RUHR-UNIVERSITÄT BOCHUM

RUB

PROCESS AND LOGISTICS SIMULATION IN MECHANIZED TUNNELING

T. RAHM | M. KÖNIG | C. KOCH | K. SADRI | M. THEWES

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Computing
in Engineering

Project partner

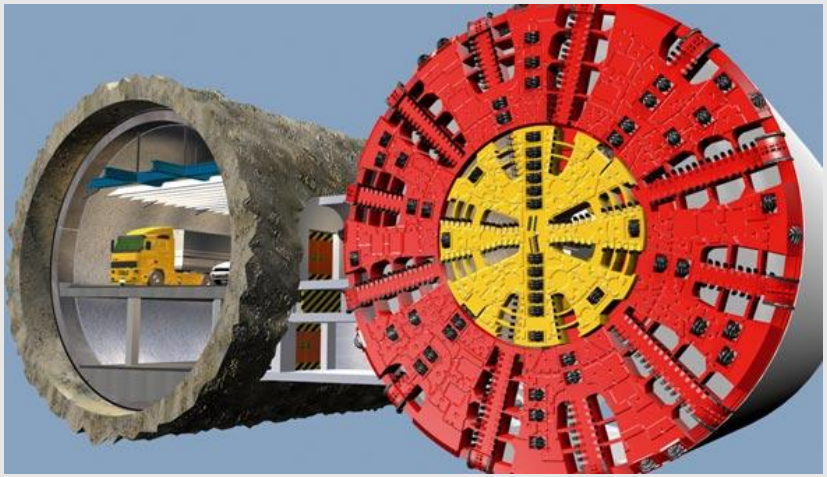
- Simplan AG, Germany
- Collaborative Research Center 837
  Ruhr-Universität Bochum, Germany

  Advisory Board:
  - Hochtief Consult, Hochtief Solutions AG
  - Herrenknecht AG, Germany
  - Ed. Züblin AG
  - Zerna Ingenieure
  - Company Management Amberg Engineering AG
  - Department for Bridge, Tunnel and Urban Rail Office for Transport Mgt., Düsseldorf
  - Research Association for Underground Transportation Facilities (STUVA)

Tunneling projects

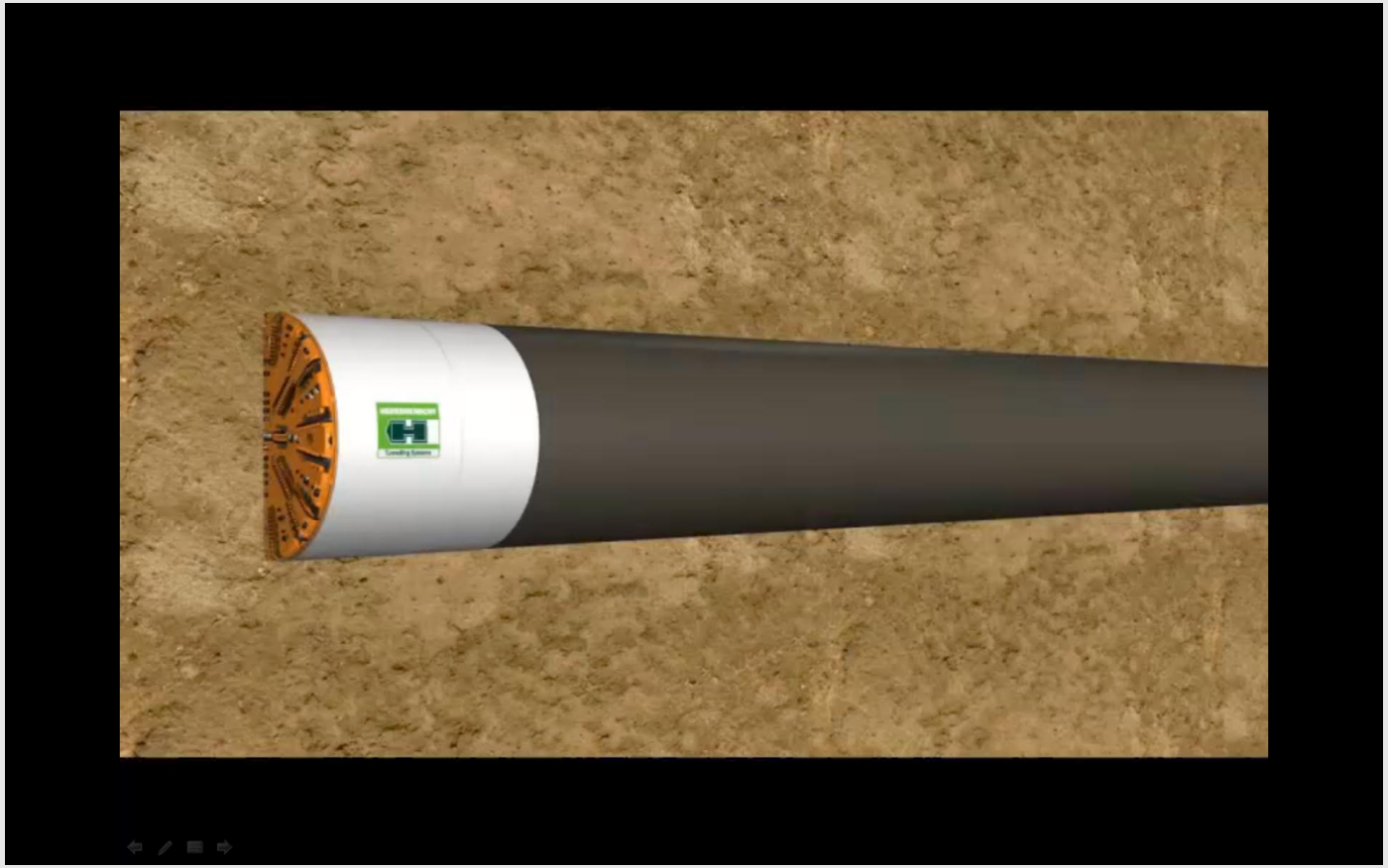
- Diameter
  - normal: 6 – 12 m
  - over 19 m (2 levels of infrastructure)
- Length
  - normal: 3 – 20 km
  - up to more than 50 km

