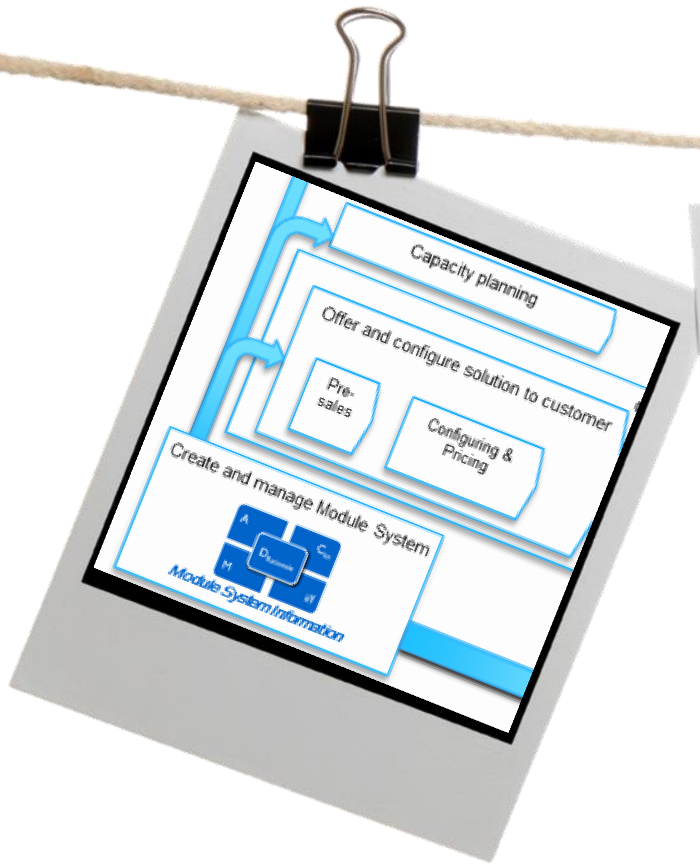
Suunnittelu kiertotalouteen



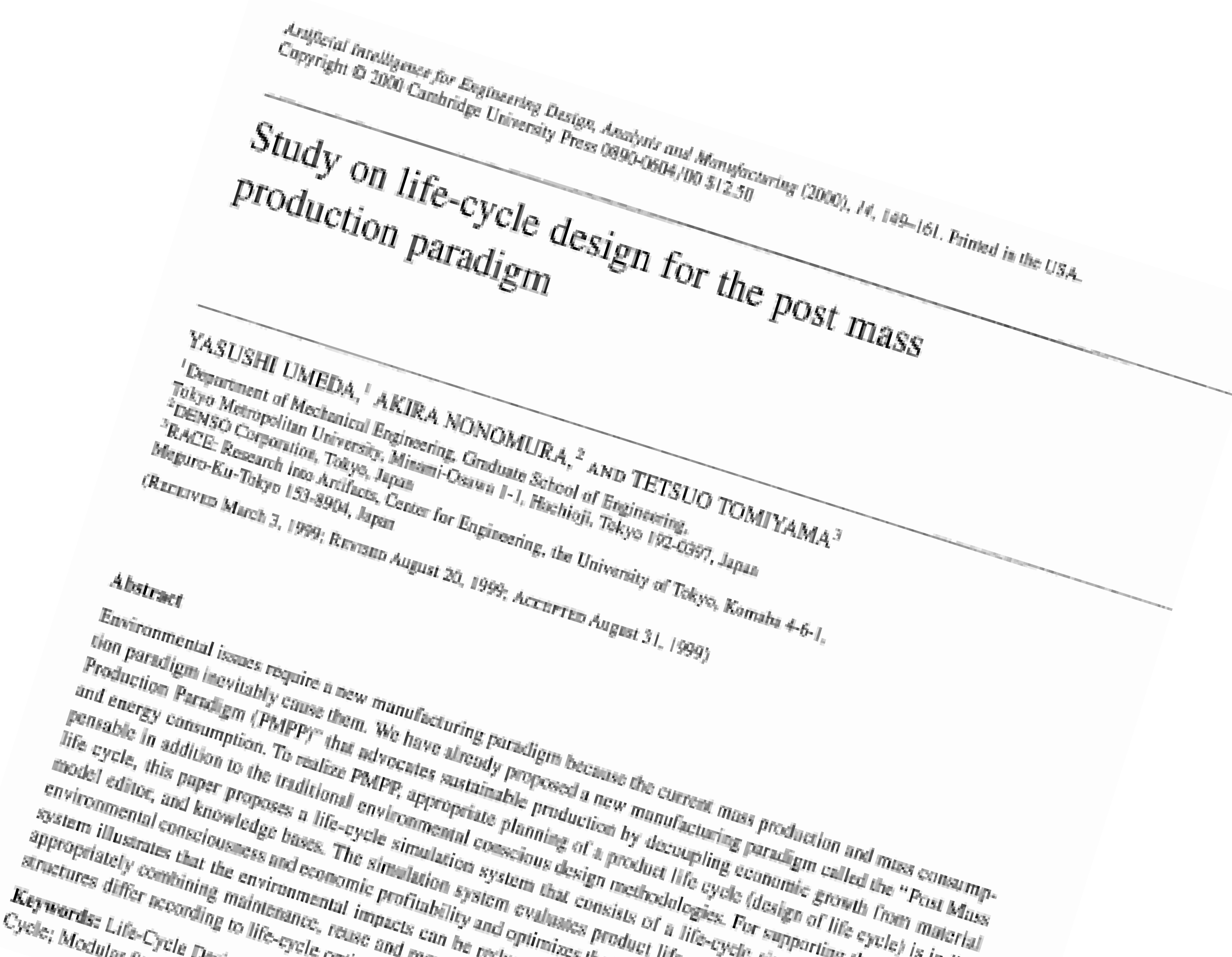
Aineisto 2

Tuoterakenteen ratkaiseva vaikutus

Erilaiset kiertosyklit – erilainen tuote

- Edelle kuvatussa CSL-kartassa tuli jo esiin havainto, että tuotteen rakenteen optimaalisuus arvontuottomekanismeille ja elinkaarimallille on tärkeää
- Seuraavassa käymme läpi yhden tutkimuksen mielenkiintoiset havainnot tästä aiheesta

TUTKIMUS KIERTOTALOUDEN VAIHTOEHTOISISTA SYKLEISTÄ


Artificial Intelligence for Engineering Design, Analysis and Manufacturing (2000), 14, 149–161. Printed in the USA.

Study on life-cycle design for the post mass production paradigm

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Abstract

Environmental issues require a new manufacturing paradigm because the current mass production and mass consumption paradigm inevitably cause them. We have already proposed a new manufacturing paradigm called the "Post Mass Production Paradigm (PMPP)" that advocates sustainable production by decoupling economic growth from material and energy consumption. To realize PMPP, appropriate planning of a product life cycle (design of life cycle) is in
