

OVERVIEW OF ERGONOMICS





Ergonomics definitions

- “Study of work”
- “User-centred design”
- “Human factors in design”

3 key domains:

- Physical
- Cognitive
- Organisational



Ergonomics definitions

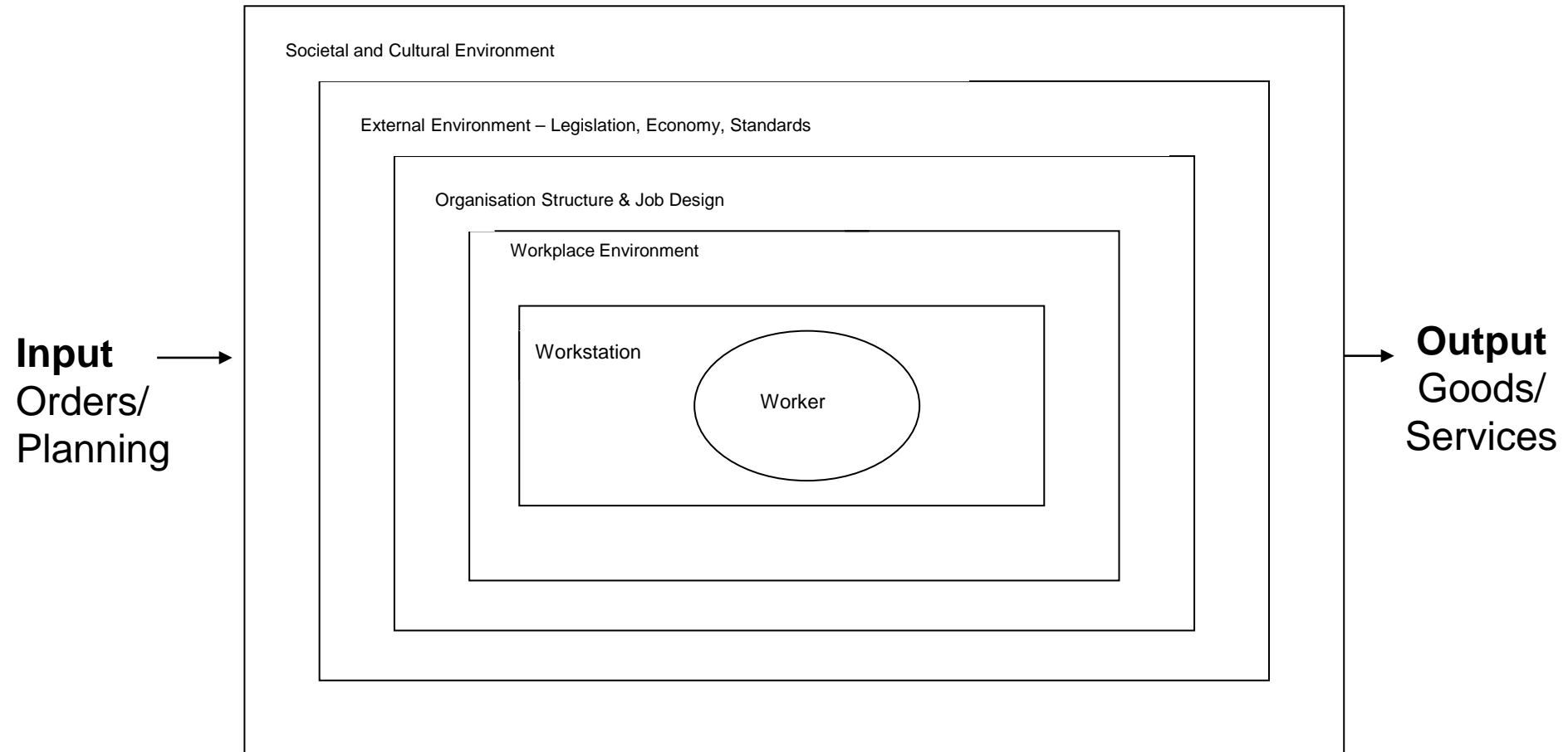
Different terminology...!

