Summary

Operations Management [OPS]

Hochschule Luzern – Technik und Architektur
Wirtschaftsingenieur | Innovation

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Content

1 Week 1: Introduction

Operations Management - Definition

Operations Management deals with the design and management of products, processes, services and supply chains. It includes the acquisition, development, and utilization of resources that firms need to deliver the goods and services their clients want.

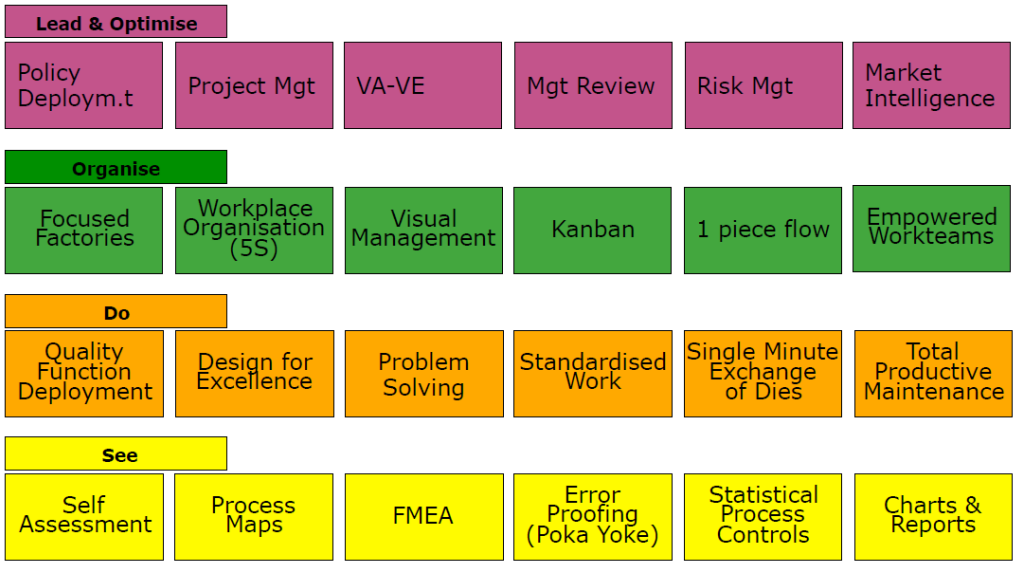
OM ranges from strategic to tactical and operational levels:

- **Strategic** issues include determining the size and location of manufacturing plants, deciding the structure of service or networks, and designing technology supply chains
- **Tactical** issues include plant layout and structure, project management methods, and equipment selection and replacement
- **Operational** issues include production scheduling and control, inventory management, quality control and inspection, traffic and materials handling, and equipment maintenance

Main Subjects of Operations Management:

- Production
- Logistics
- Purchasing
- Excellence
- Interfaces

OPS Toolkit



1.1 Manufacturing

What really differentiated mankind was **"Homo Faber"**. "Homo Faber" has the faculty to create artificial objects, in particular tools to make tools, and to indefinitely vary its makings.
➔ We were able to create, to build, to produce things that helped producing other things.

1.1.1 Inventions and Industrial revolution

The invention of Tools, their use to produce goods, their interlinked reuse to create new tools made possible the development of our civilisation.
Reason: desire to be ahead of others (e.g. space race), to conquer others → most of (or at least 50%) by military application

Innovation pace: exponential

Developments in a very speedy, fast-changing world → developments today may be old in one year!

1.1.2 Unprecedented Wealth on global scale

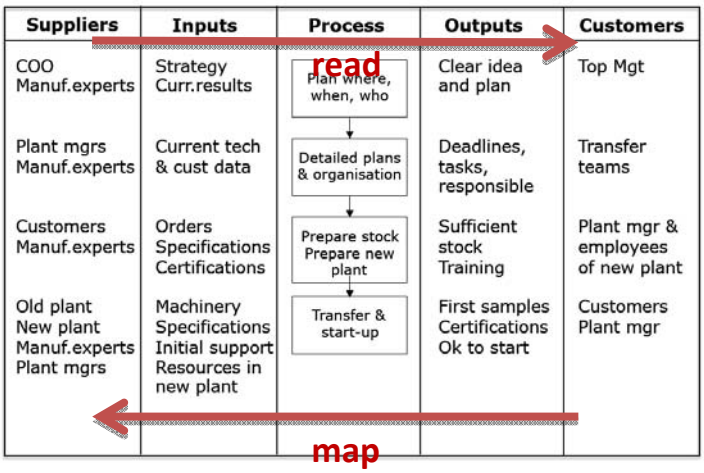
We profit, as generations before use never did. Modern manufacturing made it possible (satellites, use of solar energy, connected worldwide…), but all that glitters is not gold (DNA modification, waste…).
➔ We must "manufacture" a future, where the areas Technology, Economy, Environment and Society are concurrently optimised, not just one!

1.2 Toolkit: Process Maps

Process View	Every activity can be viewed in a sequence of related steps having one or more inputs and one or more outputs. Every activity has at least one supplier enabling it and a customer profiting from it.
Process Quality	Quality is achieved when the process outputs respect the targets defined (conformity, quality assurance) ➔ outcome should be as pre-defined requirements if too less → customer unhappy if too high → costs too much
Process based Organisation	• Business activities can be represented by sequences of elementary processes • The next process is the customer even if not yet the "end customer" Process → Process → Process → End-Customer • Breaking business activities in processes, makes it easier to understand and to manage them • Looking at activities beyond functional boundaries and customer oriented is a major step towards business excellence

1.2.1 Process mapping (SIPOC chart)

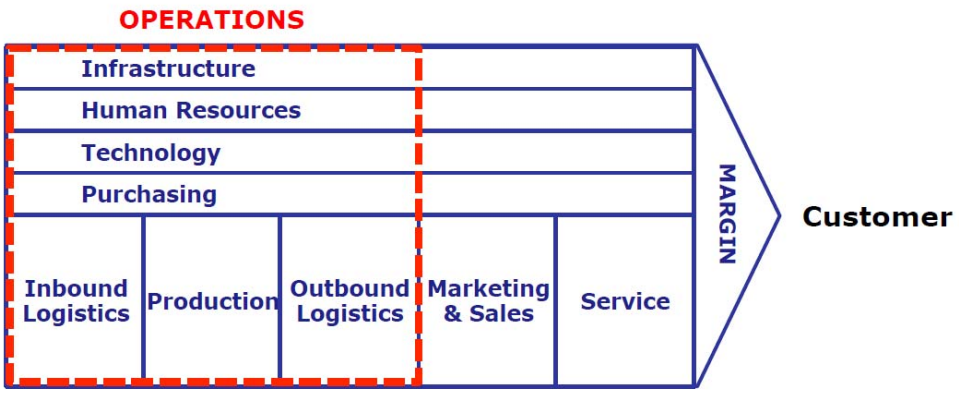
Suppliers	those who provide inputs to the process
Inputs	The materials, information or other resources provided by suppliers and transformed, consumed, or otherwise used by the process
Process	the activities done
Outputs	The products, services and information that result from the process
Customers	those who use the Outputs



Another possibility is by using **Process Flow Charting**.
How it looks and how to use are explained on p. 46/47.

1.2.2 Porter Value Chain Model

A company makes margins and is competitive, if the customer is willing to pay more than the sum of all costs. This only happens if processes and their links are well managed.



Never forget: All should start and end with the customer in mind.

1.3 Quality Management

1.3.1 Quality

Quality = an inherent or distinguishing characteristic, a property, an attribute / We tend to associate it to "good", but it is neutral: it can be good or bad.

In OPS we define quality as "Measure of conformance of a product or service to certain specifications or standards".

Quality is relative:

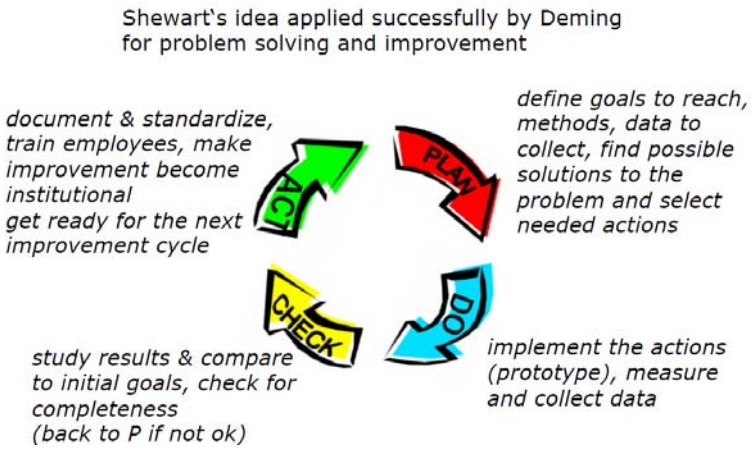
- Quality is not an absolute value, but the relation between requested and delivered product
- Quality is defined by the Customer and agreed with the Customer
- The Quality level is often an industry standard: if you reach it you're in, if not you're out

Quality Revolution – W. Edwards Deming

- 1947 first trip to Japan, several followed
- Seminars on Statistics and Quality
- Identified the "EVIL" in: Variations and Waste
- Was treated like a "God" in Japan, became the quality guru in the world, while hardly anyone knew him in his home country until 1979

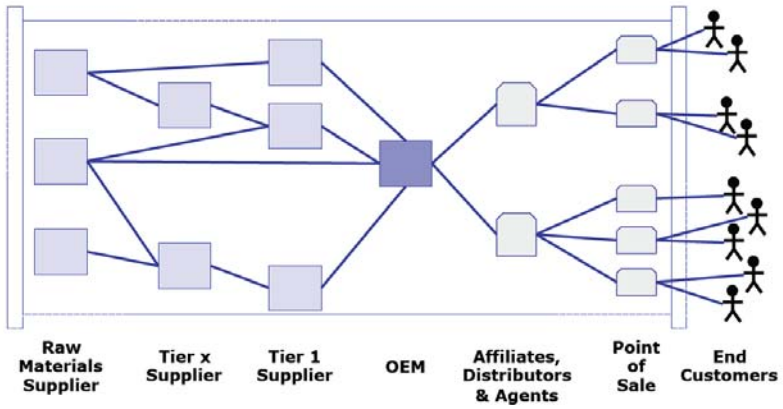
1.3.2 PDCA Wheel = "Deming circle"

➔ Continuous improvement (you never have to stop, we always find better solutions)



1.4 Supply Chain

Supply Chain – a network of interrelated players



Supply Chain Management (SCM) is about:

- moving "Goods" through the "Pipeline"
- moving back Money and information

You need to know what the End Customers want.

1.4.1 Supply Chain Management – Definition

"Supply chain management (SCM) encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities.
It also includes coordination and collaboration with channel partners who can be suppliers, intermediaries, third-party service providers and customers.
In essence, SCM integrates supply and demand management within and across companies."

1.4.2 Types of "Goods" in the Supply Chain

- **Raw materials:** materials in original, unprocessed form (like Oil, Wood, Steel)
- **Components:** processed parts with an individual form or function (like LCD panels etc.)
- **Semi-finished goods:** generated at a stage during prod. process, can individually be stored
- **Finished goods:** obtained at end of prod. process, sold to clients
- **By-products:** generated during prod. process, not found in finished product
- **Consumables:** help to do things, but are not part of the product (like lubricating oil etc.)
- **Trading goods:** support or additional products, purchased from 3rd parties
- **Services:** immaterial goods in the supply chain
- **Information:** immaterial, critical backbone of the supply chain

If we look closer, in a modern Supply Chain more than finished Goods, Money and Information is exchanged:

- Cash
- Information
- Ideas & Innovation
- Risks

1.4.3 Logistics – Definitions

Logisticts is

- Moving Goods & related Information in an optimised way between all players of the Supply Chain
- Making sure that the customers are delivered with:
  - The right **GOODS**
  - In the right **QUANTITY**
  - At the right **TIME**
  - At the right **PLACE**
  - In the right **CONDITION**
  - At the right **COST**

Types of Logistics

Inbound Logistics	Raw mat, consumables, supporting, components, spare parts
Production Logistics	Raw mat, consumables, supporting, components, repair parts, semi-finished, finished goods, spare parts, containers
Outbound Logistics	Finished & spare parts, trading goods, packaging, containers
Disposal & Recycling Logistics	Return parts, waste, empty containers

1.5 ISO 9000

ISO 9001 is a must have, but doesn't guarantee success. It's also costly.

1.5.1 ISO 9001 – Contents

This International Standard specifies requirements for a quality management system where an organization:

- needs to demonstrate its ability to consistently provide product that meets customer and applicable statutory and regulatory requirements, and
- aims to enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system and the assurance of **conformity** to customer and applicable statutory and regulatory requirements

1.5.2 ISO 9004 - Managing for the sustained success of an organization

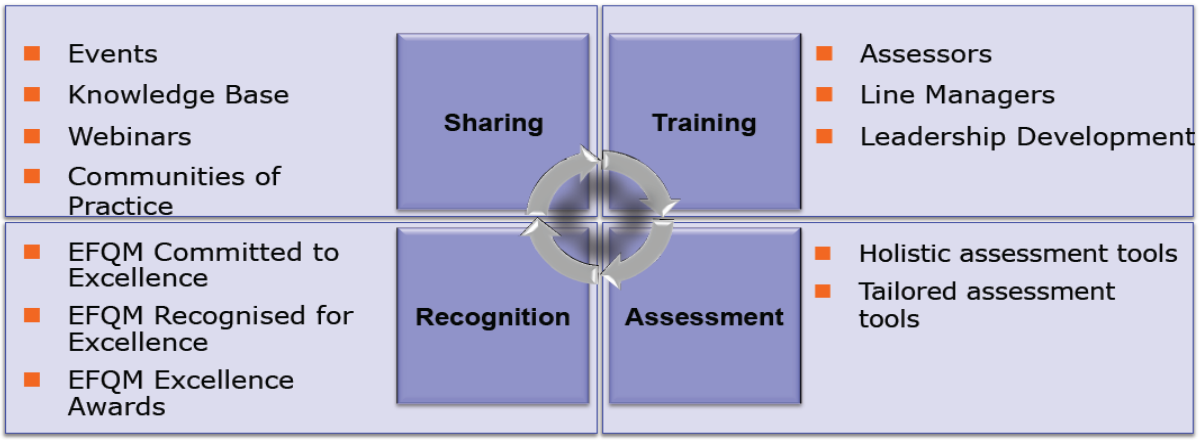
ISO 9004 provides a wider focus on quality management than ISO 9001. It addresses the needs and expectations of all interested parties and their satisfaction, by the systematic and continual improvement of the organization's performance. However, it is not intended for certification, regulatory or contractual use.1: Customer focus; 2: Leadership; 3: Involvement of people; 4: Process approach; 5: System approach; 6: Continual improvement; 7: Factual approach to decision making; 8: Mutually beneficial supplier relationships

1.5.3 Limits of a Quality Management System

- Quality is not an absolute value and is dynamic not static, while a handbook risks to be static, if not kept up-to-date
- It is not enough to write a nice handbook: it must be adhered to everyday by everybody
- It does not replace thinking and is not a recipe for success in business
- It is often seen as "everything" one must do for reaching Quality, while it is just a step towards it
- It risks to be a bureaucratic act, if it is just done to obtain the ISO certificate

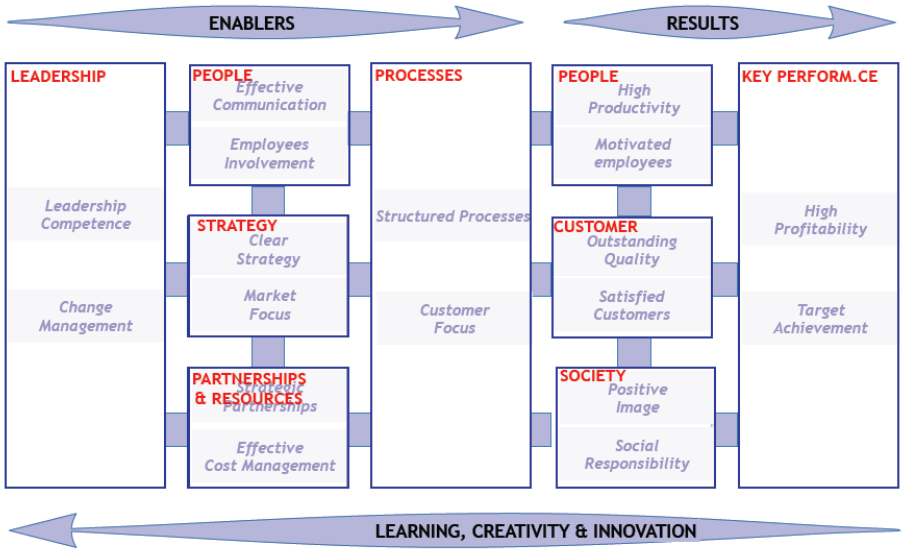
1.6 EFQM Model

1.6.1 EQFM Activities

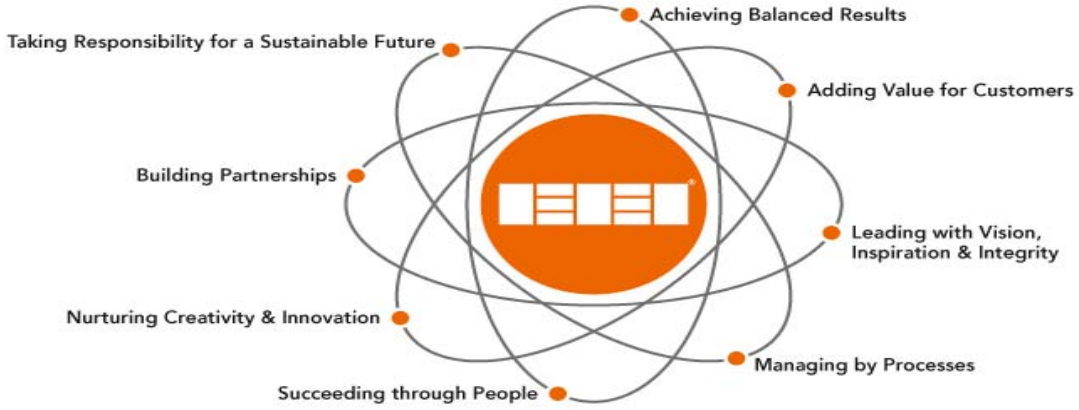


1.6.2 EQFM Excellence Model

- Assess performance, identify strengths and improvement areas
- Encourages reflection and stimulates continuous improvement
- Identifies what actions are really driving results, which areas need more attention, and which approaches should be made redundant



1.6.3 The Fundamental Concepts of Excellence (2010)



1.7 ISO9004 App. B vs. EFQM

ISO9004 App. B	EFQM
Customer focus	Adding Value for Customers
Leadership	Leading with Vision, Inspiration and Integrity
Involvement of people	Succeeding through people
Process approach	Managing by processes
System approach to management	~Achieving Balanced Results
Continual improvement	
Mutually beneficial supplier relationships	Building partnerships
	Nurturing Creativity & Innovation
	Take Responsibility for a Sustainable Future
Factual approach to decision making	
ISO is a norm → audited	EFQM is voluntary → way of thinking

2 Week 2: In Search of “Excellence”

Group exercise: (Warm up)

A company is excellent when…

- it exceeds customer expectations
- it continuous improves (on many levels, e.g. leadership)
- it creates win /win situations
- it analyses itself honestly (a company which was excellent before may not want to see that market changed → main reason for fail)
- it continuously innovate and copes with changing markets
- it motivates employees

2.1 Business Excellence Models

- Good practices have been crystallized into models of how a world class organisation should operate
- These models are only a reference, nothing else
- They continue to evolve through extensive study of the world’s highest performing organisations
- Many countries have developed their own models and use these as frameworks to assess and recognise the performance of organisations through awards programmes
  (USA: M.Baldrige Award) (EU: EFQM Award)

So... Business Excellence is NOT

- Being the biggest company by revenue
- Showing top profits
- Paying incredible bonuses
- Getting a high share of media
- Being certified ISO 9001
- Following the last “management fad“
-

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:
  - Customers and business Partners
  - Shareholders
  - Employees
  - Society and Environment
- A moving, unattainable target that requires continuous effort because:
  - Boundary conditions change and require changes in companies
  - Who is close to excellence today, has no guarantee to be still there tomorrow

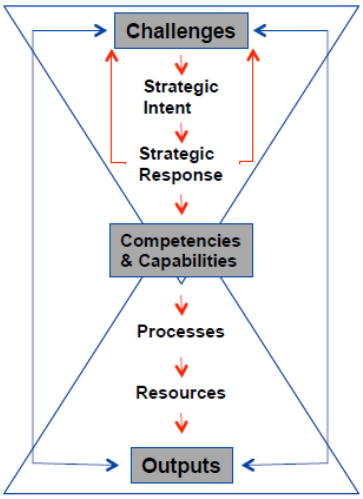
2.2 Vision & Culture for Excellence

Current Challenges for companies:

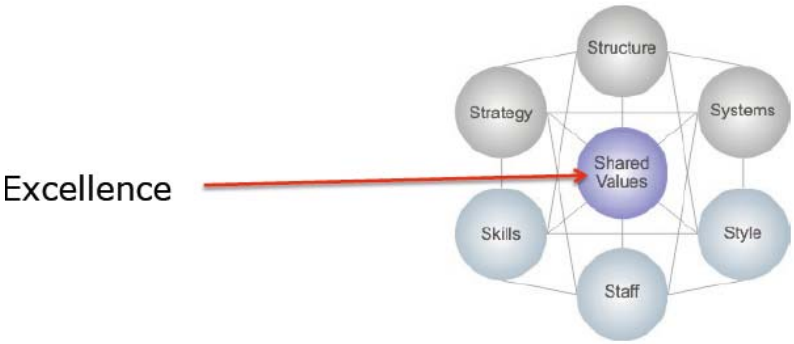
- Speed of change, - Globalisation
- Rise and fall of Nations (US and EU " but CN and IN #)
- Sky-rocketing national indebtedness
- Financial and Currency markets crisis
- Unbalanced demographics
- Social costs (unfunded pensions)
- Competition for natural resources (oil, ore, water, food)
- Competition for brains (War for Talents)

Adapt/ profit from external conditions:

- It is useless to complain about external challenges
- Adapt to them
- Turn them to your advantage
- Develop your strategy from external challenges



2.2.1 Change: The Elements to work upon (7S Model)



The 7S framework forces us to concentrate on interactions and fit of several facets/ elements of an organisation

The real power of an organisation comes when all the variables in the model are aligned

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

Shared Values: the core values of the company (vision, culture, work ethics)

Style: the leadership style Staff: the human capital

Skills: the competencies

2.2.2 Culture

- We find easy to measure financials or parts produced
- We cannot measure the value of a workforce striving for excellence...

