

Truck Ingress/Egress Safety: Field and Laboratory Research



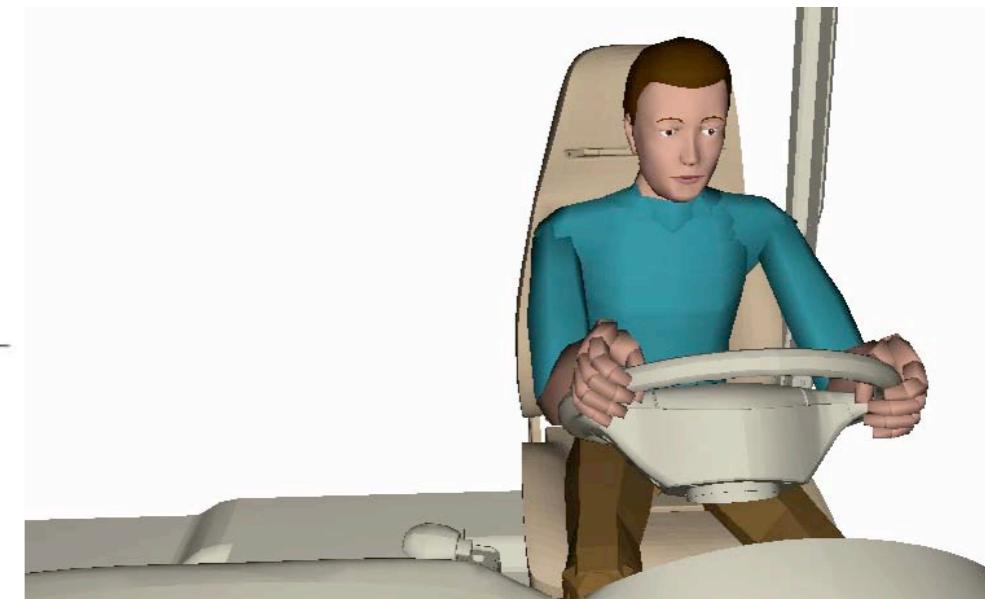
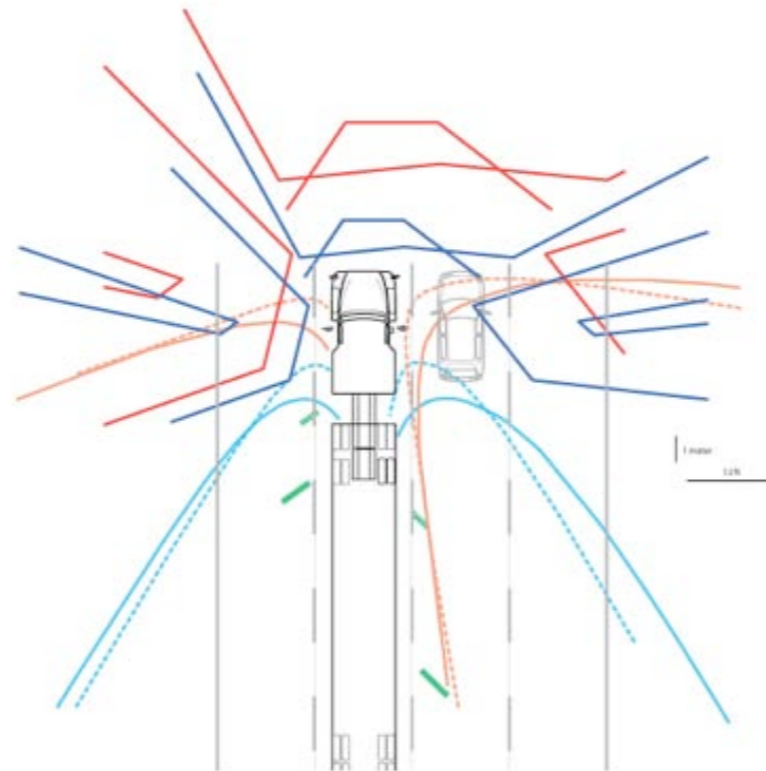
