

# IPHA PRODUCTION SEMINAR 2016

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## Efficiency in Hollowcore Production

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Elematic



INTERNATIONAL PRESTRESSED  
HOLLOWCORE ASSOCIATION

in cooperation with

**Pujol**

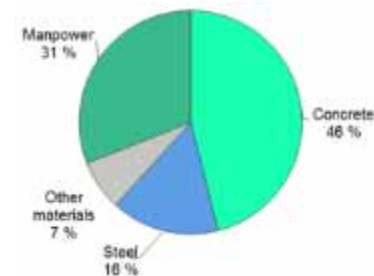


# Jani Eilola

- **Product Director 2014-**
  - Floor technologies
  - Acotec (non-loadbearing partition wall system)
- **Joined Elematic 2007**
- **MSc in Mechanical Engineering**
  - Tampere University of Technology 2002

# Topics

- **What Is Efficiency?**
- **Current State**
  - Cost structure of HC
  - What do the indicators tell us?
- **Efficiency by Area**
  - Labour
  - Material
  - Energy
  - Process
- **How To Improve?**
  - Best Available Technology
  - Line according to need
  - Most automatic hollow core production line
  - IoT / Industry 4.0
  - MES



# Motivation

- **Benefits of efficiency**
  - - 30 % less concrete
  - - 50 % less cement
  - - 65 % less manhours
  - + xx % more capacity
  - => Production cost: - 50 %

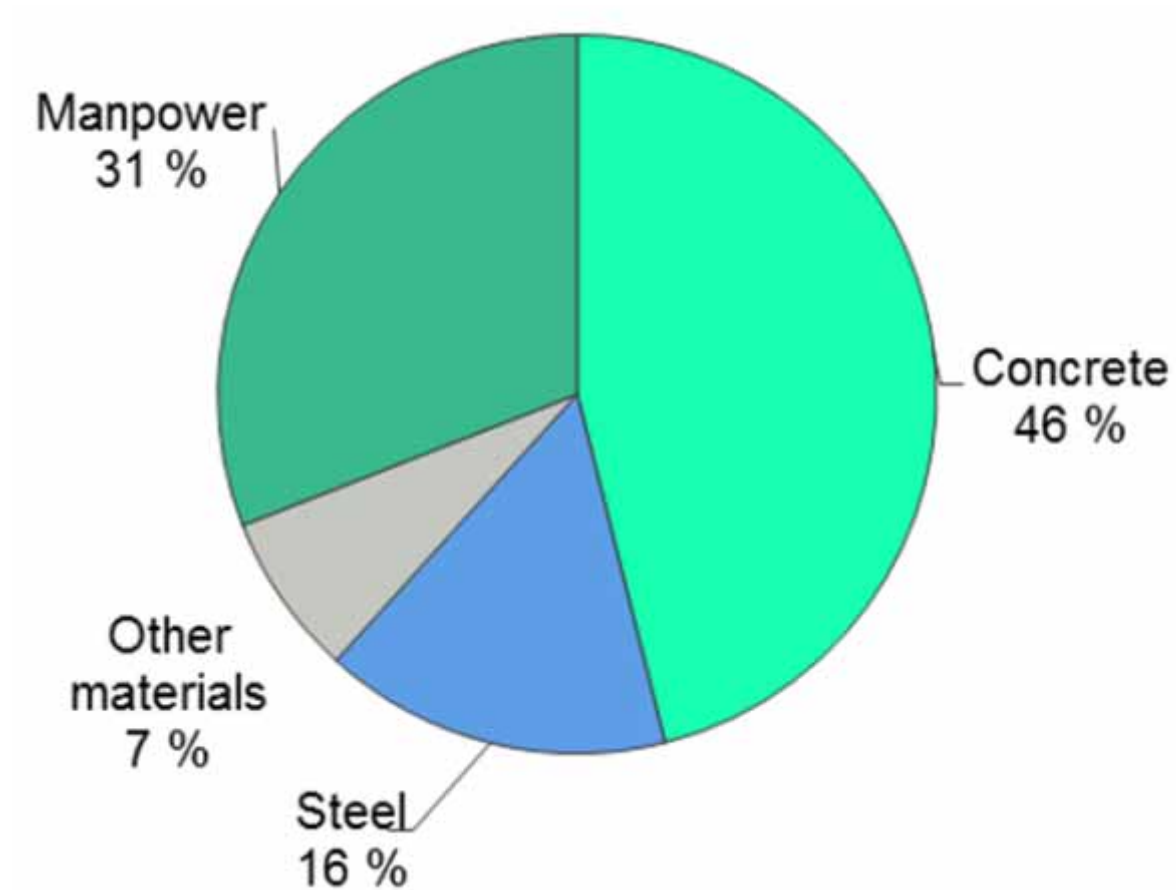
# What is Efficiency?

