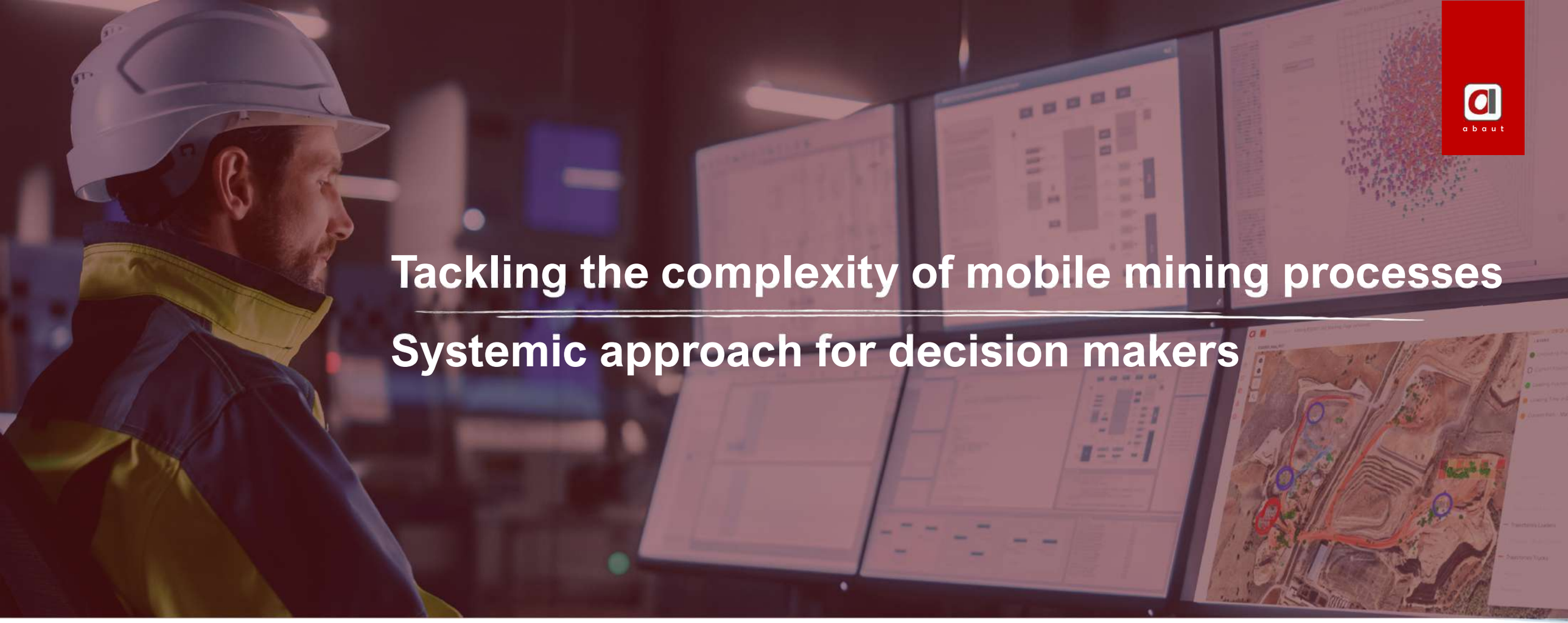

Tackling the complexity of mobile mining processes

Systemic approach for decision makers

abaut GmbH – Services for construction and mining

November 2024

abaut GmbH
Agnes-Pockels-Bogen 1
80992 Munich
Germany

www.abaut.de
www.linkedin.com/abaut/

Target and structure of the presentation

→ **Mobile mining processes**

From drill to mill

→ **Use of innovative digital tools**

Data-driven decisions to increase operational efficiency in quarries & mines

Mobile mining processes

From drill to mill

abaut GmbH – Services for construction and mining

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Mining as a logistical challenge

Target of mining logistic:

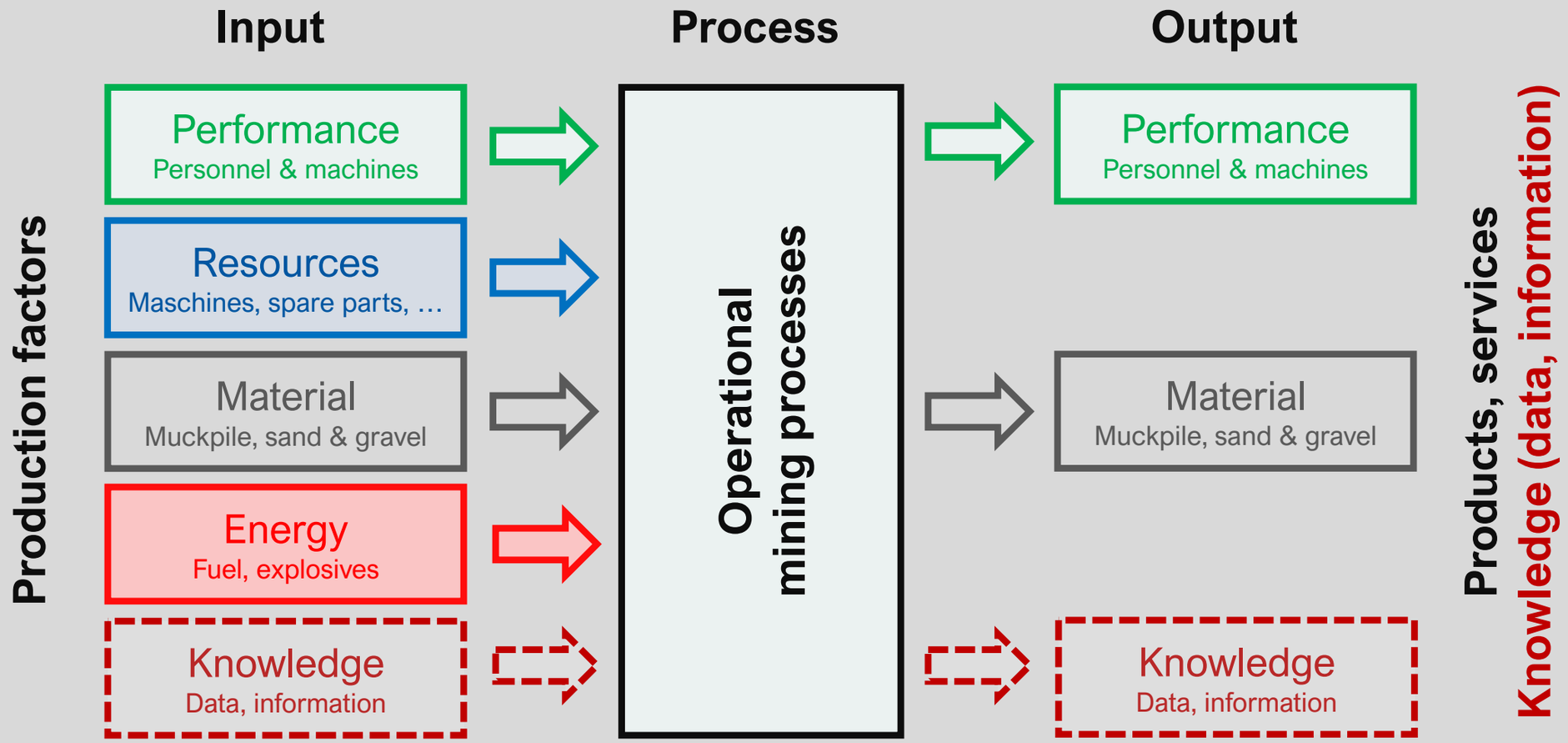
- → The right product
- → with the right quality
- → at the right time
- → in the right quantity
- → to the right place
- → with the right costs