pensable in addition to the traditional environmental conscious design methodologies. For supporting
life cycle, this paper proposes a life-cycle simulation system that consists of a life-cycle
model editor, and knowledge bases. The simulation system evaluates product life
environmental consciousness and economic profitability and optimizes
system illustrates that the environmental impacts can be
appropriately combining maintenance, reuse and
structures differ according to life-cycle

Keywords: Life-Cycle
Cycle; Modular

IMS Gnosis Inter Regional Meeting: Contributions from the University of Tokyo

Tetsuo Tomiyama

RACE, The University of Tokyo

Gnosis IRM in Paris

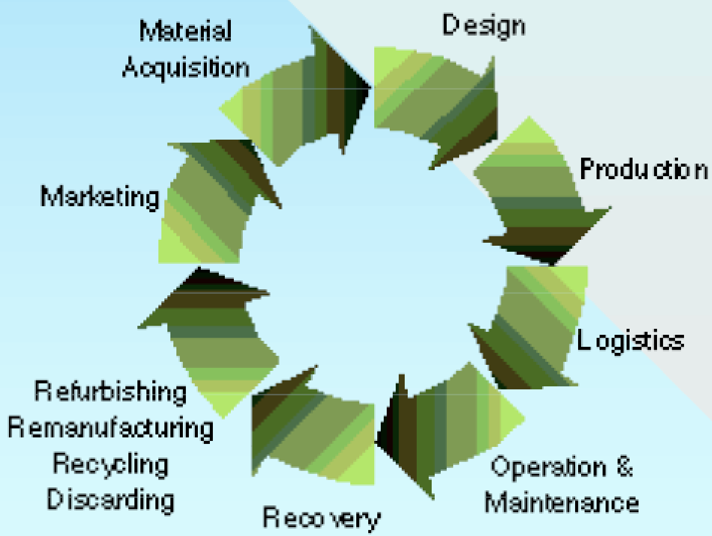
March 19, 1999

Background

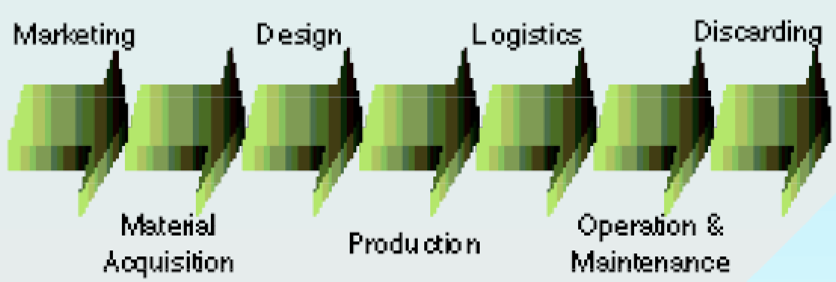
- **Post Mass Production Paradigm**
  - To Decouple Economic Growth from Material and Energy Consumption
  - Decreasing Production Volume to a Manageable Size while Maintaining Quality of Life
- **Inverse Manufacturing**
  - Closing the Product Life Cycle Loop
  - Dematerialization
- **Soft Artifacts**
  - Longer Life
  - Upgradeability/Downgradeability
    - Modular Architecture

