# Ergonomic assessments – A Must for Successful Design of Workplaces and Industrial Processes

*Prof. K. Landau*
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# Agenda

7. Conclusions

1. The need for ergonomic job design

6. Validation


2. Stress at the workplace

5. A case study – just for a laugh

3. Overview of ergonomic assessments

4. TiCon and MTM ergonomics

# Agenda


1. The need for ergonomic job design
2. Stress at the workplace
3. Overview of ergonomic assessments
4. TiCon and MTM ergonomics
5. A case study – just for a laugh
6. Validation
7. Conclusions

# A recent case that occurred during reorganization of an insolvent automotive component supplier:

- Objective of insolvency administrator: increase in productivity by further improvements in worker performance
- “Tarting up the bride” to make the company attractive to a purchaser

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- Our mission: to cut cycle times from 29 s to 24 s
- Average **age** of manual workers: **46 years**
- What is going to happen to those workers 10 years from now if the planned productivity increase is achieved?

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# Cycle time 12 seconds→ at the age of 60 years?

- We don‘t think it‘s a good idea to use ergonomics for the sole purpose of increasing productivity
- It makes it difficult to keep older workers in employment
- It does not guarantee sustainability
- Although a buyer was found for the “tarted-up bride”, that buyer soon found himself faced with serious problems


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# This study shows that…..

- Overbidding your hand (to use a card-playing expression) by cutting down cycle times
  - will not yield sustainable results
  - hinders employment of older workers
  - is not compatible with our understanding of the relationship between productivity and ergonomics



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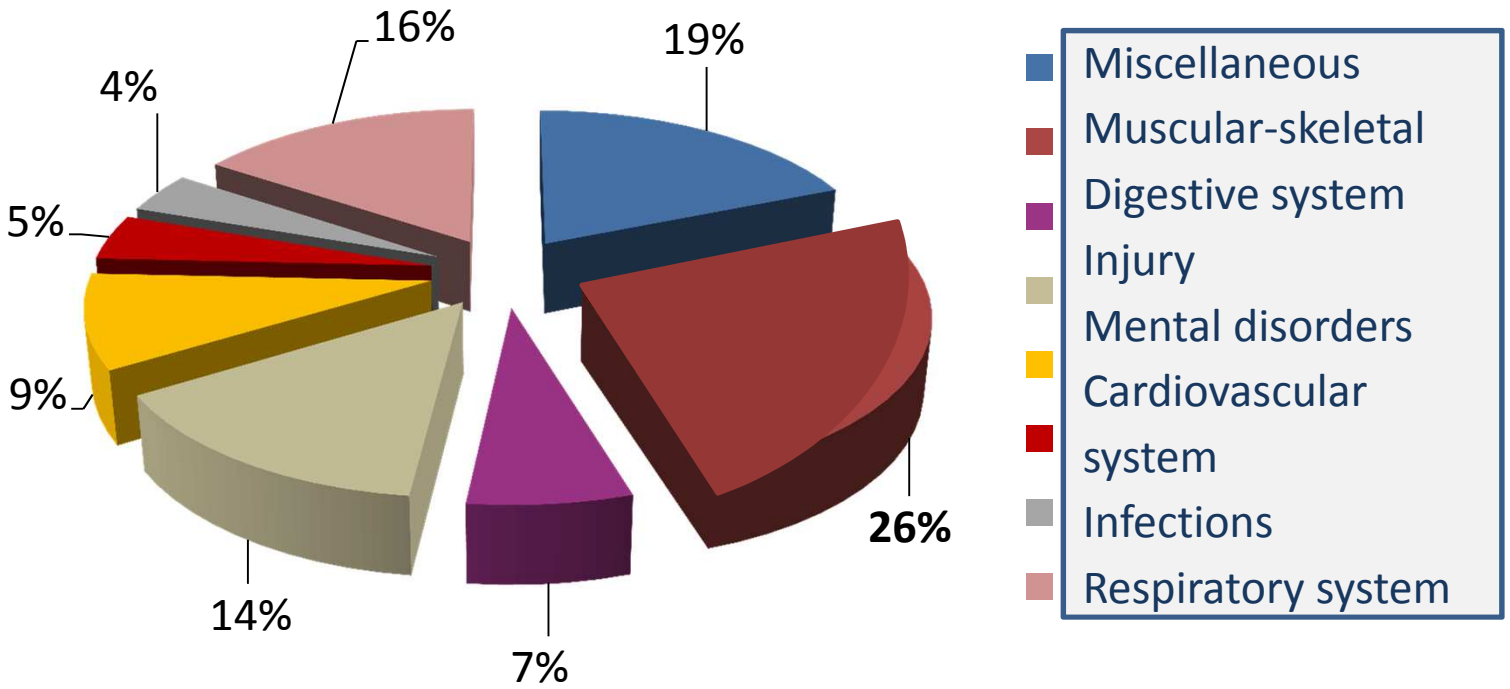
# Most frequent types of industrial diseases in Germany

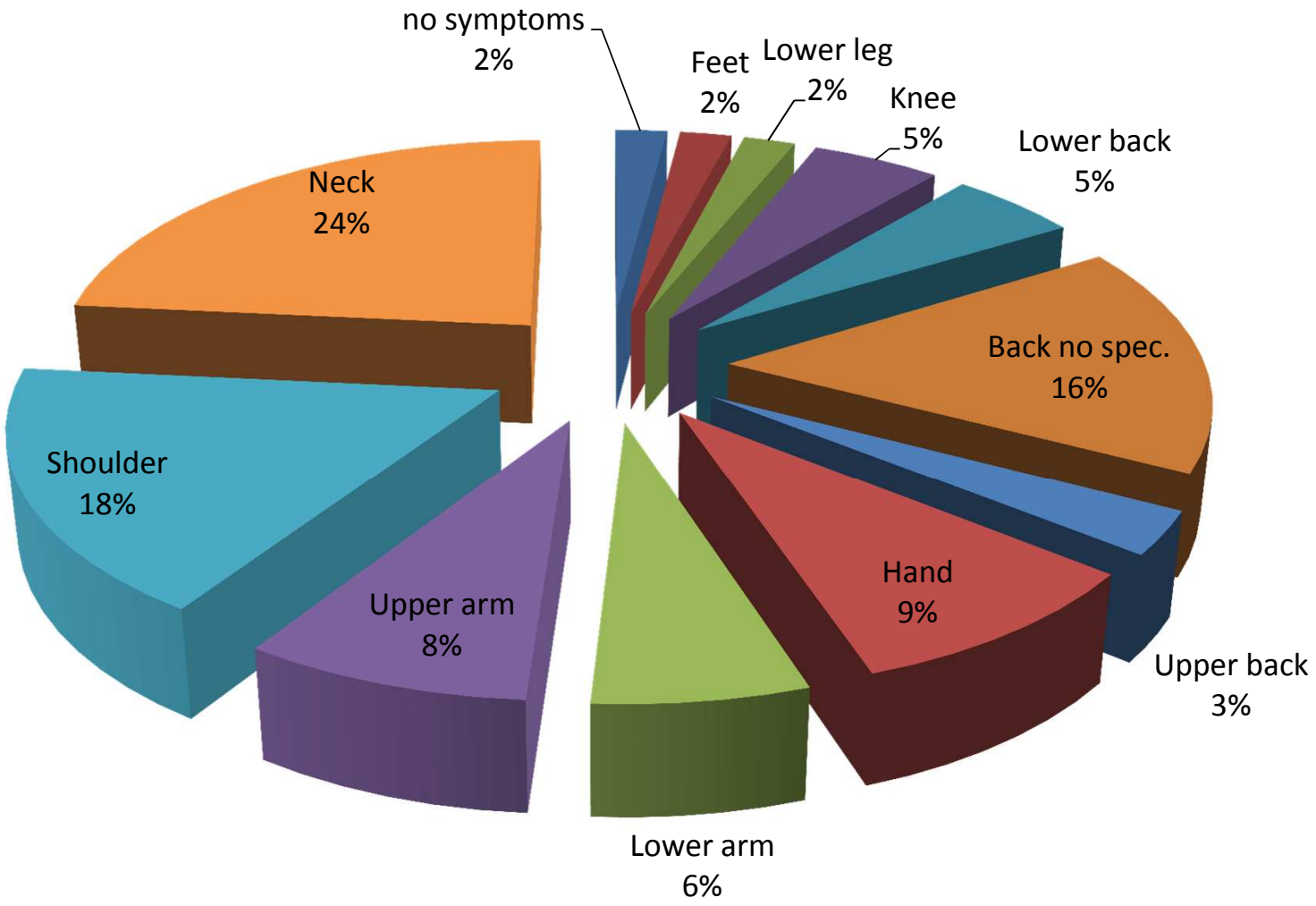
(as % of total days lost through sickness*)



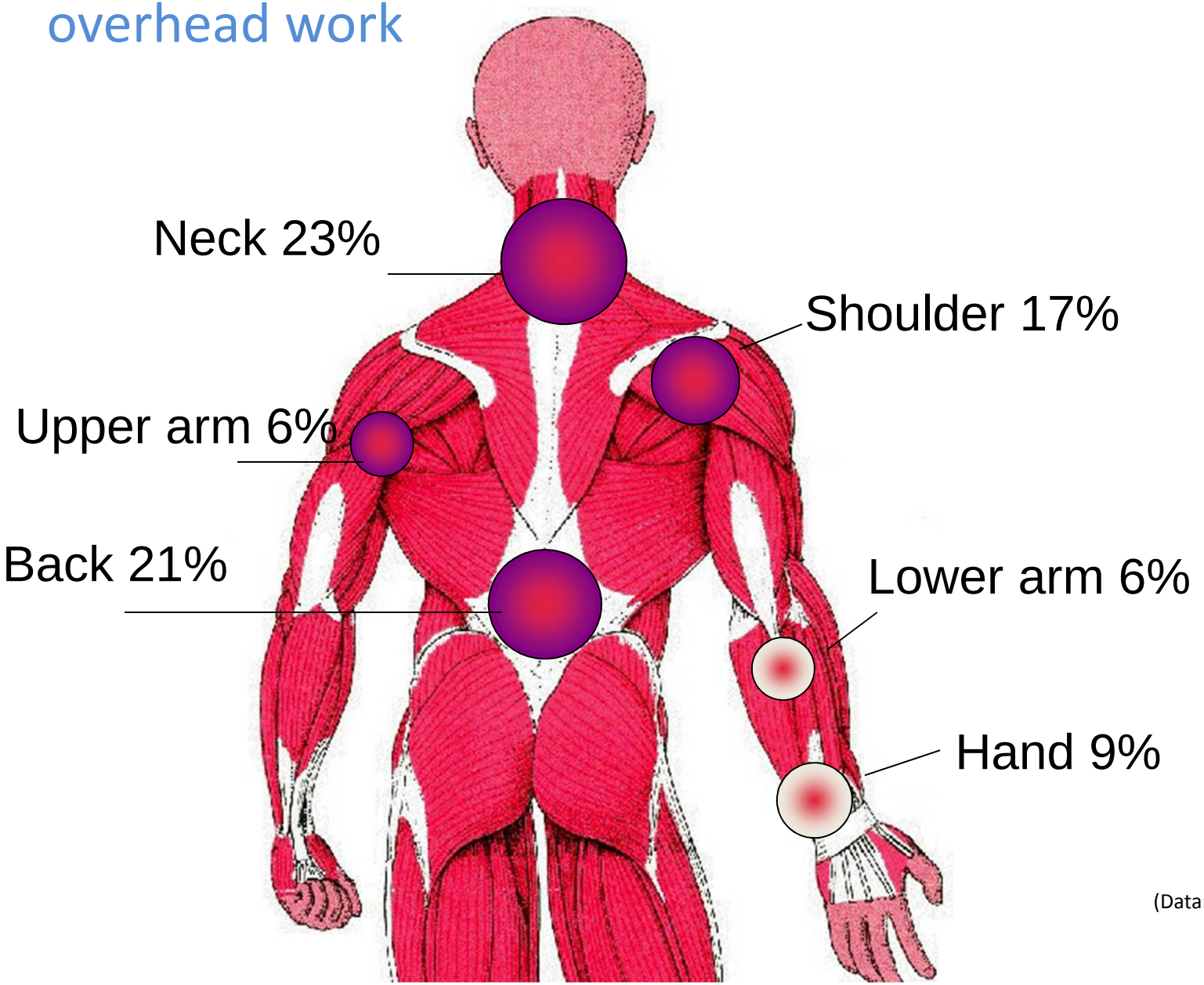

* * of compulsorily insured BKK employees

Source: BKK Health Report 2010

# Percentage distribution of symptoms in overhead work



# Symptom pattern in predominantly overhead work




(Data: G. Winter)

# Pro-active design on the product.... normally yields the best results

Changes in gas spring design

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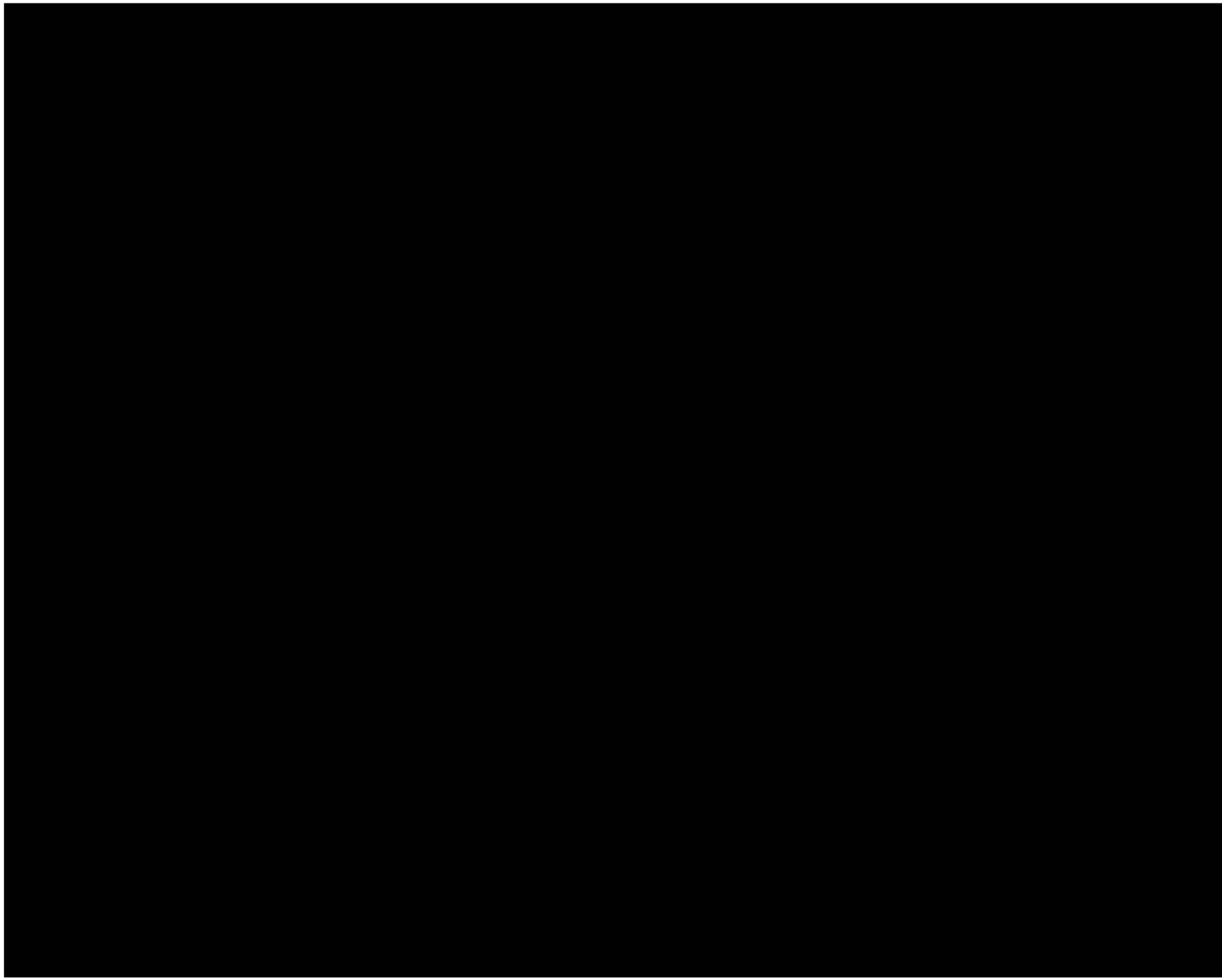
# Faults at product design stage



Component supplier to German automotive industry: Assembling an outside mirror

Motivation
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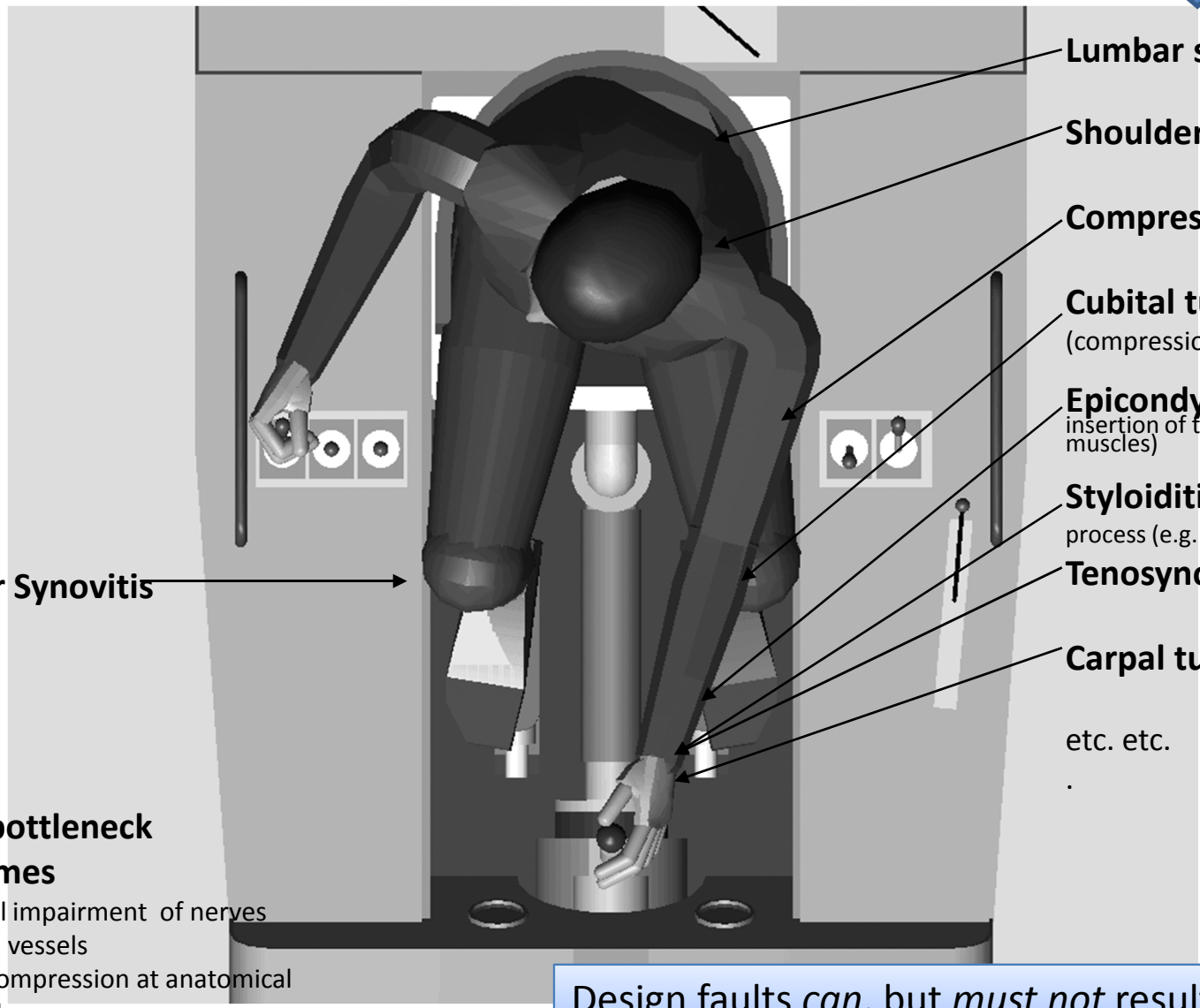
# Example: forklift