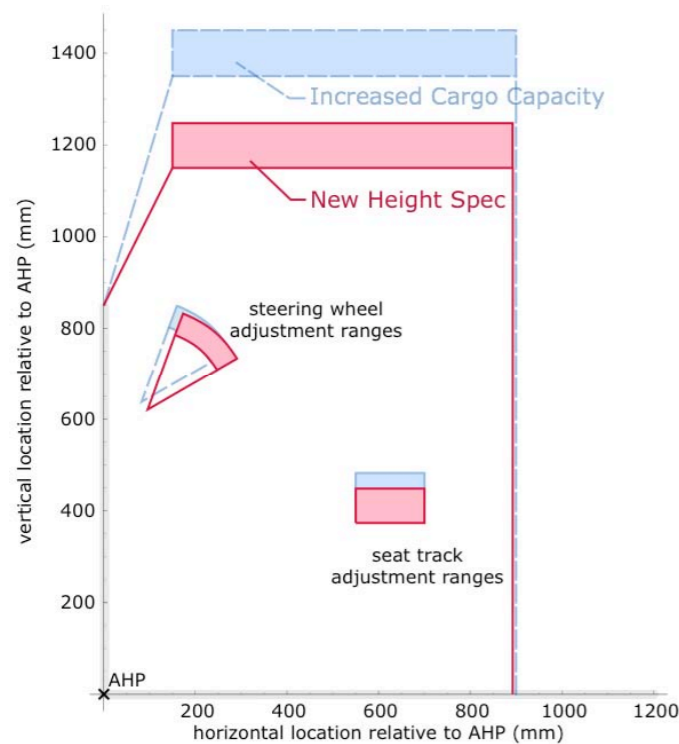
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U-M Truck Ergo Background