- There is however better correlation between long term excellence and culture in a company, than to its financials.
- Excellent companies do show "strong" organisational culture, whatever their industry sector: employees are "convinced"
- Few themes are recurrent: "Client is King", Quality and Service are the key to success

Anchor Excellence in the Company's DNA

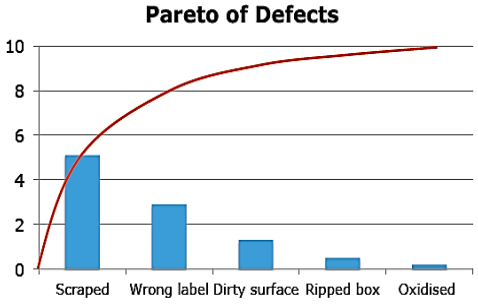
- Foster a Culture of Excellence (the Customer is King, Quality is mandatory...)
- Make it be a System used by every employe
- Push all average employees to extraordinary performance, do not just rely on the great performance of few extraordinary employees

2.3 ABC Analysis

Pareto Distribution:

- **20% of causes generate 80% of the effects**

As a rule of thumb is valid in business too: e.g. about 80% of profits is made with 20% of the clients, or with 20% of products => therefore it is worth to focus more on those 20%



2.3.1 The ABC chart

The ABC analysis is a refinement of the Pareto view: instead of two classes there are three
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%

	A	B	C	D	E	F	G
1	**OPS -- ABC ANALYSIS**						
2							
3							
4	**Part No.**	**Price**	**Volume**	**Expenditure**	**Cum. Exp.**	**%**	
5							
6	Bell Co.	1'542.00	1	1'542	1'542	38%	A
7	Assur Ltd.	1'095.00	1	1'095	2'637	65%	A
8	Benhur SA	742.00	1	742	3'379	83%	B
9	Eragon Ltd	136.00	1	136	3'515	86%	B
10	Dertan AG	128.00	1	128	3'643	89%	B
11	Moxip Inc	99.00	1	99	3'742	92%	B
12	Exonar AG	72.00	1	72	3'814	93%	B
13	Everest AG	61.00	1	61	3'875	95%	C
14	Argon Inc.	52.00	1	52	3'927	96%	C
15	Absolut Oi	46.00	1	46	3'973	97%	C
16	Xenop AG	37.00	1	37	4'010	98%	C
17	Sopala SA	30.00	1	30	4'040	99%	C
18	Pixon GmbH	25.00	1	25	4'065	99%	C
19	Kung GmbH	23.00	1	23	4'088	100%	C
20				4'088			
21							
22							
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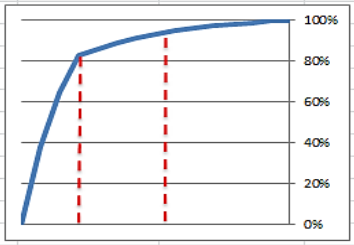
	I	J
		Responsibility
	Sales Manager	**2'637**
	Salesman	**1'177**
	Trainee	**274**



In business this is applied in many different cases:

- "ABC parts" in the purchasing portfolio, by expenditure
- "ABC clients", by sales
- "ABC suppliers", by expenditure…

with the objective to attract the focus and the actions on the most important ones: those in class A

Manage ABC Parts

"A" parts	"C" Parts
Prices reviewed with suppliers at each new order	Purchased in bulk quantities, little price negotiation
Picking strictly controlled in the warehouse	Picked freely (no picking documents in the system)
Inventory levels optimised to reduce investment	Seldom or no physical counts
Frequent deliveries by supplier(s)	Replenishment task can easily be given to supplier
Regular physical inventory counts	
Supplier market surveys and benchmarks	

Further refinement: ABC–XYZ Analysis
If we couple the consumption cost with the stability of demand:

Demand \ Value	A	B	C
X Stable, Predictable			
Y Fluctuating			
Z Sporadic, erratic			

- Example of differentiated actions:
  - - Reduce inventory value: frequent delivery or Just in Time
  - - Don't care directly: vendor managed inventory

2.3.2 ABC Summary

The better we know the behaviour and relevance for the company of Parts, of Customers or Suppliers…
… because not all are equal…

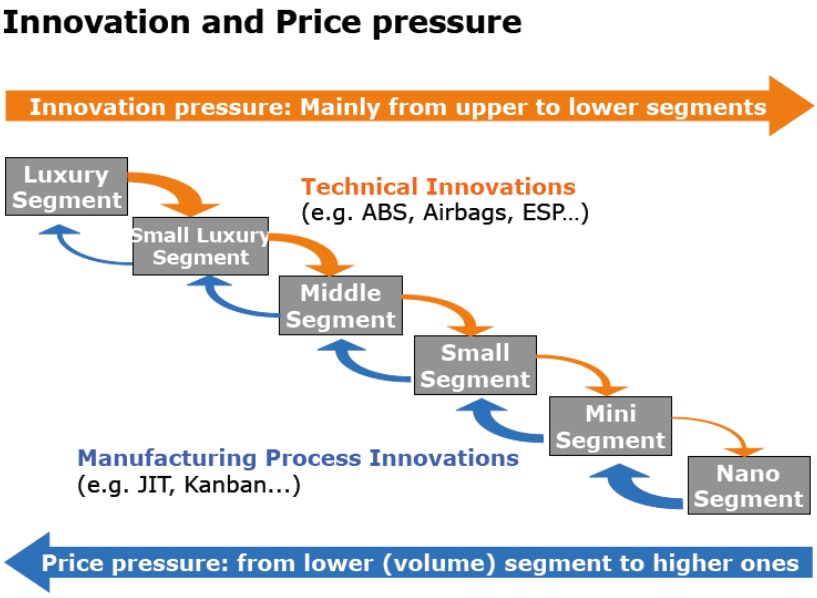
- We can assign the most suitable management method to each class
- We can manage them better focused, dedicating more attention where it is really worth

2.4 Challenges 1

No company nowadays can feel safe, not even the "best in class" (Toyota)

Those who cannot innovate their products and their processes are doomed to failure (see the big three)

The need for continuous improvement is there more than ever



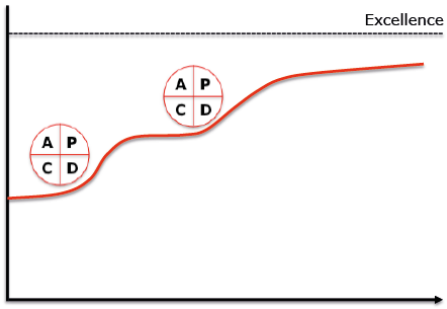
2.5 Kaizen principles (Kaizen or Continuous Improvement)

"Kai" = Change "Zen" = Good => **Change for the better**

- It is not about dramatic innovation, it requires continuous effort and discipline, it lives thanks to the participation of all-
- It is an approach deeply embedded in the Japanese culture
- It was imported in the Western world, where still gut feeling, experience and genius in solving business issues – instead of a systematic approach – tend to be preferred

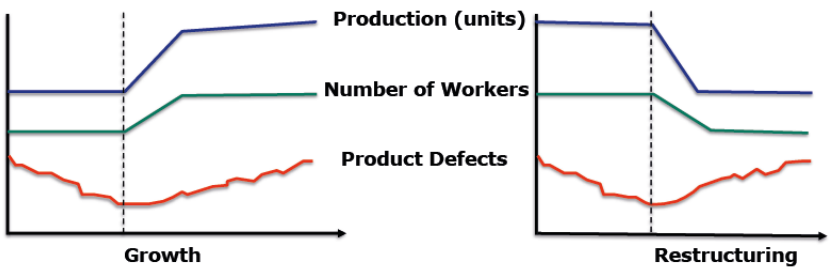
PDCA

- **Plan:** define goals to reach, methods, data collection, find possible solutions to the problem and select best actions
- **Do:** implement the actions (prototype), measure and collect data
- **Check:** study results, compare them to initial goals and check for completeness (back to Plan, if not ok)
- **Act:** document & standardize, train employees, make improvement become institutional – get ready for the next improvement cycle



The improvement path never ends
After one improvement cycle, another follows: be persistent - Standardisation of results is mandatory (stabilize) to avoid falling back to the previous state.

Education of Employees
- People forget, old people with know-how leave, new people come, interim-workers are used, restructuring projects hack the knowhow base of a company…
- Without a permanent training effort, processes get out of control and improvements vanish.



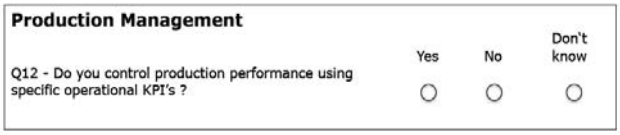
2.5.1 Kaizen "Code of Conduct"

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 improvement process
7. Teamwork and employee motivation are powerful tools
8. Control by Walking Around (at "gemba" the place where things happen)
9. Do not think too much… do it!

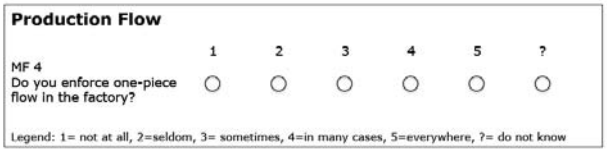
2.6 Self-assessment: know yourself before improving

- Gathers quickly and simply useful information
- Focuses mostly on qualitative elements (areas where quantitative data are normally missing)
- The more precise are the questions and the more guided the way people can answer, the better the result
- Provides an initial overview and a visual status of a unit
- Allows for comparison with other units or for the same unit overtime
- Makes evident areas of distinctive performance or weakness

Version 1: Simple Answers



Version 2: Adding more precision



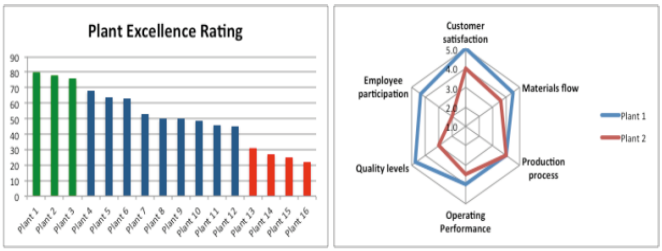
Self Assessment: Attention points:

- The more precise the question is, and the answers guided, the better the result (lower discretionality in the answers)
- Never couple two questions in one
- Really sophisticated questionnaires include the same question twice or more, differently formulated (e.g. Myers- Briggs personality test) to test reliability of answers. This is not done in most commonly used self-assessments.

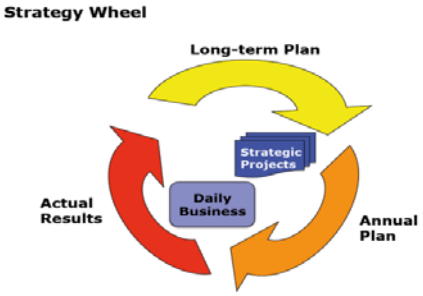
Typical Outputs and Use

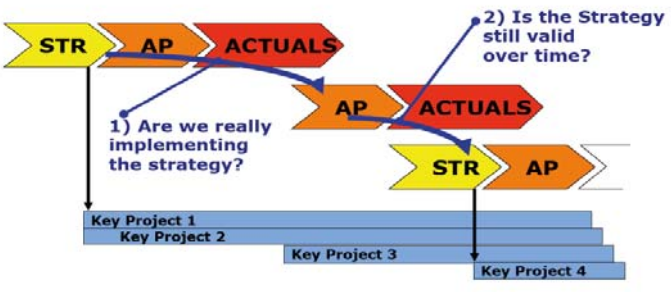
A) The simplest: obtain total points, for a ranking

B) The best way to show differentiated results: charts



2.7 Toolkit: Policy Deployment





Remember: ISO9004: Leaders establish unity of purpose and direction of the organization

Hoshin Kanri

- "Policy management" or "Hoshin Kanri" is a method to define and document the Annual Plan of a company
- The idea originated at Brigestone in Japan in the early '60s, when they recognised they weakness in planning and execution
- "Hoshin" means "objectives", "direction", but also "compass"
- "Kanri" means "control" or "management"
    - **"management of the objectives/ of the direction"**
- The strategy is broken down into initiatives and each is given a responsible and targets

Cascading

- Mission => Strategic Intent => Strategic initiatives
- Str. Initiative => Responsible, Targets, Measures, Deadlines

Example:

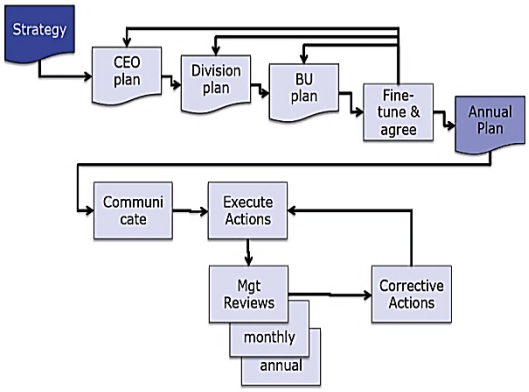
CEO: increase profits from 3 to 6%

=> Initiative: reduce product field failure (warranty)

=>Head R&D: redesign product for better performance

=>Plant mgr: reduce failures on top 3 pareto defects

Annual Planning Process



More than financial targets: Balanced Scorecard

Splits performance measures in 4 categories, urging companies to set their targets covering all four – and this for all managerial

levels:

- Financial
- Customer
- Internal Processes
- Learning & Growth

- Each dimension is given 3-5 measures to follow
- The idea is that only a balanced activity on all 4 dimensions will contribute to excellent company results

Balanced Scorecard: Example of KPI

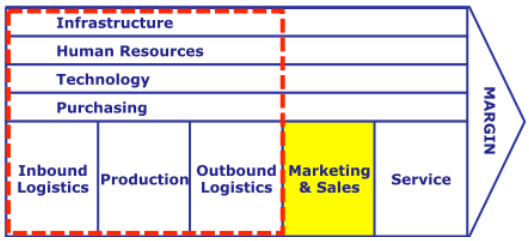
Financials - Sales growth - EBIT% - Return on Capital - Share value	**Internal Processes** - Capacity utilisation - Delivery time - Cost of non quality - Days without accidents
Customer - Market share - Account coverage rate - Success rate: deals won/chased - Face to face time w/ Customers	**Learning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

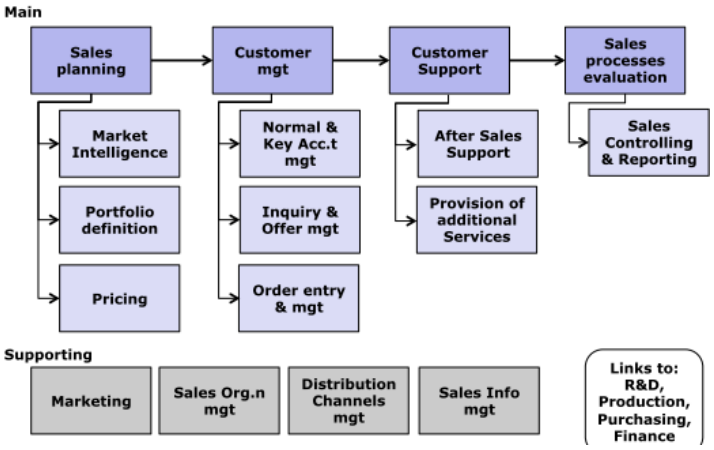
OPS Week 2: Recap:

- Excellence is not found in a certificate nor in the Stock exchange results
- The search for excellence never ends
- The Company Culture makes the differenc
- Challenges increase and surprises are always there: companies must be ready to change and improve or will die
- ABC helps focus on what is important
- Self-assessment, if well designed, gathers quickly useful information (multi-purpose)
- Strategy broken down into connected elements, can be made easy to see and to follow-up.

3 Week 3: Excellence: Sales – In & out logistics, House of quality

3.1 Excellence in Sales





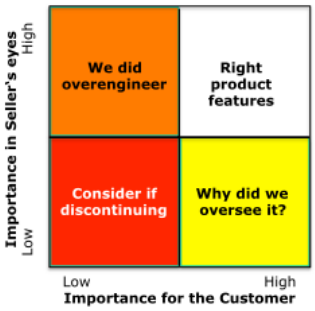
Remember ISO 9001: Customer is the focus, and his satisfaction. Also Requirements and review of those are important. And of course all has to be documented.

That the customer is going to buy our stuff, he need a provided value: Right features, high quality, low price, best delivery, Innovations, good contacts, good image of our company and Total cost of ownership. That we are able to provide him this, we need to know our customers, and this requires **market intelligence**. Where are we and where are our competitors. Where do they challenge you and what is our plan.

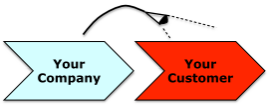
You can ask the customer how happy he is with your company. But attention: Ask not too often. Alternatively you can work with Net Promoter Score (NPS): -> Remember SM+PM

NPS = Promoters% – Detractors% Range: -100 ÷ 100
Good >0, Excellent >50

You also need to know, if your Products fit your customers need – and nothing more than that. You can mark your products and features with this matrix and find out, if they fit – or what is wrong.



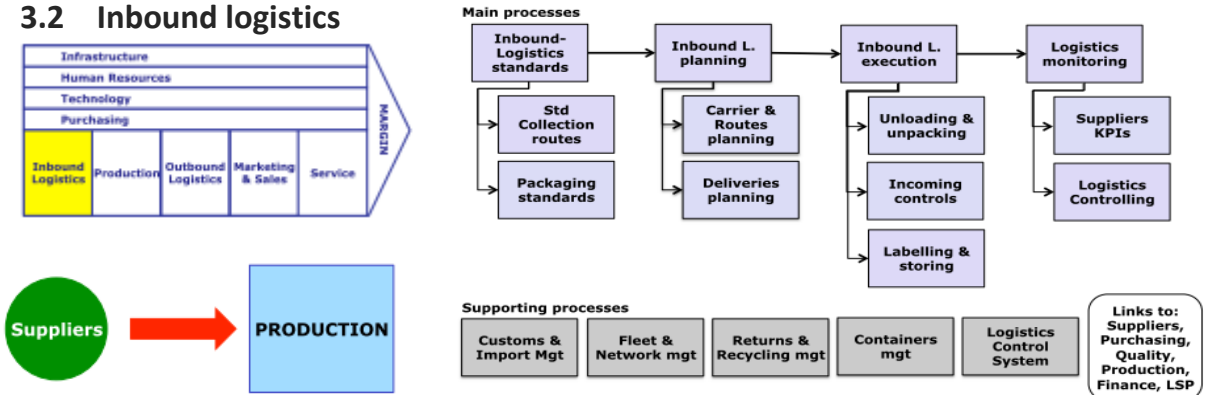
You should fit you products to the needs of your customer and therefore you need to understand his business. If you help him to increase his performance you will have a better link to him and a better sale. If you go further with this, you go to your customer's customer. If you know his needs, you can possibly make offers to your customer, fitting his customer's needs BEFORE he asks for it. This gives you much importance in your customer's eyes and helps a lot of saying in business.



You can also insource parts of your customers business. But to do this, you must be better in the areas you want to take over from your customer. In this scenario your business will grow along the supply chain.

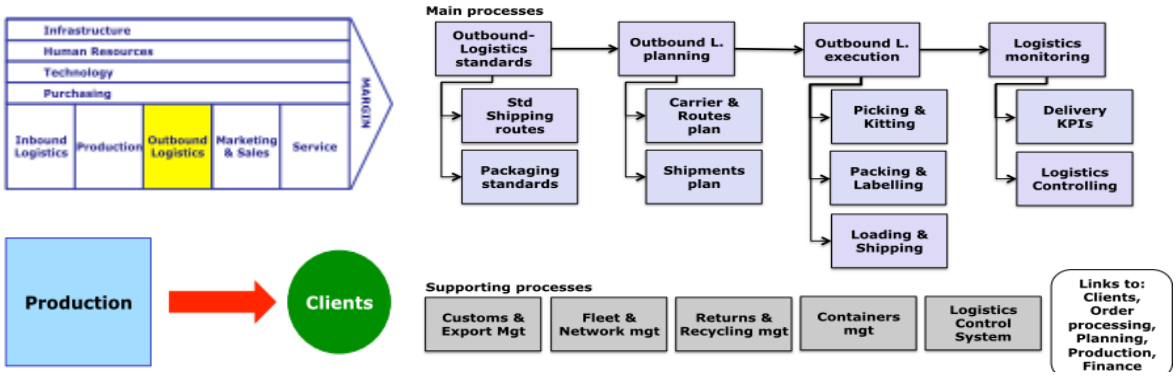
Examples of activities: Logistics, Accouting, Spare parts mgmt, Project mgmt….

3.2 Inbound logistics



Inbound logistics contains all activities of calling deliveries from suppliers, receiving, controlling, storing and internal distribution for production. The goal here is to ensure a stable flow of goods for production. With the goal in mind, that production is always able to keep up their schedule.

3.3 Outbound logistics



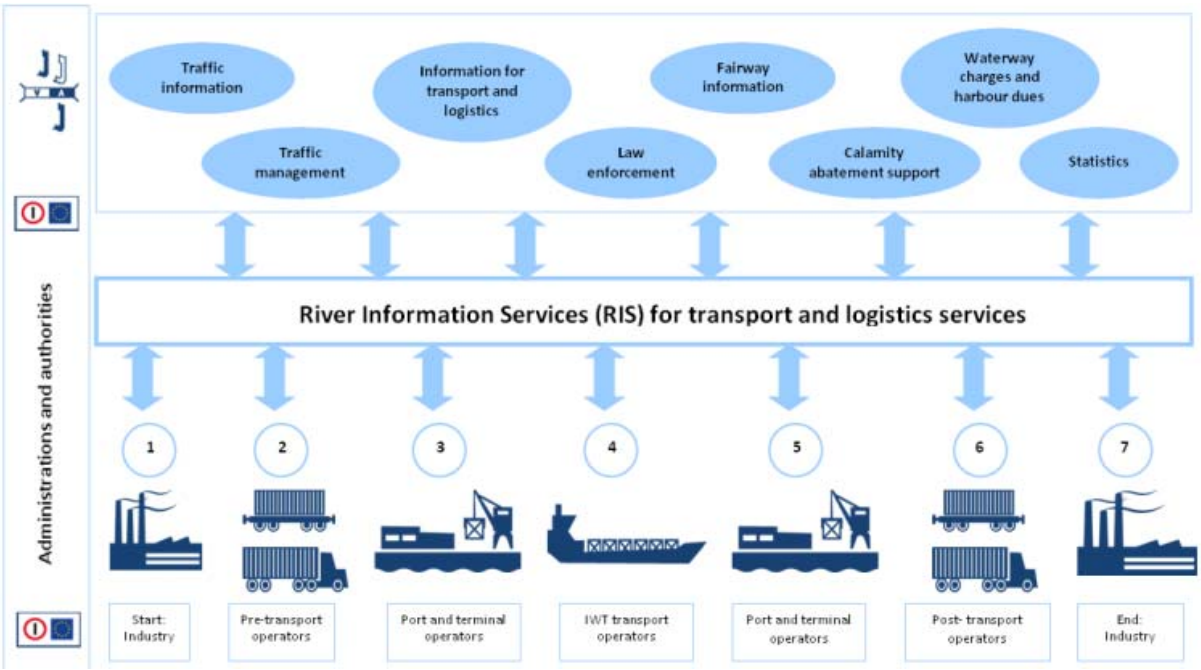
Outbound Logistics contain all activities of scheduling, packing, labeling and shipping finished goods ordered by customer and triggering the billing. Main Goal for outbound logistics is, to fulfill the customer demand and achieving the targeted delivery performance (defined KPI)

3.3.1 Transport Routes

Road		**Rail**	
Advantages: Capilary network Most flexible (24/7) Least investments Big lobbies fight for it	**Disadvantages:** Size of truck (law) Road tolls increasing Accidents / traffic jam Pollution	**Advantages:** Eco-friendly Almost no weight limtis	**Disadvantages:** Load / unload only at cargo station Schedules -> time limit Lack of investment in intermodal (Rail+Truck
Sea		**Air**	
Advantages: Extremely low cost Must fill container Volume	**Disadvantages:** Slow Special packaging (humid, temperature) Only few harbors	**Advantages:** Speed Dense network of airports Many carriers	**Disadvantages:** Most expensive Eco-impact Space limitation Not for volume production

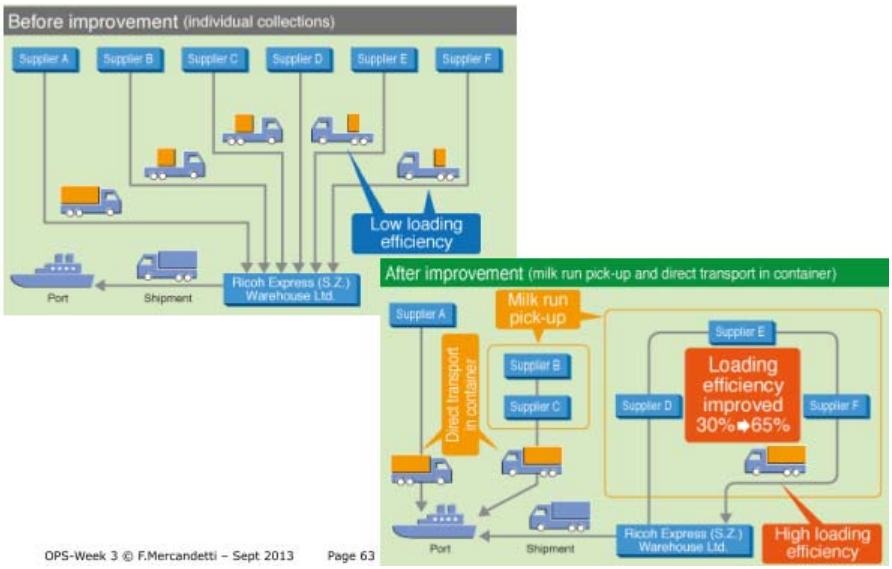
Most of the transported goods are at least on time transported on the Road. Volumes in Sales for 2012: Road (2100) Rail (194) Air (70) Sea (54)

Most transports for wider Ranges are carried out with a combination of these different methods. To combine these there is a efficient an powerful information system required. As one solution of this you can use the River Information System (RIS) for transport and logistics services;



Global trends show that sea and rail transport will increase over proportionally. Governments will continue to invest in transport infrastructure to increase competitiveness of the country. While logistic service provider invest in their IT systems

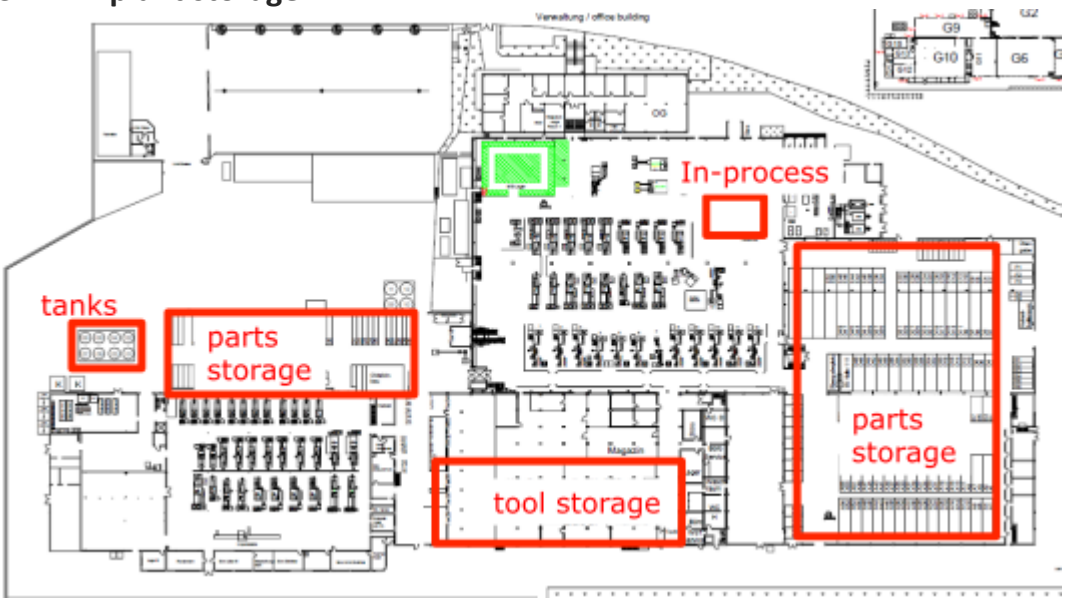
The limitations in these are, the slow rate of renovation in infrastructure, rising fuel costs, changes in legislation and environmental concerns. Due this logistics has to become more and more efficient.



This example shows, that combination of pick up routes can strongly reduce the needed trucks and results also in lower costs.

Specialized logistics companies take their chance in the actual wave of outsourcing. This wave requires much more transport capacity than before. It's their chance.

