1. Calculate Exercise

1.1 Inventory Management

On Hand = Existing + Received – Picked

Available to promise=On Hand+Ordered–Reserved–Safety Stock

Order Quantity: Economic: The EOQ minimizes the total cost where Tot. Cost = Purchase cost + Ordering cost + Storage cost

Tot. Cost= D * Uc + Oc * D/Q + Q/2 * Uc * Sc

Reorder Point (RP)	$RP = D_D * LT + SS$
Quantity needed to cover during LT	$D_D * LT$
The optimum is where Storage and Order costs are equal:	$EOQ = \sqrt{\frac{2 * D * O_c}{U_c * S_c}}$
If only demand changes: so many squared daily deviations are added as many days are in LT	$SS = Z * \sqrt{LT * \sigma_D^2}$
If also LT changes: the deviation due to LT is added too	$SS = Z * \sqrt{LT * \sigma_D^2 + (D_D + \sigma_{LT})^2}$ (expressed in quantity: DD * αLT)

KPI: Inventory Turns

Inventory turns	= Costs of goods sold yearly / avg Inventory value
	= D * Uc / (Q/2 + SS) * Uc
	= D / (Q/2 + SS)
Average Stock (AS)	= (Order Quantity/2) +SS
Cost of capital	= (%-Satz)* Inventory(AS) Value

1.2 Materials Requirement Planning

1) Independent Demand of the week
2) Planned receipt 60 Demand – 40 on Stock + 10 SS (but multiple of Lot size
3) Production Order (anticipated 1 week for Lead time)

1.3 key parameters

a) **Tact Time** = Zeit vom Kunden gefordert

$$Tact\ Time\ (TT) = \frac{(My)\ Available\ Time\ for\ Production\ (sec)}{Customer\ Demand/\ Period\ (psc/day)}$$

b) **Lead Time** = Raw material through the whole product process (Durchlaufzeit, Anfang bis Ende)

$$Lead\ Time\ (LT) = \frac{Units\ in\ System}{Customer\ Demand\ /\ day}$$

$$LT = Parts\ in\ System\ (unit)\ \cdot\ Exit\ Time\ (sec/unit)$$

c) **Cycle Time** = Time passed between two products produced by the same cell. Anbieten=> *Cycle Time (CT) < Tact Time (TT)*

d) **Processing Time** = *alle CT's addieren*

1.4 OEE Graphically

Theoretical Time (TT)	-
Planned Time (PT)	→ *Planned Stoppages: non-worked hours, weekends, planed maintenance*
Running Time (RT)	→ *Downtime: breakdowns, adjustments, set-ups*
Production Time (PT)	→ *Sub performance: reduced speed, idle (ungenutzt), minor stoppages*
Good Production Time (GPT)	→ *Non quality: defects, rework, start-up & yield loss*

$$\boldsymbol{Actual\ Cycle\ Time} = \frac{Running\ Time\ (sec)}{Units\ processed\ (psc)}$$

$$\boldsymbol{Production\ Time} = Units\ Processed\ (pcs) \cdot Std\ Cycle\ Time\ (min/pcs)$$

$$\boldsymbol{Good\ Production\ Time} = Actual\ good\ Production\ (pcs) \cdot Std\ Cycle\ Time\ (min/pcs)$$

1.5 OEE (Low OEE does limit the possibly output)

$$\boldsymbol{OEE} = Availability\ \cdot Performance\ \cdot Quality\ Ratio$$

$$a)\ \boldsymbol{Availability} = \frac{Running\ Time}{Planned\ Time}$$

(or. e.g.: 100% - 9% Breakdowns = 91% Availability)

$$b)\ \boldsymbol{Performance} = \frac{Production\ Time}{Running\ Time}$$

$$(\text{or e. g.: } \frac{1}{1.06} = 94{,}3\%\ (6\%\ \text{longer process than expected})$$

$$c)\ \boldsymbol{Quality} = \frac{Actual\ good\ Production\ \cdot Std\ Cycle\ Time}{Units\ processed\ \cdot Std\ Cycle\ Time} = \frac{Good\ Production\ Time}{Production\ Time}$$

$$(or.\ e.g.: \frac{1m - 2500}{1m} = 99{,}75\%\ (if\ 2500ppm\ defective\ parts)$$

