Musculoskeletal Disorders – Why bother?  
Applied examples and risk management methods

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Ergonomics Conference in Tallinn October 10, 2013 arranged by the Ministry of Social Affairs, Estonian Ergonomics Society and the Estonian University of Life Sciences
Ergonomics and its two objectives

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 methods to design in order to optimize human well-being and overall system performance. [IEA, 2000]
Some statistics on work and MSDs

About 60% of all sickness absence in the EU can be attributed to musculoskeletal problems. [Eurostat, 2010]

A study with 15,000 workers in the EU shows a clear trend of work intensification over the last decades. [Parent-Thirion et al., 2007]

There is a trend of increased occurrence of work-related health problems in the EU, where MSDs play a major part. [Eurostat, 2010]

MSDs form 0.5 - 2% of GNP in the EU [Hemphälä & Nylén, 2013]

Effects on individuals, organisations and societies

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50% of all born today may achieve the age of 92. [SCB, 2013]

Many abilities decline with age [Ilmarinen, 1992; Grandjean, 1980]

In several professions many employees cannot work until retirement age, due to MSDs, e.g. in the construction industry. [Byggnads, 2013]

Needs: to stay healthy & work longer & for sustainable jobs

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How to tackle MSDs?

Awareness – Knowledge – Methods – Systematic work – Communication & co-operation - Power

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Awareness... Example of Economic effects of the working environment at company level

"Old" ladle-handling: Quality problems, production stops, accidents and illnesses at SSAB

New, improved methods for handling ladles

Investment 11 million SEK
"Saving" 5 million SEK/year

[Abrahamsson, 2000]

Or 110 years for ROI?

[Diagram showing pie chart with the following breakdown:
- Quality Improvements: 59%
- Productivity improvements: 39%
- Reduced direct sick-leave costs: 2%]

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Informed decision making...
Systematic review evaluating Human & System Effects (N = 38) [Neumann & Dul, 2010]

Table: Evaluation of effects. Number of papers (%)

<table>
<thead>
<tr>
<th>System effects</th>
<th>Human effects</th>
<th>Negative (-)</th>
<th>Positive (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative (-)</td>
<td>3 (8%)</td>
<td>1 (2.5%)</td>
<td></td>
</tr>
<tr>
<td>Positive (+)</td>
<td>1 (2.5%)</td>
<td>33 (87%)</td>
<td></td>
</tr>
</tbody>
</table>

In 95% of the studies a co-variation between Human & System effects was found.

"Take home message"

Conclusion regarding "balancing"?

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Some paths to improvements

- Dialogue - Look, talk, and LISTEN - and fix early
- Systematic approach (use methods, check equipment, flow, working techniques, ...)
- Observational methods (observe, checklists, ...)
- Subjective methods (interviews, surveys, Borg scales, ...)
- Technical measurement and calculation methods (biomechanics, EMG, force, vibration, light, repetitiveness, ...)
- Training and education methods (job introduction, technique, ...)
- Risk assessment methods (RULA, REBA, NIOSH equation, ...)
- Risk management methods (OHSCO, SCA & MAWRIC, RAMP, ...)
- Development methods (technical, organisational, technique, ...)

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Example of systematic approach:

OHSCO MSD prevention guidelines

[Occupational Health and Safety Council of Ontario, OHSCO]
Examples of risk assessment methods in an applied example: Veterinarians work in and around their cars

[Rose & Larsson, 2006]

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Biomechanical analysis (with “Jack”)

Based on the NIOSH equation [Waters et al, 1993]

• The compression force exceeds the recommended force limit 3400 N.
• The shear force is near the limit 1000 N.

Actions should be taken to reduce the strain and the injury risks.

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RULA, Rapid Upper Limb Assessment

[Mc Atamney & Corlett, 1993]

Method: Positions of 7 body regions are assessed. Assessment for left and right hand/arm. Score based on body part assessments, handled load weight and type of movements (dynamic or static). The higher the score, the higher the risk.

Result: Investigation & changes are required immediately

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[Rose & Larsson, 2006]
An example of “ergonomic design” – Why engineers need ergonomics competence

Basic knowledge is vital

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An example of technical development and examples of some analysis methods

Trying to move material carriages, brick trolleys, et c over obstacles …

Reflect on how you would tackle the problem

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Material carriages with a new type of wheel suspension

Movie time 😊 !