Source: Herrenknecht AG, Katzenbergtunnel



Source: Herrenknecht AG, Highway M30 Madrid

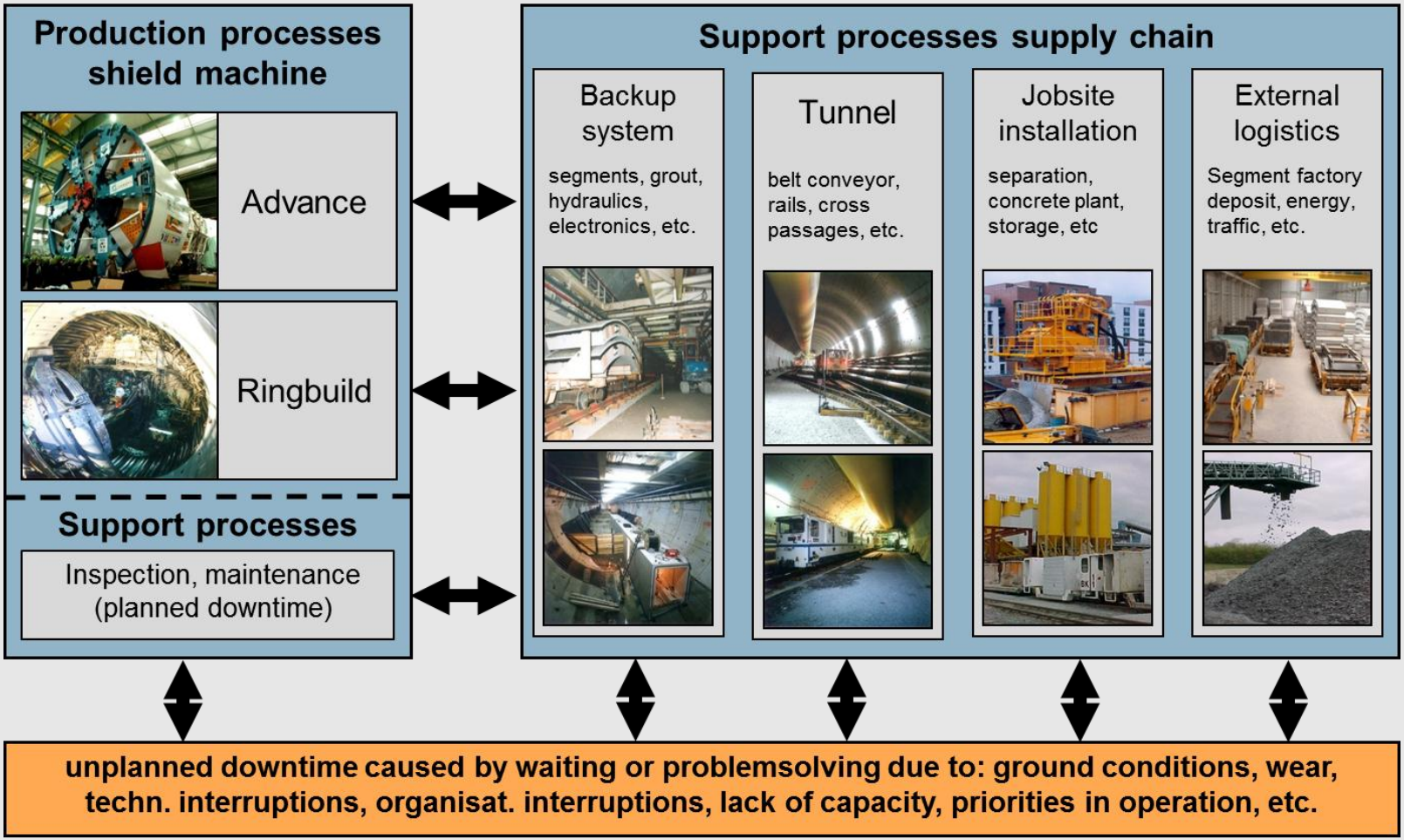
Earth pressure balanced shield machine



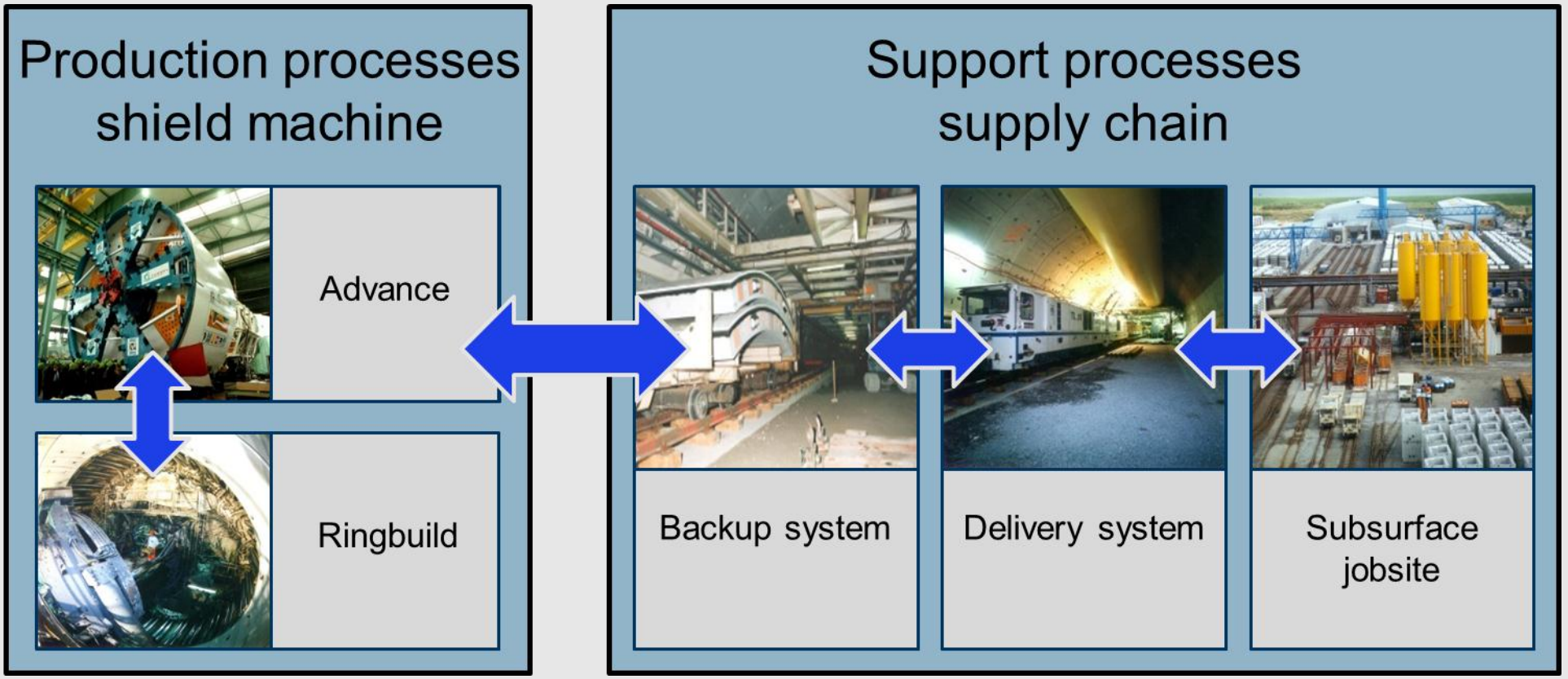
Herrenknecht AG, Germany

Full length video: http://www.youtube.com/watch?v=qx_EjMlLgqY

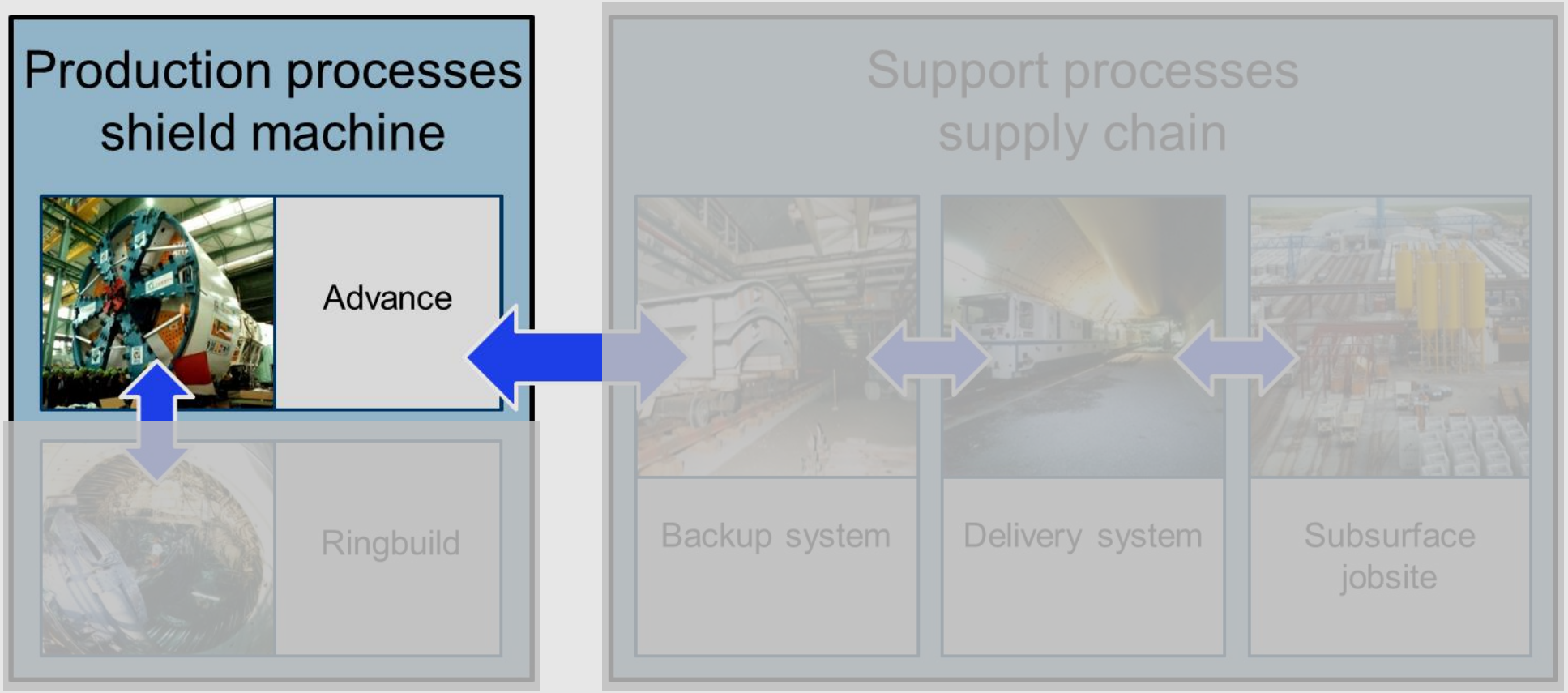
Process classification in mechanized tunneling



