EPRI’s Fleet Vehicle Study and
The Business Case for Ergonomics

EEI Occupational Health and Safety
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Acknowledgements

• EPRI Occupational Health and Safety Committee funded the entire project and have the results provided to them.
  – Utility members of OHS Committee
  – Utility members who sponsored site visits
  – Dr. Gabor Mezei
  – We Energies for substantial in-kind contributions on this and all previous studies

• Marquette University
  – Dr. Richard Marklin
  – Amy Stone
  – Grad students Steve Freier, Kyle Saginus, Bianca Bain
Organization of Presentation

• EPRI Fleet Vehicle Project
  – Process
  – Maintenance
  – Design
  – SPECIFICATIONS
  – Methodology
  – Results and Recommendations

• The Business case for Ergonomics
EPRI Fleet Study
Site visits are most important

• Interviewed workers, supervisors, health and safety personnel, fleet and maintenance managers
• Ask them for issues
• Capture best practices
• Learn what worked and what didn’t
We measured 52 trucks
Sample Vehicle Dimension Templates for Access database
Collected documents

- Requests for Bids
- Specifications
- Fleet process flow charts
- Maintenance repair requests
- Maintenance scheduling methods
Attended trade shows:
EUFMC, ICUEE
We took thousands of photos and videos

- Pole rack
- Dozer access
A problem we didn’t expect

- We looked at conventional anthropometric DTBs such as the US military, the new CESAR 3D database, peoplesize
- Appeared to be unrepresentative of utility workers
- We needed to measure utility field workers
We measured 200 utility field and plant workers 14 VARIABLES – WEIGHT AND 13 DIMENSIONS
Anthropometry Results

• Utility Workers Averages
  – Height – >1 in. taller than gen. population
  – Weight – 22 to 29 lbs heavier than gen. pop.

• For Males Only, Utility Workers
  – Avg height is 65\textsuperscript{th} to 77\textsuperscript{th} perc. of gen. pop.
  – Avg weight is 70\textsuperscript{th} to 94\textsuperscript{th} perc. of gen. pop.

• Females 1-1.5 in. taller and 6-25 lb heavier—only 13 females available
So what?

• The data assumptions from anthropometric databases matter
• An illustration: boot size and pedal clearance
DATA COLLECTION: Boot dimensions

• Boot dimensions:
  – width
  – length
  – height
  – toe height

• Percentile sizes
  – 1st, 5th, 50th, 95th, 99th

• Boots
  – work boots
  – snow boots
  – rain slickers
These boots are made for walkin…

- Vehicle manufacturers design to the 50th male percentile
- Army data\textsuperscript{1}—average male shoe size
  - 1776 size 6.5
  - 1980 size 9
  - Shoe retailers 2009 “bread and butter size” is a 12 D

\textsuperscript{1}National Shoe Retailers Association, 2009
EPRI Team clearance evaluation:

- In addition to boot space
  - Small pedal clearance—1”
  - Large pedal clearance—2”
## RESULTS

- **Work Boots - Difference Between Vehicle Dimension A and Recommended Dimension A** (snow & rain boots nearly identical)

<table>
<thead>
<tr>
<th></th>
<th>99th (Existing - Rec)</th>
<th>95th (Existing - Rec)</th>
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<tbody>
<tr>
<td></td>
<td>+1&quot;</td>
<td>+2&quot;</td>
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<tr>
<td><strong>Chevy Express</strong></td>
<td>+2.0&quot;</td>
<td>+1.0&quot;</td>
</tr>
<tr>
<td><strong>Chevy Colorado</strong></td>
<td>+1.2&quot;</td>
<td>+0.2&quot;</td>
</tr>
<tr>
<td><strong>International 4000</strong></td>
<td>+0.6&quot;</td>
<td>-0.4&quot;</td>
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<tr>
<td><strong>Freightliner</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Digger Derrick)</td>
<td>-0.3&quot;</td>
<td>-1.3&quot;</td>
</tr>
<tr>
<td><strong>Ford F450</strong></td>
<td>-0.7&quot;</td>
<td>-1.7&quot;</td>
</tr>
</tbody>
</table>
DISCUSSION

• Big problem for big feet
• Risk of an accident
• Toe can become wedged under brake pedal
• Efforts to remove toe result in accelerator depression