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Evaluation results

With the new suspension:

- Easier to climb obstacles
- Less force needed
- Fewer and smaller “jerks”
- Lower physical load
- Lower risk for sudden stoppages
- Lower risk to lose load & of injury

A technical solution for a wide range of application

[Rose, 2004]

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Risk Management Methods

Different approaches, for example:

Risk assessment & action guidance
- RAMP

Risk assessment & time aspects as a decision base
- Ergo-Index

Risk assessment, financial effects & action guidance
- SCA & MAWRIC

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RAMP: Risk management Assessment tool for Manual handling Proactively

Background

Objective

- Freely accessible method for risk assessment for manual handling
- Including suggestions for changes
- Development in co-op with users

Need for a load ergonomics assessment tool in Sweden and globally

Initiative from Arla Sweden. Co-op project with interactive methodology

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RAMP- a two-level Risk Management tool under development

RAMP I - Checklist - Physical risk factors for manual material handling
1. Movements and repetitive work
2. Lifting, carrying or holding loads
3. Pushing or pulling work
4. Influencing factors
5. Reports on physically strenuous work
6. Perceived physical discomfort

RAMP II - Repetitive manual material handling work
1. Time score
2. Posture
3. Repetitive movements
4. Force: lifting, holding or carrying & pushing or pulling
5. Recovery
6. Influencing factors

RAMP II - Pushing and pulling work
Pushing or pulling force (one or two hands)
Worsening factors

RAMP II – Lifting, holding and carrying work
Working conditions
Posture + weight + duration/frequency/time

Department | Department A | Department B
---|---|---
High risk | 2 | 2 |
Increased risk | 2 | 1 |
Low risk | 10 | 10 |

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### Draft of possible results presentation

<table>
<thead>
<tr>
<th>Questions</th>
<th>Assessment</th>
<th>Planned Action</th>
<th>When/Who</th>
<th>Done</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Arbetställningar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Hand/händer över axelhöjd</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1.2 Knästående/hukstittade</td>
<td></td>
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<tr>
<td>1.3 Böjd överkropp</td>
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<tr>
<td>1.4 Vriden överkropp</td>
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</tr>
<tr>
<td>2. Manuell hantering</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Framåtböjd &amp; vriden överkropp, eller knästående/hukstittande</td>
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<tr>
<td>2.2 Lyft från knästående</td>
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<tr>
<td>2.3 Hantering av laster</td>
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<tr>
<td>2.4 Last över axelhöjd eller under knähöjd</td>
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<tr>
<td>3. Skjuta- och dra-arbete</td>
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</tr>
<tr>
<td>3.1 Skjutarbete med två händer</td>
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<td></td>
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<tr>
<td>3.2 Skjutarbete med en hand</td>
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</tr>
<tr>
<td>3.3 Dragarbete med två händer</td>
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<tr>
<td>3.4 Dragarbete med en hand</td>
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<tr>
<td>4. Repetitivet</td>
<td></td>
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</tr>
<tr>
<td>4.1 Repetitiv manuell hantering</td>
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<tr>
<td>4.2 Arbetssykeln</td>
<td></td>
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<tr>
<td>5. Fysikaliska faktorer</td>
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</tr>
<tr>
<td>5.1 Hand-arm vibrationer</td>
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<td></td>
</tr>
<tr>
<td>5.2 Hinkroppsvibrationer</td>
<td></td>
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</tr>
<tr>
<td>6. Förvärrende faktorer</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>6.1 Kalla och varma temperaturer</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6.2 Belysning</td>
<td></td>
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<tr>
<td>6.3 Handen som släende redskap</td>
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<tr>
<td>6.4 Utbildning</td>
<td></td>
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</tr>
<tr>
<td>6.5 Påverkan på hur arbetet utförs</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>6.6 Precision i hantering</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>6.7 Bära objekt långa distanser</td>
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<tr>
<td>6.8 Objektets utformning</td>
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<tr>
<td>7. Subjektiv bedömning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1 Upplevelse av obehag och markering var på kroppen</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

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Suggestions for actions: An example:
If work with hand/ hands above shoulder height occurs
- Carry out RAMP 2 analysis
- Change the working posture so that work above shoulder height is avoided
- ...
Possible Results Summary 2 for management level

<table>
<thead>
<tr>
<th>Department</th>
<th>Department A</th>
<th>Department B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A1</td>
<td>A2</td>
</tr>
<tr>
<td>High risk</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Increased risk</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Low risk</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Analyse further</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

A base informed decision making and for prioritization

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The Ergo-Index method for comparing jobs

Different ways to study time aspects

Chisseling/drilling in concrete wall

I: No support    II: With support  [Glimskär et al.]

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Traditional comparison

UNIT TIME

ERGONOMICS

ECONOMICS

Minutes/hole

3

2

1

3000

2000

1000

N

SEK/hole

Cost for drilling

Cost for support

5.85

6.13

Would you invest in alternative II?

[Glímskær et al.]

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Ergo-Index comparison

PRODUCTION TIME

- Minutes/hole

<table>
<thead>
<tr>
<th></th>
<th>Recovery</th>
<th>Drilling</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

ECONOMICS

- SEK/hole

<table>
<thead>
<tr>
<th></th>
<th>Cost for drilling</th>
<th>Cost for support</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5.85</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>3.50</td>
<td></td>
</tr>
</tbody>
</table>

Would you invest in alternative II? [Glimskär et al.]

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An applied example

Ergo-Index results

Borg’s CR-10 & body map

Discomfort rating: 6

Discomfort rating: 0.5

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[Rose, 2012]
MAWRIC: Method to Analyse Work related Risks, Improve work environment and estimate total Cost

Studied work task

Risk identification

Risk assessment

Estimation of costs

Suggestions for risk reduction

Acceptable risks?

