Computer Simulation Programms in Mine Rescue Education and Training, on the Example of Student Mine Rescue Teams

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Outline

1 Motivation

2 Mine Rescue Education in an Academic Environment

3 Theoretical Lectures and Practical Exercises

4 Computer Simulation Programs – A Support Tool

5 Mine Rescue Simulator at TU Bergakademie Freiberg

6 Mine Rescue Simulator at Colorado School of Mines

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Motivation

- Mechanization and decreasing staff numbers

- Underground mines are deeper and larger

- Experience loss due to generation shift

- Young engineers lack experience, especially under difficult circumstances

→ Engineers face growing responsibilities

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Education of Future Mining Engineers in Mine Rescue, Disaster Management and Health and Safety

Mining schools understand safety in mining as a basic competence for their students.

Key aspects

- Mine rescue: rescue fire, smoke, gases, etc.

- Disaster management

- Health and safety

- Protecting the mine and its investment

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Mine Rescue Course: Target Groups

Basic competencies in disaster management and mine rescue organization are required in

- Mining
- Specialized underground construction
- Confined space work
- Tunneling
- Petroleum engineering
- Chemical engineering
- Energy and gas technology

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Lectures and Practical Exercises

Simulator Exercises

Basic competences

- Team structure and operation
- Fresh air base and incident command
- Rescue strategy
- Team advance
- Team discipline

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Practical Exercises – Step by Step

Basic Surface Training

Goals:

- Shouldered apparatus

- Team operation

- Communication

- Problem narrative

- Strategy

- Team movement

- Team discipline

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Practical Exercises – Step by Step

Basic Underground Training

Goals:

- Shouldered apparatus in confined spaces

- Search and rescue

- Execute typical work assignments

- Communication /

- Follow problem description

- Team strategy and decision making

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Practical Exercises – Step by Step

Basic Underground Training

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Practical Exercises – Step by Step

Movement in Confined Spaces

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Confined Space Exercise

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Practical Exercises – Step by Step

Movement Underground

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Hot Underground Exercises

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Exercises under Apparatus

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Training Under Apparatus and Live Fire

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Computer Simulation Programs

Need for Simulation Programs

- Limited underground experience for most students
- Practice goals
    - Team member role
    - Team leader role
    - Following orders
    - Knowing and adhering to rules
    - Communication skills
- Less time consuming than underground exercises
- No cost for apparatus maintenance
- Better supervision and control

Computer Simulation Programms

VR Mine Rescue Simulation Programs

- VR mine rescue are like computer games.
- Close-to-reality game environment
- Multi-player mode, first-person-actor mode
- Each player plays a mine rescue team member
- Team communications: Internal, FAB and ICC
- Trainer controls the simulator and monitors student progress,
- Trainer can create surprise hazards
- Training sessions are recorded and decisions can be reviewed in "what-if" scenario variations.

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Computer Simulation Programms

VR Mine Rescue Simulation Programs

Trainers develop specific training scenarios

- Type and level of tasks

- Allocation of challenges within the model

- Variable oxygen consumption

- Available equipment

- Visibilty (Smoke)

- Realistic ventilation including fire effects

- Gas concentrations

- Simulated equipment failures
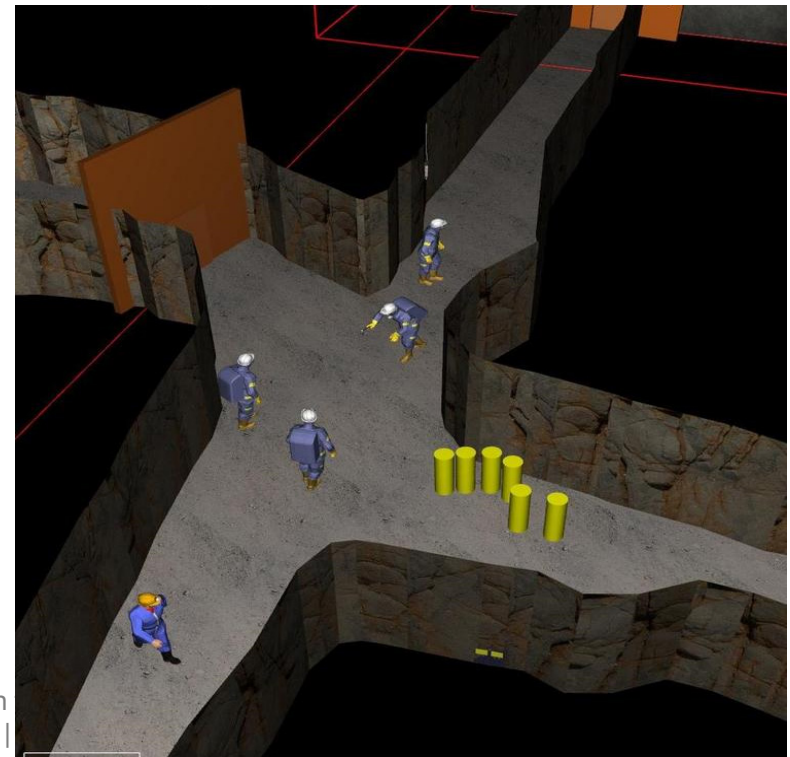
Computer Simulation Programms