UK – ‘*Ergonomics*’

USA – ‘*Human Factors*’



The human at work





Scope of ergonomics

Human characteristics considered:

- **Anatomy**
- **Physiology**
- **Psychology**



Scope of ergonomics

Ergonomics should be applied for *all designs* involving humans, e.g.:

- Furniture
- Appliances
- Tools
- Sports equipment
- Vehicles
- Transport
- Spaces



Scope of ergonomics

Describe a piece of equipment you regularly use that has considered ergonomics in its design and use. What are the relevant features that make it ergonomically well designed?



Benefits of ergonomics

- Faster
 - Easier
 - Safer
- > Enhanced productivity

Occupational ergonomics(1)

The worker



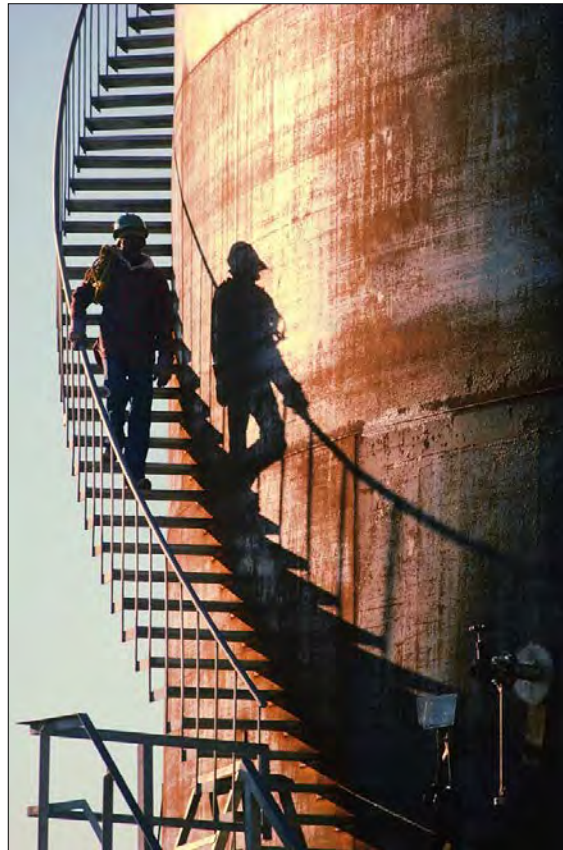
Occupational ergonomics (2)

Job / task design



Occupational ergonomics (3)

Work environment



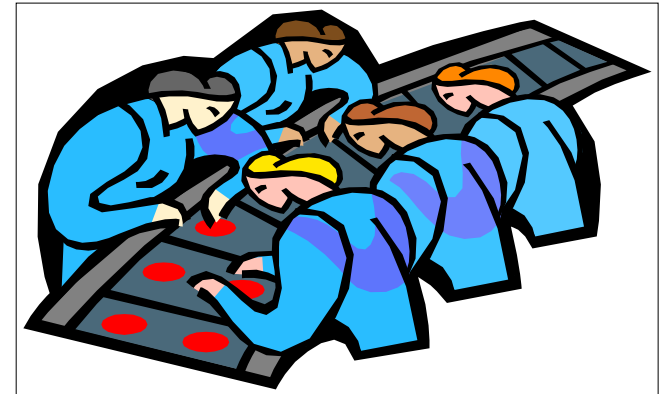
Occupational ergonomics (4)