3.4 In plant storage



Storage is an important issue in production of goods. The place where goods are stored has often to fulfill certain requirements depending on the stored goods (Temperature, Humidity, Atmosphere, Light, Pressure…). There are 4 different types of storage in the plant:

- Raw Materials and components
- In-Process
- Semi-finished goods
- Finished goods and spare parts for sale

ISO Norms are not this specific in storage, but every stored good has to be declared (traceability) and to be stored in a save way (identification, handling, packaging, storage and protection).
There are several standard storage types for different uses:

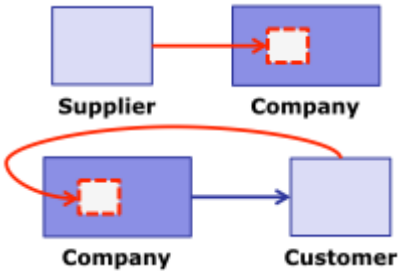
Good Type	Probable storage
Liquids	Tanks (vertical or horizontal) / Canisters
Powder / Pellets / Grains	Silos / Cans
Process Gases	Tanks / Gas cylinders
Heavy solid that cannot be damaged (Coils, Rolls, Bags, Pipes, Bales)	On the floor (only as bulk)
Components	Racks
Small parts	Drawers / Boxes / Supermarket / Paternoster
Small parts (lots of different types)	Automated warehouse
Work in process	Table / Box /Pallets / Floor -> near machine!
Tools	Racks / tool Shop -> **Separated storage Area**

To prepare and carry out transport there exists also different solutions of packaging

Packaging	Use
Specific container	Protect complex part, and present it in a position ready to use
Foldable container	Protect goods and doesn't use much space when sent back
Crates	Needed when goods are sent overseas in countries with hard weather conditions

If the stock in the company doesn't belong to itself, it's called on-consignment stock (compare VMI). There are 2 situations possible:

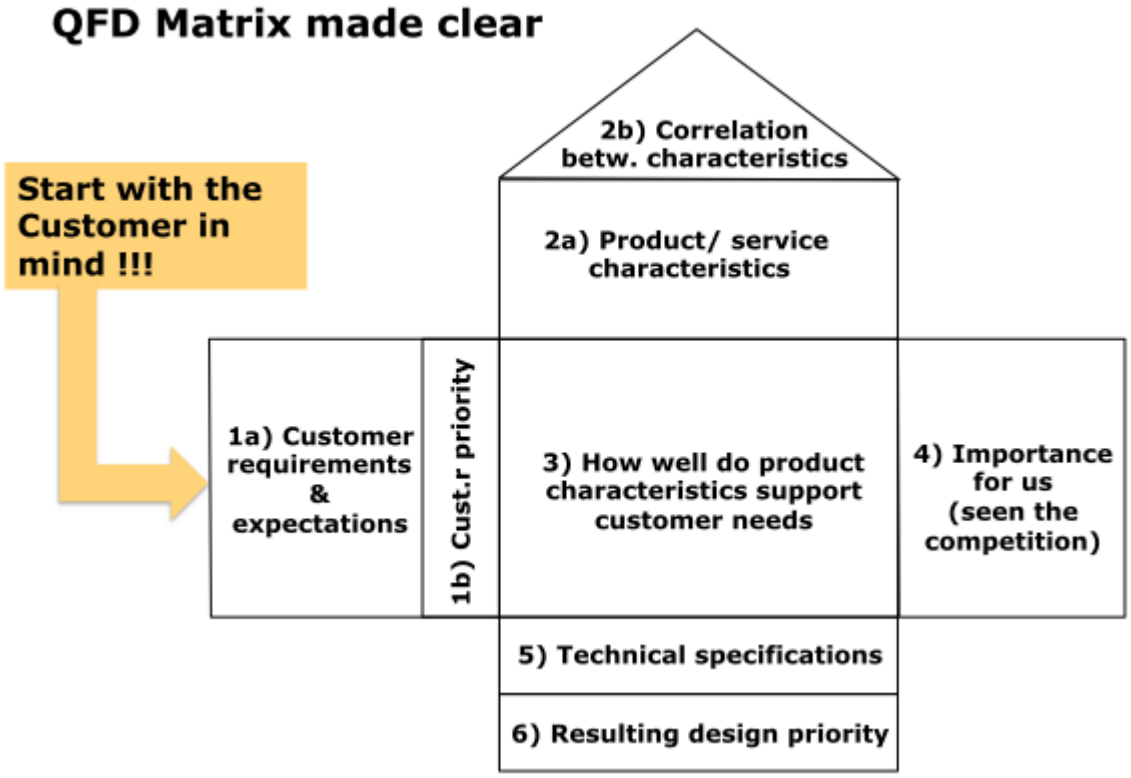
Goods belong to supplier or to customer. In both cases, the Goods have to be clearly isolated from the normal stock. The information about takeout have to be trouble free. Both sides have the right to audit the area whenever they want



3.5 Storage Risks

Risk	Countermeasures
Chemical, Gases, Fuel	Dedicated area, protection of explosions, handling warnings, Individual protection while handling
Fire	Sprinklers (make sure there is enough water), Fire retardant doors, splitting flammable goods in multiple locations
Flood	Barriers to water at (every) entrance, no storage on floor level
Obsolete inventory	Periodic control, FiFo storage, reduced amount of stored goods

3.6 OPS Toolkit – House of Quality



This matrix is a useful tool to define how to handle priorities in design for new products or services. You always start with customer, and follow through the numbers till you got the design priority. With this matrix you can develop your products better to the customer needs and do not follow the same problems as 40% of all new products on the market have. (80% Fail in total and 50% of them provide no value to customer).

You integrate customer needs into the product with this process:

1. Get Customers voice (Interview, survey, feedback, complaints...)
2. Analyze competing products / competitors moves (Benchmarking)
3. Select appropriate product / service characteristics (with qualifies measures)
4. Prioritize these characteristics (house of Quality)
5. Cascade what really counts (System -> component -> production process)

For every Step in the cascade you make a new HoQ (hell this sounds like an awful lot of work)

4 Week 4: KPI, Inventory, Plant and Production

4.1 Customer KPI

Customer measures the performance of a company with traditional and additional KPI's. For a company it will be better to monitor the same KPI's like their customers. Early information about changes is very important for initiate corrective actions.

Your Customer will monitor:

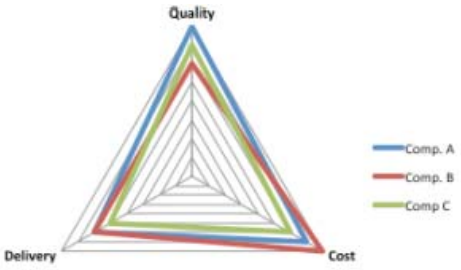
- Respect of Quality **Q**
- Cost reductions **C** — **traditional Customer KPIs**
- Delivery performance **D**
- After-sales support
- New ideas/ innovation — **additional Customer KPIs**
- ...

Q – Quality

Incoming goods should not fail to meet contractual specifications → Quality control
Nowadays suppliers are certified and do the controls on their own. Especially in case of quality incidents client may temporarily re-establish inbound controls.

PPM rates benchmark = defective parts per million received

Remark: The difference between "right" and "wrong" is difficult to define!



C – Cost

Costs are not stable but customers expect reduction of costs and productivity improvements at the same time. This could introduce a negative spiral that only can be circumventing by improving one's product intelligent.

D – Delivery

"Delivery Schedule Adherence" – the right goods at the right place and time

Typical issues:
- Wrong delivery date
- Wrong quantity
- Incomplete delivery
- Wrong label
- Wrong product (!)

But it is not enough to measure one's performance only by QCD-factors. There are also other KPI's to take a look at:

After-Sales: After a customer has sold a product he expects after-sales service. Important for customers are:
- Availability of different manuals
- Speed of spare parts delivery
- Execution of maintenance
- Consulting

Innovation: Customers bring in important ideas for your product (ex. new materials and technology or modifications)
→ Supplier-Customer-Partnership in innovation becomes key!!!

Customer Audits
Before ISO 9001, customer performed visits at their suppliers. This isn't the best way, because no one likes to show all of its business.
Now, procurement personnel, manufacturing and technical experts are sent to inspect the suppliers' production sites and document it. For documentation, they use checklists. Look at "self-assessment-toolkit" for a typical example of a checklist. This checklists identify problems and give recommendations.

4.2 Revolution from Sales to Operations

Case of Benetton → PP on Dropbox

4.3 Inventory Management

Inventory makes a company able to ship to customers all those goods which require more time to produce. This guarantees a "high service level" because the customer receives a delivery on time.

- Inventory must be the right one
- Inventory must be kept under control
- Inventory represents a lot of money

Types:

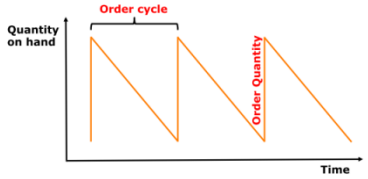
1. Transit stock: materials go through transformation steps before becoming sellable finished goods (fill the pipeline)
2. Smoothing stock: mismatch betw. demand and capacity (e.g. stock produced on weekends, because weekly capacity is too low)
3. Cycle stock: mismatch betw. process and demand volumes (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
   → buy copper when the prices are low and sell it when it's high

Inventory Management

- helps and define:
  - levels of stock to be maintained
  - right times for replenishment
  - right amount to order

- Advantages of a good IM system:
  - flexible operations
  - decoupling from variations in demand, production steps and variation in supply
  - economy of scale

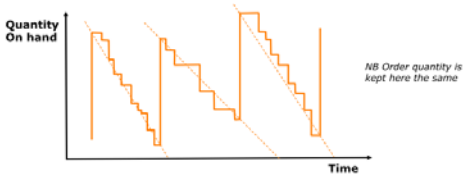
- Stock levels change over time
  Goods receipt increases the inventory.
  Pickings of goods which are required by customers or the production decreases.



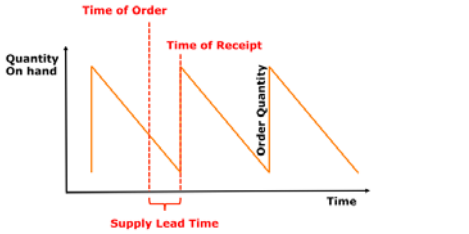
On Hand = Existing + Received - Picked

Replenishment will be executed by “order cycle” or a “replenishment cycle”. For stable demand the quantity shows a “saw tooth”.

- The demand is influenced by different factors:
  - Industry and economic trends
  - Seasonality
  - Wrong planning or ordering
  - sudden needs at customers’ (stockouts,…)



Supply Lead time = Time needed between order and receipt in inventory
It includes all steps from to order until the storage of goods



Order Quantity

Minimum — The minimum quantity a supplier will deliver for a given part number
- Optimum lot size in production at the supplier → economical
- Size of the container
- Agreement between supplier and customer

Economic — The EOQ minimizes the total costs where:

Tot. Costs = Purchase costs + Ordering costs + Storage costs

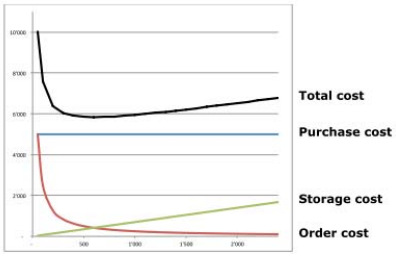
$$= D * U_C + O_C * \frac{D}{Q} + \frac{Q}{2} * U_C * S_C$$

D=yearly Demand, U_c=Unit cost, Q=Order Quantity

O_c=Order processing cost, S_c=Storage cost in % of Unit cost

The optimum is where Storage and Order costs are equal:

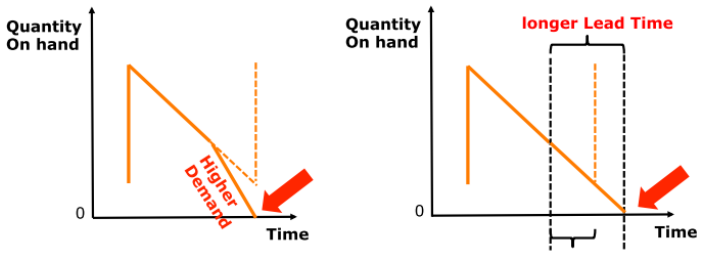
$$EOQ = \sqrt{\frac{2\,D\,O_c}{U_c\,S_c}}$$



Maximum

It is not possible to store endlessly → no space, security, …
A high stock means a high invested capital to. So it would be imperative to reduce it!

KPI: Ensuring high Service Level in case of a higher demand or a longer lead time.



→ Stockout !!!

Definition: Service Level is the probability that an arbitrary part is delivered without delay.

$$SL = 1 - \frac{\text{Backorder qty in given time period per given part}}{\text{Demand qty in given time period per given part}}$$

Backorder: order for which the goods aren't available and delivery has to be delayed beyond the initially agreed day

$\boldsymbol{SL \sim 95\% - 98\%}$ → (NB 95% means that in 5% of cases a backorder is possible, i.e. during 0.6 months a year…)

Safety Stock

SS secures the service level in **case of various demands** and **supplies lead time** for X time of average demand

→ Standard deviation → calculate with the following:

- The std. deviation for non related events is equal to: $\sqrt[2]{\sum_1^n \sigma^2}$
  (demand of a day is not related to that of previous days)

- 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
  (expressed in quantity: $D_D * \sigma_{LT}$) :

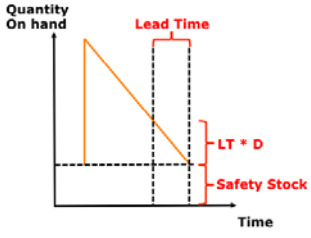
$$SS = Z * \sqrt{LT * \sigma_D^2 + (D_D * \sigma_{LT})^2}$$

$D_D = Daily\ demand\ [pieces]$
σ_D
$= Standard\ deviation\ of\ daily\ demand$
$LT = Lead\ Time\ [days]$
$\sigma_{LT} = Standard\ deviation\ of\ LT\ [days]$

Attention

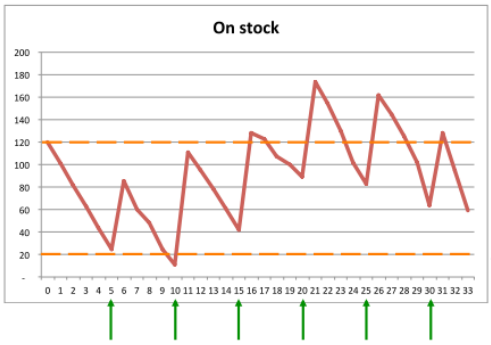
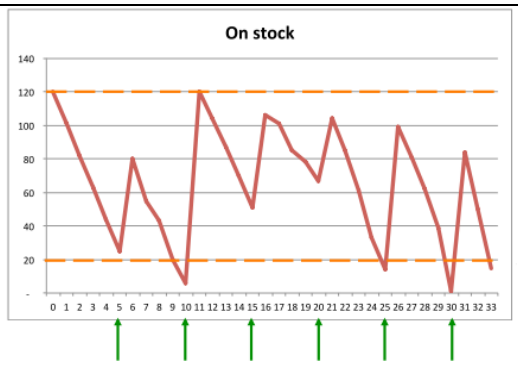
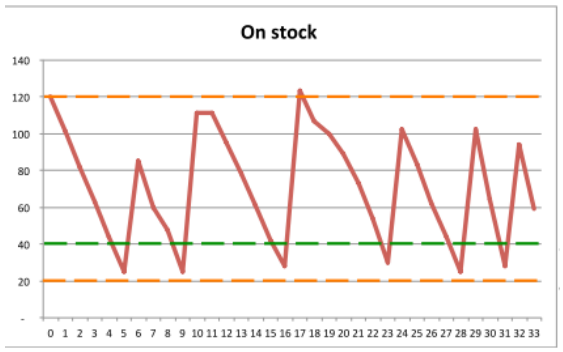
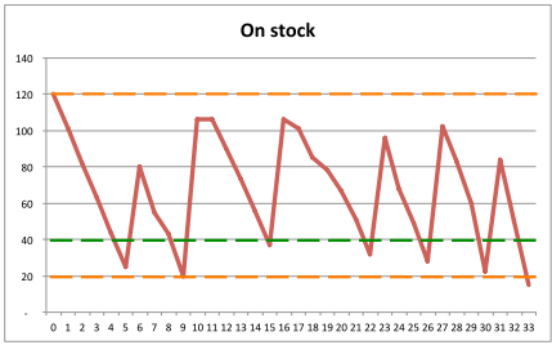
A) Inventory in the Pipeline
Meets the expected demand during LT → D * LT

B) Safety Stock
Meets the unexpected Demand (and LT changes) during LT



In Exercise 1 respectively:
A) 80 * 5 = 400 pcs
B) 39 pcs

We have to take the same KPIs to measure our suppliers like those one our customers use to measure us.
Methods for inventory → Safety stock required

Method	Description	Picture
A	• Predictable • Order always has the same quantity • Easy method • No control of maximum stock → risk of overloading a storage bin • C parts, stable demand	
B	• Changing demands • Better control of max. stocks • Lower level could be little control • B, C parts • Stable or lightly changing demand	
C	• Recorder point → a new order will be activated • B, C parts • Unstable, lightly changing demand	
D	• Recorder point must be rightly defined • A parts with unstable demand	

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

Remark: Demand is not predictable and own production schedules might be disturbed by urgent needs

Risks in Safety Stock, Lead time and Reorder Point
Demands are not stable all year round (events, sudden peaks, …) also the lead time may not be respected or own production schedules might be disturbed by urgent needs.

So it is important to adjust inventory policy, safety stock and reorder point periodically for A and B parts. This is a big effort and is done less, most companies let do this by an Information System. But it uses old values of important parameters for calculating. This makes material planning and inventory control wrong.

KPI: Inventory Turns
It tells how many times a year the company sells its inventory, unfreezing money from inventory:
→ The higher, the better!

The objective is to sell products, not to accumulate them

Inventory turns = Costs of goods sold yearly / avg Inventory value
= D * U_c / (Q/2 + SS) * U_c
= D / (Q/2 + SS)

D=yearly Demand, U_c=Unit cost, Q=Order Quantity
O_c=Order processing cost, S_c=Storage cost in % of Unit cost
SS = Safety Stock

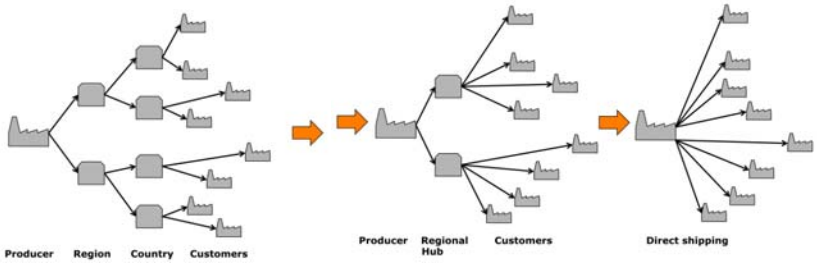
Cycle counts
Physical inventory may differ from reality because of:

- Deliveries from suppliers with different quantities than it is written on shipping bills
- Inaccurate BoM
- Inaccurate quantities registered
- Items damaged, lost or stolen

It's important to count the inventory regularly (every month, every year, …)

Logistics full costs: Size counts
The bigger the warehouse, the lower are the costs per Pallet

Warehouse footprint
There are different options of warehouse footprints



→ Centralize logistics is much more efficient. A warehouse has to reduce complexity.
There are elements to take into consideration:

- Type, number, weight, volume of shipments
- Level of standardisation of products

- Complexity of local export/ import rules
- Local complexities (regulations)
- Local logistics performance and infrastructure quality

Network of warehouse:- Investment
- Proximity of customers
- Speed of reaction
- Core competencies

- Cost of transportation
- Cost of warehousing
- Desired level of service

→ Important impact of the profitability.
Choose the right distribution channel to pass the burden to other players!

4.4 Plant conveyance

→ ISO 9001: 7.5.5

Conveyance Methods		
Manual, by operator or logistics personnel		
Hand and Platform Trucks	- easy, simple, low cost - little space needed	- only for small items - load is limited - 200 – 1'000 kg
Manual Pallet Jack	- easy, simple, low cost - little space needed	- slow - lift is manual - must be pulled by operator - 1'000 – 2'500 kg
Manual Stacker	- higher load - lifts pallets in safe condition	- more expensive than other manuals - takes more place - requires still the operator - 500 – 1'000 kg
Automatic, by conveyors or automated vehicles		
Electric Stacker	- operator does not have to walk	- speed and load limited - investment - 1'000 – 2'000 kg
Fork Lift trucks	- big loads - powered	- investment - maintenance need - only trained drivers - risk of accidents - 1'000 – 9'000 kg
AGV Automated Guided Vehicles	- No labour cost - Precise, repetitive	- High investment - Guiding aerials in the floor - Safety precautions - Not flexible in emergencies
Continuously, conveyor belt, line, pipe		
Conveyers Lines	- operators don't move parts - the line gives the "takt"	- investment - rigid - physical barrier in the shop-floor - risk of accumulation of inventory
Handling systems		
Gravity rolls	- Goods move by gravity or with little impulses - Goods get close to operators	- Investment - Space occupation - Inflexible setup (most often)
In batches, container, boxes		
Staging Areas	- After picking, goods are grouped, labelled & set ready for shipping - A (possibly) full truck-load is prepared in front of the docks	
Loading / Unloading docks	- Easy access for trucks - Quick (un)loading - No rain/ snow exposure	

→ ISO 9001: 7.5.3

Labels
They are needed to declare the product

- Own Product number
- Customer Product number (if different)
- Product description
- Quantity
- Lot number
- Production/ Packaging date
- Expiry date
- Brand name, Logo, Address
- Technical data (e.g. weight, length, voltage...)
- Barcodes
- Handling & storage instructions

RFID-Technology: Radio waves transfer information. The RFID reader transmits an encoded radio signal to interrogate the tag. The tag receives the message and responds with its identification information.
Direct communication with ERP System is possible.

4.5 Product Master Data

Every single part of a product has a lot of information which identify it.
Work with numbers! This is the best way to communicate to avoid failures ("13…" for finished products, "10…" for row material, etc.)

- Identification: Part Number (unique), description (short & long), Product class, drawings, photos, version, dates of validity...)
- Sourcing: unit of measure, reorder policy, supplier, packaging, lot size, lead-time…
- Storage: locations, available quantity, on-order, available to promise, safety stock, shelf life…
- Shipping: Packaging, labelling, handling instructions, Customer part n.o
- Value: Costs, Prices
- Additional Info: Safety & Recycling information…

In an ERP-System you combine all part master data in a common database → no redundancy.

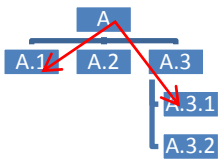
Bill of materials
Definition of a product → how do you have to build it?!
The bill of materials tells:
- the components
- their number
- their assembly sequences

This information support the production. The BoM defines the product in every details.

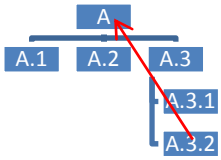
→ You couldn't have just one BoM, there are different views

- Design
- Production
- Sales
- Services

BoM explosion: Top-down



BoM implosion: Bottom-up



Traceability
Dependant on the industry, there are standards which dictate the use of additional information elements like serial numbers. These identify a single product and when it was produces for example.

For example: Food industries have to declare when a product was made in case of a call back.

Product configuration management
A product changes during a life cycle so you have to manage different versions of BoMs, etc.

Routings
A "routing" tells all the machining or assembly steps to produce a product (one-level jump in the BoM) → Manage the resources.

- Operation number
- Workcenter
- Man and machine time
- Lot size
- Ref.ce to work instructions
- Description
- Tooling needed
- Setup time
- Reject rate
- Dates of validity

Phantom parts and situations → don't really exist but they make the understanding of a routing much easier.

Time & Motion Analysis: Stopwatch method

1. Prepare to measure in "normal" conditions
   - analyse the production process
   - split the production cycle in its elementary motions, where time measures make sense and can be repeatedly performed
   - eliminate abnormal conditions
2. Conduct a sampling series of measures with a stopwatch
3. Evaluate conditions (rhythm, work intensity…) & normalize
   - Average measured time
   - Assign a performance factor (by experience & observation) such that:

   Measured time * Performance factor is independent of the worker

Time & Motion Analysis: Correction of fatigue

Time & Motion Analysis: Predetermined Motions 1
Micro-motion studies

Time & Motion Analysis: Predetermined Motions 2

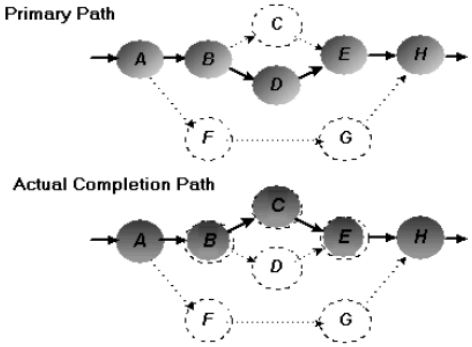
The elementary Motions of MTM© are:

- **Reach** (the basic motion)
- **Move** transport something to a given destination
- **Turn** Rotation of the hand around the forearm axis
- **Position** Align, match or assemble an object with another one
- **Grasp** Seize an object with the fingers or the hand.
- **Release** Let an object go
- **Disengage** Free two objects from their mutual contact
- **Eye time** Control an object visually
- **Body motion** Motion of the entire body, more than 30 cm

Standard times are not always that transparent they should be

Types of routings

- Normal
- Alternative

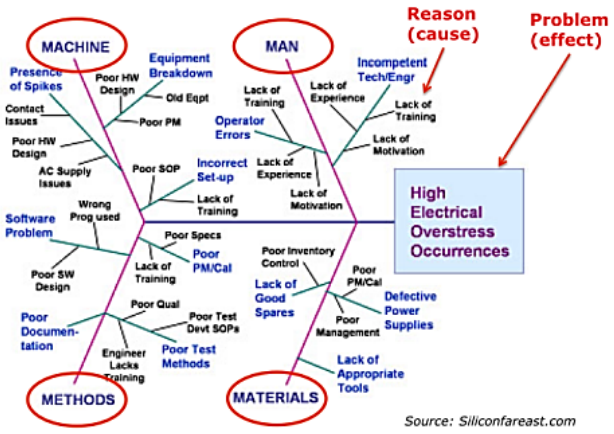


4.6 Toolkit: Problem Solving

→ ISO 9001: 8.5.2 Corrective actions
→ ISO 9001: 8.5.3 Preventive actions
Problems are also opportunities for improvements!

Ishikawa Diagramm

What are the problems? What are the reasons?