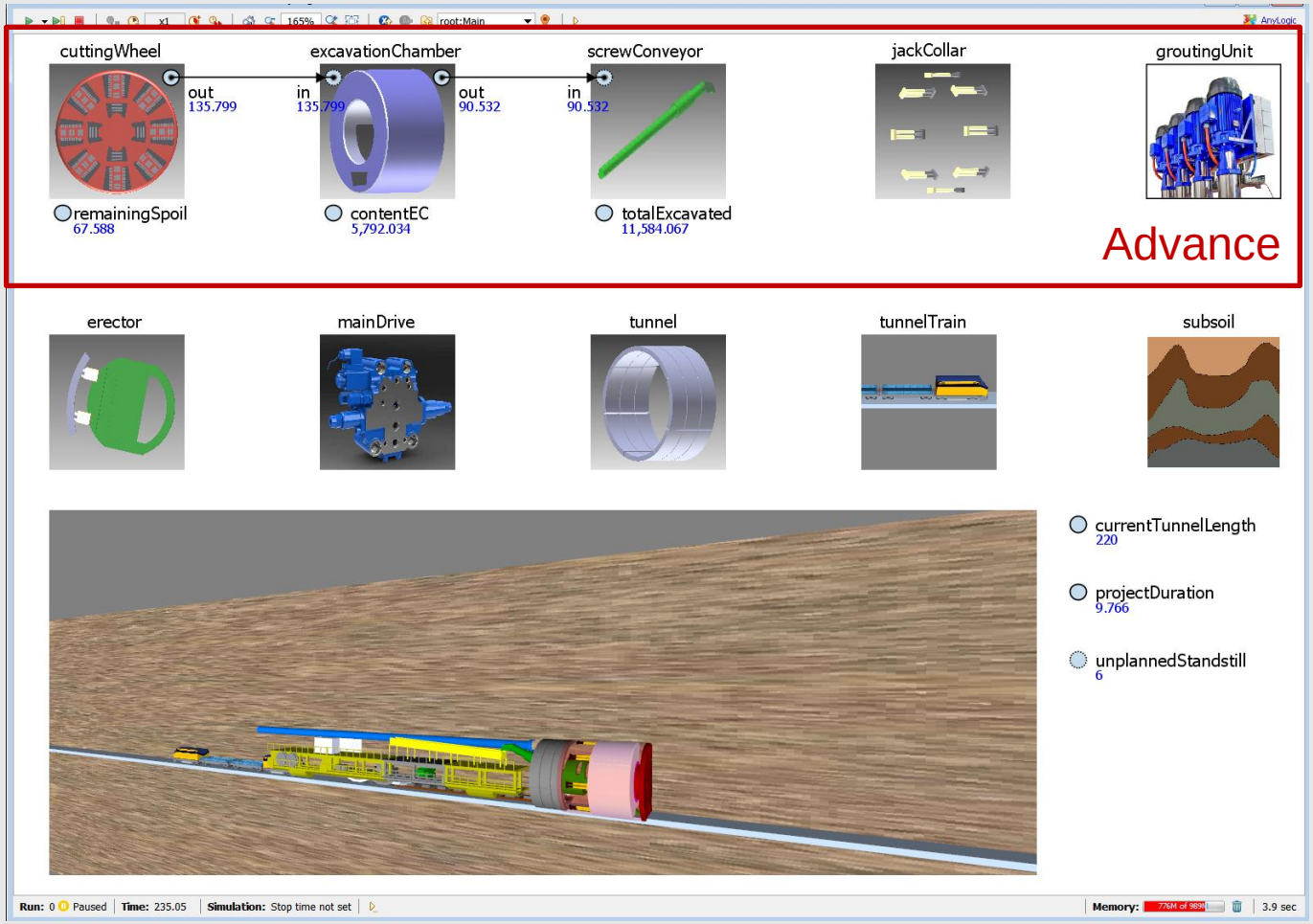
Decomposition in simulation components



Decomposition in simulation components

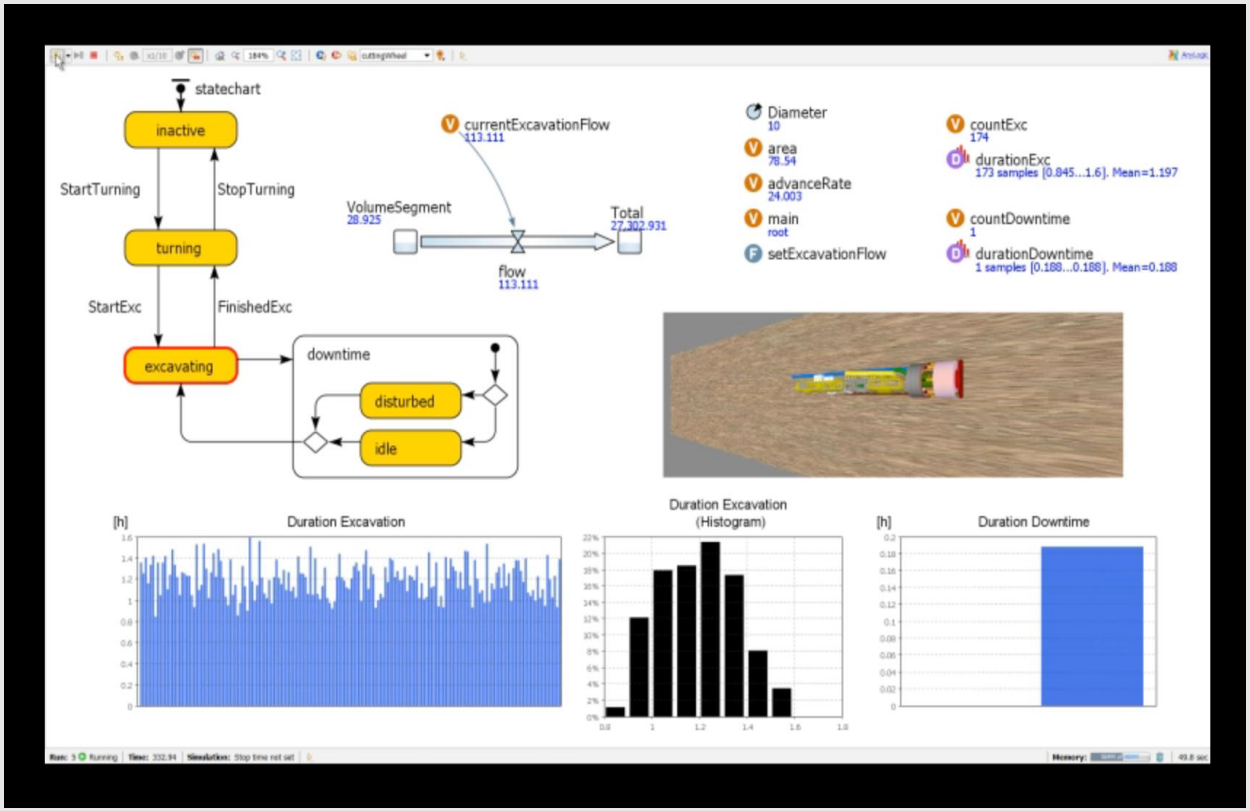


Simulation components for advancement

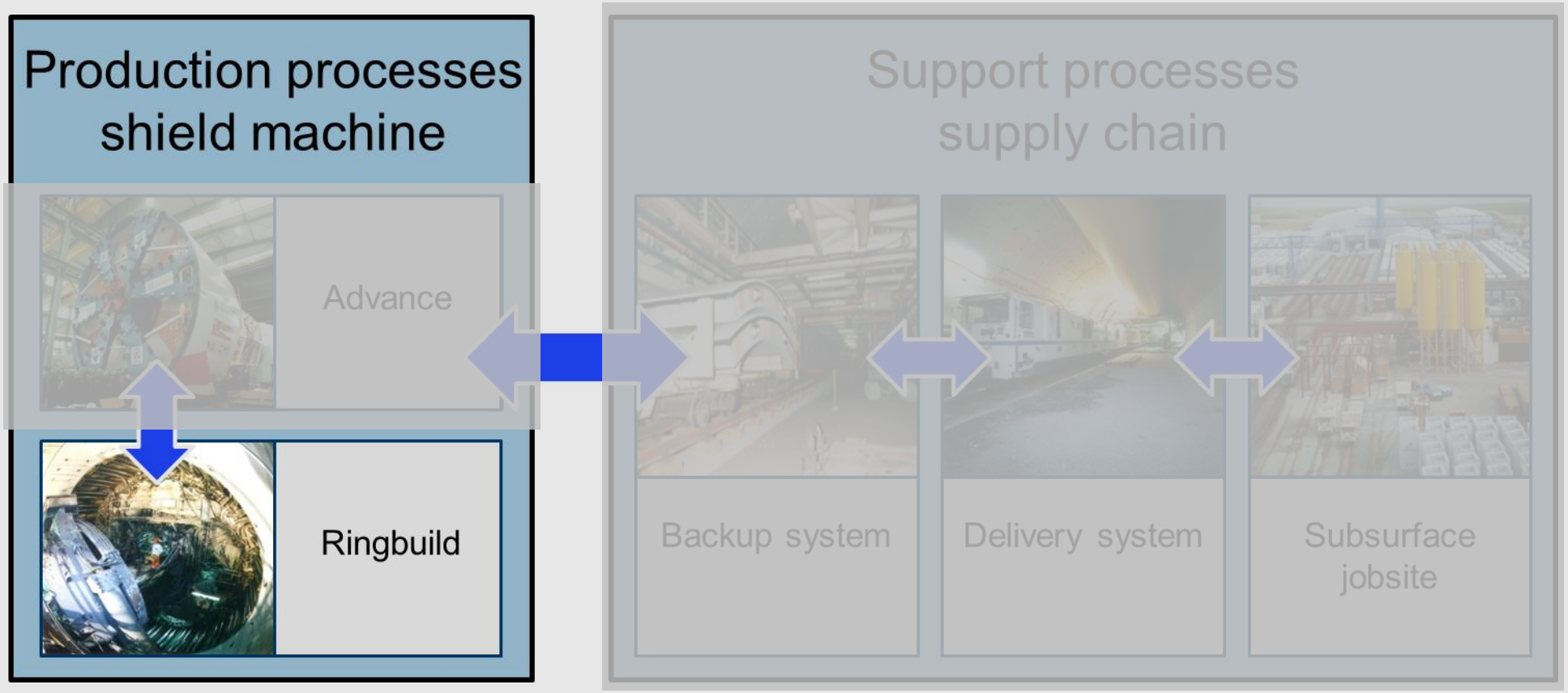


