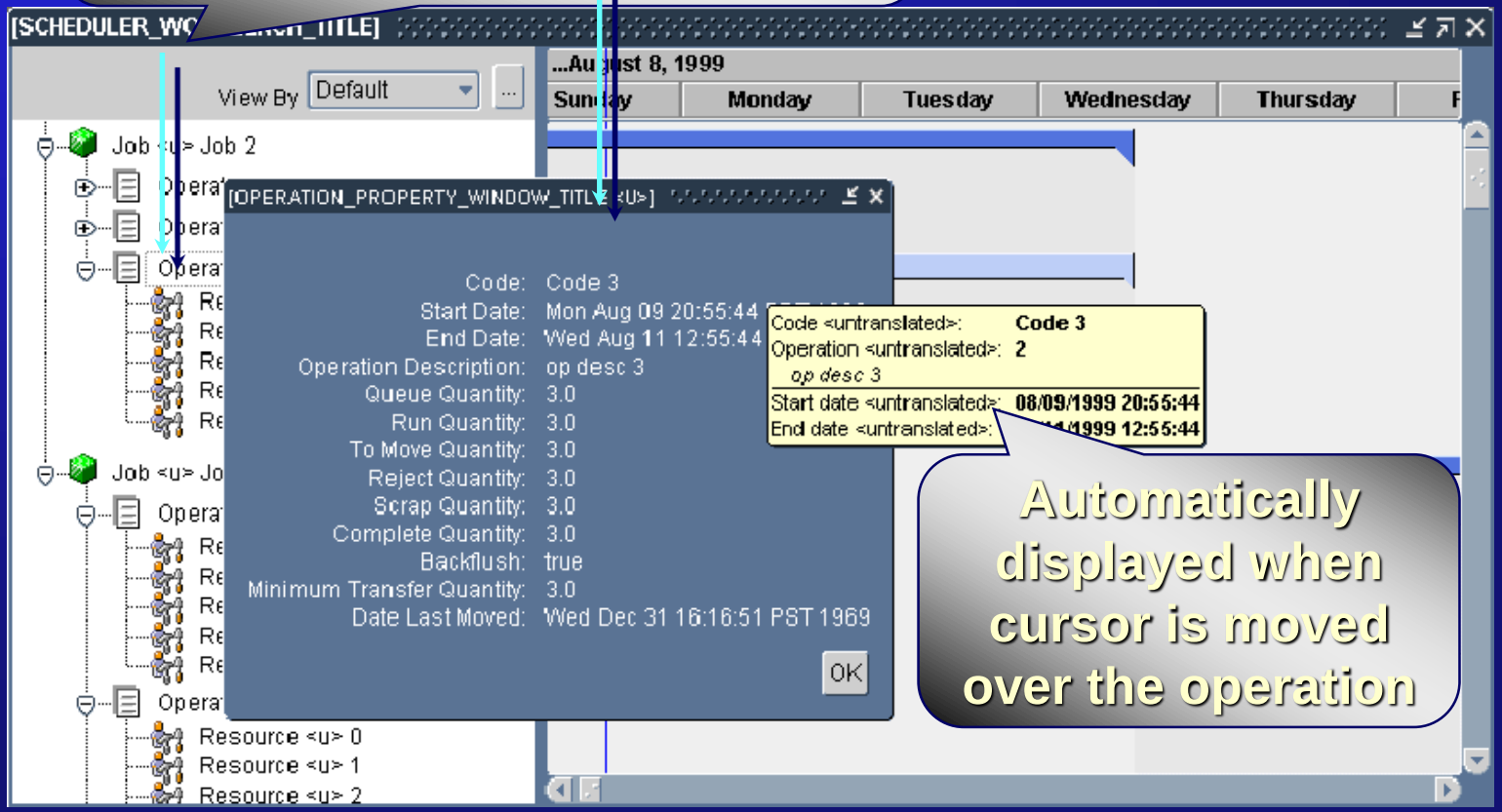
Drive efficiencies by improving asset utilization



- **Improve asset utilization**
  - Schedule around your constraints
  - Sequence production
  - Optimize setups
- **React to short term schedule disruptions**
  - Machine breakdowns
  - Absenteeism