• Many workers reported that in some vehicles they drove without boots for this reason!!!
Mobile computers lab study
Minor posture differences—huge muscular effects, even for short durations

- “Mobile office” on passenger seat
- Typical mounted laptop on pole/platform
Recommended laptop system

- **Software** to prevent use when vehicle is in gear
- **3 pivot articulated arm** that brings laptop to optimal position
  - 15-20 inches to right of SWRP
  - 4-8 inches aft
  - Line workers required more adjustability due to height than general population
- **Touch to move/stop** —not levers and knobs
- **Height and passenger air bag** recommendations
- **Right arm rest** required for all
For workers with disabilities and Lower back pain

- Separate keyboard that plugs into laptop
- Removable platform on steering wheel
- Commercial (top)
- Homemade (bottom)
- Homemade angle is better—easier to remove and replace
Bucket design study
Bucket Design concerns

- Falls
- MSD risks due to high muscular force requirements
- Getting out of bucket feet 1st (top)
- Pirouetting on one toe (bottom) and holding onto circular surface
## Preliminary results: 3 of 8 conditions

<table>
<thead>
<tr>
<th></th>
<th>No step Ingress</th>
<th>No step Egress</th>
<th>B &amp; C Ingress</th>
<th>Inside step Out</th>
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</thead>
<tbody>
<tr>
<td><strong>Load cells</strong></td>
<td>54-66% bod wt</td>
<td>52-88% bod wt</td>
<td>21-34% bod wt</td>
<td>9-22% bod wt</td>
</tr>
<tr>
<td><strong>Left/rt triceps</strong></td>
<td>Insig diff</td>
<td>60%MVC</td>
<td>Insig diff</td>
<td>20% MVC</td>
</tr>
<tr>
<td><strong>Quads</strong></td>
<td>50% MVC</td>
<td>Hovering</td>
<td>15% MVC</td>
<td>Hovering (int 3) 6-8%MVC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%MVC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dramatic Results/Design recommendations

- Interior step
- Exterior single step (not two)
- Truck mounted:
  - Platform/handle
  - Step and handle system
1st major deliverable: 2011

- EPRI Ergonomics Handbook for the Electric Power Industry
- **Process**
  - Requests for Bids
  - Requests to modify existing vehicles
  - How to upfit and select new vehicles
  - Accommodating individuals
- **Maintenance**
- Free to EPRI members: # 1021836
Examples from 2011- Maintenance Assistive devices
Aerial bucket maintenance: the most time/\$, the most awkward postures
Ergonomic Design and Specification of Turnkey and Upfitted Fleet Vehicles: 2012 Summer deliverable

• Mostly photos
• Issues (safety, ergonomics, productivity)
• Best practices (lessons learned)
• Recommendations (the best solutions)
• Case studies (process stories—pros/cons/tradeoffs)
• **Specifications for upfits, new vehicles**
• Checklists for evaluating existing/potential vehicle models/features
• Database of all measured vehicle dimensions
CAB: 55 pages

- Very detailed drawings and dimensions
  This shows required recline distance for seat driving position
  Based on recline angle of 20 degrees
  Many cab seats cannot recline when the seat is all the way back (for most drivers)
Aerial vehicles: 64 pages

- Rear work area
- Extensions pull out
- Can be used as sawhorses
Rear access/storage 95 pages: Water coolers weigh 85 lb.

Too far to reach  Too low to lower it  Too high

They weigh 85 pounds full
Good water cooler locations
Safety and security: 39 pages

- Outrigger controls location, design, labeling
- Safety cones location
Ingress/egress: 45 pages

Would you want to step off a Swing step that is likely damaged, that you can’t see, that moves away from you?
Instead: a Robust, easily stowed pullout ladder
Visual and lighting:
49 pages

- Double ballast dome lighting (top)
- (Bottom) nice idea but 2 problems—vertical tail light becomes less visible, and workers don’t obey “no step” sign because they lack rear access
The Business case for Ergonomics
Refereed articles on the business case for utility ergonomics: others in Trade journals


The best business case example

• At GM, a 2 week analysis at the GM Janesville SUV plant of material data handling of totes on tuggers and trailers instead of forklift
  • Saved GM $13 million/year for 5 years
  • At only one plant
  • Then adopted at all—has saved billions
  • Now common throughout industry
EPRI business cases

