



# GGS

# Groeien met Groen Staal

Nationaal  
Groeifonds

# Prof. Dr. Ing. Jan Post



# Dr. Maysam Naghinejad



# Groeien met Groen Staal

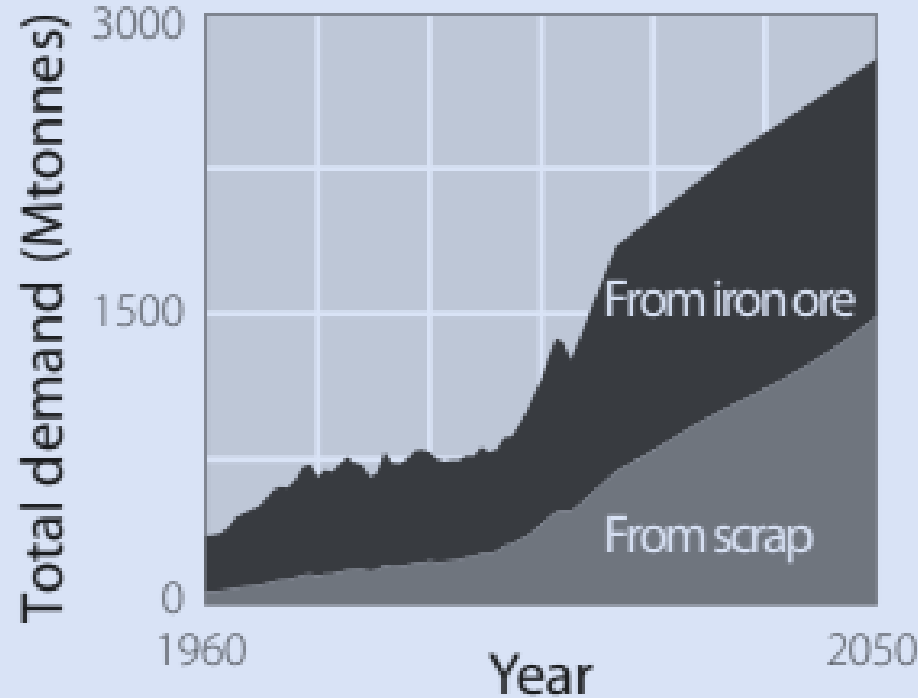


# The issue



- 7% of total CO2 emissions
- Fine dust and other pollutants
- Extreme energy consumption
- Dependence on fossil fuels
- Depletion of resources
- Bad societal image
- Large amount of scrap and landfill
- Economical challenges

# The issue



total CO2 emissions  
most and other pollutants  
energy consumption  
dependence on fossil fuels  
depletion of resources  
poor societal image  
large amount of scrap and landfill  
technical challenges

**Current method of steel production and use is not sustainable but demand increases**

# What are we heading for?

**Climate  
profit**

**Economic  
profit**

**Human  
capital**

**Resource  
autonomy**



**Groeien met  
Groen Staal**

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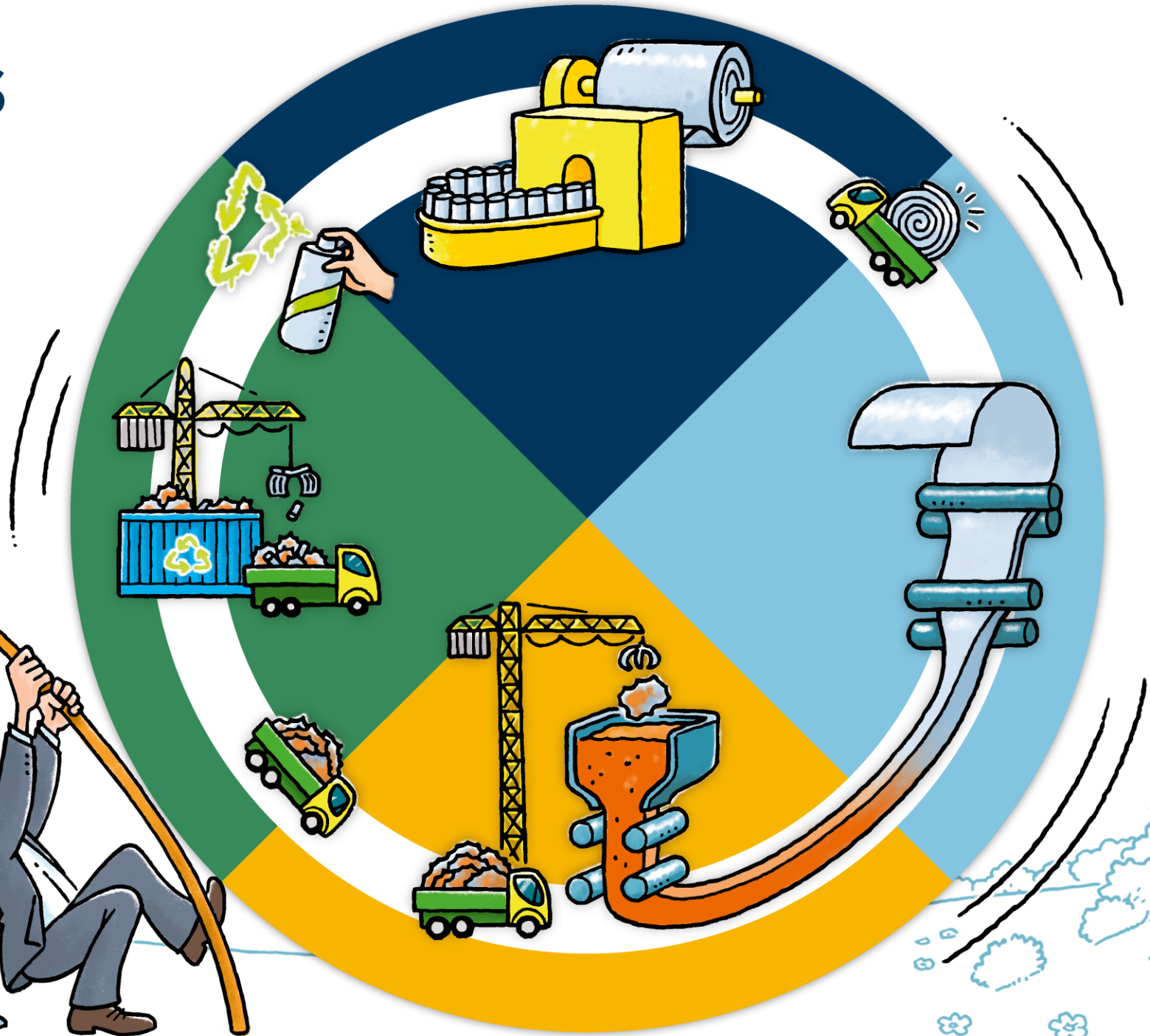
**Resource  
autonomy**