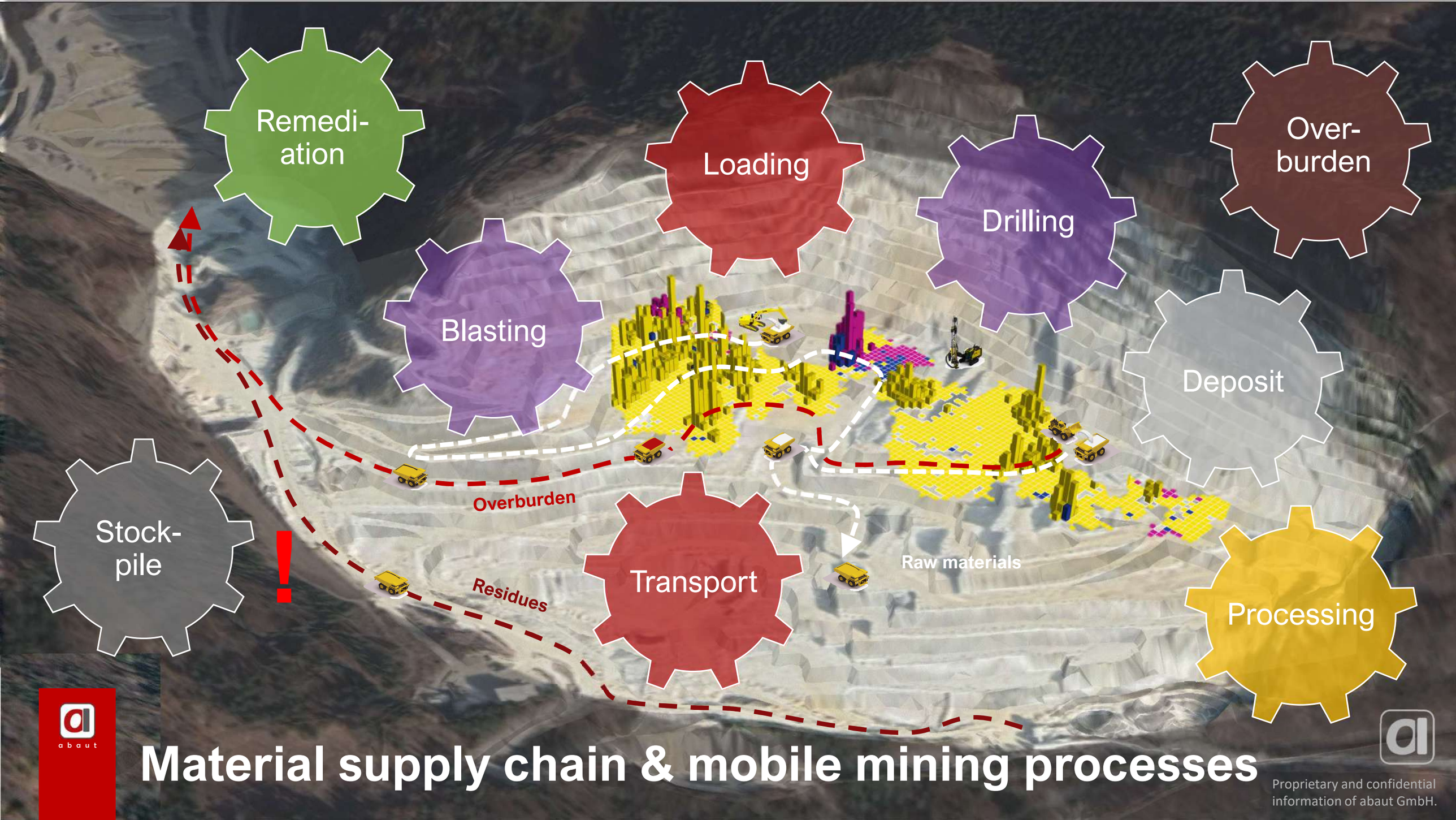
… all the way from drill to mill

Mining production factors

The right product with the right quality	**Deposit** Muckpile, sand & gravel !
at the right time in the right quantity to the right place	**Organisation** Management, knowledge, know-How
with the right costs	**Team & Technology** Machinery fleet, energy, human resources