Multi-method simulation approach for advance

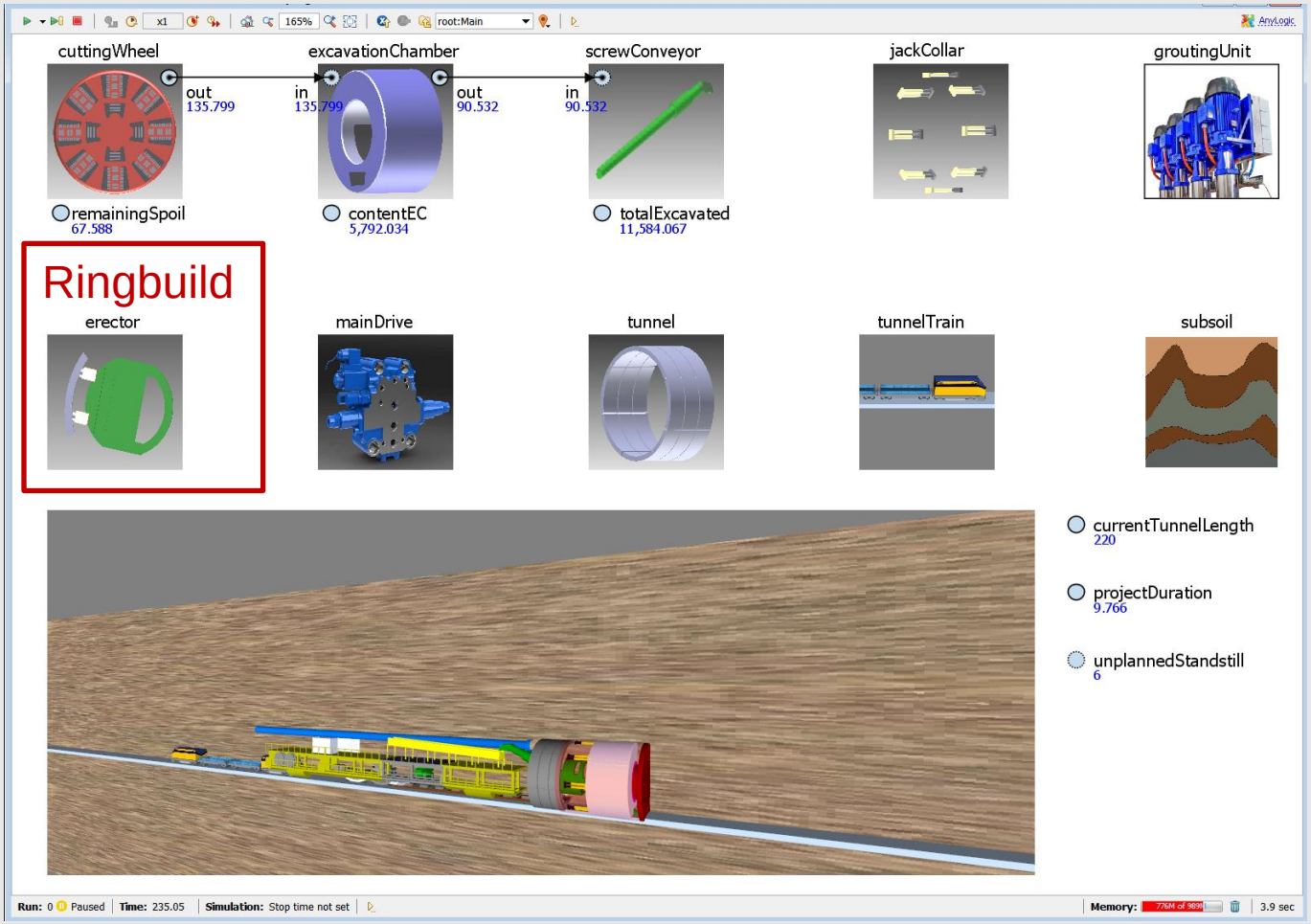
- Processes:
  - → Discrete-event simulation
- Material-flow:
  - → System Dynamics
- Technical disturbances:
  - → Probability distribution