- Driver posture prediction
- Package optimization
- Driver vision analysis
- Driver motion simulation



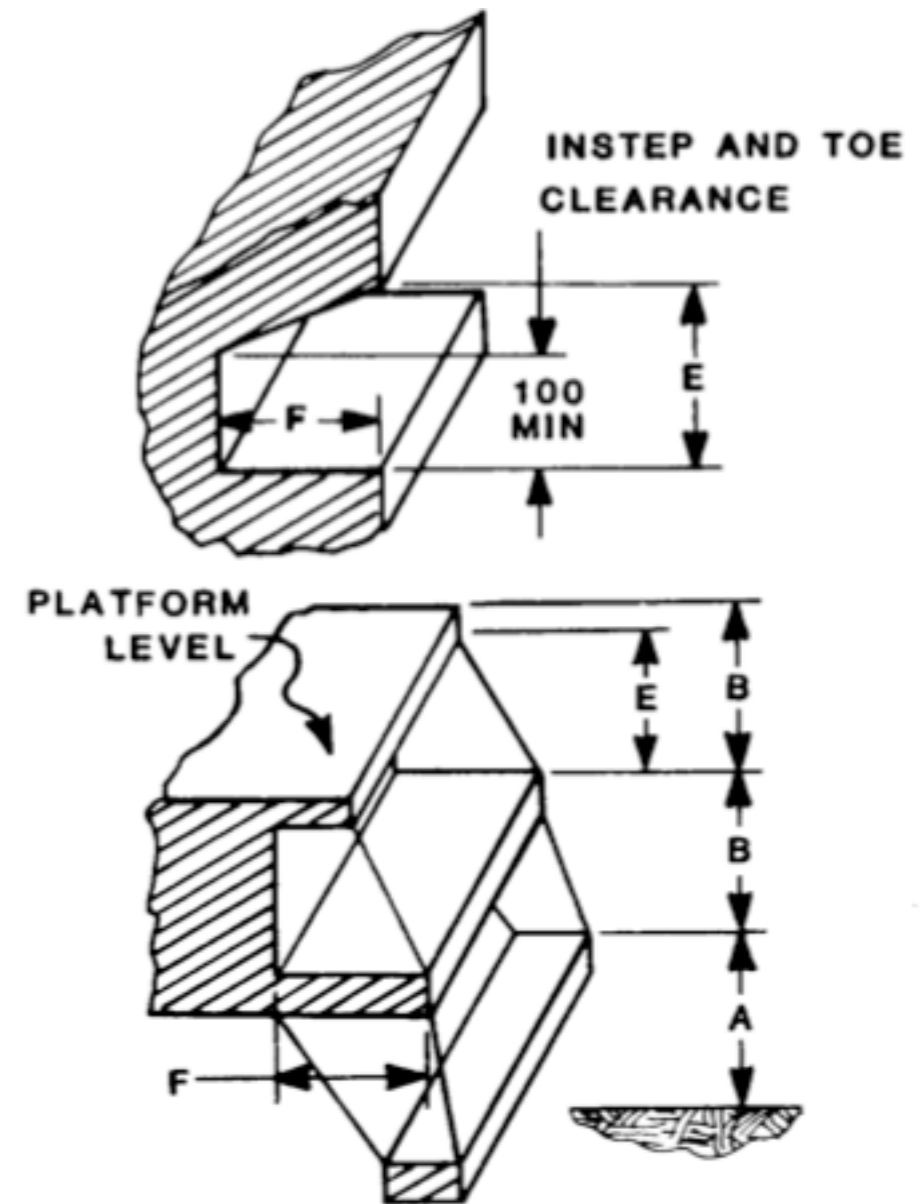
Ingress/Egress Safety

- ~15,000 lost-time slip/fall injuries to truck drivers each year in the U.S.
- One large U.S. fleet reports direct losses >US\$20M each year due to slips/falls on and around trucks
- ~50% of falls happen on the tractor, mostly on egress



Standards and Guidelines

- Society of Automotive Engineers J185: Steps and Handholds on Offroad and Construction Equipment (equiv. to ISO 2867-1980)
- US Federal Motor Carrier Safety Administration Standard Part 399 Subpart L (applicable to high cab-over-engine trucks)
- US Military Standard 1472f

