

Introduction to the Business Game

**Aycada Capacity Pharma
2021**

Prof. Dr. Jürgen Strohhecker

Business Game Aycada Capacity Pharma...



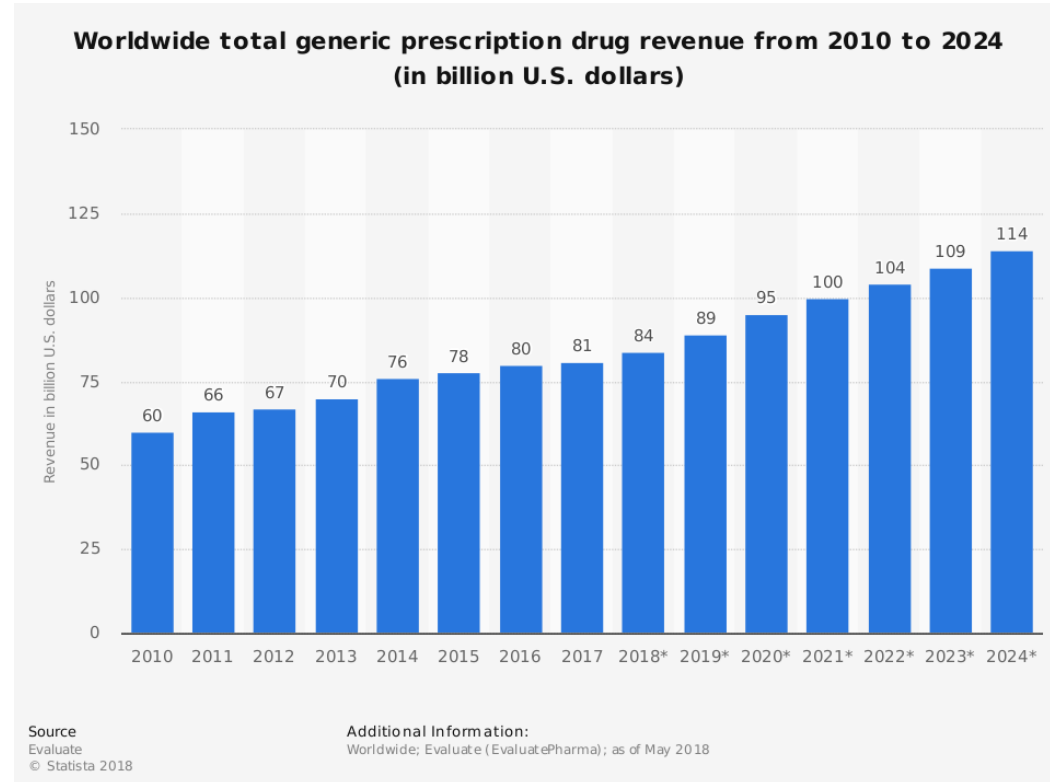
**...puts you in the perspective of a small
drug-producing pharmaceutical company**

Business Game Aycada Capacity Pharma

- **Grounded in a project conducted within a German pharmaceutical company**
- **Realistic, but still manageable case**
 - Higher complexity than textbook practice problems
 - Simplified compared to the real situation
- **Multiple pharma companies with a perfectly identical history compete on the same market for four generic drugs**
- **Limited randomness, no crisis, no shocks, no unexpected machine breakdowns etc.**
- **Success does not depend on luck but on own decisions**

Generic Drug Market Worldwide

- **Generic drugs**
 - Same active ingredient as originally branded drugs, but cheaper
 - Offered after the original's patent protection is lost
- **Increasing revenues and positive outlook**
- **Significant share of the global drug market**

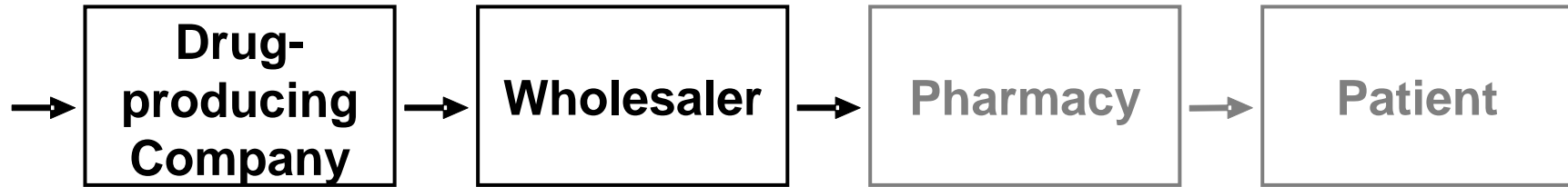


Aritir

- **Virtual land and market in the Aycada game**
- **Flexible size and population (depending on the number of active pharmaceutical companies)**
- **Highly regulated market (by ADA, Aritir Drug Association)**
 - **Prices for generic drugs are set by ADA**
 - **Restricted market access**
(number of companies between 2 and 12, does not change during the game)
- **Oligopolistic market: Decisions and actions of a company have an impact on all other companies**

Aritir (cont.)

