Integrating Ergonomics into the Manufacturing Environment

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Ergonomics Maturity Curve

- **Reactive**
  - Incident investigation
  - Ergo analyst

- **Proactive**
  - Opportunity based (CI)
  - Data-driven (risk)

- **Advanced**
  - Tools & equipment
  - Product design

EFFECTIVENESS vs EFFICIENCY
Within A Safety Management System

1. Policy
2. Planning
3. Implementation and Operation
4. Checking and Corrective Action
5. Management Review
The Truth.

• Ergonomics is an **Engineering** issue, not a Health & Safety Issue.
  • The majority of ergonomic issues are typically rooted in process and workstation design.
  • Ergonomic issues only become Health & Safety concerns once an injury has occurred.
  • Long-term fixes for ergonomic issues are typically related to engineering controls.
What is Ergonomics?

Adapted from Occupational Biomechanics, 1999
The art and science of reducing physical and psychological problems that might arise from the interaction between people, equipment, and the environment.
Definition of Ergonomics

The art and science of reducing physical and psychological problems that might arise from the interaction between people, equipment, and the environment.

Fitting The Job To The Person
What is Ergonomics?
What is Ergonomics?

It’s a BLINDING FLASH of Common Sense
What Do You See?
POWER IS NOTHING WITHOUT CONTROL.
Ergo stick?
No problem here…. (well, maybe we should look again).
Blinding flash of common sense
Which one of these two is this designed for?
What is Ergonomics?

‘CUZ
What is Ergonomics?

‘Cuz
What is Ergonomics?
The primary purpose of TPS is to achieve profit through cost reduction.

One of the main levers that TPS uses to reduce costs is to **eliminate waste** in the production process.

- Rework
- Overproduction
- Inventory
- Transportation
- Waiting
- Over-processing
- Motion
Too far.
Posture, Force, and Frequency
The Funnel

1. Is there a problem?
2. How bad is it?
3. Where do I start?
4. What do I do about it?
The Funnel

1. Is there a problem?

2. How bad is it?

3. Where do I start?

4. What do I do about it?
Do I Have a Problem?

Ergonomics Hit List™

• A helpful tool to identify ergonomic issues and job improvements

• The tool is divided into two parts:
  • Find It
  • Fix It

ERGONOMICS HIT LIST™

Work Doesn’t Need To Be A Pain!®
Would you do it this way?

- Wash Rag
- Elbows Out
- Shoulder Too High/Too Low
- Hungry Head
- Butts Up
- Twist and Shout
- Horizontal Distance
- Sit vs. Stand
- Bad Vibes
- Contact
- Tool/Target
- Comfort Zone
- Don’t Give Me Static

Ask the Operator™

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Quick and Visible Improvements

BEFORE

AFTER
Quick and Visible Improvements

BEFORE

AFTER
Bad design is universal
The Funnel

1. Is there a problem?

2. **How bad is it?**

3. Where do I start?

4. What do I do about it?
Quantifiable Risk Assessment
Example Risk Assessment

BRIEF™ Survey — Baseline Risk Identification of Ergonomic Factors

Step 1
Job Name: Hand Packing

Step 2
Identify Risks

2a. Mark Posture and Force boxes when risk factors are observed.

2b. For body parts with Posture or Force marked, mark Duration and/or Frequency boxes when limits are exceeded.

Step 3
Determine Risk Rating

In the Score box, write the number of risk factor categories (0-4) checked for each body part. Using the table at right, circle the corresponding Risk Rating for each body part.

Step 4
Identify Physical Stressors

Mark physical stressors observed.