**Revolutionize Steel Production  
Promote Recycling and Circularity  
Collaborate Across Sectors**



**Groeien met  
Groen Staal**

# Themes



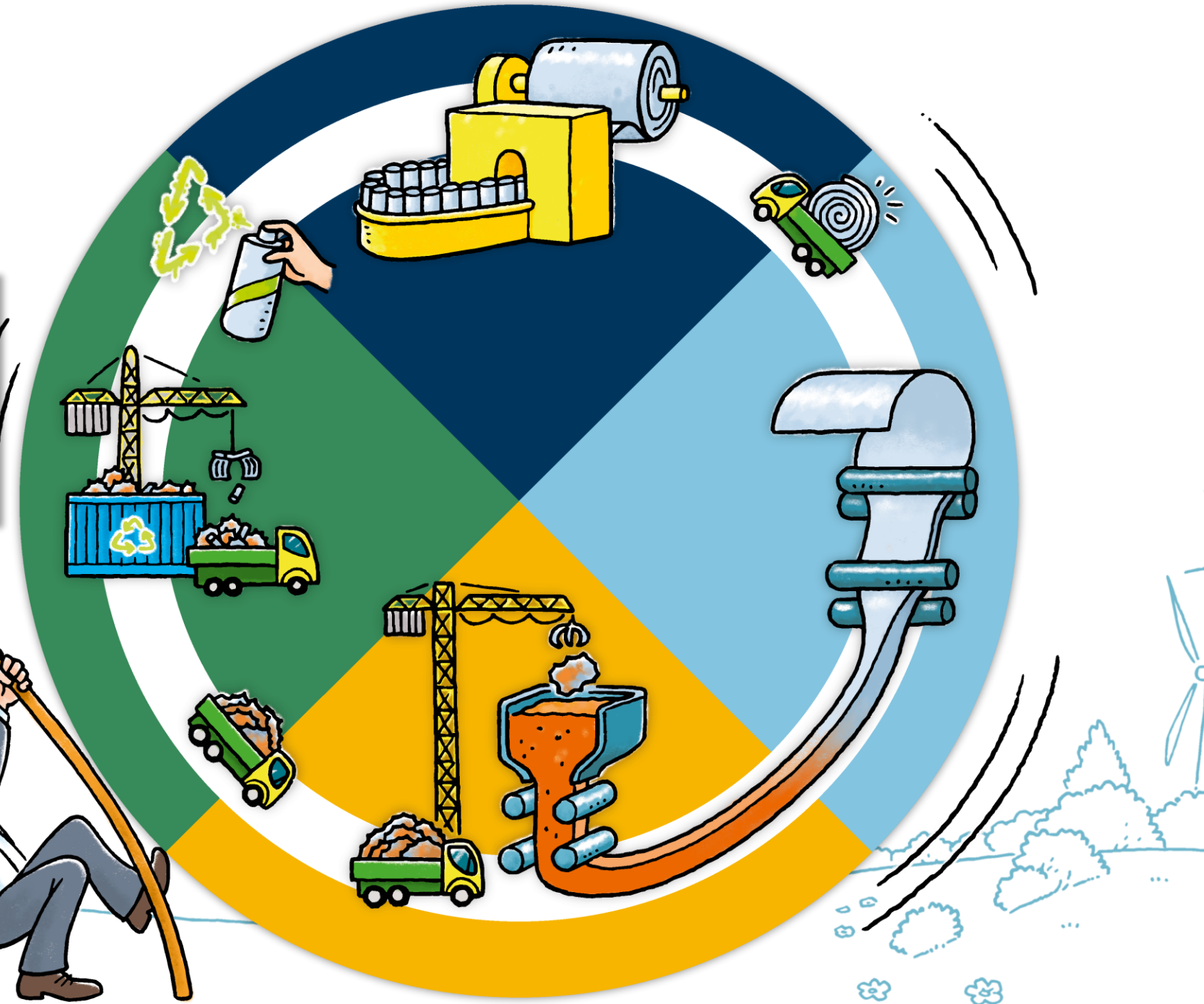


# Themes

## Theme I

### System change

- Policy and societal aspects
- Systems and environment
- Digitalization
- Infrastructure characterization



# Themes

## Theme I

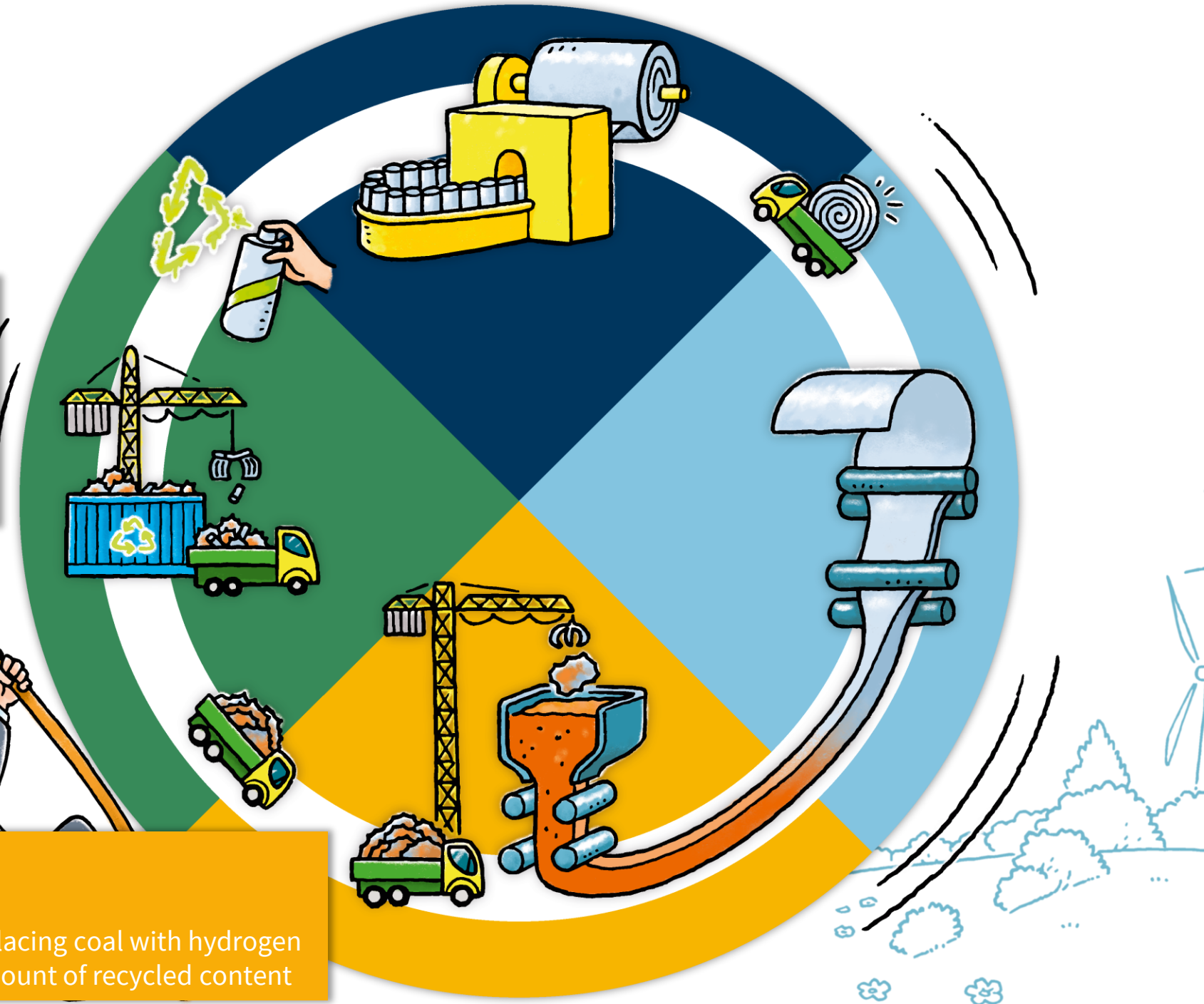
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## Theme II

