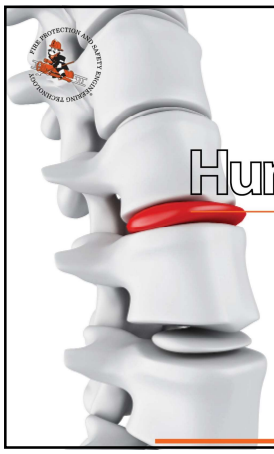


Human Factors
in Accident Prevention

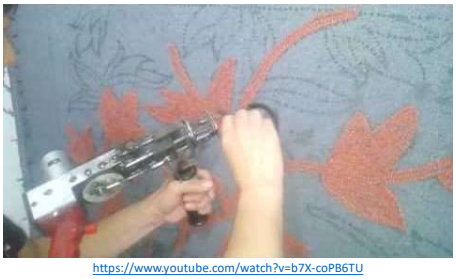
People / Environment / Work
Force / Frequency / Posture

FPST 3213

Work Design

Objectives

- Work design definition
- Consequences of poor work design
- Workplace analysis
- The occupational athlete.



https://www.youtube.com/watch?v=b7X-coPB6TU

Work design

- Organization of job demands in a job

Organizational factors influencing job demands

Management policies + Psychosocial factors = stress

Work Design

- Human centered
  - Macroergonomics

Organizational designs

- Measurements of overall effectiveness
  - Productivity
  - Efficiency
  - Profitability
  - Quality
  - Health and safety
  - Absenteeism
  - Turnover

Occupational stress from the workers' perspectives

- Job requirements
- Job control
- Communications

Shiftwork

- 1985: Expiration of the Walsh-Healy Act
  - Set limitation of hours that an employee could work in a 24-hour period before being paid overtime differential
  - Companies began to explore opportunities to work longer shifts and compressed work weeks

Shiftwork

- Shift work and employee health and safety
  - Work-related patterns such as smoking and unhealthy nutrition habits

Shiftwork

- Eight-hour shifts versus 12-hour shifts

Guidelines for selecting alternative work systems

- Specific night shifts
- Consecutive nights not less than four in a row
- Rest periods of at least 24 hours after each night shift
  - https://www.sleepfoundation.org/shift-work-disorder/tips/workplace

Design to minimize fatigue

- Physical fatigue
  - Cardiovascular measurement
- Physiological fatigue
  - Introduce a secondary task
  - Measure production rates

Sign of serious fatigue is simple exhaustion

Static muscle fatigue

- The longer the muscle remains under contraction the more time the lactic acid has built up

Dynamic work fatigue

- Workers will typically report being very tired and needing more sleep

Physical fitness of the workforce

- Job rotation
- Stretching
- Work simulation
- Work conditioning
  - The industrial athlete

Job Simulation

Repetitive work

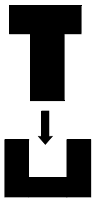
- If the cycle is repeated continuously for two or more hours of work it is considered repetitive

The design of repetitive work

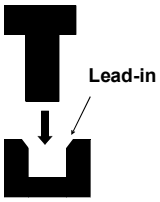
- Change positions
- Limit use of vibrating tools
- Poorly designed, machine or molded parts require excessive force on hands and arms during assembly

Chamfers & Lead-ins

Poor



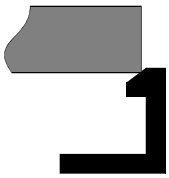
Good



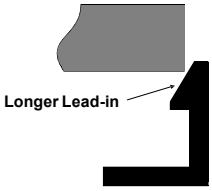
FPST 3213 22

Reduce Snap-fit Force

Undesirable



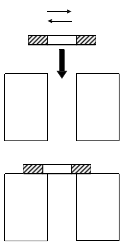
Improved



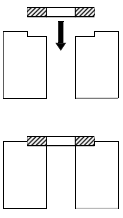
FPST 3213 23

Minimize Holding Down & Alignment

Poor

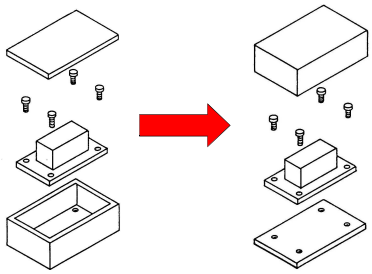


Good



FPST 3213 24

Design To Improve Access



Before

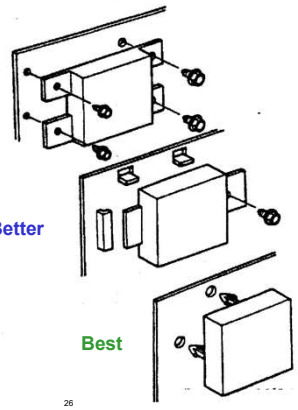
After

Poor

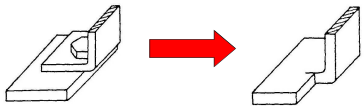
Better

Minimize Number of Fasteners

Best



Reduce Part Count



Before

After

MSDs and work design

- Train workers to recognize early symptoms and report them immediately
- Job rotation
- Identify best techniques
- Employees returning to work