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The Funnel

1. Is there a problem?

2. How bad is it?

3. Where do I start?

4. What do I do about it?
Prioritizing Ergonomic Risk

By assigning a single number to rank each of the operations, a manufacturing plant can easily determine where to start:

<table>
<thead>
<tr>
<th>Jobs</th>
<th>BEST Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin press</td>
<td>32</td>
</tr>
<tr>
<td>Spring install</td>
<td>25</td>
</tr>
<tr>
<td>Testing</td>
<td>24</td>
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<tr>
<td>Loading line</td>
<td>38</td>
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<tr>
<td>Latch inspection</td>
<td>18</td>
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<tr>
<td>Carriage subassembly</td>
<td>42</td>
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<tr>
<td>Weld subassembly</td>
<td>36</td>
</tr>
</tbody>
</table>
Prioritization

BEST™ – BRIEF™ EXPOSURE SCORING TECHNIQUE

Step 1
Job Name: Date: Station:
Complete job information

Step 2

Transfer BRIEF Scores

Hands and Wrist

Elbows

Shoulders

Back

Front

Legs

Left

Right

Left

Right

Left

Right

Left

Right

Step 3

Determine Conversion Factors

Step 4

Add Conversion Factors

Summary of Physical Stresses

Step 5

NIOSH Lifting Guidelines

Job Title: Lifting box from pallet onto conveyor

Model Inputs:

Horizontal Location (H)

Vertical Location (V)

Travel Distance (D)

Angle of Asymmetry (A)

Coupling

Duration

Frequency

Average Load Weight

Maximum Load Weight

Model Outputs:

Recommended Weight Limit (RWL): 22.1 lb.

Lifting Index (LI) = Load/RWL: 2.26

Frequency Independent RWL: 34.1 lb.

Frequency Independent LI: 1.47

Recommendations:

Engineering or Administrative Controls should be implemented

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# The Risk Map (with Prioritization)

<table>
<thead>
<tr>
<th>Job Name</th>
<th>Area</th>
<th>BRIEF Scores</th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th>BEST</th>
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<tr>
<td>1 Hand Start</td>
<td>Fuel Filter</td>
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<td>3</td>
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<td>3</td>
<td>3</td>
<td>2</td>
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<tr>
<td>2 C15 Valve Cover Base (a)</td>
<td>Valve Cover</td>
<td></td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
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<td>3 C10/C12 Valve Riser</td>
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<td>5 C15 Valve Cover Base (b)</td>
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<td>7 Manifold Subassembly</td>
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<td>8 ECM Subassembly</td>
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<td>9 6806 Nipples for Fuel Base</td>
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<td>10 3406 Spacer Deck (a)</td>
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<tr>
<td>12 C11/13 Valve Cover Base (b)</td>
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<td>13 Engine Harness (Build/Assemble)</td>
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<td>16 Valve Cover Breather Assembly</td>
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<td>17 Engine Harness (Sequencing)</td>
<td>Valve Cover</td>
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<td>18 Rubber Conduit</td>
<td>Primary Subassemblies</td>
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<td>2</td>
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<td>19 Size 13 Air Chamber</td>
<td>Primary Subassemblies</td>
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<td>2</td>
<td>1</td>
<td>3</td>
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<td>1</td>
<td>0</td>
</tr>
<tr>
<td>20 Gear Assembly</td>
<td>Primary Subassemblies</td>
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<td>0</td>
</tr>
</tbody>
</table>
The Funnel

1. Is there a problem?

2. How bad is it?

3. Where do I start?

4. What do I do about it?
Design Basis for Human Performance

Anthro = people
metry = measurement of

The Design Guidelines

• Optimize performance for most of the population
• Are based on studies of healthy, working-age adults
Design Basis for Human Performance

Two basic types of Anthropometry:

1. Functional Anthropometry
   • Considers human capabilities to perform a function (e.g., reaching to grasp an object)

2. Static Anthropometry
   • Considers the dimensions of the human body (e.g., length of a person’s forearm)
   • Info is provided for many global populations
Design for Adjustability, Extremes, or Average?