### Production

- Effects of replacing coal with hydrogen
- Increased amount of recycled content



# Themes

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## Theme II

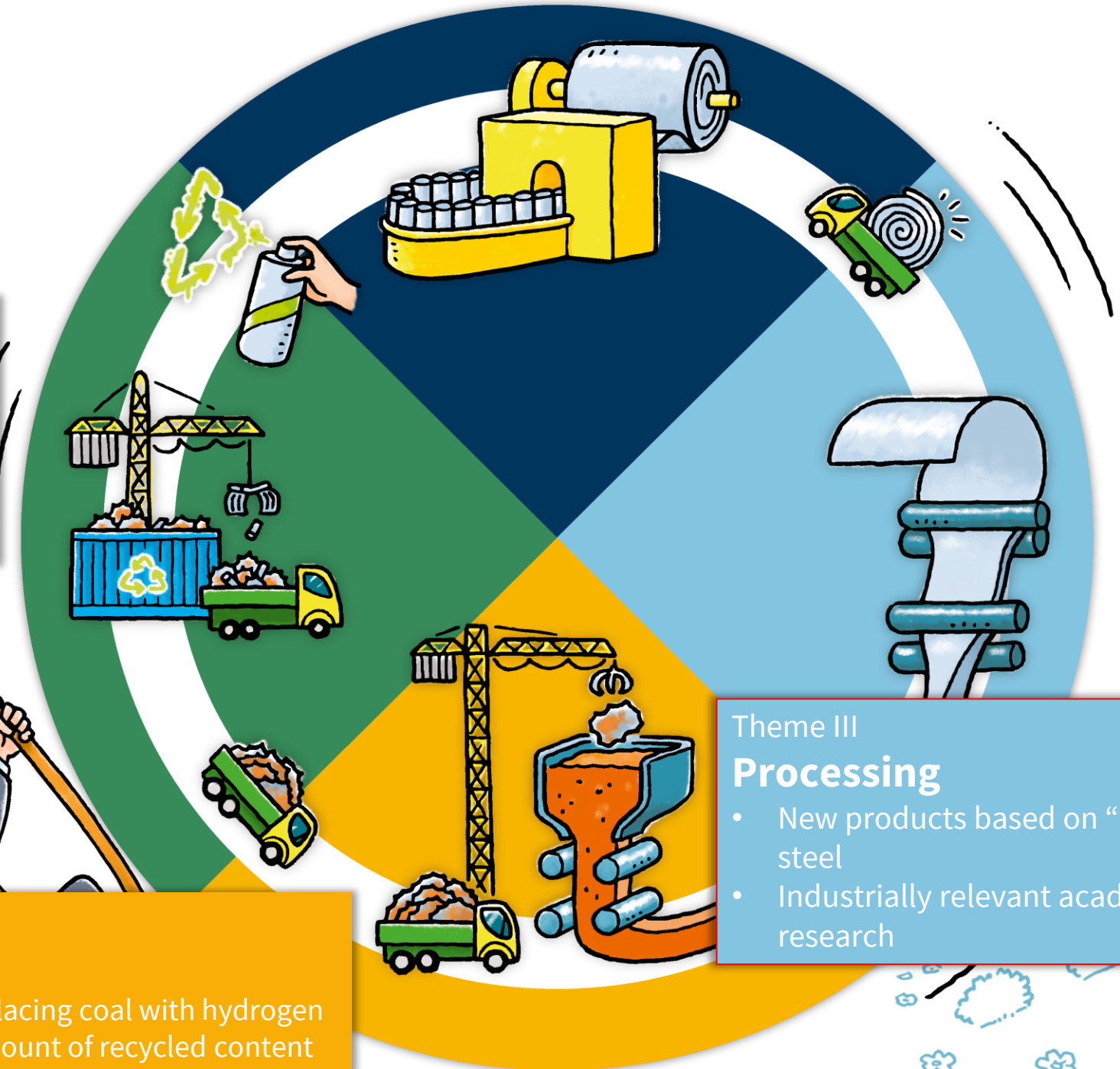
### Production

- Effects of replacing coal with hydrogen
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## Theme III

### Processing

- New products based on “green” steel
- Industrially relevant academic research



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## Theme I

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- Effects of replacing coal with hydrogen
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## Theme IV

### Use

- Properties of steel, lifetime, strength, etc
- Dissemination of knowledge to (potential) end users
- Developing digital twins
- Optimization and Control
- Demonstration

## Theme III

### Processing

- New products based on “green” steel
- Industrially relevant academic research

# Themes

Theme V

## Recovery

- Closing the value chain
- Maximizing the recycled content
- Identification and sorting of scrap

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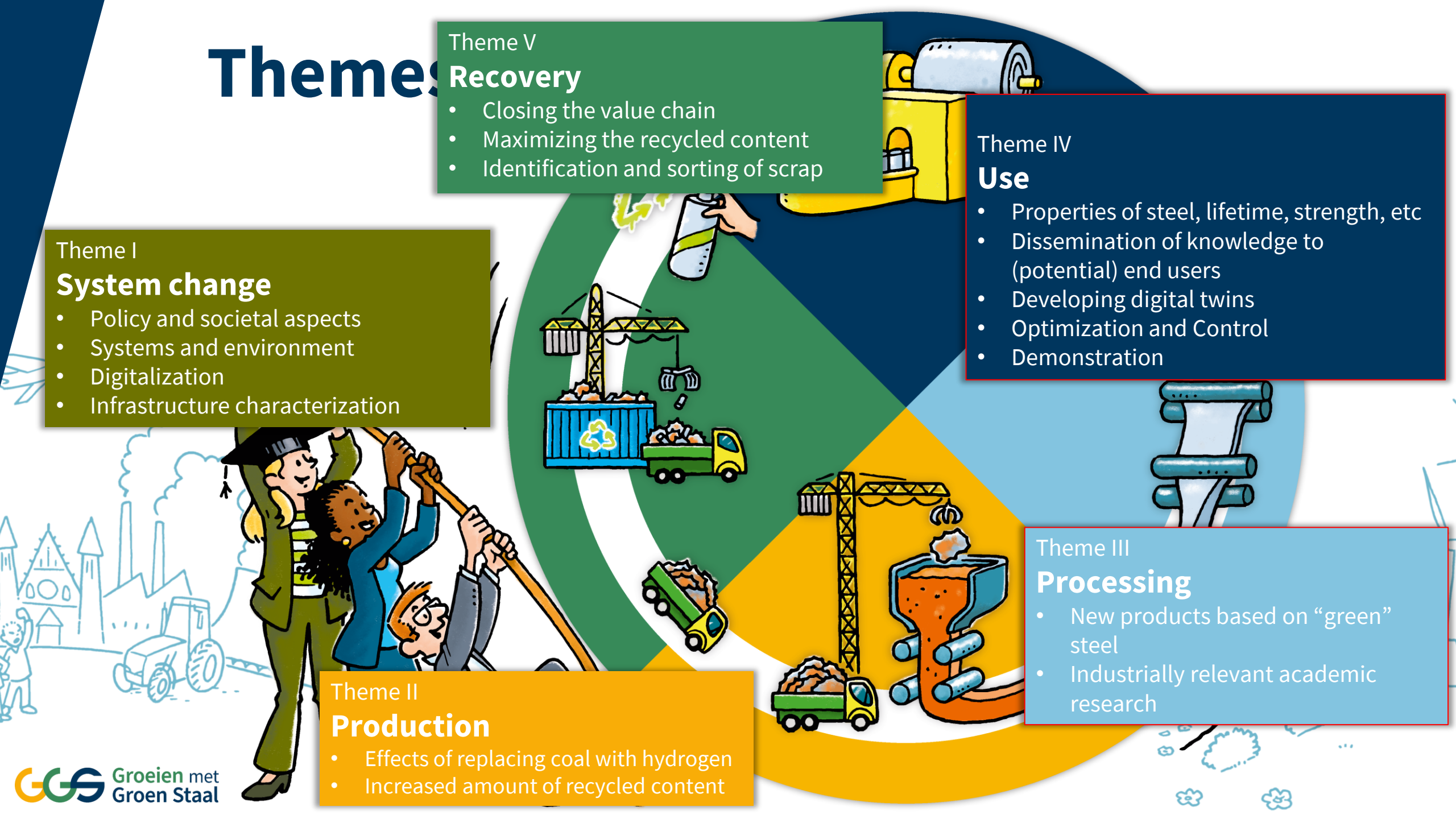
## Processing

