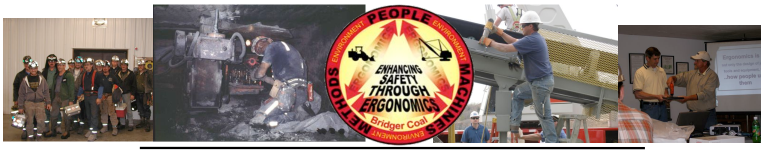
Equipment Related Issues and Controls in the US Mining Industry



Lisa J. Steiner, MS, CPE
MSD Prevention Team Leader

National Institute for Occupational Safety and Health

October 17, 2006

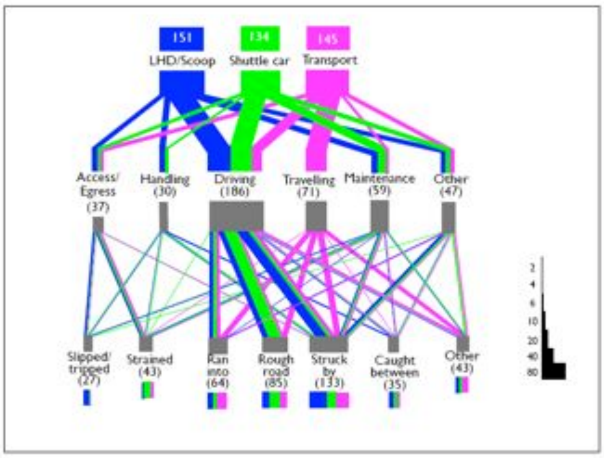
LSteiner@cdc.gov

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

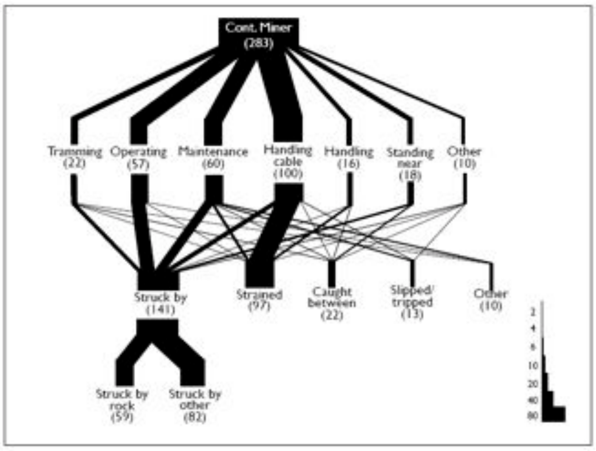
Equipment related injuries

Equipment	MSHA (2004) N=3556
Roof Bolter	593 (17%)
Continuous Miner	283 (8%)
Shuttle Car/ Transport/LHD	430 (12%) 4% each

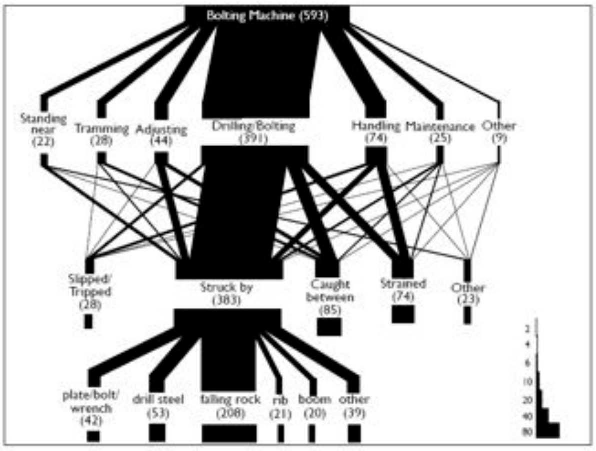
Haulage/Transport Data



Continuous Mining Machine Data



Roof Bolting Machine Data



Top Hazards in U.S.

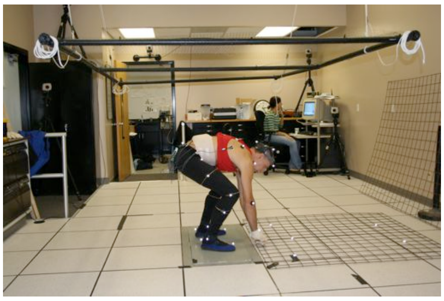
- Rock falling from supported roof
  - Screening Studies
- Collisions while driving
  - HASARDS (Proximity Warning Device)
- Driving or traveling in UG vehicles / rough roads
  - Seat Suspension and Damping Materials Studies
- Handling continuous miner cable
  - Future work
- Inadvertent or incorrect operation of bolting machine controls
  - Struck by injuries: Boom Speed (Reaction Time Tests)
  - Roof Bolter Controls Studies

Rock Falling from Supported Roof

- Roof Screening Studies
  - Lifting Roof Screen
  - Transporting (Carrying/ Dragging) Roof Screen
  - Installation of Roof Screen
    - Analysis of intervention to assist screen installation