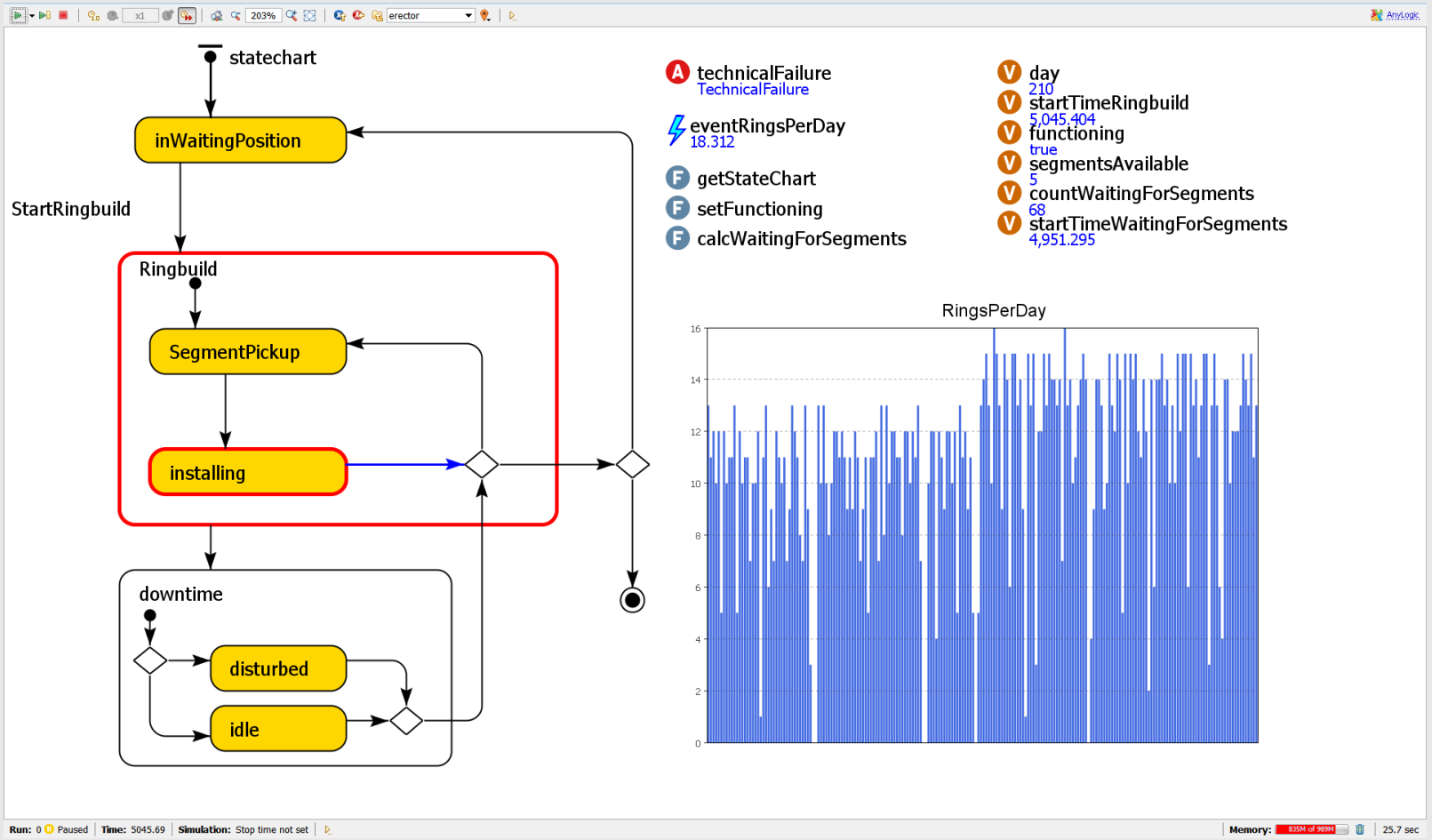
Decomposition in simulation components



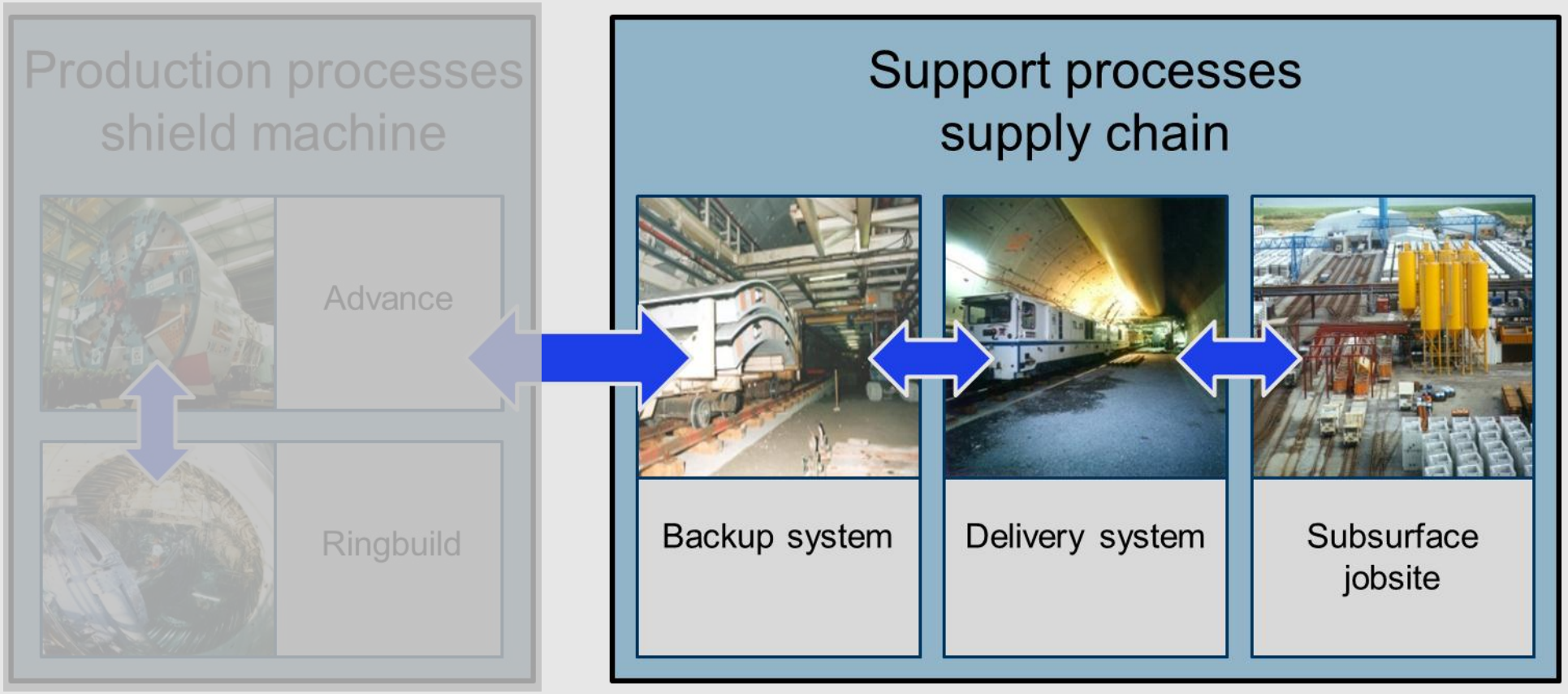
Simulation component for ringbuild



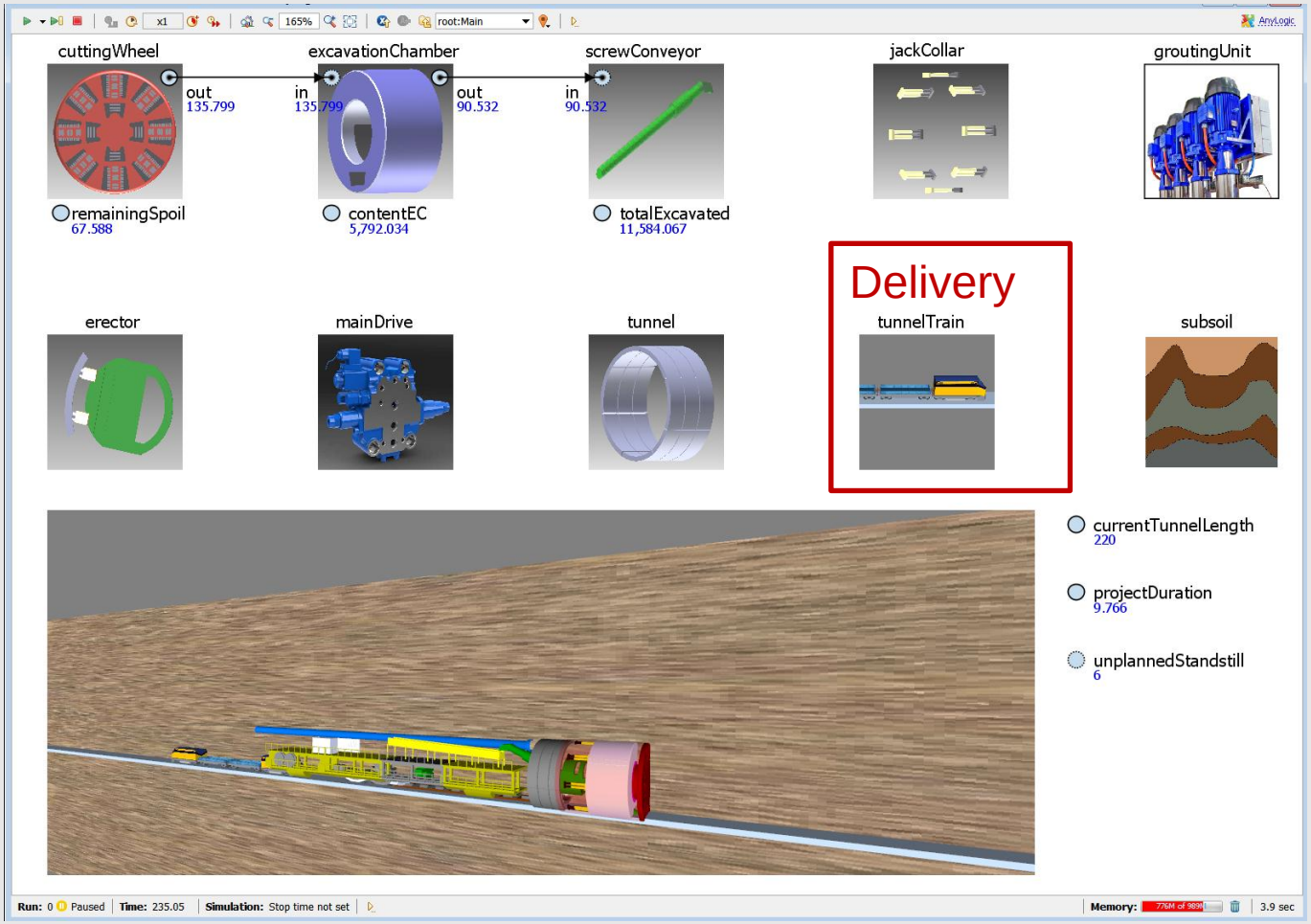
Simulation component: Erector



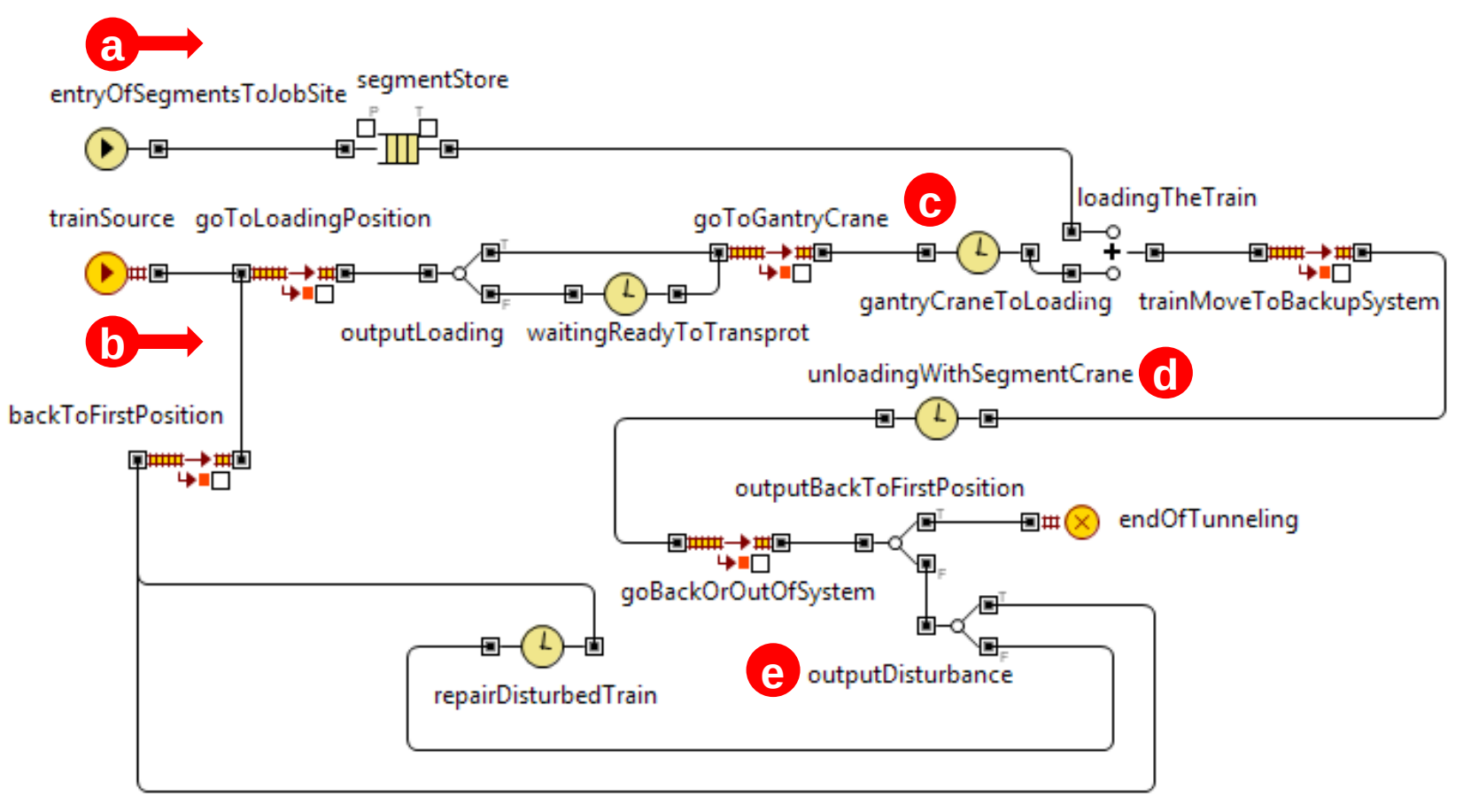
Decomposition in simulation components