- New products based on “green” steel
- Industrially relevant academic research

Theme II

## Production

- Effects of replacing coal with hydrogen
- Increased amount of recycled content



Theme VI

## Education

- Pro. & Next Gen.
- Using new results

Theme V

## Recovery

- Closing the value chain
- Maximizing the recycled content
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Theme IV

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- Properties of steel, lifetime, strength, etc
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# Vision 2031

The Netherlands will be in all aspects at the forefront of **sustainable steel**



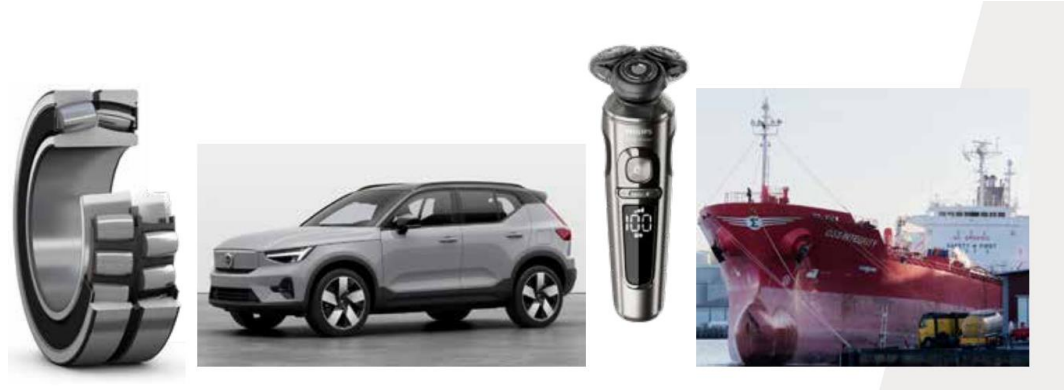


# Importance of digitization



# Digitization

- Changing steel production processes
- Predict material properties
- Impact on the final product
- The changes in properties
- Risk analysis



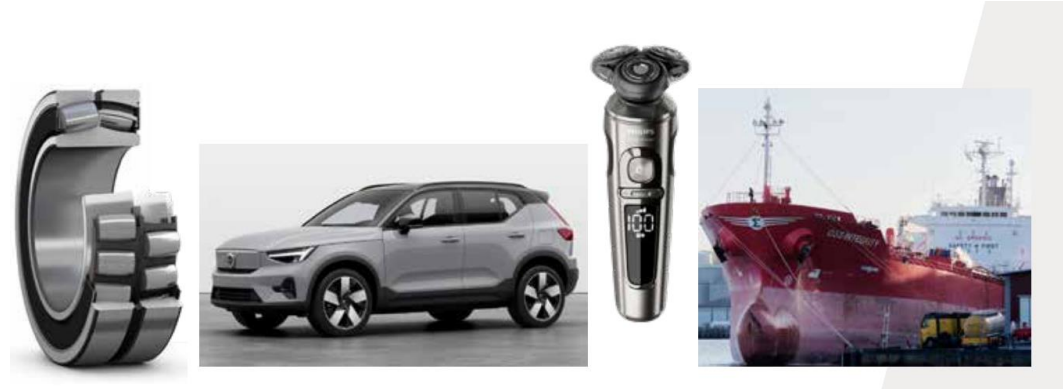
# Digitization

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  - **Digitizing the processes**
  - **Digital Twins**



# Digitization

- Changing steel production processes
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- Impact on the final product
- The changes in properties
- Risk analysis
  - Digitizing the processes
  - Digital Twins
- Demonstrators



# Focus of University of Groningen

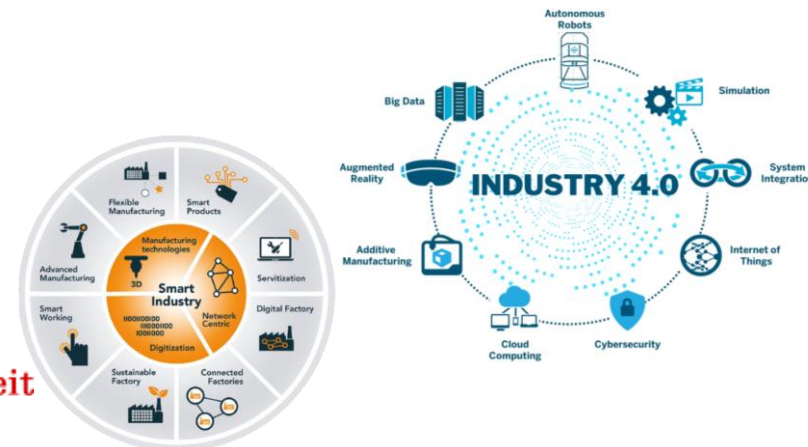
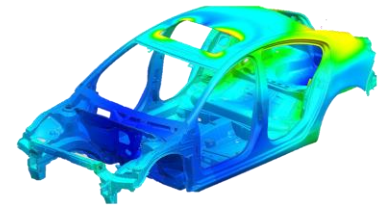
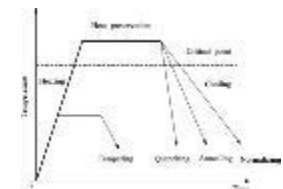
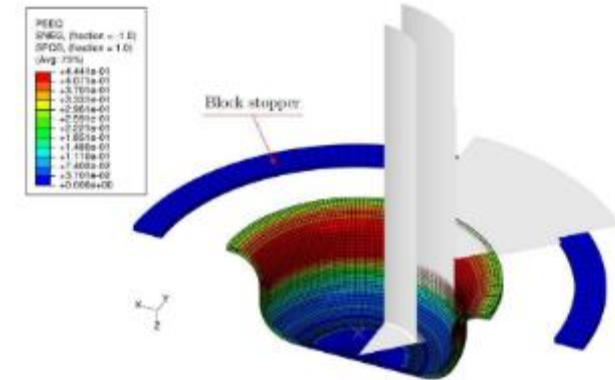
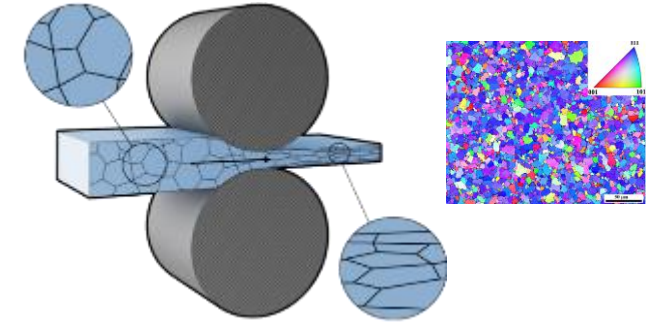
- Leadership of the user-Phase
- Development of Material Digital Twins
- Multi Material Process simulations
- Process Optimisation and validation