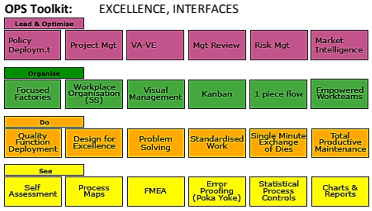
$$\boldsymbol{Real\ Produced\ Parts} = \text{should produced Parts} \cdot OEE$$

$$\boldsymbol{Defective\ Units} = Real\ Poduced\ Parts \cdot (\frac{1}{c)\ Quality} - 1)$$

$$\boldsymbol{OEE}\ (\%) = \frac{Std\ Cycle\ Time}{Actual\ Cycle\ Time}\ ?$$

1. Week, Introduction, Main Subjects, OPS Toolkit

Main Subjects: PRODUCTION, LOGISTICS, PURCHASING,
OPS Toolkit: EXCELLENCE, INTERFACES



We must "manufacture" a future..., all together, not just one: Technology, Economy, Environment, Society

Deming: PDCA Wheel: PLAN, DO, CHECK, ACT

Types of "Goods" in the Supply Chain / 4 categories of inventory: Raw Materials, Components, Semi-finished goods, Finished goods, By-products, Consumables, Trading goods, Services, Information

6 "rights" of Logistics:	Types of Logistics
" The right GOODS	Inbound Logistics
" In the right QUANTITY	Production Logistics
" At the right TIME	Outbound Logistics
" At the right PLACE	Disposal & Recycling Logistics
" In the right CONDITION	=> outsource: if it is cheaper.
" At the right COST	

Conformity: assurance to customers, to fulfil is requirements →ISO
EFQM was defined to help companies perform better – it is about "excellences

2. Week, Excellence, ABC, Kaizen,

Our Definition: Business Excellence is...:
To strive for perfection every day "being the best you can be"
Not just fulfilling, but even anticipating the needs of Stakeholder
7S Model: ***Hard Factors***
Strategy:the plan on how to build competitive advantage and grow
Structure: the physical and logical organization and reporting lines
Systems: the processes followed to get the daily job done
Soft Factors (4 stk.)
Shared Values: the core values of the company (vision, culture, ...)
Style: the leadership style ; Staff: the human capital
Skills: the competencies
The ABC chart => (Article Cube = 3 Dimensions for 3 strategies)
A) 10÷20% of items cover 70÷80% of the analysed phenomenon
B) 20÷30% of items cover the following 20÷15%
C) 70÷50% of items cover the last 10÷5%
Quality Policy: Documents which express the quality objectives.
Hoshin Kanri => Policy Mgmt.=> set action plan and its direction.
Kaizen or Continuous Improvement "Kai" = Change "Zen"= Good!
1. It is the task of everybody to improve; 2. Problems are an opportunity for improvement; 3. All ideas are equally valuable (until proven different); 4. All participants are equally valuable; 5. Base action on facts (collect and analyse data first); 6. Managers must motivate and lead in first person the Kaizen; 7. Teamwork and employee motivation are powerful tools
Self-assessment: know yourself before improving=> Goal;
Version 1: Simple Answers; Version 2: Adding more precision; Version 3: Asking specific questions. Provides an initial overview.
Balanced Scorecard: Example of KPI

Financials	Internal Processes
- Sales growth - EBIT% - Return on Capital - Share value	- Capacity utilisation - Delivery time - Cost of non quality - Days without accidents
Customer	**Learning & Growth**
- Market share - Account coverage rate - Success rate, deals - Face to face time w. Cust.	- Sales share of new prodct - R&D Expense % on Sales - Training hours/ employee - Employees suggestions

3. Week, Sales, In & Outbound Logistics, ISO9001 and Sales:

ISO9001 and Sales: Customer focus; Customer satisfaction; Determination of requirements related to the product; Review of requirements related to the product; Customer communication; Customer property
Go beyond: Know your Customer's Customers => NPS: Net promoter Score: measure costumer satisfact.