First define accurately the Problem, then classify the possible causes in:

- **Man** (training, motivation, standardised work, …)
- **Machine** (maintenance, capacity, throughput, …)
- **Method** (process followed, fluctuations, specs, …)
- **Material** (suppliers, substitute, warranty, …)

Sometimes, the following families are also added:

- **Management** (behaviours, policies, …)
- **Environment** (cleanliness, humidity, temperature, …)
- **Measurements** (reading mistakes, settings, …)
- **Information** (available instructions, reports, …)

5W – Ask questions to reach the root causes

Who	What	Where
Who does it? Who is doing it? Who should be doing it? Who else can do it? Who else should do it?	**What to do? What is being done? What should be done? What else can be done? What else should be done?**	**Where to do it? Where is it done? Where should it be done? Where else can it be done? Where else should it be done?**
When	Why	How
When to do it? When is it done? When should it be done? What other time can it be done? What other time should it be done?	**Why does he do it? Why do it? Why do it there? Why do it then? Why do it that way?**	**How to do it? How is it done? How should it be done? Can this solution be used in other areas? Is there any other way to do it?**

Problems are better solved in teams!

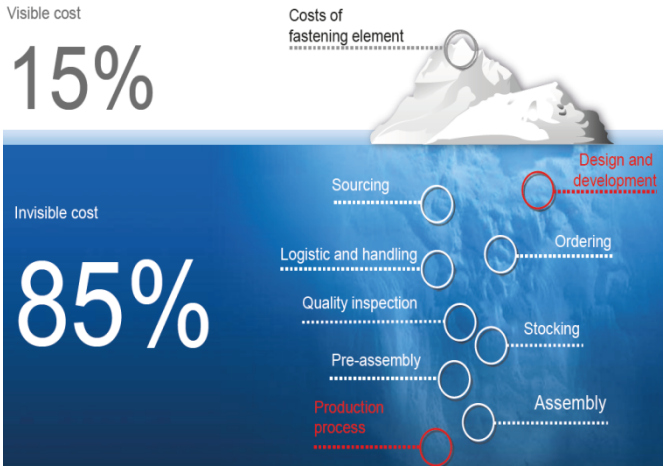
5 Week 5: Bossard, Customer Complaints, Materials Requirement

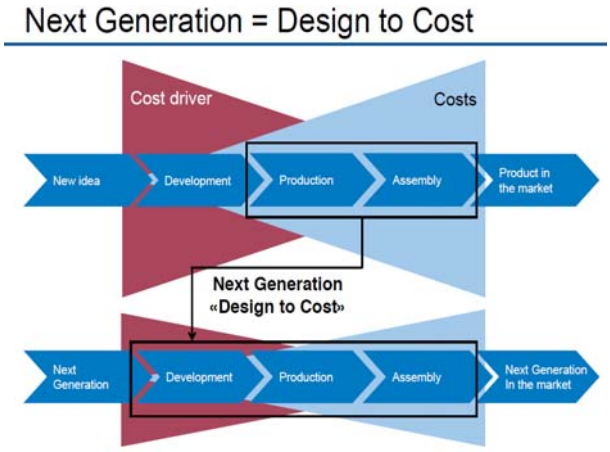
5.1 Visit Bossard

Bossard Profile

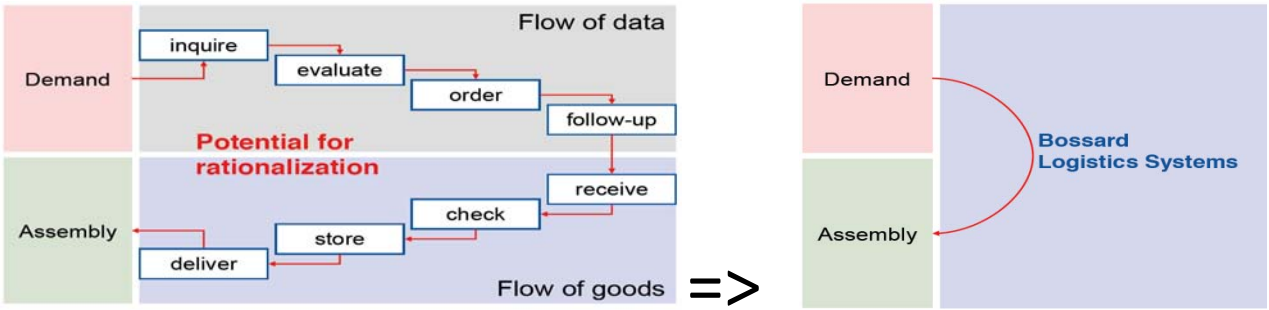
We support your economic and technical requirements by offering customer made solutions, helping you to a better and stronger competition position at higher safety – worldwide

Lean in Fastening Process



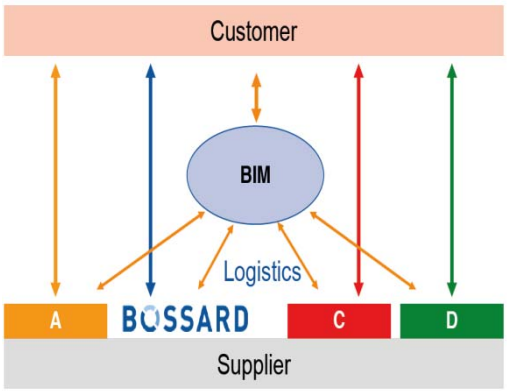


1. Lower your costs
2. Reduce your inventory
3. Increase your productivity



Success factors

Don't do	Eliminate redundancies
Simplify	Reduce complexity
Standardize	Multiply well defined processes
Bundle	Streamline the activities
Automate	Let the system do the routine work



5.2 Customer Complaints

Losing customers is expensive:

- Customers have a long memory of your bad performance
- 90% of upset customers will not buy again from you
- Upset customers tell it to 10÷20 other people: huge multiplier effect
- But only 5% of upset customers will tell you they are unhappy !
- It costs 5 times more to capture a new customer than to keep existing ones

Customer Complaints System (CCS)

- Use all possible sources of "Customer voice"
- Use a standard form to record data
- Act quickly and give feedback to the affected customer (even if the solution is yet to be found)
- Make issue and solution available in your company globally (to avoid reinventing the wheel elsewhere)
- Periodically review the CCS results
- Use KPIs:
    - Num. of complaints/ month
    - ,, ,, ,, / product family or product
    - Avg. time to resolve complaints
    - Avg. cost ,, ,, ,,

Results of a functioning Complaints System:

The profile of complaints will change over time

- From a large number of "interface issues" like delivery, labelling and administrative errors, and "cosmetic issues" like dirty or damaged parts…
- … to more substantial issues, like product design issues, on which it is also more challenging and interesting to work

It is important that CCS KPIs and relevant cases are brought to management attention, as a learning opportunity.

Customer Focus => Obsession

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

Relevance of a CCS for Operations?

- Most issues detected by customers have immediate impact on Operations (even if the root cause was not originated within Operations)
- Operations must react quickly and customer oriented to provide solutions (in cooperation with Sales and Product Development)
- Production normally issues Customer Complaints to Suppliers for what they deliver -- Purchasing manages them and checks that corrective actions are following suit

CCS is twice relevant: on the Customer and on the Suppliers side !

5.3 Materials Requirement Planning

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

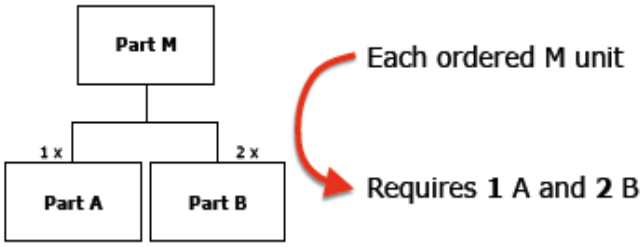
Orders:

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

Bill of Materials Explosion

But when exactly?
Parameters:

- Existing stock
- Replenishment time (production or supply Lead Time)
- Order policies (Lot size)



5.3.1 Exercise

1st Step: Customer Demand => Production Order

1) Independent Demand of the week

INDEPENDENT DEMAND									
Part Number	M				Lot size	0	Lead time	1	Safety stock	10
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Demand				60			100		20
Planned receipts				30			100		20
Qty on stock	40	40	40	10	10	10	10	10	10
Order			30			100		20	

3) Production Order (anticipated 1 week for Lead time)

2) Planned receipt
60 Demand – 40 on Stock + 10 SS

2nd Step: Explode 1 Level down – Part A

2nd Step: Explode 1 Level down – Part A

INDEPENDENT DEMAND									
Part Number	M				Lot size	0	Lead time	1	Safety stock	10
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Demand				60			100		20
Planned receipts				30			100		20
Qty on stock	40	40	40	10	10	10	10	10	10
Order			30			100		20	

1) Determine Dependent Demand

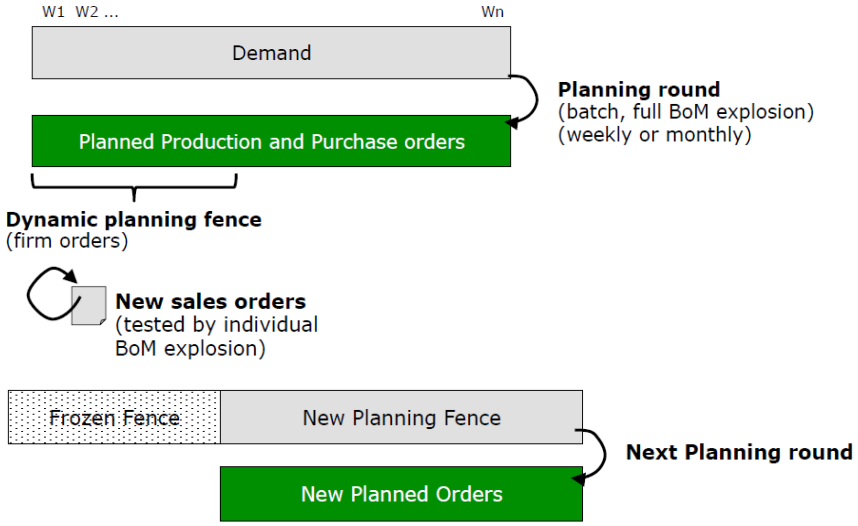
DEPENDENT DEMAND									
Part Number	A				Lot size	30	Lead time	0	Safety stock	0
Used in	1xM								
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Demand			30			100		20	
Planned receipts			30			90		30	
Qty on stock	10	10	10	10	10	0	0	10	10
Order			30			90		30	

3) Order 30 (Lead time=0)

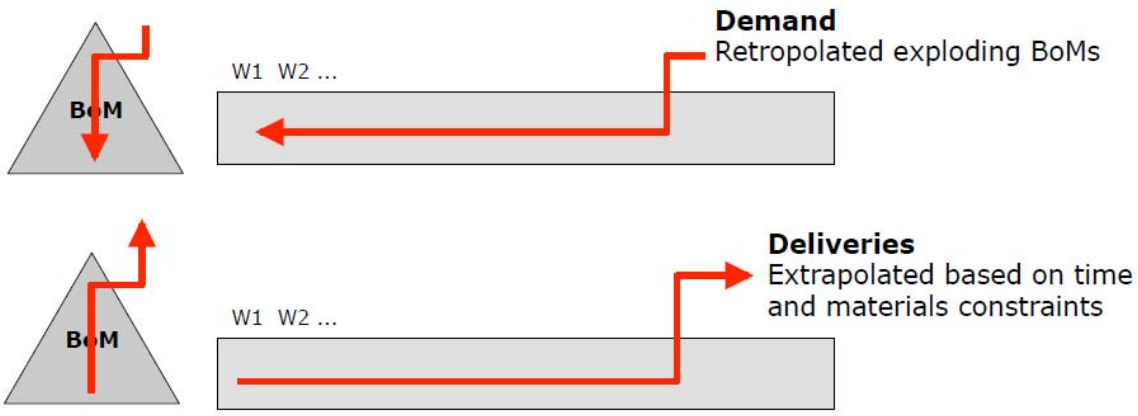
2) Planned receipt
30 Demand – 10 on stock + 0 SS = 20
but Lot size = 30 -> order 30

For the solutions of the class exercises see: OPS 05.H03 Solutions.pdf

Planning fence



Backwards and Forward



NB This is done by the MRP for all parts in the BoM

What can go wrong?

1. Actual deliveries differ from orders (missing or defective parts)
2. Physical stock differs from the inventory data in the ERP
3. Lead times are not kept up-to-date and are longer than the data in the ERP (inefficiencies, machine breakdowns)
4. The BoM or Routings were modified in reality, but not updated in the ERP
5. Alternative Components or Routings are used in production, but not recorded in the ERP
6. Last minute demands are satisfied in the shop-floor (expediting an urgent customer order) therefore altering the availability of components and/or machines

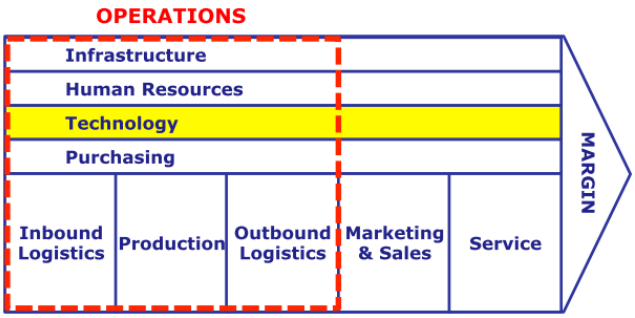
OPS Week 5: Recap

Logistics can be a USP in serving the customer (Bossard case)
Intelligent bundling of product & services makes a “non-sexy” product attractive
Consider your product (and costs) when “in use” at the customer
Take customer opinion & issues as learning opportunities
Keep current customers satisfied is less expensive than capturing new customers
Materials planning is critical and its quality is strongly influenced by values & quality of part master data (LT, Lot size, Inventory values)

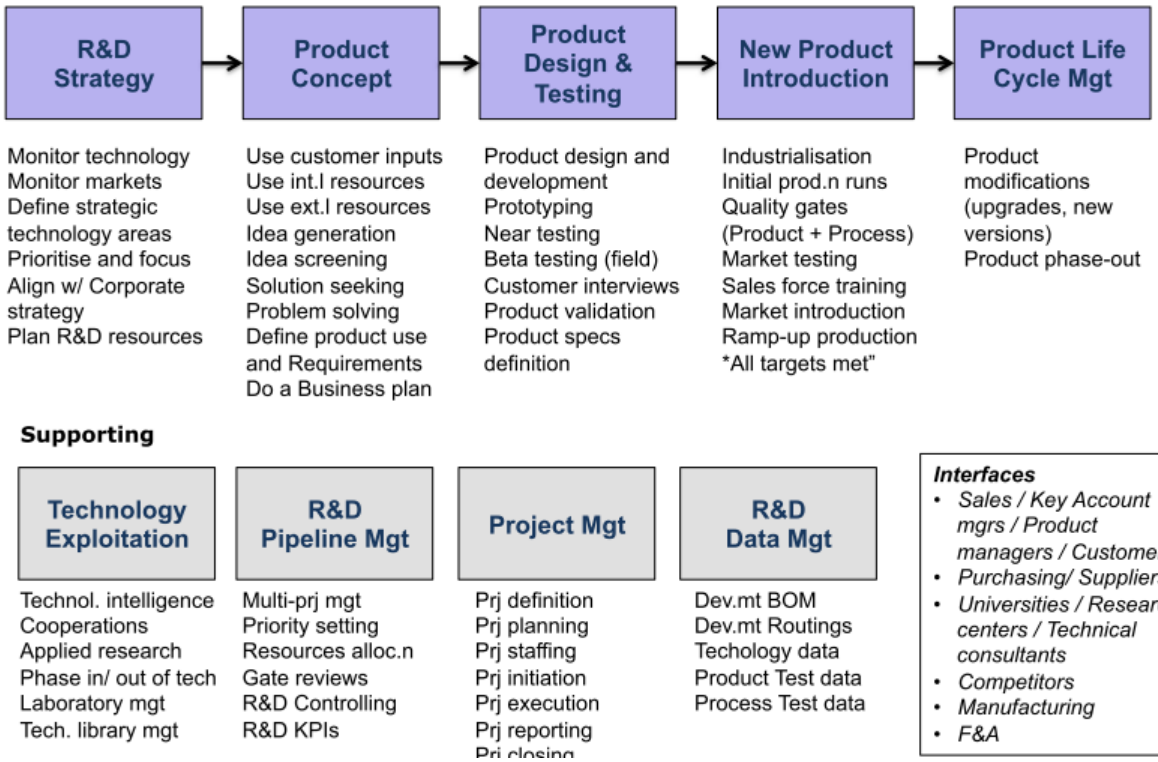
6 OPS Week 6: Dev. Process, Toolkits, Dev. quality, Innovation engine

6.1 Development process

Main issues in Operations are Interfaces. Especial if sales fills the productions with orders to produce, and R&D implements new tech. to fulfil these orders.



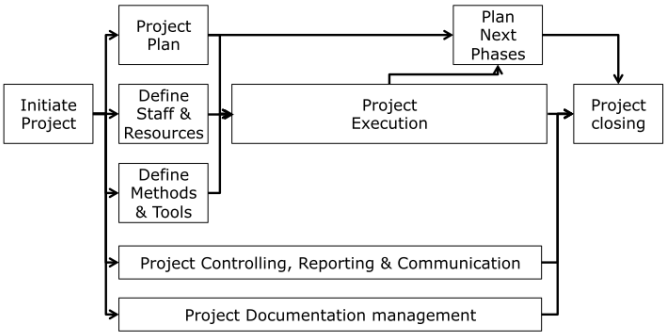
New products affect all of the departments in a company. Some tasks concerning new product development are listed below.



The job R&D is doing in a development is essential to the processes of tooling, Supply Chain, Production Equipment and all tasks directly connected to production (ramp up) and testing.
The Product Manager takes an important role in the product development. He is in charge of the concept, introduction and life cycle management. For this he needs to have well knowledge about the markets, technology and product portfolio. He is also the interface between departments and needs therefore good communication skills.

6.2 Toolkit: Project management

Typical project activities are shown in the graphic on the right. Generally they are already known from earlier modules. Additional importance has the project closing with the “Wrap-Up” meeting. In which all the results are reflected and the leanings from this project summarized.



The content of the Project itself should be broke down into manageable pieces of work. Possible this takes multiple sub points to complete the project content (e.g. W1 is spitted again into W1.1, W1.2, W1.3…).

With a Gantt chart the project can be shown in the proper timeline, and it's clear visible how long the timeframe of a task is. But you can't see the tasks workload on this chart. This set up of the timeline benefits a lot of setting multiple gates (kind of milestones) such as business case, product specs or market launch.

The project has different influences to face all the time. All of them have influence on the outcomes of the project. There has to be found a balance between cost, time and scope to have the needed quality outcome of the Project.

Different **Pitfalls** in the different project phases challenge the project & project management additional:

Planning:
Expectations are not clear or unrealistic; planning is to optimistic or to unclear.
Counter -> Discuss deep enough with p.owner and steering committee, plan proper stages, working packets and milestones.

Project Manager:
Lack of experience, has not the required authority (age, position, personality, steering committee)
Counter -> Not just select first available person, check acceptance in organisation, track his records, provide training If needed

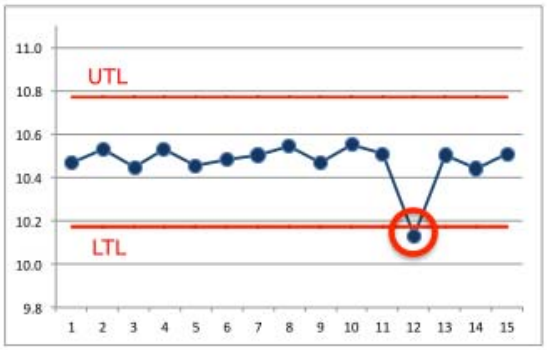
Steering Committee:
Lack of knowledge, not allowed to take critical decisions, not enough time to dedicate to project
Counter -> Select member with know-how, inform them well, commit enough time to them, ensure their authority

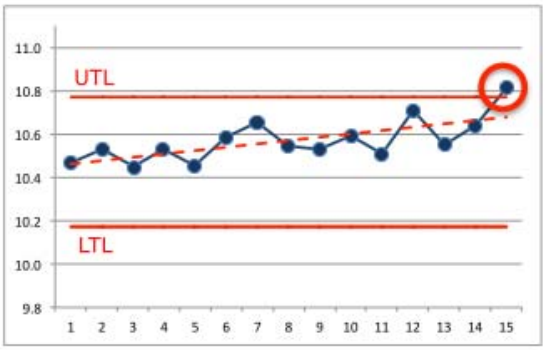
Reporting
Under- / Over detailed, shows cumulated cost and time , but no forecast
Counter -> Define reporting tool at beginning, request forecast on every milestone, define reporting sheet for steering committee which highlights important issues

Project End:
Learnings are not documented, immediate allocation of members -> no profit from their learnings
Counter -> Execute official review after project, ensure HR records project in the profiles of members

6.3 Toolkit: Statistics Process Controls (SPC)

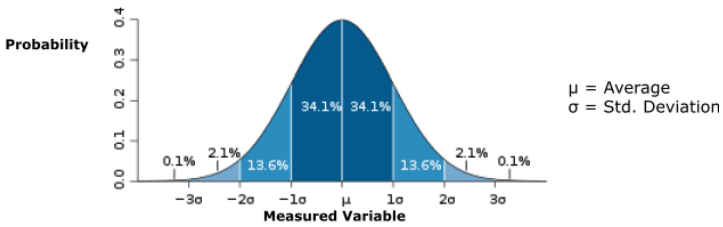
Production faces a lot of different processes and this leads to a lot of interfaces which can cause troubles. Therefore it is necessary to ensure that the processes are executed under control. If this is the case, there will be (almost) no defective parts.
To ensure this multiple tests should be done after production. Results have to be stored (ISO) and analysed for eventual failure prevention.





If the failure is just an exception (left picture) there is not so much to worry about. But if the final product comes closer to tolerance limits in time (right picture) it indicates a problem in the production process. A capable process stays in tolerance over time.

Normal variation is at 3 Sigma. But with a lower Sigma you have a better process – this leads to a higher "safety margin" and you are better able to keep up with the tolerances.



sigma multiples	1	2	3	4	4.5	5	6
area %	68.3	95.45	99.73	99.9937	99.99932	99.99994	99.9999998
ppm	317311	45500	2700	63	6.8	0.57	0.002

The C_{pk} index shows the minimum distance to the tolerance limits (UTL and LTL). It can be calculated with the following formula: $C_{pk} = min\left[\frac{UTL-\mu}{3\sigma}, \frac{LTL-\mu}{3\sigma}\right]$

If you fail to reach the needed tolerances -> improve process or discuss the tolerances

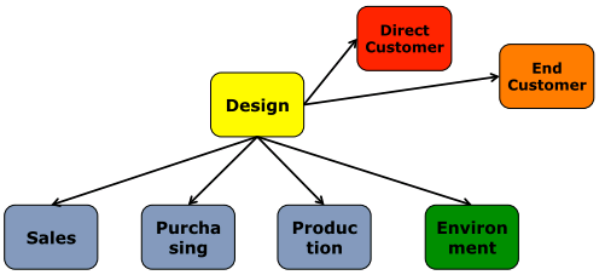
Six Sigma introduced by Motorola to improve quality is used in multiple corporations now. The assumption in this process is that a process of +/- 6 Sigma is initially needed to ensure long term a process of +/- 4.5 Sigma, because the process quality shifts overtime.

6.4 Design for excellence

A good design fulfils customer needs, differentiates from competitors, enables development further developments of variation later on and can be brought quickly to the market. The main aspects for design in development are design engineering and manufacturing engineering.

While design is focused on market, customer and technical specifications, is the manufacturing interested in machinery (tools) and available technologies.

A lot of tools for a good design are available but design is not only a matter of tools. It is important to think already during design about later production steps. There are also several groups with different requirements to the design.



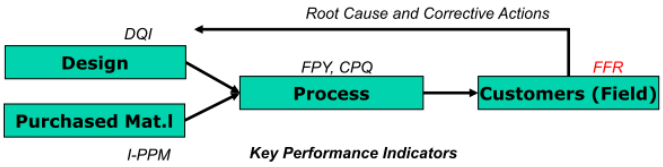
A few examples of requirements in design are:

For product	For production	For time to use	For end of life
Trends	Machinery	Installation	Reuse
Customer needs	New technologies	Usability	Easy disassembly
Performance	Volumes to produce	Documentation	Disposal (take back)
Patents	Yield / scrap	Serviceability	recycling
Costs & profits	Testing	Warranty	
performance	Packaging	reliability	

6.5 Development quality

The quality of a development can be measured with several KPI's:

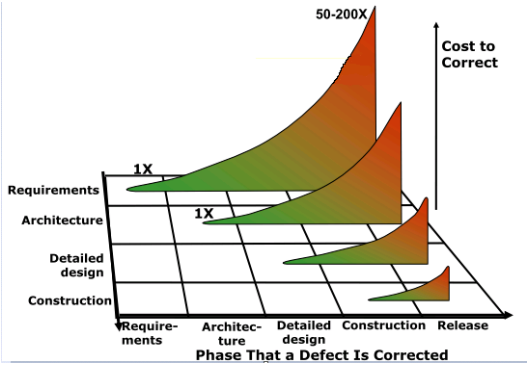
KPI	Descripion
DQI	Design quality index
I-PPM	Incoming poor quality
CPQ	Cost of poor quality
FPY	First pass Yield
FFR	Field failure Rate



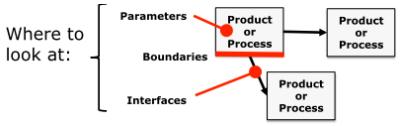
This reliability can be reached in 3 steps: Design – Process – Field

Reliability of a whole system can be done with the part list of the product. Therefore it is needed to set the reliability for all the part groups. This groups are existing parts and new parts. The new parts can also be divided again in critical parts and everything else.

Because money is the value on which a management is sensitive to, you should prepare the costs of failures and warranty in a overview which indicates how much this costs are per sold product. Also with a tracking of historical values gives a good base to argue with people in charge. Remember also the rule that early detection of failures makes them much easier to fix.



6.6 Toolkit FMEA



The FMEA tool helps you to identify problems or possible problems in the production process of a new developed product. Variations of a general FMEA are the DFEMA for Design and PFMEA for processes.