Nothing is impossible ……



**Lumbar spine disorders**

**Shoulder-neck symptoms**

**Compression of N. radialis**

**Cubital tunnel syndrome**
(compression in elbow region)

**Epicondylitis** (painful lacerations at insertion of tendons in lower arm muscles)

**Styloiditis** (inflammation of a styloid process (e.g. spoke bone, ulna)

**Tenosynovitis**

**Carpal tunnel syndrome**

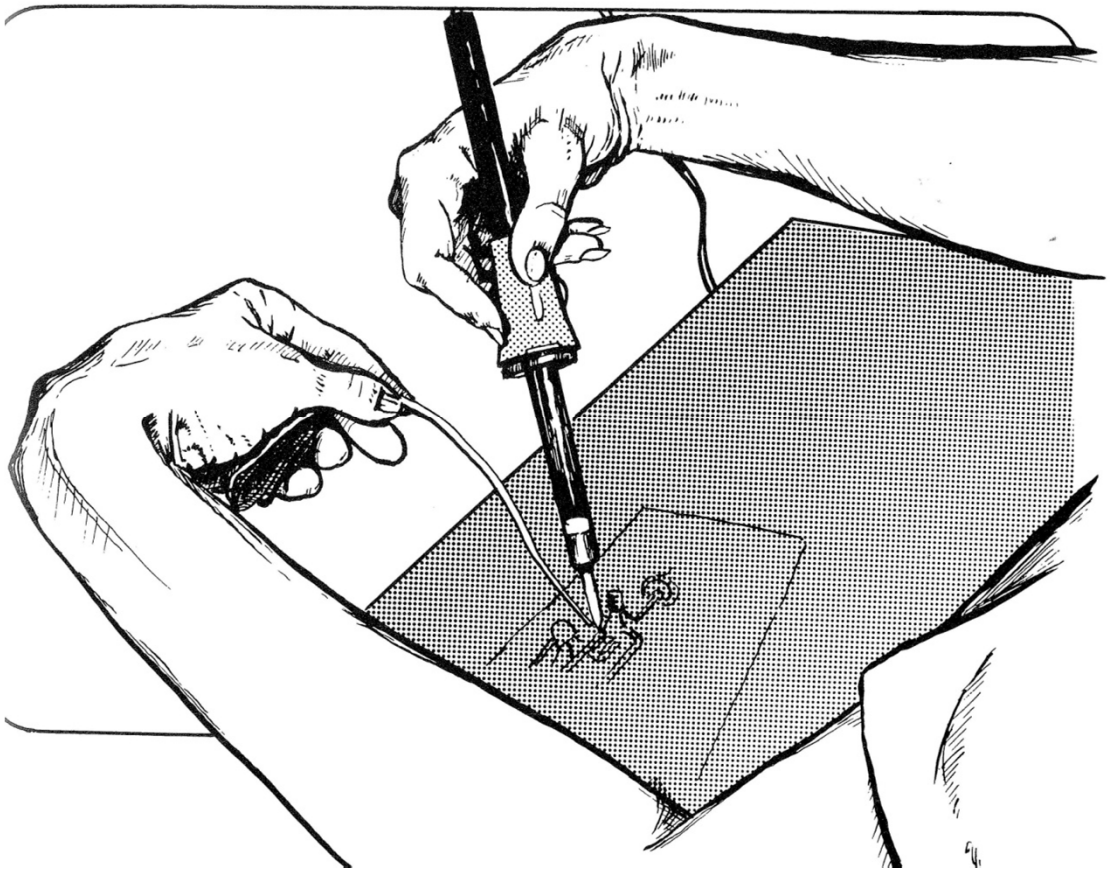
etc. etc.
.

**Patellar Synovitis**

**Other bottleneck syndromes**
Functional impairment of nerves and blood vessels through compression at anatomical bottlenecks

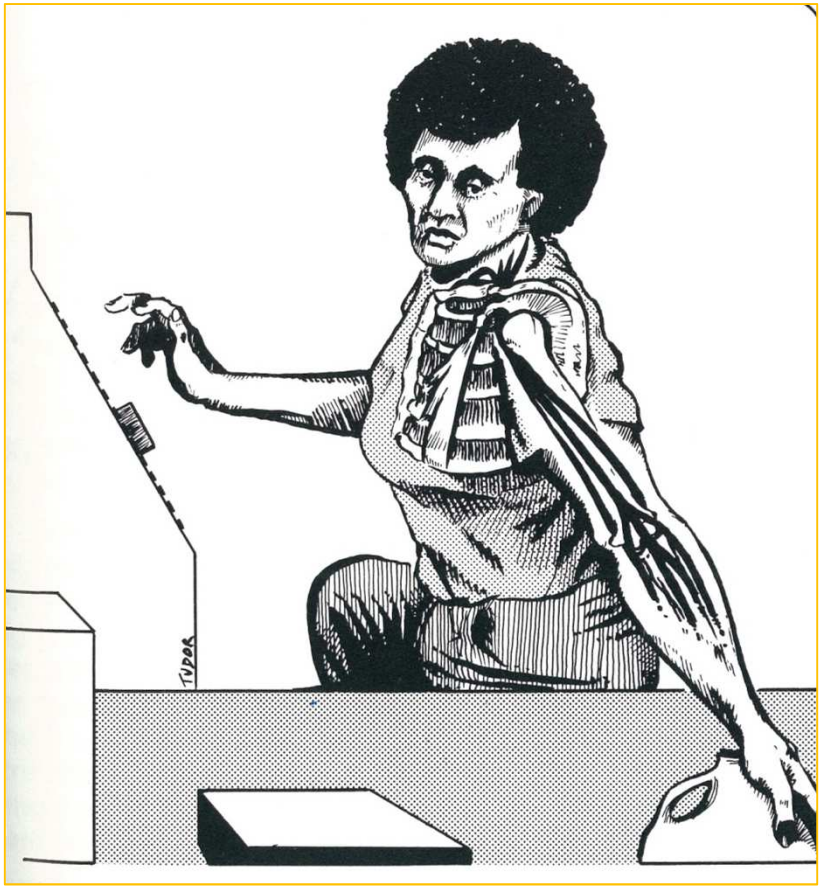
Design faults *can*, but *must not* result in illnesses

# Nothing is impossible ……



(n. Kroemer)

# Nothing is impossible ……



(n. Kroemer)

# Ergonomic workplaces are economical workplaces.

General Motors:
40% of worker absences and 60% of working days lost through sickness are attributable to ergonomic design deficits

The cost price of every German car includes between 50 and 100 euro for workers' musculo-skeletal disorders.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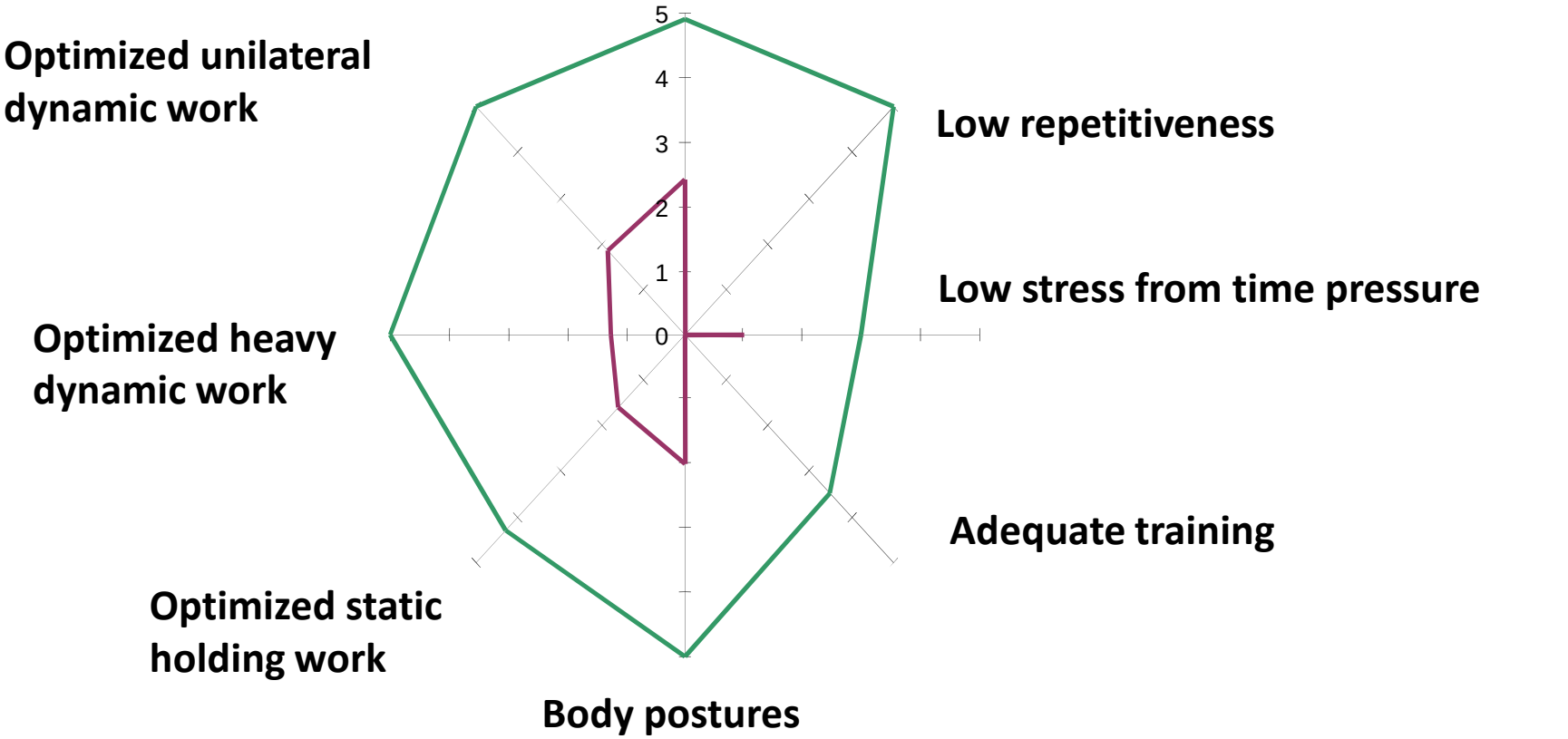
# The car body could be lowered or rotated – but would it pay off?

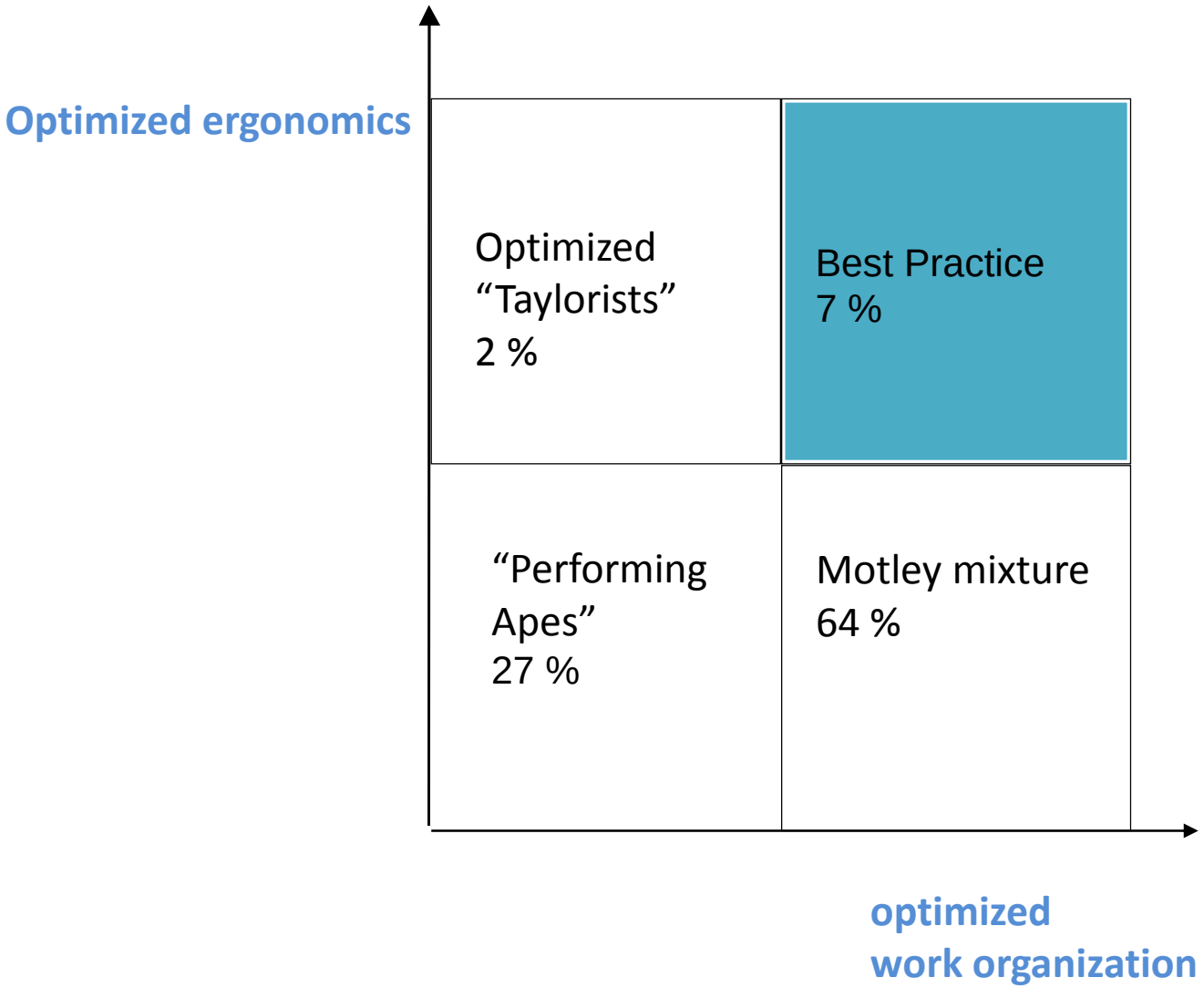
# Benchmarks for assembly work – Best vs. worst practice

Only 7 % qualify as Best Practice



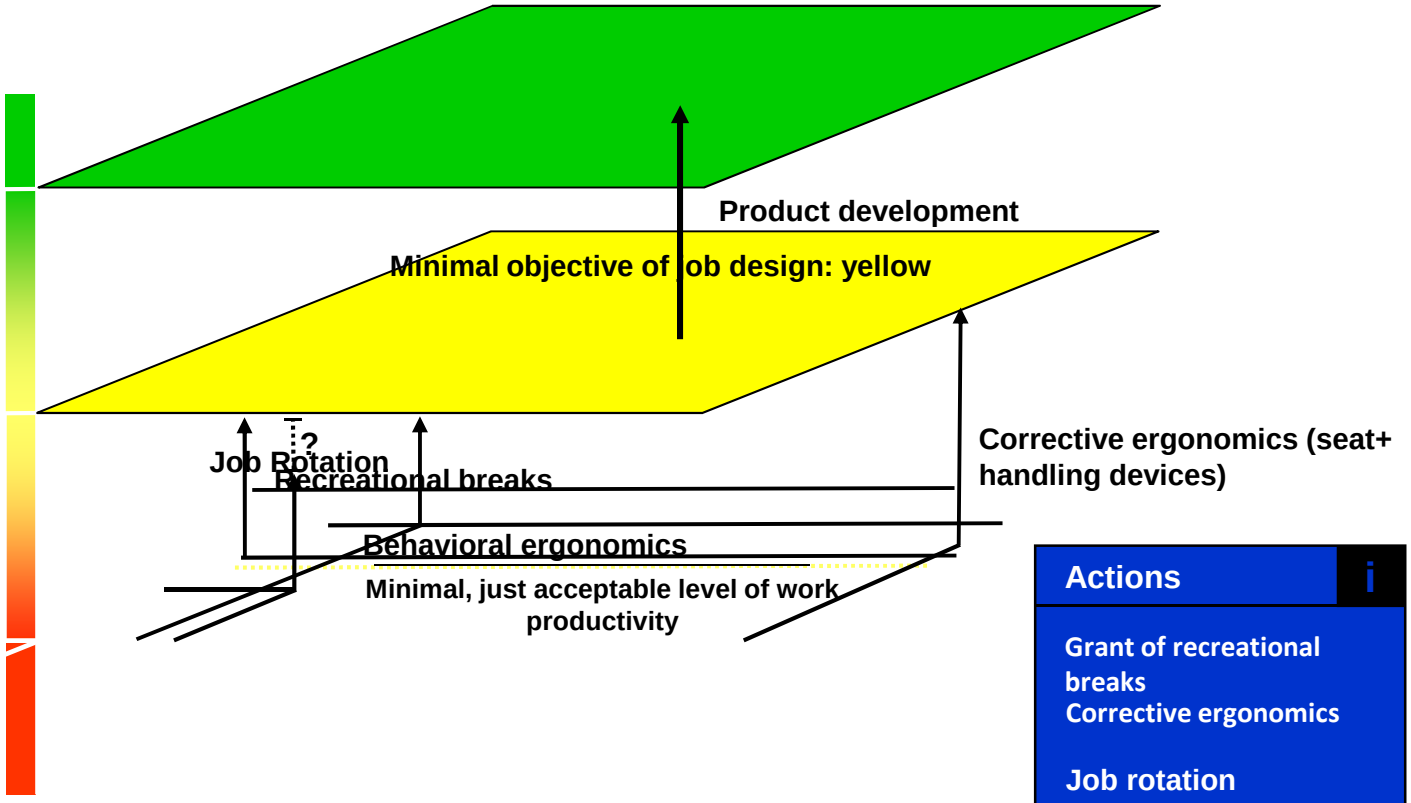

in n = 609 assembly workplaces

# Best-Practice-Tableau




N = 609
Assembly workplaces

# List of available actions




**Actions** i

- Grant of recreational breaks
- Corrective ergonomics
- Job rotation
- Behavioral ergonomics
- Pro-active ergonomics

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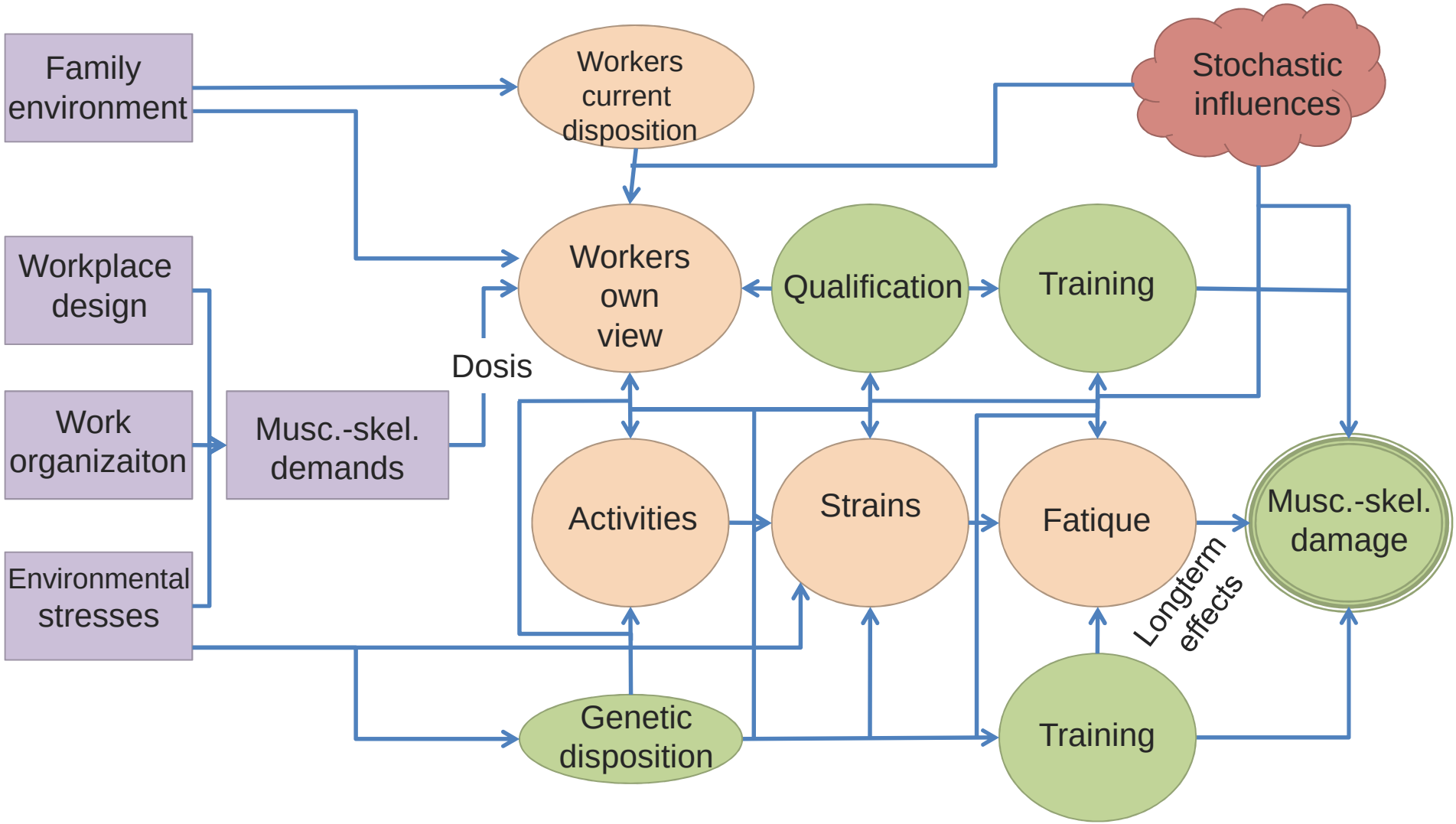
# *Ad hoc* model for symptoms and diseases