Inbound Logistics	Outbound logistics
The activities of calling deliveries from suppliers, receiving, controlling, storing, and distributing internally the incoming goods for use in production	The activities of scheduling, picking, packing, labelling and shipping the finished goods ordered by clients, triggering the billing

In- & Outbound Logistic main activities: Logistic Standard, Planing, Execution, Monitoring Air, Sea, Rail and Road Transportation
ISO9001 and Logistics
Determination of requirements related to the product; Identification and traceability; Preservation of product
Obsolete Parts: Stored but never "moved" parts → hidden cost
Customer Activity Cycle: To understand customer behaviour better
QFD: Quality function deployment: To capture costumers needs.

4. Week, KPI, Inventory

Customer KPI
- Respect of Quality
- Cost reductions
- Delivery performance
- After-sales support

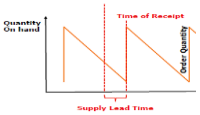
} Q C D traditional Customer KPIs

- New ideas/ innovation

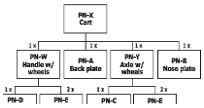
} additional Customer KPIs

- ...! You better monitor the same KPIs, like you costumers

Inventory types and their drivers
1. Transit stock: materials go through transformation steps before becoming sellable finished goods (fill the pipeline)
2. Smoothing stock: mismatch betw. demand and capacity (e.g. stock produced on weekends, because weekly capacity is too low)
3. Cycle stock: mismatch betw. process and demand volumes (e.g. batch production processes create spikes in stock)
4. Safety stock: uncertainties in customers' demand pattern as well in supply chain lead times require some "protection"
5. Hedging stock: valuable goods subject to significant price swings (e.g. Copper) may be bought in excess when prices are low



Supply Lead Time:
Definition: "Time needed between order and receipt in inventory"
Bill of Materials (BoM)
The "Bill of Materials" tells the components, their number and their assembly sequence. It is defined by Design Engineering.



BoM explosion: from a part to all its raw materials and external components (all internal sub-assemblies do not show)
BoM implosion: from a part to all finished goods that contains it.
Product Traceability: To identify, where & when a product was produced & with which components, coming from which supplier
Fishbone Diagram = Ishikawa = Cause-and-effect-diagram → What is the Problem? Machine, Man, Methods or Material?

5. Week , Customer Complaints, Materials Requirement Planning

(CCS) Customer Complaints System
Learning opportunity, customer voice, improve own products
CCS is twice relevant: on the Customer and on the Suppliers side!

Reactive approach	Pro-active approach
Manage (suffer) customer complaints Analyse failure data Corrective actions	Capture customers' voice Benchmark (competitors+best in class) Reinvent customer service

Corrective Action Request (CAR) or 8D Report
Captures the key information:
- From problem definition; - To closing of the case, actions for effectiveness

Independent Demand
- Quantity and due dates for Finished Products and Spare parts
- Defined by customer orders or Sales forecasts

Dependent Demand
- Quantity and due dates for all Intermediate products and for Purchased components/ Raw materials
- Calculated by fully exploding the Bill of Materials top-down

(MRP) Material Requirement Plan: to do before: enough people, workload not over 100% capacity

Orders
- Production or Purchase orders (or transfers from warehouse to warehouse) issued to replenish stock and satisfy Demand

Pegging
To enable a better allocation of inventory, sophisticated **MRP**s are able to link the orders generated to the original independent demand. The Materials planner can follow better and take decisions if demand changes.
To execute **(MRP) Manufacturing Resource Planning** we need: => Lead Time, Safety Stock, Lot Size (Achtung 2 versch. MRP's)