- $2 million battery operated tools for overhead and underground line crews at We Energies
- Knee protection for power plant workers
- “Ergonomic” cart wheels
- Power plant—valves and platforms:
  - Each is unique
- Handout available—contact me for more info
Let’s be frank

- What percentage of your injuries are strains and sprains (and other MSD’s)—for field workers, probably 1/3 to ½
- How much do they cost compared to acute injuries? (double or more)
- Do you know the hidden (sunk) costs of MSDs (productivity losses, higher medical premiums because people can’t report a long term MSD and go to their doctor instead of filing WC? (millions)
Dumb questions

• So how much of your H & S efforts are devoted to addressing MSDs? \( \frac{1}{2} \)???

• How many of the EPRI interventions has your utility adopted??? (Out of 64??)

• If OSHA had an ergonomics standard what would your utility do?
What stands in the way?
Partly: Beliefs that MSDs are caused by

• Stupid and deliberate acts (fix the workers)
• The aging workforce (fix the workers)
• Lack of stretching (fix the workers)
• Weekend warriors (fix the workers)
• Overreporting (fix the data)
• Give us an easy fix (for a long term injury)
Smart answers

- We can prove what causes the injuries—but science isn’t always the top agenda
- It doesn’t matter! We pay for them in reduced productivity, more days off and higher medical premiums
- We need to reduce the force required to do all tasks whose force increases task time in order to run the business decrease CAIDI
- THE EU, Canada, Australia have figured this out. Their businesses are not running away from ergonomics. They are running toward it because done right, it saves a lot of money
Think of **MSDs**—ergonomics issues—as illnesses not injuries

- **MSDs** don’t develop overnight
- The diagnosis and treatment are not simple fixes either
Myth 1  Ergonomics costs too much $?  
Number vs. cost of 32 EPRI overhead line mechanic task interventions

Initial Costs for Line worker ergonomic interventions

- $0-$100
- $100-$1000
- > $1000

Number of interventions

49
Myth 1 It costs too much money

- YOU HAVE TO MAKE A BUSINESS CASE
- The best and easiest are based on time saved, not injury data
- NO BRAINERS
- Save time
- Save effort
- Eliminate/ reduce actual cause of injury
MYTH 1 No BRAINER: Blanket slings

- Cheap
- Robust
- Save a lot of hand shoveling to replace spoil
- Even used to transport sand bags, etc.
- WIN WIN
Myth 1 NO BRAINER
Vacuum/Water Extraction vs. Manual Digging of Holes

- Rental cost $212/hour
- Purchase cost $500,000
- What is your actual labor rate
  - (this was at $31/hour)
- Additional health benefits: reduced back strains/sprains
- Great for digging through frost
- Back injuries account for 1/2 of LW injuries
Myth 1 NO BRAINER: automatic dead end shoe

- Installation time savings 3.75 min
- Times 20,000/ yr. (purchasing)
- Minutes /60 = 1250 man-hours
- Times $38 hourly rate plus benefits = $47,500 savings
- Doing it easier often saves time
- Often more reliable
- WIN WIN
MYTH 1 NO BRAINER: Lawn mats

- A bit more expensive than plywood
- Last much longer—therefore a lot cheaper
- Lighter weight, easier to handle
- WIN WIN

Fiberglass mats are lightweight, have specially designed handles and can be reused.
Myth 1 NOT doing ergonomics costs too much $

Sample medical/WC 1999-01 costs

- rotator cuff (shoulder) surgery $16,898.66
- shoulder replacement $70,821.69
- bilateral carpal tunnel surgery $10,851.49
- chronic epicondylitis $3,183.36
- back injury $20,855.60
- back surgery $26,613.60
- shoulder tendinitis $4,485.24

- Total annual cost for only these 7 cases $65,000.00
- $175 per line worker annual cost (n=301) for only these 7 cases
**Myth 1** Payback calculation for press and cutter with higher productivity benefits (also cuts ACSR) for all crews