General guidelines to improve organizational factors and job design

- Design in enhanced communications
- Minimize manual handling of materials
- Provide easy-to-use processes
- Provide any mechanism where the workers are involved in the design process
- Develop an ergonomics team
- Formulate guidelines for handling emergency events

What is Work Design?

https://youtu.be/uR3dJJjSDdM

- Workplace Analysis

Workplace Analysis

- Qualitative
- Semi-quantitative
- Quantitative

Workplace Analysis

- Qualitative
  - A walk-through survey
  - Use of Job Safety Analysis (JSA) to consider risk factors of a job based on professional judgment and experience

Workplace Analysis

- Qualitative
  - Should be familiar with injury history
  - Interviews with one or more experienced operators is **critical**

Workplace Analysis

- Semi-quantitative
  - Consider duration and intensity
  - Rodgers muscle fatigue assessment
    - Assesses the amount of fatigue and muscles during various work patterns within a five minute work period
  - Liberty mutual tables for manual materials handling Include information for lifting and lowering carrying pushing and pulling (covered later)

Workplace Analysis

Semi-quantitative

- ACGIH TLV for hand activity level
  - Evaluation is based on assessment of hand activity and the level of effort for a typical posture while performing a short cycle task
    - Step 1 – Identify the level of hand activity on the scale of 0 to 10
    - Step 2 – Characterize the effort level by noting the effort associated with a typically high force and rate on a scale of 0-10
    - Step 3 – Compute the ratio
    - If the ratio is below the action level, no further analysis. If it's above, job redesign is required

American Conference of Governmental Industrial Hygienists (ACGIH)
Threshold Limit Value (TLV)

Workplace Analysis

- Quantitative
  - Thresholds established
  - Strength and biomechanics

Quantitative Analysis

- Static Work
  - Strength and biomechanics has no time consideration
  - For static work the concern is fatigue of the muscle group
- Dynamic Work
  - Considers the relative demand of the work on the least fit individual based on population data
    - Typically the 10% female

Quantitative Analysis

- Dynamic Work
  - The percent maximum aerobic capacity is the percent ratio of the oxygen demand of the work and the criterion aerobic capacity

Metabolic demands Maximum limit	Shift lengths (hours)
33%	8
30%	10
25%	12

Quantitative Analysis

- Dynamic Work
  - If more than 33% of the heart rate range for whole body work is required during a shift, worker is likely to become fatigued

Quantitative Analysis

- Dynamic Work
  - Another good measure is the rate of oxygen consumption and the rate of energy expenditure
    - Rate of oxygen consumption is a fraction of the individual's maximum aerobic capacity

Quantitative Analysis

- NIOSH lifting equation (covered later)
  - First proposed in 1981 - Updated in 1991
  - Provides a recommended weight limit (RWL)

Avoiding Whole-body Fatigue

- The main goal is avoiding whole-body fatigue which
  - Reduces productivity
  - Results in lower psychomotor skills (which may lead to accidents and overexertion injuries)
  - Reduces comfort and acceptability

The Occupational Athlete

a.k.a. The Industrial Athlete

The Industrial Athlete

Athlete v Employee

Three Athletic Principles

Athletic Principles	At Work
Biomechanics	Occupational Role Profiling Onsite Coaching
Pre Screening	Pre-Employment
Strength & Conditioning	Job Hardening

The Industrial Athlete

- Anyone who makes a living using mental and physical talents to perform jobs that require skill, strength, flexibility, coordination and endurance—just like an athlete.

The Industrial Athlete

- Athletes and workers use their musculoskeletal system to perform their sport or job

…therefore, the employee deserves the same commitment and attention from the rehabilitation team as the athlete

The Industrial Athlete

- Treat industrial athletes as comprehensively and intensely as a competitive athlete

The Industrial Athlete

- So why does recovery from similar injuries take three to four times as long in the industrial arena than in the sports arena?
- How much rest does a football player get between games?

The Industrial Athlete

- PT's recognize the need to:
  - Design tasks and jobs so that they have rest breaks and sensible shift patterns
  - Design equipment and work to improve posture and ease the load on the body
  - Information design, to make the interpretation and use of handbooks, signs, and displays easier and less error-prone
  - Design training to cover all significant job aspects human learning requirements

The Industrial Athlete

- "If ergonomics says the job is within standards for the majority of individuals, the question that needs to be examined is could many of these injuries be avoided if we conditioned the industrial worker and modeled an exercise program based on their respective jobs?
- What is that called?