6. Week, Development process, SPC, Design, FMEA, R&D Ass.

Main process in R&D: 1. R&D Strategy, **2.** Product concept; 3. Product Design & Testing; **4.** New product introduction, **5.** Product Lifecycle Mgmt.
Product Development process
ISO9001: Design and development planning & Inputs & outputs
ISO9001: Reviews, Verification, Validation, Control of design & dev.pmt changes => Following the markets changes & listen to the customer to identify new ideas and take it through development.
State-Gate: separates project phases at critical points. (Stop/GO)
(SPC) Statistics Process Controls
C_{pk} index: It indicates in one number how well the process remains within its tolerance limits:

$$C_{pk} = \min\left[\frac{UTL - \mu}{3\sigma}, \frac{\mu - LTL}{3\sigma}\right]$$

Six Sigma: =>Six Sigma projects are systematically launched
Six Sigma = 6σ = Perfection = 0.002ppm are wrong = C_{pk} of 2
Design for Excellence:
Design for... the Product, Production, Time of Use, End of Life
(FMEA) Failure Mode Effect Analysis:
- Severity rating (1-10):
- Occurrence rating (1-10):
- Detection rating (1-10):

} Risk Priority Number (RPN) (Severity * Occurrence * Detection)

Conflicting goals: das Dreieck: Scope, Cost, Time (Mitte: Quality)
APQP = Adequate Product Quality Planning: To get early attention to quality during development/design, anticipate possible issues. Important to anticipate all possible issues during Design.

7. Week, Purchasing processes, Excellence in Purchasing:

Purchasing = (54% of tot. Cost) (also Procurement or Supply) enables the company to receive the required goods and services at the right prices
Purchasing Process: Source Planning, Demand Definition, Fulfilment, Supplier Mgmt.
Buyer = Buys all categories; Category Specialist = specific category; Lead Buyer = given category coordinated from 1 location for all
3-Way Check: Who?: Purchasing, receiving, account payable
Purchasing and Improvement:
- It is evident that an improvement in the purchasing cost base has a major effect on EBIT
- More than an improvement in Production or other Departments!
- Effective Purchasing is a "source" of EBIT

Excellence in Purchasing:
1. Purchase globally: higher complexity & risks
2. Better market intelligence: find new suppliers
3. Better communication within the company
4. Identify and leverage innovation opportunities
5. Protect company know-how (IP)

Supplier Score has huge implications
=> Having the best possible supplier is obviously vital for a firm
4 of purchasing matrix: Leverage, Routine, Bottleneck, Strategic

8. Week, Waste, Marekt Intelligence, Toyota, Five S

("Muda") The 7 types of Waste
1) Excess production (Manufacturing parts in excess of customer)
2) Motion (Unnecessary worker/ machine moves)
3) Waiting (Machines/ people idle instead of processing)
4) Conveyance (Transporting further than necessary)
5) Overprocessing (Performing add. work not normally necessary)
6) Inventory Keeping inventory (which freezes cash)
7) Defective production (Rejects, reworks, deviation)

Market Intelligence: (Have Information how the market works)
- Primary sources: Own experience, direct contacts ; Questionnaires, Surveys ; Request for Quotations, Product tests; Site visits
- Secondary sources: - Annual reports, Website, Marketing publications - Intelligence reports of market Research institutes and Banks; - Business Databases; - Literature, magazines

=>Know How about: Suppliers, Competitors, Clients
Market Intelligence Report: (you can benchmark w. competitors)
1) Executive Summary; 2) The Company; 3) Market & Products; 4) Financials; 5) Company assessment; 6) Attachments
Legal compliance: (Warranty)
an express warranty (contractual specification)
an implied warranty of quality, feature or "fitness" for a specific purpose, as commonly expected for such products
Product liability: Design & Manufacturing defects, failure to warn.
What is Production? Definition:
The processes and methods used to transform tangible inputs (raw materials, semi-finished goods, subassemblies) and intangible inputs (ideas, information, knowledge) into goods or services.
Model T (Modern Times): (Simple, solid, cheap,) started in 1908; the assembly line gave the timing to all workers; they were unskilled, performing repetitively few activities
Production types: 4 Basic ProductionTypes