Action

Follow-up

Table 3: MAWRIC for drilling in concrete ceilings. The classification follows a five-grade scale where A and I represent lowest value and E and V the highest (Figure 2, Table 1 and Table 6).

<table>
<thead>
<tr>
<th>Task</th>
<th>Risk/problem</th>
<th>Probability</th>
<th>Consequence</th>
<th>Risk estimation</th>
<th>Cause/ comment</th>
<th>Cost per man-year</th>
<th>Measure</th>
<th>Probability</th>
<th>Consequence</th>
<th>Risk estimation</th>
<th>Cost per man-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling in concrete ceiling</td>
<td>Overexertion</td>
<td>Cs</td>
<td>Ck</td>
<td>IV</td>
<td>Poor posture high forces</td>
<td>14 550 SEK</td>
<td>Use support</td>
<td>Bs</td>
<td>Bk</td>
<td>II</td>
<td>2 405 SEK</td>
</tr>
<tr>
<td></td>
<td>Jerk when hitting reinforcement rods</td>
<td>Cs</td>
<td>Bk</td>
<td>II</td>
<td>Large forces, rapid event</td>
<td>5 290 SEK</td>
<td>Use support</td>
<td>Bs</td>
<td>Bk</td>
<td>II</td>
<td>2 405 SEK</td>
</tr>
<tr>
<td></td>
<td>Particles in eyes</td>
<td>Ds</td>
<td>Bk</td>
<td>III</td>
<td>Concrete particles</td>
<td>16 111 SEK</td>
<td>Use drill with dust cleaner</td>
<td>As</td>
<td>Ak</td>
<td>I</td>
<td>94 SEK</td>
</tr>
<tr>
<td></td>
<td>Respiratory</td>
<td>Bs</td>
<td>Ck</td>
<td>III</td>
<td>Concrete dust</td>
<td>6 614 SEK</td>
<td>Use drill with dust cleaner Use safety goggles</td>
<td>As</td>
<td>Ak</td>
<td>I</td>
<td>94 SEK</td>
</tr>
<tr>
<td></td>
<td>Allergy</td>
<td>Cs</td>
<td>Bk</td>
<td>II</td>
<td>Concrete</td>
<td>5 290 SEK</td>
<td>Use drill with dust cleaner</td>
<td>As</td>
<td>Ak</td>
<td>I</td>
<td>94 SEK</td>
</tr>
<tr>
<td></td>
<td>Vibrations</td>
<td>Ds</td>
<td>Ck</td>
<td>IV</td>
<td>From drill to hand</td>
<td>44 314 SEK</td>
<td>Use support Use &quot;good&quot; drill</td>
<td>As</td>
<td>Ak</td>
<td>I</td>
<td>94 SEK</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
<td>Ds</td>
<td>Ck</td>
<td>IV</td>
<td>From drill to hand</td>
<td>44 314 SEK</td>
<td>Use ear muffs</td>
<td>As</td>
<td>Ak</td>
<td>I</td>
<td>94 SEK</td>
</tr>
<tr>
<td></td>
<td>Falling individual</td>
<td>Bs</td>
<td>Ck</td>
<td>III</td>
<td>From ladder or suchlike</td>
<td>6 614 SEK</td>
<td>Use support</td>
<td>As</td>
<td>Ak</td>
<td>I</td>
<td>94 SEK</td>
</tr>
<tr>
<td></td>
<td>Falling object</td>
<td>Cs</td>
<td>Bk</td>
<td>II</td>
<td>Drill after getting stuck in rods Concrete particles</td>
<td>5 290 SEK</td>
<td>Use support Use helmet</td>
<td>Bs</td>
<td>Bk</td>
<td>II</td>
<td>2 405 SEK</td>
</tr>
</tbody>
</table>

Partial sum: 148 387 SEK, 7 779 SEK
SUM after time weighting factor (2% of working time): 2 968 SEK, 156 SEK

Paper presented at the 18th ESReDA seminar
Risk Management and Human Reliability in Social Context
Karlstad Sweden June 15 – 16, 2013

[Rose, 2001; Rose & Örtengren, 2000]

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Possible MSD risk reducing actions - experience based advice -

- Listen and co-operate. Team-work is often needed and company culture has an impact.

- Work systematically, use adequate methods and a holistic approach.

- Develop, evaluate and implement technical solutions, involving the end-users in the process.

- Supply education, good work technique information & training - early and good introduction to jobs.

- Work with organisational solutions: scheduling, job rotation patterns, job content, et cetera

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Etu (ja töö) ootab

Üle purde
teisel kaldal
ELU ootamas.
On ilus samal hetkel
küll ette, küll
taha vaadata
või valida rada,
kus aeg nagu
virvatuli
kutsüh ja vilgub.

[Rose, 1985] [Orrenius, 2013]
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References 1(3)

- Glimskär et al. Presentation material developed at BELAB, Byggergolab AB, during the 1980-1990’es.

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References 2(3)


References 3(3)