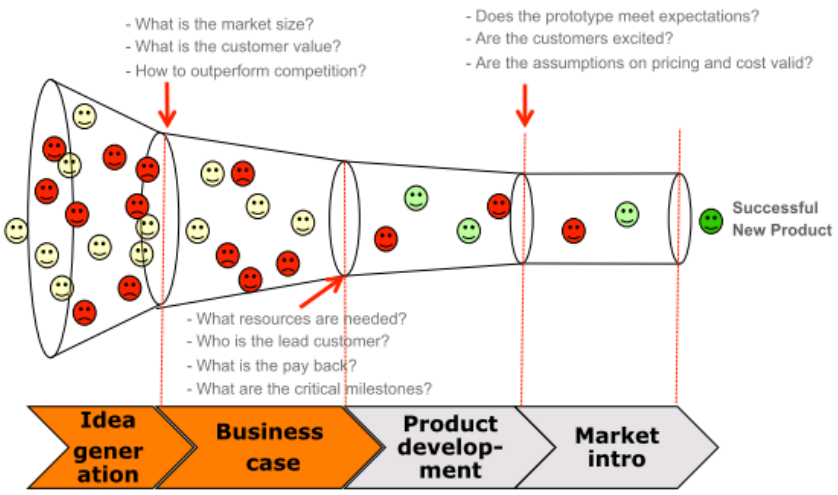
The core of a FMEA is a table in which all the possible failures are listed. In a second step these failures are rated in scale of 1-10 in 3 different areas: Severity (consequences), occurrence (frequency) and ability to detect. All of this ratings are multiplied which results in a risk priority number (RPN) so that the worst problems have the highest RPN. The highest risks will be faced with corrective actions and rated again in the same areas which they will have after implementing the corrective actions. A new RPN is then calculated and should also be much lower than those before.

Item / Function	Failure Mode	Failure Effect	Severity	Potential Causes	Occurrence	Current Controls	Detection	RPN	Actions required (incl. by when)	Owner	Actions taken	Severity - after	Occurrence- after	Detection-after	RPN - after

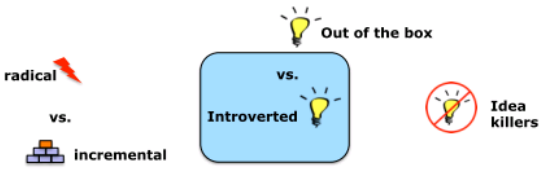
6.7 Innovation Engine

Creativity is not equal to innovation. While creativity is generating something which hasn't been here before, innovation is something new that has also success on the market. Real innovation is hard to achieve. If you do not complete innovation, you will find yourself into incremental innovation which is only slightly improving products. Main reasons for this to happen are: Lack of time (no priority / 50%), internal resistance (uncertainty 44%) or budget shortage (no priority).

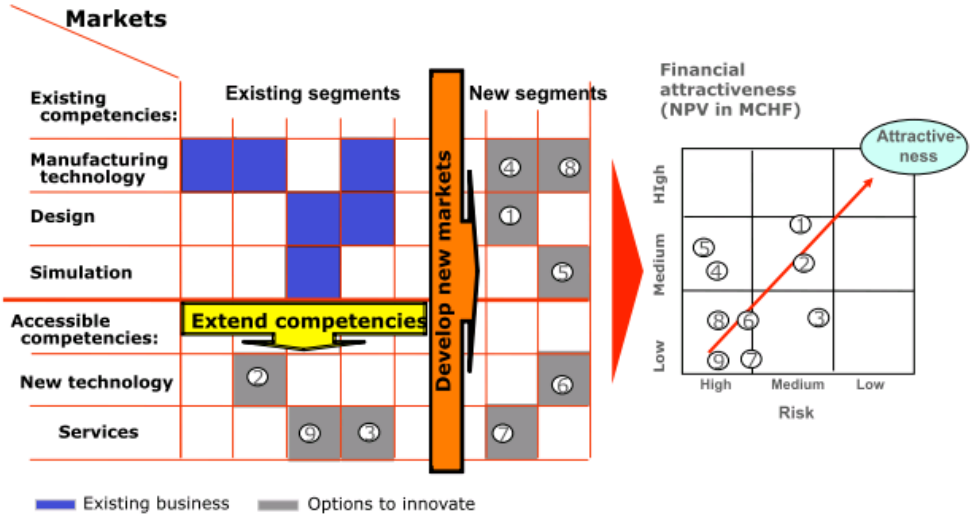
Innovations are guided through the innovation funnel, where the more promising cases pass each gate. So you will only have the best innovations at the end.



As first you need to do lots of work to generate ideas, investigation, discussions and stakeholder analysis. Therefore it is easy to kill new ideas.

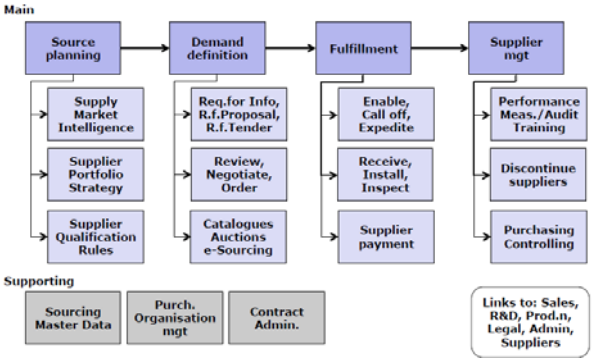


To make innovations fit your business and pocket, you have to analyse and verify the ideas in a business case. Out of this you can say what ideas more are worthy to make a business out of it and also can convince your investors.



7 Week 7: Purchasing

Purchasing (also Procurement or Supply) enables the company to receive the required goods and services at the right prices.



7.1 Source processes

The source processes should be taken with care because of oversimplification. It's not a functional view; it's a simplified process view.

7.1.1 Purchasing Classes (Direct or Indirect goods)

	Direct Goods	Indirect	Goods
	Raw materials, Components	Repairs, Consumables, Maintenance	Capital goods, Services
Quantity	Large	Low	Low
Frequency	High	Med	Low
Value	High	Low	High
Nature	Operational	Tactical	Strategic
Who drives the purchase	Central Purchasing	Local Purch. or Using Department	Users' Department
Examples	Metal sheets, Plastics, Electronic components, PCB, sub-assemblies...	Lubricants, Spare parts, Packaging, office supplies, energy, water...	Machines, Plants, Trucks & Cars, IT Systems...

7.1.2 From the initial Need to Supply to Production

Need	• Make or Buy decision • Supplier strategy and Supplier Approval Rules
Supply	• Prepare information package • Send RfQ (Request for quotation) and evaluate responses • Internal/external review (sourcing committee) issues & risks • Compare suppliers/ Approve supplier • Negotiate
Production	• Sourcing decision & agreement/ Contract/ Order • Supplier preparation • Ramp-up/ Operation in series • Monitor suppliers' performance

From Supply to Pay: Three-way check

For production materials, supplies, consumables:

- Purchasing -- negotiates, agrees price
- Receiving -- authorises payment
- Accounts Payable -- invoice control & payment authorisation

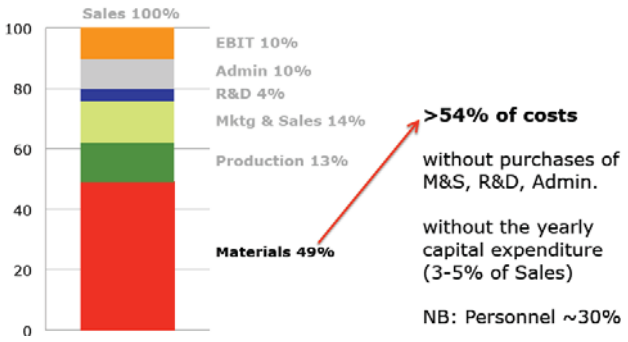
For special orders, IT, Services, Capital goods:

- Purchasing -- negotiates, agrees price (not always)
- Requestor/ User -- agrees price, authorises payment
- Accounts Payable -- invoice control & payment authorisation

7.1.3 Purchasing Process (ISO 9001 – 7.4.1)

- The organization shall ensure that purchased product conforms to specified purchase requirements.
- The type and extent of control applied to the supplier and the purchased product shall be dependent upon the effect of the purchased product on subsequent product realization or the final product.
- The organization shall evaluate and select suppliers based on their ability to supply product in accordance with the organization's requirements.
- Criteria for selection, evaluation and re-evaluation shall be established. Records of the results of evaluations and any necessary actions arising from the evaluation shall be maintained.

Relevance



Purchasing is very relevant. 49% materials cause more than 54% costs (According the interview it's 55-60% in average). Purchasing has an important influence to the success of a company.

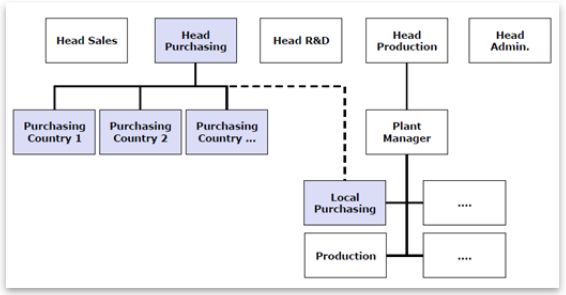
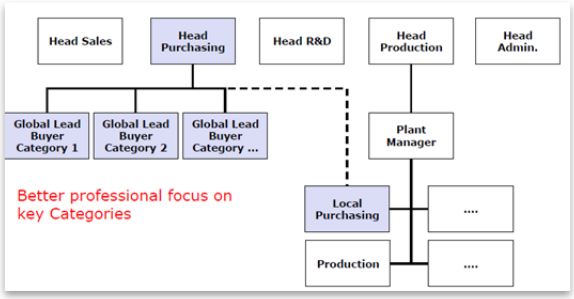
- It is evident that an improvement in the purchasing cost base has a major effect on EBIT
- … much more than an improvement in Production or other Departments!
- Effective Purchasing is a "source" of EBIT

Purchasing Managers Index (PMI)

PMI is a weighted index → leading indicator, tells in advance what's going to happen (zu deutsch: Frühindikator)

The concept behind the PMI is quite simple and has been used successfully in the US for over 50 years. Each month, over 200 purchasing managers at Swiss industrial companies are asked about their performance in the current month compared with the prior month.

7.1.4 Purchasing Organization

Traditional	Evolved
	

Buyer

- **Local** generalist who buys all categories

Category specialist

- **Local** category **specialists** (have knowledge of specific category, e.g. electronic parts) are only in charge for their category

Lead Buyer

- **all** purchases of a given **category** coordinated from one location for all other, **global** visibility

Interview: Purchasing

- use the **best** supplier
- to find the best you have to rate each for benchmarking purposes → KPI
  - KPIs are not just the **price**. Relevant indicators are quality, service level and **financial** data, too.
- Production: Active Supply Chain Management is an important function of procurement
- Focus on work and training
  - cross-functional team → a purchasing guy never works alone
  - good people need training
  - work → innovation
- Category Management (Warengruppenmanagement) → you have to differentiate in product categories (examples of grocery categories might be: tinned fish, washing detergent, toothpastes).
  The Chartered Institute of Purchasing and Supply defines Category Management as: "organising the resources of the procurement team in such a way as to focus externally onto the supply markets of an organisation (as against having a focus on the internal customers or on internal Procurement departmental functions) in order to fully leverage purchasing decisions".

7.2 Excellence in Purchasing

7.2.1 Challenges for the Purchasing function

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)
6. Find, develop and retain talented purchasing people
7. Transform Purchasing processes (outsourcing)
8. Improve supplier relationships to increase value
9. Standardise purchases (particularly Capital goods)

7.2.2 Supplier Audits (Product/ Process/ System)

Challenges for the Purchasing Function:

- Understand the business of the supplier
- Have competent people to participate to audits
- Maintain a regular pressure on suppliers
- Profit really from the audits to:
  - Retain the best suppliers
  - Help the promising ones to further improve

Notabene: The Quality Function supports directly the planning and execution of such audits with own personnel and methods

Supplier Evaluation (KPI)

1) Product quality **Q**
2) Cost **C** NB product cost ≠ Total cost
3) Delivery time **D**

4) Financial stability
5) Innovation
6) Environment / Sustainability / Corporate responsibility
7) Quality of the business relationship

Supplier evaluation example (Eaton)

1. Quality (150 Points)	
DMR* frequency & responsiveness	60
PPM levels	53
Third party certifications	22
PPAP/FAI acceptance & timeliness	15

2. Purchasing (125 pts)	
Responsive to New Business	20
Involvement in IDEAS program	35
Price Policy-Yearly contracts	30
Cooperation and Service	30
Financial Analysis	10

3. Logistics (125 pts)	
Predictability (On-time Delivery)	15
Flexibility	35
Communication	35
Logistics	30
Other Criteria	10

4. Innovation (125 pts)	
Staffing/Technology	50
Engineering Quality	20
Prototyping	20
Testing and other Doc.	15

(*) DMR= Discrepant Material Report

Supplier Score has huge implications

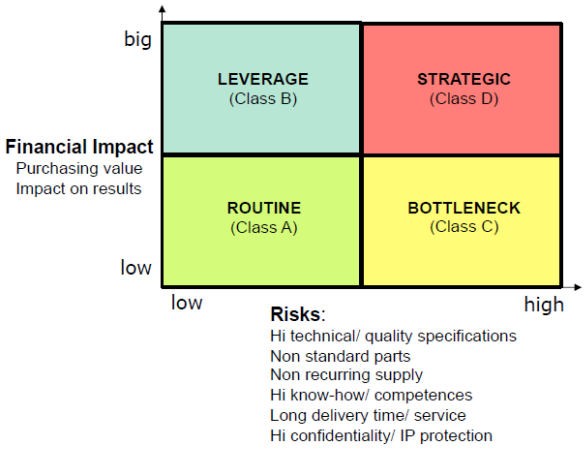
Preferred status gives a supplier increased opportunity to bid on new business (example)

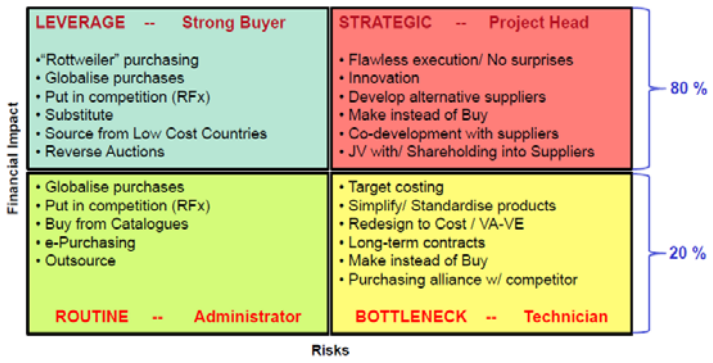
- Preferred > 80%
- Standard > 70%
- Phase-out < 70% candidate for exclusion from supply panel

NB these rankings are global: failure in one delivering plant/ country impacts a whole corporation!

→ **Having the best possible supplier is obviously vital for a firm**

7.2.3 Classify & differentiate Purchases: not all are equal





7.2.4 e-Purchasing (Auctions)

Auctions performed in real-time are a dynamic, cruel process that achieves rapid downward price pressure; real-time price disclosure increases transparency

- **Reverse English**: bid starts at given price, suppliers submit sequential offers lowering their prices, after seeing the other bids, or exit
- **Reverse English Ticker**: bid starts at given price, but buyer lowers the price in steps (ticker), suppliers tell if they stay or exit
- **Dutch forward**: Bidding starts at a price so low no seller accepts, then increased in steps until it is acceptable to one supplier

Specialised IT systems enable the handling of auctions in Internet.

Advantages

- Dynamic
- achieves rapid downward price pressure
- time price disclosure increases transparency

Disadvantages

- Cruel process →supplier doesn't like it

7.2.5 The Dyad Concept

The Dyad transforms the relationship from dysfunctional to a new, successful and sustainable collaboration: major increases in sales volume per supplier, significant reductions in the joint costs of doing business, and (even more important) critical mutual support for new product development

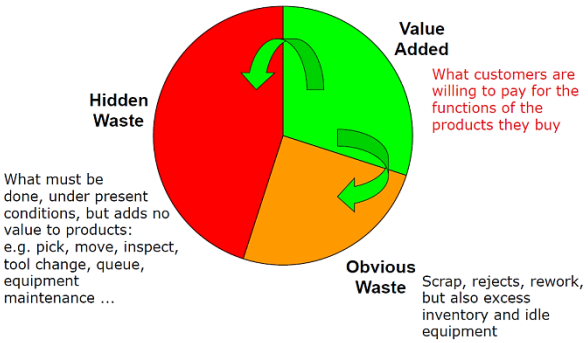
Recap

- Not all products purchased are equal: purchasing matrix – each purchasing category is to be managed differently
- Purchasing has a major impact on the financial results and on the excellence of a company, but also on business risks
- Big opportunities can be achieved in better Customer/ Supplier relations: a paradigm shift helps to strive for excellence
- The link between Purchasing and other Functions is key: early Purchasing involvement is essential

8 Week 8: Waste / Market Intelligence / Production Toyota

8.1 What is "waste"?

1) Excess production	Manufacturing parts in excess of customer demand or manufacturing them too soon
2) Motion	Unnecessary worker/ machine moves, excessive handling within a production cell
3) Waiting	Machines/ people idle instead of processing (unbalanced cycles, breakdowns, delays, waiting for materials feed…)
4) Conveyance	Transporting further than necessary or temporarily locating, restocking and moving parts again
5) Overprocessing	Performing additional work not normally necessary – to overcome ineffective design, methods, materials, tools, procedures
6) Inventory	Keeping inventory (which freezes cash that could be used elsewhere for production)
7) Defective production	Rejects, reworks, deviation from standards, repairs
8) Not Utilising Human Brains	Not taking advantage of knowledge, creativity and suggestions of all plant people
9) Waste in Administration	Excessive paperwork, cumbersome procedures
10) Abuse of Technology	Overuse of technology (e.g. too much automation, complex data collection systems not really used…)
11) Waste of Space	Excessive floor occupation due to poor design of workcell layout
12) Waste of Motivation	Dirty/ unsafe environment, negative behaviours, no positive feedback
13) Waste of Information	Excess or wrong information, wrong performance indicators, leading to wrong management decisions

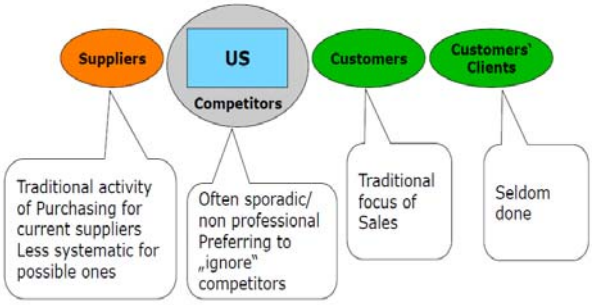


Value adding activity
- Saw wood

Non value adding activities
- Wood delivery to saw mill
- Waiting for delivery of wood
- Set-up of the saw
- Change blades
- Machine break-downs
- Cleaning
- Quality control
- Get containers
- Moving wood packages
- Meetings
- Administrative formalities

8.2 Market Intelligence:

The company is not an isolated being: one must know what happens outside:

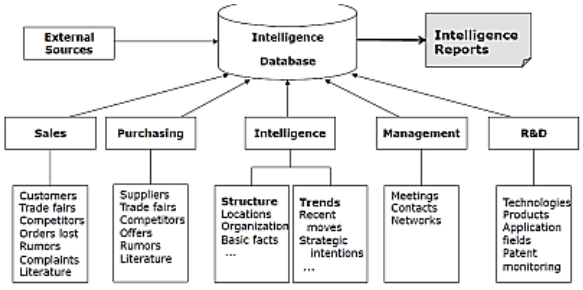


- Primary sources
  - Own experience, direct contacts
  - Questionnaires, Surveys
  - Request for Quotations, Product tests
  - Site visits
- Secondary sources
  - Annual reports, Website, Marketing publications of the company
  - Intelligence reports of market Research institutes and Banks
  - Business Databases
  - Public reports/ filings
  - Literature, magazines

Market Research Reports

Several service companies provide Market Research reports, by Industry, Geography or special topics of interest, like:

- Intelligence companies: Market Research, Frost & Sullivan, Informa/ Datamonitor…
- Finance companies: Investment Banks, Corporate Finance firms…
- Publishers: Economist Intelligence Unit, Financial Times…
- Consulting firms



Market Intelligence Report

Executive Summary	i. The company in few words ii. The competitive (or supply) situation	**The Company**	i. History ii. Locations iii. Organisation iv. Shareholders v. Strategy

Market & Products	i. Product range ii. Sales by Product family iii. Sales by Region iv. Sales by Customer v. Market positioning assessment	**Financials**	i. Profit & Loss elements ii. Balance Sheet elements iii. Cash flow elements
Company assessment	i. SWOT analysis ii. Quality vs. Price iii. Assumed strategic moves iv. Benchmark against our company (or other suppliers) v. Market positioning assessment	**Attachments**	i. Tables, Figures, Details, Sources ii. History of document modifications

After the Market Intelligence:

1. Competitors' Benchmark
2. Competitive Positioning

Input to Strategic Planning:

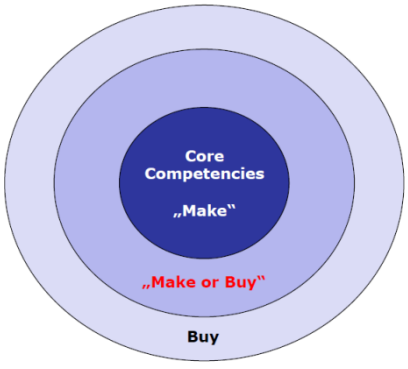
Use the information gathered on competitors / suppliers to better develop your strategy, asking yourself:

- What are competitors doing better than we do?
- What will be competitors'next strategic moves? (They do not sleep…)
- Who else is not yet on the radar screen, but could enter the market? e.g. are there suppliers trying to enter in our own turf?
- Will our investments be at risk due to potential competition/ supply issues?

Input to Strategic Sourcing:

Use the information gathered on suppliers to better develop your strategy, asking yourself:

- Are there potential sourcing bottlenecks? (too high demand, impacts of exchange rates, of commodity values, shortage of financing or of available capacity…)
- Which products/ solutions are becoming available, we could profit from in the future? (New or Substituting materials)
- Which are the major Trends among suppliers?
- Are there new potential suppliers? How reliable?
- Where are innovations coming up in the supplier world?
- Are there possible dangerous M&A deals targeting our suppliers?
- Are the additional Make or Buy decisions to take?



8.3 Legal compliance (Work closely with Corp. Legal)

=> In Purchasing as well as in Sales, there are so many contractual aspects… it can be extremely critical and may turn an interesting business into a financial disaster.
=> Often in industrial companies engineers tend to consider these aspects as details, compared to the intellectually challenging technical aspects
=> Purchasing and Sales professionals have to work on their contracts from the beginning with Corporate Legal !!!

Breach of Warranty

- Warranties are promises of the manufacturer or seller about his products during a commercial
- Breach of warranty happens when products do not fulfil:
    - an express warranty (contractual specification)
    - an implied warranty of quality, feature or "fitness" for a specific purpose, as commonly expected for such products
- In case of breach, the contract is still in force, but the buyer can claim: performance (repair or substitution), reduction of the purchase price, withdrawal and/ or damages

Liability for Product Defects

- Manufacturing defects: occur in the manufacturing process and are caused by poor materials or processes or both
- Design defects: if products are inherently dangerous (or useless) by design, fail to satisfy normal safety expectations or they risks outweigh their benefits -- no matter how well manufactured
- Failure-to-warn defects: the products carry inherent non-obvious dangers which could be mitigated through adequate warnings to the user – no matter how well designed and manufactured

Consumer Safety

- His hard battle against OEMs lead to the U.S. Environmental Protection Agency / the Clean Air Act
- Strict product liability rules were added to the US legislation ('63÷'69), later in the EU ('77 and '85)

Strict Liability

Under strict liability, the manufacturer is liable if the product is defective, even if he was not negligent in making that product defective

- Liability is based either on tort or on contract. "Strict liability" is based on tort. Liability based on tort cannot be limited. Any third party (injured party) may claim.
- Why? The manufacturer knows more and can better anticipate hazards than his customers
- Strict liability forces him to assume costs, that are redistributed via the sales price to all customers, thus making risky products noncompetitive, in the end

Product Recall

- A request to return to the producer a defined lot of a product, due to the discovery of safety issues: it is an effort to limit financial exposure and negative publicity
- Recalls are expensive and generally avoided until the last minute, but less costly than consequential costs caused by damage to the brand name of the manufacturer
- Costs range from repairing for free or replacing the recalled product, to compensating for damages caused by its use
- Country regulations for consumer protection rule how such recalls have to be handled

Corporate citizenship and Ethics

- Stakeholders expect now from companies full transparency on how they do business: more than financial compliance and anticorruption
- Companies that used suppliers in LCC where labour safety/ conditions and/or the environment were not taken care of, or child labour was used, got extreme pressure in the media
- It is the task for Procurement professionals to evaluate also these aspects
- Wrong suppliers selections may drive the company into extremely costly situations

8.4 What is Production

Definition: The processes and methods used to transform tangible inputs (raw materials, semi-inished goods, subassemblies) and intangible inputs (ideas, information, knowledge) into goods or services.
Resources are used in this process to create an output that is suitable for use or has exchange value.