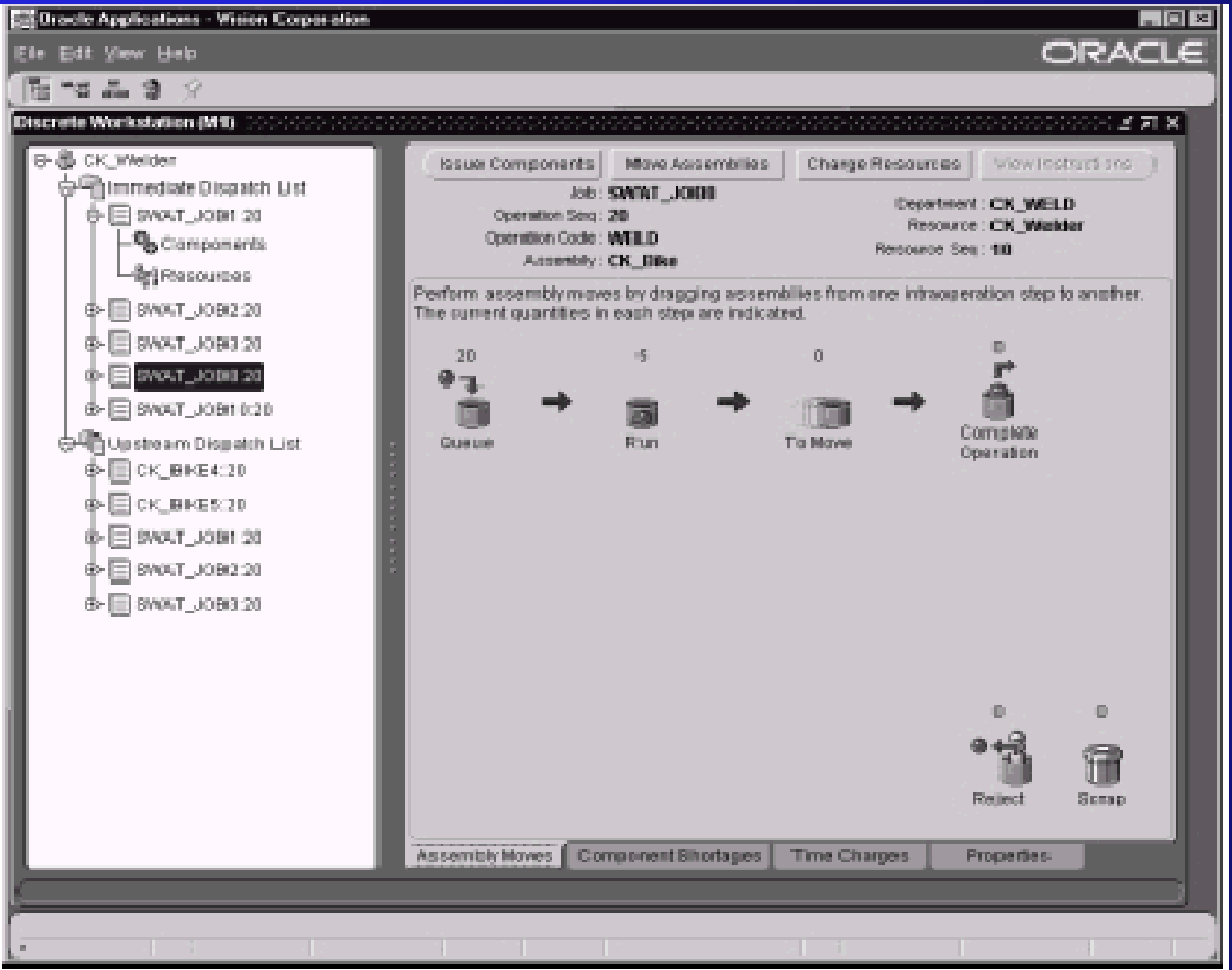
Highlight Operation, View Properties

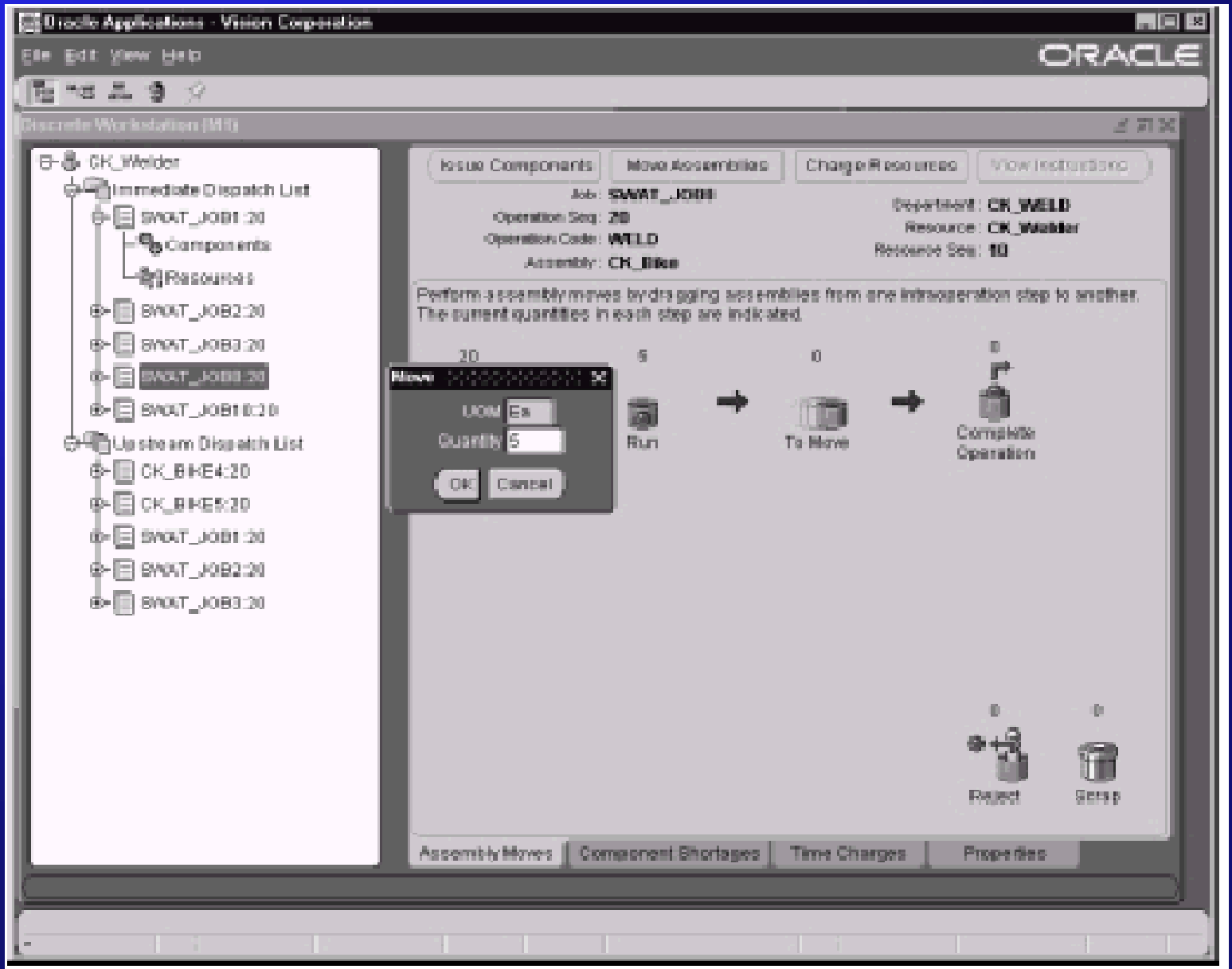
Displayed by left or right click on Operation name or bar



Automatically displayed when cursor is moved over the operation

WIP Workbench - Highlight Ope.Res.




Oracle Applications - Vision Corporation
File Edit View Help
ORACLE
CK_Welder
Immediate Dispatch List
Issue Components
Move Assemblies
Charge Resources
View Instructions
Job:
Operation Seq: 20
Operation Code: WELD
Assembly: CK_Bike
Department: CK_WELD
Resource: CK_Welder
Resource Seq: 10
Perform assembly moves by dragging assemblies from one intraoperation step to another.
The current quantities in each step are indicated.
20
5
0
0
Move
UOM Ea
Quantity 5
OK
Cancel
Run
To Move
Complete Operation
Reject
Scrap
Assembly Moves
Component Shortages
Time Charges
Properties

A classic case study by Earl Legrande, ´63

Centre for Logistics

Key to Criteria:

1. # of orders completed
2. % of orders Comp. late
3. Mean of the distribution Comp.
4. Standard derivation of the distribution of completions
5. Avg. # of orders waiting in the shop
6. Avg. wait time orders
7. Yearly cost of carrying order queue
8. Ration of inventory-carrying cost while waiting to inventory cost while on machine
9. % of labour Util.
10. % of machine cap. Util.