95th PERCENTILE MALE

STATURE 75" (1.91 m)
EYE 70" (1.78 m)
SHOULDER 62" (1.57 m)
ELBOW 48" (1.22 m)
HAND 34" (864 mm)
KNEE 25" (635 mm)

5th PERCENTILE FEMALE

STATURE 61" (1.55 m)
EYE 57" (1.45 m)
SHOULDER 49" (1.25 m)
ELBOW 38" (965 mm)
HAND 27" (686 mm)
KNEE 19" (483 mm)
Ergonomic design guidelines translate *human performance* considerations into *purchasing specifications*. 
# Horizontal Work Reach Dimensions

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Dimension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Horizontal Reach – Precision Tasks</td>
<td>Max. 11&quot; (279 mm)</td>
<td></td>
</tr>
<tr>
<td>B. Horizontal Reach – High Frequency (≥ 2/min.) or High Force (≥ 10 lb or 4.5 kg) Tasks</td>
<td>Max. 16&quot; (406 mm)</td>
<td>Horizontal reach distance from front edge of workstation to hand grasping point</td>
</tr>
<tr>
<td>C. Horizontal Reach – Large Product Assembly Tasks</td>
<td>Max. 22&quot; (559 mm)</td>
<td></td>
</tr>
<tr>
<td>D. Vertical Reach – High Frequency (≥ 2/min.) or High Force (≥ 10 lb or 4.5 kg) Tasks</td>
<td>Max. 62&quot; (1.58 m)</td>
<td>Vertical reach distance from standing surface to hand grasping point</td>
</tr>
<tr>
<td>E. Vertical Reach – Infrequent or Low-Force Tasks</td>
<td>Max. 74&quot; (1.88 m)</td>
<td></td>
</tr>
</tbody>
</table>
# Standing Workstation Dimensions

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Dimension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Hand Working Height</td>
<td>Adj. 38”–47” (0.97–1.19 m)</td>
<td>Vertical distance from standing surface to hand working height</td>
</tr>
<tr>
<td>Optimal Zone</td>
<td>Fixed: 42” (1.07 m)</td>
<td></td>
</tr>
<tr>
<td>Acceptable Zone</td>
<td>Adj. 30”–57” (0.76–1.45 m)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed: 42” (1.07 m)</td>
<td></td>
</tr>
<tr>
<td>B. Display Height</td>
<td>Adj. 58”–71” (1.47–1.80 m)</td>
<td>Vertical distance from standing surface to top of viewable portion of display screen</td>
</tr>
<tr>
<td></td>
<td>Fixed: 66” (1.68 m)</td>
<td></td>
</tr>
<tr>
<td>C. Optimal Viewing Distance</td>
<td>Adj. 18”–30” (457–762 mm)</td>
<td>Horizontal distance from eye to display screen surface</td>
</tr>
<tr>
<td></td>
<td>Fixed: 23” (584 mm)</td>
<td></td>
</tr>
<tr>
<td>D. Knee Space Depth</td>
<td>Min. 6” (152 mm)</td>
<td>Beneath the work surface, horizontal distance from front of table edge to back of the workstation</td>
</tr>
<tr>
<td>E. Foot Rail Height</td>
<td>6” (152 mm)</td>
<td>Vertical distance from standing surface to top of foot rail</td>
</tr>
<tr>
<td>Knee Space Width</td>
<td>Min. 30” (762 mm)</td>
<td>Beneath the work surface, horizontal width across front of work surface</td>
</tr>
</tbody>
</table>
# Finger Push Force Guidelines

<table>
<thead>
<tr>
<th>Force Exertions: Finger Press</th>
<th>Frequent (≥ 2/min)</th>
<th>Infrequent (&lt; 2/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recommended</td>
<td>Acceptable</td>
</tr>
<tr>
<td>1 index finger</td>
<td>3.4 (1.5 kg)</td>
<td>5 lb (2.3 kg)</td>
</tr>
<tr>
<td>2 fingers on same hand</td>
<td>5.0 lb (2.3 kg)</td>
<td>7.5 (3.4 kg)</td>
</tr>
<tr>
<td>2 fingers on different hands</td>
<td>11.0 (5.0 kg)</td>
<td>16.5 (7.5 kg)</td>
</tr>
</tbody>
</table>
# Standing Strength