- **The bottom line: €/m<sup>2</sup>**
  - Labour + Material + Capital Cost



# Current State – Typical Figures

- **Cost of HC production (Western Europe)**



# Current State – Typical Figures

- **Labour**      **0.13 – 0.3 (most: 0.2-0.25) manhours/m<sup>2</sup>**

- Assisting time ratio 0.28  
of which
- Personal                    0.12
- Workphase                    0.16
- Utilization rate              0.8 – 0.9



- **Material**

- Scrap                            0.8 – 2 % (of casted slab)

- **Concrete**

- Waste app.                    7-9 %
  - Actual produced concrete vs. theoretical volume needed for slabs
- Cement content              Typical: 350-450 kg/m<sup>3</sup>

# Current State – Typical Figures

- **Steel**

- Waste 7-9%

- **Process**

- Bed utilization rate 90-95%

- Storage duration 2-4 weeks

- Cycle time (Cover off till cover on) 3.5 – 8 h



# Labour

- **Manhours/m<sup>2</sup>**
  - Either reduce manhours
  - Or keep manhours the same and increase capacity



# Labour

- **”Hard” factors:**
  - Level of automation
  - Factory set-up
  - Market situation
- **”Soft” factors:**
  - Production planning
  - Utilization
  - Control
  - Skills & Flexibility
  - Motivation



# Concrete

- **Cross section kg/m<sup>2</sup>**
  - -30% with lighter cross section
- **Actual kg/m<sup>2</sup> vs. Planned kg/m<sup>2</sup>**
  - Preventive maintenance
  - Correct adjustment of machine
- **Amount of cement**
  - More compaction means less cement
    - Down to 300 kg/m<sup>3</sup>
  - Fly-ash as substitute
    - Min. 225 kg/m<sup>3</sup> + fly ash



# Concrete

- **Recycle concrete**

- From openings
  - typical 1-4%
- Crushed factory scrap





# Concrete

- **Recycle water**
- **Waste in the start/end**
  - Typical 3-5 m
  - Start-plate
  - Stop casting when slab is complete
  - Production planning => maximum bed utilization
  - Long beds



# Steel

## ■ Strand-material

- Available cross-sections and stranding = Planned  $\text{kg/m}^2$  vs needed.
- Actual  $\text{kg/m}^2$  vs. Planned  $\text{kg/m}^2$
- Over-stranding vs. Bed utilization
- Typical 5-10%
- Waste at the ends
  - Have long bed! (200m!)
  - Bed planning
  - Start-plates
  - Continuous strands
    - Bundle stressing

## Spare & Wear Parts

- ❑ Feeding screws, sleeves, plates
- ❑ High quality parts last longer
- ❑ High availability of spares means low downtime
- ❑ Preventive maintenance reduces concrete consumption, scrap & unplanned downtime



# Water

- **Material use: Water**

- $m^3/m^2$
- Cutting
  - Water required to cool and keep blade clean
- Washing
- Can be recycled
  - Settling and filtration needed





# Energy

- kWh/m<sup>2</sup>
  - Electricity
  - LPG
  - Diesel
  - Heat
- Machine electricity consumption
- Bed heating
  - Maturity control system
  - Cover well
  - Insulation under bed
- Aggregate heating, water heating
  - in cold countries
- Plant heating/lighting/etc.



