Business Innovation in Construction through Value Oriented Product/Service offerings for Living Buildings

Wim Gieltingh
Motivation for a Living Building Concept *

• A new Business model that supports
  – Changing user requirements
  – Sustainable construction processes
  – Reduced depreciation of capital goods
  – Proactive role of suppliers
  – The offering of Integrated Products and Services

• Pilot projects
  – School (Veenendaal)
  – Hospital (Den Helder)
  – City Center (Almere)

* Original concept developed by Prof. H. de Ridder, TU Delft, for the Programme of System Innovation in Construction (PSIB) in the Netherlands
Current Lifecycle Thinking

- Initiate Project & Specify Requirements
- Build Building
- Operate & Maintain Building
- Demolish Building
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Costs
Current Lifecycle Thinking

today: unilateral focus on lowest initial (capital) costs
Current Lifecycle Thinking

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Costs
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Value

Costs
Current Lifecycle Thinking

value

Initiate Project & Specify Requirements

Build Building

Operate & Maintain Building

Demolish Building

costs
Current Lifecycle Thinking

value

Initiate Project & Specify Requirements → Build Building → Operate & Maintain Building → Demolish Building

costs
Demolition?

value

costs

functional life
Example: Gemini Hospital in Den Helder (NL)

- Current building inefficient and expensive

Need for a new building!
Example: Gemini Hospital in Den Helder (NL)

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- Changing treatment techniques and hospitalization policies
  - Increasing policlincial treatments
  - Shorter stay of patients in hospital

Continuously changing requirements!
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Given these uncertainties, the investment in a new building is very risky
hospital > 100 year

hospital operation

functional requirements < 10 year

performance
Building types with rapidly changing user requirements

- Schools
- Healthcare facilities
- Elderly care facilities
- Retail centers
- Transport facilities (airports, stations)
- Plants
- Office facilities
- Traffic systems
- ….

Real estate preferred lifetime > 50 years
Requirements change < 5 – 15 years
The Case for Remanufacturing

disassembly
sorting
storage

cleaning
inspection
machining

coating
The Case for Remanufacturing

- Maximum Product Lifetime [years] (Technical Limits / Market demand)
- Physical/Technical Lifetime
- Functional Lifetime
- Average Product Cycle Time per Use [years]

- Upcycling (remanufacturing)
  - industrial heavy duty engine
  - machine tool
  - vending machine
  - office furniture
  - telephone
  - copier

- Downcycling (shredding, melting)
  - car engine
  - power tool
  - electricity meter
The Case for Remanufacturing
The Case for Remanufacturing

Office furniture, interior walls

Copying machines, Printers
The Case for Remanufacturing

• Profitable, environment friendly business
  – Remanufactured products are as good as new & include warranty
  – Cost 45% - 80% price of new products
  – Energy reduction of 85% - 95% compared with new products
  – Require ≈ 90% less natural resources than new products
  – Avoids emission of 28 mio tons CO₂/yr (US, 2005)

• Rapidly expanding business
  – Employs 480,000 people in US 2005 (= 2x US Steel or Pharmaceutical Industries)
  – ≈ 25% annual growth

• Current applications mainly in
  – Automotive, defense, transportation, consumables
The Physical Building Lifecycle
Demolition or Reuse?

• Total embodied energy equals:
  \[ \approx 37 \text{ years of operational energy} \]
  \[ \approx 36\% \text{ of total building related energy} \]

Research on 20 secondary schools in Australia (G.Ding)
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Large impact on CO\(_2\) emissions

Less impact on CO\(_2\) emissions
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Towards new business models

capacity

know-how

✓
Towards new business models

- process
- capacity

- capacity optimized for processes

- know-how
- time & budget

✓ ✓ ✓
Towards new business models

- Processes optimized for products
- Capacity optimized for processes

Know-how | Time & Budget | Result
---|---|---
✓ | ✓ | ✓
✓ | ✓ |
✓
Towards new business models

- **value oriented PSS**
  - products and services optimized for client value
  - processes optimized for products
  - capacity optimized for processes

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<th>know-how</th>
<th>time &amp; budget</th>
<th>result</th>
<th>client value</th>
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Integrated Product Service Systems

- PSS = a marketable set of products and services capable of jointly fulfilling a user’s need
- Key success factors are:
  - to create value for clients, in economic sense or by adding quality and comfort,
  - to customize solutions to meet specific client needs,
  - to create new functions or to make unique combinations of functions,
  - to decrease the threshold and risk of capital investment by sharing, leasing or renting,
  - to decrease environmental load and to deliver eco-benefits,
  - to respond better to changing client needs.
Integrated Product Service Offerings

- Fuji/Xerox
- Lips/Wärtsila
- Rolls-Royce
The diagram illustrates the Value Creation Process for buildings, focusing on the interplay between User processes and Operational Services & Dynamic Control. It highlights the importance of monitoring social and environmental conditions, as well as building performance.

Key points include:
- **User processes** are monitored for process and requirements.
- **Operational Services & Dynamic Control** ensure buildings operate efficiently.
- **Buildings in Operation** involve assembly and disassembly processes.
- **Module reuse** and remanufacturing contribute to minimal use of new base materials and energy.
- **Production & Construction Process** aims for minimal production of waste.

The diagram emphasizes the cyclical nature of these processes and the role of monitoring to optimize sustainability.
Towards new business models

- Value oriented
- PSS
- Products and services optimized for client value
- Product
- Processes optimized for products
- Process
- Capacity optimized for processes
- Capacity
- Efficiency

Living Building
- (customized) products & turnkey solutions
- Integrated DBMOTF
- Project
- Traditional

Client value
The Living Building Concept

• A PSS for construction
  – Providers specialize in specific Product/Service-Market combinations (e.g. schools, hospitals, retail centers)
  – Performance based rewarding scheme: user pays for output
The Living Building Concept

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  - Providers specialize in specific Product/Service-Market combinations (e.g. schools, hospitals, retail centers)
  - Performance based rewarding scheme: user pays for output
  - Provider owns the building
  - Possibility of more than one user per building (multi-functionality)
The Living Building Concept

- Buildings can be adapted to continuously changing user needs
  - Monitoring of processes that affect user requirements
  - Revitalization in stead of Maintenance
  - Building remains fit-for-use, retains its capital value
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*capital value of traditional building*

- T=0 yr
- T=50 yr
The Living Building Concept

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\[ \text{capital value of remanufacturable building} \]
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The Living Building Concept

• Reduce waste, save costs through remanufacturing
  – Design & service for disassembly
  – Released components are remanufactured
Conclusions

• Living Building Concept: a PSS for construction
• Buildings can be adapted to continuously changing user needs
• Reduce waste, save costs through remanufacturing
• Interests expressed by clients and providers
• Pilot projects:
  – School in Veenendaal
  – Hospital Den Helder
  – Almere Haven City Center