The Difficult Nature of Ergonomics Assessment of Construction and Utility Work

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Goals of the studies

- Prioritize, task analysis of typical, high risk tasks
- Quantify the human capability for the tasks
- Trial solutions for widespread acceptance
- Provide a business case and implementation assistance
- Produce deliverables for the funding utilities
Overview

- Nature of the work
- Difficulty of capturing the work
- Process and results of the studies
Applicability

- Not simply utility work
- Construction, maintenance, telecommunications, landscaping all perform many similar functions
The current studies-EPRI

- EPRI (Electric Power Research Institute) – completed overhead line workers and two underground studies (2002-2005)
- Currently studying power plant electricians, plant operators/ mechanics (due 2008)
- Also funding an ergonomics design handbook for power plants (2007)
- About 30 utilities funding the Occupational Health and Safety Committee studies
The current studies-GTI

- GTI (Gas Technology Institute)
- 9 funding utilities
- Expect to complete in 2006
- Six task groups selected from the utility priorities:
  - Wrenching
  - Barholing
  - Shoveling/ Digging
  - Lifting
  - Vehicle design
  - Slips, trips, falls
<table>
<thead>
<tr>
<th>Project methodology</th>
<th>GTI</th>
<th>EPRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ergonomic Teams</td>
<td>No</td>
<td>Yes-host utility</td>
</tr>
<tr>
<td>Task generation</td>
<td>9 Funding utilities</td>
<td>Team (from host and site visit observations)</td>
</tr>
<tr>
<td>Lab studies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Intervention trials</td>
<td>In lab, select utilities</td>
<td>Host and site utilities</td>
</tr>
<tr>
<td>Manufacturing new devices</td>
<td>Vendors, Universities</td>
<td>Machinist/engineer with team, Vendors</td>
</tr>
<tr>
<td>Site visits</td>
<td>2 utilities—short term</td>
<td>Several around US—week long</td>
</tr>
</tbody>
</table>
GTI Lab studies setup-wrenching

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GTI Lab setup: shoveling and handle length
EPRI Overhead Line workers Lab Setup

Industrial Ergonomics Lab at Marquette University

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Manhole/ vault laboratory setup
Laboratory studies--manhole/vault

Utility Worker Cutting a Cable With a Battery-Powered Cutter (left); Manual Cutter (right)
Laboratory vs. the field:
direct buried cable—elbow pulling
Laboratory testing—2 workers: 35 kV elbow terminator pulling requires a commercially available lever-action pulling tool
Utility Worker Injuries and Illnesses

- Workers are exposed to the following MSDs (as well as others):
  - Back -- low back pain
  - Shoulder – tendinitis, bursitis, rotator cuff, shoulder replacements
  - Elbow -- tennis elbow (lateral epicondylitis)
  - Wrist -- carpal tunnel syndrome, tendinitis
We Energies DO injuries 1999-2001

- sprains, strains: 40%
- inflammation or irritation of joints, tendons or muscles: 4%
- carpal tunnel syndrome: 3%
- acute injuries: 53%
It’s just the aging workforce

- We can’t fire them
- We can’t line them up and shoot them
- What we really mean is “old” since people are always aging: if only we had a group of 25-30 year olds, we would never have a problem getting the work done
The “walking wounded”

- Some leave the job well before retirement—among overhead line workers, 90%
- Others work less productively and their off-working hours are affected with pain and disability
- I/I review of these work groups show many start down this road after as few as 5 years of work—not exactly “old” or “mature” but always aging
Common elements of this work

- Difficult environmental conditions
- Constantly working in different, unpredictable locations
- Three types of work:
  - New installation/construction
  - Preventive maintenance/planned outages
  - Emergency repairs
- Awkward postures
- High forces for manual labor tasks which heavy equipment cannot accomplish
- Highly variable tasks at unusual intervals
Risk factors need to be identified and quantified

- Force--jarring, vibration, contact stress, push/pull, lift…
- Posture—arms elevated, bending forward, twisting
- Others: repetition, duration—not amenable to change
Cultural barriers to change