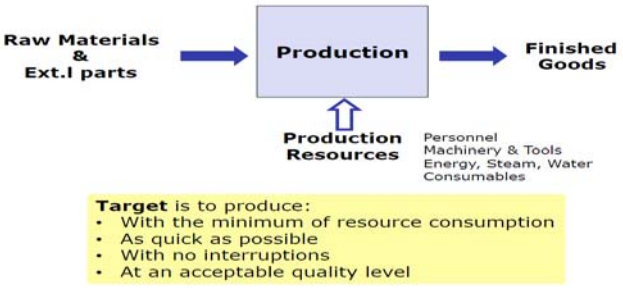
Modern mass production: the Model T line

- Until Model T, car production was "shop" based: the car was assembled piece by piece in one place, skilled workers around it - Model T started in 1908; the assembly line gave the timing to all workers; they were unskilled, performing repetitively few activities
- It allowed to cut significantly the production time of a car
- It significantly lowered the price (5 times less), setting the base for the Consumerism era
- Model-life production totalled 15 m units, surpassed only in '72 by the VW Beetle

Production types :

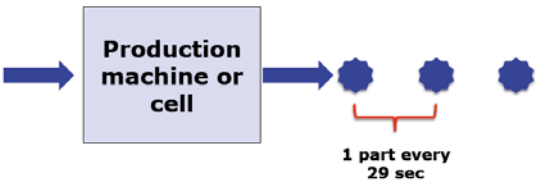
Production	Volumes	Product variability	Equipment Flexibility	Examples
Job shop	1 piece to very few	Highest (custom)	highest	Toolmaking
Batch/ Group	medium	high	mid	Metal parts workshop
Flow	high	few variants	limited	Car assembly
Continuous	highest	minimal to none	almost none	Paper mill

Production simplified:



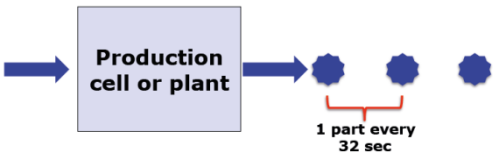
Production key parameters: Cycle time

Time elapsed between two products coming out of the same production cell.
"Actual" cycle time (vs. the "expected or standard" one) is affected by the efficiency and availability of workers and of machines. Actual cycle time can be higher than the standard.
Process improvements can reduce cycle time.



Production key parameters: Takt time

Time at which products must come out of a production cell in order to exactly satisfy the customer's demand

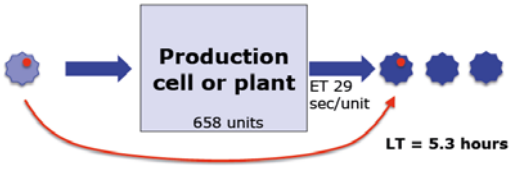


$$Takt\ time\ (sec/\ unit) = \frac{Available\ time\ for\ production\ (sec/\ day)}{Customer\ demand\ (units/\ day)}$$

- Own working rules (shifts, pauses…) determine the Availabletime for production
- Customer demand is an external constraint
- CT must be lower than TT, or demand will not be met

Production key parameters: Production Lead time

Time needed by an "identified" part to go through the whole production process from beginning to end (starting from its initial components) – (called: Throughput time)



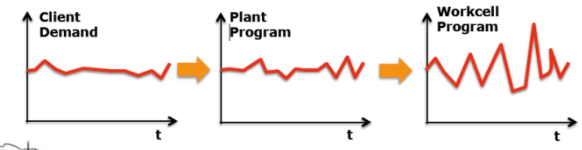
Lead time (sec) ≈ Parts in system (units) * Exit Time (sec/ unit)

On top of processing time, LT contains the initial setup time, moving, waiting in intermediate or final storage until picked for the next use (the following production cell or the customer)

The 2 Evils for Production: Demand Variations

- Internal Variations**:** due to rework for defective parts, breakdown of machines, unavailability of raw materials or external components or operators, expediting for changed priorities (or badplanning)...

- External variations: all changes applied by each member of the supply chain, because of his own internal issues and for his interpretation of future demand



The 2 Evils for Production: Waste

ISO 9001: 6.3 Infrastructure

The organization shall determine, provide and maintain the infrastructure needed to achieve conformity to product requirements

Infrastructure includes, as applicable:

- buildings, workspace and associated utilities,
- process equipment (both hardware and software)
- supporting services (such as transport, communication orinformation systems)

ISO 9001: 6.4 Work environment

The organization shall determine and manage the work environment needed to achieve conformity to product requirements

NOTE The term “work environment” relates to those conditions under which work is performed including physical, environmental and other factors (such as noise, temperature, humidity, lighting or weather)

ISO 9001: 7.5.1 Control of production and service

The organization shall plan and carry out production and service provision under controlled conditions:

a. availability of information that describes the character- istics ofthe product,
b. availability of work instructions
c. use of suitable equipment
d. availability and use of monitoring and measuring equipment
e. implementation of monitoring and measurement
f. implementation of product release, delivery and post-delivery activities

ISO 9001: 7.5.2 Validation of processes

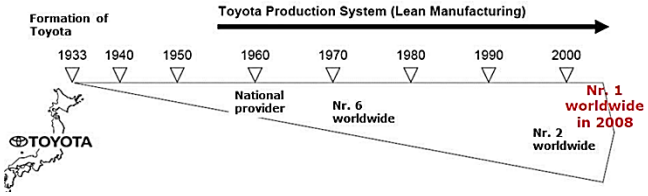
The organization shall ensure that product which does not conform to product requirements is identified and controlled to prevent its unintended use or delivery. A documented procedure shall be established to define the controls and related responsibilities and authorities for dealing with nonconforming product, by:

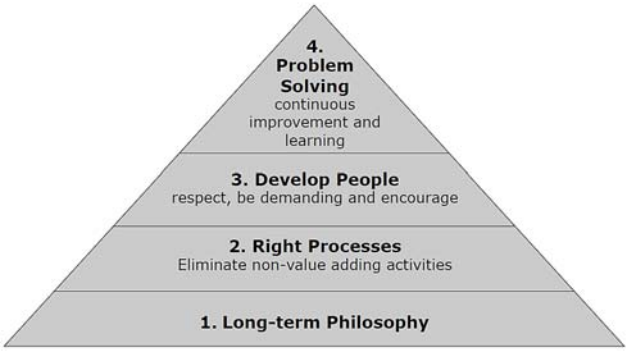
a) taking action to eliminate the detected nonconformity
b) authorizing its use, release or acceptance under concession by a relevant authority and, where applicable, by the customer
c) taking action to preclude its original intended use or application
d) taking action appropriate to the effects, or potential effects, of the nonconformity when on conforming product is detected after delivery or use has started

8.5 Toyota Production System

"Lean manufacturing is a production philosophy which has been developed at Toyota and aims at an improvement of the whole production chain through continuous elimination of waste, fluctuations and inflexibility."

Taiichi Ohno, Pioneer of Lean Manufacturing





The Toyota Way

1) Long-term Philosophy

- Base your management decisions on a long-term philosophy, even at the expense of short-term goals

2) The right Process will bring the right results

- Create continuous process flow to bring problems to the surface
- Use "pull" systems to avoid overproduction
- Level out the workload
- Build a culture of stopping to fix problems, to get quality right the first time
- Standardized tasks are the foundation for continuous improvement and employee empowerment
- Use visual control so no problems are hidden
- Use only reliable, thoroughly tested technology that serves yourpeople and processes

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

3) Develop your People

- Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others
- Develop exceptional people and teams who follow your company's philosophy
- Respect your extended network of partners and suppliers by challenging them and helping them improve

4) Solving Root Problems drives Organizational Learning

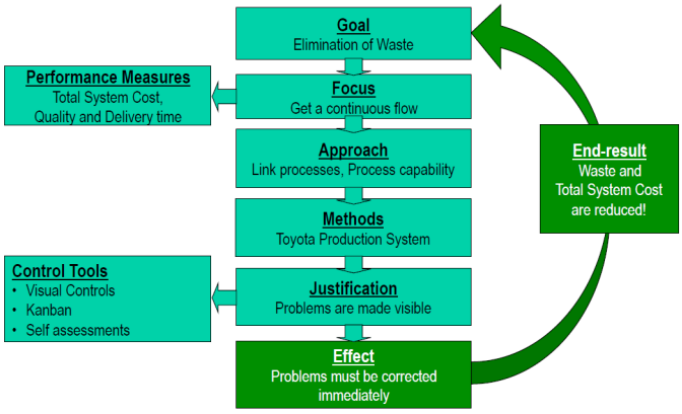
- Go and see for yourself to thoroughly understand the situation (genchi genbutsu)
- Make decisions slowly by consensus, thoroughly considering all options; but then implement decisions rapidly
- Become a learning organization through relentless reflection and continuous improvement

New concepts for production

1) Only high quality products, no waste
2) Use leveled, stable production processes
3) Produce only the amount necessary now
4) Produce Just-In-Time

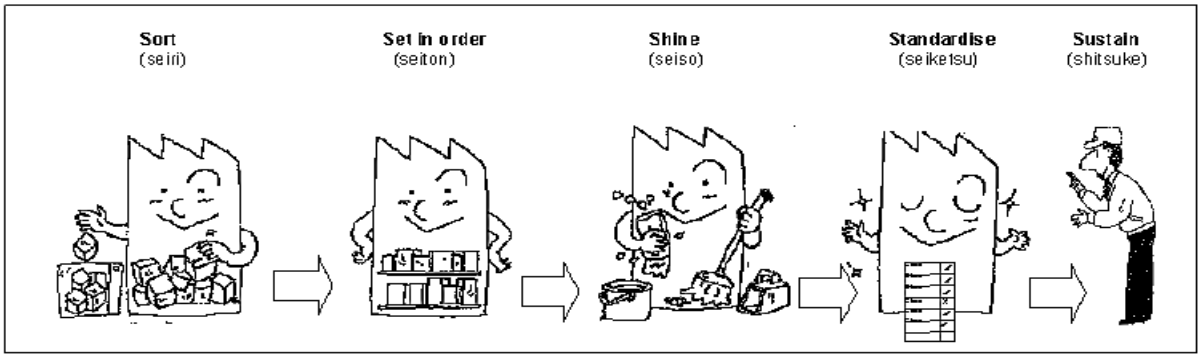
=> Efficiency and Cost Reduction are a consequence

Lean Production focus: Waste reduction



8.6 Workplace organisation: Five "S"

1) Sort. Separate the necessary from the unnecessary; first tag then get rid of the useless tools, work in process, machinery, products, papers, and documents
2) Set in order. Put needed tools and material in a set place and keep things in order, so that what is needed to do the job is found without wasting time looking (markings on floor or tools)
3) Shine. Keep the workplace clean, so problems are avoided or easily spot (no dust, fluids, debris…), make cleaning part of daily machine inspection and small maintenance tasks (e.g lubrication) part of operators' work
4) Standardise. Define working standards. Deviations are easily seen
5) Sustain. Adhere with discipline to standardized work procedures



Attention: Resistance:
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

Prerequisites:

- Operators are allowed and want to take on responsibility for shop floor conditions
- Managers build a sense of personal commitment in all people concerned

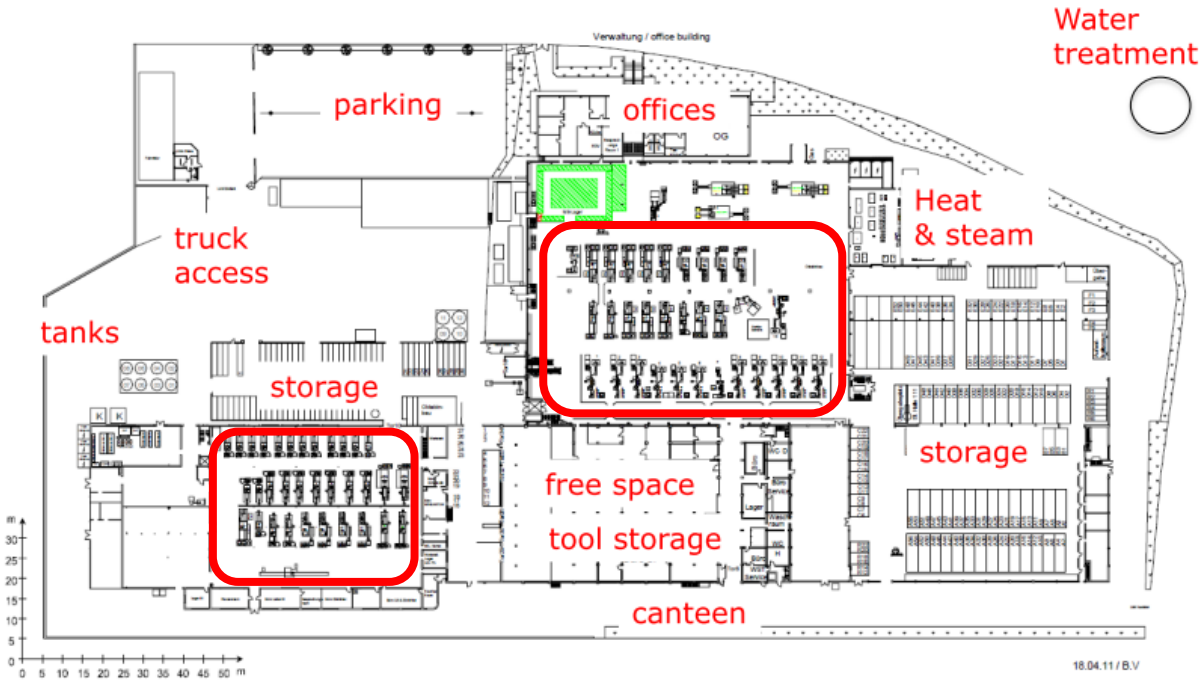
Attention: Five S is not enough
- Often companies start and stop here
- Improving the look of the shop floor is good, but is not enough
- More significant changes must occur to really impact the bottom line
- Redesign the layout - Reduce setup times to reduce batch sizes (SMED) - Ensure machines are always operational (TPM) - Balance workflow and reach Just in Time production - Make sure results are stable and do not stop improvement efforts (Kaizen)

OPS Week 8: Recap
- Market intelligence helps open the eyes on the outside world in three areas: Suppliers, Customers and Competitors
- Legal compliance is increasingly important and requires attention, both on the Sales and the Purchasing side
- Different production types serve different needs
- The Toyota System parted dramatically from Western methods, with impressive results
- Waste is hidden in all activities (not just Production): seeing and then eliminating it sets the basis for improvement - Waste reduces the value of a company
- Five S is much more than cleaning, but just a first step in Kaizen: alone it does not bring you far

9 Week 9: Plant, Workcell design / One Piece flow / Kanban

9.1 Inside a Plant

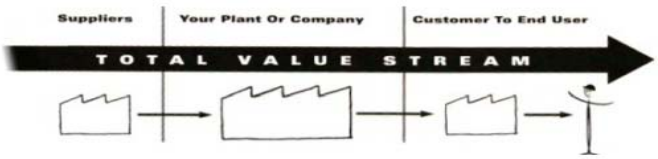
By planning a production facility you have to consider a lot of different things. With the right layout of the plant you can make the workflow during production much easier and therefore also set a basement for success or fail. Even if the shop floor (red squares) are very important, the plant itself is much more than this.



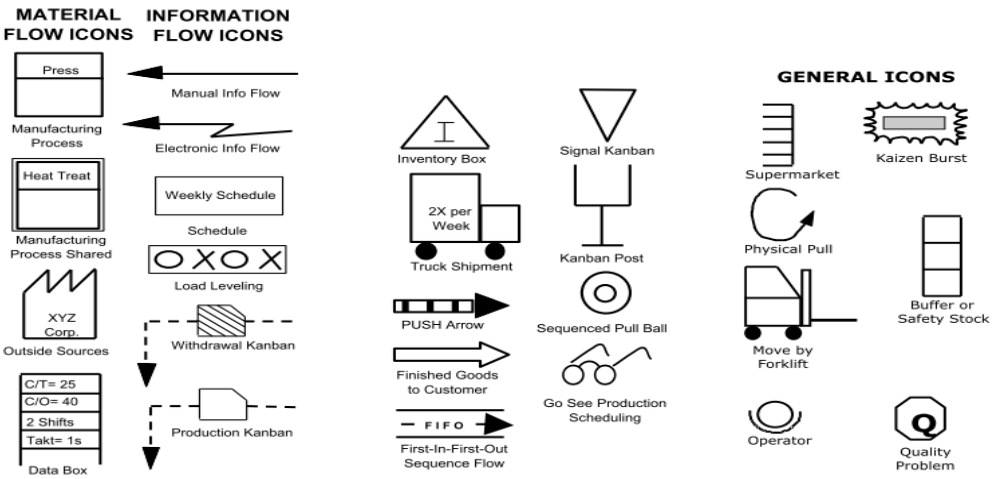
If you want to improve production (or plan it correct in the beginning) you should make a map

9.1.1 Value Stream Mapping

The value stream refers to all activities, no matter if they add value or not, required to bring a product through your plant.



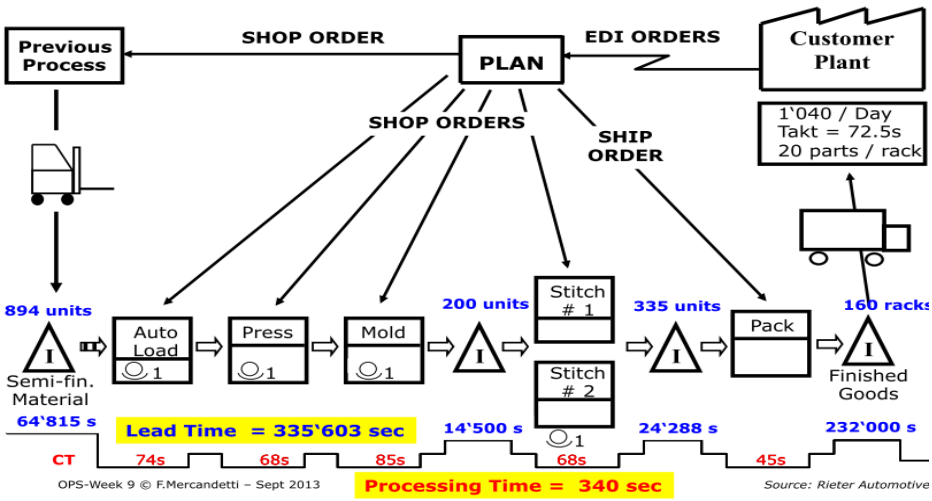
1) In a first step you list the products and mark all the work steps they undergo during production. If some of the products are produces using the same work steps, group them together (this makes it simpler in following steps). Select the most relevant Products / groups to develop a map.
2) Define Start an end of the workflow. Mostly start is the supplier, and end is the customer. Add the information to the databox.
3) Draw the Physical flow and add information to the databox. For Drawing, use the given Icons



4) Draw the information flow (e.g. Orders). The traditional way is to push goods through production with work orders.

5) Calculate and add lead time. $LT[days] = \frac{Units\ in\ system \cdot Takt\ Time\ [\frac{sec}{unit}]}{available\ sec.\ per\ day} = \frac{Units\ in\ system}{cust.demand\ per\ day}$

   Units in system are all products which are passing the same process



Your map should now look like this. You can now see, where the most time gets "wasted". You can now make improvements in optimizing these problem zones. Remember, that if you are improving one process, you have to do a new round to identify the next zone. In this example you can everywhere reduce stock and improve cycle time in the process "mold" if possible.

9.2 Inside a workcell

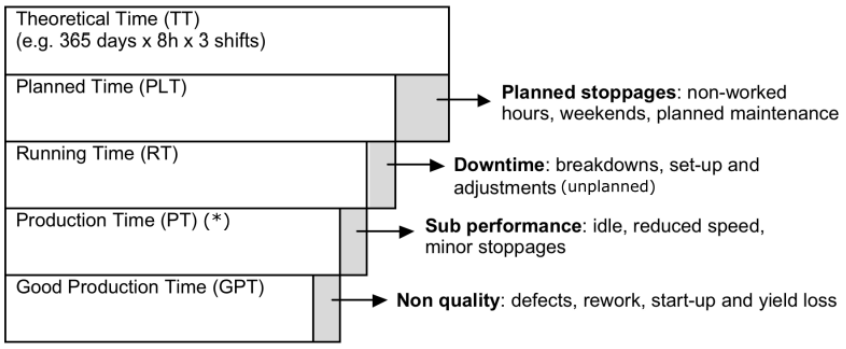
Organize the work inside a cell, means to make the work as balanced as possible. For this it is necessary to eliminate bottlenecks inside the cell. As a result for this, the slow process is at the beginning to set the timeframe for the rest. If the bottleneck exists inside the cell, you have some ways to eliminate it.

Usual	Smarter
Speed up	Offload by cutting out some processes
Add more available time	Use alternate existing resources
Add machines	Reduce setup- and downtime

To find out, If you can satisfy customer demand, you need to calculate the available Takt Time and compare it to the demand.

$$Takt\ Time[\min\ per\ unit] = \frac{Net.Operatoing\ time}{Units\ required/period} = \frac{available\ time - breaks - setuptime[all\ in\ minutes]}{\frac{monthly\ requirements\ [units]}{Working\ days\ per\ month}}$$

You map all steps and write the production time to them. The slowest process shows you the bottleneck and if it is slower than the demand requires you need to improve this process. For this you mostly need to improve the effectiveness of the equipment. This is measured in the OEE (Overall Equipment Effectiveness).

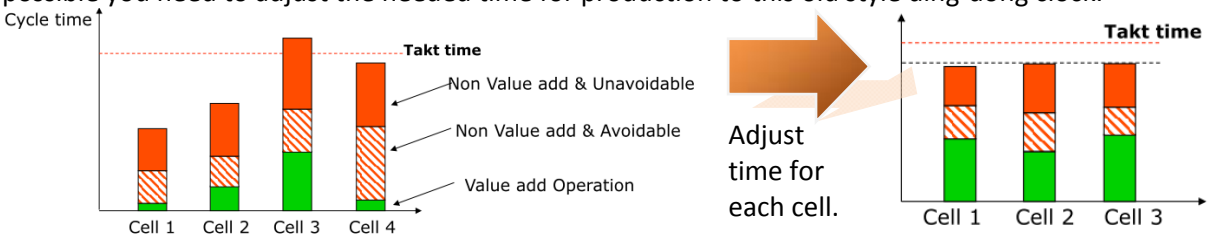


(*) PT = Production time at standard (the reference, target, conditions)

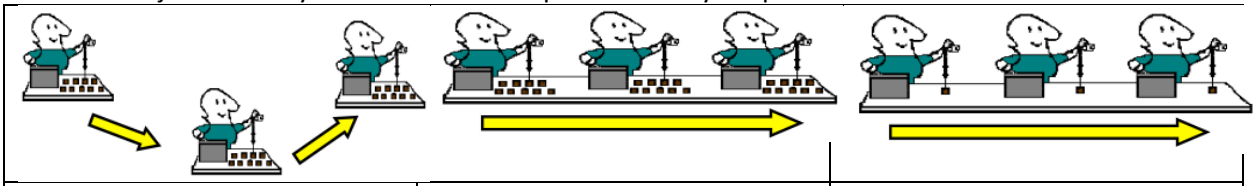
Note: an OEE calculation in the MEP is very possible.

9.3 Toolkit: One Piece Flow

The Takt Time is the voice of the customer, how much pieces per time he needs. To make this possible you need to adjust the needed time for production to this old style ding-dong clock.



With the adjusted cells you can reach a one piece flow in your production.

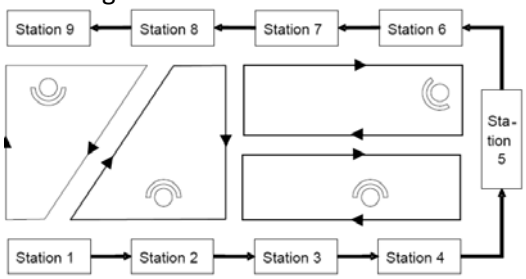


Ordinary "Batch" production	Fake "Flow" Production	True "One Piece Flow"
- Separate work areas - Lot of in-process stock	- Still separate work areas - Still lot of in-process stock	- One by one production - Levelled production - No stock in between

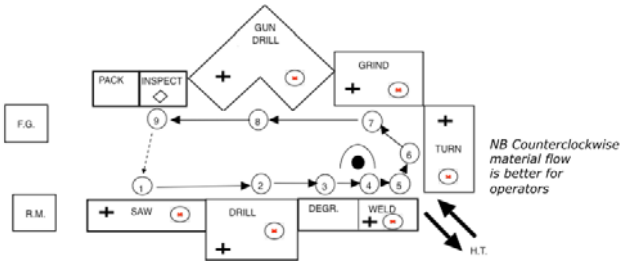
With the changes to one piece flow and have the interoperational stock at 1 piece you avoid overproduction completely.

9.4 Toolkit: Cell Design

To set up good throughput in U-cells you need to implement one piece flow from previous chapter. With this design you benefit from improved communication with previous / next step process, reduce moves of operator / material and the operator has a easy self-check in quality. The Layout of this design is close to the letter U and could look like this:



Cell with multiple operators

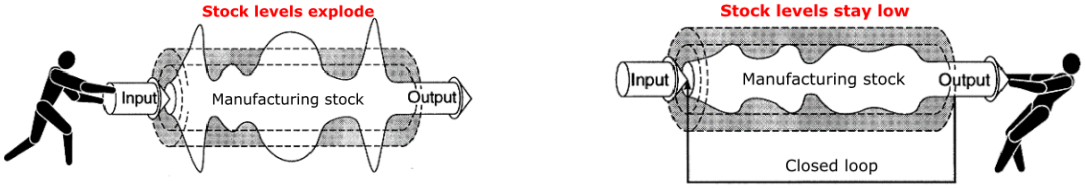


Cell with one operator

Ensure safety of the workers in the cell, they have only one exit way –> this way shall not be blocked. If you place them outside they can easily escape, but are no longer able to sever multiple machines. This design is not only limited to workcells it can also be applied to whole plants.

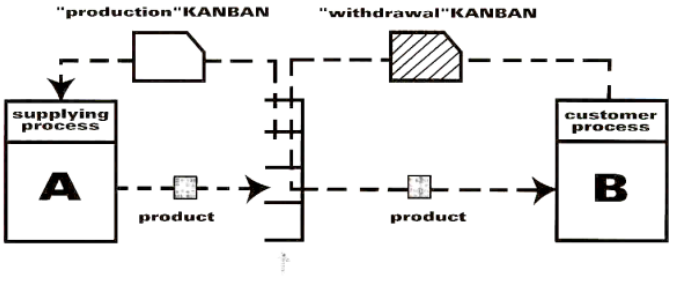
9.5 Toolkit: Kanban

Kanban is a word combination from Japanese KAN = card and BAN = signal. This Kanban is a way of organizing workflow through production and place orders at suppliers. While traditional organized plants "push" with orders in every step (purchase, production, sale), the Kanban system works in the opposite direction. Production is initiated with the customer order and this cascades backwards till the purchase orders at suppliers.