<table>
<thead>
<tr>
<th>Benefit/worker</th>
<th>Cost/worker</th>
<th>Annual</th>
<th>Total 8 yr.</th>
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<tbody>
<tr>
<td>BOP x</td>
<td>$ 95</td>
<td>$ 35,000</td>
<td>$280,000</td>
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<tr>
<td>BOC x</td>
<td>$167</td>
<td>$ 79,000</td>
<td>$632,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$530</strong></td>
<td><strong>$332</strong></td>
<td><strong>$912,000</strong></td>
</tr>
</tbody>
</table>

Capitalized investment payback in 8 months
Myth 2: Nature of the beast work

• Select the heaviest, most difficult tasks
  – Overhead line work: Cutting, crimping
  – Direct buried cable: digging, shoveling, cutting crimping in trenches
  – Power plants: valves, lack of platforms

• For ALL of these—there are excellent retrofit as well as design solutions to make the job more efficient: easier, faster, better
It doesn’t have to be that way!

• Battery operated crimpers and cutters make the work much easier, more productive
• Less physically stressful
• How much?
• Before:<1% capable
• After: nearly 100%
Ergonomics laboratory results

- 45%

-88%
More interesting lab results

Exceeds 100% MVC

- 39%
- 68%
Myth 3: OHS vs. productivity data

• Yes we can look at MSD data
• But this is a LAGGINg indicator
• NOT in OSHA data—couldn’t even agree on a simple MSD column!
• Looking in crystal ball and predicting how we can change the future by preventing an injury that now doesn’t happen: how do you prove it?
• We don’t have the time machine yet
MYTH 3
The data problem

• OSHA data—no MSD column
• WE can only guess what happened over months/years from the “what were you doing when the injury occurred” column
• LAGGING INDICATORS!!

- Previously Unreported Injuries: 73%
- Reported Injuries: 27%
Where are the big economies from battery tools for overhead line workers?

- Apprentices: 48%
- Med/WC Costs: 24%
- Replacements for RD, LWD: 28%
**Myth 4 Stretching**

- Stretching programs are generally popular
- Are they:
  - Mandatory for all field workers?
  - At the end of the day as well as throughout?
  - Developed by kinesiologists/PTs for the SPECIFIC work tasks?
- Do top managers and supervisors participate routinely, randomly at work locations?
- If so—fine, but.....
Myth 4 Stretching

• The facts:
• Stretching per se is good—but when not absolutely properly done, not designed for the work tasks, and MANDATORY—will not help the people who most need it

• **NO study of stretching done with randomly selected control vs. experimental group has shown any benefit**

• Best stretch is at the end of the day, throughout day
• Administrative control—no substitute for engineering controls to **CHANGE THE WORK ITSELF**
Myth 5: Overexertion

- Who intentionally goes to work, planning to get hurt?
- What is overexertion: “so much exertion that discomfort or injury results”
- Essentially: trying too hard
- Why? because that is how to get the task done—that is the effort required by the task design: the task is too hard, not the effort was too much
- We have a lot of tasks suited to someone with 3 or more hands, to the strength of a giant....
- HOME PLUMBING???
Sample results
1 year before /after BOP/BOC:

Double the projected savings: BUT

1st aid reports TRIPLED

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
<th>% Change</th>
<th>$ Change</th>
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<tbody>
<tr>
<td>LW days</td>
<td>111 days</td>
<td>0</td>
<td>-100%</td>
<td>-$44,400</td>
</tr>
<tr>
<td>RD days</td>
<td>110 days</td>
<td>0</td>
<td>-100%</td>
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<td>Workers comp</td>
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<td>-100%</td>
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<td>PPD</td>
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<td>557 days</td>
<td>0</td>
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<td>$274,750</td>
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<tr>
<td>Minus tool costs</td>
<td></td>
<td></td>
<td></td>
<td>-$110,000</td>
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Net calculated **$164,750 benefit**
More lessons learned—MIMP

- Multiple Injury Management Process (Excel—We Energies) track, meet with “frequent flyers—walking wounded”
- Provide resources and support (mainly to supervisors) in helping this worker prevent any more injuries
- Excel made it mandatory
- We Energies made it voluntary
One year results: MIMP