Close-to-Reality-Environment

Pros:

+ „Real-life" environment based on survey data

+ Scenarios are realistic

+ Ventilation and visibility can be simulated

+ Ralistic duration, moving speed and challenge levels

+ Any specific mine can be simulated, as long as mine data are available

Cons:

- High upfront effort for the creation of the model

- High end CPUs and graphic cards necessary

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Computer Simulation Programms
Animated-Mine-Layout

Pros:

+ Any mine can be created using a ‚drift library'

+ Well-developed gaming technology

+ Mine ventilation / visibility can be simulated

+ Choice of moving speed and challenge level

+ Large library of equipment and scenarios

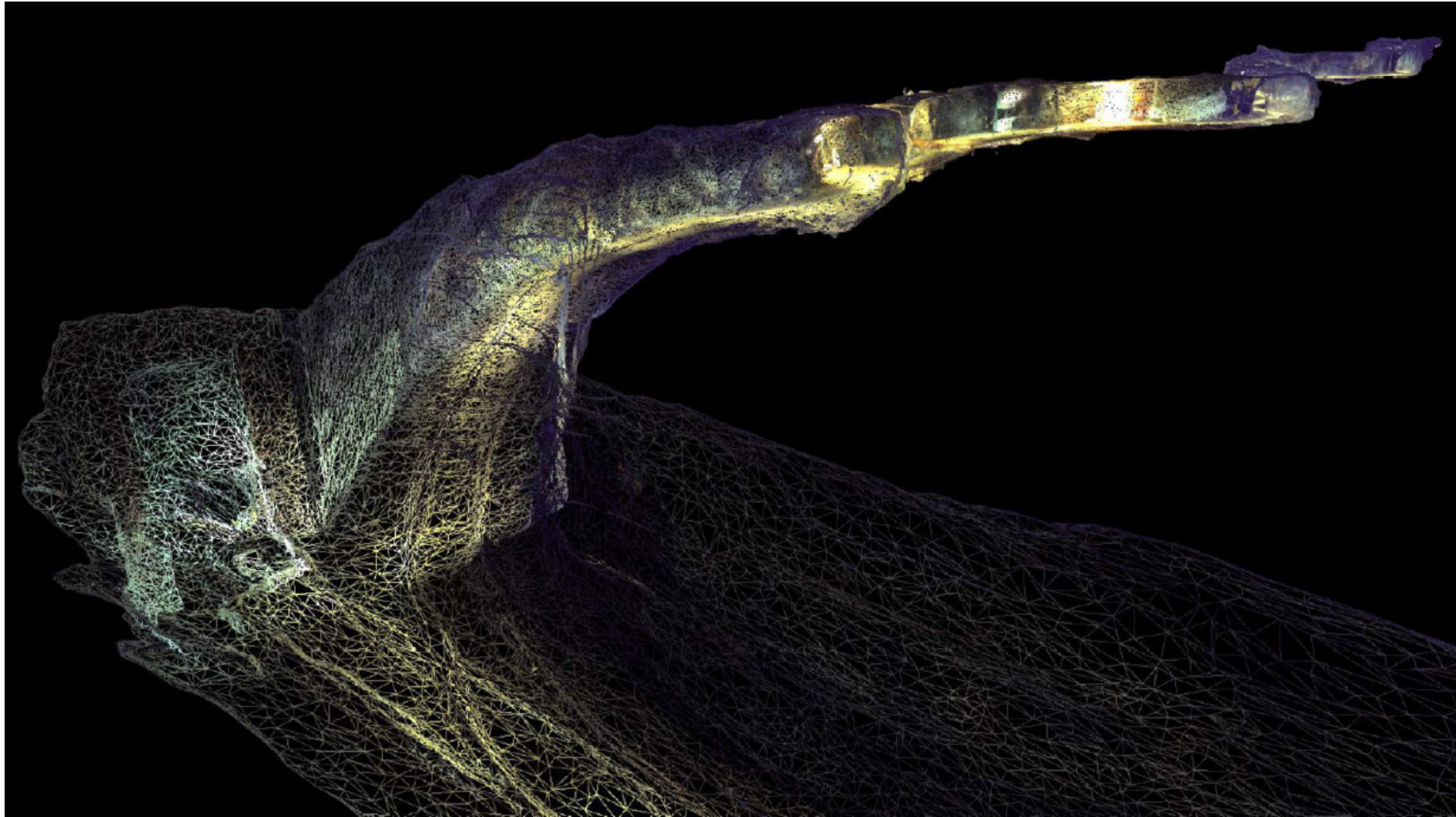+ Equipment can move and run

+ Runs on lower end computers

Cons:

