Ergonomic Exposure Assessment

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Ergonomics

- *Ergon* = Work
- *Nomos* = Natural Laws of

- Interaction between human capabilities and the work environment

*International Ergonomics Association (IEA), 2000*

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance.
Goals of Ergonomics

- Effectiveness and Efficiency of Work
  - Efficient/increased production
  - Improve product quality
  - Reduce errors

- Enhance desirable human values
  - Improve quality of work life
  - Optimize health and safety
  - Reduce fatigue and stress
**Occupational Exposures**

- High repetition
- Excessive force
- Awkward postures
- Vibration
- Insufficient recovery
- Extreme temperature
- Contact stress
- Psycho-social

**Multifactorial!!!**

**Outcomes**

- WMSDs: work-related musculoskeletal disorders
  - Carpal tunnel syndrome
  - Epicondylitis
  - Rotator cuff
  - Low back pain

- So why do we care???
  - Most prevalent
  - Most costly
  - Occur across all occupations
Exposure Assessment

- Systematic review of the processes, practices, materials, and division of labor present in a workplace that is used to define and judge all exposures for all workers on all days

The Occupational Environment: Its Evaluation, Control, and Management
AIHA, 2003

Why is Exposure Assessment Important?

- Reduce the risk of injury/illness
- Evaluate the risks present
- Prioritize & implement controls
- Relate exposure to disease outcome
- Estimate work requirements
- Validate perception of a task
- Determine stress on the body
Why is Exposure Assessment Difficult?

- Risk factors and outcomes are not well understood
- Exposures are difficult to quantify
- Adequate exposure assessment is very complex
- Risk factors are not independent of the worker
- An increase in exposure is not linearly associated with an increase in risk
- The most common outcome is pain (non-specific)

Types of Exposure Assessment

- Qualitative
- Semi-quantitative
- Quantitative

- Depends on:
  - Purpose
  - Time
  - Cost
  - Outcome significance
Qualitative

- Professional judgment and experience
- Walk-through survey
- Checklists, JSA, JHA
- Direct observation
- Video/camera

Advantages
- Simplicity and speed
- Assess a large # at low cost

Disadvantages
- Moderate reliability
- Only produces data such as presence/absence

- National Institute for Occupational Safety and Health (NIOSH)
  - NIOSH Elements of Ergonomics (Pub No. 97-117)

- Occupational Safety and Health Administration (OSHA)
  - Guidelines: Poultry, Retail, Nursing & Shipyard
  - Industry Specific eTools

- Washington Department of Labor and Industries (WISHA)

- American Conference of Governmental Industrial Hygienists (ACGIH)
  - Lifting TLV’s

- Trade and professional association guidelines
Semi-Quantitative

- RULA and REBA (Cornell University)
  - Whole body

- Liberty Mutual MMH Tables
  - Push/pull, carry, lift/lower

- Rodgers Muscle Fatigue Analysis
  - Whole body

- ACGIH TLV Hand Activity Level (HAL)

Advantages
- Assess large # at relatively low cost
- Relatively easy to use
- Provides some quantitative data

Disadvantages
- Observation is time consuming
- Subjective judgments still involved
- Reliability and validity not demonstrated for many of these
Quantitative

- Biomechanical analyses
- NIOSH Revised Lifting Equation (Pub No. 94-110)
- Strain Index
- Vibration analysis

“Direct Measures”
- Electromyography (EMG)
- Electrogoniometry
- Accelerometry, Inclinometry
- Nerve conduction
- Heart rate, blood pressure, VO₂

http://www.nexgenergo.com/index.html

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**Quantitative**

**Advantages**
- Good reliability and validity
- High level of detail

**Disadvantages**
- Expensive
- Time consuming
- May interfere with worker
- Difficult for large workforces
Exposure Assessment Research

Study 1
- Rater Reliability
- 2 Raters Cyclic Tasks
- Neck, Shoulder, Wrist

Study 2
- Rater Reliability Expanded
- 4 Raters Cyclic & Non-Cyclic Tasks
- Neck, Shoulder, Wrist

Study 3
- Inter-Method Reliability
- Video Observation vs Inclinometry
- Shoulder, Trunk

Study 4
- Sampling Strategy
- Inclinometry
- Shoulder, Trunk
- Comparison of Sampling Durations
Reliability and Validity

Observation of Posture from Video

- Low cost
- Relatively quick analysis time

Challenges
- Work environment
- Cyclic vs non-cyclic
- Rater judgments
Multimedia Video Task Analysis (MVTA)
Ergonomics Analysis and Design Consortium – University of Madison, Wisconsin

Rater Reliability of Neck Postures

G-Coeficient

Neutral Flexion >45° Extension >20° Miss na Data

Posture

Rater 1
Rater 2
Rater 3
Rater 4
Convergent Validity

- Cross-validation
- Video observation (MVTA) vs Inclinometry
- Brewing industry
  - 3 major work areas
  - 7 repetitive tasks

Inclinometry
Left Upper Arm Results

0°-44°

45°-90°

> 90°
Sampling Strategy

- Compare different sampling durations
- Full-shift (~8 hours) inclinometry
- Brewing industry
  - 3 major work areas
  - 7 repetitive tasks

Video 1

Video 2
### Results

#### Right Upper Arm

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<th>&gt;5</th>
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Acknowledgments

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Publications


Dartt et al. Convergent validity of video observation and inclinometry in the assessment of postures among manufacturing workers. In progress: *Ergonomics*

Dartt et al. Measures of Reliability for Assessing Postures among Workers in Manufacturing Tasks. In progress: *Journal of Occupational and Environmental Health*