Equipment design

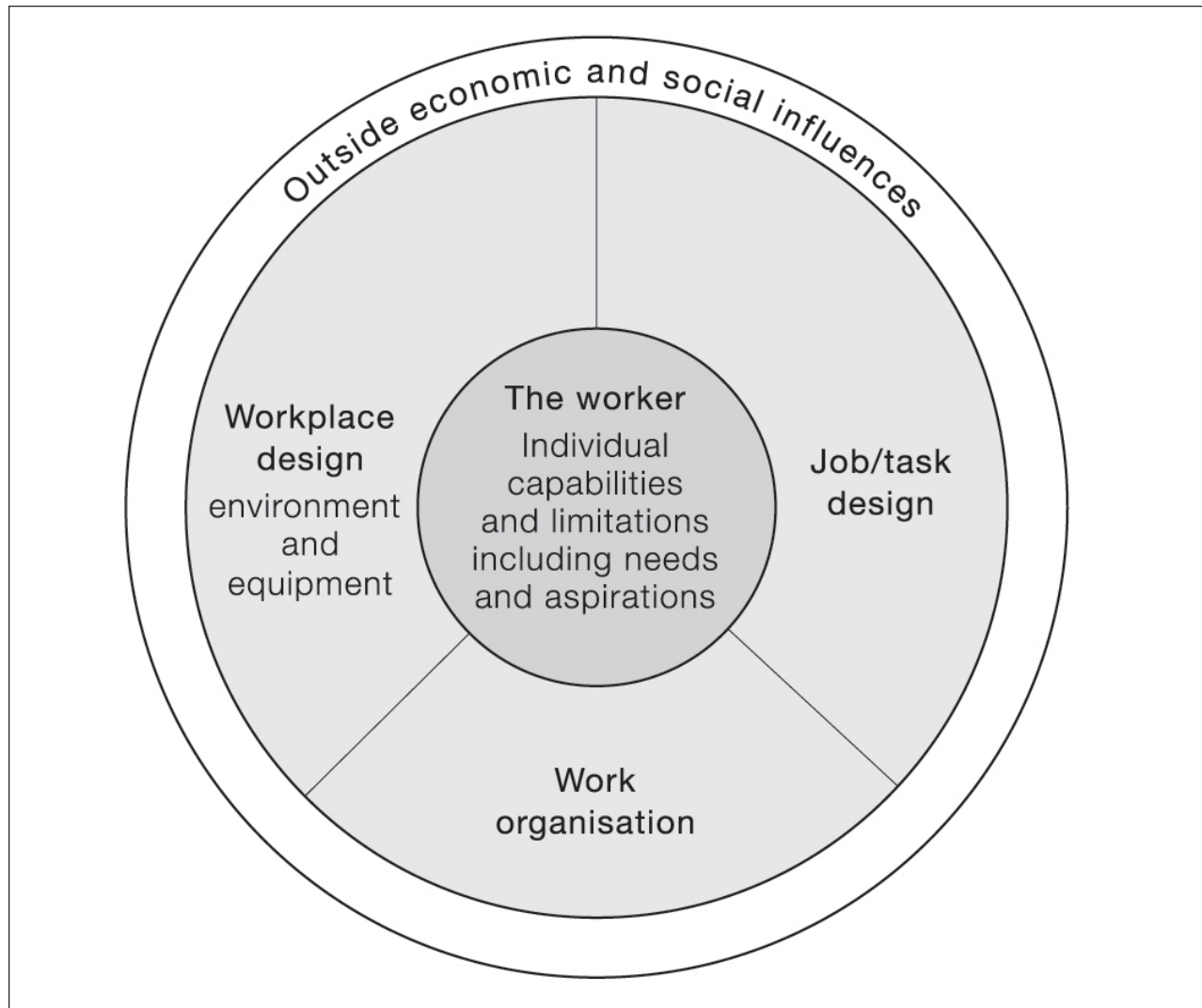


Occupational ergonomics (5)

Work organisation



Occupational ergonomics (6)



Systems of work

Factors to consider?





Human characteristics & limitations

- Physical
- Cognitive

What impacts on these characteristics and results in differences between people?

Human error (1)