# Process

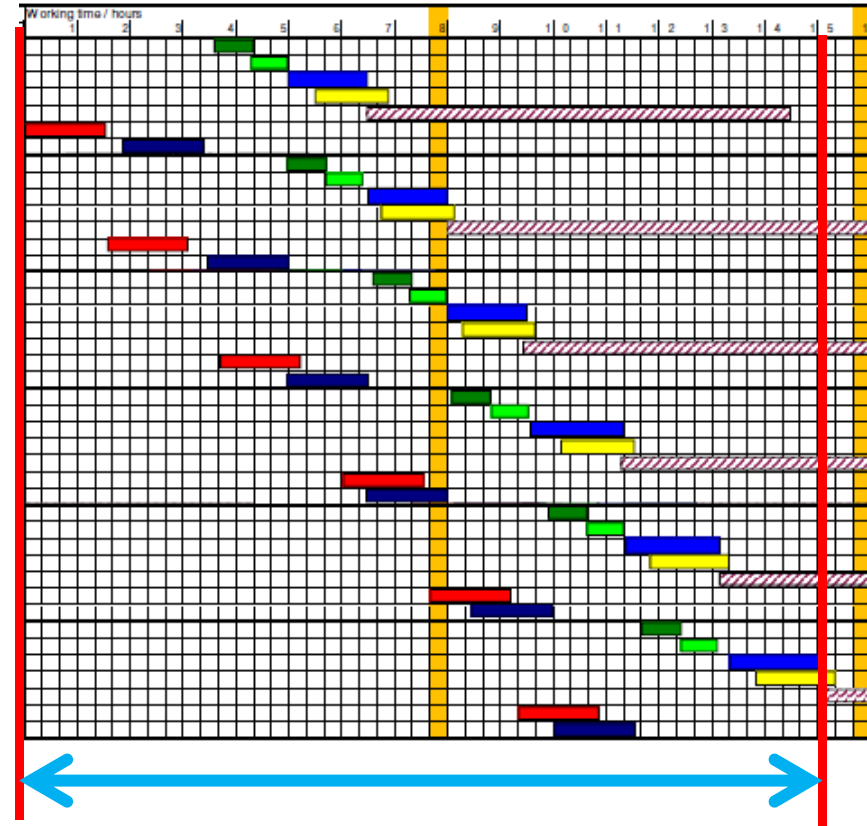
- ❑ Correct plant design
- ❑ Automation level / Efficient equipment
- ❑ Production planning, control, analysis



# Process

## ■ Process

- Cycle time defines the capacity
- Total time = X times cycle time
- Casting usually bottle neck
  - Add an extruder/slipformer
- When casting beds more than once a day, the curing is also a bottle neck.
- Speed of extruder/slipformer
  - 1 – 2.6 m/min
  - Means 15-25 m<sup>3</sup>/h



# Partners

- Selection of reliable partners
  - Plant supplier
  - Raw material supplier



# How to improve efficiency of existing line?

- **Factory audit**
- **Reduce waste**
  - Preventive maintenance
  - Better planning and analysis with modern tools
  - Improve cycle time
  - Adjust the machines
- **Remove bottle necks**
  - I.e. Buy new mixer & shuttle
  - I.e. Add more transportation capacity / Half or Full load handling
  - etc.

