KS SUPPLY CHAIN FUNDAMENTALS

04 Product & Service Design

SS 2025

JKU
PLM Institute of
Production and
Logistics Management

Learning goals

- Understand the strategic importance of product and service design.
- Know what product and service design does.
- Know about legal, ethical, and sustainability considerations.
- Know about product life cycle analysis and the 3 Rs.
- Be able to perform basic reliability computations.

Literature

Stevenson, WJ: Operations Management. McGraw-Hill Education Ltd; latest edition - Chapter 4

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Products and services...

- ... are the essence of a business organization and every aspect of the organization and its supply chain are structured around those products and services.
- Well designed products are key to organizational success.
- Poor design is often the reason for errors in operations.
- Product and service design is interconnected with the business strategy.

What does product and service design do?

1. Translate customer wants and needs into product and service requirements (marketing, operations).
2. Refine existing products and services (marketing).
3. Develop new products and services (marketing, operations).
4. Formulate quality goals (marketing).
5. Formulate cost targets (accounting, finance, operations).
6. Construct and test prototypes (marketing, engineering).
7. Document specifications.
8. Translate product and service specifications into process specifications (engineering, operations).

Key questions and reasons

- Is there a demand for it?
- Can we do it?
  (Manufacturability / Serviceability)
- What level of quality is appropriate?
- Does it make sense from an economic perspective?

Reasons: (market changes can be an opportunity or a risk)

- **Economic** (eg low demand, excessive warranty claims, the need to reduce costs)
- **Social and demographic** (eg population shifts)
- **Political, liability, legal** (eg government changes, safety issues, new regulations)
- **Competitive** (eg new or changed products or services, new advertising/promotions)
- **Cost or availability** (eg of raw materials, components, labor, water, energy)
- **Technological** (eg in product components, processes)

Example: LEGO

Lego “The Danish toy maker enjoyed sustained success for its popular Lego City and Lego Star Wars sets. Its new Lego Friends theme, targeting girls, sold twice as well as initial expectations and helped triple sales to girls.”

Before its introduction: only 10 % of sales to girls.
Criticism: enforcement of gender stereotypes.

Today’s challenge: Sustainability (bricks are made of plastic); currently a number of activities at Lego.

Source: https://www.lego.com/en-us/sustainability/environment/zero-waste/

Idea generation

... by customers, the supply chain, suppliers, **competitors**, employees, and **research and development**.

- **Reverse Engineering** Studying a competitor's products and services and how the competitor operates.
- **Research and development** organized efforts that are directed towards increasing scientific knowledge and product or process innovation.
  - **Basic research** (Uni) has the objective of advancing the state of knowledge about a subject, without any near-term expectation of commercial applications.
  - **Applied research** (Uni/Companies) has the objective of achieving commercial applications.
  - **Development** (Companies) converts the results of applied research into commercial applications.

IBM spends around $ 6 billion per year for R&D, **Hewlett-Packard** around $ 2 billion. (Stevenson, 2021)

Framework

- **Legal and ethical considerations** eg emissions, regulations wrt harmful substances, accessibility for people with disabilities.
- **Human factors** eg safety (crash tests), ease of use.
- **Cultural factors** different designs for different countries or regions.
- **Sustainability**

McDonalds' 🍔 offers specific burgers in different countries: **Egypt** McHalafel, **France** Croque McDo, **Germany** Gemüse Mac, **Greece** Greek Mac, **India** McAloo Tikki Burger ...

Sustainability

Product and service design is a focal point in the quest for sustainability.

- **Life Cycle Analysis** (LCA) systematic assessment of the environmental impact of a product or service throughout its useful life (cradle-to-grave), part of the ISO 14000 environmental management standards.
- **The 3 Rs: Reduce, Reuse, Recycle**

Reduce: Value Analysis

Goal Reduce the cost and/or improve the performance of a product.