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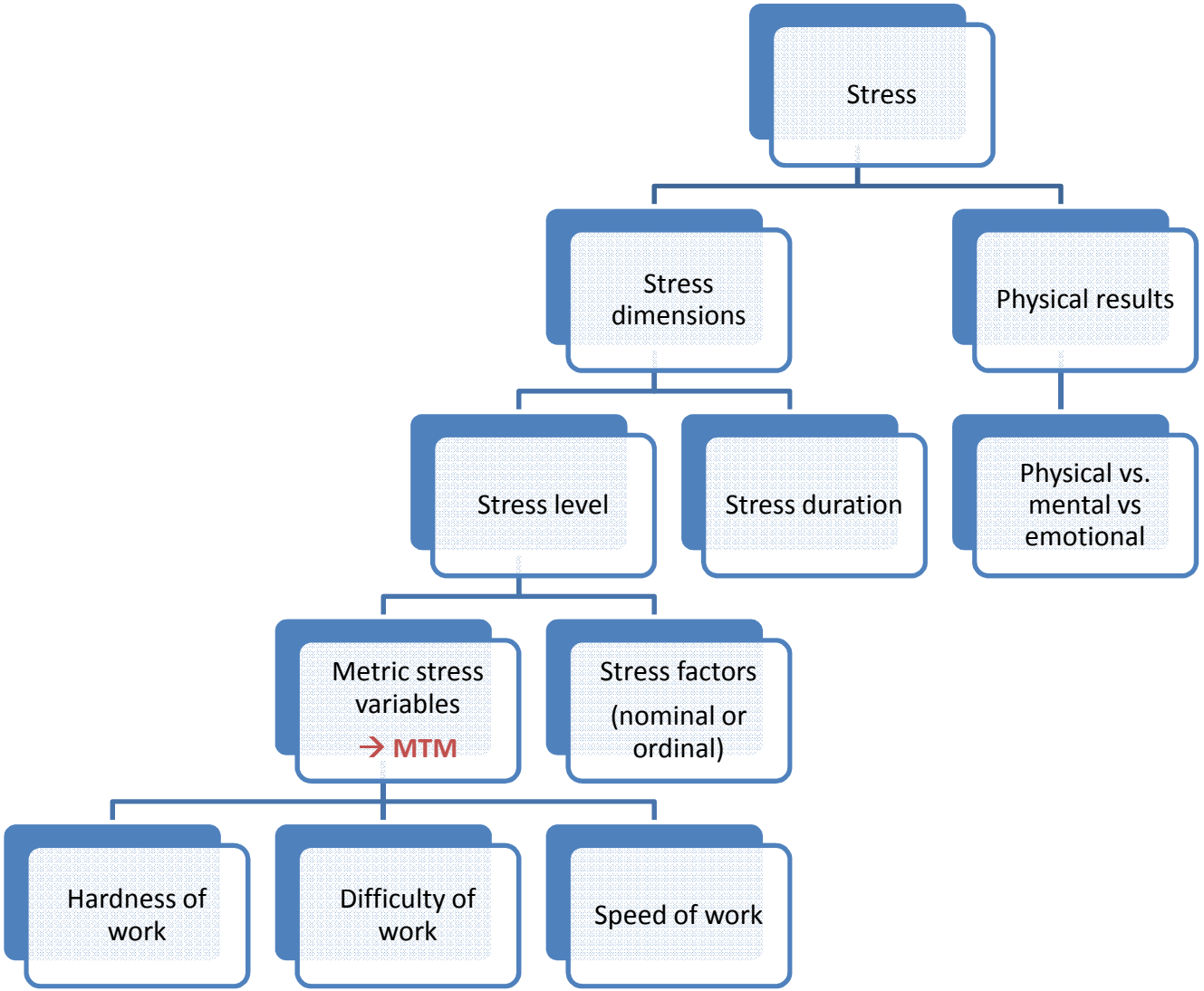
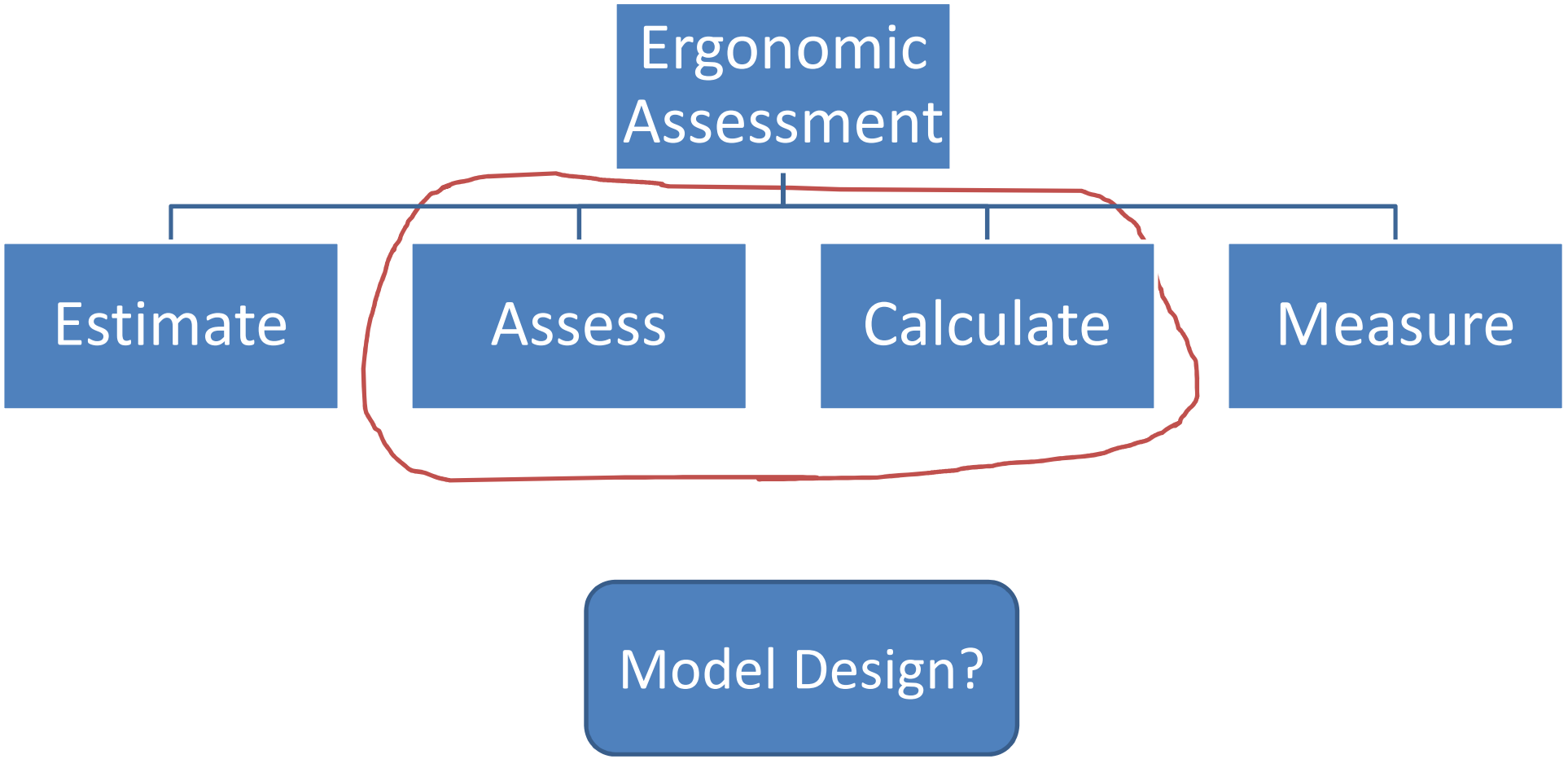
# Overview of stress at the workplace



# Focus of my paper

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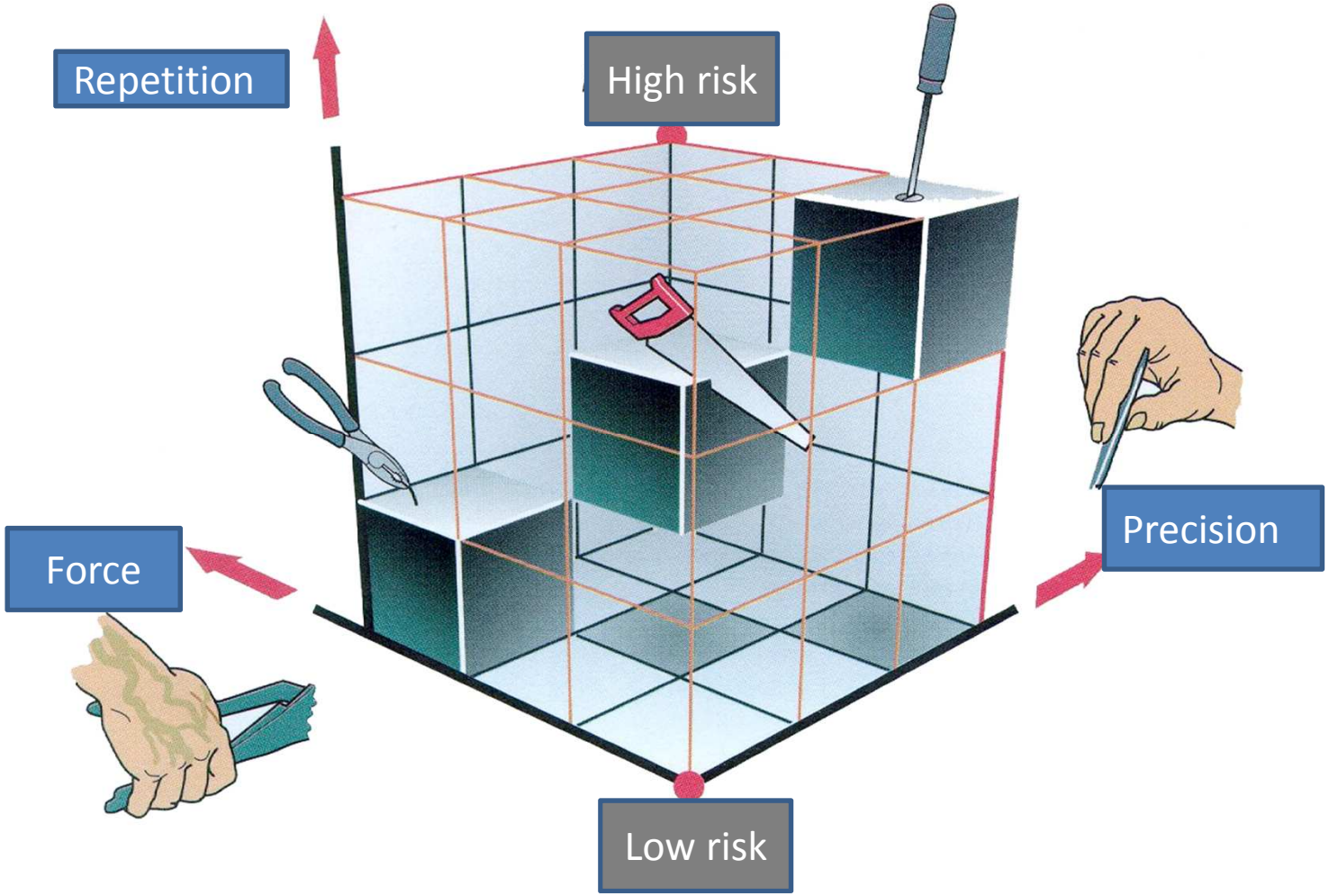
# Cube model

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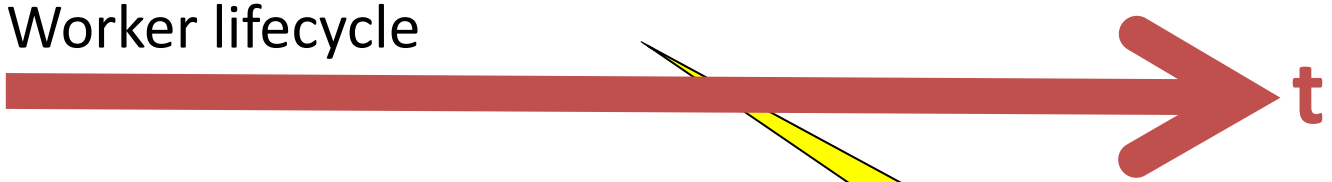
## Product lifecycle


Product idea….Market research…. Prototype…. Pre-production….
Production…. Maintenance…. Disposal

## Worker lifecycle




Qualification….Perfection…. Routine…. Enhanced performance…. Erosion

**The two lifecycles are not synchronized.**

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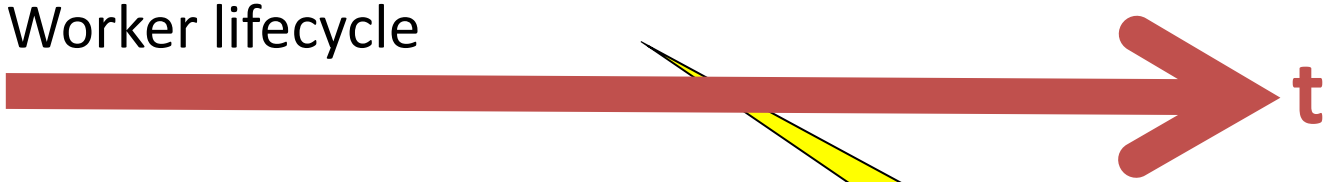
## Product lifecycle


Product idea….Market research…. Prototype…. Pre-production….
Production…. Maintenance…. Disposal

## Worker lifecycle




Qualification….Perfection…. Routine…. Enhanced performance…. Erosion

**Corrective design comes too late.**

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**3. Overview of ergonomic assessments**

## Ergonomic assessments ….

- investigate stresses
- resulting from or associated with the
- interaction of human beings with work materials and work objects
- forming parts of a work system.

# Key Objectives

- Identification and evaluation of weaknesses in job design and organization
- Improvement of job design and organization
- Initiation of action to protect workers
- Coordination of job demands and worker capabilities
- Optimization of labor deployment
- Application of knowledge gained to design of return-to-work programs

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# Key Criteria for an Assessment Procedure

The procedure should…..

- Be based on a theoreticel model that allows a practical interpretation of the results obtained
- Offer a complete coverage of all demands that are present on a specific work system
- Offer maximum cost-effectiveness with regard to application, data processing, and data evaluation
- The application should allow standardisation
- Go beyond a merely verbal work description and allow quantitative statements at least at the ordinal scale level.

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# Key Criteria for an Assessment Procedure

- Standardisation → minimization of confounding variables
- Clear differentiation → Are the test components highly selective?
- Objectivity → Cannot be subjectively influenced by individual analyst?
- Reliability → Intrinsic consistency, long-term stability and repeatability
- Validity → Does the test actually measure what it is supposed to measure?

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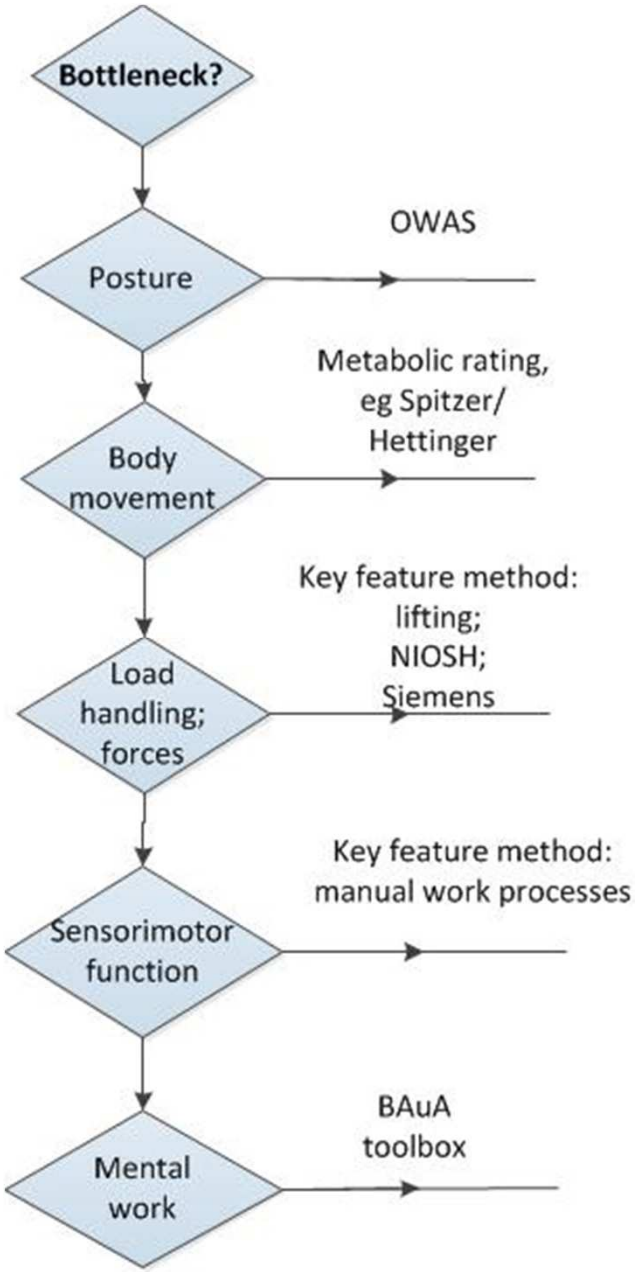
# An overview of available procedures for determination of stress and health risk

http://www.ergo-online.de/site.aspx?url=html/gefaehrdungsbeurteilung/konzepte_verfahren/auswahl_anerkannter_beurteilu.htm

# Stress Accumulations and Examples of Assessment Methods

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## Focus on: Assessment Procedures for Planners

- Industrial planners and developers are still failing to focus their efforts on ergonomic, health-promoting design of work systems and procedures.
- Sensitivity of designers and planners to the need for ergonomic job design should be enhanced.