*Criteria**	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	
Relative Wegiths	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*Total Relative Rank*
MINPRT	1,00	0,83	1,00	0,20	1,00	1,00	0,76	0,91	1,00	1,00	8,70
MINSOP	0,87	1,00	0,63	1,00	0,73	0,52	0,96	0,99	0,92	0,92	8,54
FCFS	0,80	0,54	0,54	0,20	0,73	0,38	0,84	0,98	0,93	0,93	6,87
MINSD	0,84	0,48	0,46	0,22	0,68	0,36	0,91	1,00	0,91	0,91	6,77
MINDD	0,94	0,62	0,64	0,24	0,84	0,51	1,00	0,99	0,87	0,87	7,52
RANDOM	0,84	0,68	0,79	0,20	0,67	0,66	0,80	0,93	0,92	0,91	7,40

Input/Output Control

The Input / output control system is a method of managing queues and work in process lead time.

- ***To control queue and meet delivery commitments, production activity control must:***
- ***Control the work going into and coming out of a work center, called Input / Output control***
- ***Set the correct priority of orders to run at each work center***

Notice

- ***Planned input* should never exceed *planned output***
- **Focuses attention on bottleneck work centers**

Input-output data gathered at end of week 8 for a work center

	Week							
	1	2	3	4	5	6	7	8
Planned input	60	60	60	60	60	60	60	60
Actual input	68	70	75	70	68	60	55	55
Planned output	65	65	65	65	65	65	65	65
Actual output	60	62	63	63	64	65	63	60

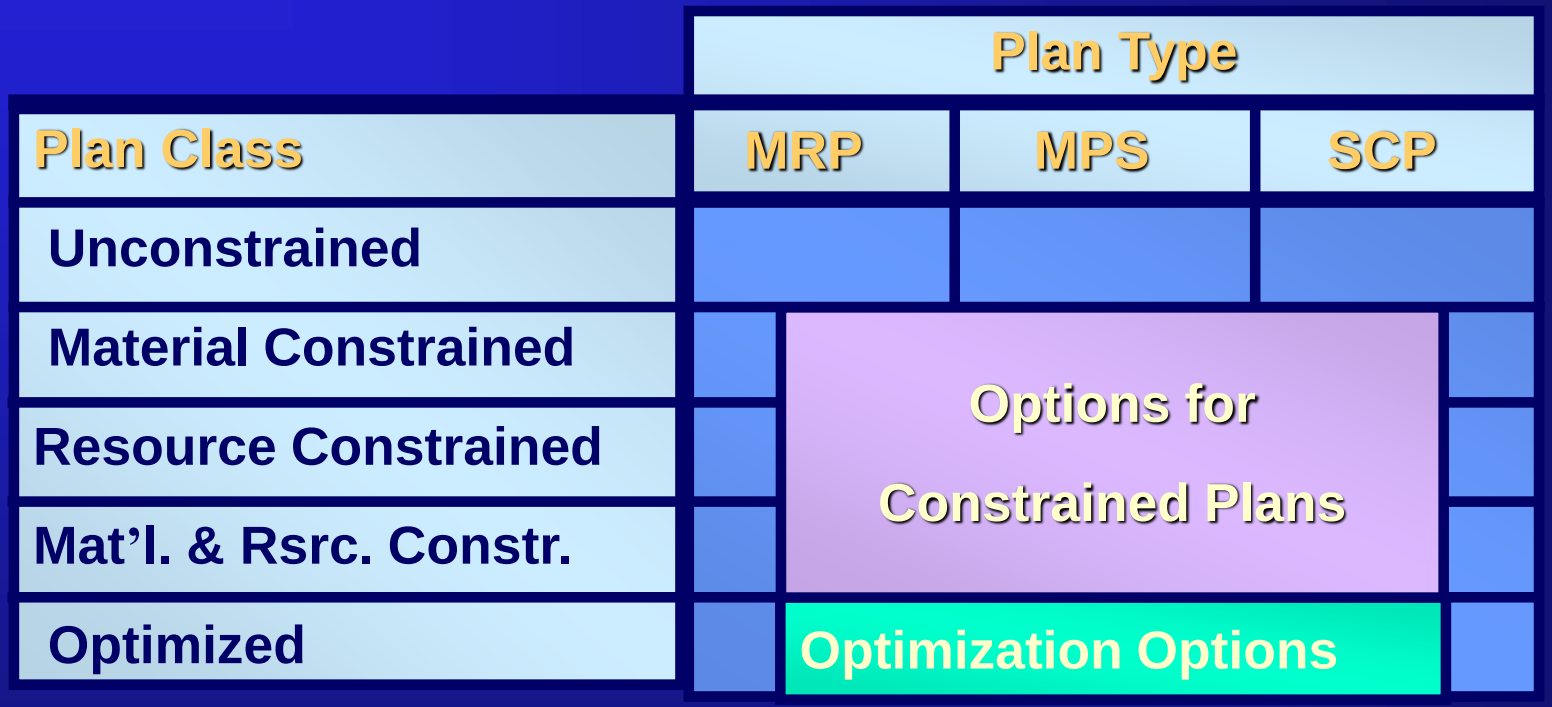
Beginning backlog = 50 hours.

Results

Week		1	2	3	4	5	6	7	8
Planned input		60	60	60	60	60	60	60	60
Actual input		68	70	75	70	68	60	55	55
Cumulative deviation		8	18	33	43	51	51	46	41
Planned output		65	65	65	65	65	65	65	65
Actual output		60	62	63	63	64	65	63	60
Cumulative deviation		-5	-8	-10	-12	-13	-13	-15	-20
Planned backlog	50	45	40	35	30	25	20	15	10
Actual backlog	50	58	66	78	85	89	84	76	71

- Plan objectives?
- What is the recommendation?

Plan Options



Multiple LP Objective Approaches

1000$ for Invest.
Option 1: 6 % return and 4 % risk = 2-10% return
Option 2: 3 % return no risk!

Min: invest 200$ max. Invest 700 $ for each option.
Objective is max return with min risk

We need a method of dealing with the trade-off among them.

Two approaches:

weighted obj. and abs. priorities

Weighted Objective Approaches

Objective is max return (80%) and min risk (20%)!

$0.8(\text{return}) + 0.2(\text{-risk}) \Rightarrow 0.8(.06X_1 + .03X_2) + 0.2(-0{,}4X_1)$

$\Rightarrow$ MAX: $0.4X_1 + 0.24X_2$

Subject to

$X_1 + X_2 \leq 1000$ \$

$X_1, X_2 \leq 700$ \$ and

$X_1, X_2 \geq 200$ \$

$X_1, X_2 \geq 0$

Weighted Goal Programming

Hard constrains are not under control of the decision maker but soft constrains are!