Mining processes

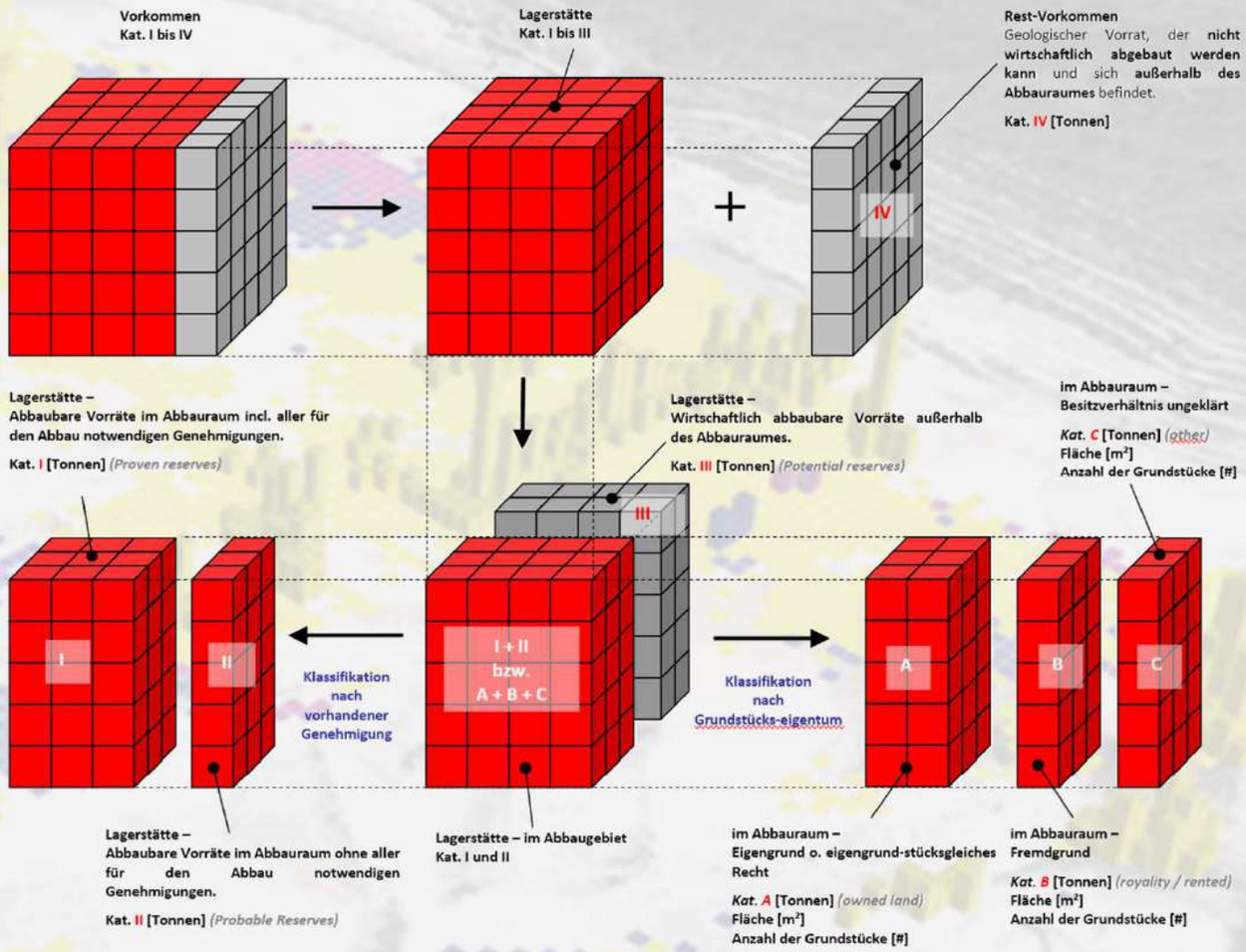




Deposit

Deposit

Classification model



→ **Reserve: natural occurance > deposit**

→ **Minable: permits, property, qualities**

Deposit

Deposit types
- Sand & gravel,
- Solid rock

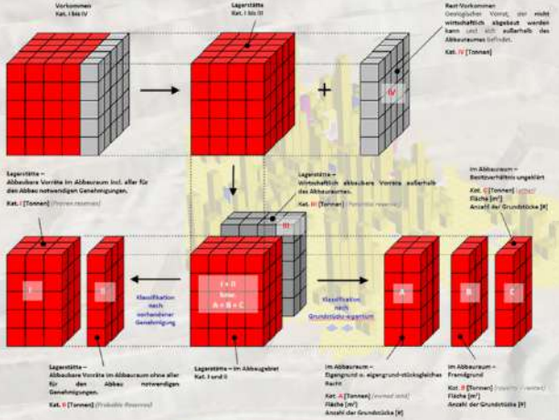
Rock type
- Hard rock
- Medium hard rock (MPa)

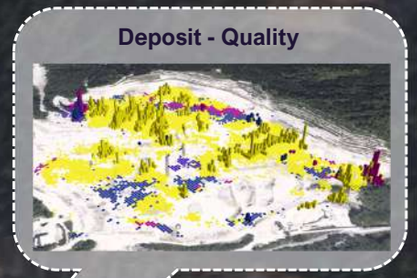
Technical rock parameters
- Los Angeles Index (LA)
- Polished Stone Value (PSV)

Quality:
- Selective mining !
- Several extraction areas !

Extraction type
- Mechanical (Ripping)
- Drilling & blasting

Minable part of the deposit



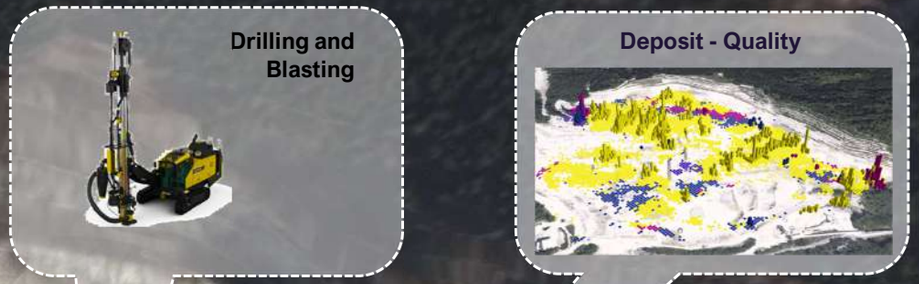


Drilling & Blasting

Blasting parameters
- Layout – burden, spacing, stemming, subdrilling
- Target size of blasted material > Loadability **!**
- Explosives type

Drilling
- In-house competence center
- Subcontractor

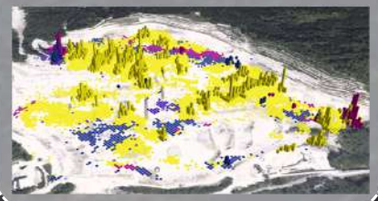
Choice of drilling equipment
- Planned quantity for mining / year
- In one / more mining sites
- Capacity of drilling equipment (m^3 / day – year)