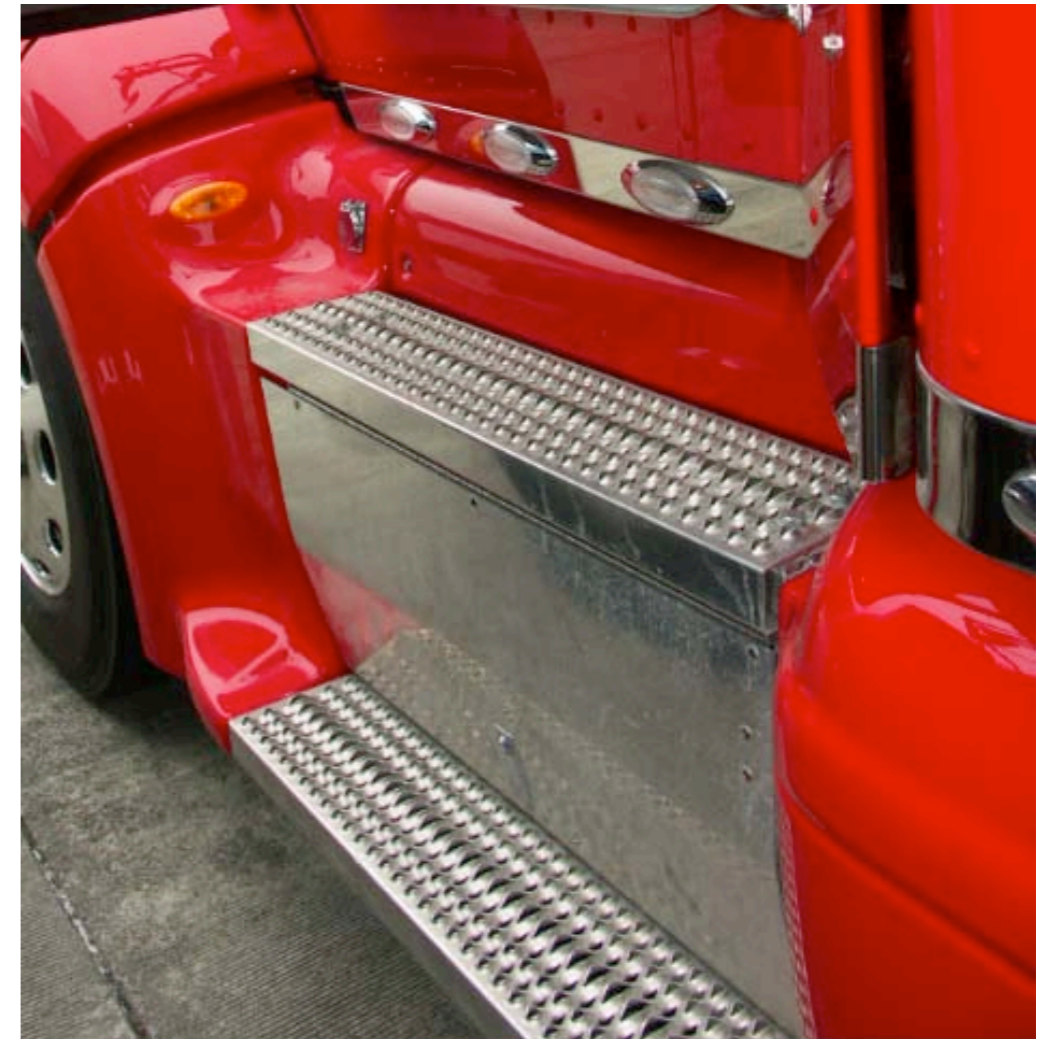


Summary of Standards

- “Slip resistant steps”
- Step depth at least 100 mm
- First step height ~400 mm
- Second step height ~300 mm
(or even step spacing)

Central Issues:

- Essentially all trucks comply with the standards, in spite of having widely varying step and handhold configurations
- Many drivers still fall and are injured



Risk Factors

- Weather conditions: ice, snow, rain
- Footwear
- Driver physique, strength, fatigue, coordination, training, risk-taking
- **Step and handhold configurations**