Closed Life Cycle and Life Pipe

- **Product Life Cycle**



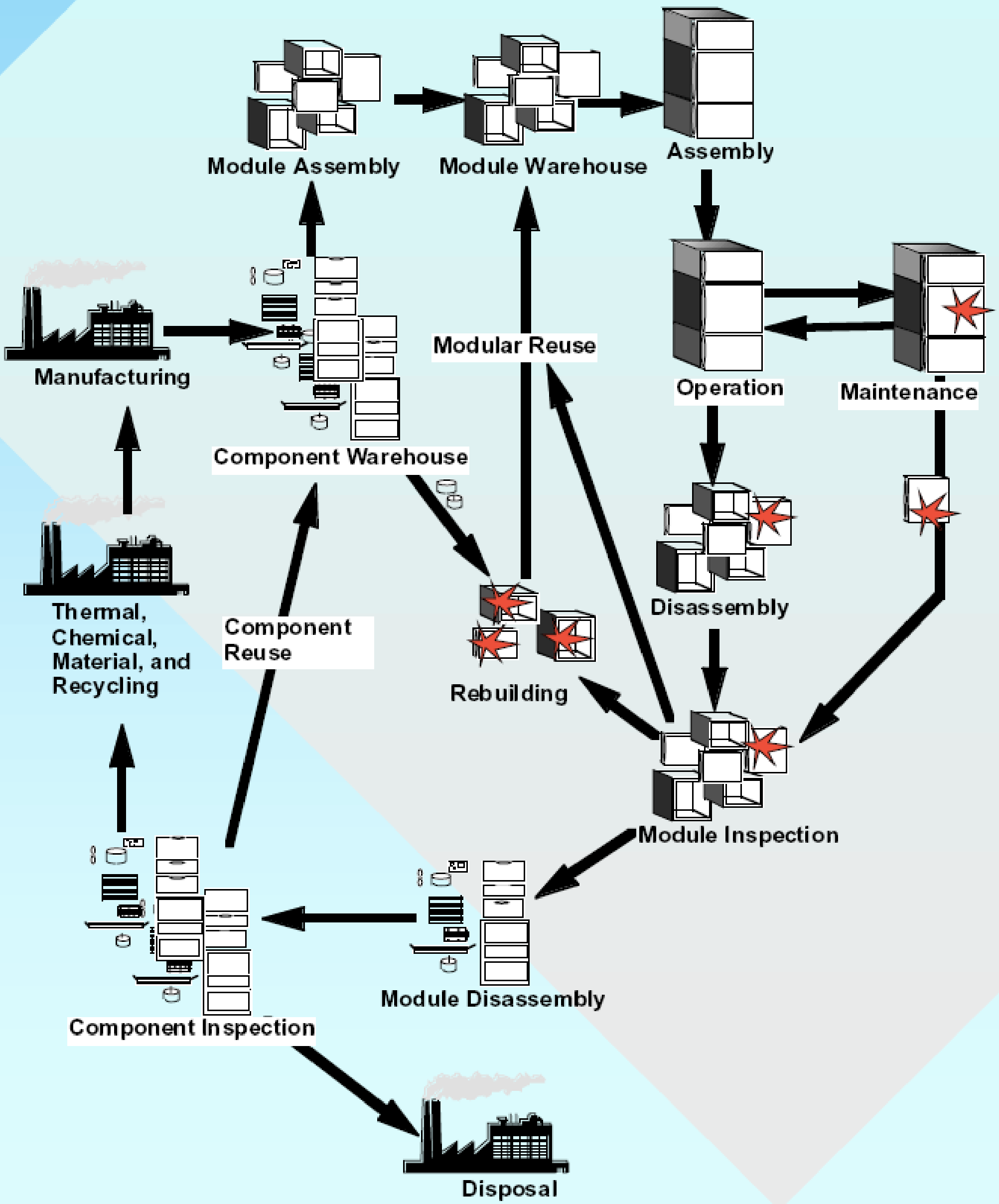
- **Product Life Pipe**



Product Life Cycle Design by Life Cycle Simulation

- Proposal of Design of Product Life Cycle
- Modular Artifacts for PMPP
  - Longer Life
  - Upgradeability/Downgradeability
- Life Cycle Simulation System
  - Life Cycle Simulation based on Discrete Event Simulation
  - Optimization of Life Cycle Parameters with Genetic Algorithm
  - Optimization of Modular Architecture
- Case Study of Refrigerator

Ideal Product Life Cycle Model



Model of Product

- **Product**
  - Consists of Modules
  - Possible to Repair it by Replacing Modules
- **Module**
  - Consists of Components
  - Possible to Rebuild a Module by Replacing Components at Factory
- **Component**
  - Cannot be Disassembled nor Repaired
  - If a Component is Broken, it is Recycled or Just Thrown Away