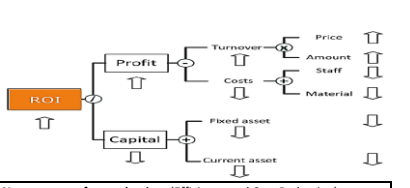
Production	Volumes	Product variability	Equipment Flexibility	Examples
Job shop	1 piece to very few	Highest (custom)	highest	Toolmaking
Batch/ Group	medium	high	mid	Metal parts workshop
Flow	high	few variants	limited	Car assembly
Continuous	highest	minimal to none	almost none	Paper mill

The 2 Evils for Production: Demand Variations & Waste (Costs)
Internal Variations: due to rework for defective parts, breakdowns
External variations: all changes applied by member supply chain.
(TPS) Toyota Production System (a production revolution)
Improvement of production chain continuous elimination of waste, fluctuation & inflexibility, value generation for customer, employee, society&community. A diff. Culture as in West-World:
- Management decisions are long-term oriented
- At the forefront lies the company's future
- Company is a vehicle to generate value for Customers, Society

No zero, but minimized & controlled inventories!
The Toyota Way: 4 P's:
1. Long-term Philosophy (Base your management decisions)
2. Right Processes (Eliminate non-value adding activities)
3. Develop People (respect, be demanding and encourage)
4. Problem Solving (continuous improvement and learning)

Traditional approach	The Toyota way
People make mistakes	Processes cause errors
Single employee is responsible for errors	All employees are responsible for errors
Product quality is tested at the end of production	Quality starts from the beginning
Objective = Improvement of efficiency	Objective = Competitive advantage through quality
Zero errors are not achievable	Zero errors is the objective
Purchase from many suppliers	Partner with few suppliers
Customers have to accept the quality level offered	Customer satisfaction is key

New concepts for production: (Efficiency and Cost Reduction)
1) Only high quality products, no waste
2) Use levelled, stable production processes
3) Produce only the amount necessary now (quantity orders)
4) Produce Just-In-Time



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5 "S" Workplace organisation:
1) Sort. Separate the necessary from the unnecessary;
2) Set in order. Put tools and material in a set place and keep in order
3) Shine. Keep the workplace clean, problems are avoided,easily spot
4) Standardise. Define working standards. Deviations are easily seen
5) Sustain. Adhere with discipline to standardized work procedures
Five types of resistance to Workplace Organisation
1. Why clean when it just gets dirty again?
2. Implementing 5S will not boost production
3. My workplace is a mess, but I know my way around it
4. We're too busy to spend time on this "nice to have" program
5. We don't need 5S, we make money, let us focus on our real work

9. Week, Inside a Plant, Workcell, Cell design, 1 Piece flow, Kanban

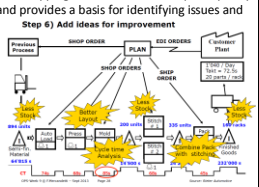
Production levelling: Reduce cell, Level Cycle Time for each single work cell to match given Takt Time, Small batch sizes to avoid overproduction, Frequent change of model mix on a given line

N_B = Number of Boxes needed
LT = Lead Time for delivery of a Box (sec)
D_D = Demand of Parts (units / sec)
SS% = Safety margin (additional stock desired)
Q_B = Units per Box

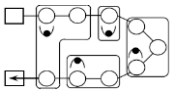
Kanban (PULL): reduces amount of stock between work stations, no stockout Picking small quantity from supermarket rack, with two kanban card (production, withdrawal)= Order from the customers

$$N_B = \frac{LT * D_D * (1 + SS\%)}{Q_B}$$

(VSM) Value Stream Map: Learn to see potential for improvement, Mapping the value stream helps to quickly view the flow of goods and provides a basis for identifying issues and improving processes
Bottleneck, what to do?: Balance them to Takt time. more people/machines/shifts , offload bottleneck, use alternative existing resources, reduce setup-downtime, =>- Reduce Waste, not just increase efficiency of work steps



One Piece Flow:
- One by one production
- Levelled production
- No stock in between



U-Cell: 1 piece flow, reduced handling, high visibility, easy self-check, Multi-skilled operators. Improve communication.
Just in Time: Design Flow Process, Balance workstation capacities; Levelled schedules; Work with Vendors, Reduce lead times, Frequent deliveries, Kanban pull, Small lot sizes, Operator self-control.