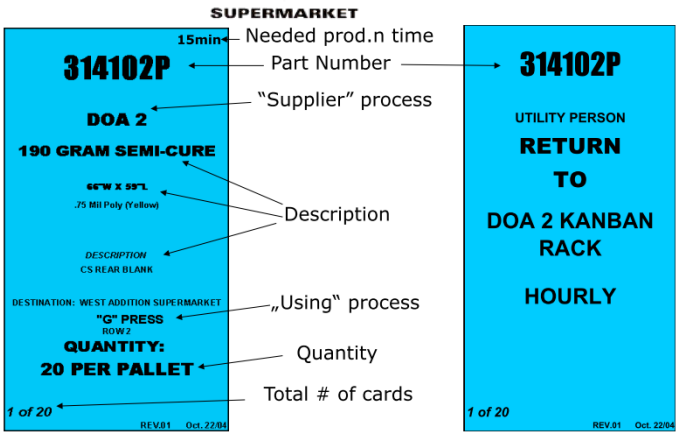


This reduction of the stock is possible with the way of refill the stock. It is organized in a Supermarket manner – you pick a small quantity for production of the shelf, turn the card which signs now one package needed and logistics brings this card to the previous process which then starts with

production of the needed parts. When these are produced, they will be stored in your supermarket shelf. You can also pick them again. This reduces inventory to the number of cards * Quantity per card. And it ensures to have always the production parts available.



Kanban Cars may look like this: There have to be two sides (one for production on the left and one for withdrawal on the right). On these cars is the necessary information for the department to which they are addressed. And they also tell how many cards of this product are available in the Factory (maximum stock). The needed number of Kanbans can be calculated (attention: MEP)

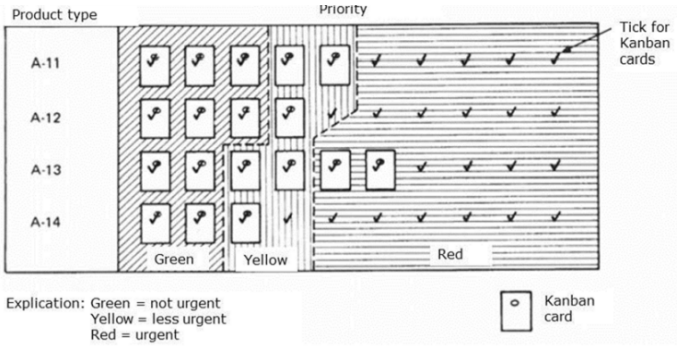


$$N_B = \frac{LT \cdot D_P \cdot (1 + SS\%)}{Q_B}$$

N_B = Number of Boxes | LT = Lead Time for delivery of a box [sec] | D_P = Demand of parts [units/sec] SS% = Safety Stock margin (additional stock desired) | Q_B Units per box

9.5.1 Kanban priorities

Even with a Kanban System running, production priorities need to be handled properly. For this it is useful to implement color-codes priorities for each part. This system sets a priority to the production of the part of which you know are more important to produce (they are earlier red).



With such a System for production planning you now can set the production from a "push" way to the "pull" way. To set up or change to such a system is a huge effort. But you reduce costs dramatically and improve also your production availability.

An example of a whole industry (automobile) compared between "push" and "pull":

	Design	Source	Produce	Sell
PUSH	• Mass models preferred • No customer input • No supplier input	• Adversarial relation towards suppliers • Component sourcing • Big supply buffers against variations	• Max production & capacity utilisation (volume models) • Produce to Stock	• Orders based on dealer allocations • Pricing based on targeted sales • Big discounts & incentives • High stock at dealers
PULL	• Even niche models become profitable • Customer and Supplier input	• Suppliers located at or close to own plant • Collaboration • Module sourcing • JIT & low stocks	• Produce to Order • Flexible prod.n • Reduced inventories & overhead	• Customer originated order • Pricing order-by-order • Few incentives & discounts • Low stock at dealers

10 Week 10: VA/VE, SMED, Poka Yoke, Organisation Toolkits

10.1 Toolkit: VA/VE

The aim of a company should be addition of value for its customers. That's the reason why a company shall strive to add value and eliminate all non-value adding activities from its processes.

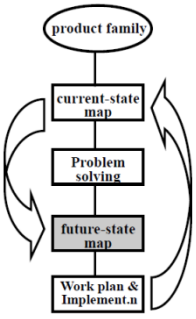
The VA/VE was created in 1940s by General Electric with the aim to reduce costs for products and systems while maintaining or improving value to customers. To do VA/VE at its best, a company has to understand the functions of the products, material and processes.
Remark: The most costs are raised by material!

VA = Value Analysis	VE = Value Engineering
• Continuous improvement of current products, systems & processes • Eliminates non value-adding elements • Employed after launch into production	• Creates products with value in mind • No unnecessary steps/parts • Optimizing engineering & manufacturing before expenditure is done

VA/VE Methods in ten steps	Procedure
1. Identify components/ system to study 2. Perform function analysis 3. Determine costing, process & purchasing information 4. Understand how parts are manufactured/ assembled 5. Identify waste 6. Review all costs 7. Brainstorm ideas for improvement 8. Determine risks & benefits of ideas 9. Develop implementation plan 10.Monitor implementation	• System function analysis • Component function analysis • Value Chain Flowchart (VCFC) • Total cost chain model (TCCM) • Spaghetti chart → (un)necessary moves?! • Process Flowchart • Process time reduction • Ideas • Priority settings • Proposal summary

10.2 Improve a workcell

Production Process Improvement



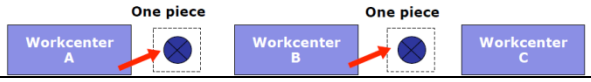
After having mapped the current state:
1. Issues are identified and discussed
2. Improvement ideas selected
3. The future state -- as target -- is drawn
4. A plan to implement the changes done
5. Implementation is done
6. A new improvement round can be launched

Getting to the future state

1. Identify sources of waste and eliminate them (7 Waste Analysis)
2. Takt Time Analysis: Takt vs Actual at each step, identify the bottleneck operation – Level production
3. Pull product through the process – Supermarkets – At what point in the production chain do we trigger Production?
4. Will One-Piece Flow work? – What is Preventing it from working on the remaining operations?
5. What other process improvements are necessary? (increase uptime, shorten changeover time, increase productivity, reduce scrap, train operators,…)

To reach the future state, different tools will help for each step:

Step	Name	Discription
1	Cycle diagramm	document current state
	Chase waste	
	Redesign cycles	
	Reduce batch size	Parallelisation of activities
2	Work on bottlenecks	

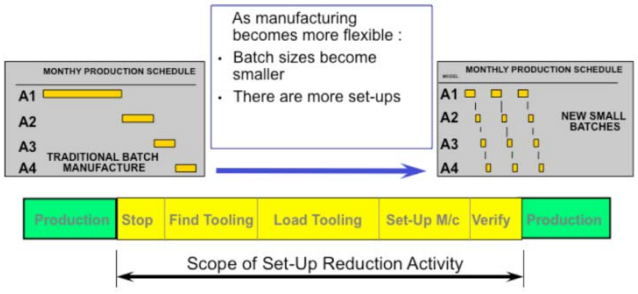
3	Implement "Pull"	KANBAN for every workcenter
	be flexible	alternate often the part produced → break down batches
	every part every x (EPEx) OXOX	EPE indicates the time frame a process needs in order to produce all types of variations
	Pitch = Takt Time x Quantity per tray = time needed to empty a tray 60 sec x 20 units = 20 min (in ACME case)	
	reduce changeover time	
	combine separate activities into Cells	
	FIFO Lanes	
4	One piece flow	FIFO Lane: visually defined agreement betw. workcenters  Ill-defined flow: Workcenter A breaks the agreeement  One-piece-flow: strictest possible rule 
5	Production continuum	**Traditional Batch & Queue** ← → **Ideal State of Lean** Push or Scheduled: Schedule each process and push to the next Supermarket Pull (Kanban): Upstream process replenishes what downstream customer took away FIFO Sequenced Flow: Defined lane with defined standard WIP between unlinked processes in FIFO sequence Continuous Flow (1 piece Flow): Physically link process steps with no inventory between

10.3 Toolkits: SMED / Poka Yoke

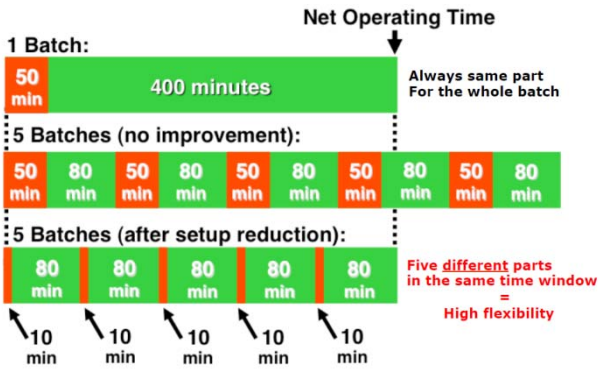
SMED = Single Minute Exchange of Dies

The amount of lost money due to unproductivity reasoned by changing production batches, is incredible. On one hand, the workers are traditionally more conderned of efficiency during production than during changeover.

With „Pull" downtime becomes more critical

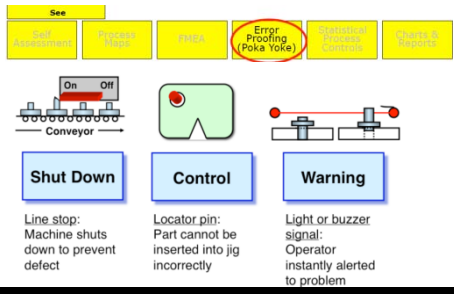


SMED for flexibility



Poka Yoke

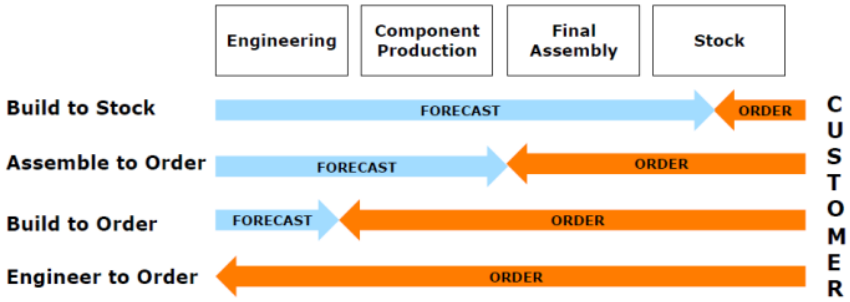
The target of Poka Yoke is preventing errors.
But not all errors are defects. Errors can also be come up when the customers' requirements don't fit with the functions the product has. A company has to ensure that an operator cannot do anything wrong, even if he's not paying attention.



	Task	Description
1	Identify items by their characteristics	• Weight • Dimension • Shape
2	Detect omissions	• Process sequence method • Process-to-process sequence method
3	Detect variations from fixed values	• Using a counter • Odd-part-out • Critical condition

In-line quality control helps to prevent costs caused by defective parts in a production line that works at high speed. In this case, it sometimes would be better to stop production instead of throwing away a lot of "defect" material.
Important: The control tools have to be measured and calibrated too → ISO 9001

10.4 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

10.5 Production Organisation Toolkits

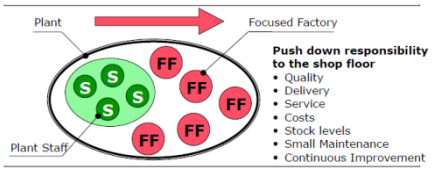
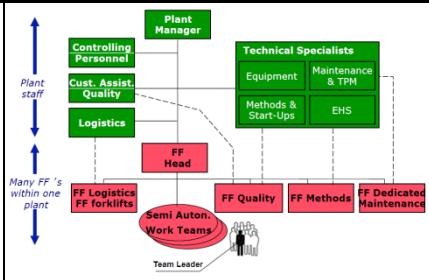
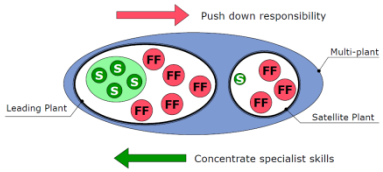
Focused Factories

Focused Factories are factories which are divided into smaller, logical Units. They focus on customers and are designed with lean principles. Focused Factories work autonomously.

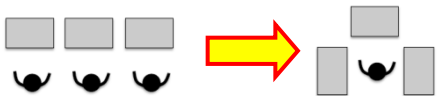
Advantages:
- ✓ Minimize material handling and in-process stock
- ✓ Reduce the use of floor space
- ✓ Minimize operator moves
- ✓ Utilize labor efficiently & effectively
- ✓ Eliminate bottlenecks

With a lean layout a company are able to reduce waste

Waste	Layout driven sources of waste
Overproduction	Large storage areas and aisles allow overproduction, with the intent to maximise own production targets
Waiting	Long distances between workcenters increase waiting time
Conveyance	Unnecessary docks and storage areas cause double and triple handling
Processing	By not segregating operator and maintenance areas on a line, daily production, set-up and maintenance tasks are hampered and strained
Inventory	Buffers and conveyors tie up costly work-in-process and increase lead time
Motion	Poor station and line design create unnecessary physical strain for workers
Defects	Repair areas and excessive inventory levels create a haven for defects
Motivation	A more efficient working environment increases effectiveness and efficiency of workers

Push responsibility into Shop-Floor	Focused Organisation	Multi-plant organisation
		

Empowered Working Teams



If a company works with one operater per machine, they waste time and money. These wastes are avoided by cross-training people to operate different machines within the cell.
Continuous trainings are important. The operators become multi-skilled and the work more interesting. If someone is absent, another person could substitute him. On a training matrix there is shown the skills of each operator. The Team leader has to know every single process.

SAWT (Semi autonomous Work Teams)

This allows a blue collar worker to become responsible of his own working area. He has to use their minds, not only their hands. On the other hand white collars have to accept to "let go" some of their "power".

Visual management

The practice of making all standards, targets and actual conditions highly visible in the workplace. This way, everyone can see and understand the conditions and requirements to work effectively.
Visual or audio signals, charts, measurements, light, etc. provide understanding.

Types: - Standard
- Target
- Progress
- Problem
- Defect

Jidoka

Stop production so that production never has to stop

Jidoka is the ability of production lines to be stopped in the event of such problems as equipment malfunction, defects or work delay

- Defective parts are not passed on to the next process which is viewed as "the customer"
- Equipment trouble is prevented because problems and the causes are identified and acted upon immediately

Standardised work

The documentation of working activities helps to ensure that operations are performed consistently and it helps newcomers to learn. This reduces waste!

Steps

- ✧ Measure times: walking, waiting on processing, manual work times
- ✧ Draw workers' motions on a layout schematic
- ✧ Determine the most efficient and safe work sequence
- ✧ Optimise work flows and define the "standards"
- ✧ Make people sensitive to working by adhering to standards
- ✧ Review and update Standardised work charts when changes occur

NB one product may have alternative routings, used under rising or decreasing customer demand conditions (different Takt times), therefore different Std Work sheets may be posted at a Workstation

Standards

Product Specifications	• Dimension and tolerances • Processing methods • Equipment operation parameters • Equipment operation sequence • Corrective action information
Quality, Safety & Environmental	• General appearance • Colour matching • Deformities, abnormalities • Gaps or tolerances • Surface quality • Limitations of defect size and quantity
Quality Standards	define key characteristics of a product and its tolerances (Company)
Quality Norms	define general principles to follow. They are not product, but process related (ISO 9001)

11 Week 11: Quality Mgmt & Cert., Kaizen, Change, TPM, Safety

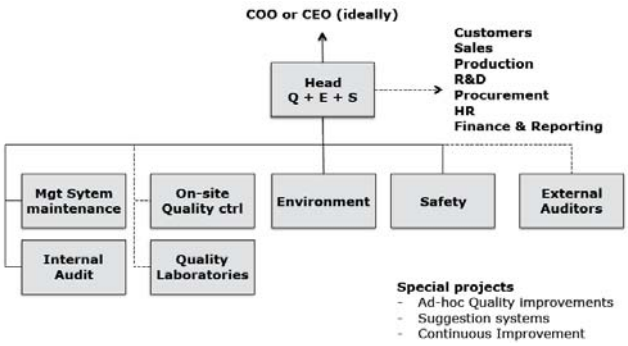
11.1 Quality management & certification

Quality, Environment & Safety Function

Head QES should ideally report directly to the top. Quality Laboratories normally report to the plant manager, that's why only in dotted line in the org. chart. The external auditors also are dotted, because the work with (and not for) the quality guys.

The quality organisation is a "service" organisation, because it:

- Represents the Customer's interests
- Has a deep understanding of company processes
- Helps solve and prevent problems
- Helps in maintaining Customer satisfaction



11.1.1 Personality traits

Quality People are driven by norms and laws and are like policemen

Strengths - Precise - System oriented - "See" the processes - Know deeply the company	**Weaknesses** - Pedantic, by the book (driven to be so by Specs & Norms) - Quality is the only objective of the company
Opportunities - Increase Clients' confidence - Change problems into solutions - Support cont. improvement - Help knowledge sharing	**Threats** - Radicalism (Q for Q sake) - Conflict with Production - Complicate systems to be on safe side

Non-quality People

Manufacturing
- Quantity and delivery come before quality
- Quality people are a nuisance
- Decisions by Quality people can be overruled

Sales
- Accept whatever specs the Customer want (without asking Production and Quality)
- Forget in pricing the existing cost of non quality

All Functions
- Remember to clean up their stuff and look at the Management System just shortly before an audit comes

11.1.2 ISO 9001 continued

ISO 9001: 4.2.2. Quality Manual (Mgt System)

The organization shall establish and maintain a quality manual that includes
a) the scope of the quality management system, including details of and justification for any exclusions
b) the documented procedures established for the quality management system, or reference to them, and
c) a description of the interaction between the processes of the quality management system

ISO 9001: 4.2.3. Control of Documents → all documents in a company should be controlled

[…] A documented procedure shall be established to define the controls needed
a) to approve documents for adequacy prior to issue,
b) to review and update as necessary and re-approve documents,
c) to ensure that changes and the current revision status of documents are identified,
d) to ensure that relevant versions of applicable documents are available at points of use,
e) to ensure that documents remain legible and readily identifiable,
f) to ensure that documents of external origin determined by the organization to be necessary for the planning and operation of the quality management system are identified and their distribution controlled, and
g) to prevent the unintended use of obsolete documents, and to apply suitable identification to them if they are retained for any
purpose

ISO 9001: 4.2.4. Control of Records

- Records established to provide evidence of conformity to requirements and of the effective operation of the quality management system shall be controlled
- The organization shall establish a documented procedure to define the controls needed for the identification, storage, protection, retrieval, retention and disposition of records
- Records shall remain legible, readily identifiable and retrievable

Document Management is important to properly identify and safeguard documents, but also to dispose of them at the right time and safely (if of confidential nature).

- Define document disposal rules (time to disposal: depends also from legal compliance rules)
- Label project binders with expiry date
- Remember the files in computers and e-mails !
- Have appropriate rooms/ systems for archiving

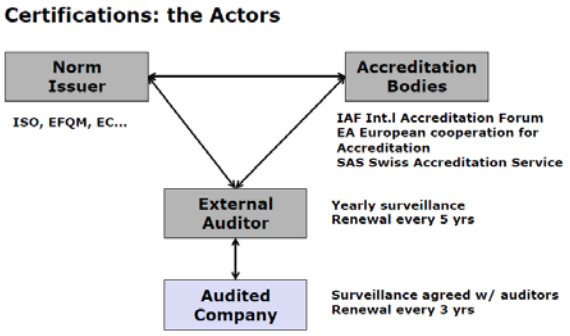
11.1.3 Auditing / Certification

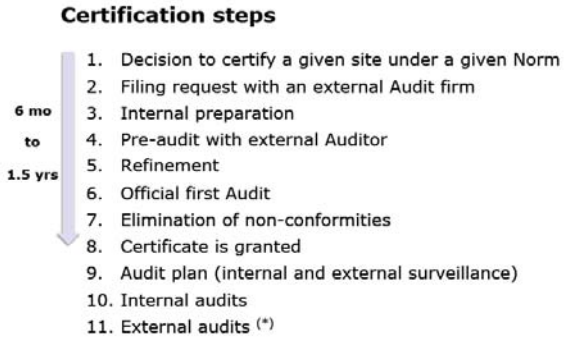
ISO 9000: 2.8.2. Auditing the Mgt System

Audits are used to determine the extent to which the quality management system requirements are fulfilled. Audit findings are used to assess the effectiveness of the quality management system and to identify opportunities for improvement.
First-party audits are conducted by, or on behalf of, the organization itself for internal purposes and can form the basis for an organization's self-declaration of conformity

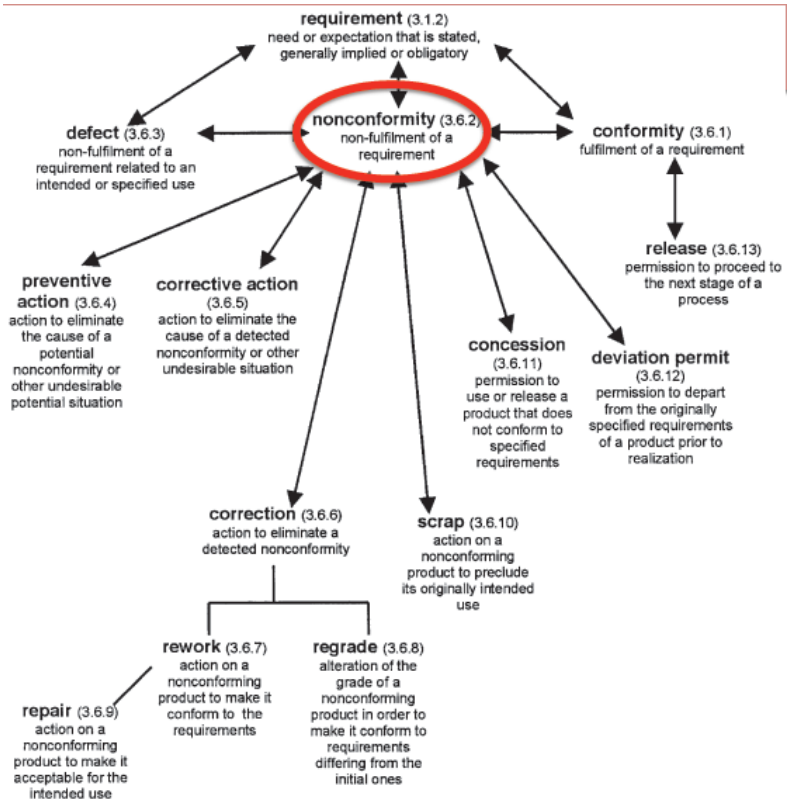
Second-party audits are conducted by customers of the organization or by other persons on behalf of the customer.
Third-party audits are conducted by external independent organizations. Such organizations, usually accredited, provide certification or registration of conformity with requirements such as those of ISO 9001.

Note: The Norm ISO 19011 provides guidance on auditing
Note: ISO 17'021: Independence of ext.l Auditors





Key words



Non-conformity → if something is not respecting/fulfilling the norms

A re-certification costs a lot of money (auditors etc.).But if those non-conformities are not removed as defined in step seven above, the auditor has to take away the certificate.
When an automotive company for example loses its certification, it won't get orders anymore. Therefore companies should bear the effort.

One may have to certify the same site against more Norms, which are similar but not exactly the same: →more time, complexity, costs

External auditors provide added value: They see a lot besides and beyond the scope of audits. Good Auditors provide a Feedback to Top Management on what they see. Smart Managers give to external Auditors specific topics to report upon. This puts the Organisation under pressure on specific topics of top management interest and provides top-management with a valuable independent view on the progress of the company.

Internal audit document looks exactly like the external.

11.1.4 Key points of Interview with a Quality responsible

- Auditors have better understanding of company because they see more areas.
- Focus on human factor – invest in your people (people make the difference). Training is important → Costs / Benefits?
- standardisation
- short-cuts
- ISO 9001 certification will not eliminate customer audits
- higher complexity → more costs, more benefits / The effort is higher than the return…
- ISO 9001 was in the early year's kind of a marketing tool. Since almost everybody has it now, it's no more.

11.2 Launching a Kaizen program

Cost of non-Quality: a Mine of Gold

Hidden costs of non-quality (some examples – for more check the slides)

- Premium freight for urgent inbound delivery of materials/ components or for late production
- Rework and associated material losses (material inefficiency)
- Line disruption or Line changes due to material non-availability
- Downtime of equipment, Line speed reduction
- Additional manpower to overcome process inefficiency
- Excess inventory
- Product modifications not carefully planned/ managed

Such costs may account for ~15% of Sales

11.2.1 Company Wide Kaizen Initiative

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". A pragmatic approach is **Kaizen Weeks**:

- One intensive, focused week without disturbance
- A team of people (cell operators, maintenance, others) "dirtying their hands" in a production cell to improve it
- Simple solutions, no investments
- Measurable improvements at the end of one week
- Highly motivated participants
- Example for all others employees ("it works!")
- A tool to accelerate improvements and spread training

Kaizen is not only for production, it applies everywhere

- **In Development:** a gold mine lies in the design of new products and processes "Design for manufacturing" will help Plants to be "excellent" from day one (instead of correcting after)
- **In the Offices:** all Business Processes can be simplified, made quicker and less bureaucratic

The biggest contribution doesn't come from top educated people. You need diversity! Select a team of approx. 10 people, including cell operators, supervisors, maintenance, technicians, even a salesman. Continuous improvement is not just for smart educated people: blue collars do bring great results.

A Kaizen initiative is only successful when top management is involved. People should see that action is appreciated from the top. Make sure to obtain top management support.