Procedure for Life Cycle Design

Definition of Product Architecture

Build a Life Cycle Model for Simulation

↓

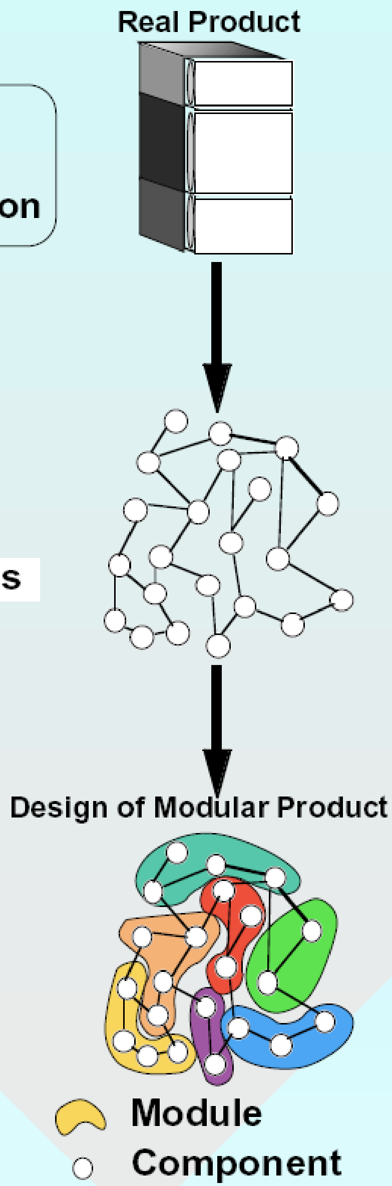
Life Cycle Simulation

↓↑ Optimization by Genetic Algorithms

Life Cycle Evaluation:
Economically, Environmentally

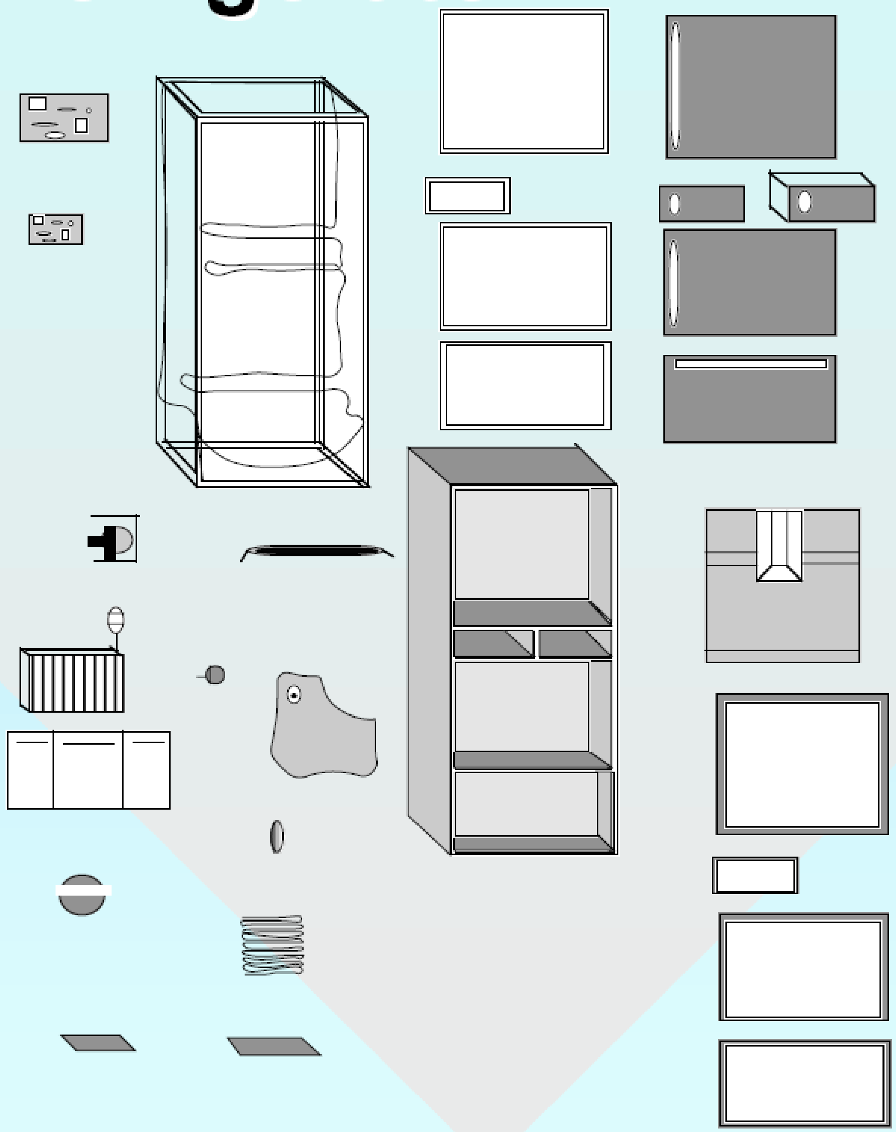
↓

Optimized:
- Module Configuration
- Life Cycle Parameters
- Component Selection

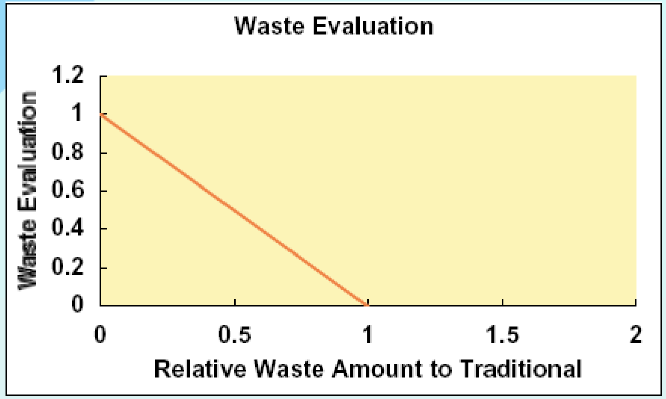


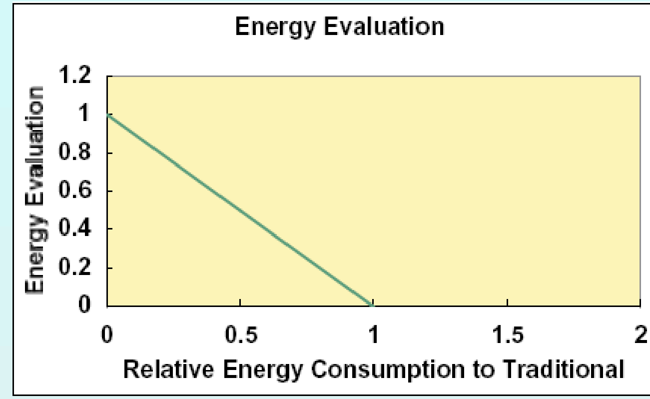
Case Study: Refrigerator

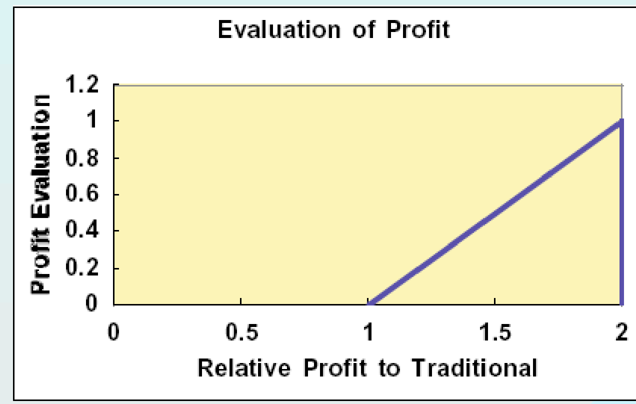
