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Cleaner Production and TRIZ

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CP standard model

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- The standard approach to apply Cleaner Production originates from chemical engineering.
- It follows the steps of:
  - Drawing a process flow sheet
  - Collecting input/output data
  - Doing mass and energy balances
  - Identify sources for waste and emissions
  - Set priorities
  - Identify options.
- In the process of option generation one generally relies
  - Expert knowledge or
  - On checklists or
  - The best available technology reference (BREF) notes

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CP and TRIZ

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- The authors wanted to develop a generic approach for option identification
- Especially for teams with little formal engineering background or teams which have to go beyond their professional experience
- By using elements of the so-called TRIZ method (Theory of inventive problem solving, “теория решения изобретательских задач“)

The origin of TRIZ

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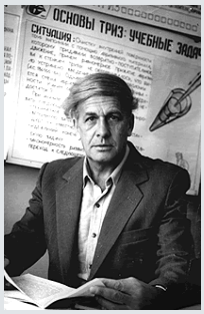
Analysis of about 40.000 patents for the development of several TRIZ-Tools (since 1946)

TRIZ – Tools:

- Technical Contradictions (1956 – 1971)
  - 40 Inventive Principles
- Physical Contradictions (1979)
  - 4 Separation Principles
- Ideality (1956)
- SuField-Model (1974 – 1979)
- Laws of Evolutions (1969 – 1979)
- ARIZ (1959 – 1985)



Genrich Saulowitsch Altschuller
1926 – 1998

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Laws of evolution

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- Stepwise evolution of systems
- Increasing ideality
- Different evolution of system elements
- Increase in dynamics and control
- Increase in complexity and decrease again
- Increase of coordination
- Miniaturisation
- Decrease in human interaction

Backcasting

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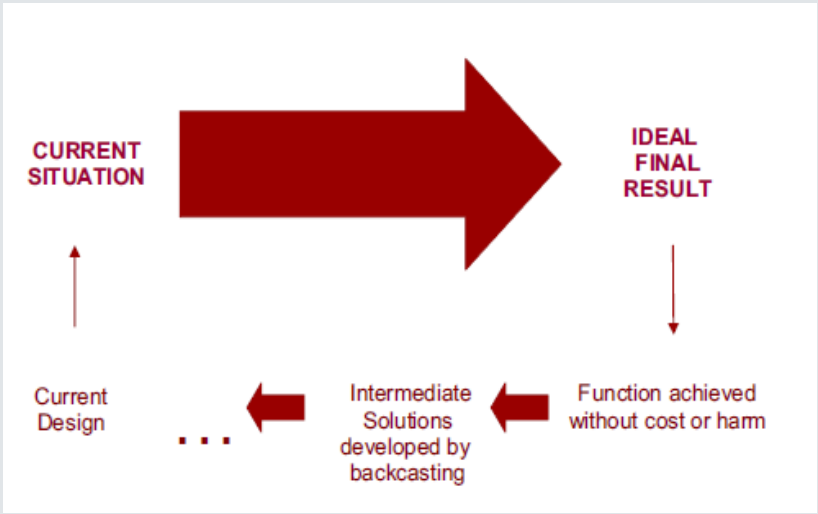

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Function analysis

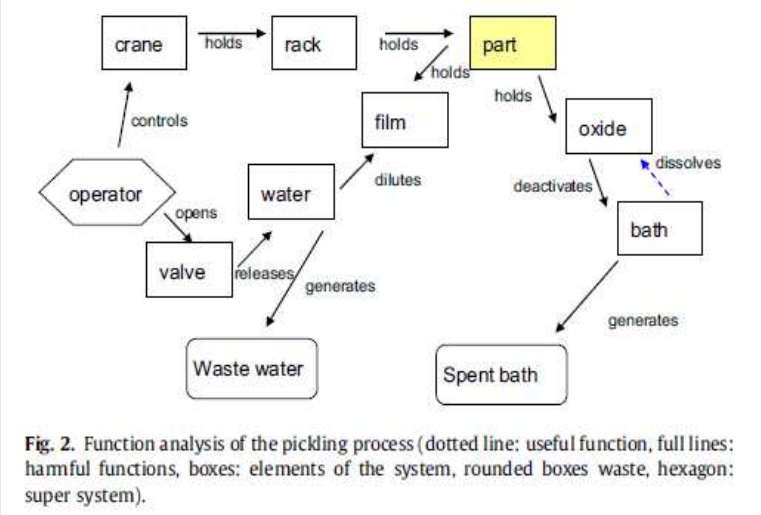

Fig. 2. Function analysis of the pickling process (dotted line: useful function, full lines: harmful functions, boxes: elements of the system, rounded boxes waste, hexagon: super system).