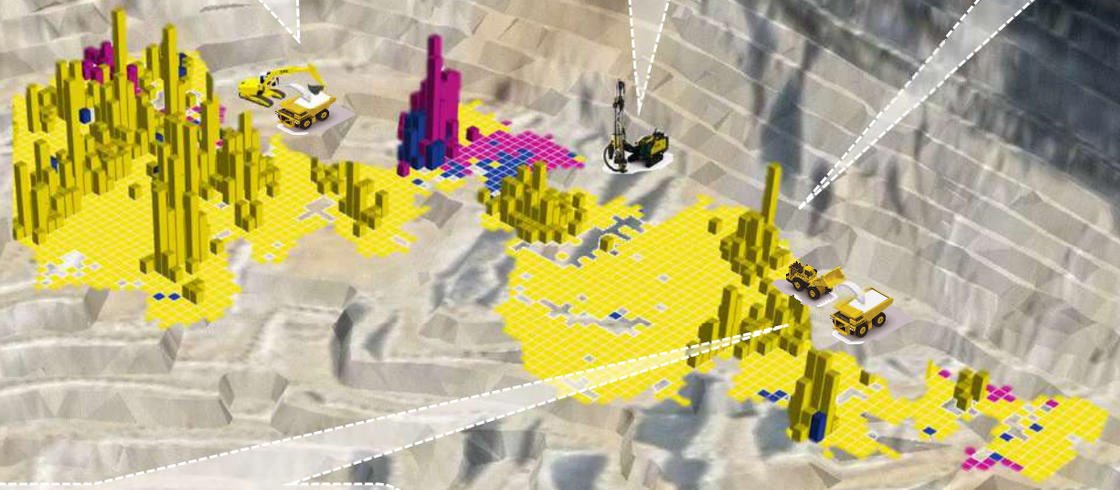


Loading with hydraulic excavators

Drilling and Blasting

Deposit - Quality





Loading with wheel loaders

Loading with wheel loader vs hydraulic excavator

Loading with wheel loader vs hydraulic excavator

Choice of loading equipment

→ **Weight and bucket or shovel size**
= function of (geology, material, size of muckpile, production)

→ **Correlated with the lateral height of the dump truck**

→ **Wheel loader**

- Loading / Load & Carry / very flexible
- Max. 3-4 buckets / truck
- Bucket size = Muckpile size
- Suitable for wide extraction areas

→ **Hydraulic excavator**

- Loading / less flexible / selective mining
- Max. 7-8 buckets / truck
- Muckpile size > Bucket size
- Suitable for narrow benches

Wheel loader

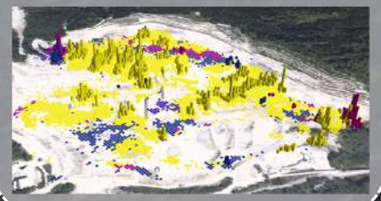
Hydraulic excavator

Loading with hydraulic excavator

Loading with wheel loader

Drilling and Blasting

Deposit - Quality



Loading with wheel loader vs hydraulic excavator

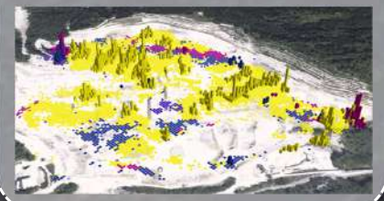
Transport

Loading with hydraulic excavator

Loading with wheel loader

Drilling and Blasting

Deposit - Quality

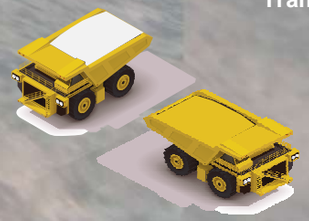


Overburden

Raw material

Residues

Transport cycles



Technological transport

Hauling performance
- Dominated by the processing plant
- Dependent on hauling route (distance, width, slopes, road surface, curves)
- Machine pairing → Correlation of loading and hauling equipment

Transport fleet
- # Transport units = function (production, hauling route)
- Cycle times are important for the number of transport units
- Transport units should be of similar size for having similar characteristics: velocity, cycle times, …

Inneficiencies in the cycle times
- Waiting for loading / unloading
- Narrow hauling routes → longer cycles
- Poorly maintained hauling routes / Weather

Entire fleet
- Consider entire fleet availability for covering peak production
- Optimize equipment utilization
  → avoid unneeded driving
  → avoid excess preparation work
- Monitoring shift efficiency

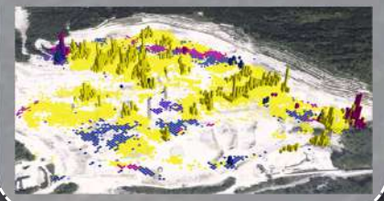
Intermediary stockpiles

Loading with hydraulic excavator

Loading with wheel loader

Drilling and Blasting

Deposit - Quality

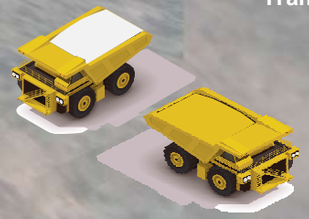


Overburden

Raw material

Residues

Transport cycles



Intermediary stockpiles

Intermediary stockpiles

→ **Still rarely considered in the workflow and organization of processing plants**

→ **Important advantages**

- Flattening production peaks (LEAN-Prinzip)
- Decoupling the quarry and the processing plant
- When more qualities: better exploitation of the deposit
- Sustained production in case of mobile machinery break-down

→ **Type of stockpiles:**

- Cone heaps
- Shafts

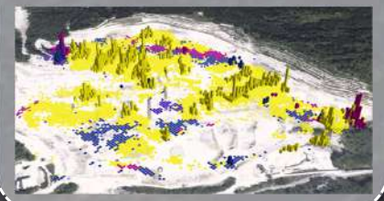
Processing plant

Loading with hydraulic excavator

Loading with wheel loader

Drilling and Blasting

Deposit - Quality

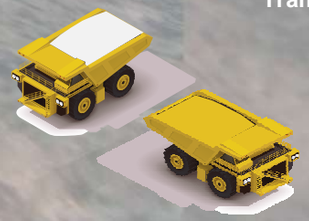


Overburden

Raw material

Residues

Transport cycles



Intermediary stockpiles

Processing plant

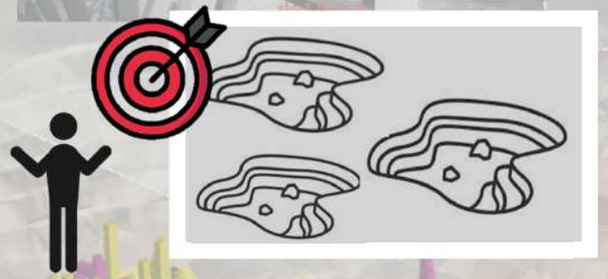
Processing plant

Production
- Usually: Target-production (tons / hour)
- Dictates the haulage performance of mobile machinery
- When possible: intermediary stockpiles

Location of the infeed hopper
- Hauling downwards
- Best in central location – Deposit !
- Short hauling routes = more trucks !
- Generous maneuvering area

Dimensions of the infeed hopper
- Usually: too small
- Unnecessary waiting for unloading
- Queueing of trucks

Ingredients for reaching the target



- Production (t/h, t/d, …)
- Quality (technical)
- Costs (€/t)

Skills

Innova-tion

Collabo-ration

Attention

Know-How

Safety

Glück Auf!