Goal (risk): $0.04X_1 + s_1 - r_1 = (\max)\ 12\ \$$

Goal (return): $0.06X_1 + 0.03X_2 + s_2 - r_2 = (\min)\ 45\ \$$

Weighted 75% and 25%, s_2 , $r_1 \Rightarrow 0$,

Min: $0.25r_1 + 0.75s_2$

or Max: $0.25s_1 + 0.75r_2$

Subject to

$X_1 + X_2 \leq 1000\ \$$

$X_1, X_2 \leq 700\ \$$

$X_1, X_2 \geq 200\ \$$

$X_1, X_2, s_1, s_2, r_1, r_2, \geq 0$

$0,4X_1 + s_1 - r_1 = 12\ \$$

$06X_1 + .03X_2 + s_2 - r_2 = 45\ \$$

APS Planning Approaches

Hard and Soft constraints

- Demand due dates
- Capacity constraints
  - Material
  - Labour capacity
  - Machine & tool capacity
  - Inventory capacity
  - Transport mode capacity

APS Planning Approaches

- **Constrained approach**

  In this option the generated plan respects the specified constraints. This option produces a executable, but not necessarily an optimal plan as no plan optimization objectives or criteria are considered.

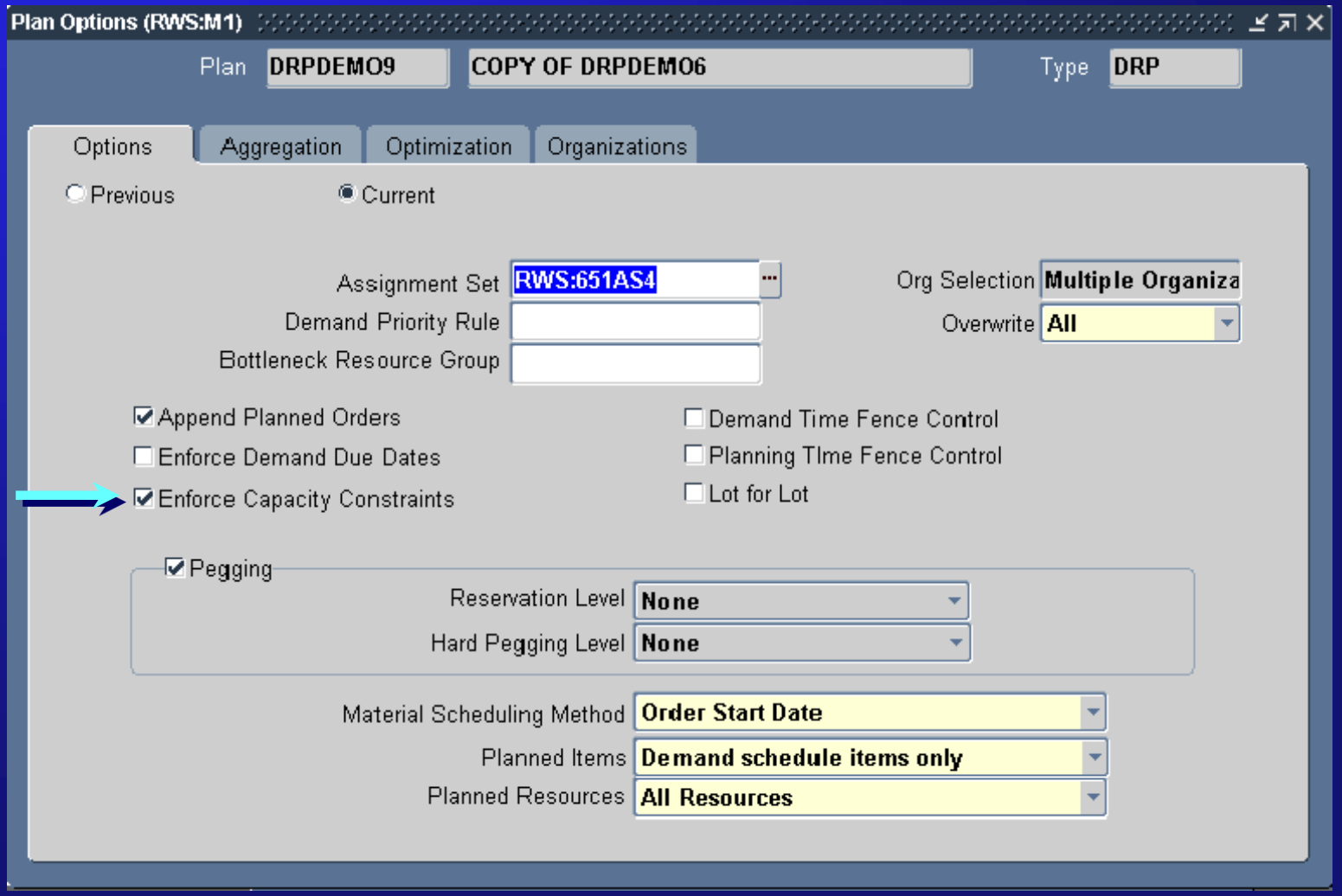
- **Optimization approach**

  In this option an optimized and executable plan is generated based on plan objectives and constraints. The optimization is entirely based on cost and profit, which means that SOFT constraints could be overruled, if this will maximize the plan profit/objectives.