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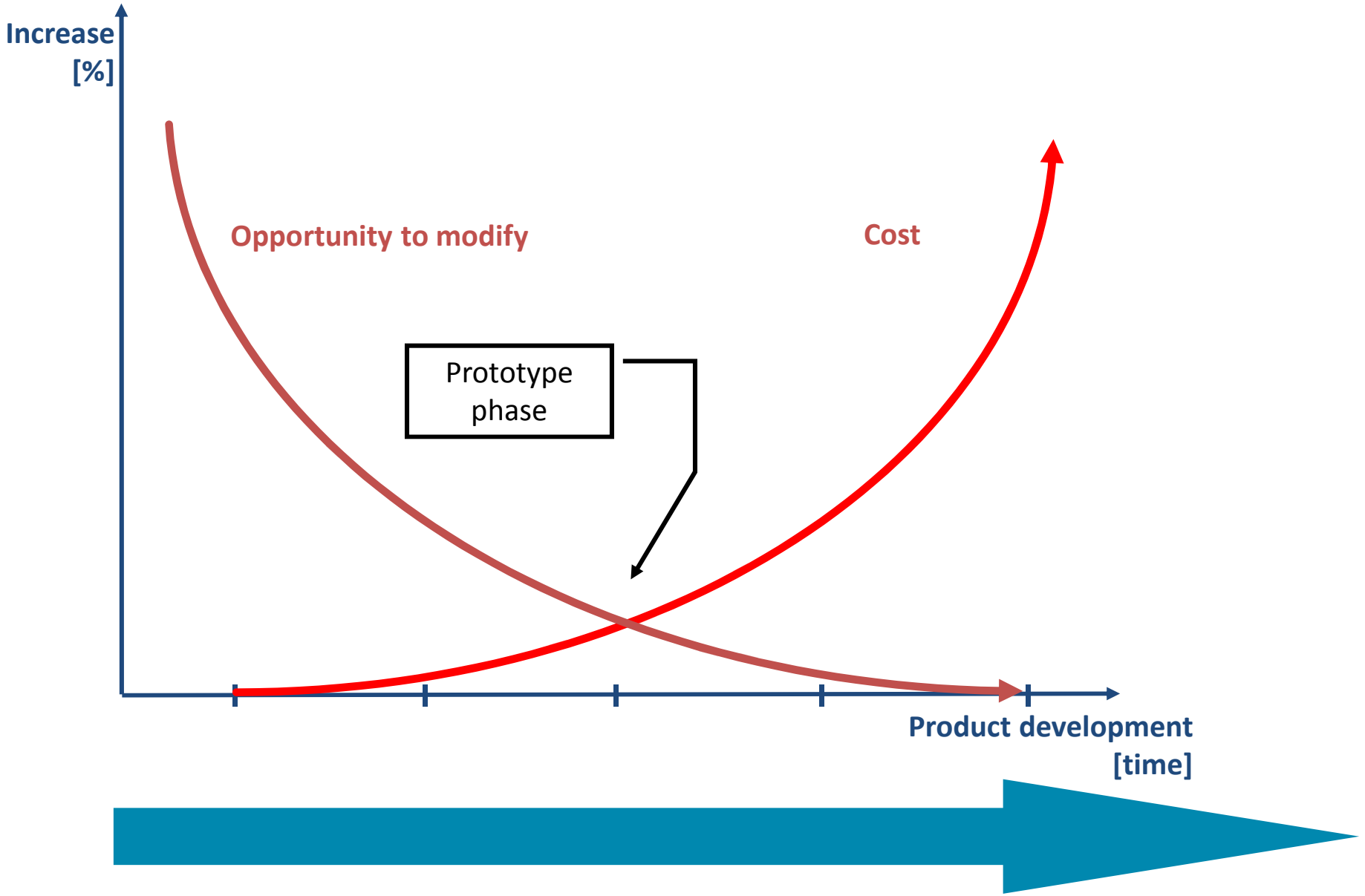
# Relationship between ergonomics and economics

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## Load handling and physical exertion

- 1. Epidemiological models
- 2. Biomechanical models
- 3. Physiological models
- 4. Psycho-physiological models

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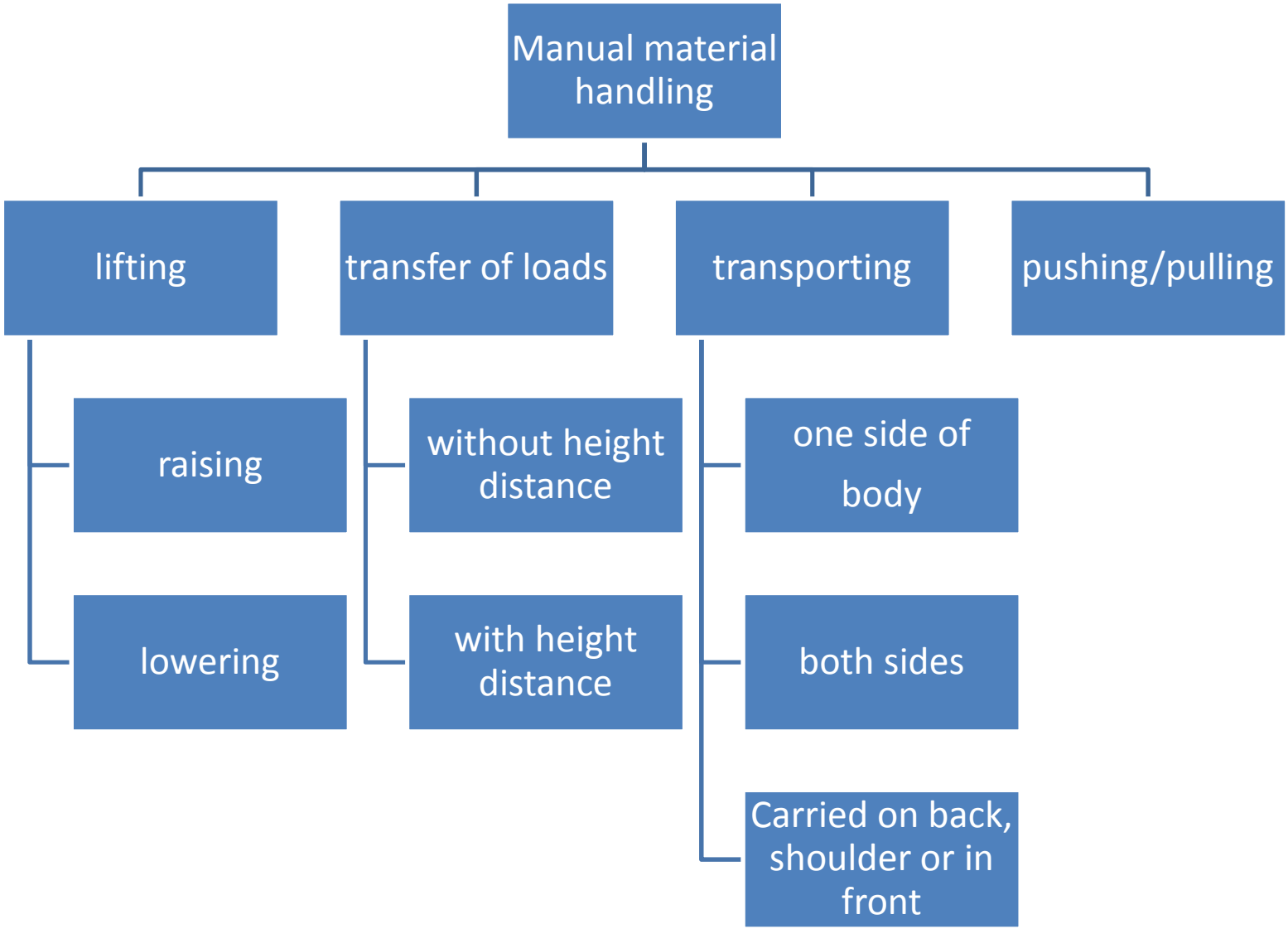


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# Selection of methods for determining load limits

- 1. NIOSH method for determining weight limits
- 2. ErgonLIFT (Vedder and Laurig)
- 3. Pangert procedure (abridged)
- 4. Stress determination and assessment in activities involving lifting and carrying heavy loads or lifting and carrying with extreme forced postures of trunk (Hartung und Dupuis)
- 5. Weight limit determination method (DIN EN 1005 Part 3 2002–2005)
- 6. *Luxembourg*: European *Coal and Steel* Community Guide (Davis und Stubbs)
- 7. Weight and force limits (Mital et al.)
- 8. Company-specific procedures for determining maximum weight limits

to name only a few

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# Example: Key Features Method – Lifting and Carrying

- Overall assessment of working conditions in activities involving lifting and carrying of heavy weights
- Biomechanical, psycho-physical & physiological mechanisms involved
- Problems in summary assessment of a series of part activities
- Immediate identification of design needs and approaches

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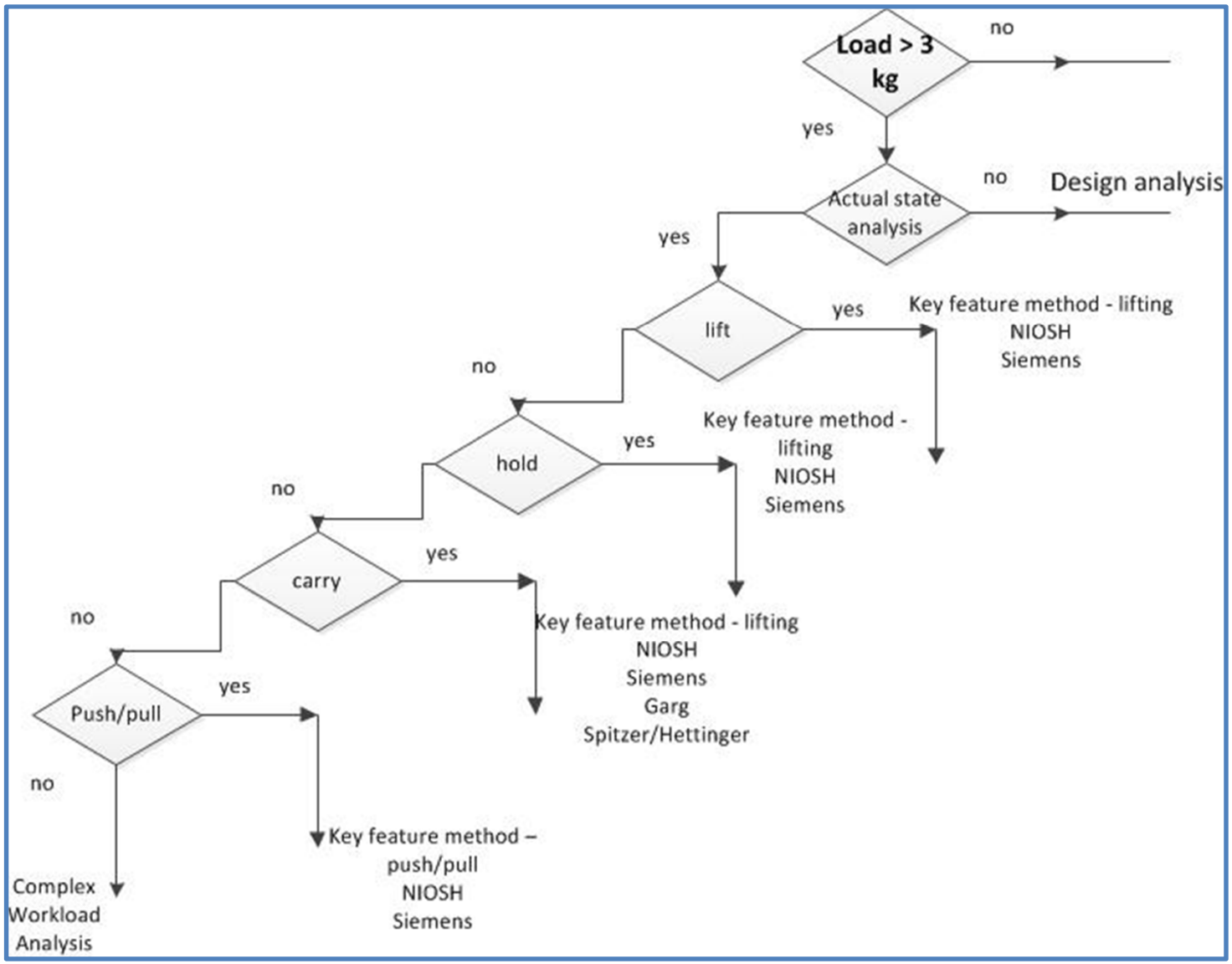
# Decision work flow

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## To what extent do “Procedures available on the market” produce matching results?

Example: NIOSH/Siemens
Similar results in the 45-50 age group when high biomechanical stresses are present.
Siemens yields higher upper threshold for younger workers
NIOSH‘s multiplicative approach very quickly yields threshold values tending toward zero .
Siemens enables differentiation between age and gender groups.

(Note: method differences between Siemens – Schultetus – Burandt are neglected in my paper )

## Example: Siemens-Burandt-Schultetus

- Not validated
- Data sources unknown
- But yields good results in practice

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# Force exertion

Siemens procedure is used to determine maximum „permissible“ forces exerted by hand-arm system and legs after allowing for

- personal factors (gender, age, fitness),
- type of force exertion (static / dynamic),
- frequency and duration of force exertion,
- location of force application point (distant / average / close; in relation to body: frontal / lateral / diagonal; level: head / shoulder / waist / pelvis),
- hand position,
- direction of force exerted.

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## (highly) repetitive movements – *Key Features Method: Manual Work Processes*

- This method is used to assess activities mainly involving stress on the hand-arm system
- when processing work objects (manual work).
- Typical features are frequent repetition of identical or similar movements, high skill requirements and ability to discern small details.

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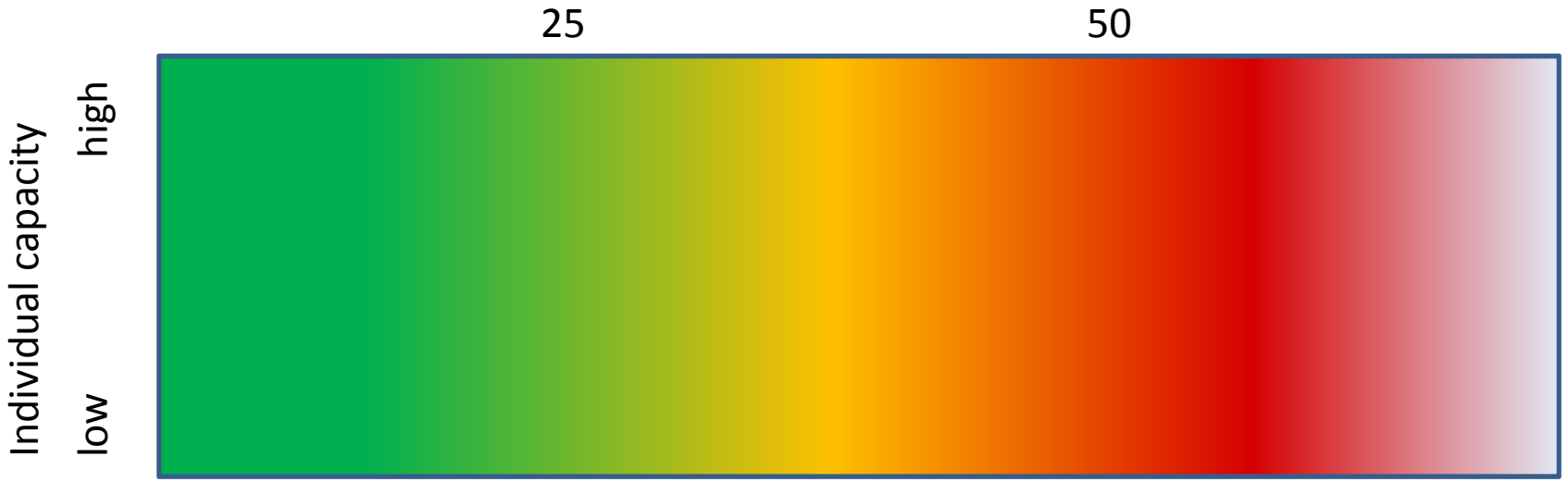
# (highly) repetitive movements – *Key Features Method: Manual Work Processes*

*→ traffic light system*




| | | |
|---|---|---|
| Design objective: Safe for all healthy operatives | • Risk for untrained operatives<br>• Safe for trained operatives possessing necessary capacity | Design fault: Basic risk for all operatives |

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# Objectives

- To upgrade the role of good design in work systems and processes with MTM ergonomics
- This means design of work systems that will increase productivity by cutting absenteeism, delivering better quality etc.
- It will also mean readiness to accept a reasonable increase in planning costs

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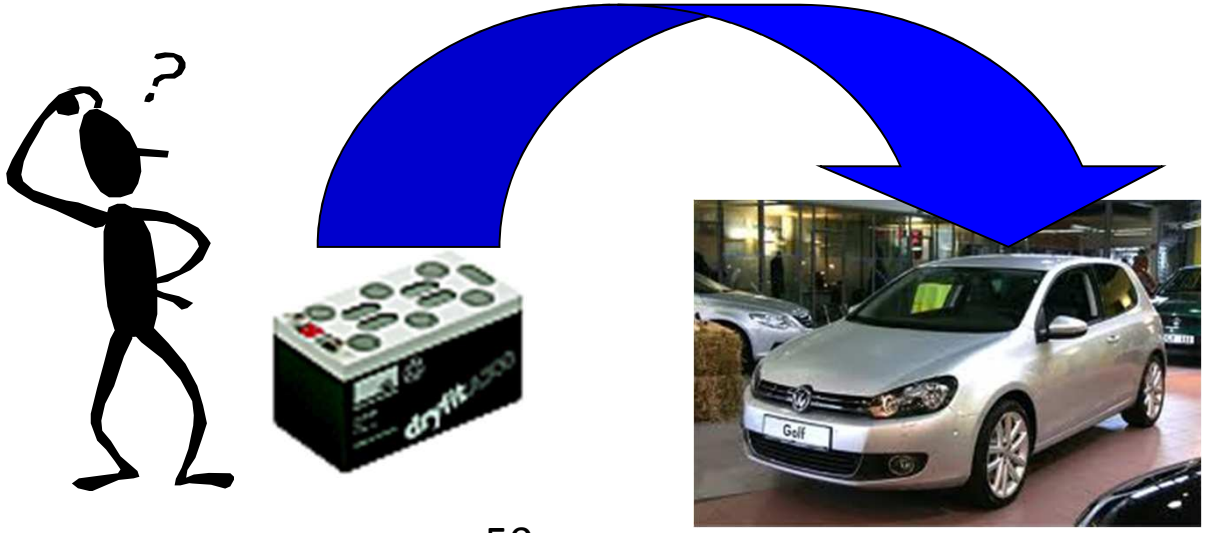
# Target groups

Primary target group: The planners

Secondary:
The motivators, stakeholders, opinion leaders

e.g. line managers
works councils
industrial medics
technical staff in industrial associations
trade union leaders
work scientists …..

# Traffic light assessment method





Green: Low risk – recommendable No action

Yellow : Possible risk – not recommendable Redesign necessary / Take risk management action

Red: High risk - Avoid at all costs - Take risk management action

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# Ergonomic assessment in MTM-IE concept

## Preventive function

- Development and procurement
- Optimization of work systems and logistics
- Standardization of manufacturing and assembly processes

**Assessment** →economic and worker-related

- Whole working life without health impairment
- Give workers a feeling of fulfillment
- Environmental compatibility
- high social compatibility