Use of innovative digital tools

Data-driven decisions to increase operational efficiency in quarries & mines

abaut GmbH – Services for Mining & Construction

October 2021

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Move mountains with your data

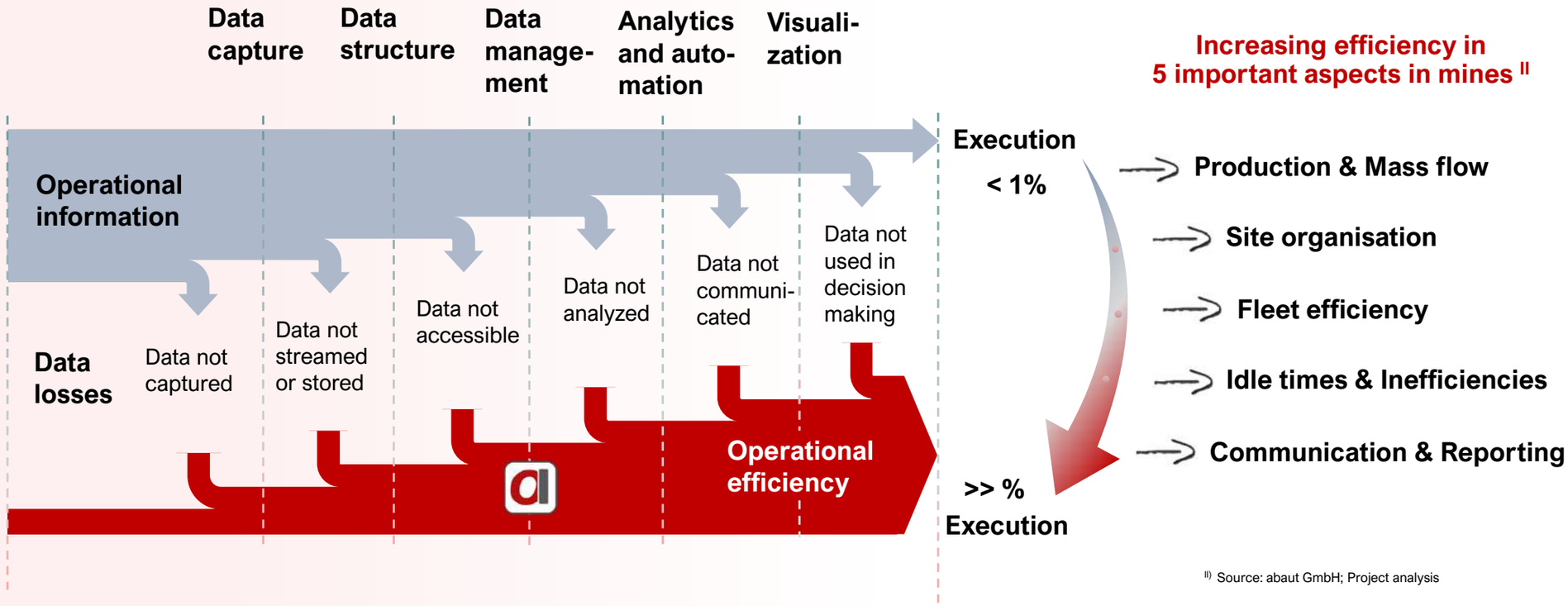
Why process mining analysis in the mining industry?

In mines, quarries and gravel pits, the available data and information are not used for decision-making. With only little effort, relevant operational data can be measured and analysed, offering enormous potential for increased operational efficiency.

Mining companies only use a fraction of their data [I]

[I] Source: McKinsey; https://www.mckinsey.com/industries/metals-and-mining/our-insights/how-digital-innovation-can-improve-mining-productivity

Innovative IaaS-Solution to tackle the performance gap



[II] Source: abaut GmbH; Project analysis

Reality capturing

Mobile mining machines are good means to capture processes on site in real time.
They are involved in every activity in the mine, reaching every corner of an operation several times a day.

abaut edge

Inertial measurements
e.g. intelligent data generation

Edge Artificial Intelligence
e.g. GDPR-conform images (person blurring on edge)

WiFi & Bluetooth
Machine2Machine communication

Celllar modem
Internet connection & localisation (2G/3G/4G)

OTA
New algorithms and features directly from the cloud

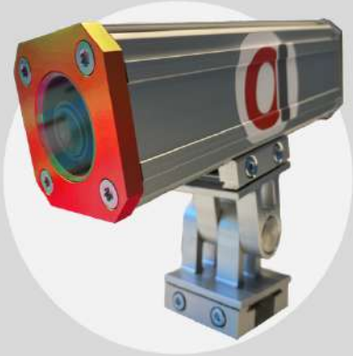
Ready for …
360° camera, stereo camera, lidar, …

Plug & Play
Installed in <10 Minutes

No CAN-Bus
Platform independent → no CAN-BUS needed

Mixed fleets
For every machine type and independent from machine manufacturer

abaut mView



abaut sView

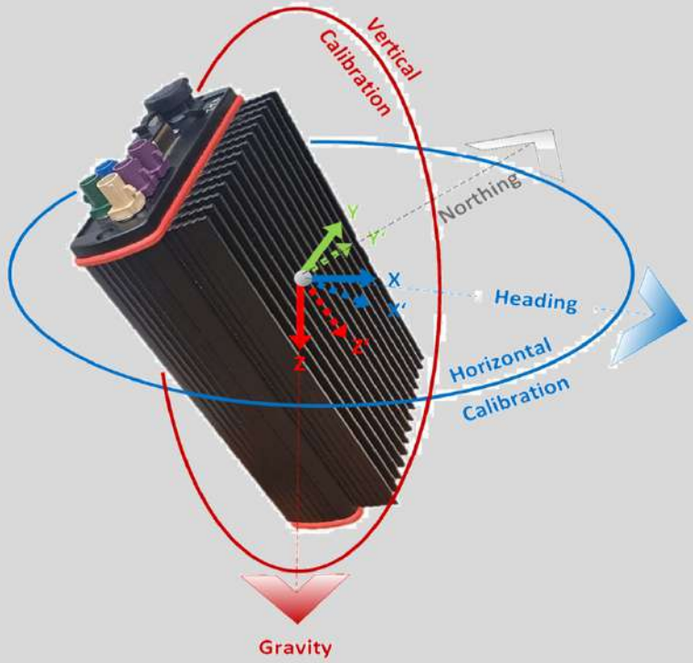
Automated movement pattern recognition

Each time a machine performs an activity such as

- loading, unloading, driving
- digging, manoeurving, dumping
- preparation work
- idling