10. Week, VA/EV, Improve, SMED, Poka Yoke, Assemble to Order

Value Engineering EV: creates the products with value in mind, designing "out" all unnecessary steps/ parts, optimizing engineering and manufacturing before expenditure is done
Value Analysis VA: continuous improvement of current products, systems & processes. Eliminates non-value adding elements.
Both: cost reduction, Maintaining or improving Value to Customers.
Improve a Workcell: 1. Document current state: Cycle diagram; Chase Waste; Redesign Cycles, Current: 2 Machines + 2 Operators, Future: only 1 multi-skilled Operator, Redesign Cells, Reduce batch size, 2. Work on Bottlenecks, 3. Implement "Pull"; Be flexible; Every Part Every x **(EPEx)**; When Changeover time is high; FIFO Lanes; 4. Going to one piece flow; 5. Production continuum; 6. Ideas for improvement
SMED: (Single Minute Exchange of Dies) Between different production batches often dies and fixtures must be changed, with teams of operators and maintenance at work, but keep machines until ready again
Poka-Yoke: (Target "Zero-Defects" - Prevent Errors) Implementing simple, low-cost devices that either detect abnormal situations before they occur, or once they occur, stop the line to prevent defects.
Assemble to Order: Producing based on forecasts increases the risk to have too much (or the wrong products) on stock. The earlier the value chain is penetrated by customer orders the better: one produces what and when the customer wants, stocks are minimised.
Focused Factories: An organisational approach that splits a plant into smaller, logical units, focused customer and designed lean principles. => Responsibility to the shop floor.
SAWT: (Semi Autonomous Work Teams), Self-control of product quality, Filling of Production, Checking inventory levels, Proposing improve.
Jidoka: is the ability of production lines to be stopped in the event of such problems as equipment malfunction, →Zero defects.
Standardized Work: Visibly documenting how the work activities have to take place in a production cell (process), help newcomers
Visual Management: Let the workplace talk to you (simple signals)

11. Week, QM, Kaizen, Safety & Enviroment

Quality management & certification: The Quality organisation is a "service" to the company => Pushes the company to Excellence.
1. Q-Mgt System, Control of Documents, Control of Records
Auditor: External, Internal, Costumer, Certification steps 6m to 1.5 yrs
Kaizen: A Continuous improvement initiative is a significant project that should involve the whole of a company. - Name and the focus can differ widely, but the objective is always the same: the "Search for Excellence". Many steps for the whole company, not only production.
(TPM) Total Productive Maintenance: Maintain the machine before it breaks down, not because => 1. Breakdowns minimize, 2. Setup & Adjustments minimize, 3. Production Rejects, pareto syndrome, 4. Start-up, controlling, 5. Slowdowns, to see the problems. 6. Stoppages, Observe what is happening.
Safety & Environment:
1. Unsafe Conditions: (Technical improvements needed)
2. Unsafe Actions: (wrongdoing of people) => Modify Behaviours.

Safety Risk Management: Safety awareness, Safety expert => MGI
Sustainability: Sustainable development must meet our present needs without compromising the ability of future generations to meet their own needs. Ecological Footprint of a Company

12. Week, Scheduling production, Production Cost Accounting

Priority setting if capacity is short (ex. First in First out)
The key financial statements:
Profit & Loss statement: all costs and profits cumulated
Balance sheet: The photograph of all accounts at a given time
Cash flow statement: All cash movements (in & out) of the company
Activity Based Costing: Distortions due to traditional Cost Accounting techniques can be corrected by more accurately representing the reality in the CA system

13. Week, Scheduling production, Production Cost Accounting

Charts & Reports: There must be a clear message, Readability must
Management Review: Whatever you use must be... SMART, pick the right measures for what you want to improve, Operational KPI's.
Move to East: Cost advantages, Entry in new growing Markets, Higher flexibility in supply, Reduction of shortfalls in capacity