**No more predatory capitalism** **No sweatshops**

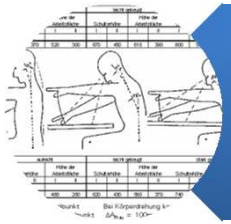
# Preventive function in detail

**Methodical conception of innovative products, highly suitable for intended use, easy to maintain and recyclable**

MTM-ProKon

**Low production, maintenance and disposal costs**

MTM process building brick systems + TiCon



**Ergonomic work systems**

**Optimally designed for workers' personal profile, abilities and skills**

**Avoid overtaxing and 'undertaxing'**

MTM ergonomics

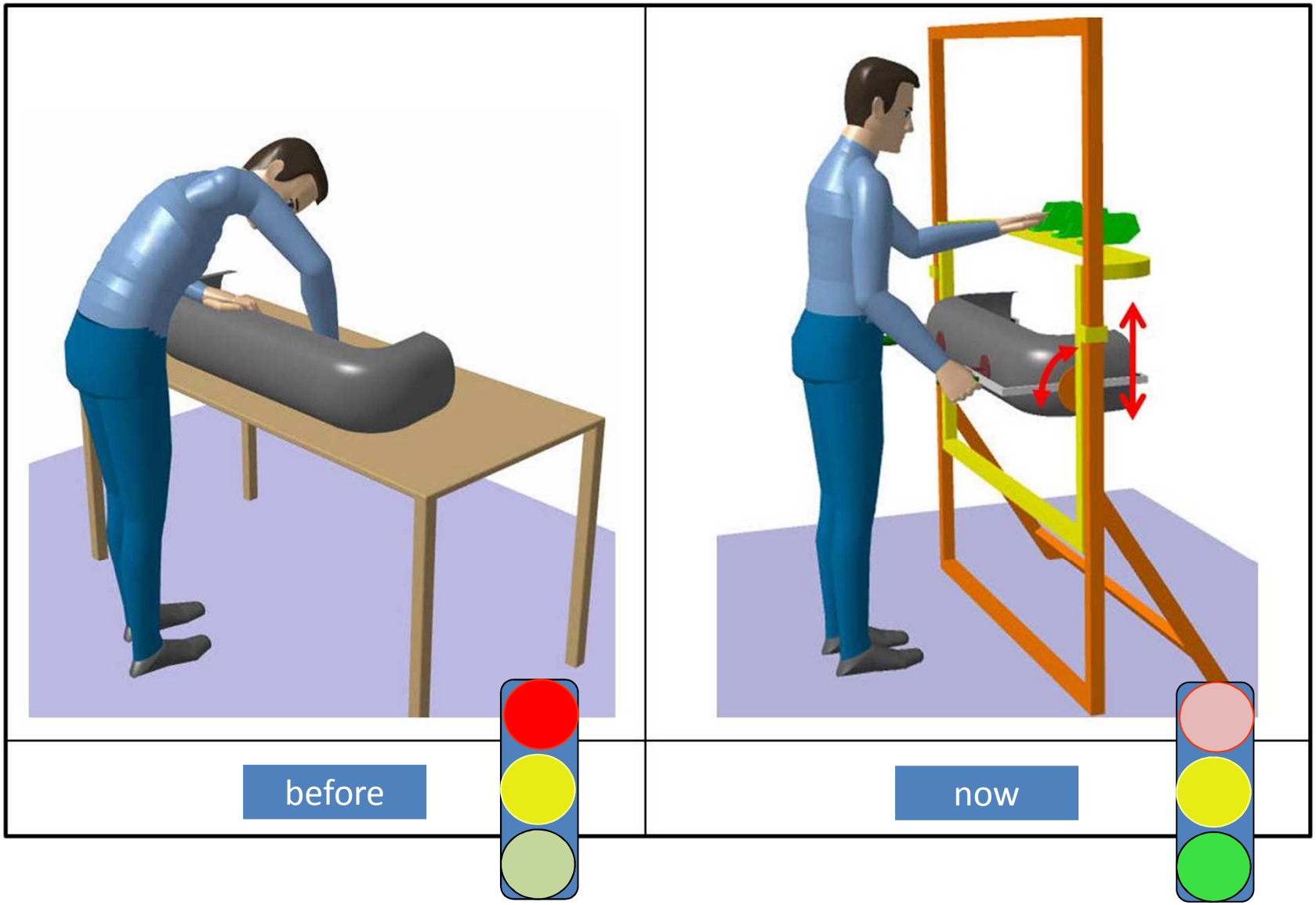
**Minimize process and transit times**

**Cut changeover time, reduce capital tie-up**

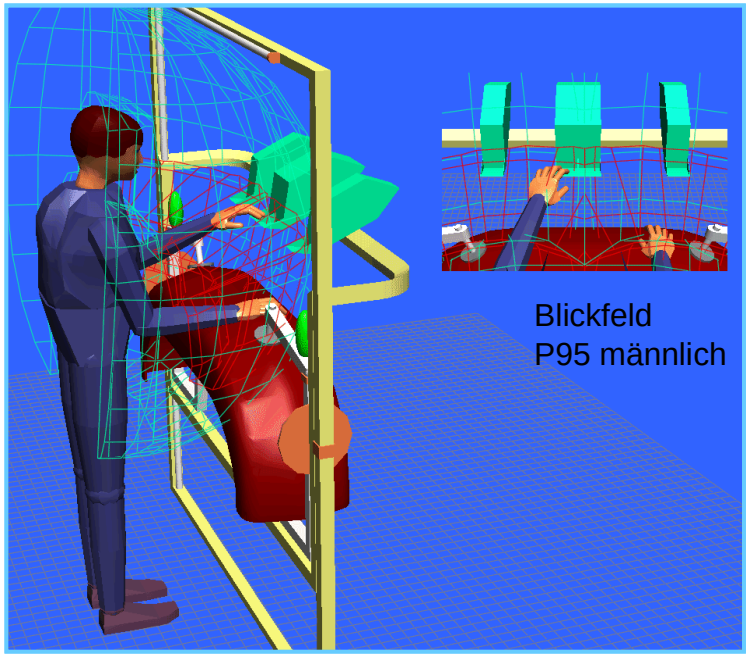
**Maximum flexibility in manufacture and assembly**

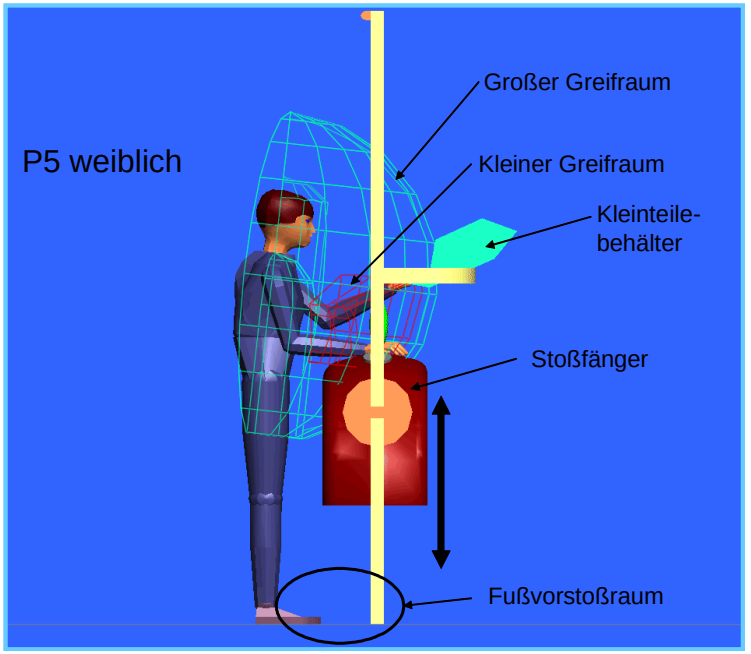
Maximization of value added

MTM visual inspection, MTM logistics, MTM value stream


before
now

# MTM Productivity Management Concept




**1. Function**

Production

**2. Resource**

in equipment

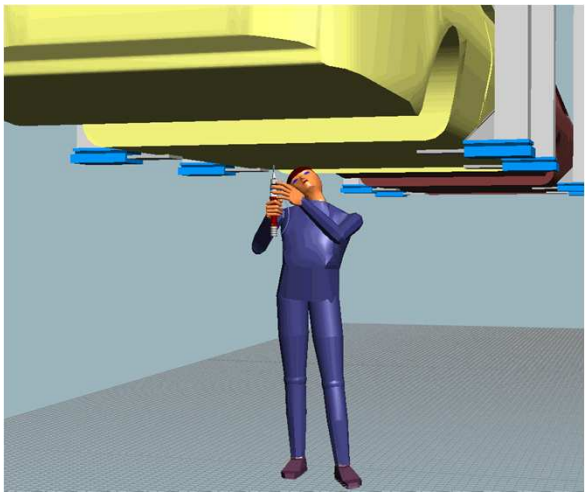
**3. Field of action**

Design optimization

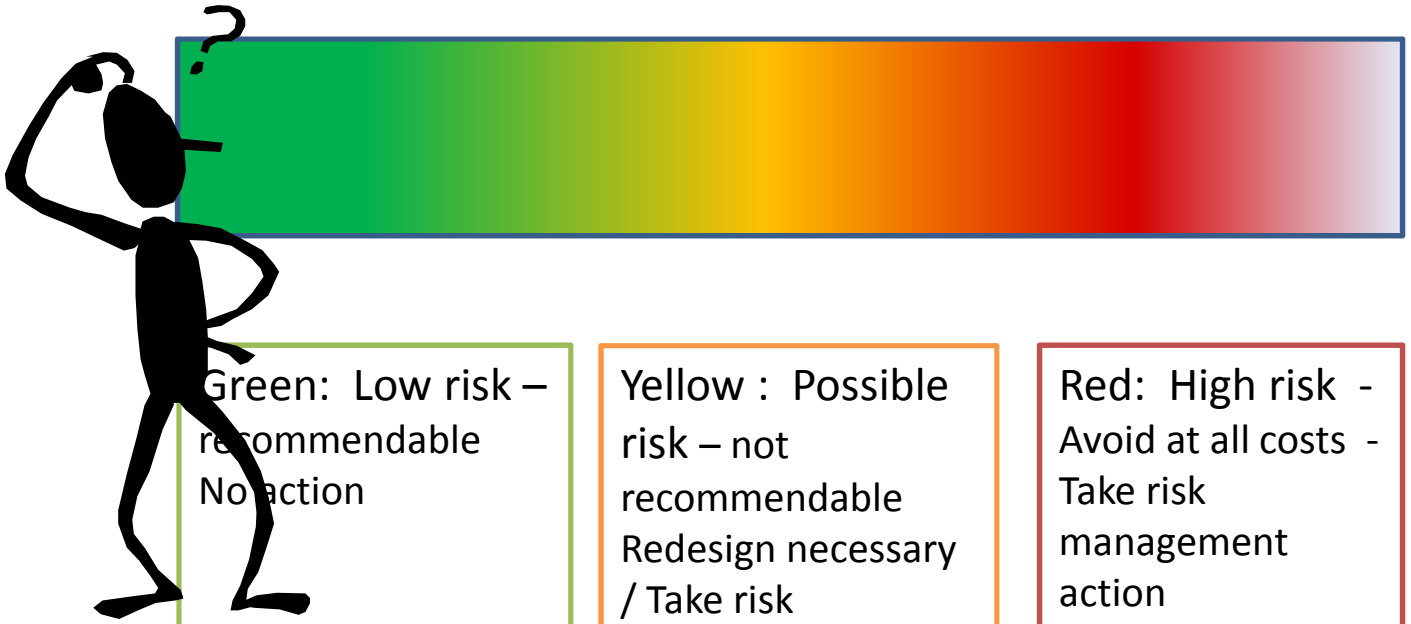
**Design standards: this example shows a workplace for bumper assembly that is standard throughout the whole corporation**

Use MTM to introduce universal design standards

## Ongoing assessment concept for planning and production



**Bottlenecks:** forced postures, physical strength, hand-arm system, loads etc.



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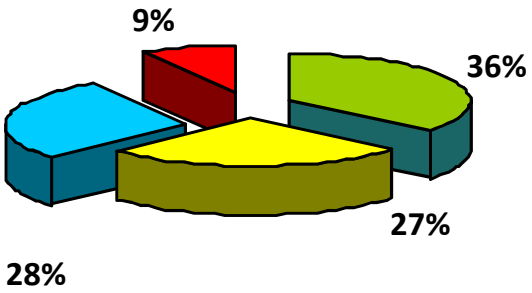
**Standardized screening procedure e.g. Automotive Assembly Worksheet ( AAWS) Design check**

# Inventories: Ergonomic potential

**Percentage feasibility of suggestion for improvement (n=128)**
**(categories: tools, materials/equipment and product)**
**Results from ergonomics workshops (n=14)**




- **readily feasible (within 10 weeks)**
- **feasible medium-term (within up to 24 weeks)**
- **feasible long-term (within up to 52 weeks)**
- **feasibility conditional on peripheral conditions**

Ergonomic optimization of **tools and equipment** at workplace; work organization

Ergonomic optimization (mainly) of **materials/equipment** used on production line

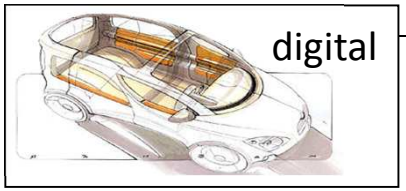
Ergonomic optimization of the **product**: realizable at next model change; ergonomic **process design / conveyor equipment**

**Product design potential e.g. by changes in model at prototype stage** → helps to sidestep ergonomic **weak points**

# Ergonomic Assessments in individual process steps

MTMergonomics

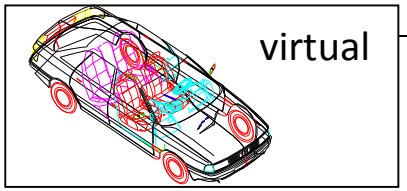
**Product, components**




Reference model

Rough geometric data, location of components, Number of joints

**Assembly process**




Location of joints, seams
Sequence of process steps in priority graph Installation sequence

**Work, assembly processes, logistics**


Optimization of installation sequence Materials flow, handling devices, materials/equipment , conveyor equipment etc.

**Production**


Timing and flow design following decision on installation sequence and timing analyse

**Quality Gates**

Ergo-Tool stage1

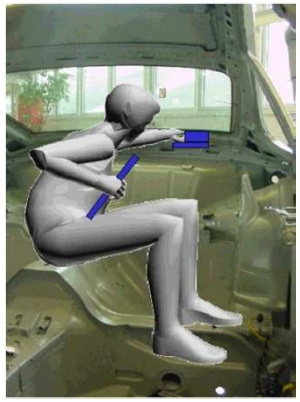
Ergo-Tool stage 2

Ergo-Tool stage 3

Ergo-Tool stage 4

## Example Porsche: Installation of rear window wiper = Ergo-tool Stage 3

Assessment of operations with prototype at technology stage



**Areas where ergonomic design can be applied**
Forced body postures
Shoulder-/overhead region
Load handling
Hand-arm system
Plus: work organization, worker deployment etc.

Process layout

**Work, assembly processes, logistics**

**Ergo-Tool stage 3**

Prototype,
Test lab

Optimization of installation sequence, Materials flow, handling devices, materials/equipmen , conveyor equipment etc.

**Ergo-tool**

*Assessment criteria*

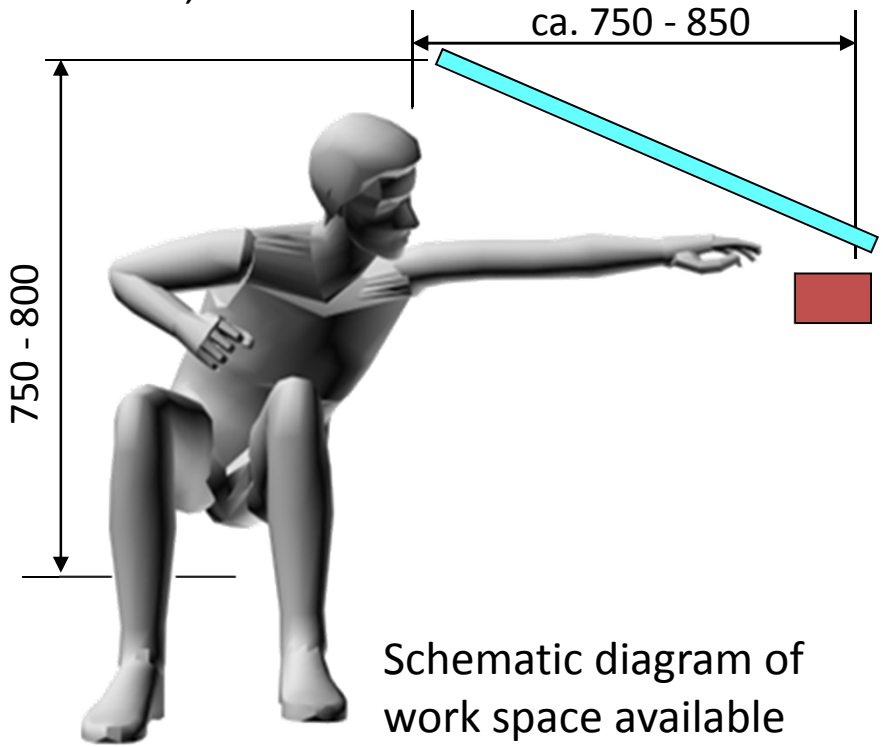
- Body posture,
- physical strength,
- **hand-arm system,**
- **loads,**
- **environment**

Ergo-Tool stage 3

# Risk analysis at an early stage

**Work flow planning**
**Operation / content**

Rear window, lateral




Schematic diagram of work space available in car interior

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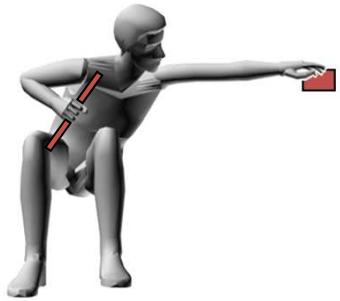
# Example of work flow assuming cycle time of 2.5 min

**Planning aspect**

**Production aspect**

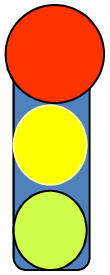


| Operation /content | Timing (sec) |
|---|---|
| Operation 1 Enter car and position central console, deposit tools and components | 30 |
| Operation 2 Position components and fasteners | 20 |
| Operation 3 Adjust wiper motor and tighten screws manually | 38 |
| Operation 4 Lay and clip in power cable | 18 |
| Operation 5 Tighten screws with tool | 24 |
| Operation 6 Collect tools and exit car | 20 |

- Posture, support of body weight
- Force / weight
- Hand-Arm forces
- Vibrations

Initial data for screening procedure

Assessment with MTMergonomics



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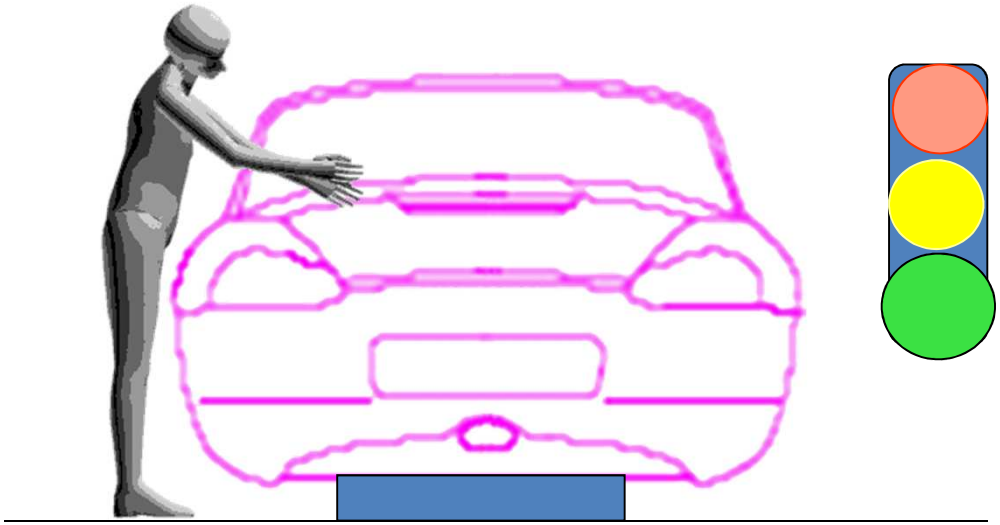
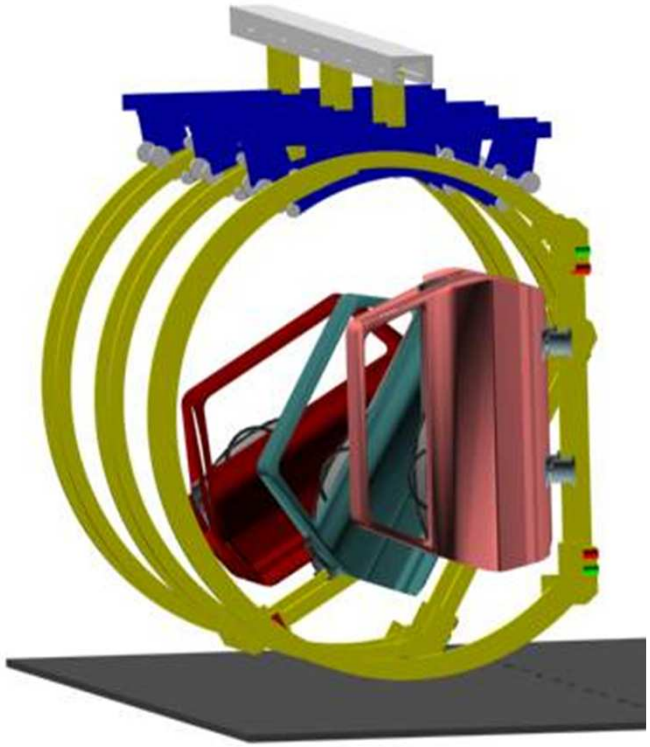
# Transfer of results?