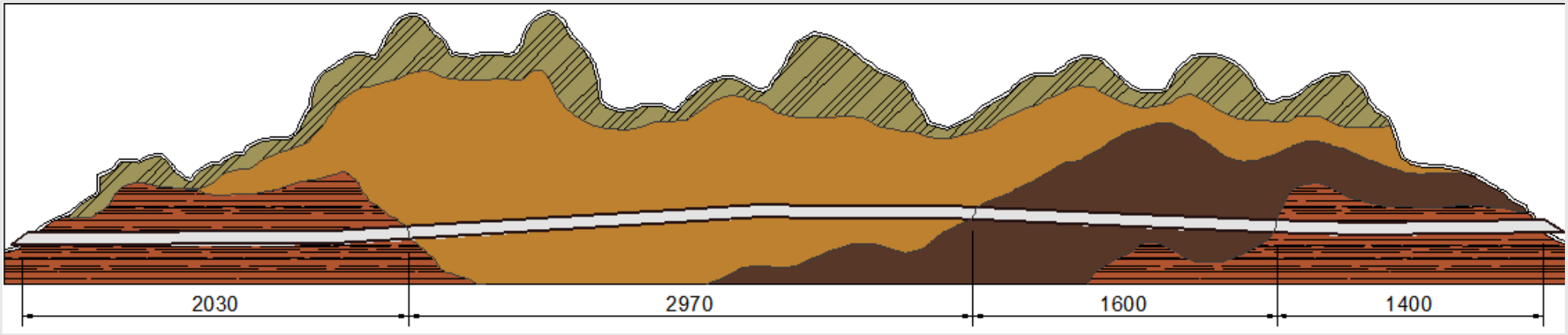
Simulation component for supply chain



Simulation model of supply chain



Case study

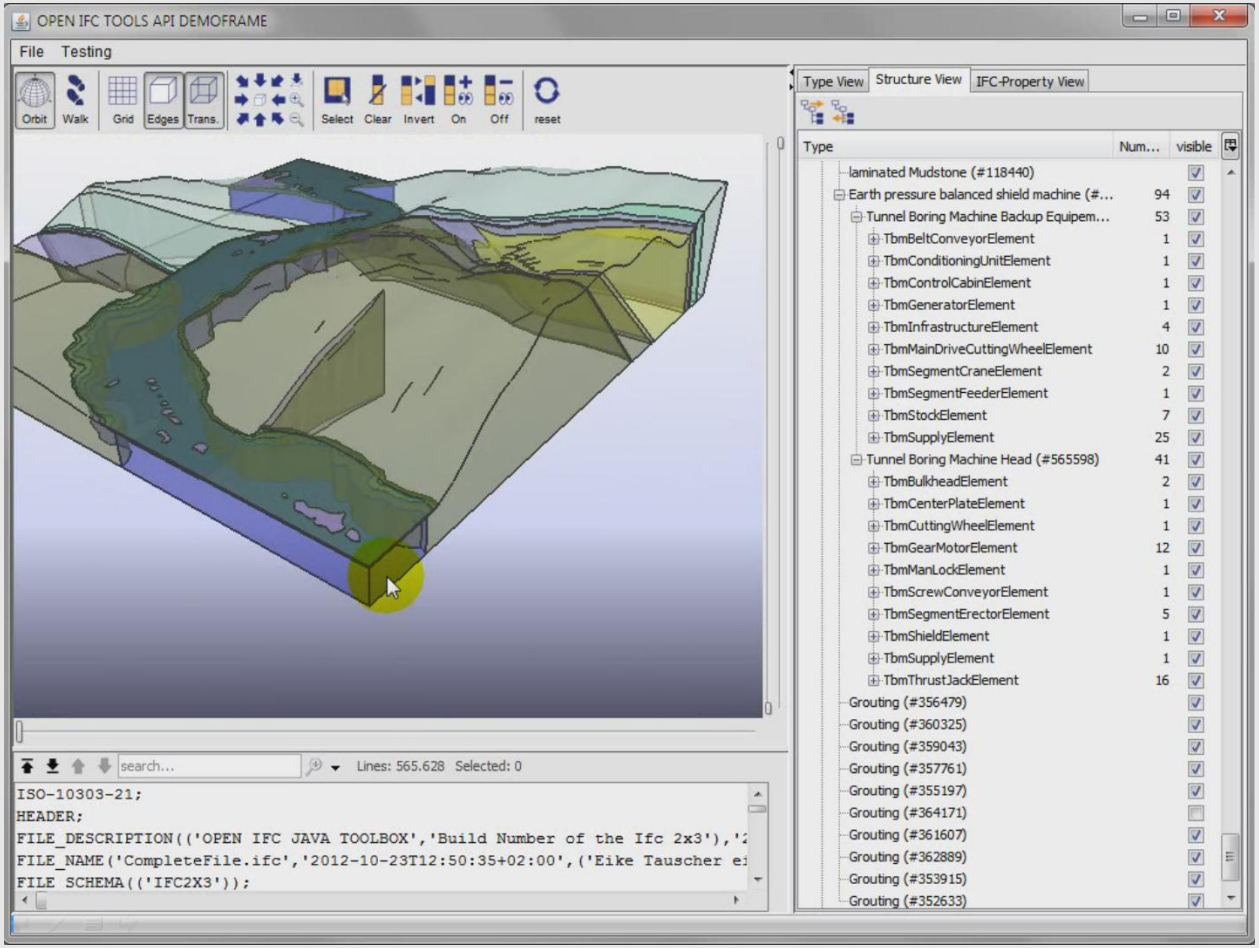


Project parameter	
Length of tunnel	**8000 m**
Diameter machine	**10 m**
Length of segment	**2 m**
Segments per ring	**7 (6+1)**

Techn. disturbance parameter			