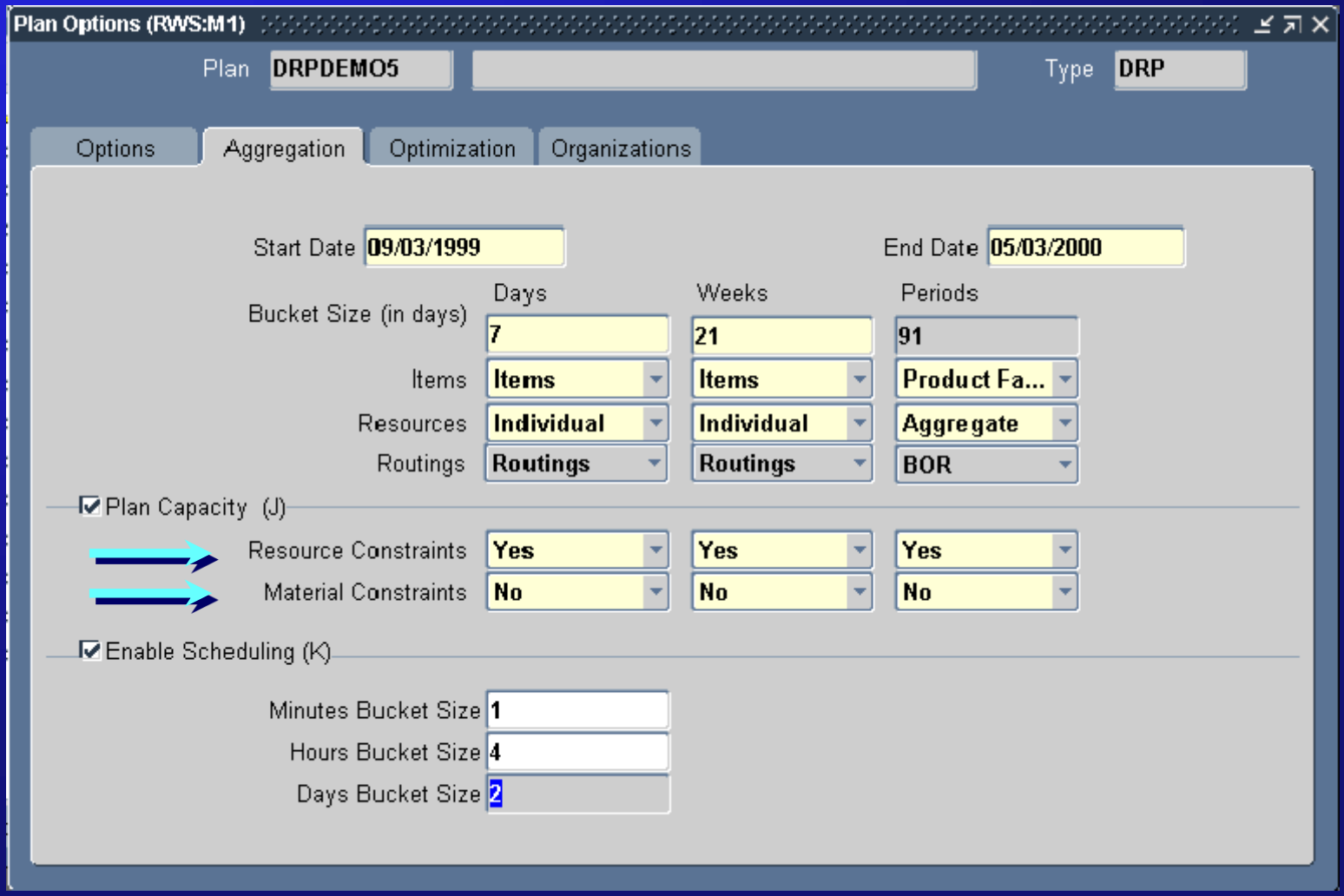
CBP Rules

- Respect priority across demand types
- Respect sourcing allocations
- Use primary BOMs, no alternates
- Use primary items and components, no substitutes
- Use primary routings, no alternates
- Alternate resources WILL be considered

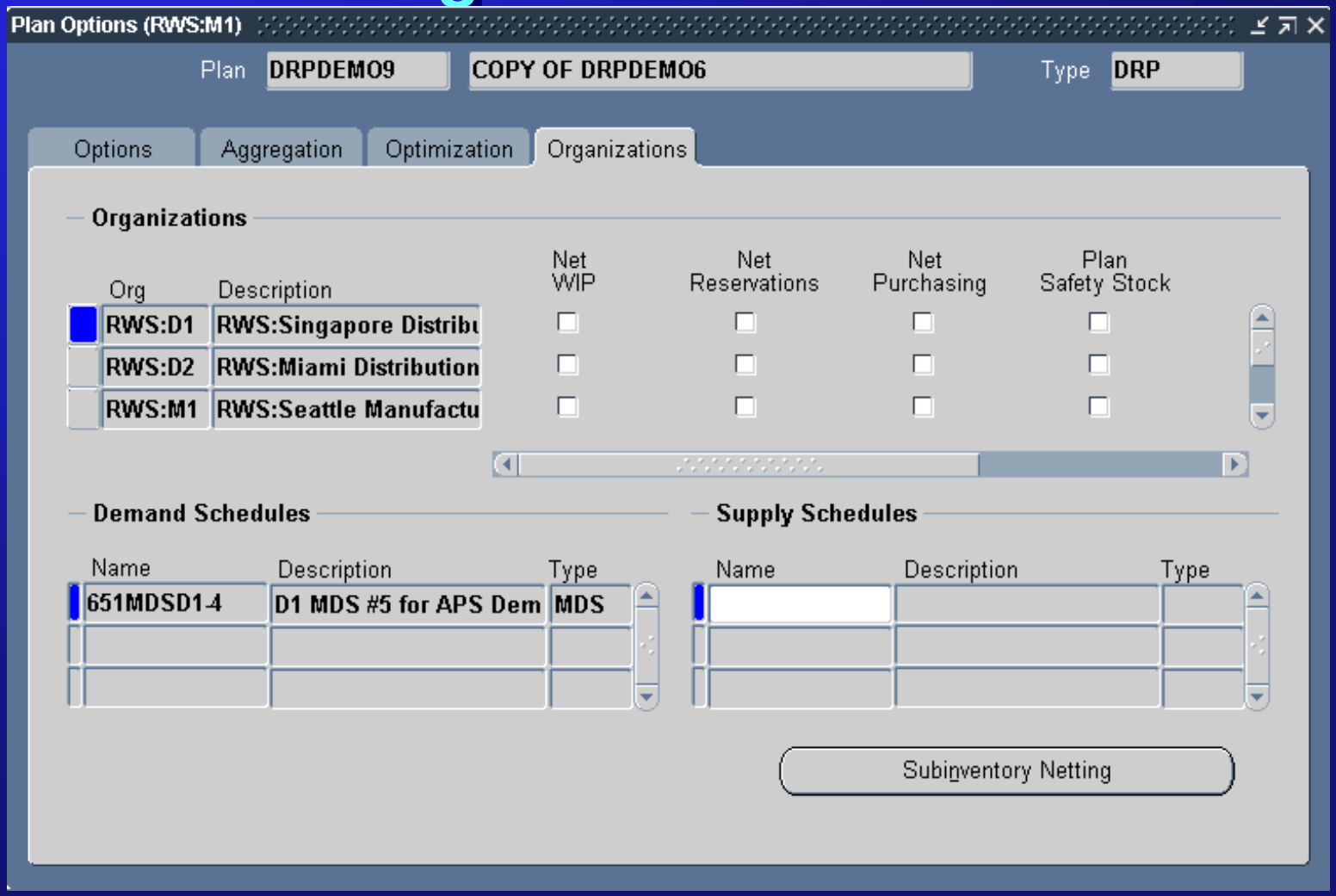
Constrained Plan Options — Options Tab



Constrained Plan Options — Aggregation Tab



Common Plan Options — Organizations Tab



Optimized Plan Setup

- Same setup as constrained plans

+

- Optimization check box = yes
- Adjust optimization objective weights
- Set penalty factors

Optimization Decision Variables

- Production, supplier sources
- Production, purchasing quantities
- Choice of BOM, items
- Choice of routing, resources
- Choice of transportation carrier modes
- Safety stock levels

