Chair for Building Realization and Robotics

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Technische Universität München (TUM)
Outline

1. Automation, Robotics, Services (ARS)
   - Case Studies – Prefabrication
   - Case Studies – Single-Task Robots
   - Case Studies – Automated/Robotic On-Site Factories
   - Br2 projects in Horizon 2020
   - Sustainable Automation from an S-curve Perspective
   - Outlook – Future Health Environments
2. References

Chair of Building Realisation and Robotics | Automation, Robotics, Services in Construction
ARS requires a highly interdisciplinary approach…
Module 1

Adaptation of products, management, and processes towards robot utilization
Module 2

Customization and personalization through prefabrication of components
Module 3

Single-task construction robots
Module 4

Integrated automated construction sites
Module 5

Enhancement of the functionality of buildings through advanced technology
Case Studies – Prefabrication
Case Studies – Prefabrication

e.g. in tune with ISO 14001 certified environmental management systems
Prefab: Closed Loop Manufacturing and Re-Customisation

A new type of house, of which 70% can be reused

The waste emitted from the demolition of a single house is said to be 40 tons. If a house having completed its initial role becomes waste equivalent to the amounts carried by 10 trucks of 4 ton loading capacity, this cannot readily be accepted under current and future situations.

According to the concept of "reusing system houses", the familiar house, where you have long resided, does not become waste. Instead, 70%, excluding the foundations, will be reused for a new role, meaning that it minimizes environmental loads and also responds to the emotional attachment of the family having lived in the house.

Flow of the "Reuse system house"

- Old house
  - Sekisui Heim and Togo Homes can be assembled as trade-offs to build a new Sekisui Heim.
- Ecological demolition work
  - The demolished house is transported to a specialist factory unit by unit, meaning the amount of waste and environmental load can be minimized.
- Inspection and removal
  - Strict quality inspection and maintenance work are meticulously applied to every unit for the reuse.
- New members
  - Inspected units are furnished with new members, such as a water section and outer and inner finishing.
- Transportation to the site
  - The renewal units are used to build a "Reuse-sysem house" on a new foundation in a different site. The methods used for the transportation and construction of the "Reuse-sysem house" are thoroughly the same methods as those applied to a new building.
- Reuse house
  - Sekisui Heim System Re-Use House

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Case Studies – Single-Task Robots (for Renovation and Recycling)
STCRs: Human-Machine-Collaboration

SRL variant 1: prototype used in a drilling task (Image: © [2014] IEEE. Reprinted, with permission, from Parietti and Asada, 2014)

Vuzix M200AR waveguide HD device used by an electrician (Image: Vuzix Corporation)
STCRs: Facade Renovation

Brunkeberg® System - Outline of logistics and installation strategy
(visualisation; Image: Stefan Borell)
Case Studies – Automated/Robotic On-Site Factories
A/ROFs: optimized environmental management in construction

Reduction of construction waste realized through the application of SMART

(adapted from documentary material received from Prof. Maeda/Shimizu; see also Maeda, 1994; Maeda & Miyatake, 1997).
A/ROFs: optimized environmental management in de-construction/dis-assembly

Taisei’s TECOREP deconstruction system
Images: Taisei Corporation
Br2 projects in Horizon 2020
BERTIM (Building Energy Renovation through Timber Prefabricated Modules)

This project has received funding from the European Union’s HORIZON 2020 research and innovation programme under Grant Agreement No. 636984

New prefabricated modules  Renovation process supporting tool (RenoBIM)  Innovative business models

Case studies

Research and Technology Institutes  Timber Prefab Module Manufacturers  Software Developers  Market Research

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BERTIM

Maximize off-site manufacturing process of the modules within the existing facilities by a Modular assembly workstation kit

Minimize on-site Installation time and cost of the modules by a rapid installation system
ZeroPlus (Achieving near Zero and Positive Energy Settlements in Europe using Advanced Energy Technology)

**Objectives of the project**

Implementation of different technologies in order:

- to achieve a reduction of the operational energy usage in residential buildings to an average of 0-20 kWh/m²,
- to generate at least 50 kWh/m² of renewable energy per year, and
- to reduce by at least 16% of the NZE settlement costs, compared with current level.

**Partners:**

- **Universities:**
- **Industry:**
- **Case study owners:**
Demonstration of the integrated energy technology (Freescoo system & frame) using the example of Cyprus case study

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<tr>
<th>PIM Database</th>
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Sustainable Automation from an S-curve Perspective
According to Foster (1986) an overlay of S-curves can be used to describe the relation between the stagnation and technical limits of one technology and the initiation, development and growth of new strategies and technologies.
S-Curves Example

Double-decker  |  Drei-decker  |  Vier-decker

Full Metal Airplane Approach allowed for new S-Curve with higher limits
S-Curves and sustainable Automation

Construction Technology is unable to cope with rising Product Complexity:
- Stagnating Productivity
- Rising Defect Rates
- Rising Organizational Problems
- Rising Cost Overruns

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Outlook – Future Health Environments
GEWOS: Gesund Wohnen mit Stil

ECG
Oxygen saturation

Body weight
PASSAge: Personalized Mobility Assistance and Service Systems in an Ageing Society
USA²: Robot Assisted Working & Cloud Manufacturing
Utilization of Robotic Elements
LISA: Living independently in Südtirol Alto-Adige
Rapid Installation / De-installation

Rapid De-installation (TUM br2, Germany)

Rapid Installation (Bozen, Italy)

Images: LISA Industry Consortium & Chair of Building Realisation and Robotics
Contactless/Ambient Sensing

contactless stationary sensors
Contactless/Ambient Sensing
Contactless/Ambient Sensing
Contactless/Ambient Sensing
Contactless/Ambient Sensing
REACH (Responsive Engagement of the Elderly promoting Activity and Customized Healthcare)

Research:
- Technische Universität München
- Technical University of Denmark
- EPFL
- Fraunhofer IAIS

Industry:
- ARJOHUNTELEIGH GETINGE GROUP
- ALREH Medical
- sturrm.
- biozoon
- SmartCardia
- DIN
- PHILIPS

Application:
- Hôpitaux Universitaires Genève
- Zuid Zorg
- Schön Klinik Bad Aibling
- Lysby-Taarbæk Kommune

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REACH – First Prototypes

[Image of first prototype]

[Image of second prototype]

[Image of third prototype]
REACH – First Prototypes
BaltSe@nioR – First Prototypes
**User Integration and Usability**

**Evaluation collaborative work:**

NASA TLX: average perceived task load levels (M) for test persons when operating the JRA in the collaborative assembly station by various, alternative control modes; N=21.

![Chart showing perceived task load levels for different control modes](chart.png)

**Image:** This work has been developed in the project USA² - the research project was financed by the German Federal Ministry of Education and Research (BMBF, grant number: 16SV6191) within the Human-Technology Interaction (MTI) program/Usability evaluation by br² in cooperation with Berliner Institut für Sozialforschung (BIS)
References

http://www.br2.ar.tum.de/ (website of the Chair of Building Realisation and Robotics)

http://www.zeroplus.org/ (website of the ZeroPlus project)

http://www.bertim.eu/ (website of the BERTIM project)

http://reach2020.eu/ (website of the REACH project)

http://baltsenior.up.poznan.pl/ (website of the BaltSe@nioR project)

http://www.cambridge.org/us/academic/collections/cambridge-handbooks-construction-robotics/titles (website of the Cambridge handbooks on construction robotics)