- **Drug-producing companies sell to pharma wholesalers**



- **Bounded rational customers**
 - Do not react instantly to, need time for information processing and decision making
- **Restrictive import policy**
 - Competition from imported drugs is restricted
 - Only demand that is not filled in time is covered by imports

Focus on Four Generic Drugs

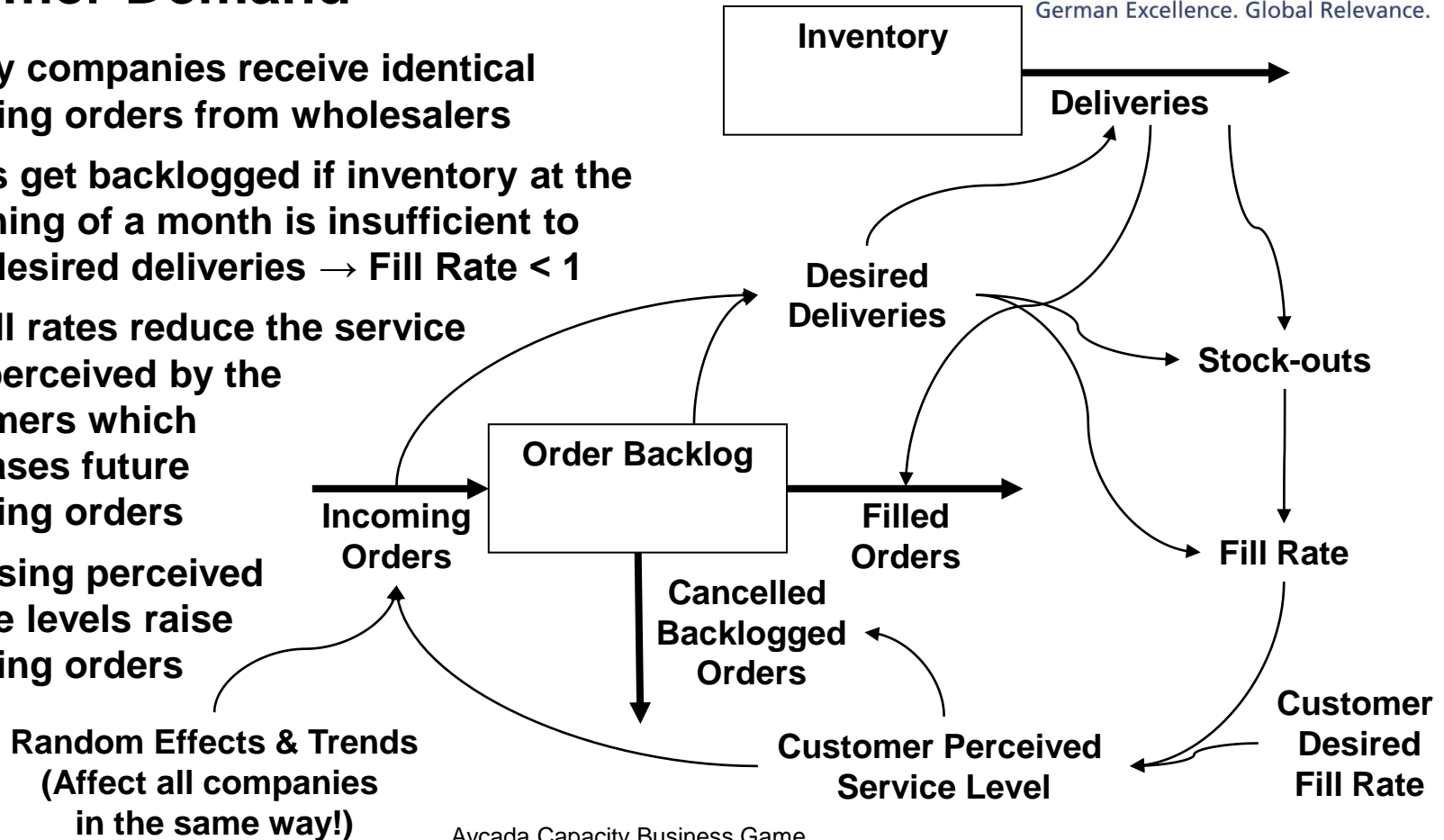
	Product 1	Product 2	Product 3	Product 4
Tablets	20	7	20	10
Blister	2	1	2	1
Leaflet	1	1	1	1
Folding box	1	1	1	1