- Assuming a Modular Refrigerator
  - Technically Feasible
- Saturated Market
- Exterior Components are not Reusable
- Interior Components are not Reusable

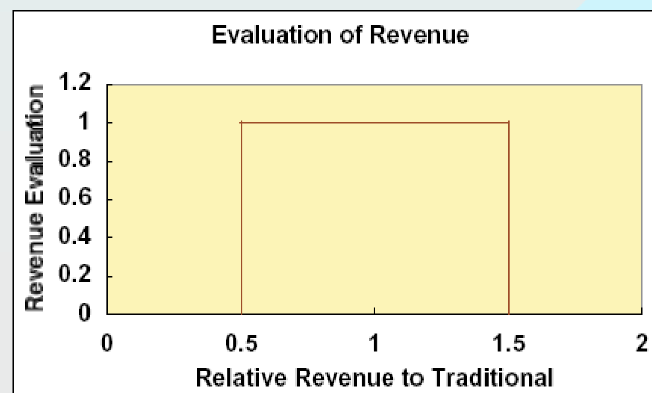


Life Cycle Optimization









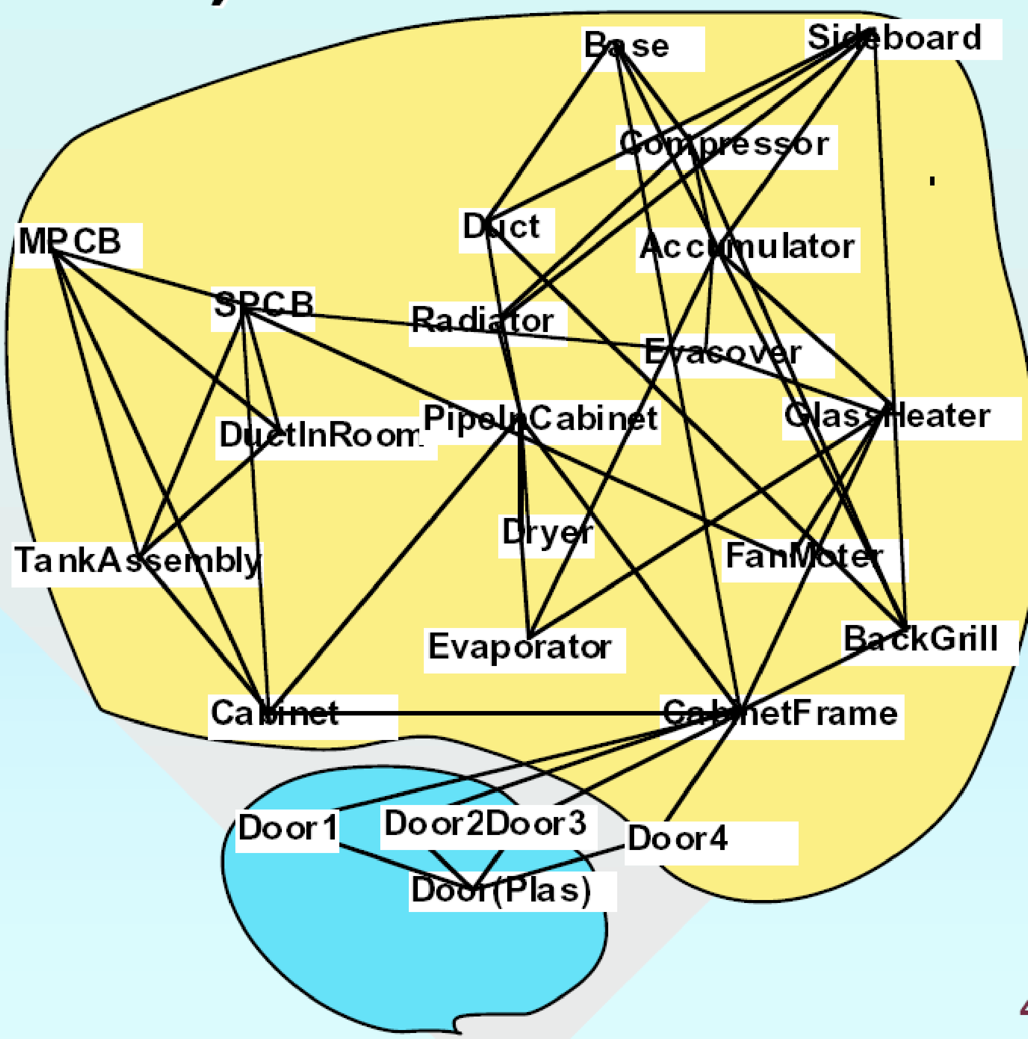
- **Optimization of**
  - Solid Waste
  - Energy Consumption
  - Revenue
  - Profit
- **By Searching Optimal**
  - Life Cycle Parameters
  - Life Cycle Strategy
  - Module Configuration (Product Architecture)
- **With Genetic Algorithm**