# Digital Twin Project

## Challenges with Advanced Stainless Steels

## Simulations of realistic industrial processes

## Interoperability and Standardization



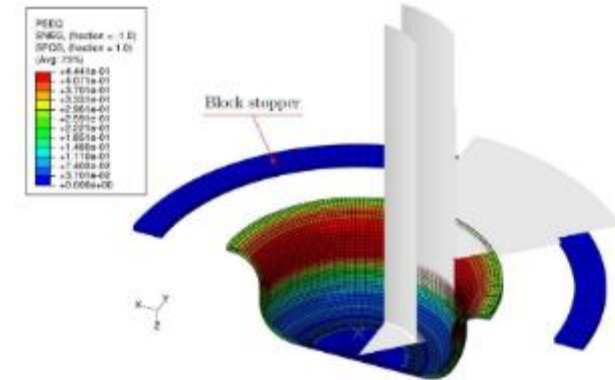
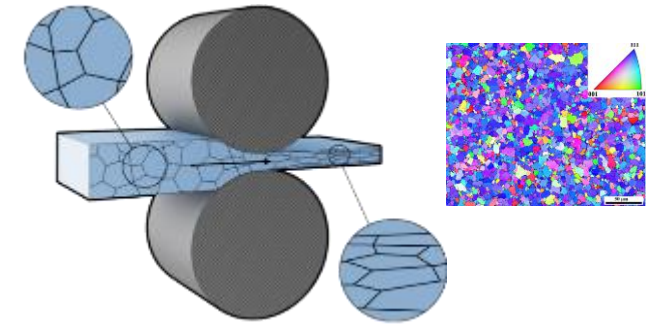
# Digital Twin Project

## Challenges with Advanced Stainless Steels

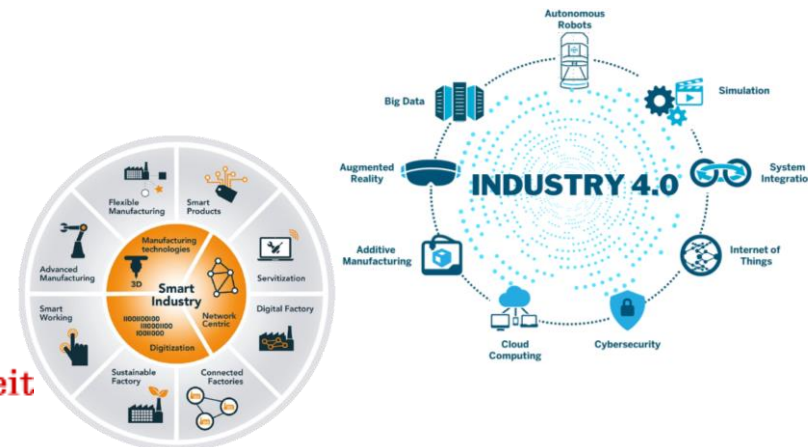
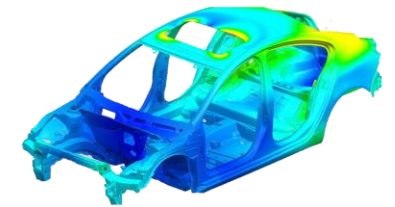
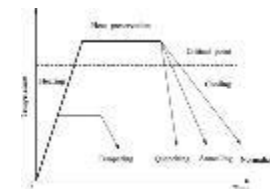
*Complex microstructures*

*Empirical Research Challenges*

## Simulations of realistic industrial processes



## Interoperability and Standardization



# Digital Twin Project

## Challenges with Advanced Stainless Steels

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*Empirical Research Challenges*

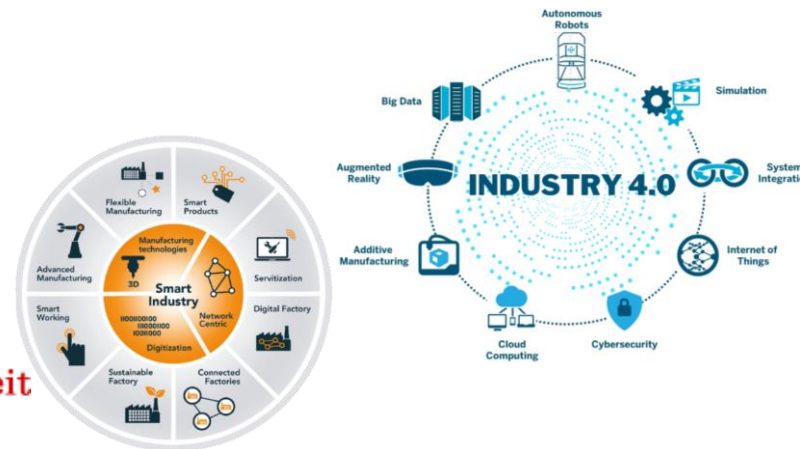
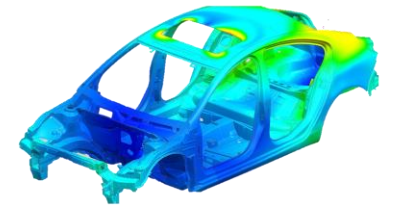
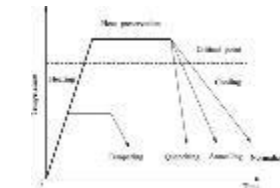
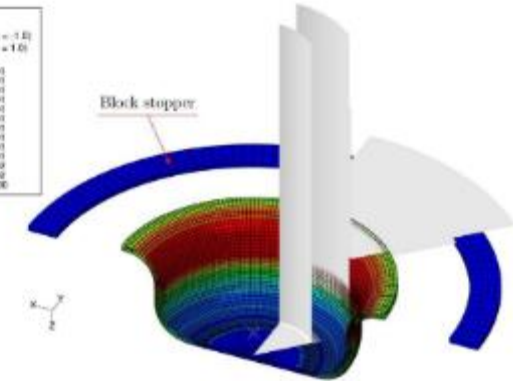
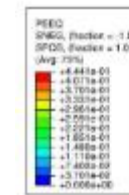
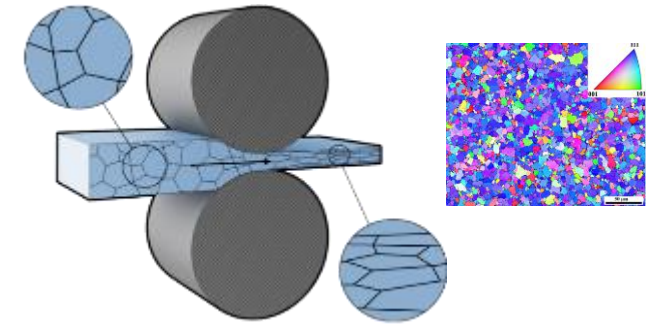
## Simulations of realistic industrial processes