<table>
<thead>
<tr>
<th>Force Exertions</th>
<th>Frequent (≥ 2/min)</th>
<th>Infrequent (&lt; 2/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recommended</td>
<td>Acceptable</td>
</tr>
<tr>
<td>A. Push out at shoulder height</td>
<td>6.8 lb (3.1 kg)</td>
<td>10.2 lb (4.6 kg)</td>
</tr>
<tr>
<td></td>
<td>B. Push out at elbow height</td>
<td>7.4 lb (3.4 kg)</td>
</tr>
<tr>
<td></td>
<td>C. Push out at elbow height</td>
<td>11.8 lb (5.4 kg)</td>
</tr>
<tr>
<td></td>
<td>D. Pull in at shoulder height</td>
<td>7.0 lb (3.2 kg)</td>
</tr>
<tr>
<td></td>
<td>E. Pull in at elbow height</td>
<td>7.5 lb (3.4 kg)</td>
</tr>
<tr>
<td></td>
<td>F. Pull in at elbow height</td>
<td>13.1 lb (5.9 kg)</td>
</tr>
</tbody>
</table>

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### Standing Strength (Cont.)

<table>
<thead>
<tr>
<th>Force Exertions</th>
<th>Frequent (≥2/min)</th>
<th>Infrequent (&lt;2/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recommended</td>
<td>Acceptable</td>
</tr>
<tr>
<td>G. Pull down from overhead – 2 hands</td>
<td>17.9 lb (8.1 kg)</td>
<td>26.8 lb (12.2 kg)</td>
</tr>
<tr>
<td>H. Pull up from knee height – 1 hand</td>
<td>6.3 lb (2.9 kg)</td>
<td>9.5 lb (4.3 kg)</td>
</tr>
<tr>
<td>I. Pull across body (lateral) at waist height – 1 hand, elbow fully extended</td>
<td>2.5 lb (1.1 kg)</td>
<td>3.8 lb (1.7 kg)</td>
</tr>
<tr>
<td>J. Pull across body (lateral) at waist height – 1 hand, elbow at 90°</td>
<td>3.3 lb (1.5 kg)</td>
<td>5.0 lb (2.3 kg)</td>
</tr>
<tr>
<td>K. Lift up at shoulder height – 2 hands</td>
<td>4.7 lb (2.1 kg)</td>
<td>7.0 lb (3.2 kg)</td>
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<tr>
<td>L. Lift up at elbow height – 2 hands</td>
<td>7.7 lb (3.5 kg)</td>
<td>11.5 lb (5.2 kg)</td>
</tr>
<tr>
<td>M. Press down at elbow height – 1 hand</td>
<td>12.8 lb (5.8 kg)</td>
<td>19.2 lb (8.7 kg)</td>
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</table>
# Tool Guidelines

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Dimension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Handle Length</td>
<td>3.8”–6.0” (95–152 mm)</td>
<td>Distance from base to top of handle</td>
</tr>
<tr>
<td>B. Power Grip Handle Diameter</td>
<td>1.2”–1.7” (30–43 mm)</td>
<td>Diameter throughout entire grasping area</td>
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<tr>
<td></td>
<td>Tool Weight</td>
<td>Max. 4 lb (1.8 kg)</td>
</tr>
<tr>
<td>C. Precision Grip Handle Diameter</td>
<td>0.3”–0.6” (8–15 mm)</td>
<td>Diameter throughout entire grasping area</td>
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<tr>
<td></td>
<td>Tool Weight</td>
<td>Max. 1 lb (0.5 kg)</td>
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<tr>
<td>D. Handle Span Fully Closed</td>
<td>Min. 2” (51 mm)</td>
<td>Distance between the two outer grasping surfaces of the tool</td>
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<tr>
<td>E. Handle Span Fully Open</td>
<td>Max. 3.5” (89 mm)</td>
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# Did It Work?