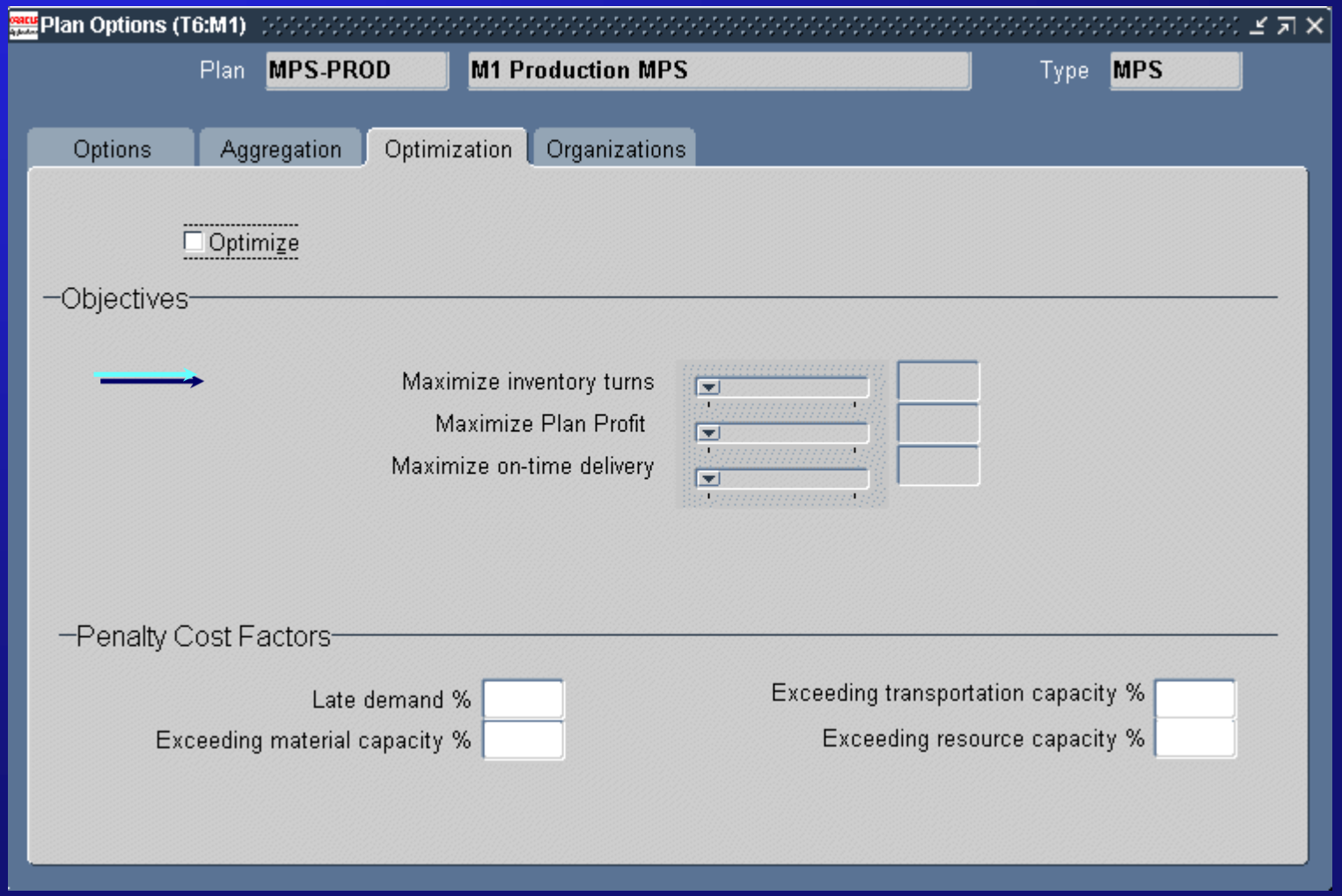
All decision variables are time-phased

APS Planning Approaches

Plan Objectives and Penalty factors

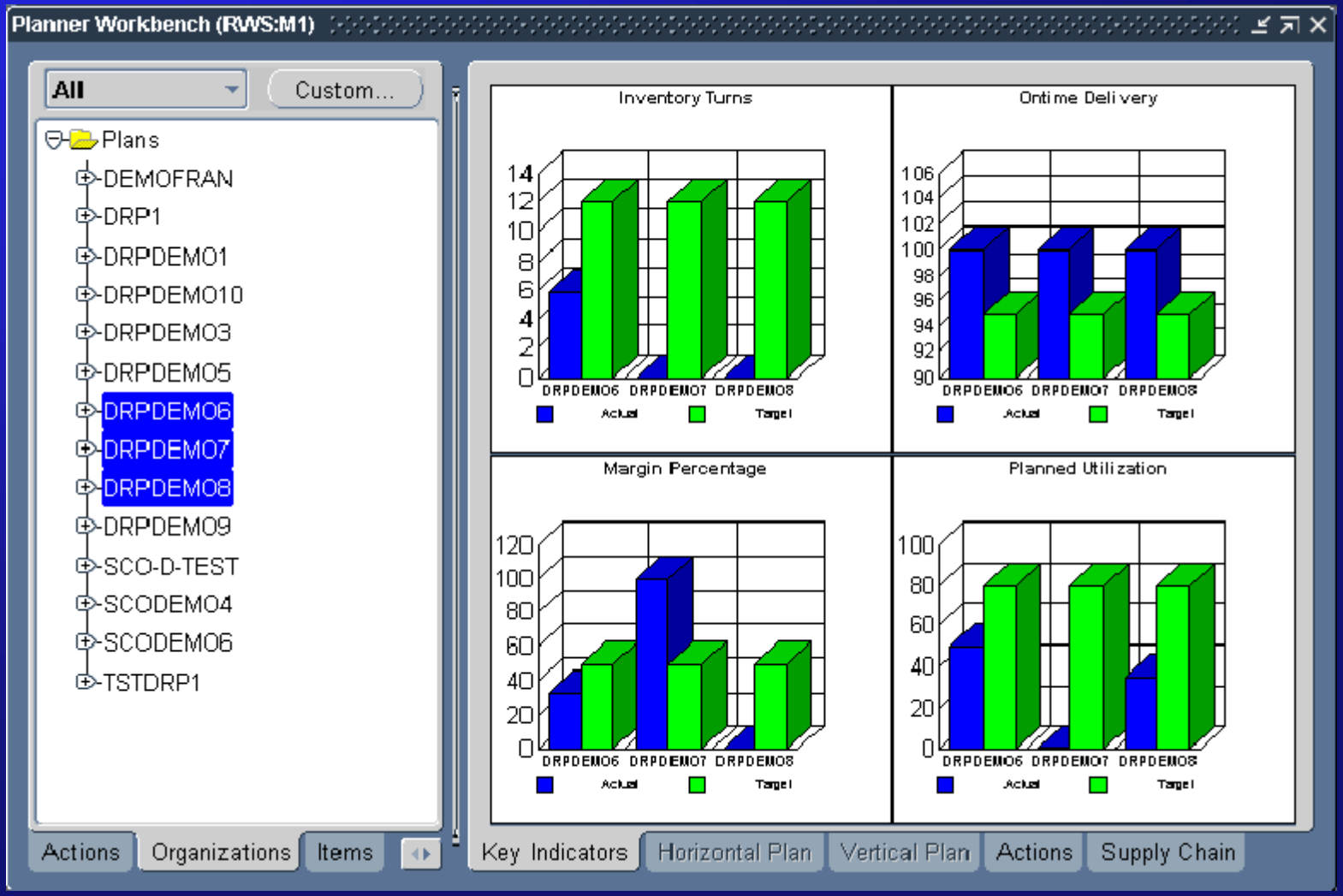
- Objectives
  - Max. inventory turns
  - Max. plan profit
  - Max. on-time delivery
- Penalty factors
  - Late demand
  - Exceeding material
  - Exceeding resource capacity
  - Exceeding transportation resource capacity

