Robotizing Workforce in Future Built Environments

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Automation and Robotics

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• Mechanization on construction site
• Collaborative design

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• Construction management & engineering
• European strategy in construction
A method for analyzing unsafe and unhealthy production processes on the construction site.

Develop equipment in relation to products.
The Construction Sector in EU27 (1)

The biggest industrial employer:

- **10.4% of GDP** and 49.2% of Gross Fixed Capital Formation (FIEC, 2008)
- **30% of industrial employment**, 7.6% of total employment (16.3 million operatives)
- 3 millions enterprises (95% **SMEs** with <20 workers, local markets, low innovative)
The Construction Sector in EU27 (2)

A large influence on the whole economy

- 48,9 millions workers depending on Construction
- The buildings/infrastructure supplied by the Construction sector serve a lot of other industries and services
A large influence on the whole economy

- Construction can make the difference
- Automation and Robotics can help construction to do so!
European policy (1)

Challenges:
To address and to adapt

- Climate change
- Demographic change,
- Energy supply and security,
- Food shortages
- Safety
- Environmental concerns.
Demands:
For convenience

• Low maintenance
• Automation
• Flexibility
• Health improve features
• Optimal environmental integration
From Production to Performance

- Not just what construction makes
- Does it fit?
- Are users happy?
- Are working conditions safe?
Busan Geoje Fixed Link
Busan Geoje Fixed Link

IMMERSED TUNNEL 18x180m = 3.2km
Busan Geoje Fixed Link

Automation

To measure location
To measure the flow and waves
To control, check and steer tunnel elements
Future needs in Automation and Robotics

- Human machine technologies
- Process management
- Performance technologies
- Client and societal values
Topics

Human machine technologies
Mechanization phases, Labor analysis, Modular construction

Process management
Design meetings, Quality control, Lean construction

Performance technologies
Users needs, Active aging, Automated data collection, Safety

Client and Societal values
Mechanization graph (1)

**Horizontal axis:**
- Control tasks equipment

**Vertical axis:**
- Energy supply in production process.
Mechanization graph (2)

Energy task equipment

- Equipment supplies all energy
- 100% Equipment supplies a certain amount of driving energy
- 0% Equipment does not supply energy

Use of control equipment
Use of guides
Use of drives
Optimization of tools

Use of remote control
Use of computers
Use of artificial intelligence

Control task equipment

Hand tools
Manually controlled devices
Tele controlled devices
Pre programmed devices
Cognitive robots
Topics

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Client and Societal values
Before starting to mechanize and robotize construction processes there is a need to get more insight into the production tasks of the construction worker and equipment.

To get this insight an analysis method has been developed.
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Topics

Human machine Technologies
- Mechanization phases
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Performance technologies
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- Active aging
- Automated data collection
- Safety

Client and Societal values
Modular construction

To shift heavy and complex construction tasks from the site to the factory modular construction can be a solution.

To design the production process of such modular system a method has been developed and applied.
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Client and Societal values
Design meetings (1)

Designing mechanized and robotized production processes needs collaboration between all kinds of professionals.

During design meetings this collaboration can be taken place.

Working methods are needed to produce new concepts.
Design meetings (2)

1. Making what you think visible: mind maps
2. Group idea creation: brainstorm sessions
3. Systematic idea generation: Systematic Inventive Thinking (SIT)
4. To create insight: simulation games
A design meeting has to be prepared very carefully.

To obtain really new concepts a certain order of activities is necessary.
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Process management
Design meetings, **Quality control**, Lean construction

Performance technologies
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Client and Societal values
Clients don’t know how to measure the performance of contractors.
Quality control (2)

- Need for automated data collection
- Need for real time automated data processing
Topics

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**Process management**
- Design meetings, Quality control, **Lean construction**

**Performance technologies**
- Users needs, Active aging, Automated data collection, Safety

**Client and Societal values**
Transferring this approach to construction focuses on:

- the reduction of construction period
- the reduction of the variability
- the simplification of tasks
- the increase of transparency
- the increase of flexibility
Lean Construction (2)

Project values 1

- Reduction building period (25-50%)
- Better communication
- Less stress on the work floor
- Reduction on general construction costs (e.g. man-hours, equipment, offices for staff, rooms for personnel)
Lean Construction (3)

Project values 2

• Building specialists know what they and the others have to do

• Building specialists take responsibility for their scope of work, the interfaces and the success of the entire project
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**Performance technologies**
Users needs, **Active aging**, Automated data collection, Safety

**Client and Societal values**
Active aging in an Aging Society (1)


The graph shows the projection of workforce (15-64 yrs) and median age of the total population from 2000 to 2060. The workforce is expected to decrease while the median age is expected to increase.
Active aging in an Aging Society (2)
Active aging in an Aging Society (3)

Themes:
• Housing & Daily Living
Active aging in an Aging Society (4)

Themes:
- Housing & Daily Living
- Mobility & Transport
Active aging in an Aging Society (5)

Themes:
- Housing & Daily Living
- Mobility & Transport
- Work & Leisure
Aging-in-place
Aging workforces
Robotics
Societal changes

Gerontechnology

Automation and Robotics in Construction
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Client and Societal values
Automated data collection (1)

Large public works
DBFM (O)
Performance
Measure during operation
Automated data collection (2)

Geometrical track quality by optical glassfiber sensors

Each sensor measures, with an accuracy of 0.05 mm:
- movement in vertical direction
- movement in lateral direction, i.e. crosswise on the track
- rotation in cross direction
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Client and Societal values
Client’s and societal values

- **Process**
  - Make work less heavy and more safe
  - Support collaborative design and construction
  - Monitor the performance of the designers/suppliers/contractors

- **Product**
  - Create low maintenance products
  - Support aging people at work and at home
Rotterdam Medical Centre (1)

- City centre of Rotterdam
- New hospital
- Condensed urban area
- No space
- 31 stories high building
- In a factory
Rotterdam Medical Centre (3)

- No space
- 31 stories high building
- In a factory
Every week one floor in the factory on top of the new building
• Every week one floor in the factory on top of the new building
• Prefab wall elements
• Prefab floor elements
• In situ top layer at the floor
Rotterdam Medical Centre (10)
Rotterdam Medical Centre (12)

concrete elements
As wall
As floor
Fixed with dry joints
2 “Frames” support the steel factory
2 steel beams support the shed from 2 levels below.
Hydraulic jacks move the factory up every week one floor
Rotterdam Medical Centre (16)

- Health and Safety conditions
- Integration of Design and Build
- Community relation
- Quality
Thank you for listening and enjoy the 28th ISARC Symposium in Seoul

Frans van Gassel & Ger Maas