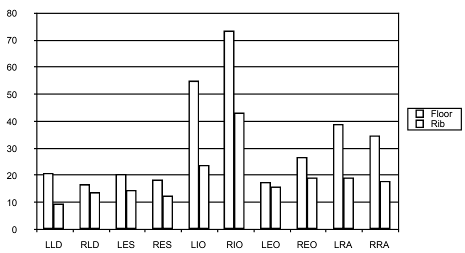
Lifting Screen

- Independent variables
  - Two screens (Full screen, personal bolter screen)
  - Vertical space (66", 84")
  - Screen orientation (leaning against rib, flat on floor)
- Dependent variables
  - Muscle Activity
  - Motion analysis
  - Force plates



Results

- Muscle activity
  - Rib condition resulted in lower muscle loadings than lifts from floor
  - No difference between lifting PBS (1 person lift) and FRS (2 person lift)
  - No difference between side/ overhead lifting

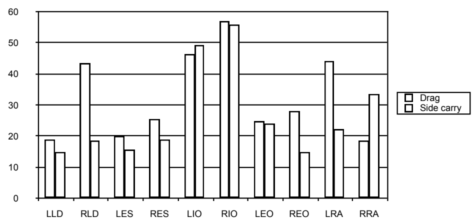


Transporting screen

- Two screens (FRS, PBS)
- Overhead carry, carry to the side, drag
- Vertical space (66” and 84”)

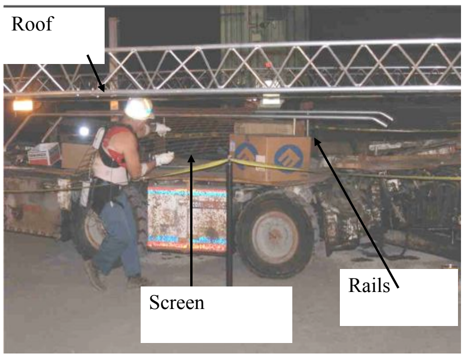
Results of Screen Transport

- Dragging increases muscle activity compared to side carry
- Other comparisons not significantly different



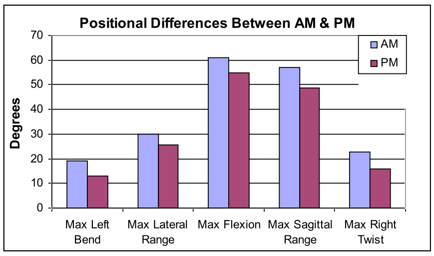
Screen Installation

- 8 subjects tested in late October in our Human Performance Research Mine
- Monitored trunk kinematics (LMM) and muscle activity (trunk and forearms)
- Performed installation task at two seam heights (60” and 84”), with and without intervention (rails to assist sliding screen across bolter)



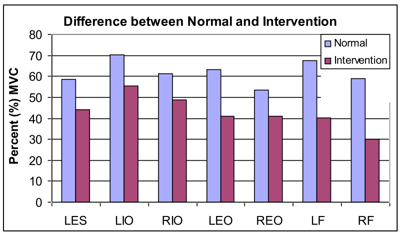
Roof Screen Installation –

- Subjects exhibited increased torso flexion and velocity of motion in morning trials
- Workers may be at increased risk early in the shift

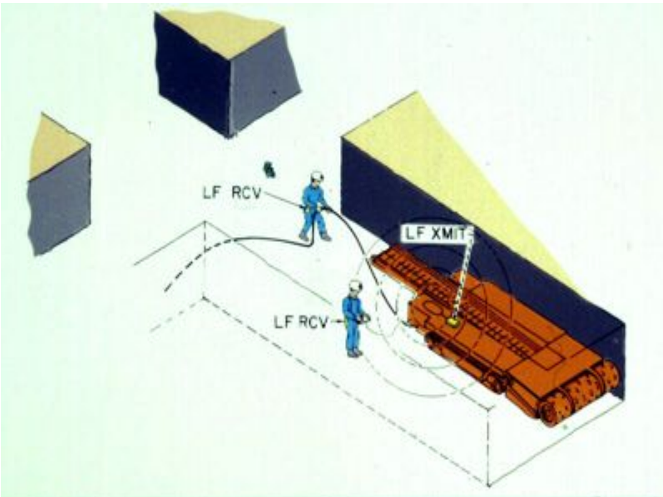


Rail Intervention Effectiveness

- Intervention did not affect trunk kinematics
- When looking at overall task, muscle activity not affected by intervention
- When isolating intervention phase, muscle activity was found to be significantly lower