it leaves a specific „footprint“…

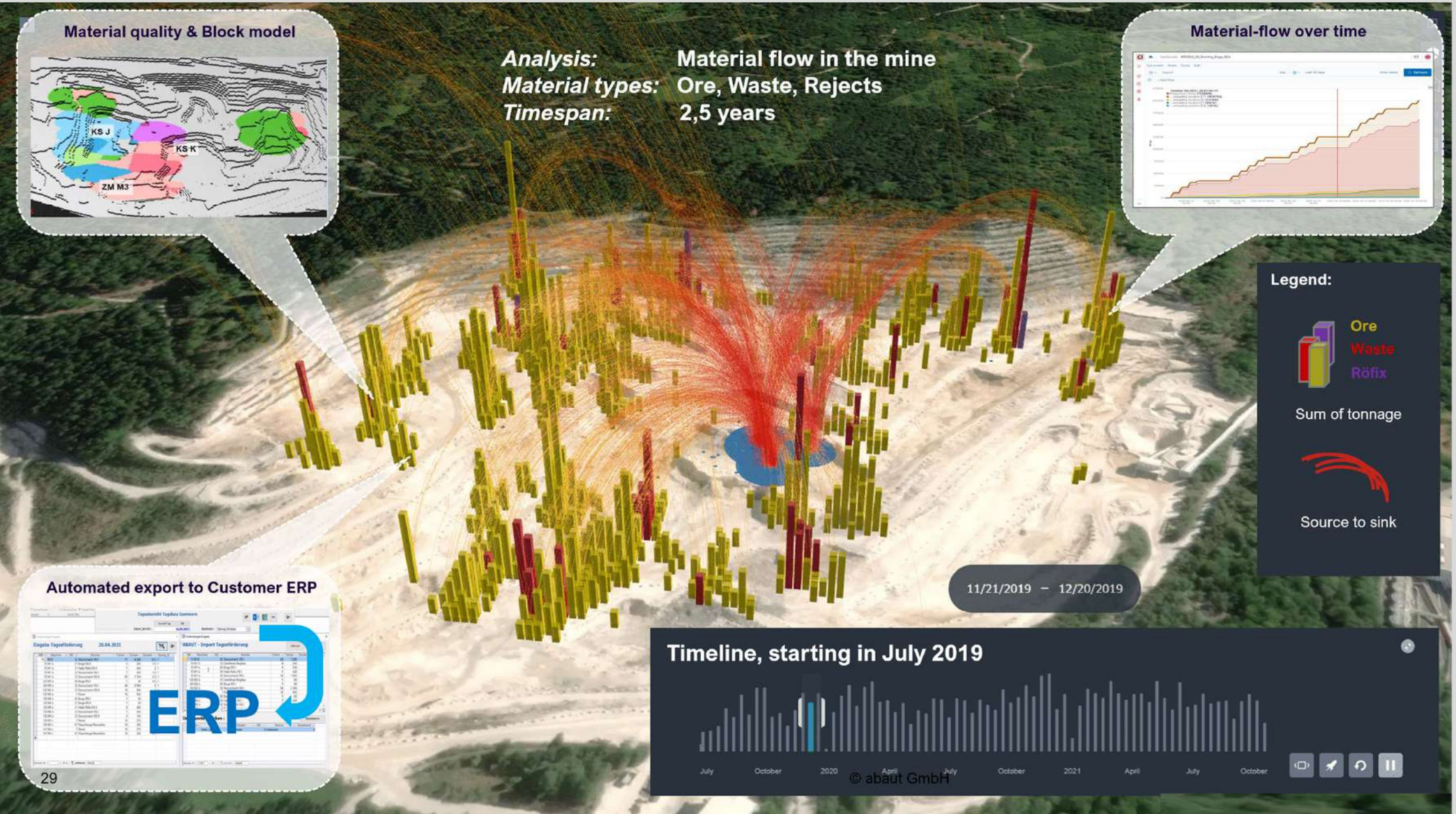
... that is captured by the intelligent sensor edge module ...



... and used to identify the movement patterns and the correlated performed activities with the help of AI algorithms.

Mounting in any heavy machinery

Fully automated monitoring & material flow reporting



Material flow monitoring

- Following the transports of all types of material in the quarry in near-real time
- Tracking of loading & unloading activities, transport routes and participating machines
- Actitvities-recognition of machines used (movement pattern)