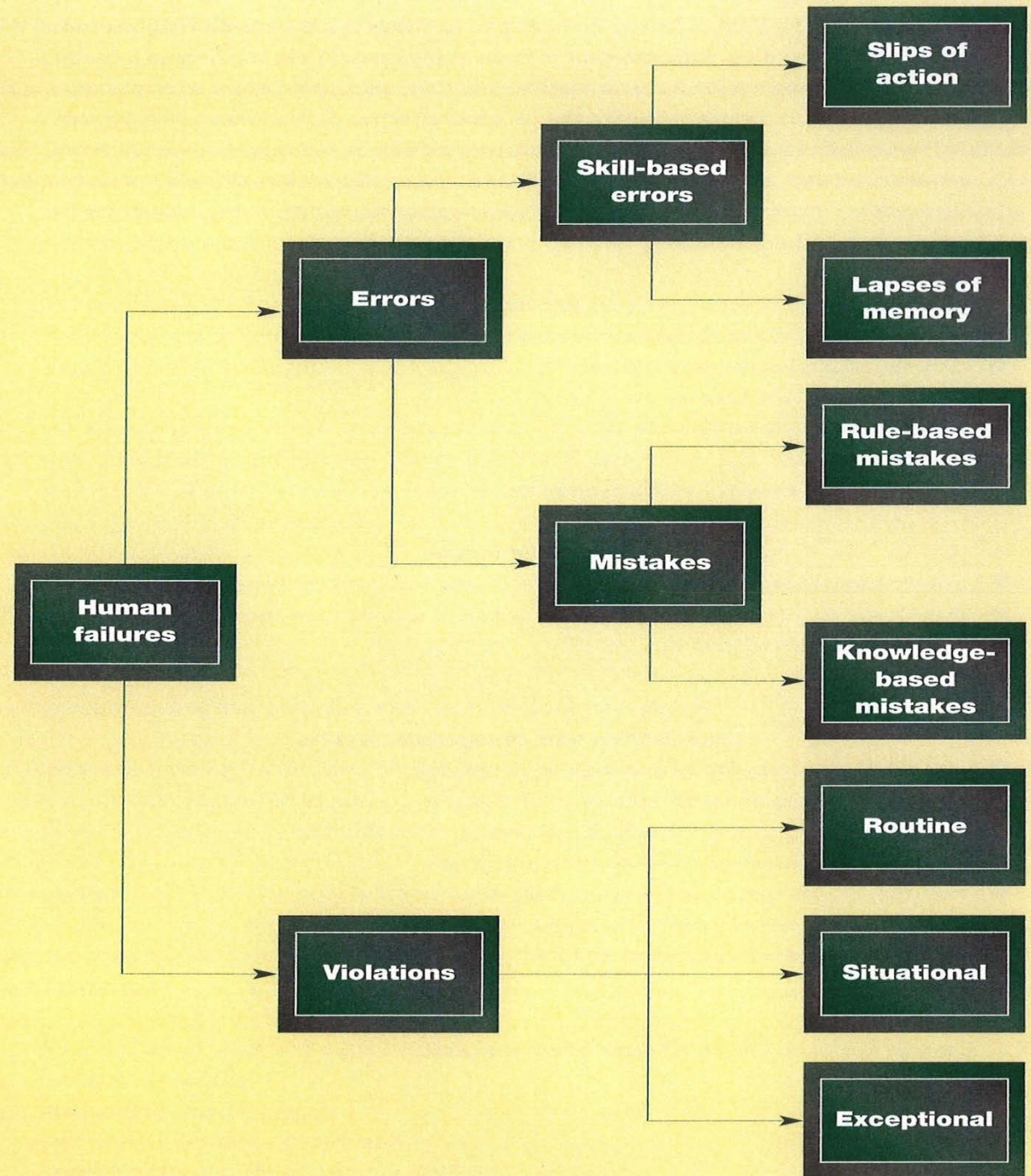
“An inappropriate or undesirable human decision or behaviour... that reduces or has the potential for reducing effectiveness, safety or safety performance..”

Error indicates a poor design.

Good ergonomics **reduces** errors.



Human error (2)





Human error (3)

- Active failure – immediate consequence
- Latent failure – systems failure

Examples from your work??

Human error (4)

Causes:

1. Organisational factors
2. Individual factors





Human error (5)

Reduce problems with errors by:

1. Improving the training
2. Improving workplace design, and detecting errors early
(eg feedback to allow remedial actions)
3. Reducing impact of the error



Teamwork (1)

Work team – *Collection of individuals who work together to achieve a goal or complete a set of tasks*

- Self-managed
- Integrated





Teamwork (2)

Benefits?