*Continuum models with FEM*

*Constitutive relations formulation*

*Multi-step, Multi-material, Multi-vendor processes*

## Interoperability and Standardization



# Digital Twin Project

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*Complex microstructures*

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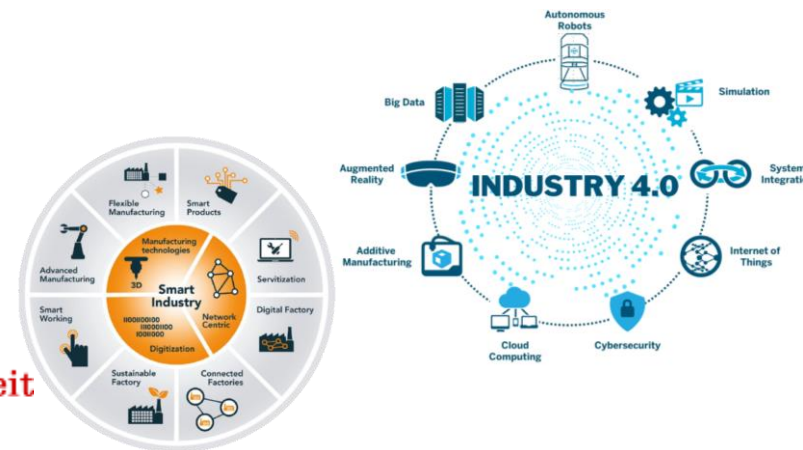
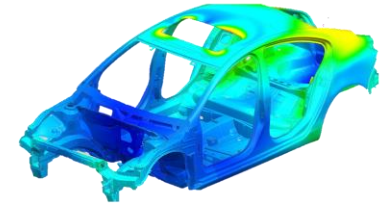
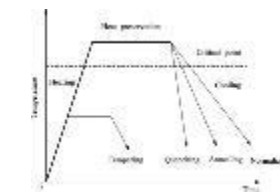
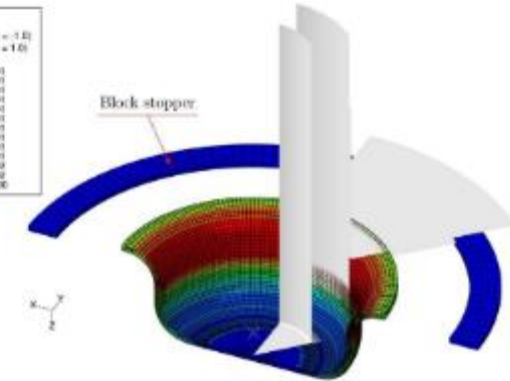
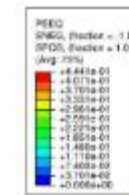
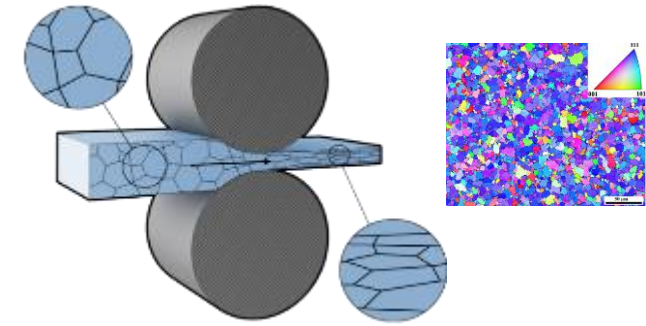
## Interoperability and Standardization

*Interoperability*

*Consistency*

*Maintenance*

*Knowledge*





# Solutions

## A Virtual Lab framework

*Employing micromechanical models*

*Calibrating the constitutive parameters*

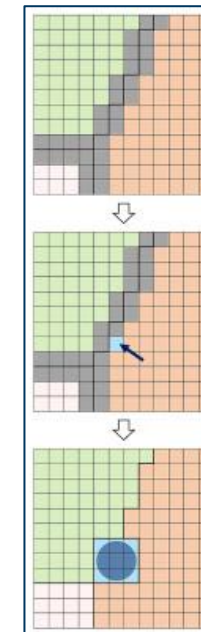
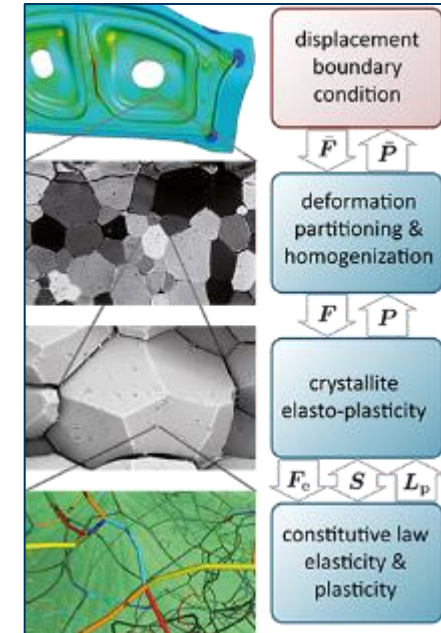
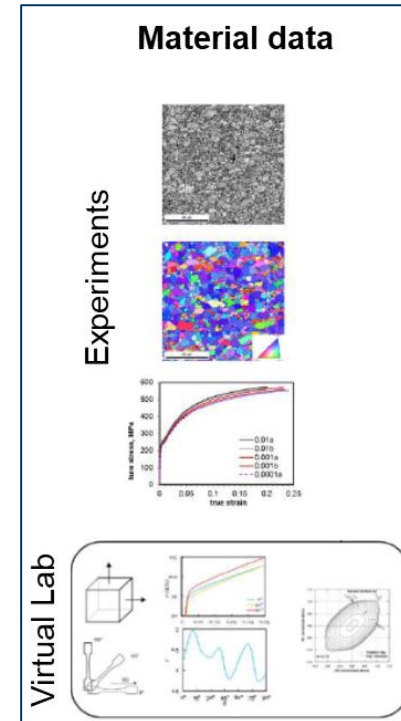
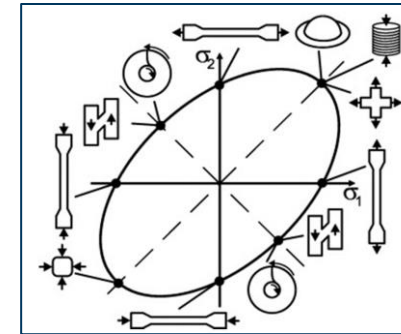
*DACE*