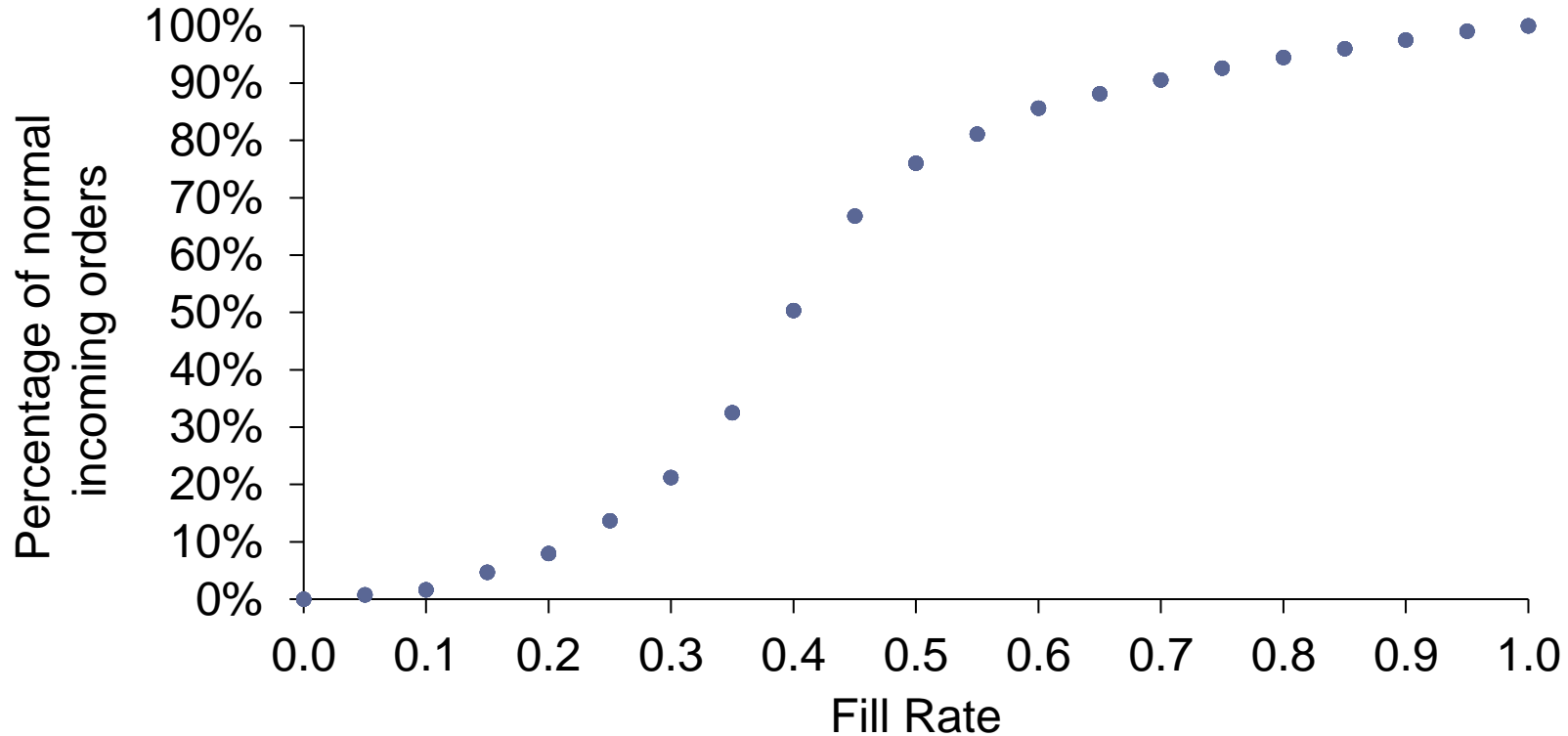
**Drugs are perfect substitutes: no difference in efficacy, brand, etc.
Only potentially differentiating factor: availability**

Customer Demand

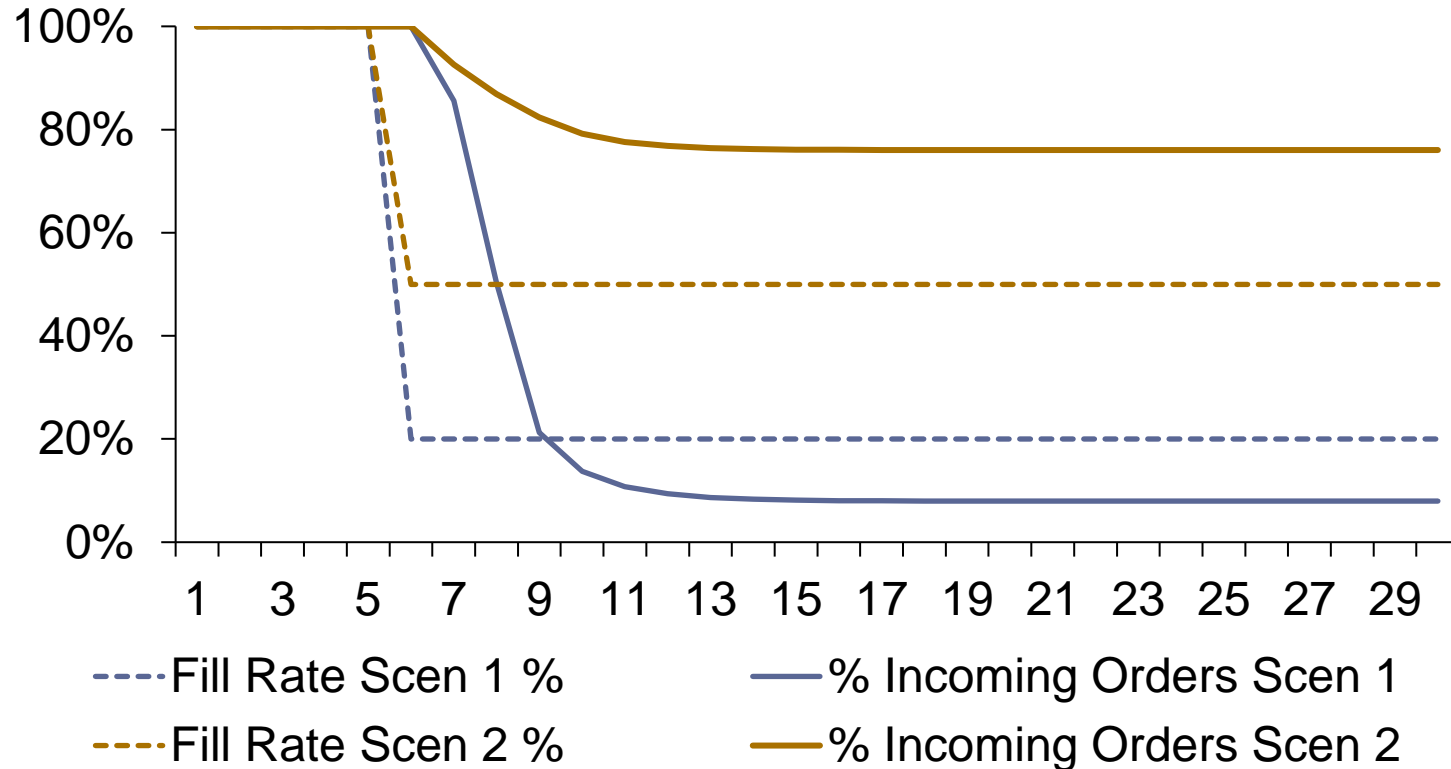
- Initially companies receive identical incoming orders from wholesalers
- Orders get backlogged if inventory at the beginning of a month is insufficient to meet desired deliveries \rightarrow Fill Rate < 1
- Low fill rates reduce the service level perceived by the customers which decreases future incoming orders
- Increasing perceived service levels raise incoming orders