- Environment looks less realistic

- Difficult to design three-dimensional games

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Close-to-Reality-Environment

3-D-Scan with Autonomous Robot

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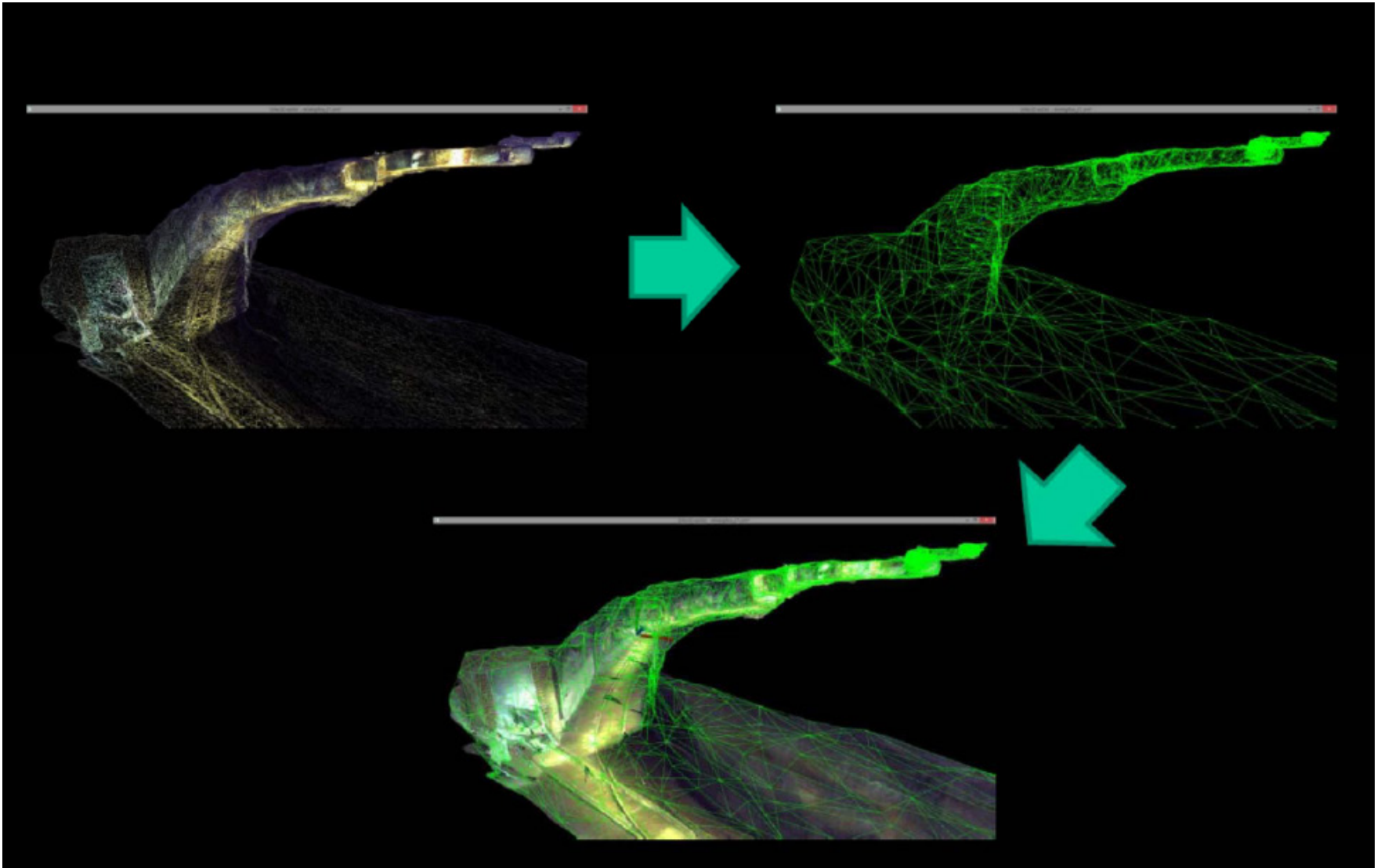
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Close-to-Reality-Environment