Trimming

- Can components or (ancillary) functions be gotten rid of?
- Can the need for a function be eliminated?
- Can functions of other components or the components themselves be taken over?
- Can operating components be replaced by other components?
- Can an element be introduced to fulfill the function without harm?
- Can operating components be replaced by existing resources?
- Can the system take over functions itself?
- Can freely available resources be used?

Case study textile mill

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- Initially, a flowchart was drawn for the processes in each of these mills.
- These flowcharts were used to identify sources of waste water and energy emissions.
- Then together with the project teams in the companies, priorities were assigned.
- Consequently, detailed analyses were conducted for priority areas.

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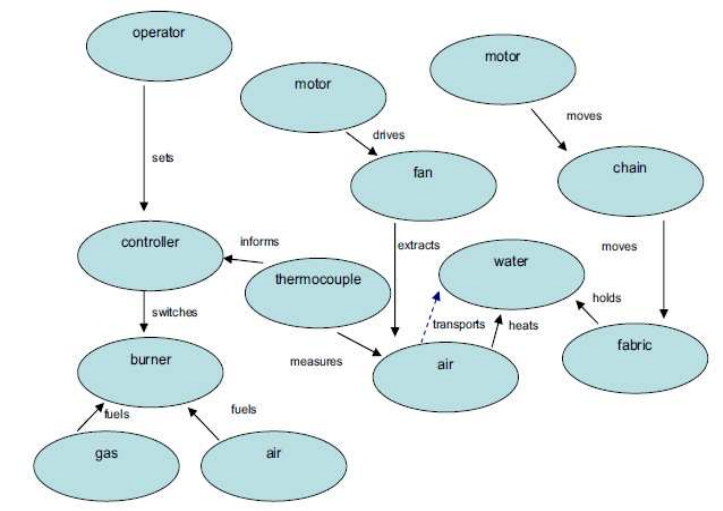
Function analysis for stender



Application of the new approach

- The ideal solution would be dry fabric without any harmful functions (costly use of energy, generation of waste heat in the exhaust air).
- Replacing the wet process at all was out of scope because of the specific requirements of the client.
- The closest approach to the ideal final result could be realized by eliminating the water first mechanically by squeezing the fabric
- Changing the drying mechanism to high frequency microwave drying, would eliminate the need for air for heat transfer and reducing its function to the transport of humidity.

Results

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- In the case of two companies, the motor was driving the fan at a constant speed, regardless whether they were drying heavy fabrics holding 200 g/m² of water or light ones with less than 70 g/m².
- This was pointed out during the discussion in the team while developing the function model.
- Measuring the humidity in the exhaust and controlling the volume of airflow accordingly was the approach that led to a 30 % reduction in gas consumption

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Suggested Procedure

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- drawing of a flow sheet
- performing a function analysis in the process steps where waste and emissions are generated
- definition of ideality in these steps,
- applying trimming and backcasting
- intermediate solutions
  - select ideal raw materials (air, water, biogenic materials)
  - improve control of the process
  - reduce human interaction
  - improve the coordination of the production process with external requirements
  - look for alternative technologies (following the principles of reduction of number of transformations, use counter current flows, use staged processes)
- collect data on flows and monetary value of raw materials, energy and waste and evaluate the feasibility of the options.

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Conclusions

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- The TRIZ based approach is a valuable tool to moderate group work on developing CP options
- It does not require encyclopaedic knowledge of sector specific technologies.
- It is a systematic semantic approach to create powerful, though simple models for project steps, allowing to identify the origin of process inefficiencies.
- The approach also allows to expand the problem solving space beyond the original disciplines of the team members.
- Because it is more qualitative and relies on less data it is apparently easier to apply, less time consuming than the usually applied mass and energy balance based approaches

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Books, Software, Tipps from STENUM

NACHHALTIGwirtschaften

- Resourceneffizienz in der Produktion
  ISBN 3939707481, 2009
  (also Spanish and English)

- SankeyEditor 3.0:
  www.sankeyeditor.net
- 100 energy saving tips:
  energiesparen.stenum.at

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