The Industrial Athlete

- Work hardening and work conditioning

The Industrial Athlete

- "Injury prevention should include strength and endurance training to build better work fitness, learning how to safely perform work tasks with good body mechanics, and adapting the work environment to promote ergonomically correct work sites"

https://www.ptonthenet.com/articles/The-Industrial-Athlete-%E2%80%93-Part-1-2101

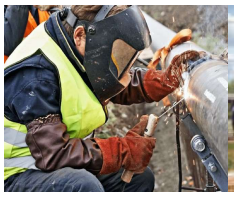
The Industrial Athlete

- Use of protective equipment while working or performing the event. The least expensive injury is the one you never have to treat.
- Training that strengthens potential areas of weakness and enhances performance at work. Better adaptation to handle the demands of the job or activity.
- Diagnose the injury as quickly as possible and initiate measures to decrease the severity of disability.
- Rehabilitation that improves flexibility, muscular balance, and other factors that may have contributed to the injury and may prevent future injury

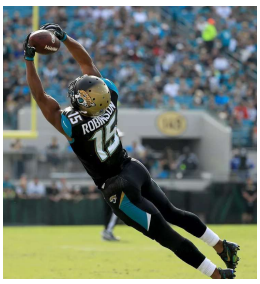
The Industrial Athlete

"Bringing the sports medicine model to the industrial setting can reduce the medical and non-medical expenditures related to repetitive stress injuries. The goal of returning competitive athletes to their functional status before their injuries should be just as aggressively pursued for industrial athletes. In a competitive business environment, it is crucial to have a healthy, strong, highly motivated team to get the job done."

https://oem.bmj.com/content/57/4/285.1

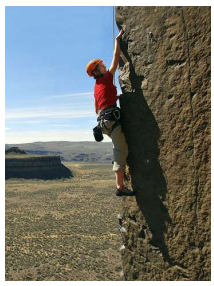





ROBINSON



CCM




Industrial Athlete at Boeing Since 2004

- The Industrial Athlete program is an innovative, voluntary workplace program designed to improve the health and productivity of employees and address the need to keep employees strong and healthy.

Industrial Athlete at Boeing

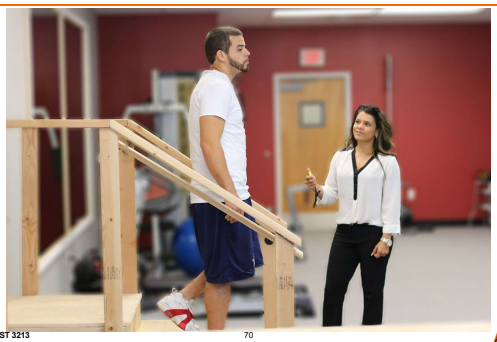
- By using sports medicine techniques, the program has been found to reduce discomfort after employee participation

By Sabyasachi Basu, Laurence S. Wechsler, Deborah R. Smith, Corinne D. Towler, Catherine M. Curley, Karen Rogers and Tina L. Hermans
https://www.boeing.com/features/innovation-quarterly/dec2016/feature-technology-ind-athlete.page

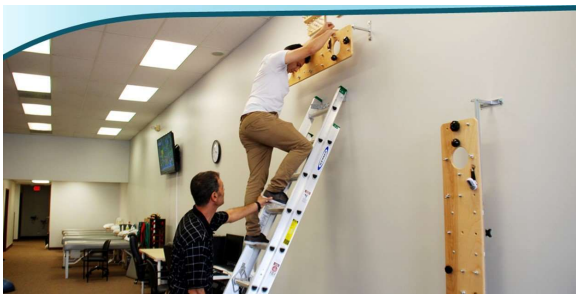
The Industrial Athlete

Work Hardening/Conditioning

Work Hardening/Conditioning



Work Hardening/Conditioning



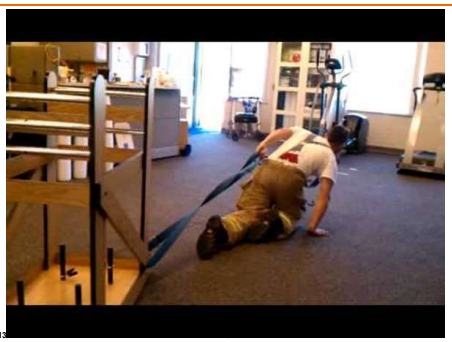
Work Hardening/Conditioning

Work Hardening/Conditioning

Work Hardening/Conditioning

Work Hardening/Conditioning

Work Hardening/Conditioning



Human Reliability and Information transfer

How to make a PB&J Sandwich

https://www.youtube.com/watch?v=XWe4iohhmIw

Questions?