In Ergonomics, The Whole Person Matters

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Why Does the Whole Person Matter?

- Practitioners of Ergonomics / Human Factors (E/HF) exist to make things better, typically in the workplace.
- When we go in to a new work situation, we cannot be sure what the problems are.
- They may not be what management thinks an E/HF should do!
- Can we build on our success to do more?
Is the E/HF issue MSD, or cuts, or lighting, or incentives?
Is the E/HF issue Steps/Falls, or restricted spaces, or quality?
Is the E/HF issue chemical weapons safety..
or working in DPE suits…
or isolation on an atoll?
The Point?

- At first, we just don’t know for certain!
- Typically the people who call us in (or we!) have rather fixed ideas of what E/HF practitioners should be doing:
  - Reducing musculo-skeletal disorders
  - Reducing complaints of office workers
  - Reducing human errors
  - Making the workforce happier
All of the Above?

- We come from a rather broad training in E/HF: physical, cognitive, socio-technical
- …but we don’t always get to use this breadth in the race for rapid evaluations and quick fixes (important as these are!)
- Can we write ourselves a broader job description?
- Surprise and (hopefully) delight customers
Back to Basics

- The International Ergonomics Association (IEA) defines the purpose of ergonomics as “…to optimize human well-being and overall system performance.”
- Both are equally important measures:
  - Human Well-being
  - System Performance
- Without both, we can’t optimize.
Posture or Performance? Both!

Examining B-737 Hold for Cracks
The Good News:

- What we do for human well-being often improves system performance (and vv.)
- e.g. TQM and E/HF at L. L. Bean sewing plant (Rooney, 1992/3). Replaced piece work with annual bonus, added job complexity with cross-training & teamwork, plus E/HF job analysis
- 78% Drop in MS injuries over 4 years
Practical Manufacturing Example

Remember Film?
Practical Manufacturing Example

- Two Assembly lines for Fun Saver disposable cameras, multiple stations/line
- For each Station, we measured:
  - Postural Stress, using non-neutral body angles for back, neck, wrists, shoulders
  - Time Stress: Time needed for each task despite fixed line speed
  - Quality: Errors /week at each station

What Drives Camera Assembly Errors:

- Line A:
  
  Errors/week = 94.2 + 17.2 (Time Needed) + 3.63 (Posture Score), $r^2 = 0.863$, $p = 0.051$

- Line B:
  
  Errors/week = -45.3 + 3.0 (Time Needed) + 3.9 (Posture Score), $r^2 = 0.584$, $p = 0.001$

- Quality is driven by E/HF factors: Pacing & Posture!
What do we Mean by Measures?

- **Human well-being:** No injuries, No illness AND job satisfaction
- **System Performance:** Speed/productivity AND Accuracy, Quality, No Waste
- It was never just about injury reduction!
- In fact, all measures can be thought of as errors we can reduce by E/HF design.
Examples of Aha! Moments

- When you are asked to look at factor A, the workplace situation forces you to look at B, or C or all of the above.
- This is hardly new, but can still become a restriction to factor A for many E/HF practitioners.
At a large airline, Safety Culture was Issue A...
At a large airline, Safety Culture was Issue A… But artefacts revealed much about the system.
At a food plant, product damage was Issue A…
…but excess handling was a root cause of damage & MSD.
At a garment plant, MSD was Issue A…

… but managerial issues were part of the cause.

But 100% Direct Incentive!
For Spacecraft Maintenance, the brief was spot-on.
The procedure documents did not meet E/HF good practice.
WARNING

THIS SEQUENCE INVOLVES HAZARDOUS HYPERGOLIC OPERATIONS. PAD CLEAR, ORBITER CONFIGURED FOR REMOTE OPERATION AND PERSONNEL IF ON STATION, ATTIRE IN SCAPE SHALL BE VERIFIED BEFORE PROCEEDING.

S0024 CONTROLS THE FOLLOWING REQUIREMENTS:
1. CLEAR PAD TO PERIMETER SPACE
2. VERIFY ESSENTIAL PERSONNEL ATTIRE IN SCAPE
3. INITIATE RECORDING OF REQUIRED CAMERAS AFTER PERSONNEL ARE ON STATION.

CAUTION
IF THE CROSSFEED AND ENGINE FEEDLINES ARE SOFTFILLED AND THE PRESSURES ARE GREATER THAN 70 PSIA, THIS SEQUENCE CAN NOT BE RUN IN PARALLEL WITH THE FLOW INITIATION SEQUENCER.

NOTE
OPERATIONS INVOLVING CRIT 1, 1R AND/OR 1S ITEMS ARE CONTAINED IN THE FOLLOWING SEQUENCE/STEPS.

WARNING not in text box
WARNING contains action steps
CAUTION not in text box
Conditional steps not clear
NOTE not in text box
All text in CAPITALS
No end point if condition TRUE
WARNING
This sequence involves hazardous hypergolic operations. Follow this procedure from S0024 for safety:

1. Clear pad to perimeter space
2. Make sure essential personnel are attired in escape
3. Start recording of required cameras after personnel are on station.