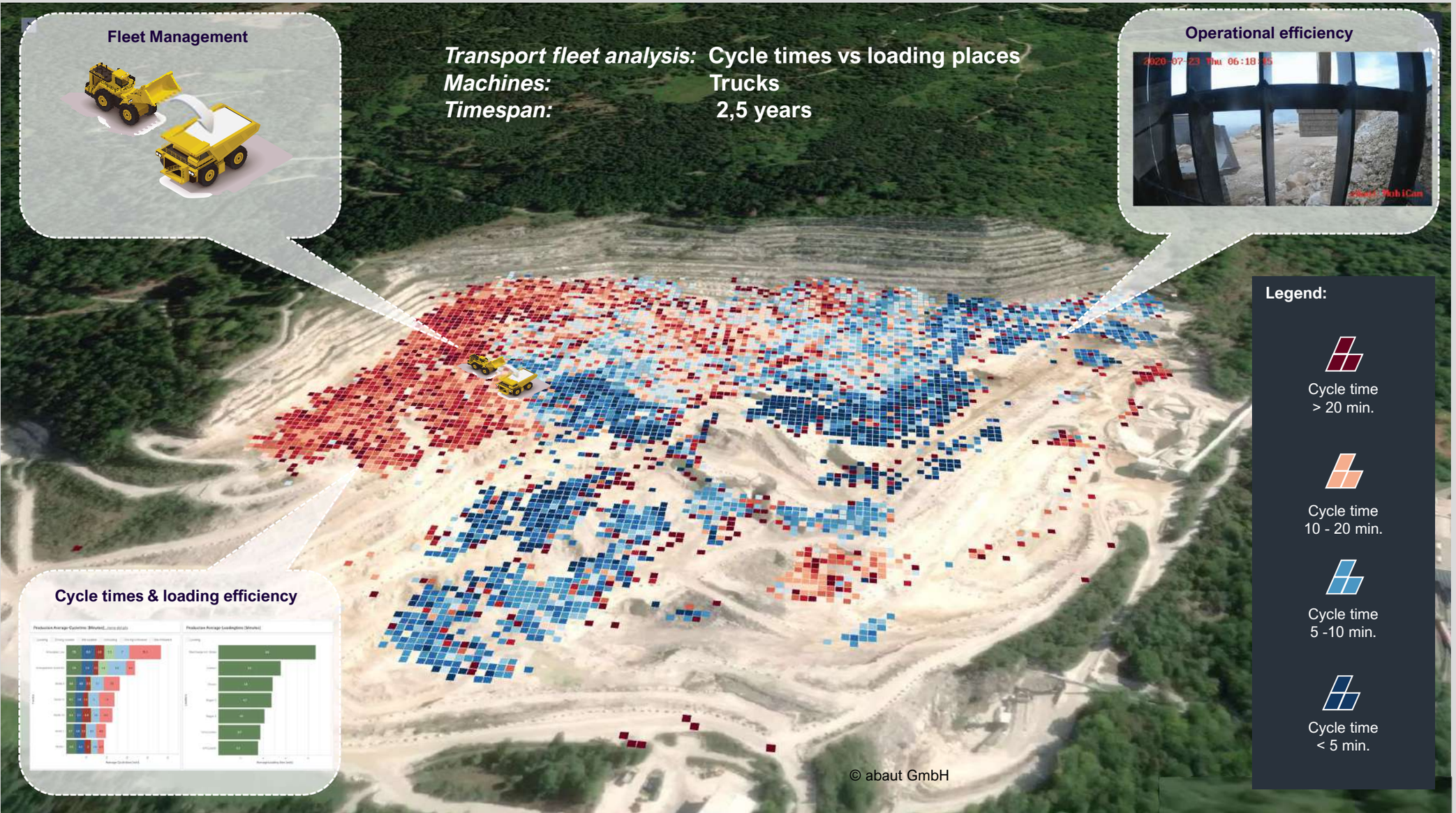
Quality management

- Connecting loading place and time with block model and material quality

Standard reporting

- Dashboard
- Automated export to Customer ERP-System

Fleet management & operational efficiency



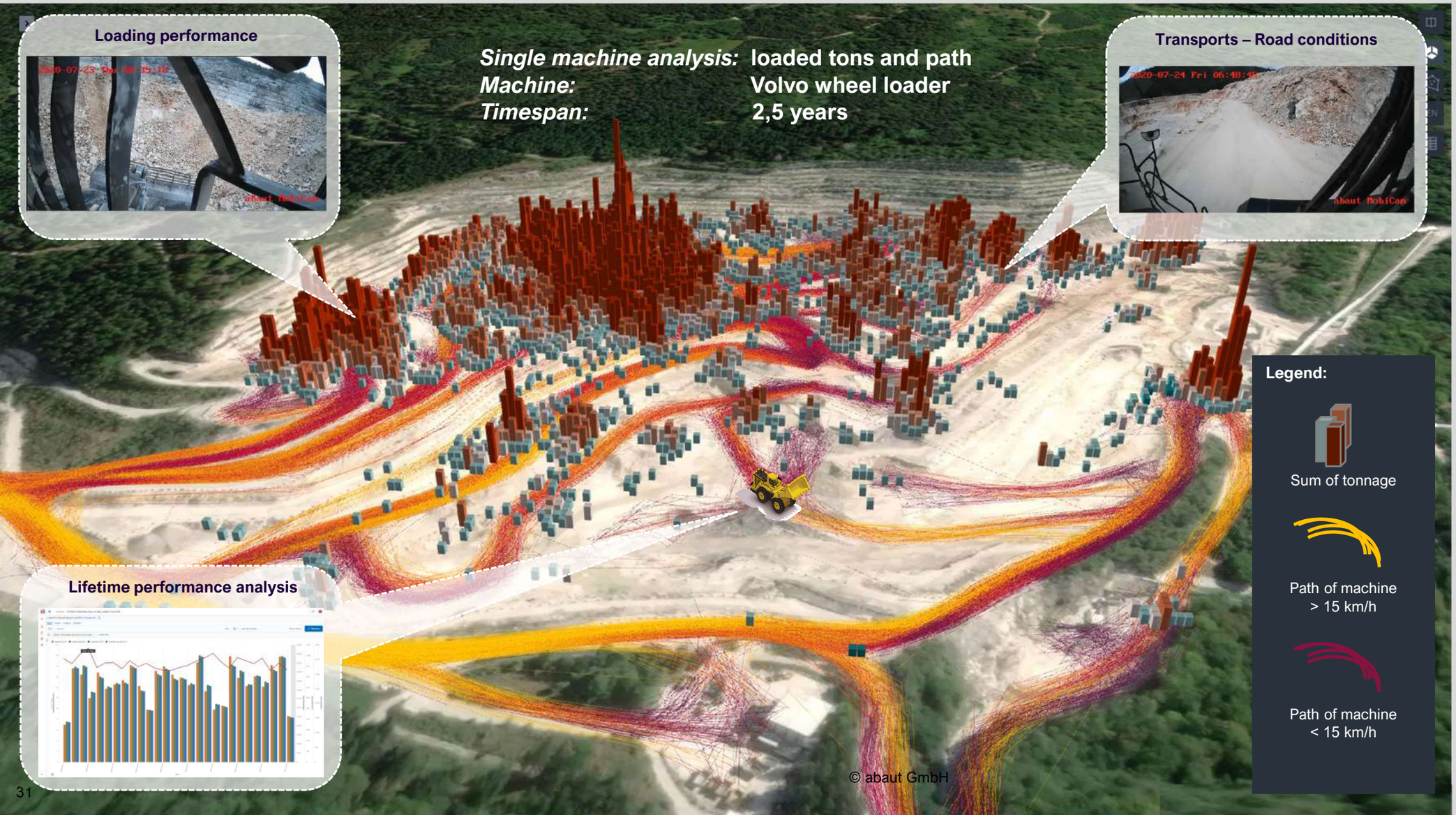
Fleet management

- Matching loaders & trucks for increased machine utilization
- Fleet size and composition by analysing cycle times and loading performance

Operational efficiency

- Detecting inefficencies like idle times, unneeded driving, preparation work
- Road maintenance
- Speeding events

Supporting investment decisions on mobile machinery



Lifetime monitoring

- Operating time, ON, OFF, Idling
- Activities analysis: Availability & utilization