## Before

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<tr>
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<th>Left</th>
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<tbody>
<tr>
<td><strong>Hand/Wrist</strong></td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
<td>HIGH</td>
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<td><strong>Elbow</strong></td>
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<td><strong>Belt Sanding/Sink</strong></td>
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## After

<table>
<thead>
<tr>
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<th>Left</th>
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</thead>
<tbody>
<tr>
<td><strong>Hand/Wrist</strong></td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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</tr>
<tr>
<td><strong>Elbow</strong></td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
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<td>Medium</td>
<td>Low</td>
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</tr>
<tr>
<td><strong>Shoulder</strong></td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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<td>Low</td>
<td>Low</td>
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</tr>
<tr>
<td><strong>Belt Sanding/Sink</strong></td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
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<td>Low</td>
<td>Low</td>
<td>Medium</td>
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Characteristics of World Class Companies

- Establishing common minimum program requirements in the form of a standard or guideline, with the expectation that each site organization develops a local program that best fits their needs, organization, and resources.
- Establishing key program measures and routinely reporting and tracking progress at the site, business, and enterprise levels.
- Using a limited set of common risk assessment tools to simplify the assessment process and establish a common language and measure.
  - Assessment tools include thresholds of acceptability that translate into High, Medium, and Low risk.
    - Using a qualitative screening tool to identify visible indicators of ergonomic issues.
    - Using quantitative risk assessment tools to measure exposure to ergonomic risk factors.
Recommended Strategic Elements

1. Policy
   - Focus on reduction of MSD risk.
   - Manage as an improvement process.
   - Align with an existing, non-safety, initiatives.
   - Define roles and responsibilities at all levels.
   - Establish a common leading goal for risk reduction and measure of results.
   - Assign leadership to engineering or operations.
   - Establishing a Sponsor within senior level management.

2. Planning

3. Implementation and Operation
   - Provide process managers formal training to support and lead the overall ergonomics process.
   - Provide common set of risk assessment tools and engineering design guidelines.
   - Include ergonomics in Kaizen Events.

4. Checking and Corrective Action
   - Conduct follow up assessments.
   - Conduct detailed review of site ergonomics process/program.

5. Management Review
   - Hold engineers accountable for the quality of new processes and equipment.
   - Establish a library of effective solutions to share and duplicate at similar operations.

Highest rate of improvement
The Road to World Class

Phase 4: Establish Accountability and Audit to Sustain Process (Site)

- Process Audits (Based on Required Minimum Expectations)

Phase 3: Establish Internal Expertise and Management System for Continued Improvement

- Senior Commitment
- Support Infrastructure
- Training
- Methods and Tools
- Risk Assessments
- Reduce Hazards
- Validate Risk Reduction

- Leadership
- Assessment
- Engineering
- Supervisor/Mgr
- Employee

- Guidance Doc
- RAPID Events
- Hit List
- BRIEF
- BEST
- NIOSH L.E.
- Design Guide
- RPM
- Ergopoint Office Suite
- Solution Sheets

- Medical Mgmt
- Return to Work

- Repeat Effective Solutions
- Reactive
- Humantech assessment
- Ergo Team assessment
- Proactive
- Design review
- Ergonomics approval

End Results
- Reduce I/I Rate
- Improve Wellness
- Ensure Compliance
- Decrease WC Cost

Communication

Measurable Goal
Required Minimum Expectations
Roles and Responsibilities

Ergonomics Standard (Audit Criteria)
Ergonomics Maturity Curve
Questions & Discussion

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www.humantech.com
www.the30inchview.com
Handbook of Ergonomic Design Guidelines

All the ergonomic design guidelines are from Humantech’s *Handbook of Ergonomic Design Guidelines*