<table>
<thead>
<tr>
<th></th>
<th>MIMP Before Totals</th>
<th>MIMP After Totals</th>
<th>Non MIMP Before Totals</th>
<th>Non Mimp After Totals</th>
<th>Change MIMP</th>
<th>Change Non MIMP</th>
<th>Difference</th>
<th>Winner</th>
</tr>
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<tbody>
<tr>
<td>Total in group</td>
<td></td>
<td>20</td>
<td>20</td>
<td>38</td>
<td>38</td>
<td>XXX</td>
<td>XXX</td>
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<tr>
<td>LW Cases</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>-50%</td>
<td>25%</td>
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</tr>
<tr>
<td>LW Days</td>
<td>100</td>
<td>15</td>
<td>14</td>
<td>128</td>
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<td>+1002%</td>
<td>1089%</td>
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<tr>
<td>RD Cases</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>-67%</td>
<td>+600%</td>
<td>667%</td>
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</tr>
<tr>
<td>RD Days</td>
<td>216</td>
<td>12</td>
<td>181</td>
<td>149</td>
<td>-92%</td>
<td>-55%</td>
<td>37%</td>
<td>MIMP</td>
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</table>
How to do an Ergonomics Business Case
Lessons learned

- Sell it to top management
- They need operations CHAMPIONS to get it done
- It takes time to listen to the workers
- But hear about a “knuckleheads” story next:......
Knuckleheads lessons

• Huskie tools was great about initial cutter replacement
• One service center was responsible for almost all the breakage
• There were a few workers determined to prove these tools were bad and abused them because they were mad that they hadn’t been part of the original ergonomics team
• It took DATA—breakage patterns, repeat replacements—OHS had to present this several times until the area manager was EMBARRASSED in front of the other AMs and, most importantly, the VP
• He had to talk to the knuckleheads PERSONALLY (WE know what you are doing—this will stop!!)
• He brought in the line workers ergonomics team to retrain everyone—cut this—Do it this way—DO NOT CUT THIS!!
• No more breakage
LESSONS Learned: Knuckleheads

- FUTURE ERGONOMICS TEAM—HAVE ALL GEOGRAPHIC AREAS REPRESENTED
- BUYIN!!!
What must you have?

• Target dates
• Champions
• Progress/issues
• ACCOUNTABILITY
Lessons learned

• Get the ear of top management—the Board of Directors, CEO, top VPs
• Quick no brainers — WIN WINS and CAIDI
• Propose each work group identify 3 top ergonomic task goals/year and assign an owner
• OHS data won’t cut it
• Scientific proof won’t cut it
Lessons Learned

• Get your hands dirty in Follow through
• Keep ears to the ground —find out what the “glitches are” and contact the champions—keep reporting at all high level safety meetings
Measure task time

- Get to know an industrial engineer
- We love to do time motion studies—but it doesn’t have to be that complicated (utility work is not an assembly line)
- Do repeated measures of how long a current task takes
- Compare it with the proposed intervention
Lessons learned

• Tool committees can be your best friend
• They need to review the latest and greatest—get samples out there to workers trained in ergonomics
• Do pilots before going “whole hog”
Better yet: get someone else to do it

• Border States distributor formed an engineering/supply chain/health and safety/worker team
• Provided lunch and “did the legwork”
• Showed some new products we’d like you to test—gave samples (shown above—the gel-wrap splice instead of heat shrink)
• Review for engineering acceptability, field trials, then document time savings
• Result: >$1 million savings up front, and manufacturers then came to We Energies for ideas and pilots 1st
Other business cases (handout)

Knee protection (sure we make it available…)
Rolling cart wheels (so what?)
Power plant platforms and valve retrofits
Training for design engineers (substations, power plants)
Take home messages: EPRI field study

- EPRI has done the work so you don’t have to
- Lessons learned, case studies, best practices—learn from your PEERs
- Most importantly—**PROCESSES** for how to do it, and **SPECIFICATIONS**
- Feasible solutions, save time and money
- EPRI is starting a project on implementation of specifications with manufacturers
Take home messages: the business case

- The business case for ergonomics is MOST helpful for productivity
- effort = time = money
- Prioritize by work group the tasks/equipment/materials that require the most effort, produce the most discomfort
- H& S personnel need to be ergonomics champions—spend time in the field with the workers—find the rabble rousers who will advocate for and support change
- BUT 1\textsuperscript{st}—get top management on board!!!!!
Contact information/Thank you!

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