**Solutions:** Installation of wiper motor from outside (seal in rear window automatically)



*Possible rotation scenarios for installation from outside (90°. 30°, 60°)*



**Transfer** of assembly principle to other components (components in rear end and interior):
Transfer specific assembly operations from plate conveyor to rotating hanger

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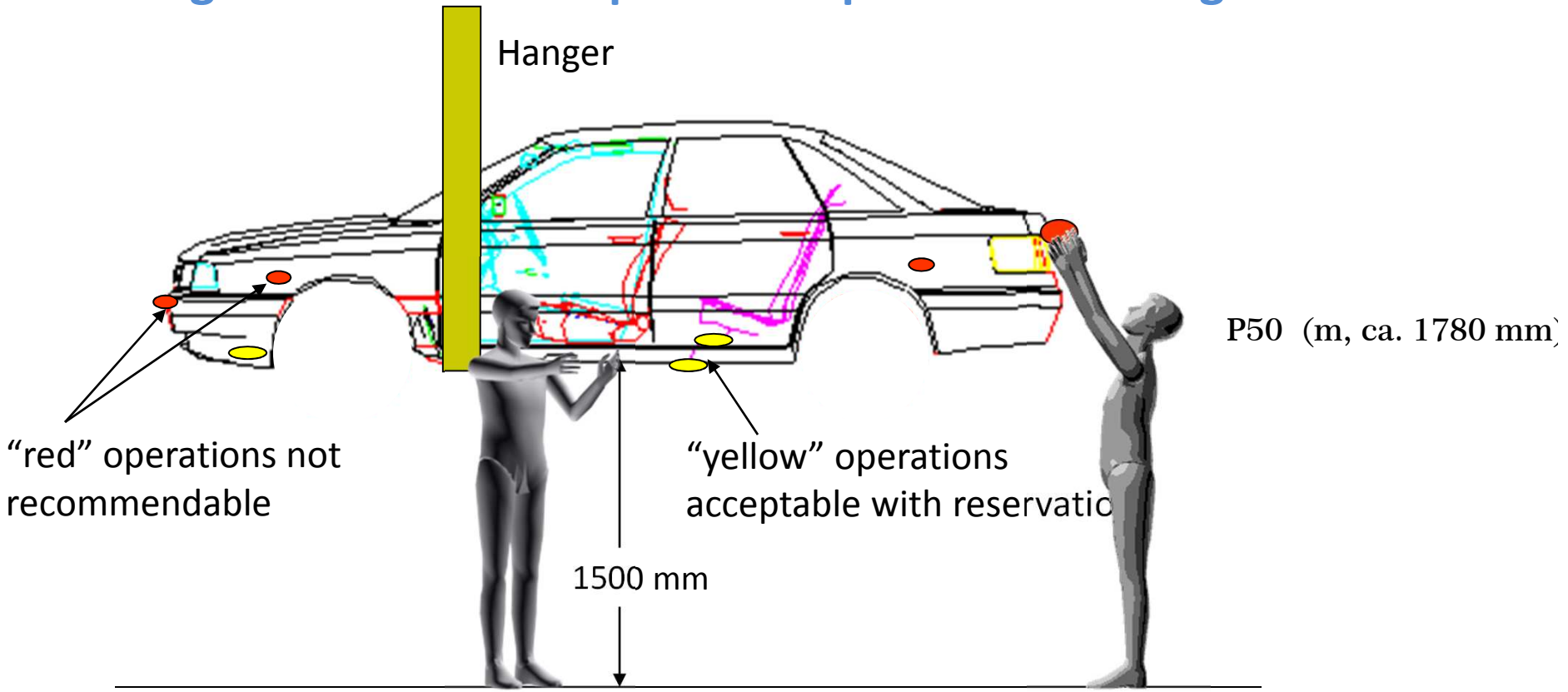
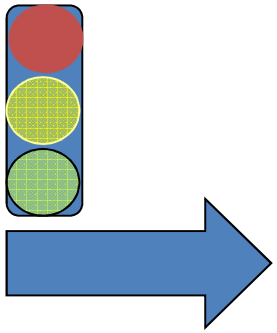
# Planning of installation sequence – Operations in hanger



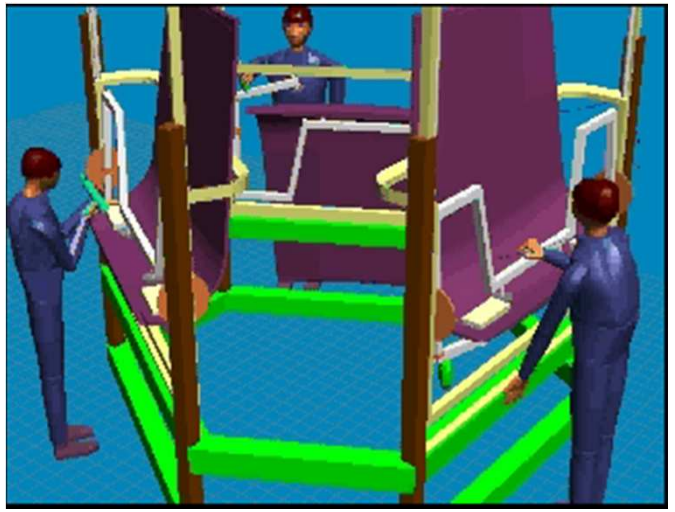

Transfer of operations on underside of chassis → reduces overhead work
Change of installation sequence at rear and front ends → reduces overhead work
Combination of manual screwing operations with semiautomatic jointing operations on underside of chassis → reduces overhead work and physical force exertion
Optimization of balancer setting →Reduces physical force exertion

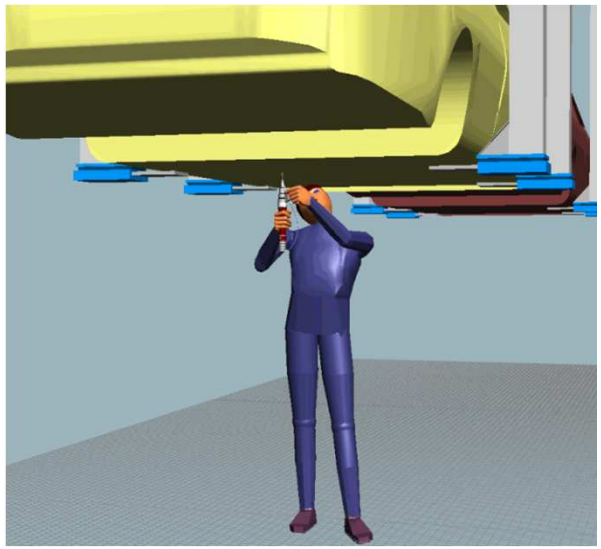
# Long-term ergonomic objectives with lasting effect

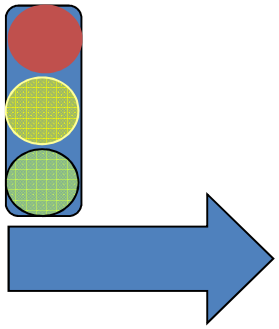
Before: Assessment of overhead work

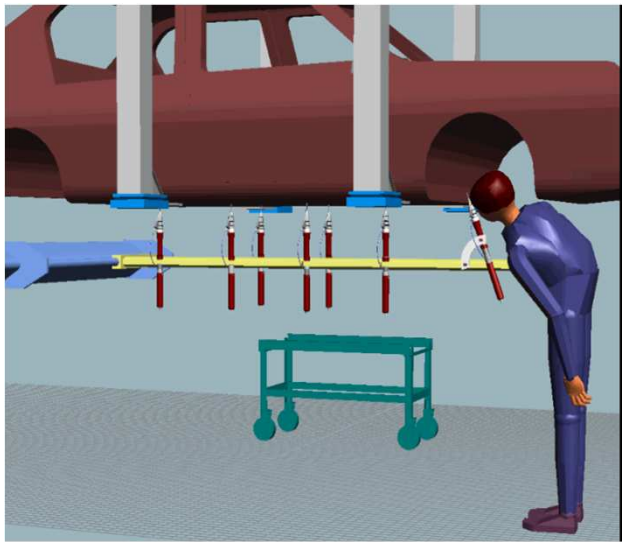


After: Revised assessment









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# Potential for improvement

- During external assembly at front and rear end and central areas below door sills à Lower the chassis (underside of central chassis min. 1200 mm, max. 1500 mm)
- Overhead load handling (>10 kg) →Use lifting aid
- Assembly in front-central area (near windshield, increase reach) à Use platform, improve tool design, use modules
- Joints in interior and on sides of central area à Raise chassis, use modules (integrate assembly operations in the central area)
- Fitting / clipping: keep fitting pressures as low as possible (plan for approx. 20 - 30 N for snap-fit closures)
- Rotation with optimal stress changes (postural changes) and introduce preventive behavioral training
- Optimize component availability arrangements

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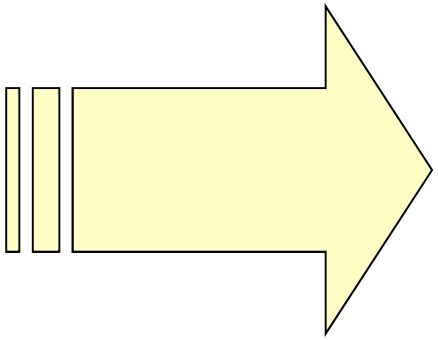
# Ergonomically justified design recommendations for assembly work (selection only)

**Trunk and hood covers:** Place components at ergonomically optimal height,
(resulting reduction cable channels cuts material and time expenditure)

**Trunk and engine space: Relocate joints (e.g. weld seams)** in front areas where possible
(improved access, less seams): cuts material and time expenditure Battery installation:
Assemble components to form module à Saves time, better work posture

**Underside of chassis:** Introduction of semi-automatic handling in underside assembly work reduces overhead work, saves time

**Choice of materials:** Use of more pliant sealing components reduces hand-finger stress and saves time



**Reduction in forced body postures and need to exert higher physical force**
**and**
**Savings in material cost and assembly time**
Enhanced process stability
Shorter amortization period

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# Ergonomic loop

Start

Databank

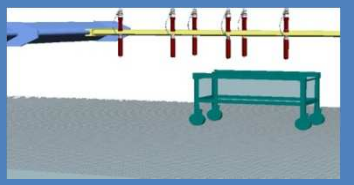
Best Practices

Variante n

Variante …

Variante 2

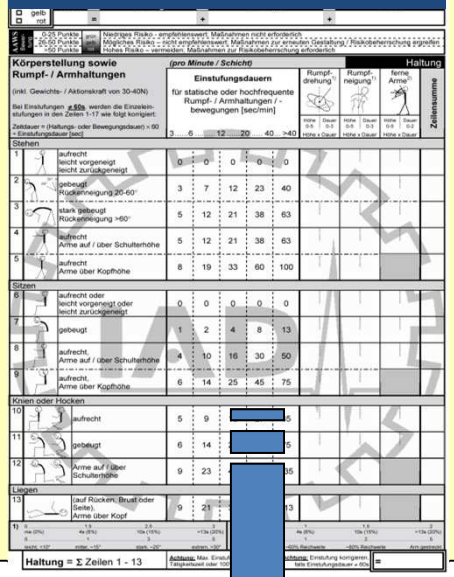
Variante 1



Tool tray

Planning and Development team

MTMergonomics



Re-assessment

Choice of a variant

Working height
Fitting pressures
Component weight
tool

If job design acceptable -> issue of planning approval

# What benefits does ergonomic analysis yield?

Use of screening procedures in planning and development process

- Aid to planning and development teams in decisions during early phases of a project
- Identification and assessment of body postures that could constitute a health risk
- Comparison and assessment of alternative manufacturing process options
- Ergonomically optimized processes normally cut assembly times

## Anticipated benefits

- **Better ergonomic design / reduction in physical stresses to which production/assembly workers are exposed**
- **Enhanced efficiency**
- **Lower production costs**
- **Enhanced process stability**
- **More flexibility in workforce deployment**

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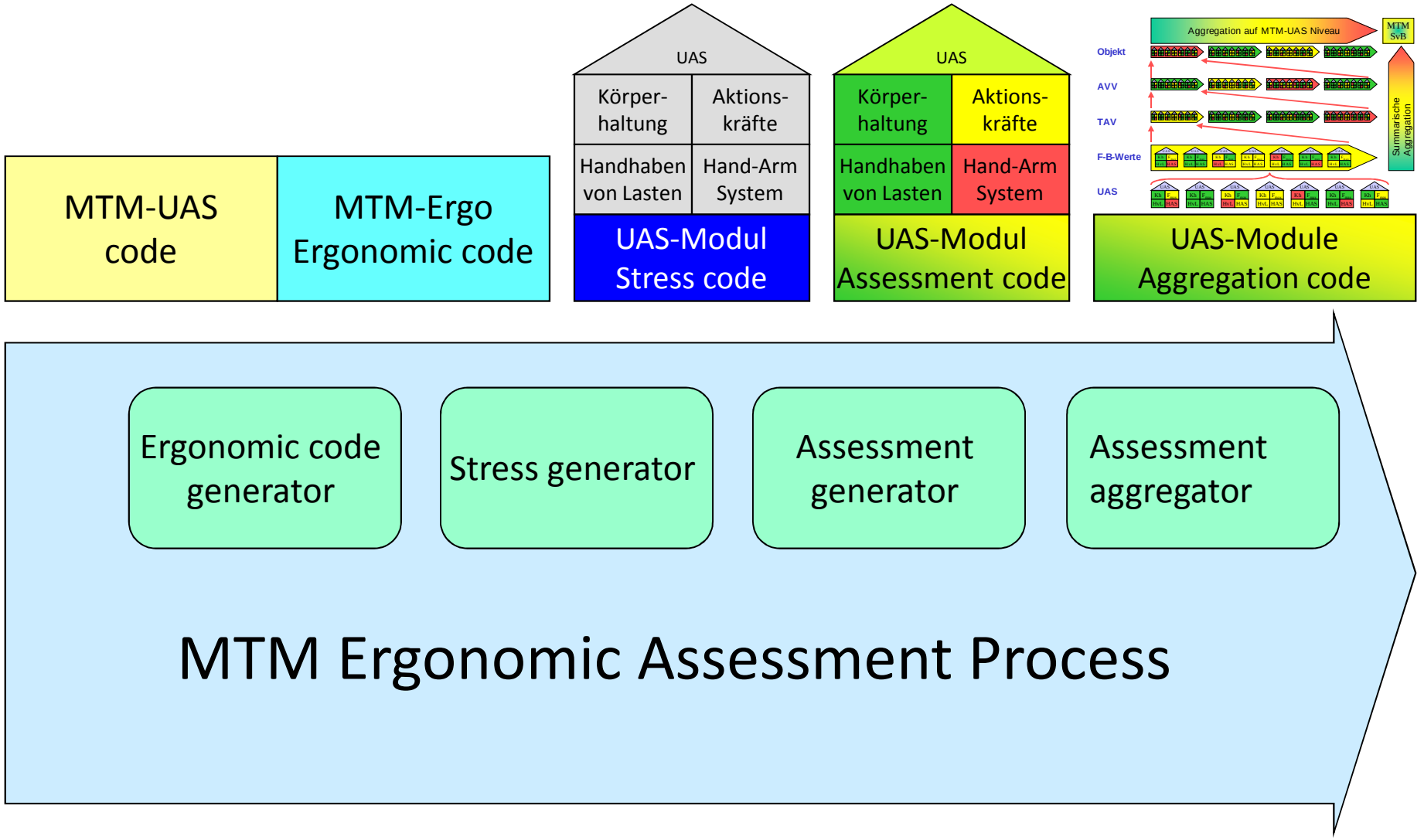
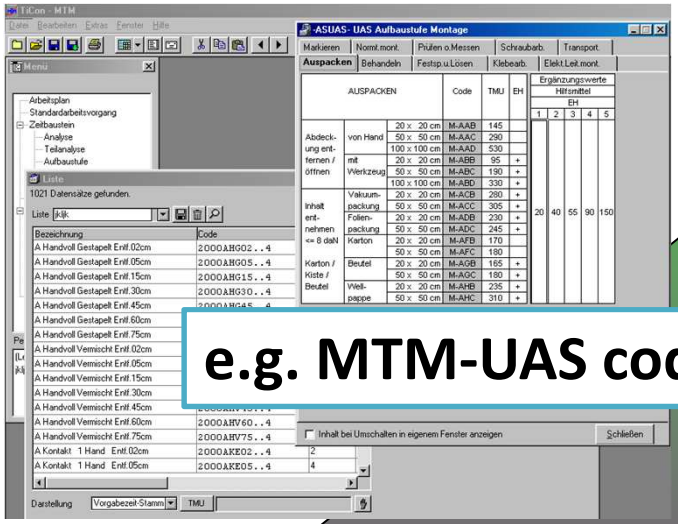
# MTM design system

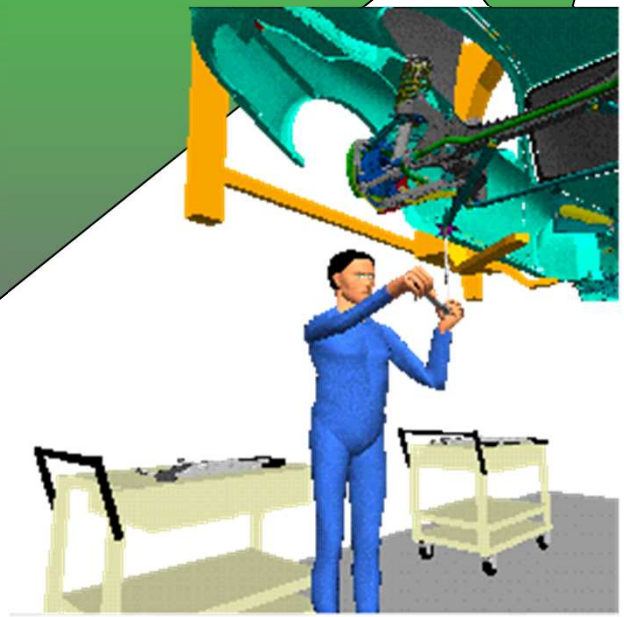


# MTM design system

**Risk analyses at an early stage in planning process – based on**




**e.g. MTM-UAS code**



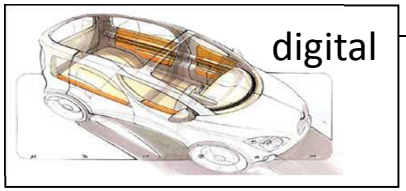
**deliver ergonomic risk assessments meeting relevant EU requirements**

Please remember this slide…..

# Ergonomic Assessments in individual process step

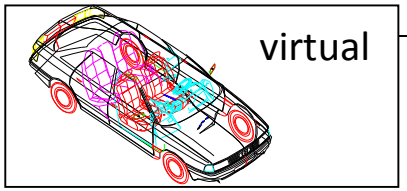
MTMergonomics

**Product, components** → **Assembly process** → **Work, assembly processes, logistics** → **Production**




Reference model

Rough geometric data, location of components, Number of joints




Location of joints, seams
Sequence of process steps in priority graph Installation sequence


Optimization of installation sequence Materials flow, handling devices, materials/equipment , conveyor equipment etc.