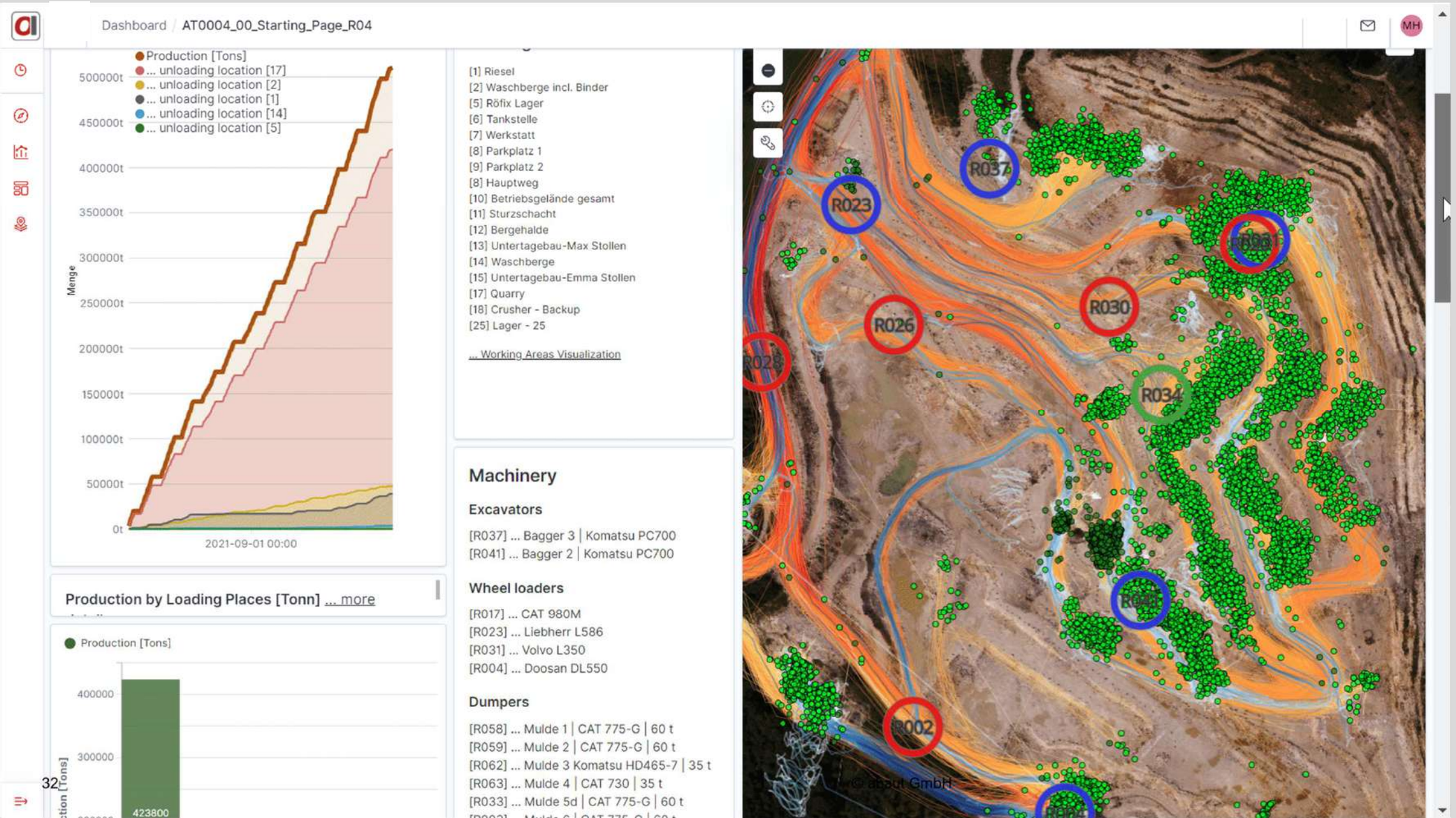
Performance indicators

- Loading performance
- Hauling performance
- Speeding events

Working conditions

- Road conditions vs machine behaviour (accelerations)
- Muckpile charateristics

Dashboard for mine monitoring and analysis



Web-Dashboard

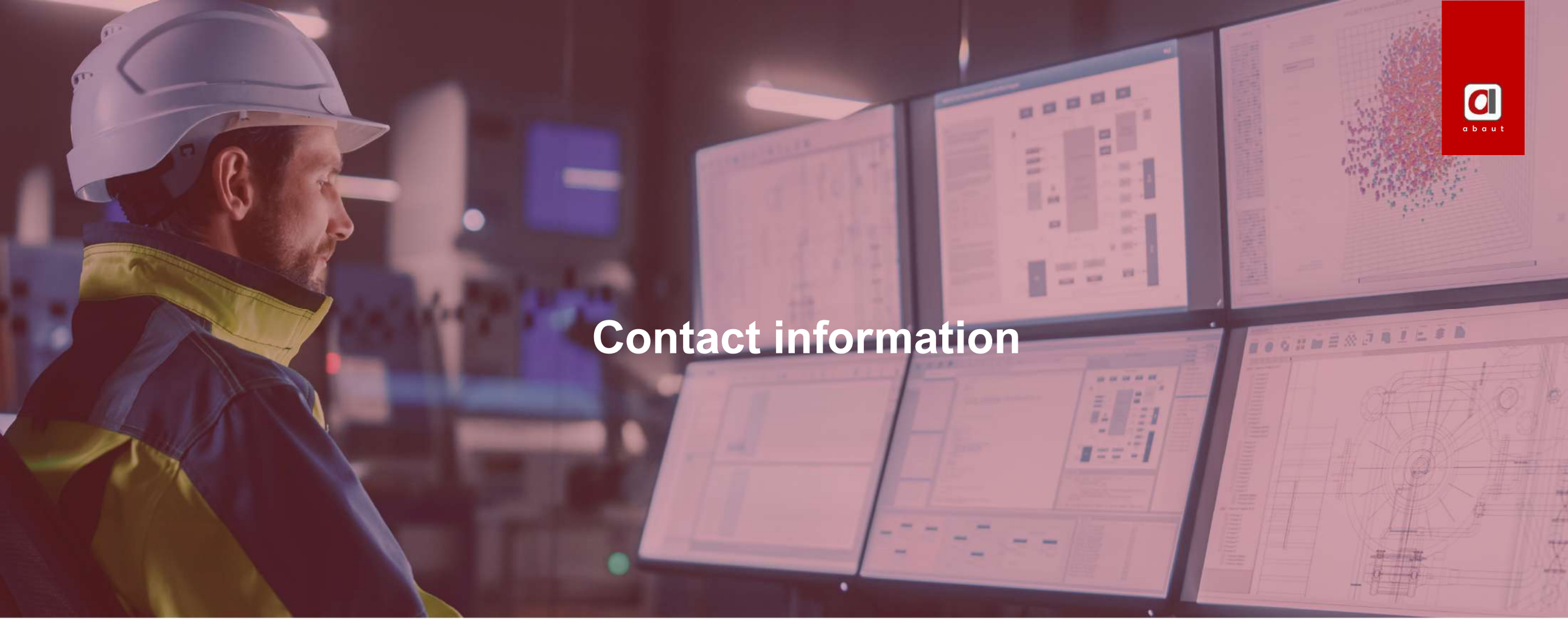
- For all decision makers in mining and mine foremen
- Information in near-real-time
- Any language
- Easy to access

Flexible for all users

- Machine monitoring
- Material flow
- Filters for time, machines, locations and activities
- Aggregated vs detailed information

Automated recognition of vehicle types

in construction, mining and logistics



Contact information

Dr. Markus Häupl (Mining)

markus.haeupl@abaut.de

+43 676 789 8475