11.3 Leading Change

Change creates confrontation

- not only advocates or contrarians, but also a number of people who are uncertain → convince them

People resist because of:

- fear, loss of control, uncertainty and increased workload

Suggested strategy:

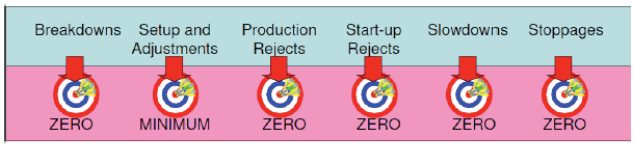
- Avoid surprises, move slowly at first, start with a pilot
- Respond quickly, treat people with respect, be positive
- Empower advocates + work on contrarians

Be aware of Cultural diversity: The Kaizen approach differs according the position of a country. E.g. USA is very Egalitarian and Task oriented, Korea in contrast is more people oriented and strongly hierarchical.

Kotter's 8 Steps to Lead Change	**The Role of Managers in Change Processes**
1. Create Urgency 2. Form a Powerful Coalition 3. Create a Vision for Change 4. Communicate the Vision 5. Remove Obstacles 6. Create Short-term Wins 7. Build on the Change 8. Anchor the Changes in the Corporate Culture	- Take responsibility for the results of today and tomorrow - Be an advocate for change - Motivate your people to continuously improve - Convince them that it is possible and non-negotiable - Empower them to do it - Help them grow their competencies (starting by yourself) - Share results and learning within the company

11.4 Total Productive Maintenance

- Prerequisite for JIT are machines that do not break down: rapid maintenance after breakdown is not enough
- Maintenance to prevent breakdown and activities to predict breakdowns become necessary
- Push responsibility onto Operators allows Maintenance technicians to focus on complex tasks



Stop production when YOU want to

NOT because the machine broke down

Actions towards TPM

1) Breakdowns	• Stop deterioration – improve the appearance of the machine • Improve the maintenance quality – no "quick fixes"
2) Setup & Adjustments	• Establish clear reference points – don't rely on operator intuition • Create and promote standardization for set-ups, tools, fixtures, etc.
3) Production Rejects	• Pareto chart to consider – with priorities – all possible causes • Look for relationships between conditions and causes
4) Start-up	• Quantify amount and types of start-ups • Observe process start-up: identify potential causes of delays
5) Slowdowns	• Run machine at full speed to "see" the problems • Conduct root cause analysis → Ishikawa diagram
6) Stoppages	• Observe what is happening, collect data (when, how often, type…) • Determine optimal machine conditions and train operators

Preventive Maintenance	**Predictive Maintenance**
Prevention Is Better Than Healing! Maintain the machine before it breaks down, not because. • Daily, weekly, monthly inspection & maintenance • Critical spares list based on historical and OEM data • Spare parts management, Kanban for spare parts • Schedule general inspections • Breakdown history log • Identify and resolve chronic problems • Root cause analysis • Provide technical support to operators	Tries to analyze and prevent typical failure behavior. It is done by maintenance engineers. • Develop and analyze equipment history • Determine equipment parameters that predict failure • Implement equipment monitoring systems But also: • Redesign equipment (thanks to know-how acquired) that need less maintenance and still is less prone to break down • Standardize equipment (as a way to better control)

11.5 Challenges: Safety & Environment

Production is a dangerous place

Unsafe Conditions (do not depend on people)
- Not guarded/ not protected equipment
- Faulty equipment
- Hazardous procedures
- Unsafe storage of hazardous materials
- Untidy work areas, slippery floors
- Inadequate lighting/ ventilation

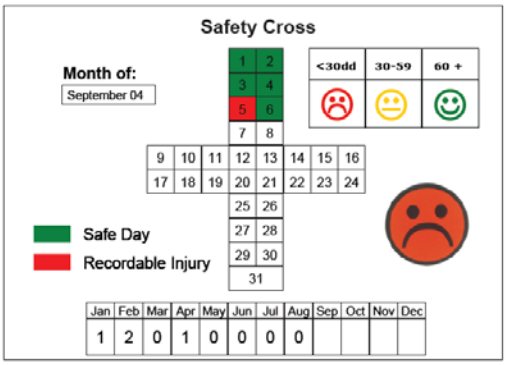
Technical improvements needed

Unsafe Actions (wrongdoing of people)
- Procedures not followed
- Inappropriate use of equipment
- Personal Protection Equipment not used
- Stress/ Burnout

Modify Behaviours:
Raise Awareness against Indifference
Training against Ignorance

Safety Risks may have serious consequences
- Illnesses & Injuries
- Physical & Psychological pain
- Stoppage/ Loss of production
- Damage to equipment/ facilities
- Spoilage of materials/ Damage to the Environment
- Loss of individual/ company income
- Loss of Jobs
- Absenteeism
- Higher insurance costs
- Replacement of staff and retraining
- Replacement of equipment/ facilities

Safety awareness



Legend:
1. Fire at Felt press exhaust
2. Harm to oven maintenance staff
3. Water contamination at recycling plant
4. Accident in the presses
5. Spillage of hazardous chemicals
6. Forklift accidents
7. Isocyanate pollution
8. Cut injuries to operators

Key Points out of the Interview with a Safety Expert

- Safety vs. extreme lean
- safety risk map → as a company you should do it
- you cannot insure 100% risk → first you have to do risk mitigation. An insurance company provides insurance on the residual risk.

11.5.1 Sustainability

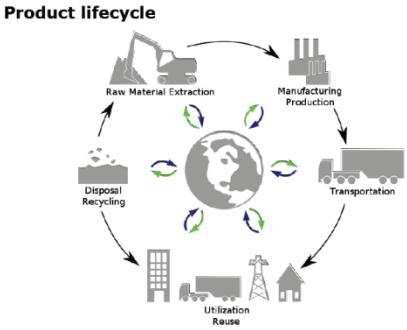
Production that gave us a tremendous advantage, represents also a risk for the environment: be aware of our production footprint and foster Sustainable businesses.

Business Excellence is today more than just managing at best your own operations.
Interrelationships in our world are complex and wide ranging; they force us to widen the angle of our vision. Sustainable development must meet our present needs without compromising the ability of future generations to meet their own needs.

The Ecological Footprint of a Company

- Energy consumption (heating, light, power for machines)
- Emissions (CO2, other greenhouse gases, dangerous gases)
- Waste (scrap, hazardous substances, heavy metals...)
- Water consumption

Reducing this footprint is not just a moral obligation to future generations, but has also a positive impact on costs



Follow the Complete Product Life Cycle: The company impact does not end when the product leaves the company gates...

➔ **ISO 14'001: Environmental Managment System**

Assume more Responsibility: Ethics & Business

- Compliance with local laws and regulations
- Respect of the Environment
- No kickbacks, bribes and other illegal payments
- Respect of people:
- No Child labour; appropriate working conditions (at least minimum legal wages)
- No Discrimination
- Freedom of Association

Due to globalisation, Purchasing has to monitor suppliers and sub-suppliers beyond the pure delivery of products/ services, in countries where all the above is not a given!

12 Week 12: Visit Schurter / Scheduling production/ Production Cost Accounting

12.1 Visit Schurter

The SCHURTER Group is close to its clients in all the main sales markets. Apart from the superior client proximity, SCHURTER's broad geographical reach gives it the flexibility needed to adjust resource procurement to the rapidly changing market conditions.

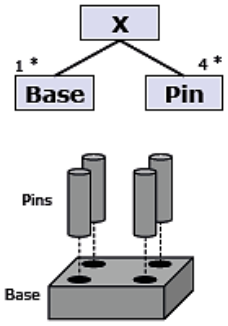
Short summary from the visit what we have seen:

- Location, nice place to live, but very expensive. They want to have the Know-How on place.
- Quality: High level of quality, many tests during manufacturing
- Production: Group and Shop, new they want Lean production
- LEAN: they made a Test area and a value stream map
- NEW Business Idea: Look after the whole process from the costumer.

12.2 Scheduling production

Exercise: Calculate minimum lead times

When you assemble a product, consider the lead time of each operation to obtain the total one (start from the end & go backward)



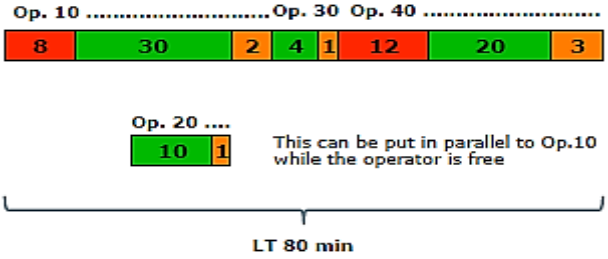
Op#	Description	WC	Lot	Setup	Work	Move
10	Drill 4 holes in base	003	10	8'	3' (*)	2'
20	Polish & check pins	003	10	--	1'	1'
30	Insert 4 pins in base	003	10	--	0.4'	1'
40	Paint after assembly	003	10	12'	2'	3'

(*) Op.10 is fully automatic

1) Draw the cycle & calculate the minimum lead time
2) Where to act to reduce it? How?

Solutions

1) LT is 80 min for the production lot of 10 units
2) To improve reduce first setup times with SMED(material move times with priority 2, being small) Re-discuss the Lot size



Exercise: Real working conditions limit production

With OEE we calculate the realistic production capacity of a work cell Low OEE does limit the possible output:

- Calculate the real residual daily capacity in minutes for a machine with OEE 76% and the following production plan

	Day 1	Day 2	Day 3	Day 4
Production capacity (min)	430	430	430	430
Units A	100	76	25	65
Units B	0	37	65	70
Real residual capacity (min)				

Standard CT
A: 3min/unit
B: 2.5 ,, ,,

Solutions

	Day 1	Day 2	Day 3	Day 4	Tech. data
Volume A (units)	100	76	25	65	min/ unit
Std Workload A (min)	300	228	75	195	3
Volume B (units)	0	37	65	70	
Std Workload B (min)	0	93	163	175	2.5

Available capacity (min)	430	430	430	430
Real capacity (after OEE)	327	327	327	327
Std Workload (A+B)	300	321	238	370
Residual capacity (min)	27	6	89	-43

Exercise: Changeover times

Changes in product mix cause changeover times, thus reducing the available capacity: scheduling of production must consider it:

- All 4 products are produced in whatever sequence on one machine
- Family changes (A => B,
- B => A) require more time

From \ to	A1	A2	B1	B2
A1	x	15	30	30
A2	15	x	30	30
B1	30	30	x	10
B2	30	30	10	x

1) Highest

A1 → B1 30
B1 → A2 30
A2 → B2 30
B2 → A1 30 = **120** min in total (always change of product family)

2) Optimal

A1 → A2 15
A2 → B1 30
B1 → B2 10
B2 → A1 30 = **85** min in total

Exercise 4: See solutions → PDF

Priority setting if capacity is short

When assigning production orders to the work cells there will always be conflicts (unless a lot of free capacity is available)

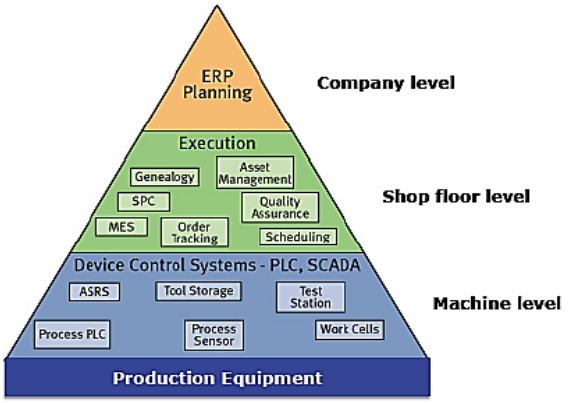
Possible rules to assign priority:

- First in First out
- Orders with shorter time left to completion (already advanced)
- Smaller jobs

Last minute changes and expediting of orders will always be disruptive of any planning and cause the worst use of capacity.

IT Systems in a Plant: 3 levels =>

- Closed-loop planning system
- Enterprise Resource Planning
  - An ERP system manages and integrates the whole information flow within a company, and with customers and suppliers



12.3 Production Cost Accounting

The key financial statements

Profit & Loss statement

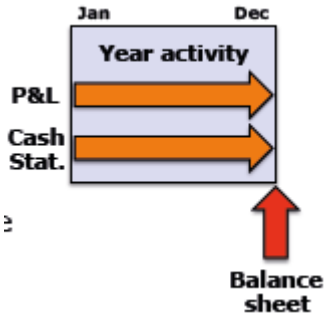
- All costs and profits cumulated during a given period are shown
- Not all are physical cash flows

Balance sheet

- The photograph of all accounts at a given time (at closing or at other reporting deadlines)

Cash flow statement

- All cash movements (in & out) of the company during a given period



How to classify Costs

- By nature:	materials, labor, expenses…
- By function:	production, selling, administration, R&D…
- By traceability:	direct and indirect
- By variability:	fixed, variable, semi-variable
- By controllability:	controllable, uncontrollable
- By normality:	normal, extraordinary

Exercise: See OPS 12.H03 Solutions.pdf

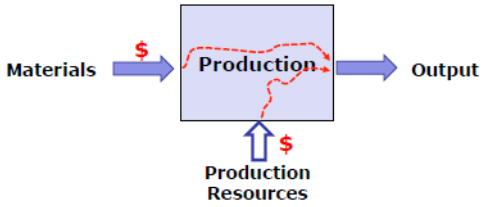
The most important classifications

Direct costs	vs.	Indirect costs
Direct material		Indirect materials (Consumables)
Direct labour		Indirect labour and salaries
		Utilities (Electricity, Gas, Heat, Water, Steam…)
		Maintenance & Repair
		Other Variable Expenses
		Building rental
		Depreciation of Equipment
		Other Fixed Expenses

Variable costs	vs.	Fix costs
Dependent on Production Volume		Independent of Production Volume

Plant costing

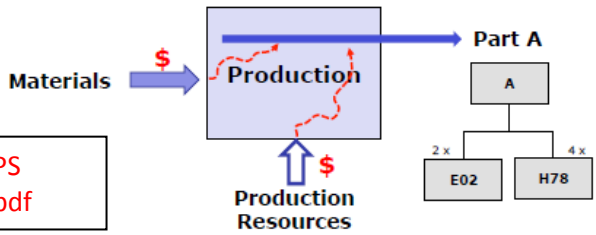
- Direct and Indirect costs
- Plant (or Work cell) cost rates



Product costing

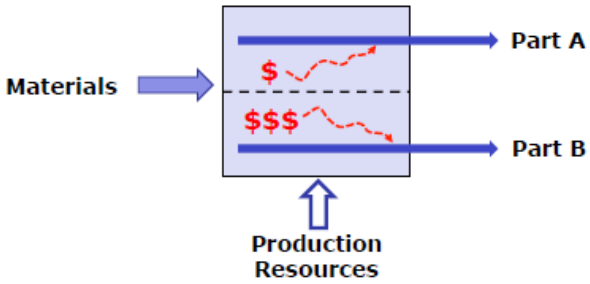
- How to bring onto a single product all related costs?
  - BoM
  - Routings
  - Cost Rates

Exercise: Check OPS 12.H03 Solutions.pdf



Cost distortions

Are Absorption rules precise?
When production areas in a plant are not homogeneous in terms
of costs, these must be allocated with more accuracy to the
products or work cells that cause them.
Otherwise the risk are wrong business decisions



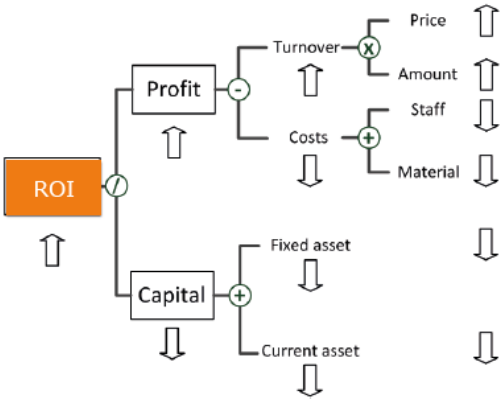
Variances

Separating causes and effects, Variances allow to better understand
financial results of the company and take appropriate corrective
actions
Variances are normally analysed monthly

Activity Based Costing

- Distortions due to traditional Cost Accounting techniques can be corrected by more accurately representing the reality in the CA system
- The difficult part is always the correct allocation of Overhead costs
- The key is to make sure that all activities and cost elements related to a given product enter its cost structure –> so the idea of ABC
- Tracking the activities that contribute to the creation of a product is the best way to determine its costs. This is not always easy and is seldom done on a continuous base for accounting; it serves more for ad-hoc verifications of the cost base and for decision purposes

Beyond P&L: Return on Investment (ROI)



OPS Week 12: Recap

- The usual situation in the shop floor is the continuous rescheduling due to delays and changing priorities : huge hidden cost
- Even integrated Planning Systems do not avoid the above
- The minimum Lead Time can be calculated on a chart, the actual one will depend on accumulation of parts in the system
- Production planning must take in consideration the real capacity of work cells, not only the materials requirement: production may need to start earlier than imagined
- Appropriate costing of work centers and products helps in making the right business decisions
- Wrong costing may lead to wrong management decisions
- The BoM allows to bring the costs to products

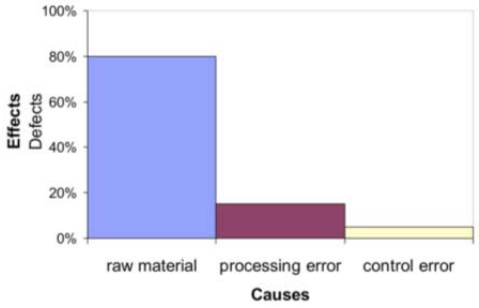
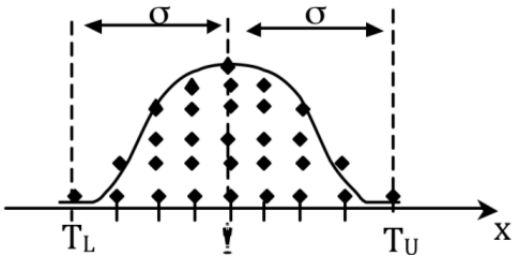
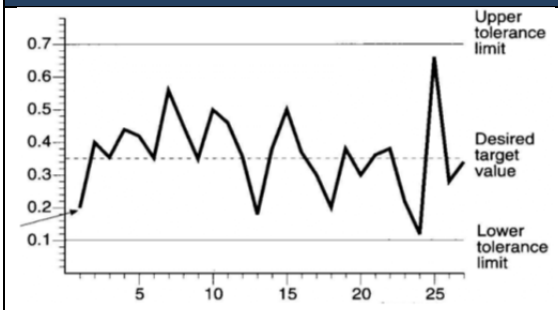
13 Week 13: Charts & Reports / Move to East / Leading operations

13.1 Charts & Reports

A chart helps you to see the facts. There must be a clear message which is easy to read. This way the following rules are important.

- Not show artistic abilities
- Make it simple
- No need for 3D-Charts
- Use few colours
- Don't play with scales and proportions
- Always explain axes
- Labels, titles and legends are not the prominent information

You can distort a message by using charts wrong. "Just believe in statistics you have falsified/faked on your own!"

Pareto	Distribution
 Shows the relative importance of categories	
Control Chart	**Scattergram**
 Shows trends	 relationship between two variables

13.2 Management review

A company should be able to monitor and measure the processes of the quality management system. This way planned results shall be achieved and if not, correction or corrective actions shall be taken.

The monitor will give the management information to judge past performance, estimate future trends, identify areas needing corrective actions and direct improvement efforts.

The monitor report must be **SMART** (**S**pecific, **M**easurable, **A**chievable, **R**elevant, **T**ime-bound).

Type of measurement	Description
1. Key Performance Indicator (KPI) • Inventory • Time to deliever • …	• Focus on specific products / processes • Easy to understand • Uniquely defined → no interpretation possible • Standardised → all plants have the same KPIs • Coming from "certified" systems • Regularly followed up

Plant KPIs are close to the facts. That means that KPIs will help to see effects of bad performance early enough and help to find the causes and eliminate them. Financial data are important to manage a company. But they are useless as a performance indicator because they are just available monthly.
Lagging indicators: focus on past (things that happened)
Leading indicators: help identify trends (future)

Financials These are available in Profit & Loss or Balance Sheet statements
- Sales
- Labour costs
- Overhead costs (ind.empl, energy, maint.cost...)
- Value of Inventory

...

Plant KPIs These are of operational nature
- Delivery accuracy
- Quality data
- Use of Labour (productivity, attendance)
- Use of Materials
- Use of production infrastructure (Capacity, Energy)
- Safety (accidents data)
- Improvement initiatives

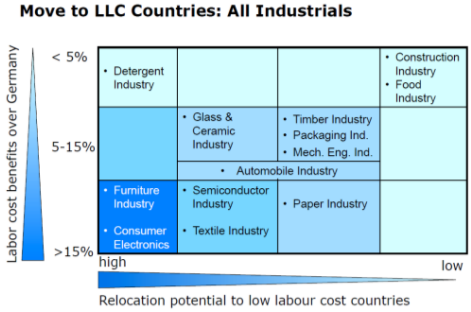
...

2. Measure the "use of tools" • 5S • Kaizen	Example: Correlation Kaizen & Margins 
3. "perceived/assessed" achievement • EFQM • ESPRIX • …	

Management commitment
The top management has to ensure that the quality management system will be developed and implemented with a continually improvement. This means they are responsible for the availability of resources, establishment of quality policy. Furthermore the conducting management reviews and the communication to the organization is important.
These steps are done to ensure the continuing suitability, adequacy and effectiveness of the quality management system.

13.3 Move to East

Reasons:
- Cost advantages
- Entry in new growing markets
- higher flexibility in supply
- reduction of shortfalls in capacity
- state subsidies, taxation benefits
- Proximity to customers who moved East already



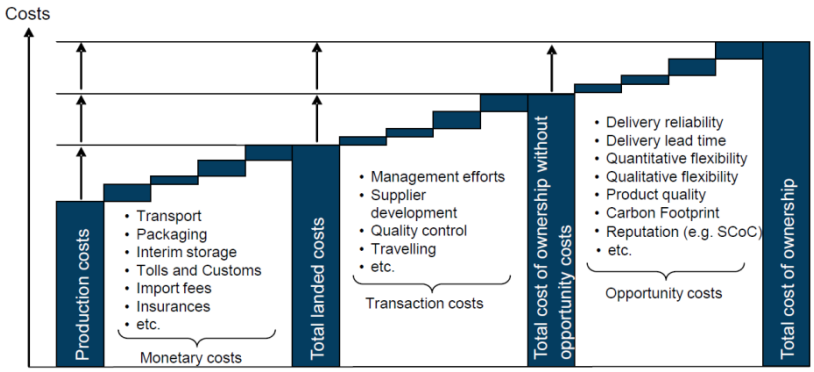
On the other hand, some companies come back because:

- bad quality of local suppliers
- unreliable / expensive local supply chain and infrastructure
- shortage of competent people
- high coordination and communication costs

Reshoring of production increases because of logistic issues, better collaborations or a shorter time-to-market.

Keep an eye on total costs
Production costs are not all of them!

For Switzerland it is important to build on typical strengths as an innovation driver and in a sustainable role.



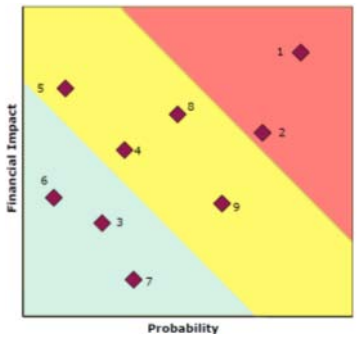
13.4 Risk Management

Next to the normal business risks like customer which not pay or a supplier who cannot deliver on time, there are some other risks. These risks are generated by the global, interconnected world of today and can have a significant monetary value.
In Switzerland, Risk Management is part of strategic management of an enterprise and belongs to the duties of the Board of Directors.

Key questions

- Have we identified all major risks?
- Have we identified appropriate counteractions?
- Do we have an early warning system in place (measures)?
- Are we compliant to all rules & regulations?
- Are we "State of the Art"?
- Did we test the processes defined in case of emergency?
- Is a conscious Risk Management integral part of our management practices?

Categories: Environment, information and process risks



For the **assessment** review and identify risks that could happen.
After that define the risks and evaluate each risk for probability of occurrence and its monetary impact.
Put the risks on a risk matrix. That will help to show the improvements of a continuous risk management (countermeasures)

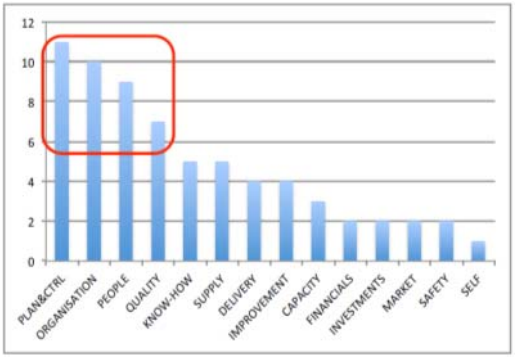
13.5 Leading operations

Plants in different location are a huge challenge (location, countries, language, law, culture), because they are different to compare. For each plant you have to define priorities with a focus on a plant's lifecycle. In this case key performance indexes are mainly financial. Operational KPI's shall not give room for interpretation.
The pressure of cutting costs is high. Adjusting capacity mostly means restructuration.
Development should be as close to plant as possible (at best inside). But be attentive on the employees – a plant is normally "protective" (protects the old ways, or its people / not willing to

change). So it is challenge to find out how to motivate people to improve. If people couldn't be motivated the start of production readiness is very time critical.

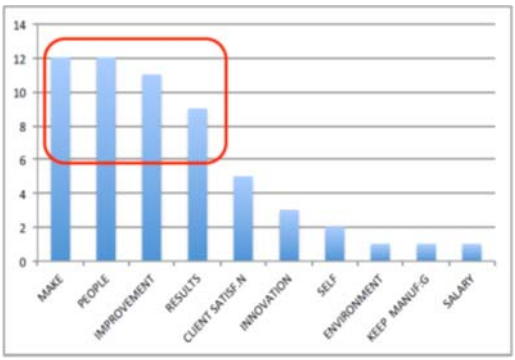
ADVICE TO STUDENTS: get experience in different fields (logistics, quality, production) from first hand, before you take a job in an office. Learn what it means to work in a plant.

Plant Manager Surveys: concerns



What are the concerns in a plant manager's life? Most important problems or what keeps them wake at night is planning & controlling of the enterprise

Plant Manager Surveys: gratifications



What are the plant manager's most important motivations?

1. Produce for customer
2. People