*Material Digital Twin*

*Performing virtual experiments*

*Material data and properties*

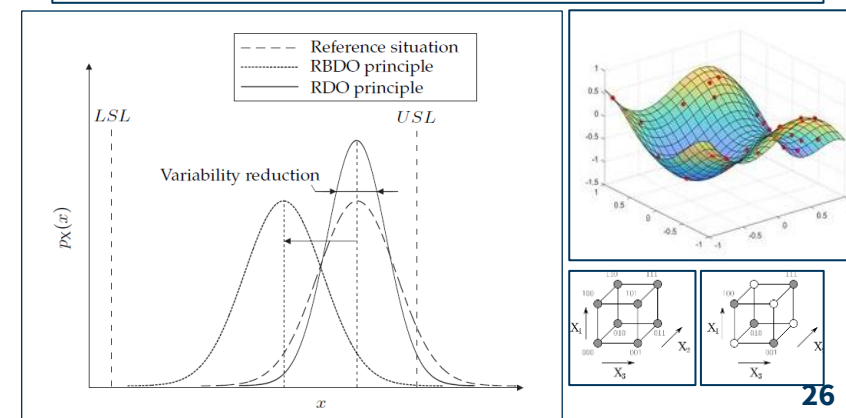
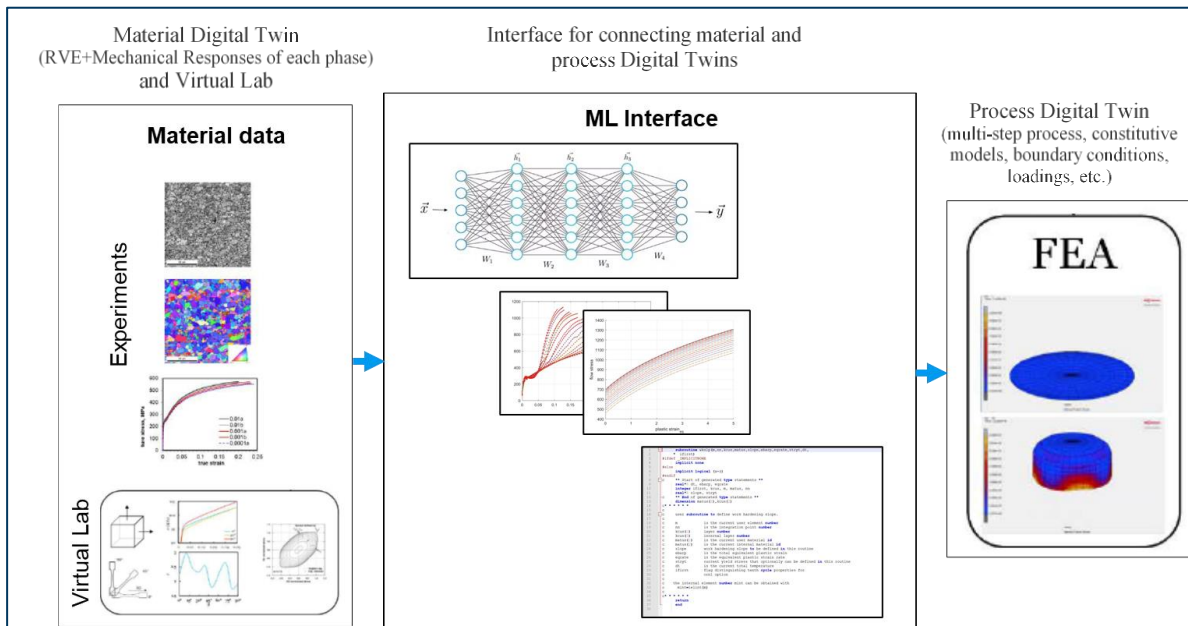
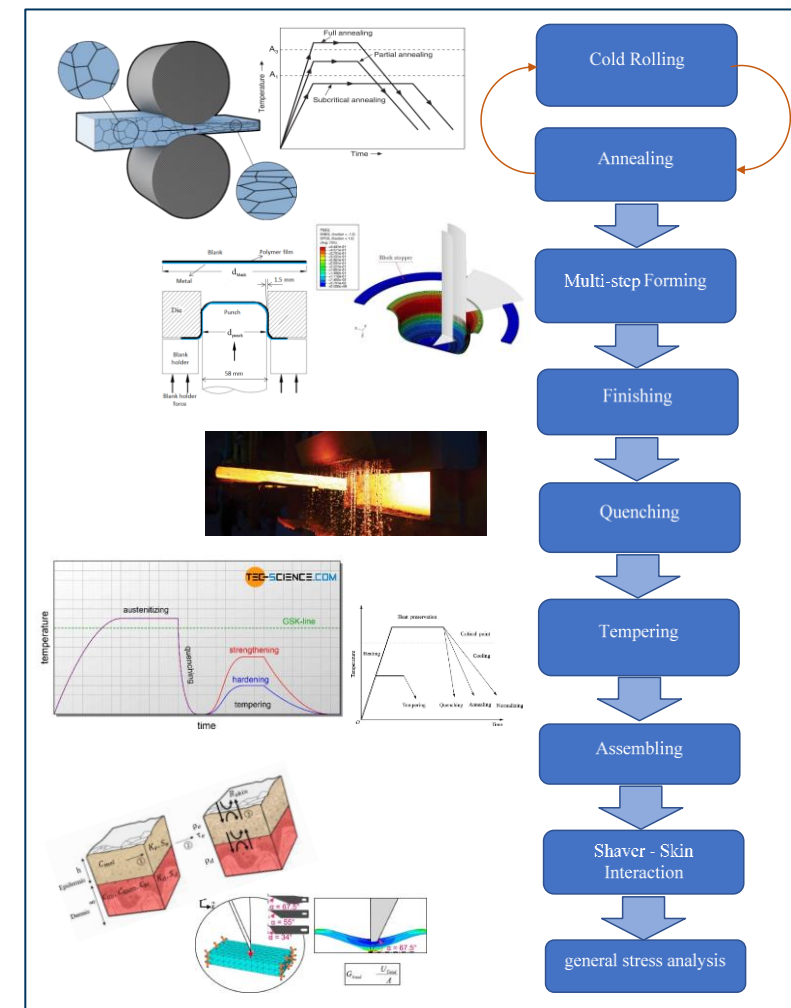
*Improving efficiency and accuracy*