Comparison Between Different Life Cycle Strategies

- Traditional Type
  - Life Cycle Pipe
  - Even No Recycling
- Recycling Type
  - Material or Thermal Recycling of Disassembled (Recyclable) Components
  - Any Other Things Go to Landfill
- Reuse Type
  - Recycling + Reuse of Components
- Maintenance Type
  - Recycling + Modular Maintenance
- Inverse Type
  - Recycling + Reuse + Maintenance

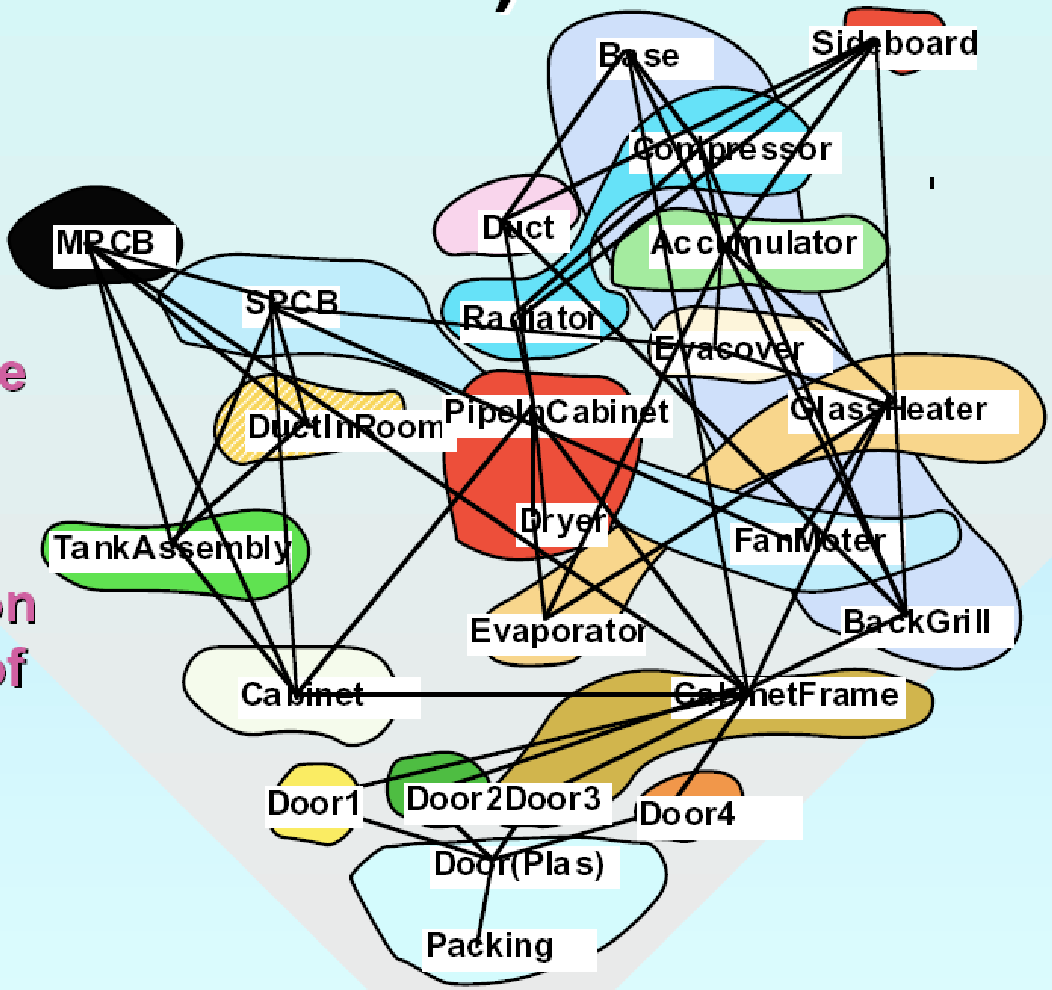
Optimized Module Configuration (Recycle + Reuse)