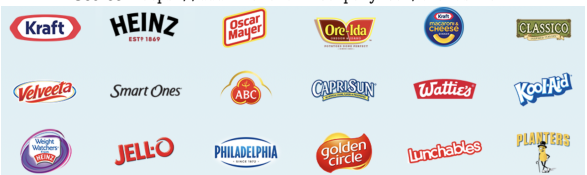
- Select an item that has a high annual dollar volume. This can be material, a purchased item, or a service.
- Identify the function of the item
- Obtain answers to these kinds of questions:
  - Is the item necessary and does it have value, or can it be eliminated?
  - Are there alternative sources for the item?
  - Advantages/Disadvantages of the present arrangement?
  - Could another material, part, or service be used instead?
  - Can specifications be less stringent to save cost or time?
  - Can two or more parts be combined?
  - Can more/less processing be done on the item to save cost or time?
  - Can packaging be improved or made less costly?
- Derive recommendations.

Example: Kraft Foods

Kraft Heinz, generally known for its brands Kraft, Heinz, ABC, Capri Sun, Philadelphia, and more, states on its website that it “is dedicated to the sustainable health of our people, our planet and our company”. Before merging with Heinz, Kraft started the following initiatives among others:

- Slimmer pizza cartons → 14% additional pizzas per pallet → 1.4 million pound less packaging material used, less trucks for transport.
- Salad dressing packaging: 19% less plastic per bottle → 3 million pound less plastic per year → 18% more efficient transport (more bottles per truck).

Source: `https://www.kraftheinzcompany.com/brands.html`



Example: Grüne Erde

`https://www.grueneerde.com`

“Grüne Erde furniture, mattresses, and bed cloths have completely plastic-free packages.” (since fall 2021).

Grüne Erde

Slow fashion. Returned cloths are not thrown away. Alpaca wool from the Alpaca Association Austria. Linen from Europe. Furniture made in Europe.

Reuse: Remanufacturing

Broken parts are replaced. An old product turns into a “new” one.

Sometimes it only concerns components, eg cars, printers, copiers, ...

Products can be sold for about 50% of the cost of a new product.

Europe: Lawmakers are starting to require old products being taken back by the producer.

Design for disassembly (DFD) Designing products so they can be more easily taken apart.

Refurbished Apple products: `https://leapp.nl`

`https://www.remanufacturing.eu/studies/3f16822be130d2d33ddb.pdf`

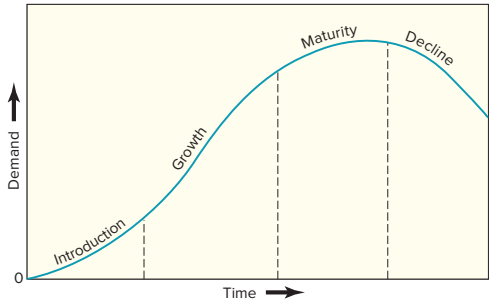
Recycle

= recovering materials for future use.

rePET: PET bottles out of PET bottles (circular economy)
Source: `https://www.voeslauer.com/nachhaltigkeit/repet`

Design for recycling (DFR) design that takes into account the ability to disassemble a used product to recover recyclable parts.

Product Life Stages



Source: Stevenson (2021)

Many products go through a series of stages over time. Each stage may require a different strategy.

Considerations when a new product is launched (is it ready (enough)?)

Reliability (eg bug fixes) increases.

Does not apply to some products, eg pencils, knives, forks, nails.

Product Life Cycle Example

Introduction: not the first mp3-player but “cool” design and click-wheel control.

Growth: supported by intro of iTunes Music Store in 2003, iPod Mini in 2004, iPod Nano, iPod Shuffle, iPod Touch; market share > 70%; competition.

Maturity: kept market share via product differentiation strategy; new features (color display, camera, battery life), stayed ahead of competition.

Decline: sales declined, high discounts on prizes; introduction of iphone.

Source: `https://www.superheuristics.com/product-life-cycle-ipod/`

Product Life Cycle Management (PLM)

... is a systematic approach to managing the series of changes a product goes through, from its conception, design, and development, through production and any redesign, to its end of life.
conceive - design - realize - service

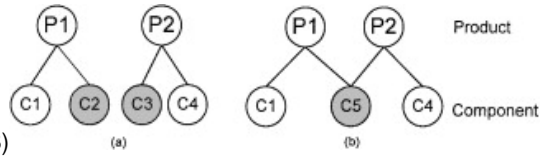
- incorporates everything related to a particular product: people, data, processes, ... (all product related information)
- Goal: eliminate waste and improve efficiency.
- Software: integration with ERP.