CAUTION
IF the crossfeed and engine feedlines are softfilled
AND the pressures are greater than 70 psia,
THEN do not run this sequence in parallel with the flow initiation sequencer
ELSE ????????

NOTE
The following sequence/_steps contain operations involving Crit 1, 1R and/or 1S items.
So What do we Know in E/HF?

- **Physical E/HF**: Body sizes, reach, clearance, biomechanics, MSD causation, thermal environment,…

- **Cognitive E/HF**: Error causation, Speed/accuracy Trade-off, Error-proofing of controls & displays

- **Socio-Technical E/HF**: (Macro Ergonomics) Influence of work system on workers, work design

- Plus appropriate analysis tools for each
Physical E/HF
...includes Handles!
Cognitive E/HF
Cognitive Includes Inspection
Cognitive includes arrays –
Good for inspection…
…terrible for controls!
Colin Drury, IIE/ACE Webinar

Fun Stuff from The Cognitive Side
Colin Drury, IIE/ACE Webinar

Socio-Technical Systems

Reorganization of whole shop floor
Practical Advice

- Presenting Symptoms are not the end of your diagnosis.
- Build on your reputation for success.
- Work with other groups: Product Design (e.g. shoe factory), Six-Sigma/Lean, *(add today’s latest movement here)*
- Many examples of E/HF + Quality, less for E/HF and Lean.
- Brush up on the Other Factors:
Use Certification for Breadth

- Example: Board of Certification in Professional Ergonomics (BCPE) covers the underlying science and application
- If we all had this at our fingertips, we could be more effective:
Some BCPE Core Competencies

- Anthropometry, Physiology, Biomechanics
- Psychology, information, software
- Physical environment
- Social environment
- Organizational Environment, Macro Ergs
- …includes tools for each.
Don’t Forget the Fundamentals
Don’t stop improving Physical Work – it is the basis of your reputation
Use Broad Analysis Tools

- Many physical work analysis tools (you know them already)
<table>
<thead>
<tr>
<th>Action level</th>
<th>RULA score</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-2</td>
<td>The person is working in the best posture with no risk of injury from their work posture.</td>
</tr>
<tr>
<td>2</td>
<td>3-4</td>
<td>The person is working in a posture that could present some risk of injury from their work posture, and this score most likely is the result of one part of the body being in a deviated and awkward position, so this should be investigated and corrected.</td>
</tr>
<tr>
<td>3</td>
<td>5-6</td>
<td>The person is working in a poor posture with a risk of injury from their work posture, and the reasons for this need to be investigated and changed in the near future to prevent an injury.</td>
</tr>
<tr>
<td>4</td>
<td>7+</td>
<td>The person is working in the worst posture with an immediate risk of injury from their work posture, and the reasons for this need to be investigated and changed immediately to prevent an injury.</td>
</tr>
</tbody>
</table>
Use Broad Analysis Tools

- Many physical work analysis tool (you know them already)
- Try Hierarchical Task Analysis for a broader view.
- Can find where mismatches occur between job demands and human capabilities
HTA for Mining Haul Truck Operation

HTA Format via TaskArchitect®
Use Broad Analysis Tools

- Many physical work analysis tool (you know them already)
- Try Hierarchical Task Analysis for a broader view
- Analyze Accident Patterns
At 9:50 a.m. on Tuesday, May 23, 2006, a 23-year old miner with 10 months of mining experience was fatally injured at XXX Coal LLC, YYY# 1 Mine. The accident occurred when ZZZ, driving a Mack water truck, lost control while descending a steep mine access road. The accident occurred because the service brakes were not adequate, the engine brake was inoperative, and because the victim was not task trained. The approved training plan was not followed and effective procedures were lacking to ensure adequate braking systems. The truck overturned and slid over an embankment.

Note: The actual accident had been analyzed in the Fatalgram to ensure no repetition of that accident at that workplace.

Our task was to find repeating patterns.
Use Broad Analysis Tools

- Many physical work analysis tool (you know them already)
- Try Hierarchical Task Analysis for a broader view
- Analyze Accident Patterns
- Try Socio-Technical Systems Analysis for an even broader view. Good methodology in “Performance by Design, Taylor (1993)."
Socio-Technical Systems Design

Discovery

System Scan

Technical Analysis

Social Analysis

Joint Optimization

Provisional Design

Implementation
STS Design procedure

- Starts with Discovery that *something* must be done
- System Scan defines inputs, outputs, demands, purpose, boundaries
- Technical Analysis focuses on product, not on process or tasks. Where do Variances arise? Where do they get controlled? Who controls?
- Produces technical variance matrix and control table
Why Does the Whole Person Matter?

- Really the Whole Person + the Whole System
- Be aware of all aspects – You never know beforehand where the issue might be.
- Affect well-being AND performance.
- Make a nuisance of yourself – expand your boundaries
...and Enjoy your Work