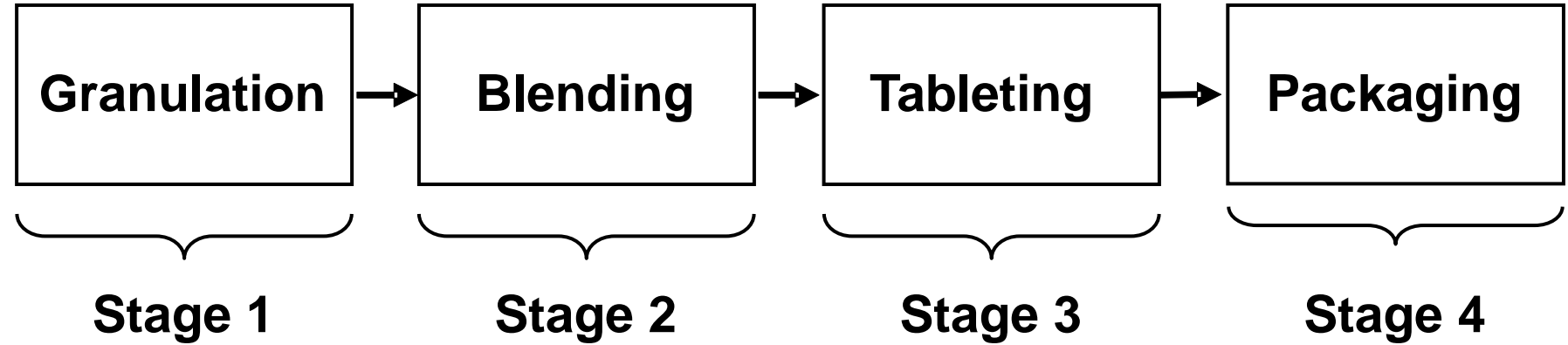
Eventual Effect of Fill Rate on Customer Demand