- Bigger Modules are Preferred
- Disassembly and Assembly Cost can be Saved



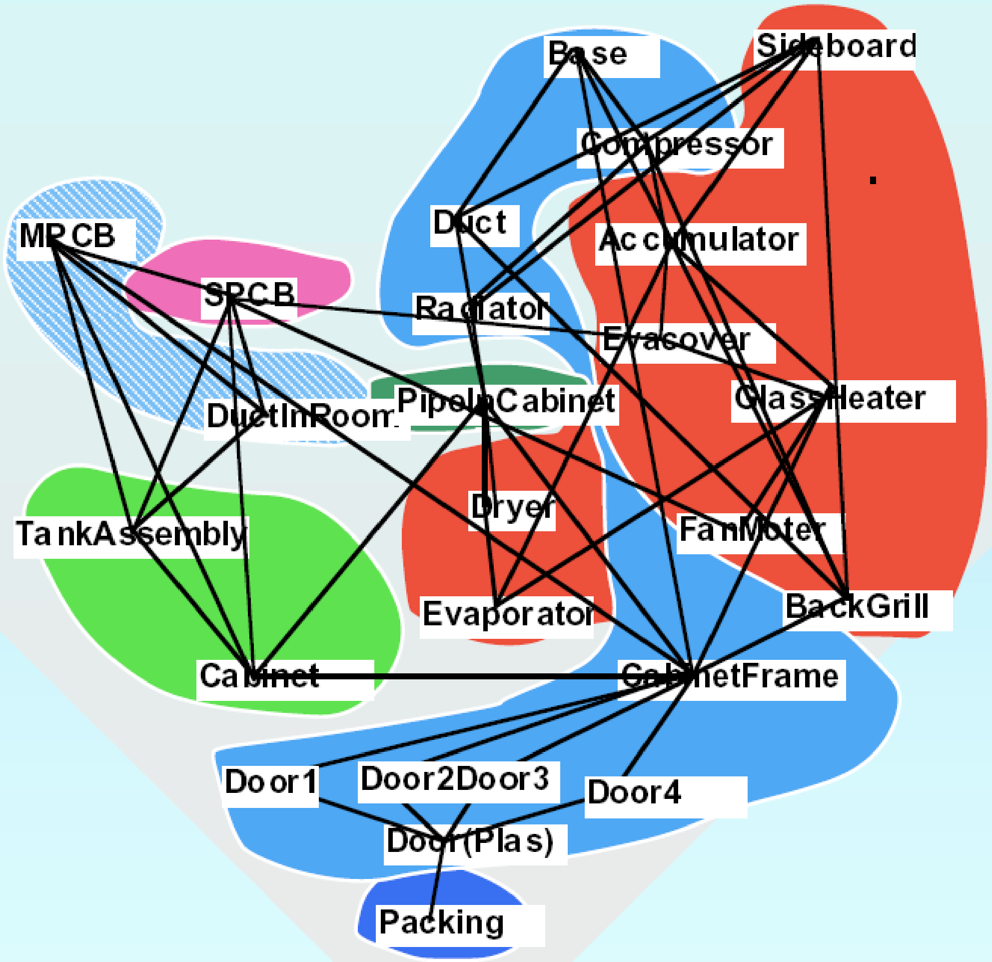
Optimized Module Configuration (Recycle + Maintenance)

- Smaller Modules are Preferred
- Unnecessary Replacements of Usable Components can be Avoided
- Modularization based on similarity of Lifetimes of Components



Optimized Module Configuration (Recycle + Maintenance)

- Between reuse type and the maintenance type



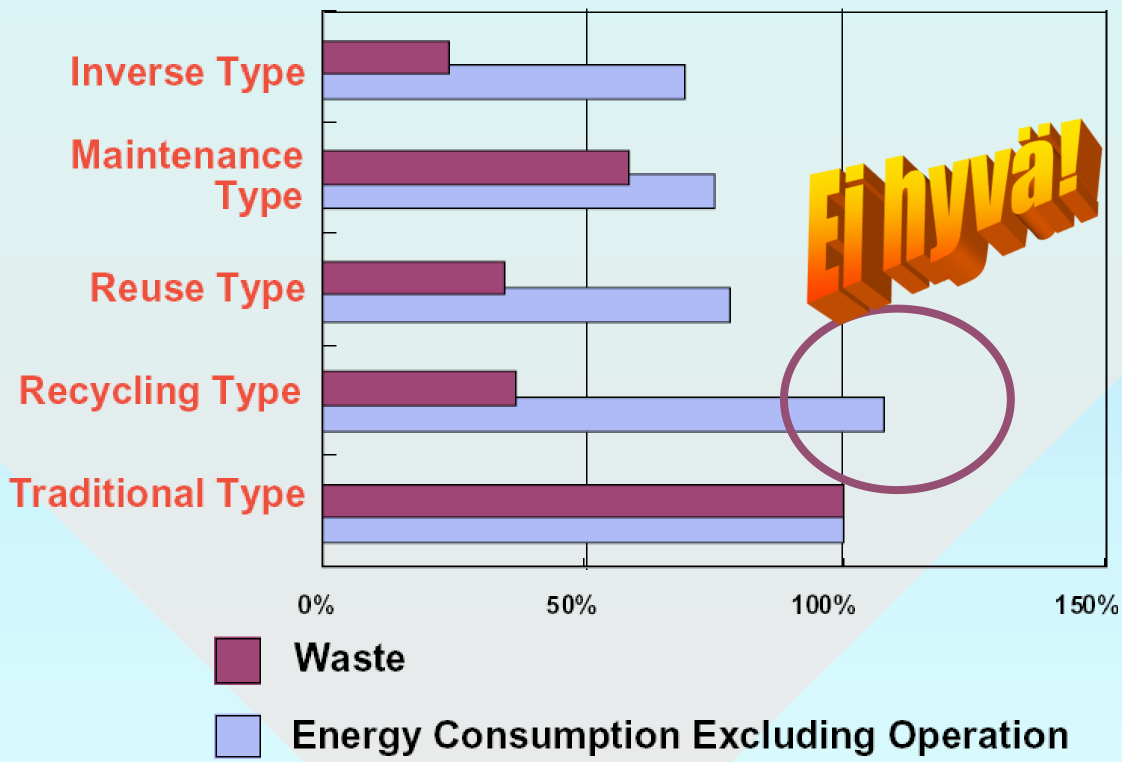
Optimized Results (Environmental Impacts)