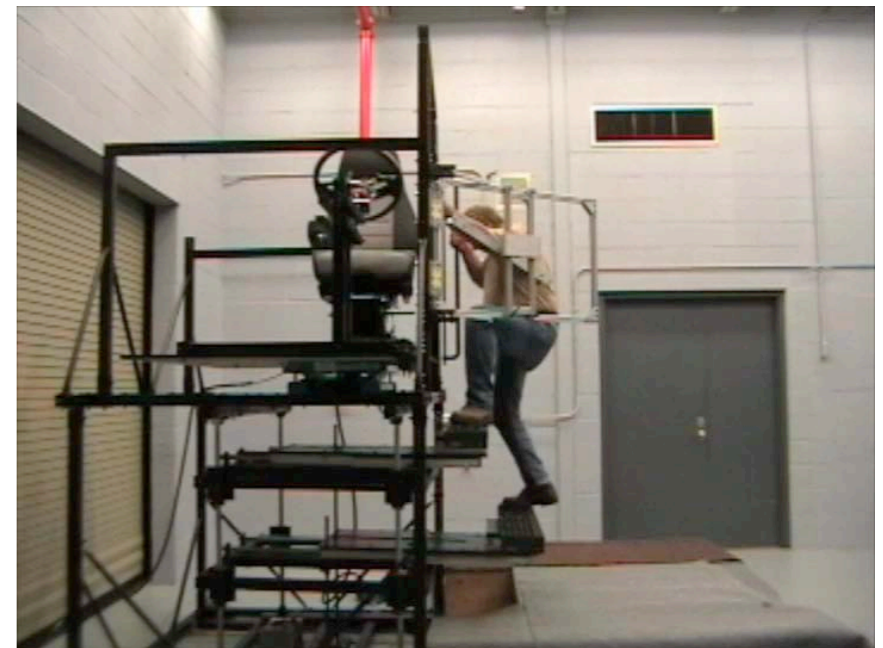


- obese
- sandals
- facing outward
- one hand

NIOSH Study at U-Michigan

Three-year grant from U.S. National Institute for Occupational Safety and Health (2007-2010)

- Field studies of truck geometry and I/E
- Laboratory study with motion capture
- Development of design guidelines and assessment procedures



Overall Goals

Design guidelines for I/E systems:
What characteristics make a system more safe?

Assessment techniques:
Differentiate between systems using simulations with digital human models.



Components: Steps



Tank



Box



Integrated



Smooth



Grate



Perforated

Components: Handholds



Exterior



Interior



Exhaust

Components: Handholds



Map Pocket



Diagonal



Internal

Video Study

33 drivers videotaped getting in and out 3 times



Interviews

107 drivers interviewed about their experiences with I/E

- median age 46 years, median experience 12 years
- 4 women
- 13% owner/operator

Results:

Previously slipped or fallen: 8% ingress, 21% egress

Of those who slipped or fell: 47% injured

Features associated with slip/fall:

Steps: 57%

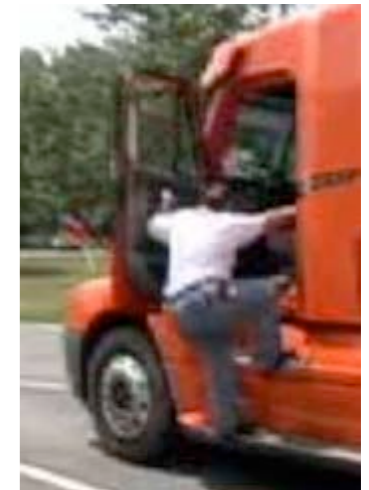
Handholds: 7%

Ground: 20%

Fall or injury from trailer (including hooking up): 7%

Covert Observation

Egress	Video (N=33 x 3)	Covert (N=250)
Facing Truck	68%	47%
Facing Out	18%	46%*
Switch	14%	7%