Dynamic Effect of Fill Rate on Customer Demand

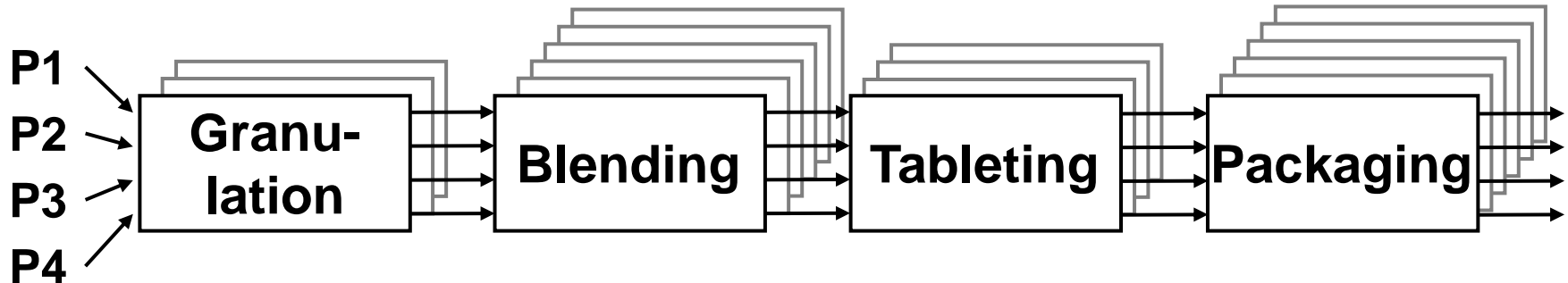


4-Stage Drug Production



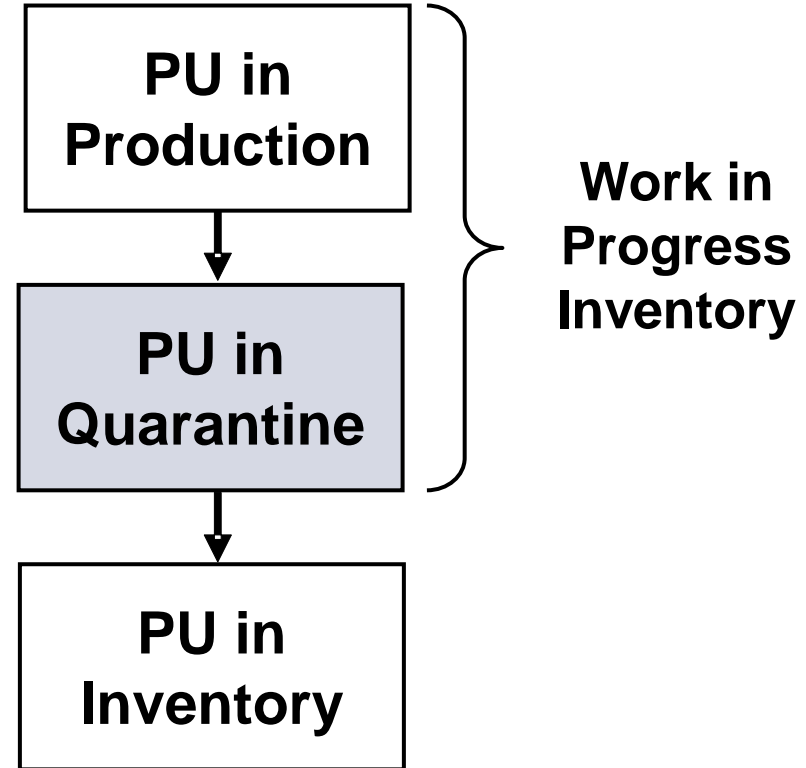
Non-dedicated Equipment

- **Multiple machines are available in each production stage**
- **In a stage, any machine can be used to produce any of the four products (no machine is specifically reserved for one product only)**



Quality Inspection

- **PU leaving production are put into quarantine first**
- **Samples are drawn and analysed in the laboratory**
- **Only if qualified persons assert in-specification quality, PU are released from quarantine, sent to inventory and can be used to fill demand**




Your Job

- **You are member of the operations management board**
- **You are appointed for a two-year term (24 month), starting in month 36**
- **Your responsibilities (predetermined):**
 - **either managing one product and one production stage**
 - **or acting as spokesman of the board**
- **You make tactical decision on production capacity and operational decisions on production quantity**
- **Your job is secure**


Monthly Board Decisions

■ Operational decisions on


Planned production quantities next month

Product 1 production quantity [PU/month]: 


250,000

Product 2 production quantity [PU/month]: 

150,000

Product 3 production quantity [PU/month]: 


100,000

Product 4 production quantity [PU/month]: 


25,000

■ Tactical decisions on


Planned production capacity

Planned production capacity of granulation [hours/month]: 


1,814

Planned production capacity of blending [hours/month]: 

2,419

Planned production capacity of tableting [hours/month]: 

2,117

Planned production capacity of packing [hours/month]: 

2,722

Objectives

Shareholders expect maximal cumulated operating income and sustainable long-term profitability. This results in the following managerial objectives:

- **Spokesman**
Maximize cumulated operating income [EUR] of the company!
- **Product Manager**
Maximize cumulated contribution margin [EUR] of the product you are responsible for!
- **Capacity Planner**
Maximize average capacity utilization [%] of the production stage you are responsible for!

Calculation of Monthly Operating Income Based on Variable Costing

Cumulated value is objective of Manager of Product 1!

	P1	P2	P3	P4
Sales price [€/PU]	2.79	4.55	10.89	28.79
- Variable cost [€/PU]	0.36	0.92	3.07	13.68
= Contribution margin [€/PU]	2.43	3.63	7.82	15.11
* Deliveries [PU/month]	300,000	187,500	100,000	61,260
= Contribution margin [€/month]	729,000	679,988	781,900	925,639
= Total contribution margin [€/month]				3,116,526
./. Fixed company costs [€/month]				1,599,000
= Operating income [€/month]				1,517,526

Cumulated value is objective of the board and the spokesman!