Example Main Drive			
	Min	*Mean*	*Max*
MTBF	**50 h**	**150 h**	**450 h**
MTTR	**2 h**	**10 h**	**50 h**

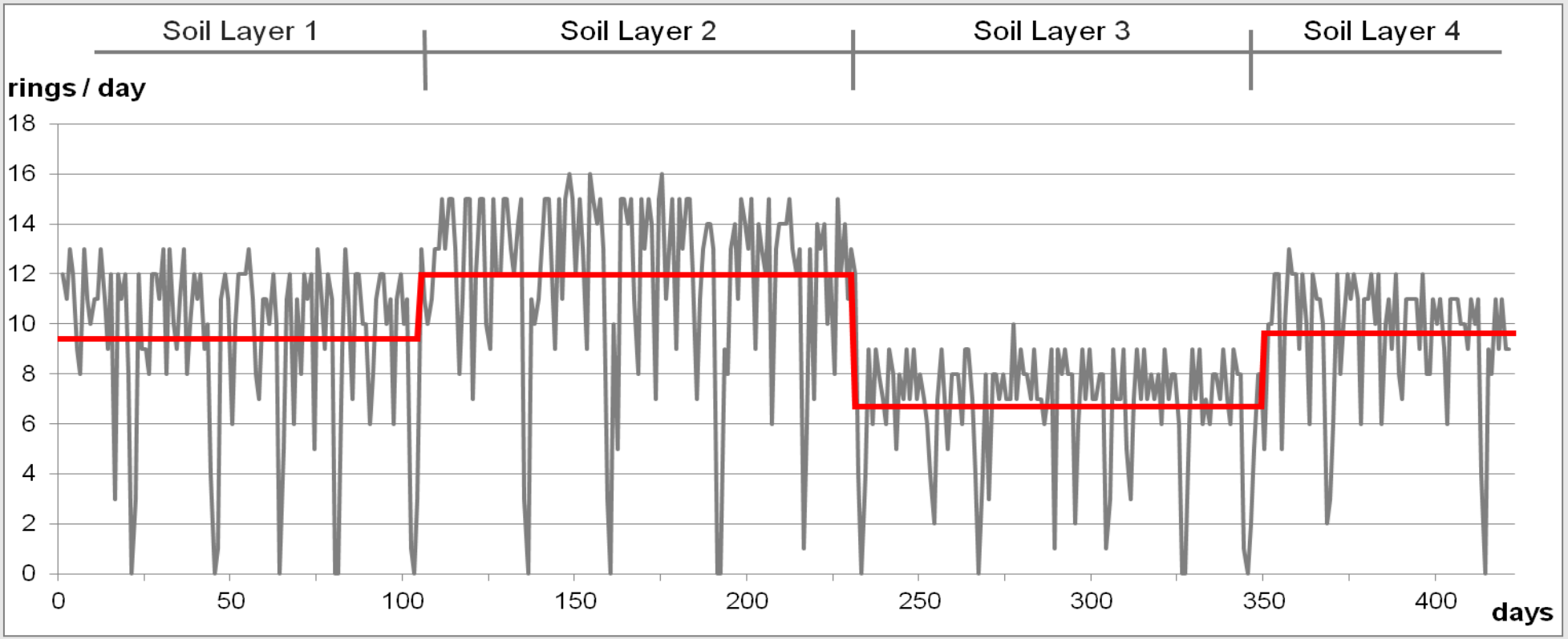
Input data – soil conditions

- Connection to database
- Soil conditions allow a certain speed of excavation (min, max)
- Triangular random distribution to generate a specific value