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Close-to-Reality-Environment

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Interactive equipment, e.g. gas measurement

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Trainer / Supervisor Screen

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Moving Equipment

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Animated Mine Layout

Moving Equipment

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Outlook
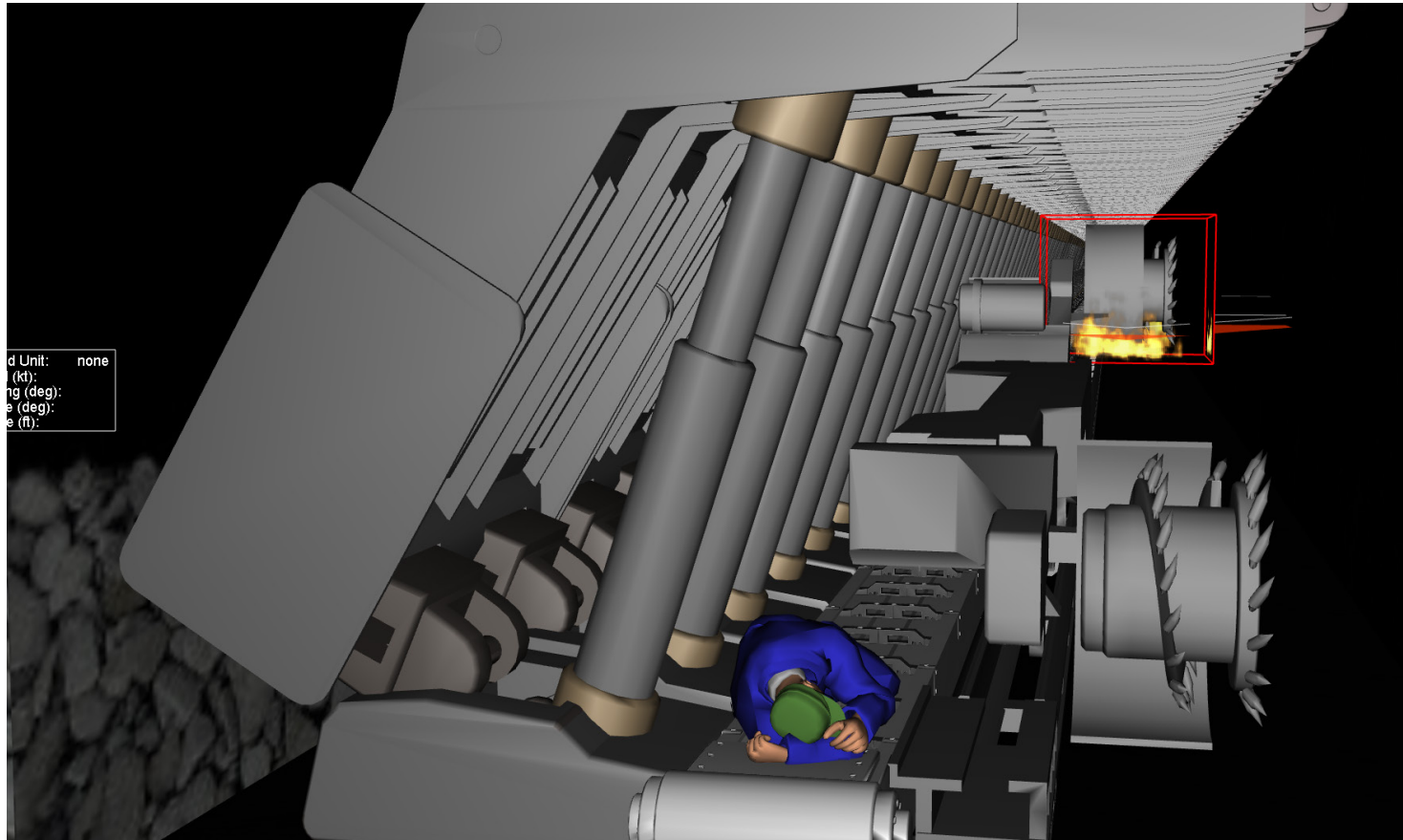
- Positive impact of mine rescue simulators

- Positive feedback from professional mine rescue teams

- The simulator software is being updated for flash scans from flying drones

- The simulator software is being updated for personal VR headsets

- Improvement towards augmented reality is at an early project stage.

- Model for other training simulators (fire fighters, ambulances, hospital emergency rooms and ICUs).

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Thank you for your attention

Glück Auf!

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