Digital Human Modeling of Non-Occupational Risk Factors for Manufacturing Work Task Design

1st International Symposium to Advance TOTAL WORKER HEALTH
Bethesda, MD, October 6-8, 2014

Presented by:
Mark Schall, MS, AEP
Comprehensive Evaluation of an Integrated Health Protection and Health Promotion Program

Four-year intervention trial (2012-2016)

Two facilities operated by same manufacturing company

Does an integrated approach:

1. Reduce occurrence and impact of musculoskeletal health outcomes?
2. Reduce modifiable risk factors for chronic health conditions?
3. Provide an economic benefit?

Project Team

Nathan Fethke, PhD (PI)
Fred Gerr, MD (Co-I)
Linda Merlino, MS (Study Coordinator)
Cassidy Branch, MA (Wellness Coach)
Mark Schall, MS (Graduate Fellow)
Program Design

Strategic Planning 2011

Safety and Wellness Committee 2012-2016

ERGONOMICS (2012-2016)
- Training
- Exposure Assessment
- Development of Controls

WELLNESS (2012-2016)
- Needs Assessments
- Facility-Wide Events
- Wellness Coaching

Ergonomics Goals

Wellness Goals

Execute

Employee and Management Participation at All Levels
Work-related musculoskeletal disorders (MSDs) are prevalent among manufacturing workers  
Gerr et al., (2014)

Risk factors associated with the development of MSDs

- Physical risk factors (e.g., repetition, forceful exertions)
- Psychosocial risk factors (e.g., high job demands / low job control)
- Workplace organizational factors (e.g., no job rotation)
- Non-occupational risk factors (e.g., age, gender, body mass index)
Background and Significance

Manufacturing safety committees are commonly tasked with

- Identifying potential occupational risk factors
- Modifying work tasks to reduce exposure

Methods used to assess the ergonomics of work tasks do not typically consider non-occupational risk factors

*Example*: Strain Index

- Rating system to estimate risk for upper extremity MSDs
- Observer assesses six work-related variables
  - Intensity of exertion
  - Speed of work
  - Hand exertions per minute
  - Hand and wrist posture
  - Duration of exertion (i.e., duty cycle)
  - Duration per day work is performed

*Does not* consider non-occupational risk factors!
Digital Human Modeling

- Evaluate the ergonomics of existing work tasks
- Develop and evaluate alternative designs
- Consider non-occupational risk factors in work task design

http://www.ccad.uiowa.edu/vsr/
http://blog.industrysoftware.automation.siemens.com/blog/2009/03/19/are-digital-humans-cool/
http://biomechanicsforeverybody.wordpress.com/category/modeling/

www.hwce.org
Santos Digital Human

Biomechanical, computer-based model that predicts static posture, dynamic motion, joint strength and fatigue

Human performance capabilities based on research conducted by University of Iowa Virtual Soldier Research program

Initially developed for military applications

http://www.ccad.uiowa.edu/vsr/

www.hwce.org
Evaluate Existing Work Tasks
Develop and Evaluate Alternative Work Stations
Develop and Evaluate Alternative Work Stations

Original - 90° from horizontal drilling
Develop and Evaluate Alternative Work Stations

Alternative – Adjustable drilling position
Consider Non-Occupational Risk Factors

Example: Evaluate effect of BMI on work task design criteria

**Healthy BMI Model:**
BMI = 19.1 kg/m²
Strength and mobility profile based on empirical data of 100 healthy BMI individuals

**Overweight BMI Model:**
BMI = 31.1 kg/m²
Strength and mobility profile based on empirical data of 100 overweight BMI individuals
Compare Model Capabilities While Completing Common Work Tasks

Push Cart

Lift Window

Paint

Lift Door

HEALTHIER WORKFORCE CENTER FOR EXCELLENCE

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Results: Maximum Right Shoulder Torque

- Current work task design demands exceed right shoulder torque capability of 65% of overweight BMI population and 10% of healthy BMI population.
Moving Window From Pallet to Conveyor

Walking with window

Lift and place (36 in)

Lift and place (48 in)
Results: Spine Compression

- NIOSH recommended action limit for spinal compression is 3400 N (Waters, 1993)
- Work task requiring placing window on 48 in. conveyor is very close to action limit
Digital human modeling software is becoming more sophisticated

Non-occupational risk factors may be modeled

- Age
- Gender
- Joint range of motion limitations

Adds value in context of TOTAL WORKER HEALTH
References

Program Data Sources

- **Company/Facility Level**
  - Health insurance claims/cost & EAP usage
  - Worker’s compensation claims/cost
  - Video-based exposure assessment

- **Participant Level**
  - HRA/Biometrics
  - Demographics
  - Personal health
  - Job Content Questionnaire
  - SF-36
  - Musculoskeletal health

**Participants Enrolled (2012-present)**
- Intervention facility: 191
- Referent facility: 230

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Results: Left Shoulder Fatigue

- No worker should push cart for more than ≈ 13 minutes (779 sec)
- No worker should paint continuously for more than ≈ 28 minutes (1685 sec)