# How to improve efficiency?

- **Invest in higher mechanization and automation level**
  - Step-by-step upgrade of existing line
    - Bundle lifting
    - Automatic concrete transportation
    - Automatic saw
    - Automatic machine for making openings
    - Automatic machine for installing lifting loops
    - Plotter
  - For automatic machines you need production data in electronic format
    - Production planning software needed
    - For automatic concrete transportation electronic data not needed

# Bundle lifting





# Automatic Concrete Transportation

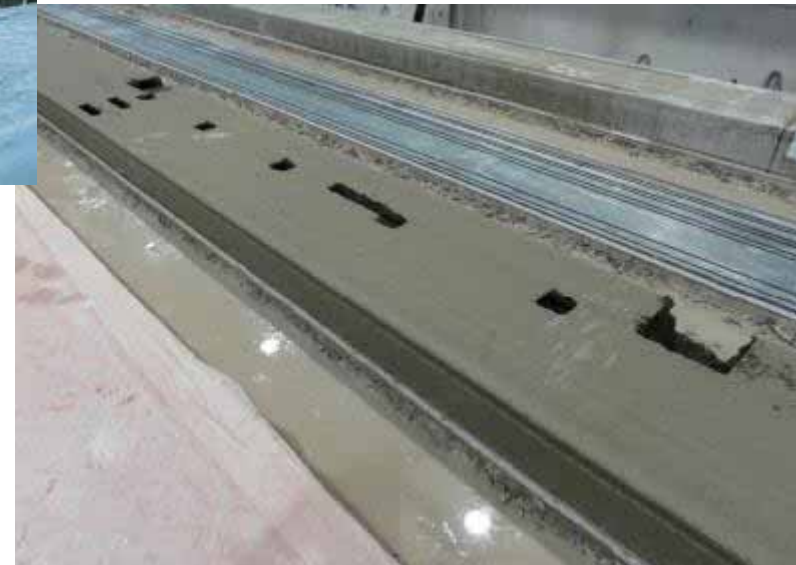




# Automatic Saw



# Automatic machine for making openings



# Automatic machine for fixing lifting loops





# Plotter



# How to improve efficiency?

- **When building a green field factory**
  - New state-of-the-art factory
    - Suitable for specific need

# Best Available Technology

- **Suitable factory for customer need**
  - Need for low, medium, high automation level
  - Labour cost can be 3 – 50 €/h
  - Needed capacity 50 000 – 1 200 000 m<sup>2</sup>/a
  - Uncertainty and availability of financing: Investment level lower than optimal (in tech/econ. point of view)



# Most automatic HC production line





## Most automatic HC production line

- **Possible to reach** **0.04 – 0.09 manhours/m<sup>2</sup>**
  - -75% compared to current 0.25 manhours/m<sup>2</sup>
  - Automatic operation on beds
  - Automatic unloading of beds
  - Automatic lifting in storage
- **Better safety**
  - Low noise and dust
- **Higher end-product quality**
- **Max capacity** **upto 1 000 000 m<sup>2</sup>/a**

# IoT / Industry 4.0

- **What does it mean for hollow core industry?**
  - Automated and flexible production and workflow planning
  - Line monitoring and storing of work phase duration to database automatically
  - Accurate planning based on statistical data
  - Electronic tool for Lean optimization process

# MES = Manufacturing Execution System

## ■ CONSISTS OF:

- MES application
- Wifi communication with machines
- Embedded computers & sensors in machines
- Indoors positioning system