Standardization

- (A) Standardized products are made in large quantities of identical items (eg milk). Example for a standardized service: car wash.
- (B) Standardization of components greatly lowers the cost of production while increasing productivity (eg less parts used in production)
- Downside: less product variety.

(A)

(B)



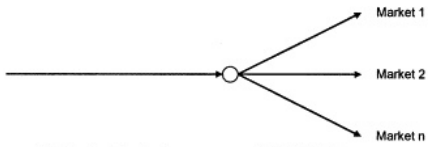
Source (A): Open Science – Lebenswissenschaften im Dialog (cc/by-nc-sa 4.0)
Source (B): https://doi.org/10.1016/S0925-5273(98)00179-0

Mass Customization

= producing standardized goods or services, but incorporating some degree of customization in the final product or service.

Can be achieved by using different strategies, for example:

- **Delayed differentiation** (C) is a postponement tactic: the process of producing, but not quite completing, a product or service, postponing completion until customer preferences and specifications are known.
- **Modular design** Modules represent groupings of component parts into subassemblies. The final product is put together based on customer's choice of modules (eg Dell)



(C)

Source: https://doi.org/10.1016/S0925-5273(98)00179-0

Atomic Skis https://prime-skiing.de/atomic-custom-studio-designe-deinen-eigenen-ski-pid4610/

https://plattformindustrie40.at/blog/2017/08/04/atomic-produktionsoptimierung-mit-digitaler-sensorik/

Reliability

- is a measure of the ability of a product, a part, a service, or an entire system to perform its intended function under a prescribed set of conditions (eg temperature).
- The optimal level of reliability is one where any additional benefit is equal to the cost incurred.

Measuring reliability (1)

that a system works.

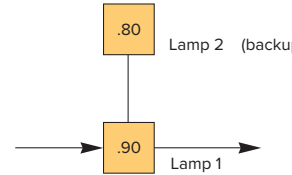
Assumption: independent events $\rightarrow$ rules of probabilities

Example two lamps. Every lamp has a known probability to work. Chance of both lamps working: $0.8 \times 0.9 = 0.72$

Measuring reliability (2)

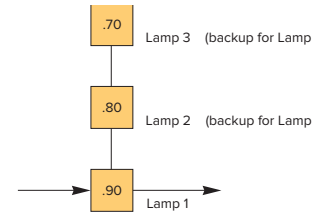
Redundancy to increase reliability. Probability that at least one of two components works:

$p_1 + p_2 \times (1 - p_1) = 0.98$



Probability that at least one of multiple components works $1 - p(\text{all are faulty})$

$1 - [(1 - 0.9) \times (1 - 0.8) \times (1 - 0.7)] = 0.994$



Source: Stevenson (2021)

Impact on the supply shain

"A product might be attractive for customers but drive unnecessary supply chain costs because of the impact the product design has on sourcing, packaging, production, warehousing and transportation. 70-80% of the cost of goods of a product is decided at the development and design stage by factors such as the number of materials and components, country of supply, lead time of materials, standardization of parts across the product portfolio, physical characteristics, and the complexity of the product."
https://www.logichainsolutions.com/post/how-product-design-impacts-the-supply-chain

Sourcing: number of materials; where they have to be sourced.

Production: standardization, common components (shared with other products), how is the production process organized?

Warehousing: how must/can the product be stored?

Transport: how much packaging is necessary? how heavy is the product?

Design for Supply Chain

Summary

- Product (and service) design is key to satisfy customers.
- Awareness of what the customers want, what competitors are doing, government regulations, novel technologies etc. is essential.
- The design process requires the consideration of organizational capabilities, especially operations, forecasting (expected demand), product life cycles, legal, ethical and environmental aspects as well as the level of standardization.
- R & D can play an important role in product and process innovation.
- Reliability is often considered to be an important dimension from the perspective of the customer.
- Product/service design affects every area of an organization as well as its supply chain.