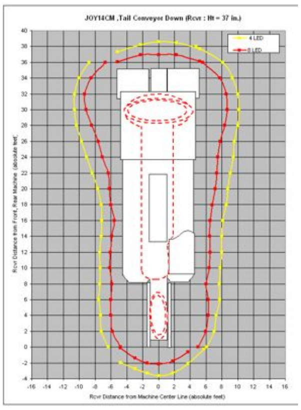


Collisions While Driving

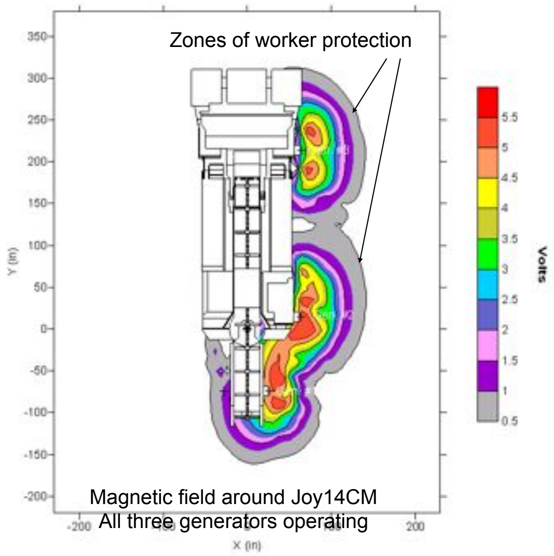


HASARD

- Hazardous Area Signaling and Ranging Device
  - Accurate to Inches
  - Penetrates
    - Rock
    - ½" Steel
    - Water
  - Survived 6 Months Production
  - IS or XP compliant



Test on Joy 14CM



Driving/Traveling – Rough Roads

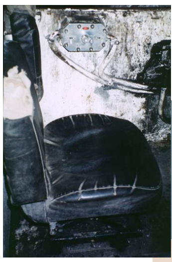
- Accounted for 20% of the UG injuries associated with Scoop/ LHD/Shuttle car/Transport in 2004
- Jarring/jolting is a major contributor
  - averaging 77% of back, neck, and head injuries for each year from 1999-2003 (MSHA Injury Data)

Research Methods

- Laboratory studies of foam padding and seat suspension systems
- Mockup of prototype seats
- Field studies before and after intervention trials.
- Research Design
  - Compare NIOSH and existing seat designs for no-load (empty vehicle) and full-load (vehicle fully loaded with coal) conditions on low- and mid-coal seam shuttle cars.

Seat Design Comparison

Low-Seam Shuttle Cars



Mid-Seam Shuttle Cars

Results to date

- For two shuttle car models 1999 through 2005:
  - >510 with newly designed seats
- Estimated 2600 shuttle cars are in operation worldwide (1500 in the USA).
  - So far, 15 percent of global shuttle car population equipped with the new seat or padding design.
- U.S. domestic market:
  - 26 percent low-coal seam shuttle cars equipped with improved seat design.
- Estimate that the new seat design positively impacts the health and safety of approximately 1140 shuttle car operators.**

**Assume: 380 shuttle cars with new seat designs – 130 shuttle cars on low-seam model (2 seats per vehicle) and
am model (1 seat per vehicle); 500 total shuttle cars in
car per shift, 3 shifts per day.

Handling Continuous Miner Cable

Control Activation – RB Boom Speeds

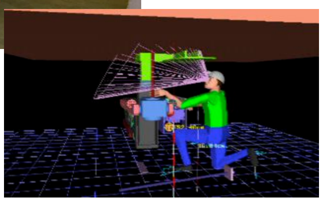
Vertical Boom Speeds

Swing Speeds

Tramming Speeds (CMM)

Observations

Laboratory Studies

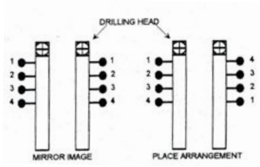


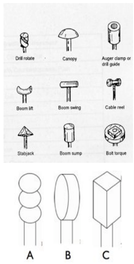
JACK Simulations

Inadvertent or Incorrect Activation of

Standardization of Controls?

- Consequences of mirror vs non-mirrored control layouts on error and reaction time
- Relative importance of location coding, shape coding and length coding
- Relative strengths of direction control-response compatibility relationships in different planes.
- Consequences for new operators of different designs and layouts
- Consequences for current operators of changing to a new design and/or layout





Proposed Controls Design Research

- Lab investigations at Perception and Motor Systems Laboratory, UQ
- Lab investigations at NIOSH Pittsburgh Research Laboratory – Human Performance Research Mine
- Field testing by NIOSH Pittsburgh in collaboration with Fletcher and/or ARO

NIOSH Future Research

- Form Alliances with OEMs to:
  - Integrate human factors principles into the design of equipment
  - Educate the OEM interface to communicate best practices
    - ordering new equipment
    - Retrofitting equipment – warranty/liability issues
    - Problem solving techniques
- Validate equipment design research in the field
  - Roof bolter boom speeds
  - CMM tramming speeds
- Specific research related to
  - Handling miner cable
  - Roof bolter controls