* Driver jumped from first or second step in 4.4% of egresses

* No supporting hands in 10% of egresses

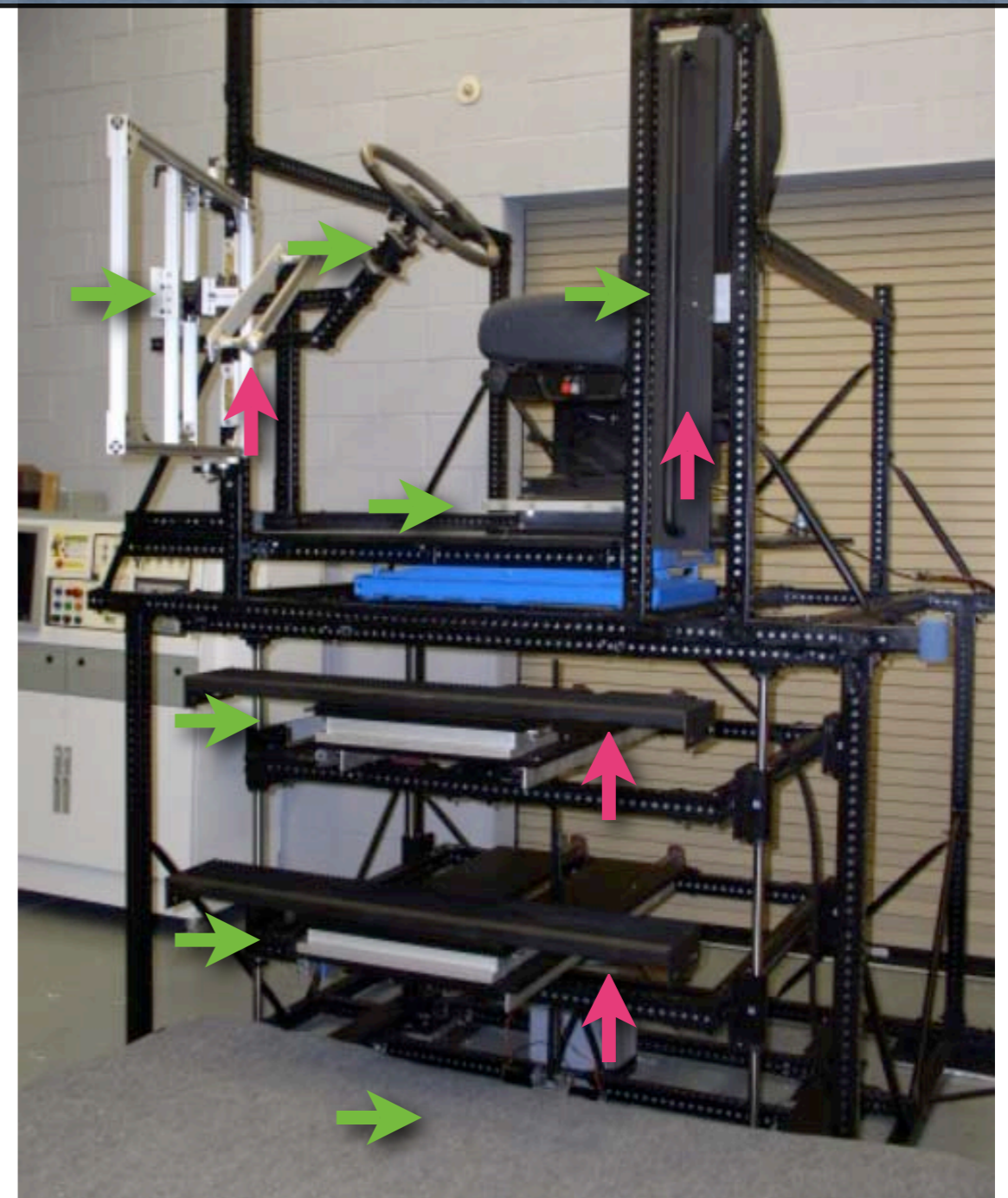
† Object in one or both hands 14% of the time (10% left hand)

Data collection at truck stops on I-94, the major Chicago-Detroit and Chicago-Canada route