Calculation of the Capacity Utilization of a Production Stage

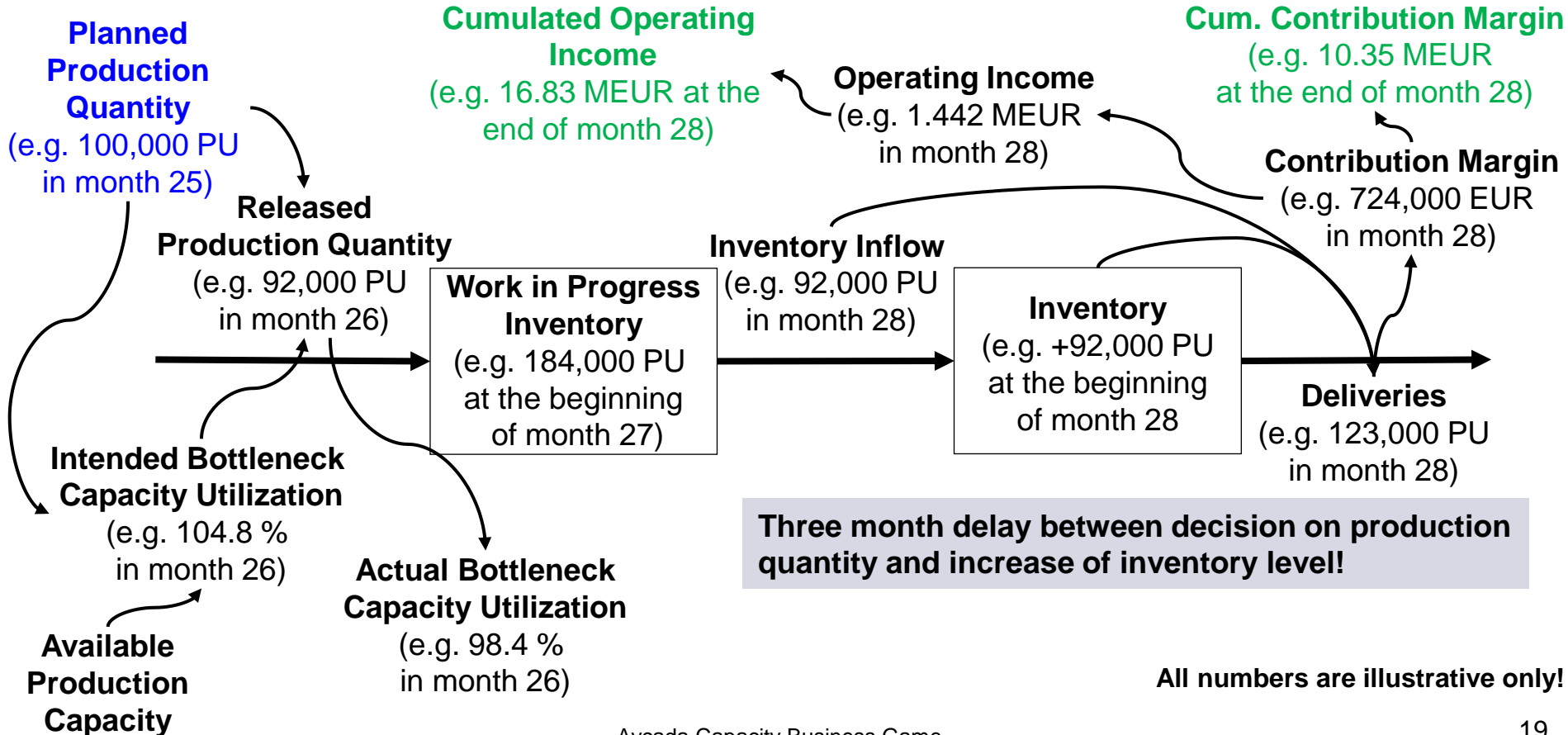
$$\text{Capacity Utilization} = \frac{\text{Workload}}{\text{Available Production Capacity}}$$

For example, the stage „Granulation“:

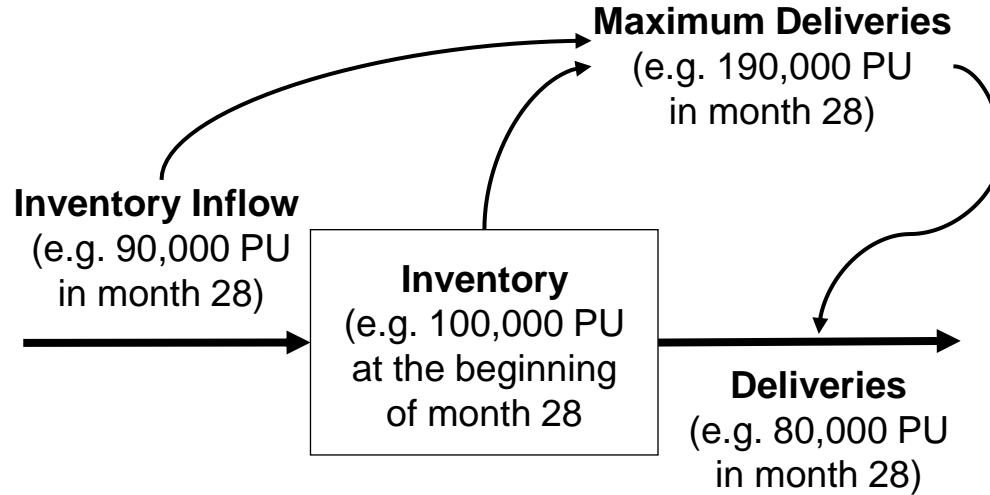
$$90.91 \% = \frac{1004 \text{ [hours/month]}}{1104 \text{ [hours/month]}} (\times 100)$$

Average capacity utilization is objective of the capacity planner of „Granulation“.

Impact of Production Quantity Decisions (Excerpt)