Optimization - Plan Options

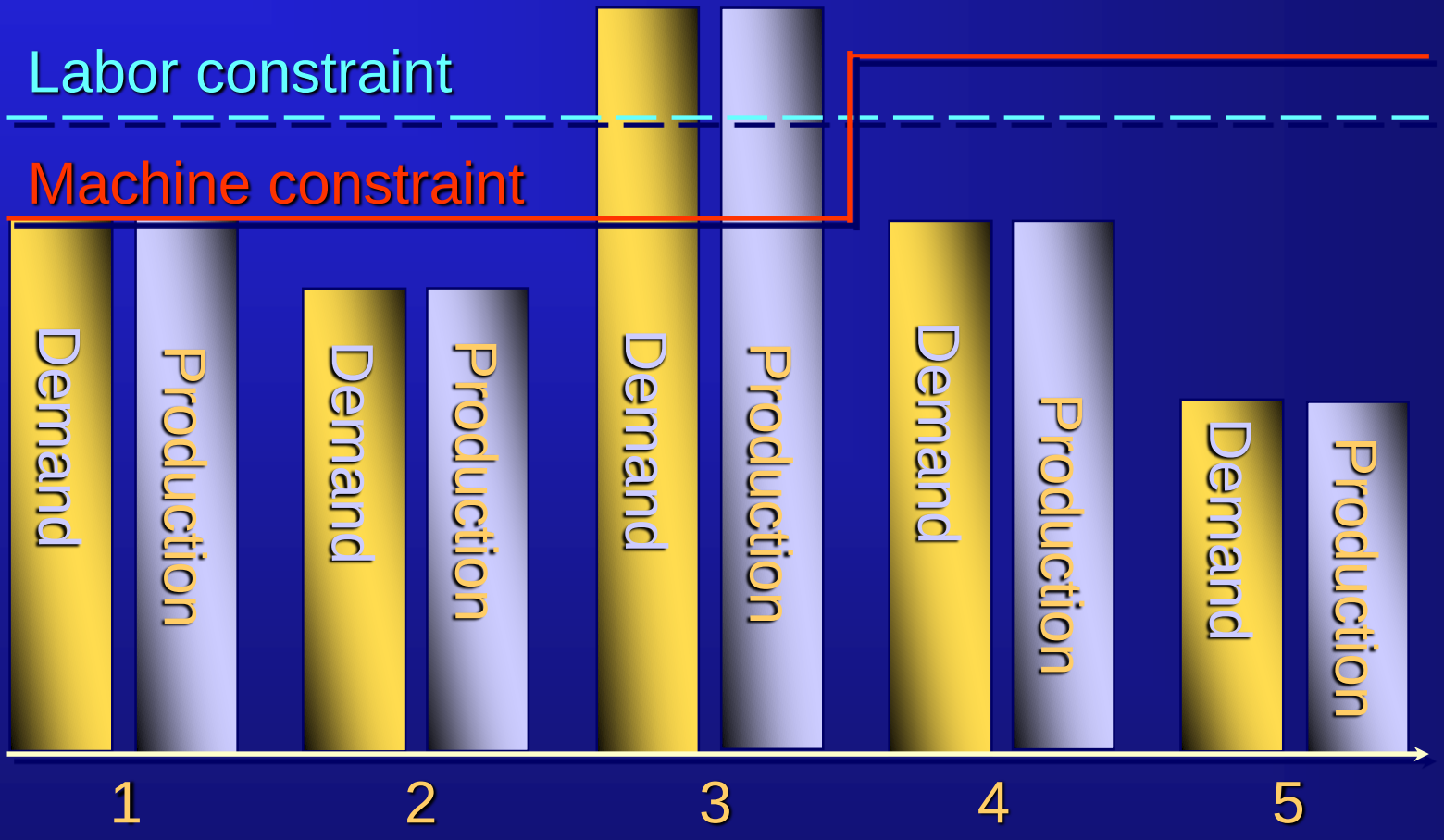


Centre for Logistics

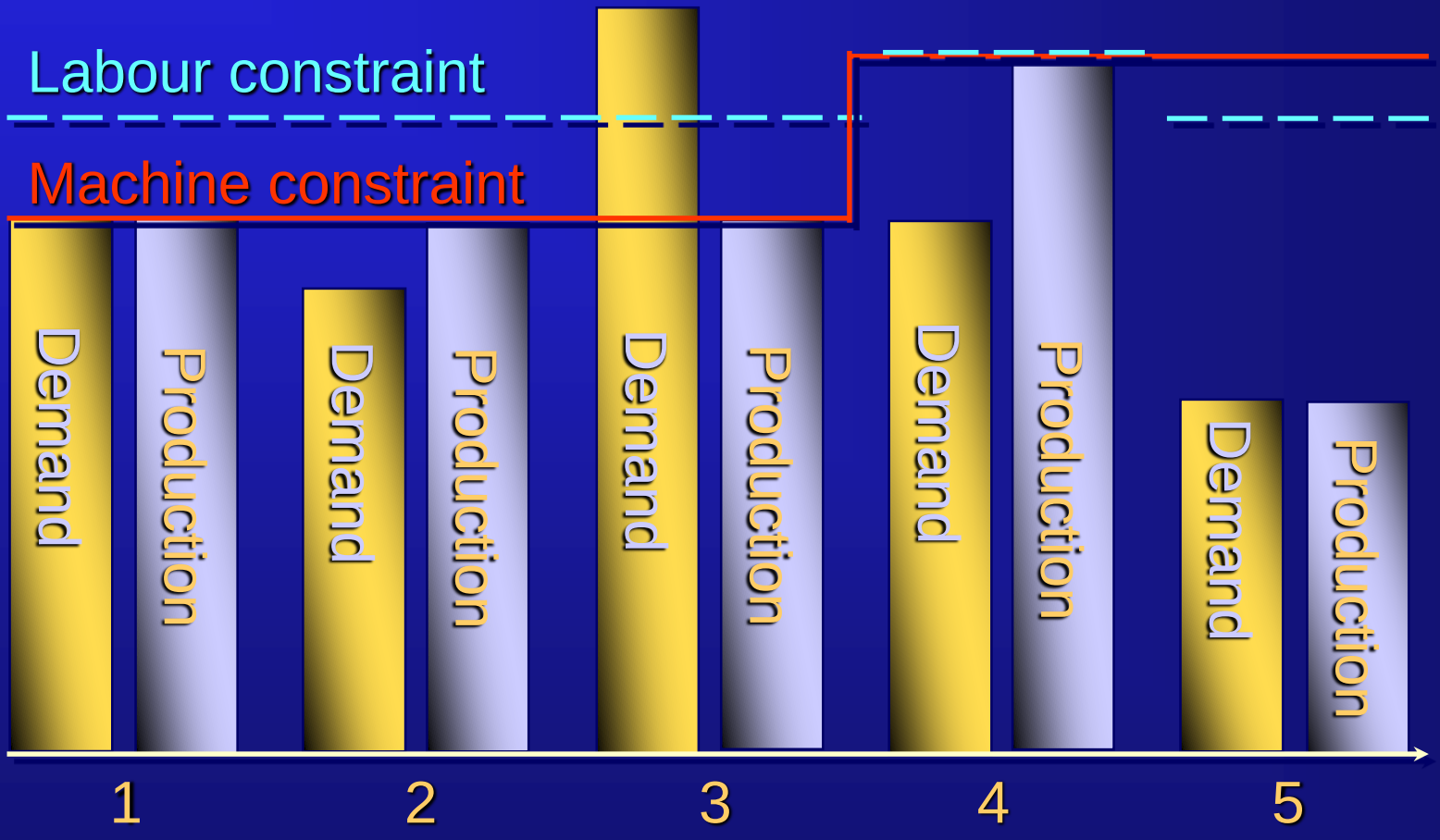
Compare KPI Targets to Plan Actuals



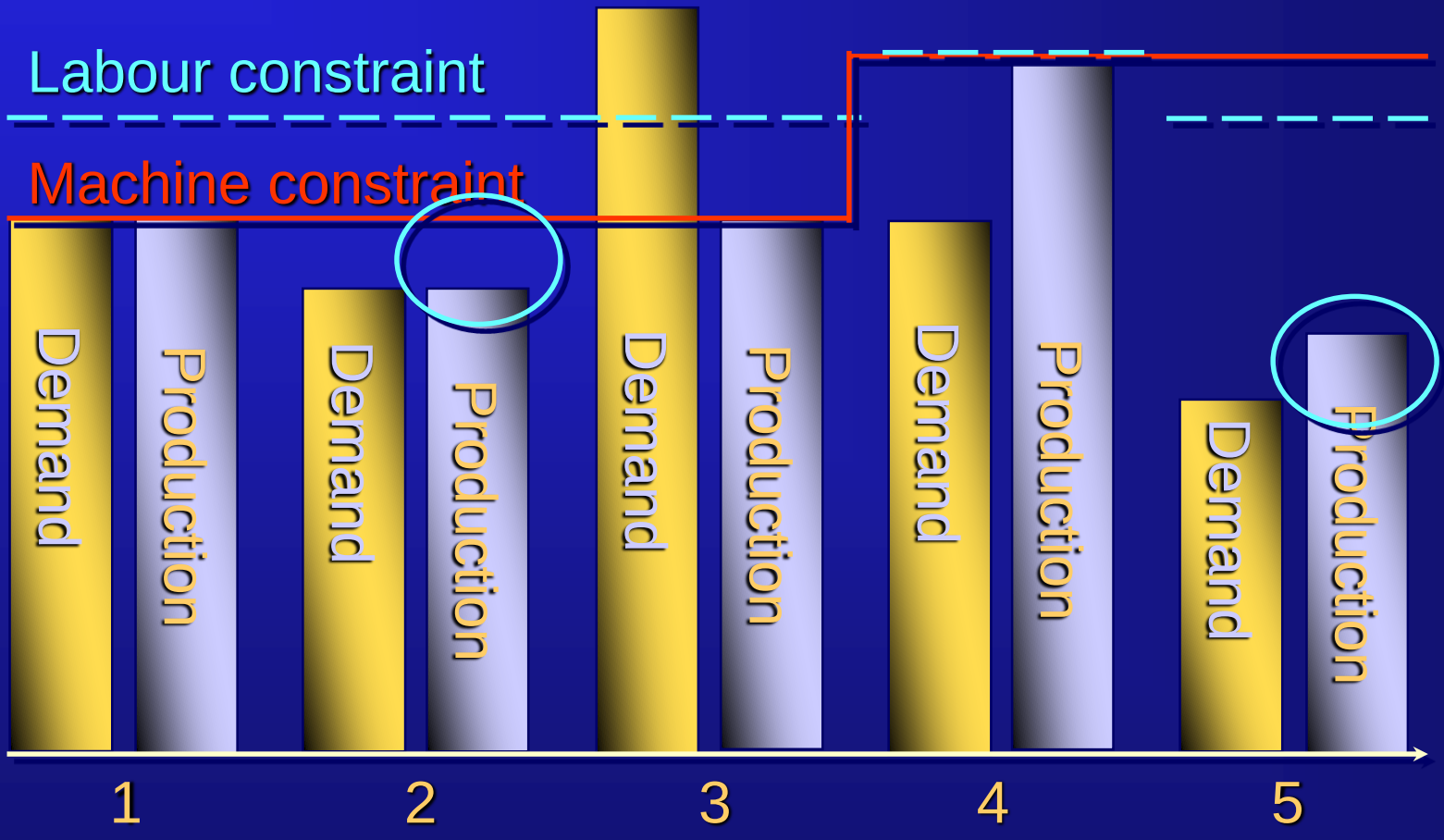
MRP/CRP


Labor constraint
Machine constraint
Demand
Production
Demand
Production
Demand
Production
Demand
Production
Demand
Production
1
2
3
4
5

Optimization—Max. On-time Delivery



Optimization—Max. Inventory Turns



Summary of APS

- "Optimal" results can be dramatically different depending on
  - Choice of hard and soft constraints
  - Penalty factor settings
  - Objective weights

- Constraint based planning and optimised planning are not based on the same decisions and assumptions.