Timing and flow design following decision on installation sequence and timing analyse

**Quality Gates**

Ergo-Tool stage1

Ergo-Tool stage 2

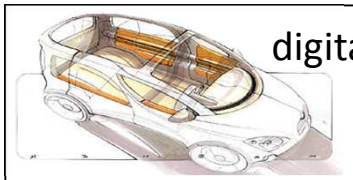
Ergo-Tool stage 3

Ergo-Tool stage 4

# Ergonomic screening tools for stage 4?

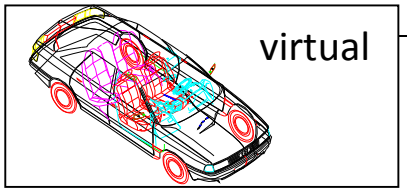
## Ergonomic Assessments in individual process steps

**Product, components** → **Assembly process** → **Work, assembly processes, logistics** → **Production**




Reference model

Rough geometric data, location of components, Number of joints

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Timing and flow design following decision on installation sequence and timing analyse

**Quality Gates**

Ergo-Tool stage1

Ergo-Tool stage 2

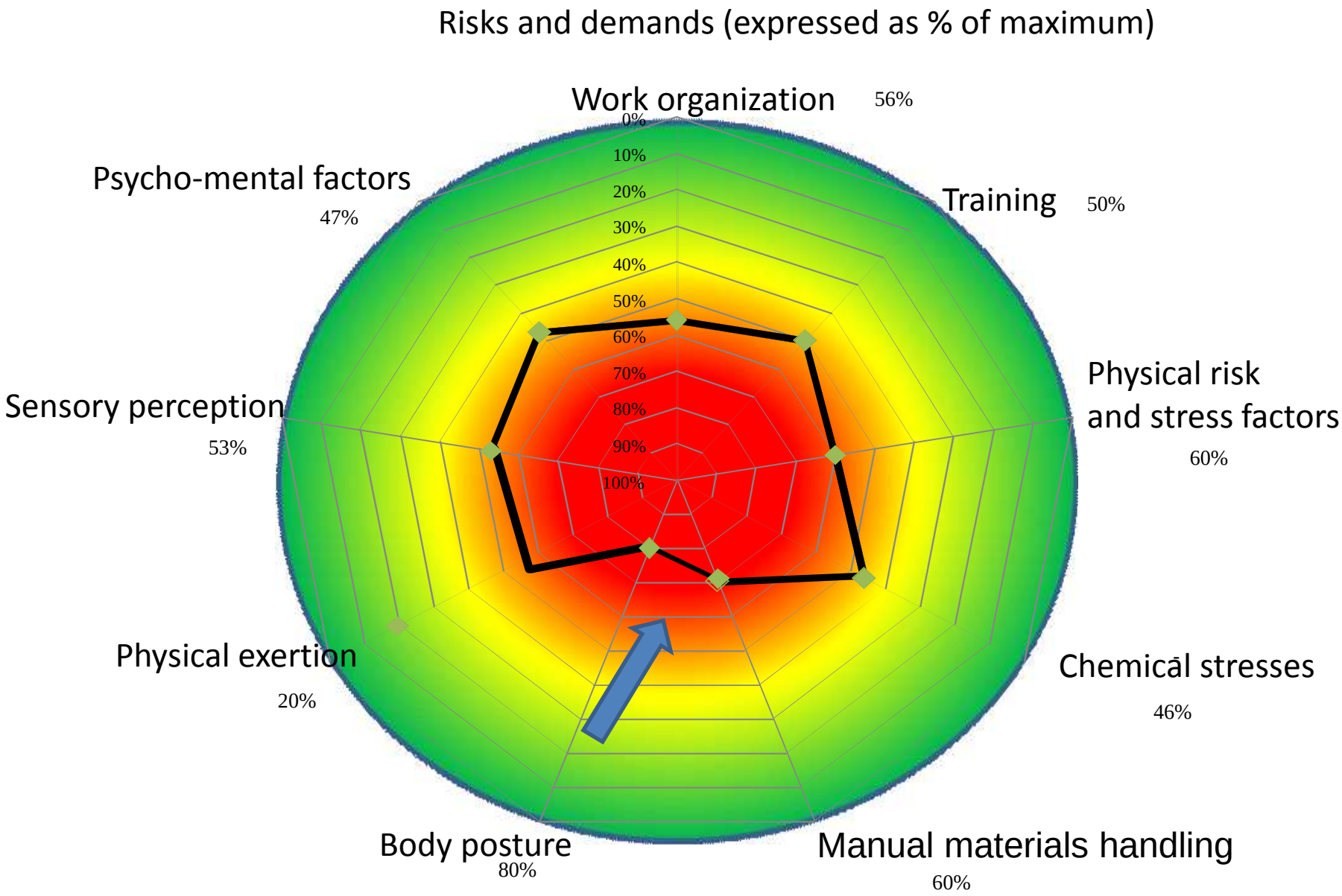
Ergo-Tool stage 3

Ergo-Tool stage 4

## Automotive industry supplier

**Handling of paint drums**

# Handling of drums

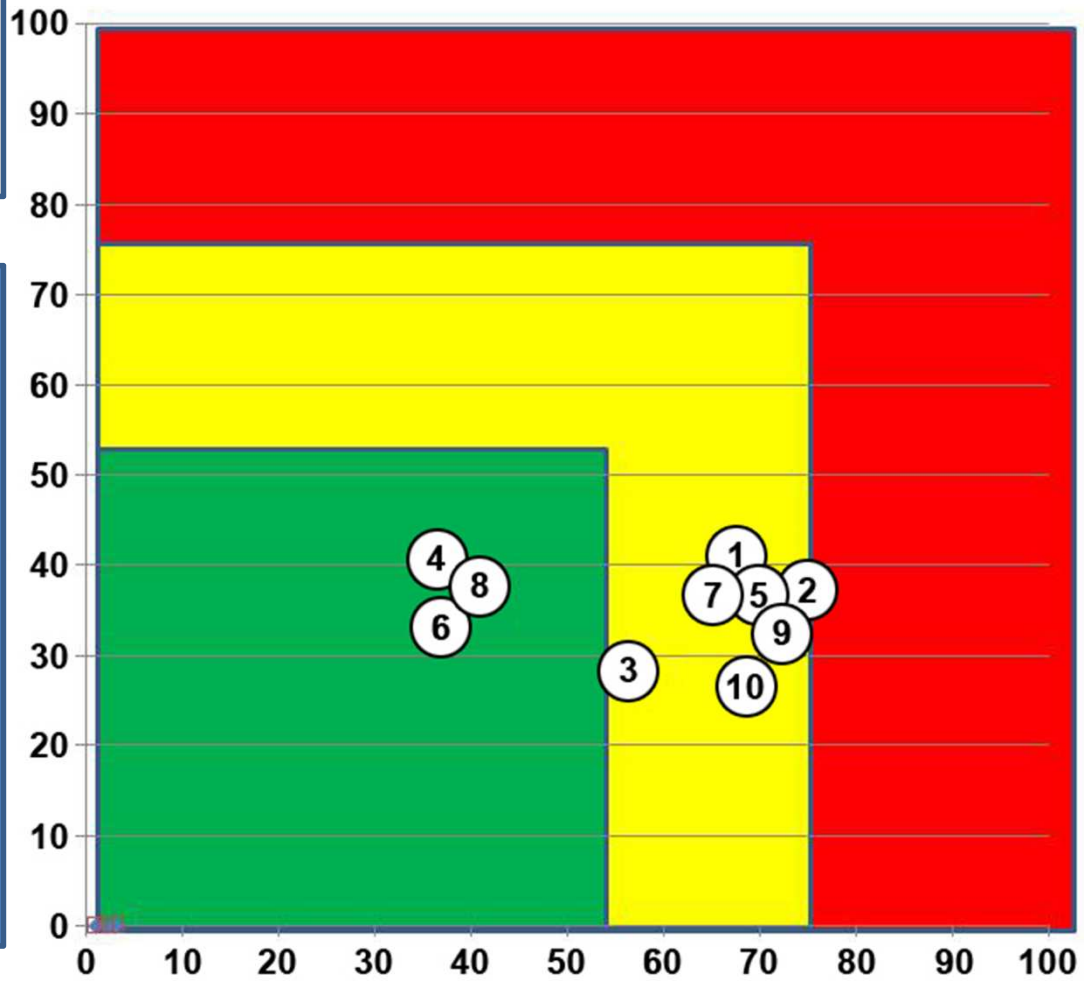


# Register of stresses

Demands (expressed as % of maximum)

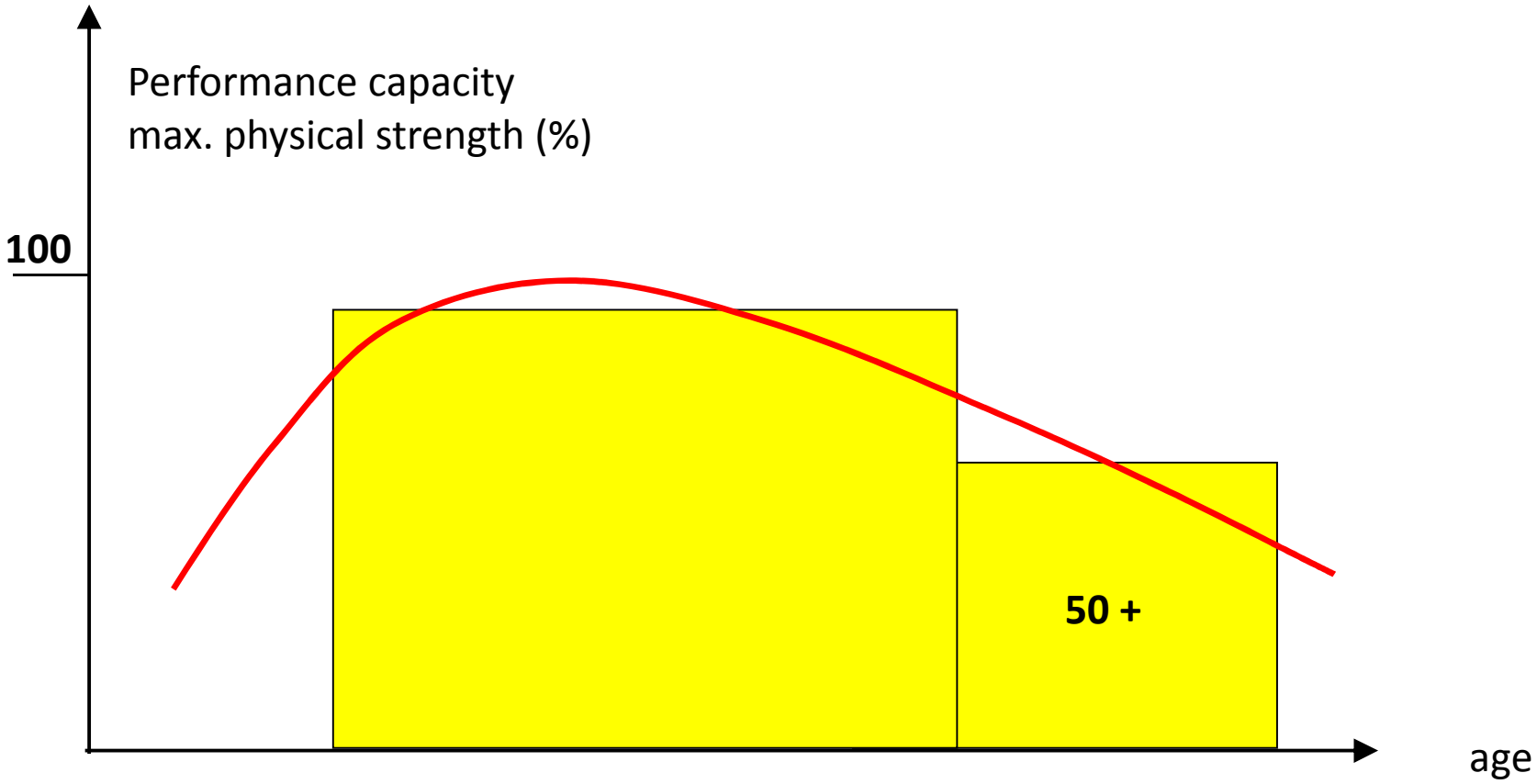
**Psycho-mental demand**

1. Foodtainers
2. Packing crates
3. Packing into packs
4. Pre-sorting
5. Packing plates
6. Glass Robi
7. Mixing
8. Filling
9. Labeling
10. Picking




**Physical demand**

# Ergonomic tools for the production of the future




Age-adjusted ergonomic standards are needed ???
(e.g. making due allowance for performance limits)

# Agenda

7. Conclusions

1. The need for ergonomic job design

6. Validation


2. Stress at the workplace

**5. A case study – just for a laugh**

3. Overview of ergonomic assessments

4. TiCon and MTM ergonomics

# Risk assessment of assembly jobs in the automotive industry with the EAWS procedure

*Then*: back in the early days
Video source: Ford Model T - 100 Years Later, CarDataVideo


Risk area: KH, LH, RSI
EAWS, MTM-Ergonomics

*Now*: a modern workplace Video source: VW, installation of hood installation

Risk area: KH, LH
EAWS, MTM-Ergonomics

# Risk assessment of assembly jobs in the automotive industry with the EAWS procedure

*Then*: back in the early days
Video source: Ford Model T - 100 Years Later, CarDataVideo




Risk area: KH, AK, LH, Kräfte
EAWS, MTM-Ergonomics

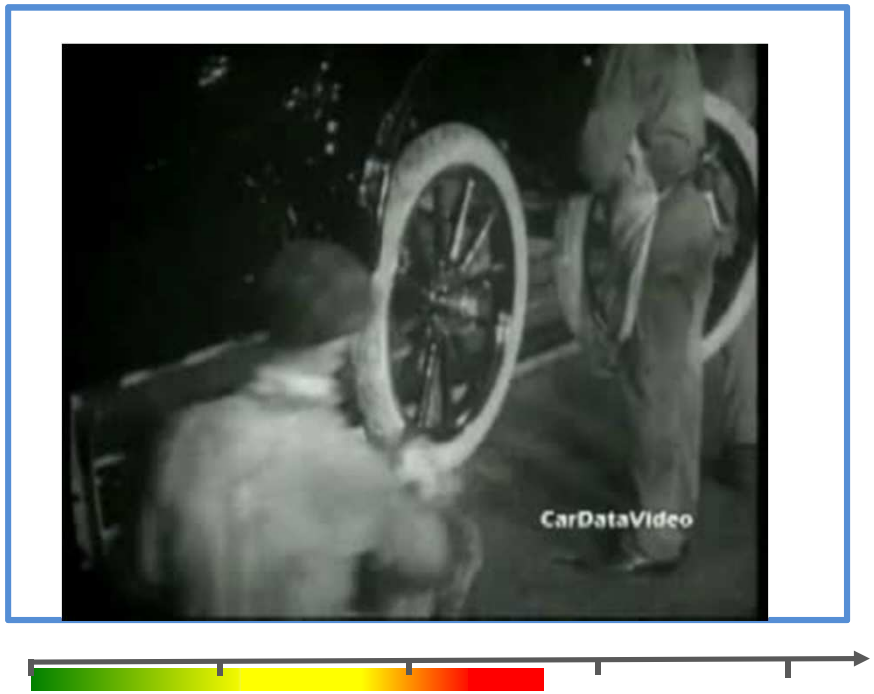
*Now*: a modern workplace Video source: Opel, installation of battery




Risk area: KH
EAWS, MTM-Ergonomics

# Risk assessment of assembly jobs in the automotive industry with the EAWS procedure

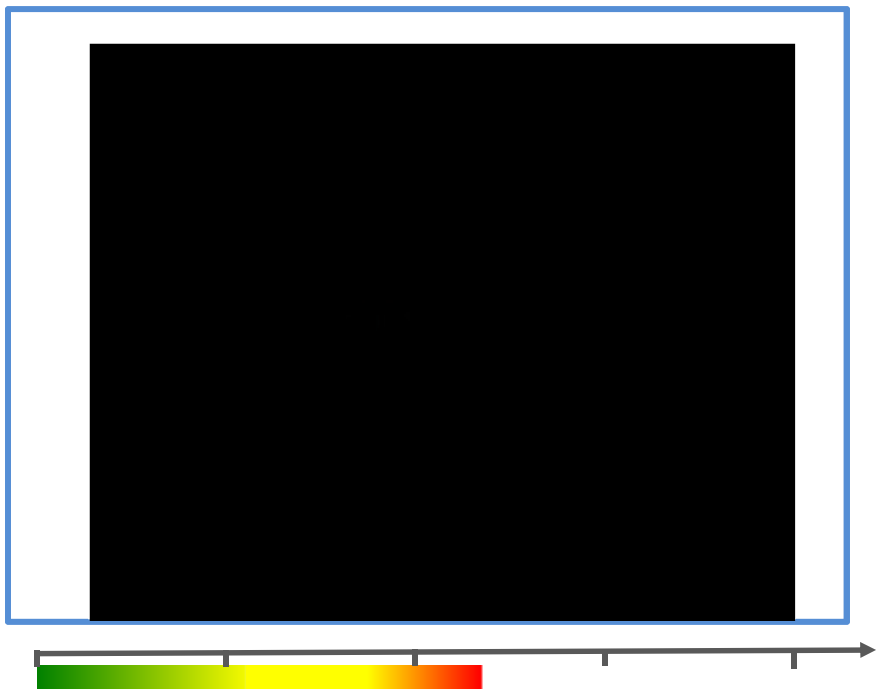
*Then*: back in the early days
Video source: Ford Model T - 100 Years Later, CarDataVideo






Risk area: KH, AK
EAWS, MTM-Ergonomics

*Now*: a modern workplace Video source: VW, AC duct





Risk area: KH, AK
EAWS, MTM-Ergonomics

# Risk assessment of assembly jobs in the automotive industry with the EAWS procedure

*Then*: back in the early days
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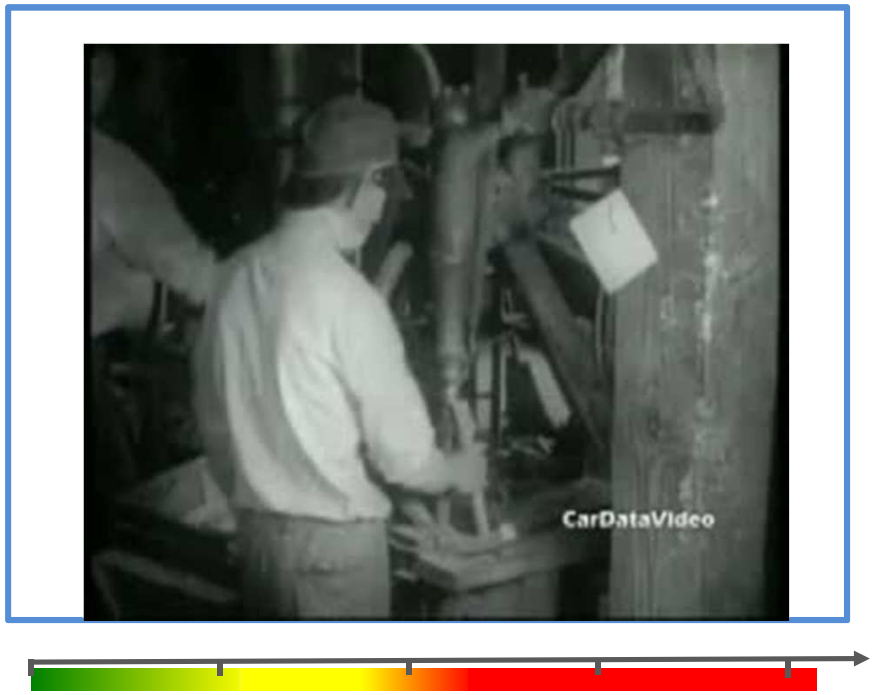





Risk area: highly repetitive actions
EAWS, MTM-Ergonomics

*Now*: a modern workplace
Video source: VW, trailer hitch



Risk area: AK
EAWS, MTM-Ergonomics

# Agenda

7. Conclusions

1. The need for ergonomic job design

**6. Validation**


2. Stress at the workplace

5. A case study – just for a laugh

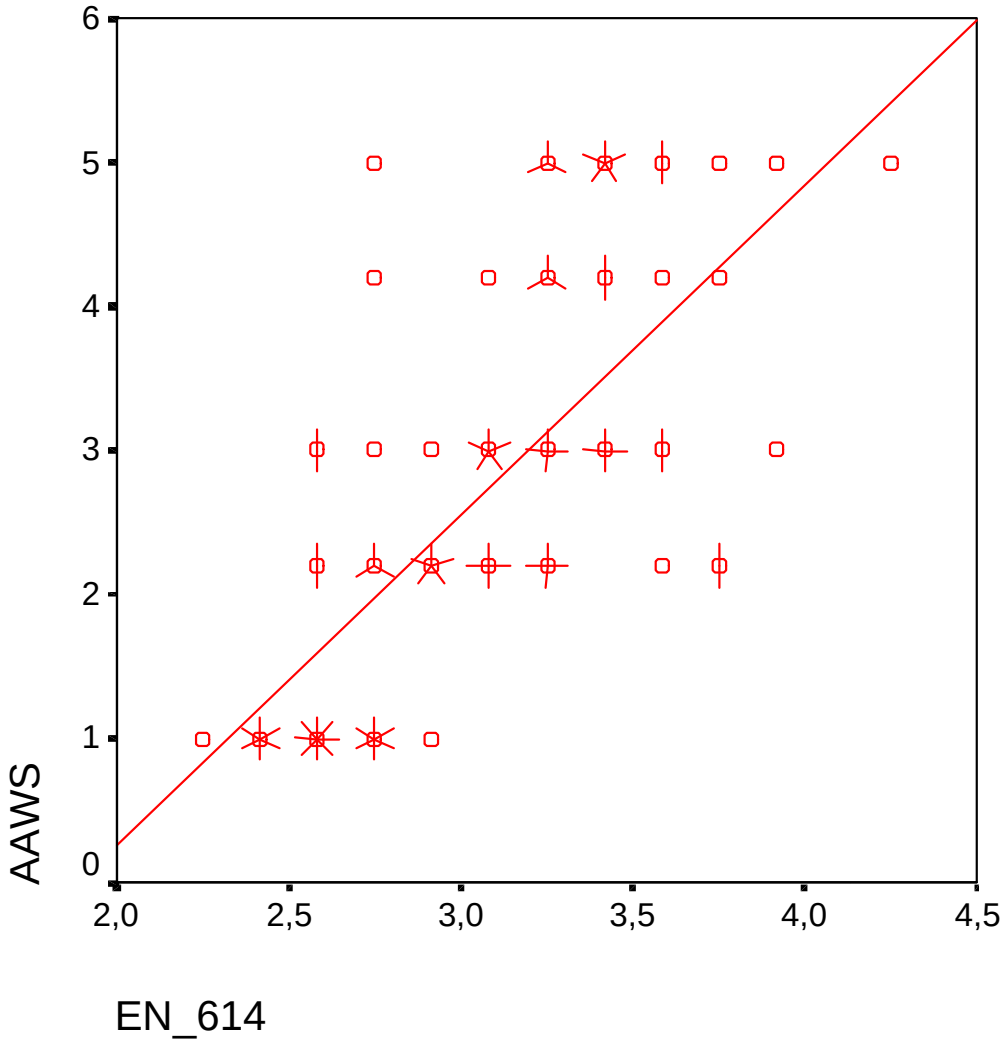
3. Overview of ergonomic assessments

4. TiCon and MTM ergonomics

# Correlation MTMergonomics and EN 614, Toyota-Assessment and RULA

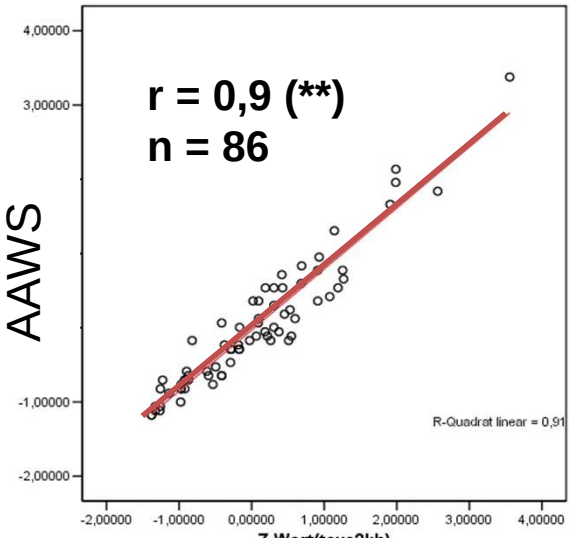
**EAWS-results** correlate significantly with **EN 614, Toyota-assessment, and RULA**

r = 0,67 (**)
n = 86

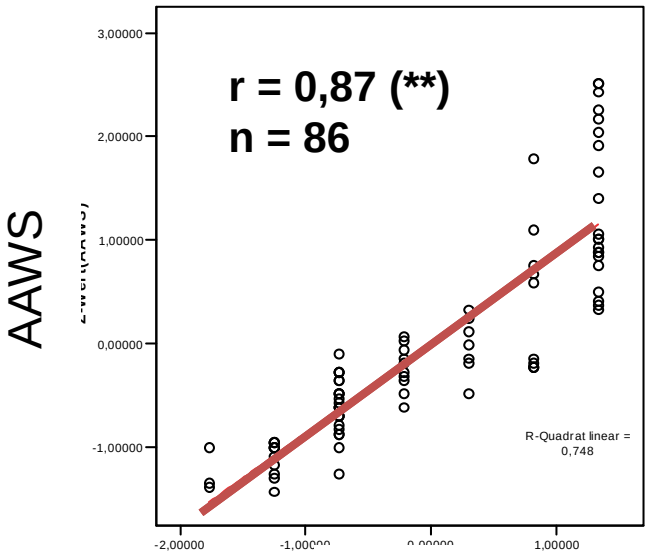



(Winter & Landau 2010)