- “We’ve always done it that way”
- If we didn’t invent it here, we won’t do it
- We’ll make the work easy enough for women to do
- Cutting corners to save time and get customers back in service
- Too many stakeholders in decisions and implementation
- Inaccurate reporting and procrastination
Difficulty of ergonomic analysis of this work

- The most difficult thing—seeing and documenting the work itself
- The workers have many and varied tasks
- The most work is done when things are NOT working!!!!
- Hard to be proactive
Some Solutions

- Use of worker teams to identify, videotape
- Different review of injury/illness data to look for patterns of MSDs among prioritized work groups
- Ergonomic “accident investigation” forms required
- Laboratory analysis
Common task—digging and shoveling

- While a lot can be dug with the backhoe, there are strict rules requiring hand digging within 18 inches either side of a suspected utility line.
- The remainder—36 inches or more—has to be dug by hand.
It isn’t just dirt you have to dig through
Some strategies to improve hand digging/shoveling

- Use the right shovel for the task
- Improve utility locating
- Use battery operated tools in the trenches instead of manual cutters/crimpers which require a wider trench
- Use of blanket slings
- Vacuum and vacuum/water excavators
After the hand digging

The ground fault has been repaired.

Property owners demand a perfect restoration.

Cleaning up takes nearly as long as the job itself!!
Blanket slings are no brainers

- Cheap
- Robust
- Save a lot of hand shoveling to replace spoil
- Even used to transport sand bags, etc.
Water-vacuum excavation machine

- Will dig a 4 foot hole in 15 minutes
- Two workers can take 4-8 hours to dig the same hole, depending on frost
- ON the gas side, it is just a vacuum machine
- Their use presents its own ergonomic issues
Location is everything

- When you have to dig, you want to dig in the right place
- Drawings show where the various utility lines—telephone, cable, gas, electric—are SUPPOSED to be, or were 20 years ago when they were installed
Location is everything

Locating utilities by vibration or manual methods is not always very accurate. They can be off as much as a couple feet.
3d Radar—state of the art

- 3D radar walk behind units
- Used by construction contractors for extremely accurate locating
- Most utilities still do it the old fashioned way
- Cost of unit recapped quickly by improved productivity
After locating the damaged section, it must be trimmed and spliced: gas conduit is a lot easier to fix.
Common issue: vehicle design for storage and access
Vehicle mounted laptops—before and after
Electric utility task: manual cutting and crimping of cables

- Using large manual tools in cramped quarters requires great physical effort
- We found that
  - <3% of the population has the physical strength to manually crimp cable in trenches
  - <1% females/<50% males to manually cut cable
Pulling cable

- Training (shaping) and pulling cable weighing up to 20lb. per linear foot is tough
- Cable pulling is extremely hazardous to the musculoskeletal structure
The easier way also is more productive
Use of jackhammers

- 90 pound breakers have excessive vibration and are difficult to get in and out of vehicles
- New jackhammers weigh as little as 60 pounds and meet the European vibration standard, yet get the job done
- New “ergonomic” handles which flex on smaller breakers
- Most utilities do this hydraulically as much as possible

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Challenges of gas underground work

- Gas leaks spread even more in cold weather
- Very risky, not just inconvenient
- Barholing is done manually to detect leaks quickly
Gas utility task: detecting gas leaks

- May be under pavement
- May be in frozen soil
- Multiple holes required
- In frost, the bar heats and freezes and is extremely difficult to extricate
Gas fitter task: wrenching pipe fittings

- Old fittings are often rusted on
- Require a great deal of force to remove
- Some utilities just cut them off
- Then you have a lot of rebuilding to do; tendency to use brute force
Ladders are common equipment

- Numerous ergonomic issues with handling ladders—not just safety issues of climbing and using
- Numerous ergonomic solutions to carrying, positioning and loading/unloading
Acknowledgements

- Gas Technology Institute (GTI)
  - Bruce Campbell
  - Dennis Jarnecke
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  - Dr. Janice Yager
- We Energies
- Questar
Union participation

- Overhead, underground, power plants:
  - International Brotherhood of Electrical Workers Locals 2150 and 510
  - International Union of Operating Engineers Local 317 - Plant Operators, Control Operators, Plant Mechanics

- Gas ergonomics
  - AFLCIO United Steelworkers of America
  - Local 2006 Units 2-18 and 12005