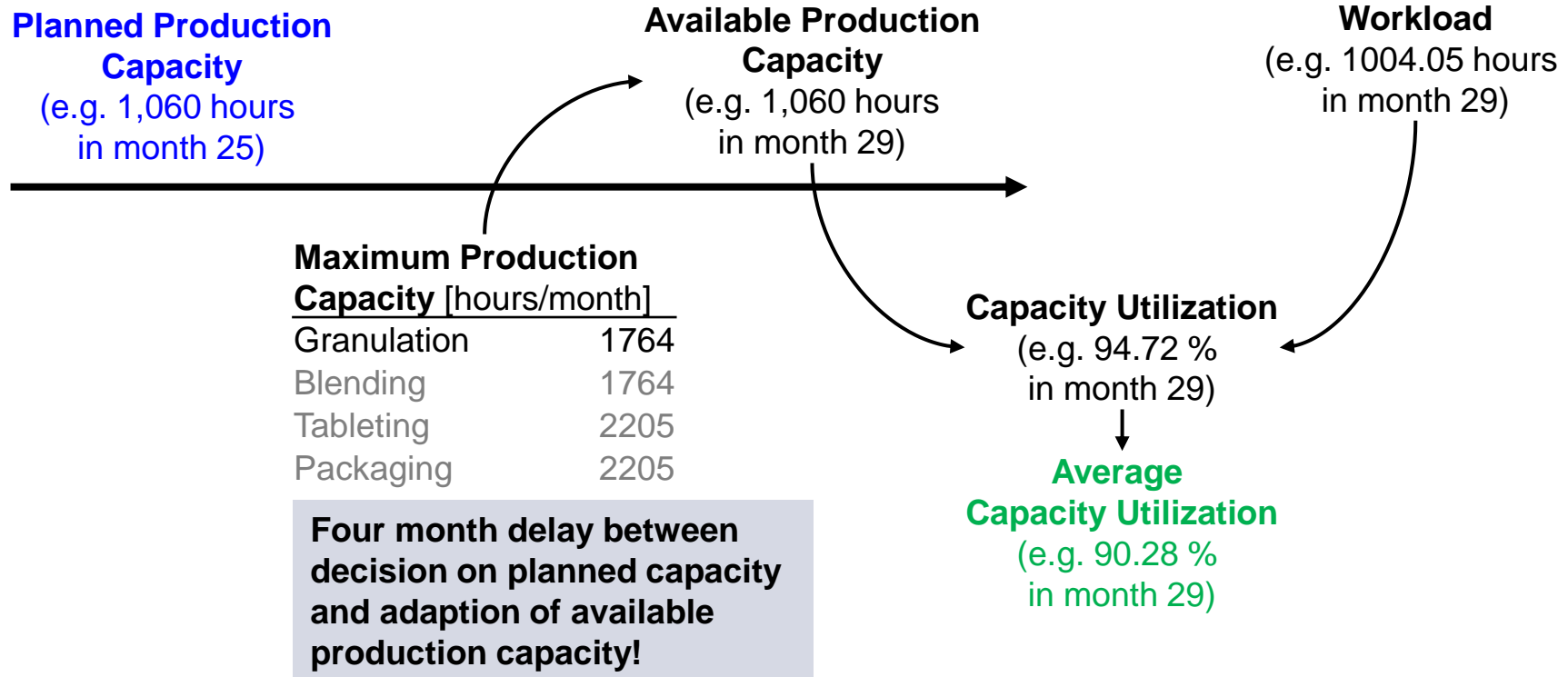
Inventory Balance and Maximum Deliveries



Inventory beginning of month 29 =
Inventory end of month 28 = Inventory beginning of month 28
+ Inventory Inflow in month 28
- Deliveries in month 28

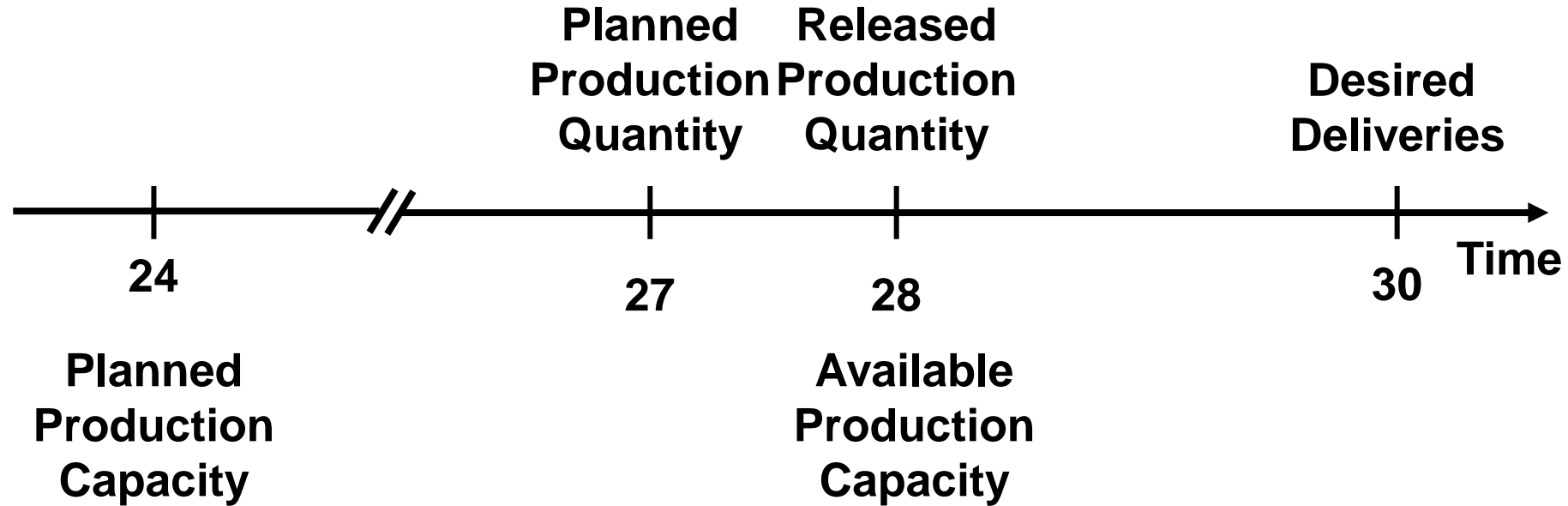
Impact of Capacity Decisions (Excerpt)

Granulation



All numbers are illustrative only!