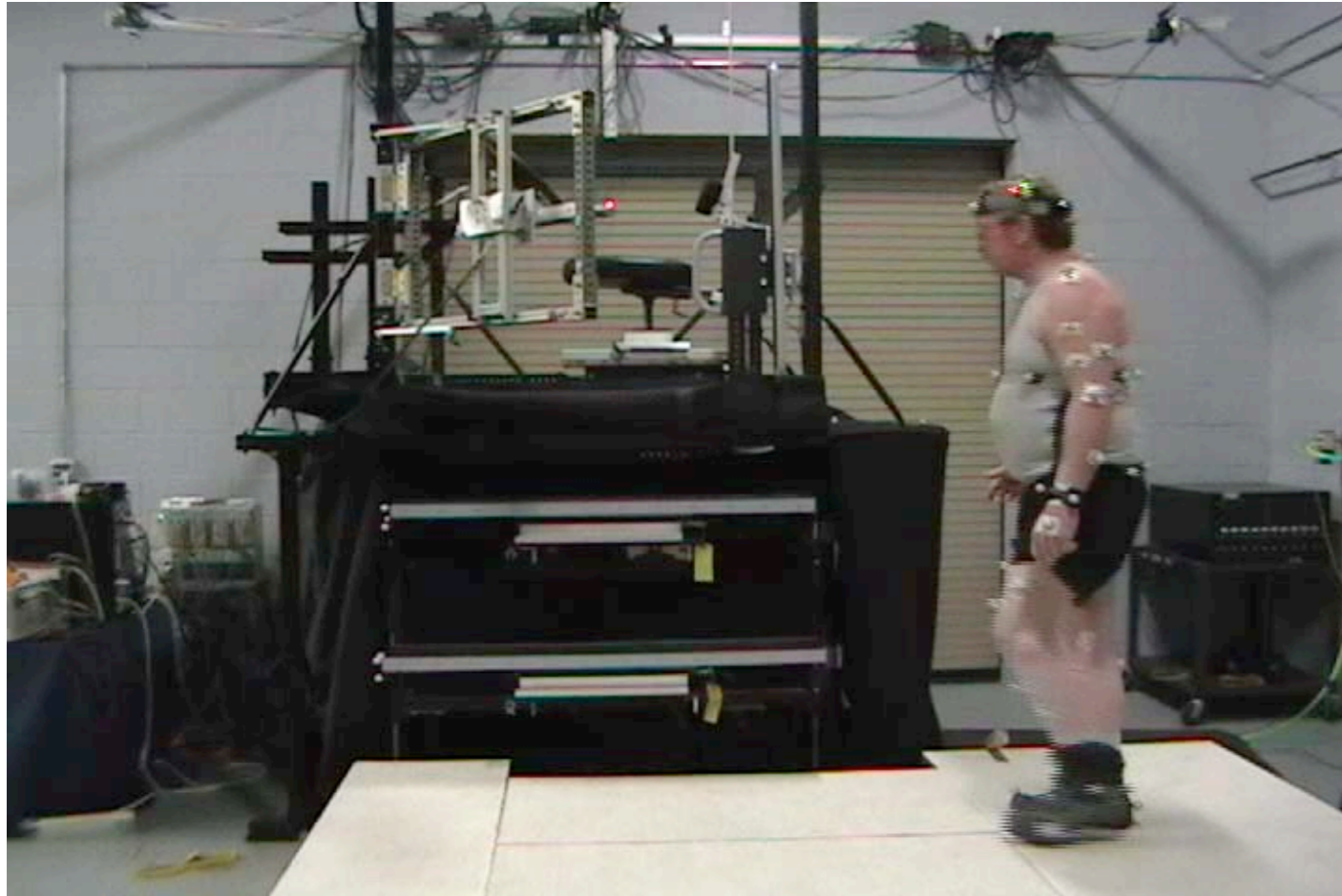
Laboratory Study

- gather subjective responses to a wide range of truck step configurations
- record whole-body motions and reaction forces