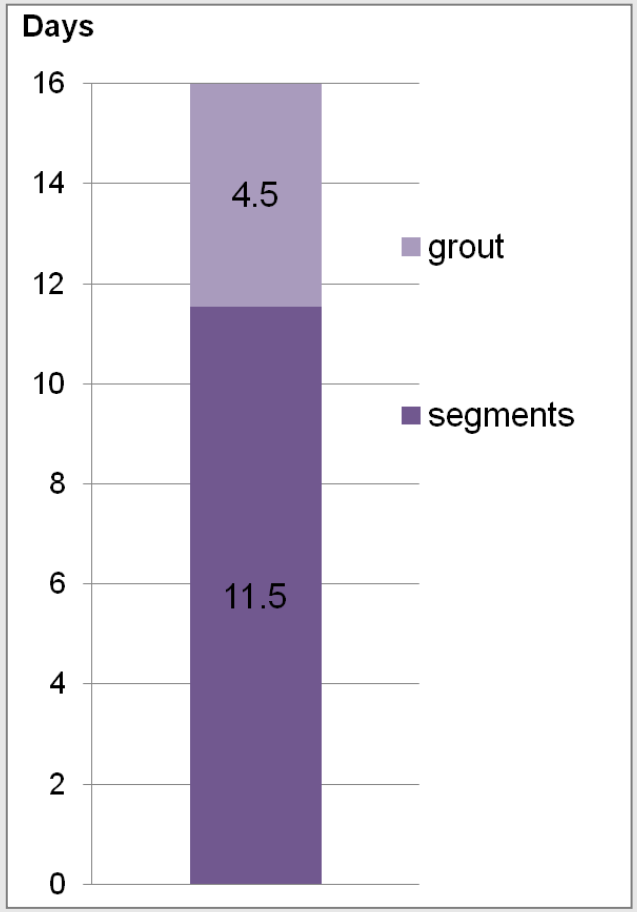


Simulation results: daily advance rate

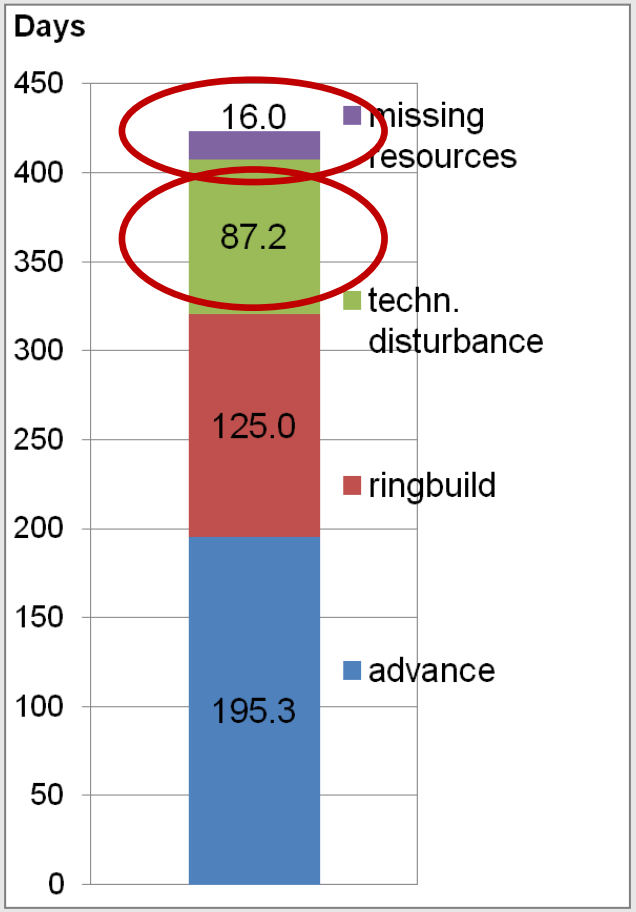
- Consideration of alternating soil conditions
- Impact of disturbances



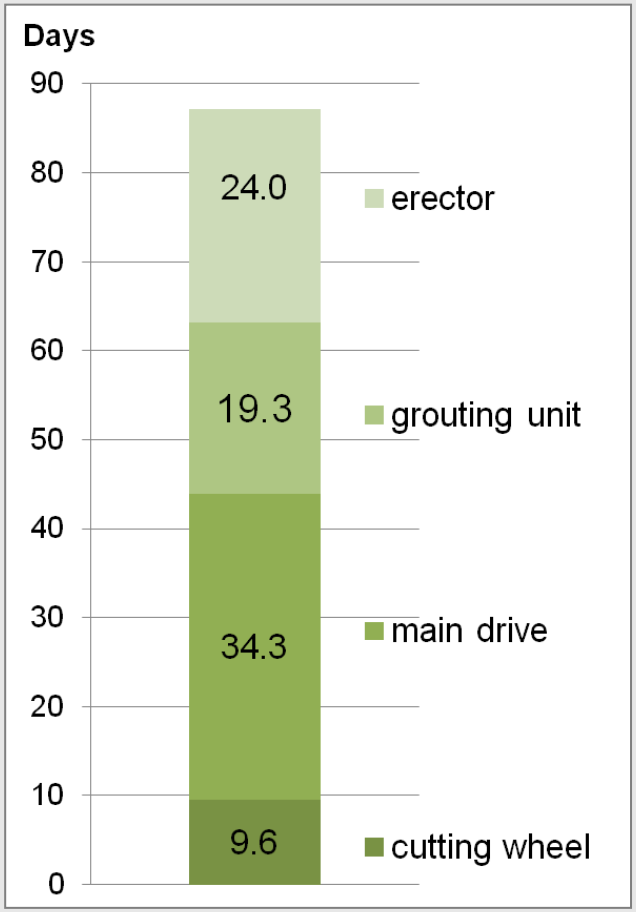
Simulation results: analysis of disturbances



Missing resources

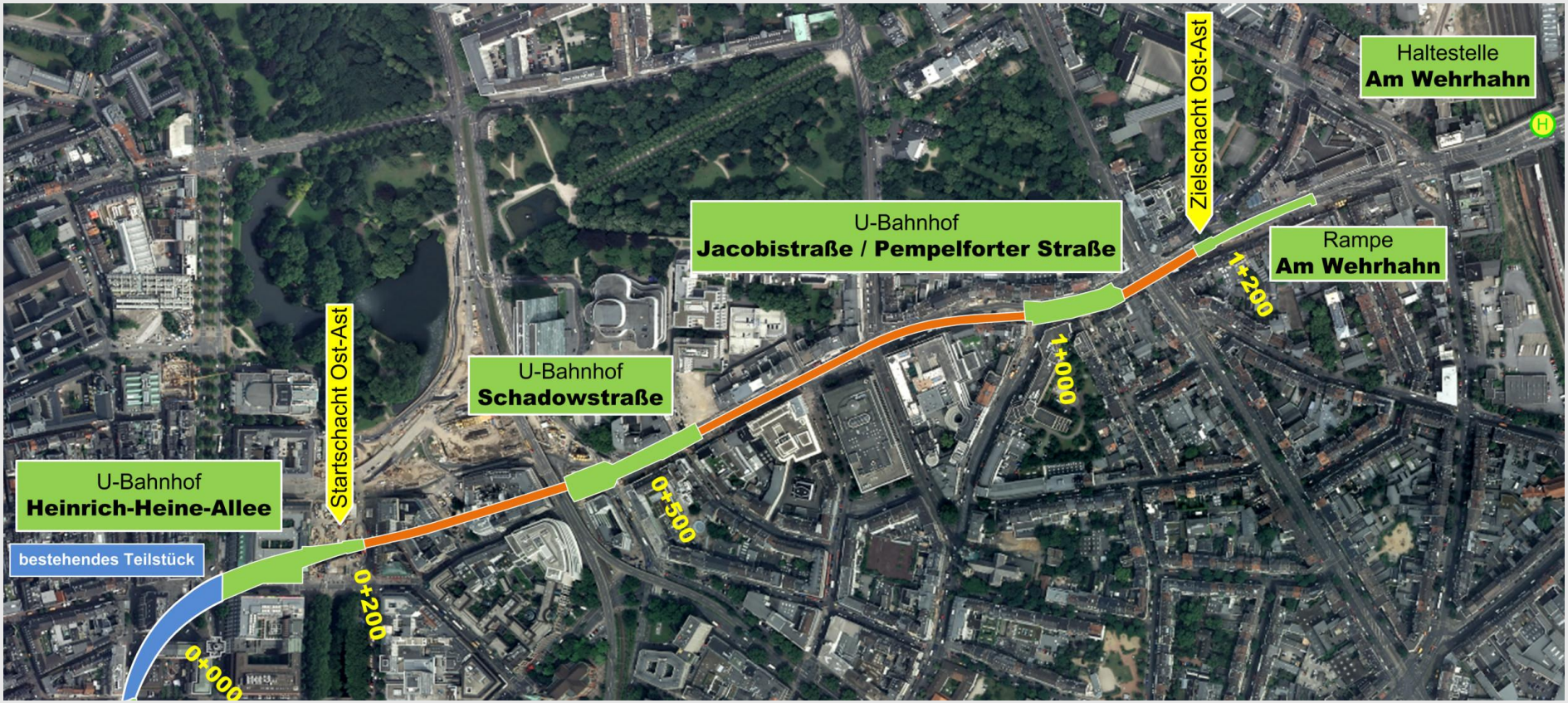


Time share of total project



Technical disturbances

Validation with Wehrhahn Linie Düsseldorf



Source: Bautechnik 89 (2012) Issue11; Mark, et al.

Ruhr-Universität Bochum

Chair of Computing in Engineering

Prof. Dr.-Ing. Markus König

Gebäude IA 6/151, Universitätsstraße 150, D-44780 Bochum

office@inf.bi.rub.de