Capacity and Production Planning Time Scale



Calculation of Workload

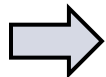
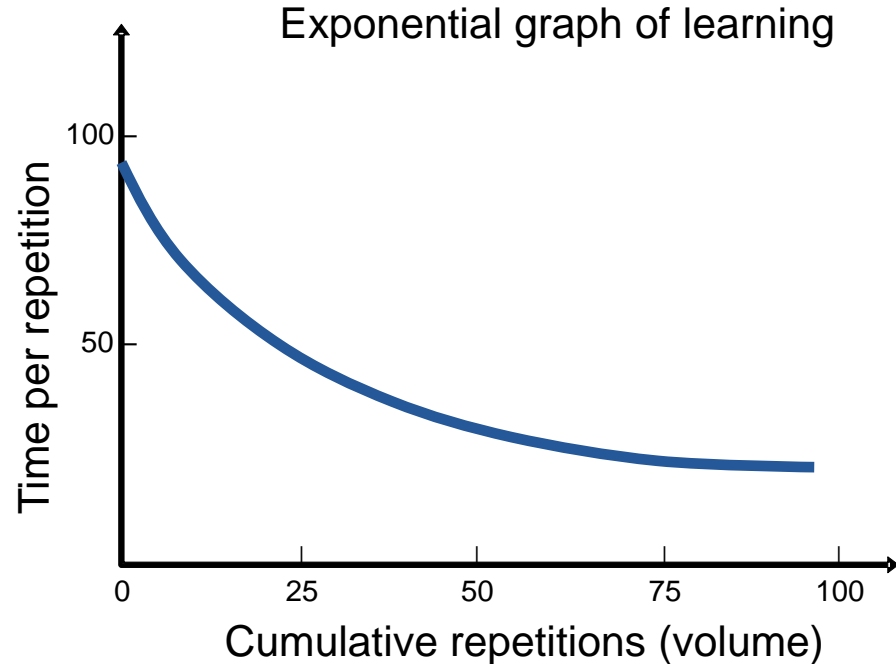
Workload = Released Production Quantity × Processing Time per PU

Numerical Example for Granulation:

Pro- duct	Released Production Quantity		Processing Time per PU		Workload
P1	300,000[PU/month]	×	0.000627[h/PU]	=	188.10[h/month]
P2	187,500[PU/month]	×	0.000840[h/PU]	=	157.50[h/month]
P3	100,000[PU/month]	×	0.002106[h/PU]	=	210.60[h/month]
P4	53,000[PU/month]	×	0.008450[h/PU]	=	447.85[h/month]
Total					1004.05[h/month]

Learning Curve Effects

- **People and organizations become better at their tasks as the tasks are repeated**
- **Time to produce a unit decreases as more units are produced**
- **Time savings per unit decreases over time**



Processing times per PU are not constant!

Order Backlog Costs

- Backlogged orders mean that service is poor: customers get the products later than desired
- As a compensation, customers receive allowances equivalent to b € per PU and month for the backlogged quantity.
- Order backlog costs [€/month] are calculated for each product as follows:

$$\text{Order Backlog [PU]} \times b[\text{€}/(\text{PU} \times \text{month})]$$

- Order backlog costs are treated as fixed costs of the sales and administration cost department

Inventory Holding Costs

- Holding a finished products inventory incurs cost.
- Inventory holding costs [€/month] are included in the fixed costs of the sales and administration cost department.
- Using an inventory cost rate of h € per PU per month, they are calculated for each product as follows:

$$\text{Average Inventory [PU]} \times h \text{ [€/(PU*/month)]}$$

where

Average Inventory=

$$\frac{\text{Inventory Start of Month [PU]} + \text{Inventory End of Month [PU]}}{2}$$

Trade-off between Inventory and Backlog

- **Higher Inventory Levels**
 - ⇒ **Higher Inventory Holding Costs**
 - ⇒ **Lower Backlogs**
 - ⇒ **Lower Backlog Costs**
 - ⇒ **Higher Future Incoming Orders**

- **Lower Inventory Levels**
 - ⇒ **Lower Inventory Holding Costs**
 - ⇒ **Higher Backlogs**
 - ⇒ **Higher Backlog Costs**
 - ⇒ **Lower Future Incoming Orders**

Cost Departments and Fixed Costs

Six cost departments

Cost Department	Fixed Other Costs* [€/month]
1000 (Purchasing)	17,640
2000 (Material)	80,100
3000 (Production)	—
4000 (Quality Control)	60,320
5000 (Sales)	180,500
6000 (Admin)	202,000

Fixed production costs depend on the Available Production Capacity!

* Inventory holding and order backlog costs not included

Calculation of Fixed Production Costs

Fixed Production Costs =

Available Production Capacity × Capacity Cost Rate per Hour

Numerical Example:

Stage	Cost Dep.	Available Production Capacity	Capacity Cost Rate per Hour	Fixed Production Costs
S1 Granulation	3100	1104.45[h/month] ×	202.05[€/h]	= 223,154[€/month]
S2 Blending	3200	1092.03[h/month] ×	136.49[€/h]	= 149,051 [€/month]
S3 Tableting	3300	1701.26[h/month] ×	101.97[€/h]	= 173,477 [€/month]
S4 Packaging	3400	1900.98[h/month] ×	255.16[€/h]	= 485,054[€/month]
			Total	1,030,737[€/month]

Trade-off between Capacity and Backlog

- **Higher Levels of Capacity**
 - ⇒ **Higher Fixed Production Costs**
 - ⇒ **Lower Backlogs**
 - ⇒ **Lower Backlog Costs**
 - ⇒ **Higher Future Incoming Orders**

- **Lower Levels of Capacity**
 - ⇒ **Lower Fixed Production Costs**
 - ⇒ **Higher Backlogs**
 - ⇒ **Higher Backlog Costs**
 - ⇒ **Lower Future Incoming Orders**

Let's start producing!