**Automatic  
planning**



**Automatic  
scheduling**



**Monitoring**



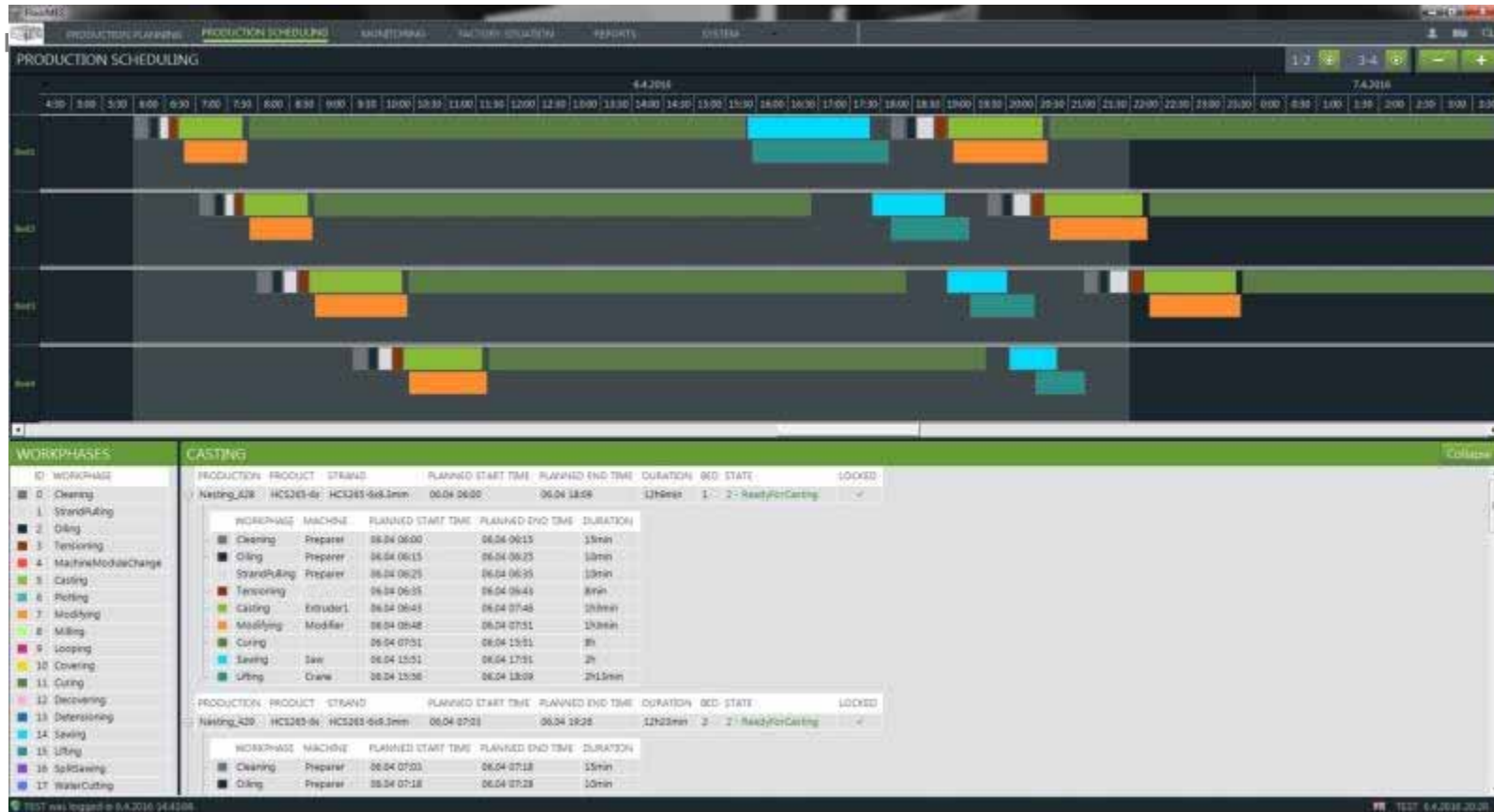
**Production  
reporting**



## IoT / Industry 4.0

- **Communication between MES system and machines**
  - Machine "health" monitoring via sensors/wifi
  - Information on machine status to MES system
  - Heat treatment report read from maturity control to database
  - Pre-stressing report from stressing machine to database
  - Quality control data from handle held devices or machine vision QA control
  - Communication between machines
  - Reports in cloud
  - Remote monitoring i.e. with tablet computer anywhere in the world
  - Production optimization based on Big Data

# MES = Manufacturing Execution System



# CONCLUSION

- **Lot of old tricks and basic things you can improve on**
- **New exciting technologies and ways to improve efficiency**
- **Everybody can tune-up performance**
  
- **Let's make Hollowcore even more competitive, conquer new market and prosper together!**

# Questions?

- Questions?

# Thank You!

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