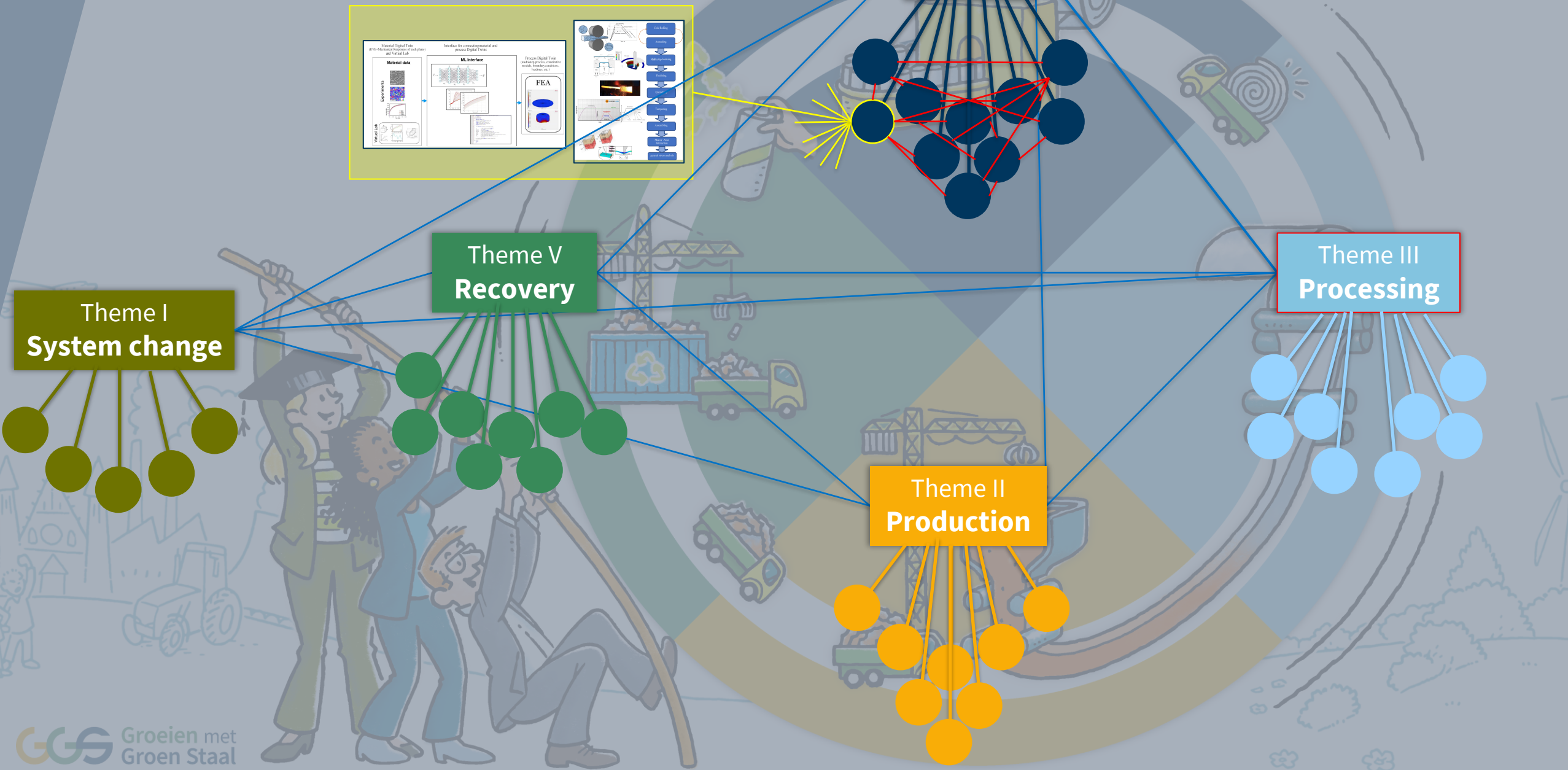
# Solutions

## A General Standardized Platform

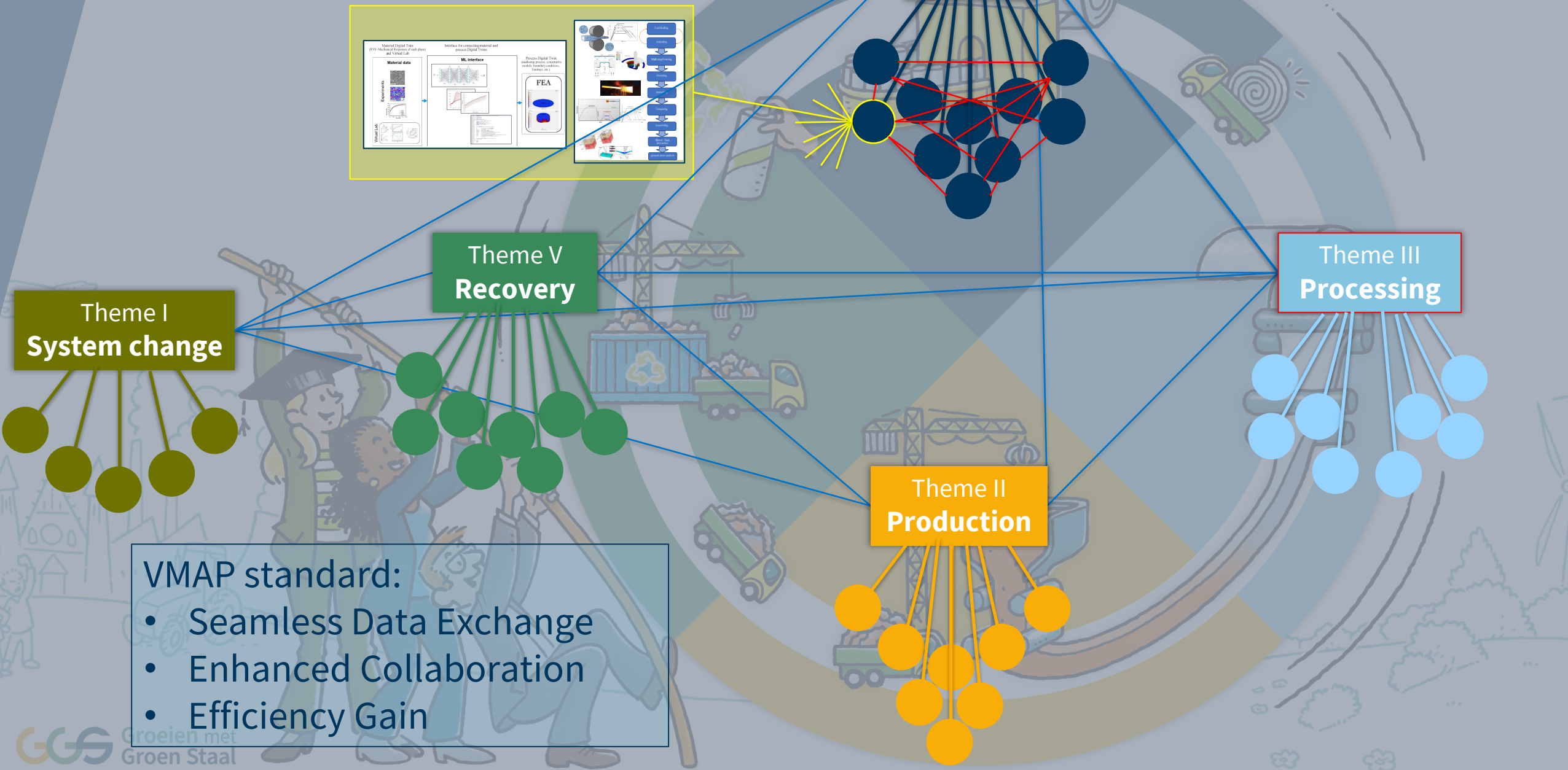
- Replace/upgrade process, software and methods*
- Doing simulations without deep knowledge*
- Integrate software and codes, and automate*
- Simplifying collaborations and Interoperability*
- Sustainable futureproof solution*



# VMAP usage (Interoperability)



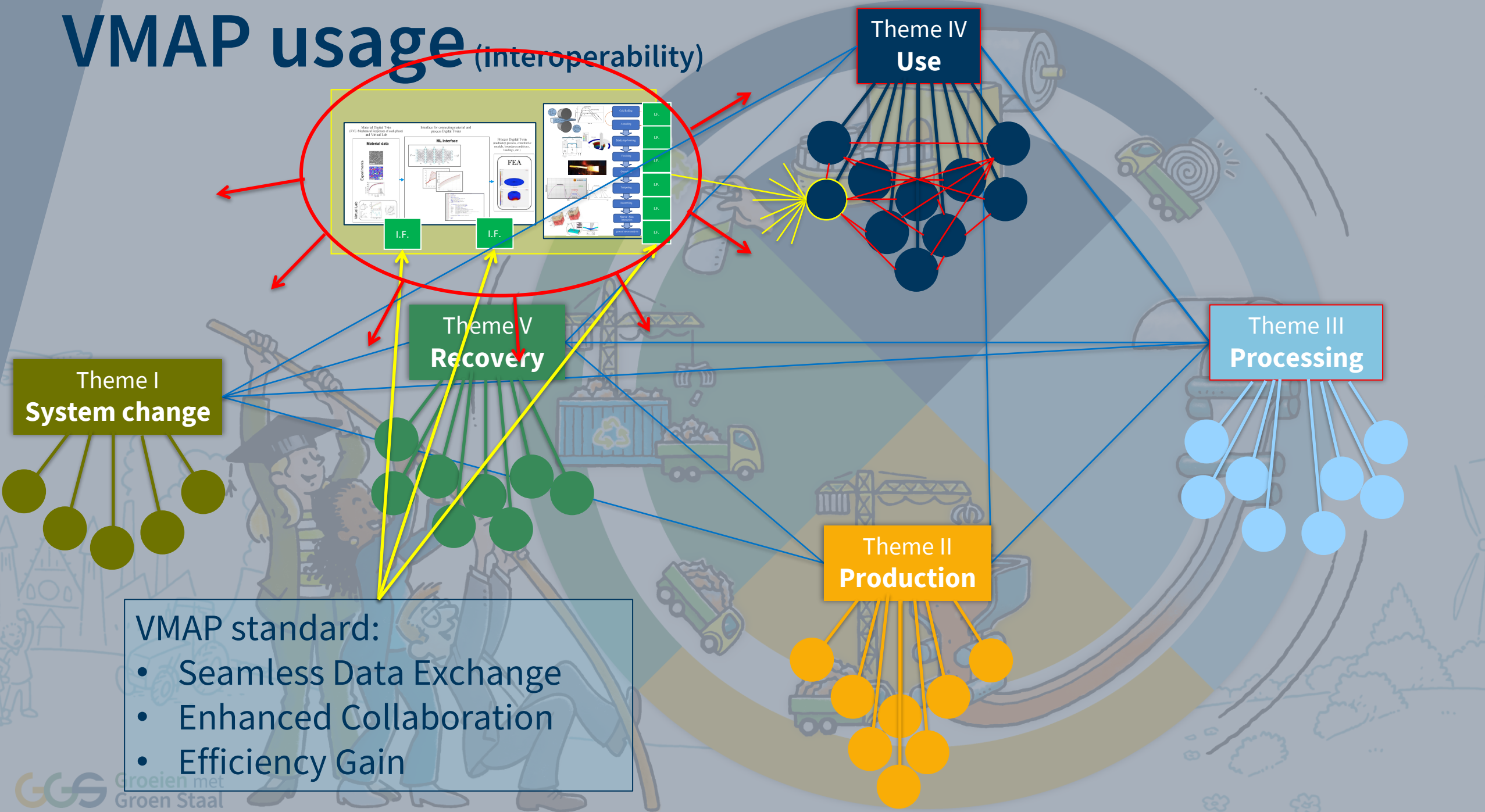
# VMAP usage (Interoperability)



## VMAP standard:

- Seamless Data Exchange
- Enhanced Collaboration
- Efficiency Gain

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- Enhanced Collaboration
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Thank you