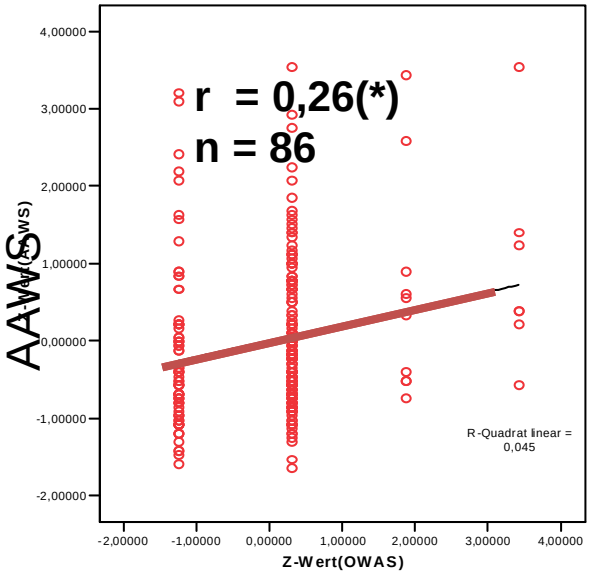
# Correlations of **AAWS** / **Toyota** / **OWAS** and **RULA**




Toyota




Rula




OWAS

**High correlation of AAWS, Toyota and RULA**

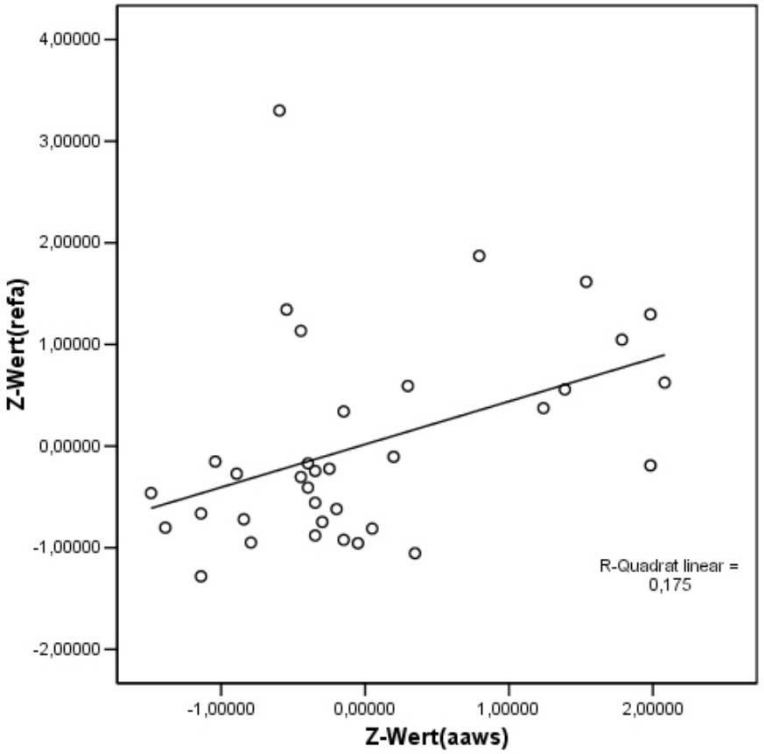
**weak correlation of AAWS and OWAS**

Different assessment methods yield lower degree of correlation:
AAWS looks at the full sequence of postures during a cycle, OWAS only at a typical or at the most stressful posture occurring during a cycle.

(Winter & Landau 2010)

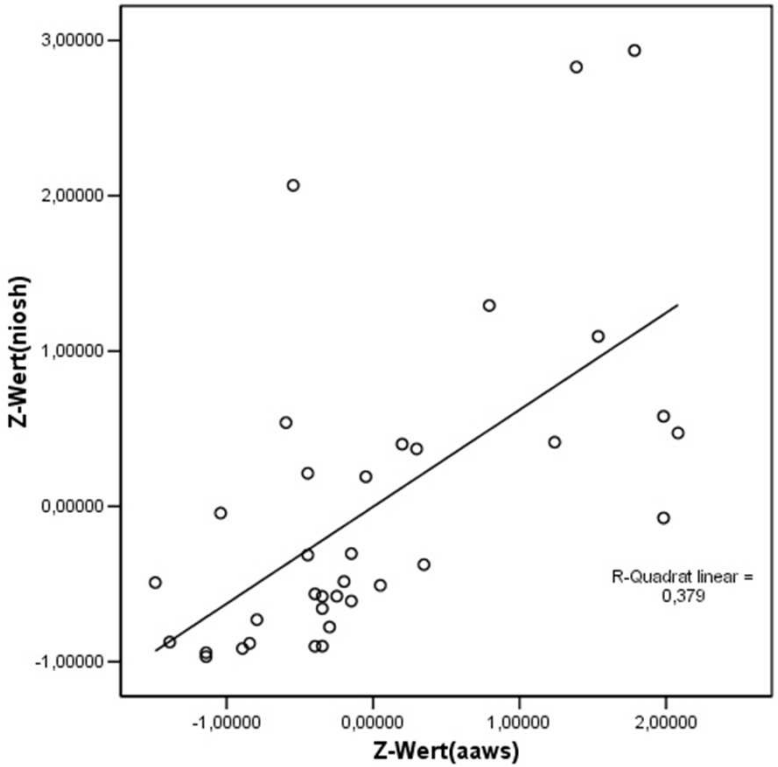
## **Manual materials handling**

correlation of **REFA** and **AAWS**




r =0,42(*)
n=36

**NIOSH** and **AAWS**




r =0,62(**)
n=36

(Winter & Landau 2010)

# Correlation between MTMergonomics score and subjectively perceived severity of symptoms

**Severity of work-induced symptoms**

Do you have any symptoms caused by postures required during your work?
Put a cross on the scale to indicate severity of symptoms (if no symptoms, cross zero)

No symptoms — Very severe symptoms

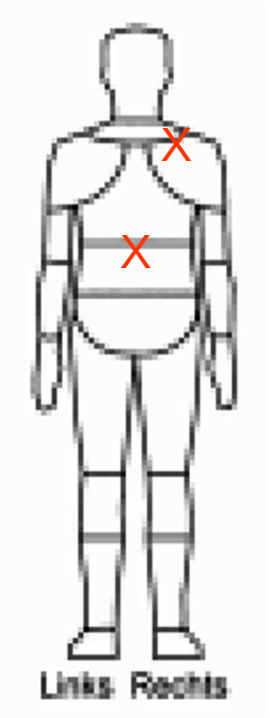
0 1 2 3 4 5 6 7

grün

gelb

rot

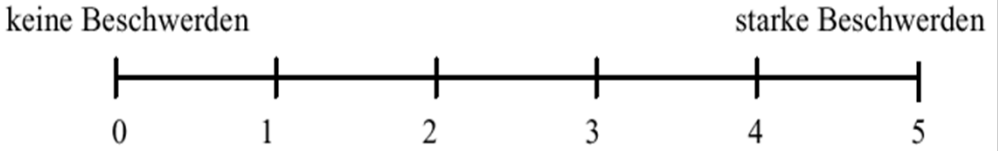
**r = 0,41****
**(n =247)**




(Winter & Landau 2010)

# Correlation between AAWS score and subjectively perceived severity of symptoms caused by working postures

Do you have any symptoms caused by postures required during your work?





**r = 0,55****
**(n =247)**

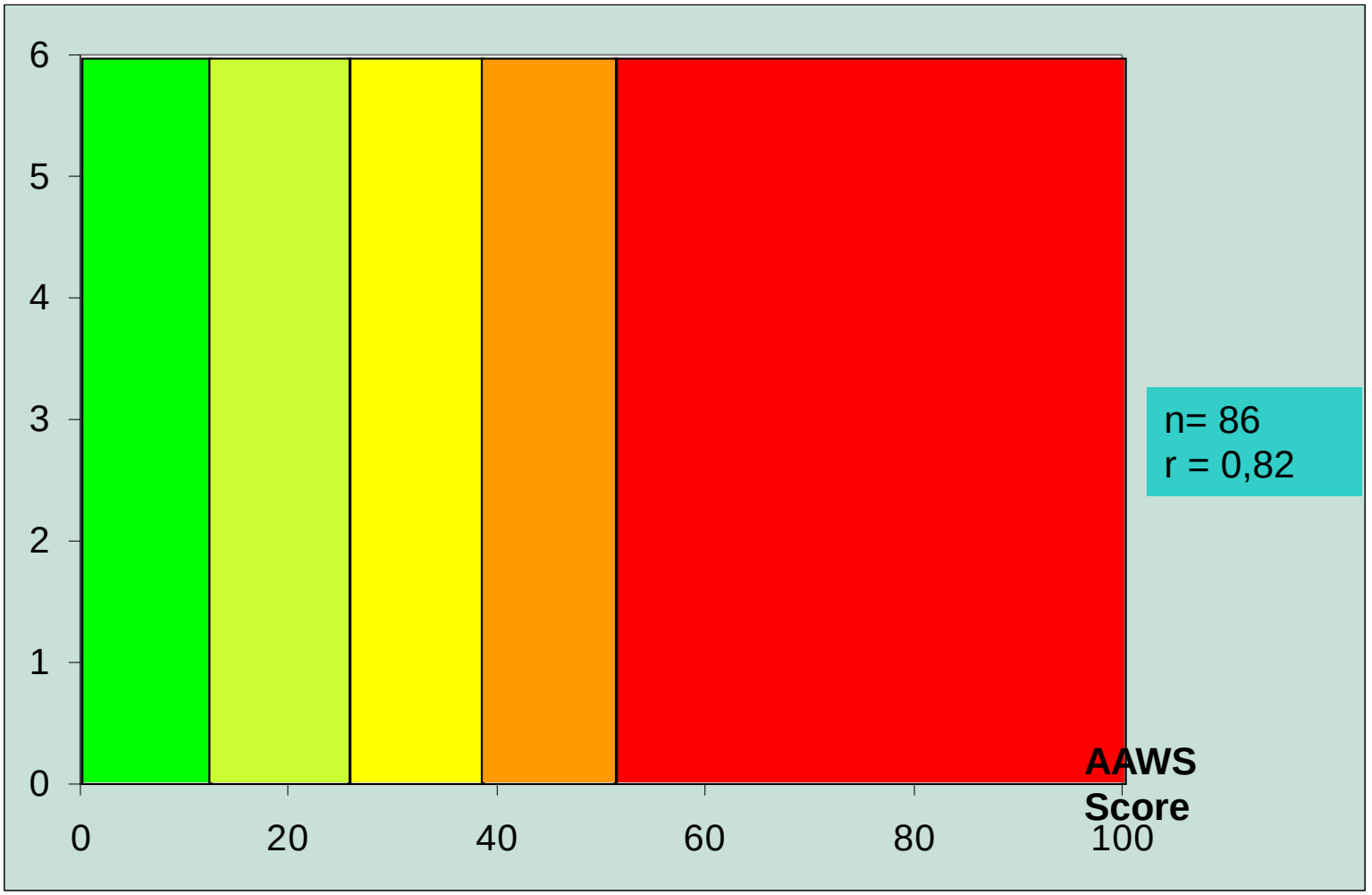
(Winter 2010)

Correlation between **AAWS-Score** and
subjective **complaints** because of physical forces


**r = 0,29****
**(n =247)**

(Winter 2010)

# Expert rating and MTMergonomics

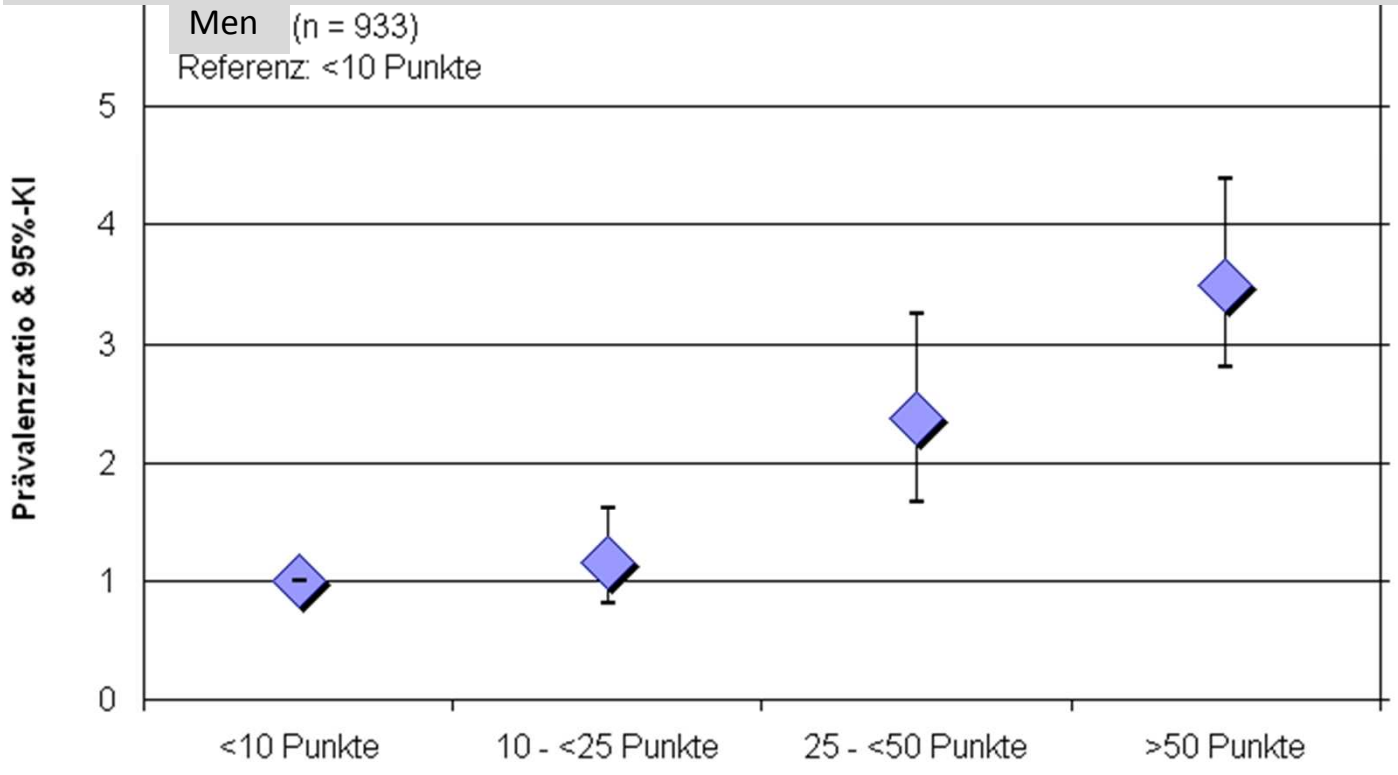



(Winter & Landau 2010)

Experts from assembly departments (foremen, work study practioners, industrial engineers, health and safety specialists), p =**

# Example of epidemiological validation

**Relative risk of wrist symptoms (12-month prevalence) in jobs involving stresses from manual work processes – Assessment by LMM-MA (2007 version)**




According to *F. Liebers, U. Steinberg, U. Latza, H.-J. Gebhardt, M. A. Rieger, A. Klußmann*

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# Problems with Ordinal Scale

- Rating “2” is twice the value of rating “1”?
- Is a rating “2” for one item equivalent to a rating “2” for another item?
- Despite this, ordinal scales are used in the same way as interval scales: algebraic operations with point scores

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# Problems with Traffic Light Risk Assessment Procedure

- The traffic light risk assessment procedure specified in European Norm EN 614-1 → is simple to interpret by industrial work safety officers.

….but

- Summary 3-stage assessment implies that results of individual safety tests can simply be added up.
- It makes no allowance for effects of simultaneous and successive stress superimpositions.
- It makes no allowance for action taken to reduce stress.

## However….

Industrial engineers and work study people  need evaluation results

- simple
- ready to implement
- in conformity with national and international standards

Traffic light risks may be understood as an early warning system

## Questions still to be answered

- To what extent do some stresses cancel or balance each other out?
- One very basic question: The accuracy of assumptions on stress reduction functions (e.g. standing versus walking yes; use of force versus sensomotor function  no). No research on this in many cases
- Is it permissible to borrow from procedures for determining recovery times?

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## Weaknesses of many assessment procedures

- Not possible to offset different stress types against each other
- (Example: bumper assembly)
- Stresses capable of causing health risks have to go through the full calculation procedure in all cases with MTM ergonomics
- Effects of successive stresses?

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## Factors lying outside the parameters of the assessment procedure

- Technical and ergonomic quality of job design?
- Body stability?
- Worker attitude?
- Anatomical type?
- For which section of working population?
- Job training/fitness?
- Health status?
- Environmental influences?
- Epidemiological validation?

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# Long way to cause-effect models….

| | Neck | Shoulder | Ellbow | Wrist (carpal tunnel) | Wrist (tendons) |
|---|---|---|---|---|---|
| Repetitive movements |  |  |  |  |  |
| Force |  |  |  |  |  |
| Posture |  |  |  |  | |
| Vibrations |  |  | |  | |
| Combination | | |  |  |  |

 Strong relationship  Moderate relationsship  Small relationship

(NIOSH 1997)

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# Agenda

**7. Conclusions**

1. The need for ergonomic job design


2. Stress at the workplace

3. Overview of ergonomic assessments

4. TiCon and MTM ergonomics

5. A case study – just for a laugh

6. Validation

## Conclusions

- Wide selection of assessment procedures for physical work
- MTMergonomics is
  - standardized and
  - validated
- MTMergonomics has high correlation with other procedures
- MTMergonomics correlates with rating of IE-experts
- EAWS/MTMergonomics most suitable for use during planning phase with support from TiCon

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## Conclusions

1st case: Successive effect of different types of stress → can reduce stress (e.g. alternate walking and standing)
2nd case: Successive effect of same type of stress (e.g. alternation between green and red stress levels)
3rd case: Simultaneously occurring stress types which may, to a certain extent, cancel each other out
4th case: Successive or simultaneously occurring stress types with synergistic (stress-multiplying) effects
5th case: Reversible vs irreversible overshoot of stress limits

## Conclusions

Analysis of actual status with EAWS in manual operations too costly and time-consuming

Instead: use screening tools for systematic identification of bottlenecks in any given work area

Example: ABG

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