Collection Rate : 90%

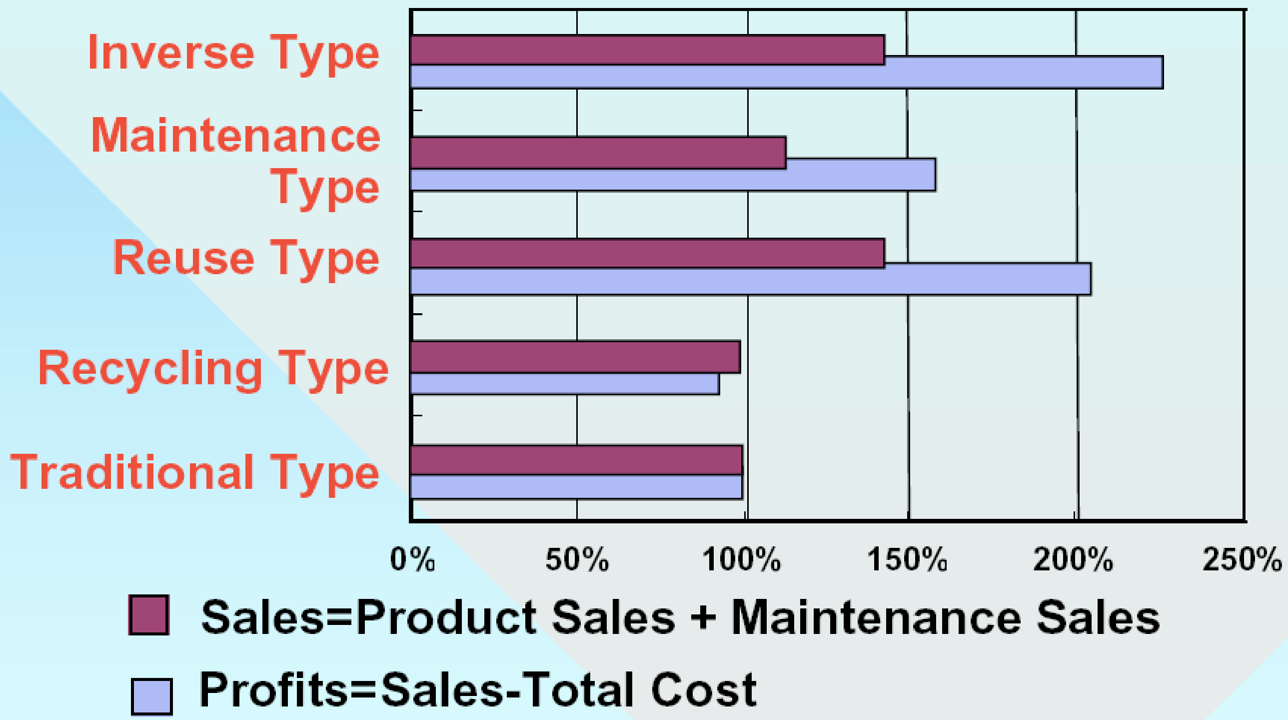
Recycle Rate : 40%

Life Time of Product : 6year

Maintenance Preference: 0.66

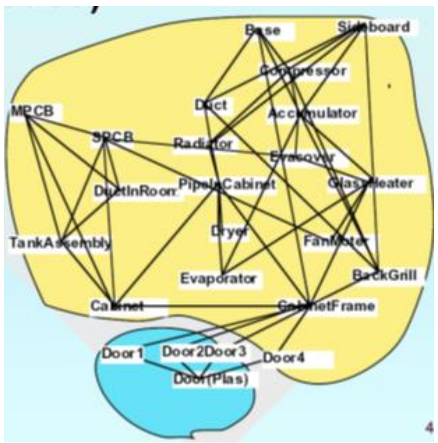


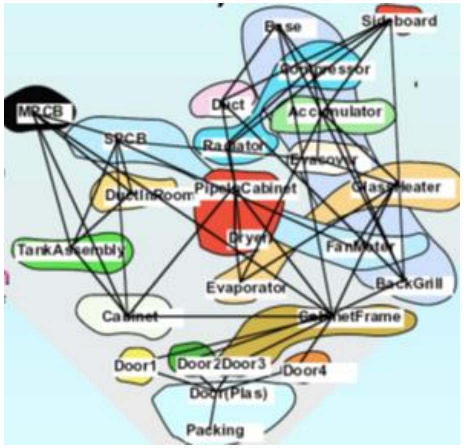
Optimized Results (Economic Factors)

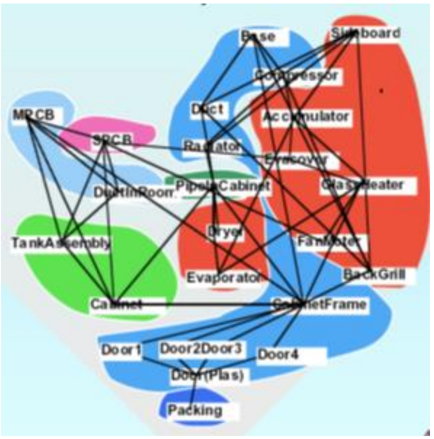


Yhteenveto

- Optimaaliset rakenteet eri sykleille olivat hyvin erilaisia







- Tässä tapauksessa kiertotalous tarjoaa merkittävän mahdollisuuden sekä vähentää ympäristöjalanjalkeä ja samalla lisätä liiketoiminnan tuottopotentiaalia