- Force plates and load cells
- Adjustable steps and handholds

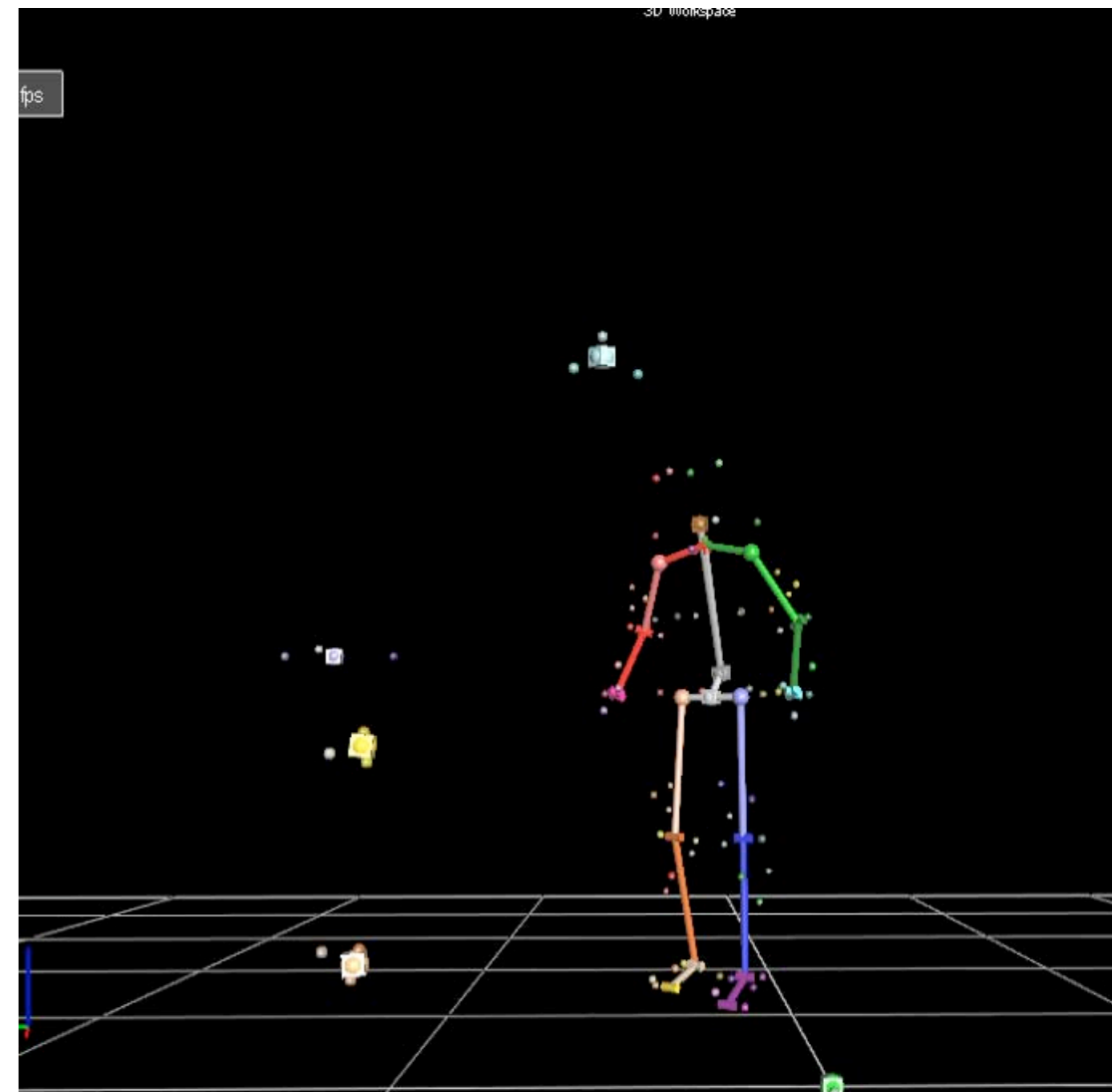


Driver Motion Capture



Experienced driver in the lab with motion capture targets

Quantitative tracking data



Some Observations

Approximately half of drivers exit facing outward.

Inward-facing egress tactics are complex.

The wide variation in the design and configurations of steps and handholds suggests a lack of optimality in most designs.

Published design guidelines and assessment procedures for I/E systems are minimal and do not address many design variables.

Valid assessment procedures are not currently available.

Keeping Drivers Safe

Training: Teach drivers to maintain contact with two hands (don't carry objects); no jumping; check before you get out.

Footwear: One company reported a significant reduction in incidents after providing good footwear

Maintenance: Keep steps and handholds in good condition

Future Work

Test procedures for steps and handholds based on usage (forces, ambient conditions, footwear, gloves)

Step/handhold system optimization under constraints: different service types, truck configurations

Apply research methods to other driver activities (loading, hookup, tarping, etc.)

For More Info

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