- Increase problem solving
- Improved employee performance
- Multiple perspectives
- Increased output
- Frees up managers



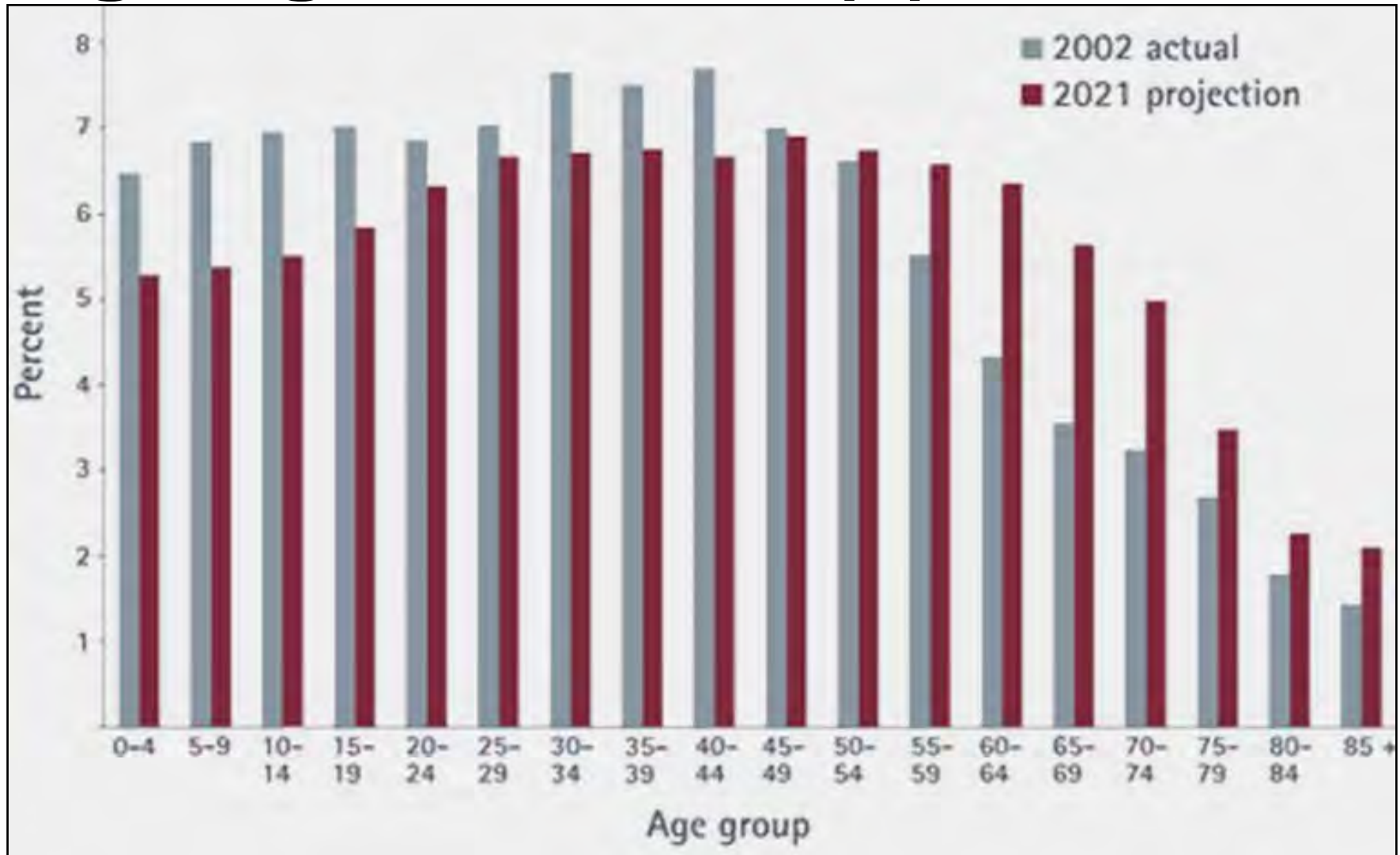


Teamwork (3)

Limitations / drawbacks?

- Unequal effort
- Different levels of skill/ fitness
- Slow achieving agreements – time wasting
- Conflict
- Competition

Ageing workforce (1)



Age profile of Australian population, Australian Public Service Commission, 2003

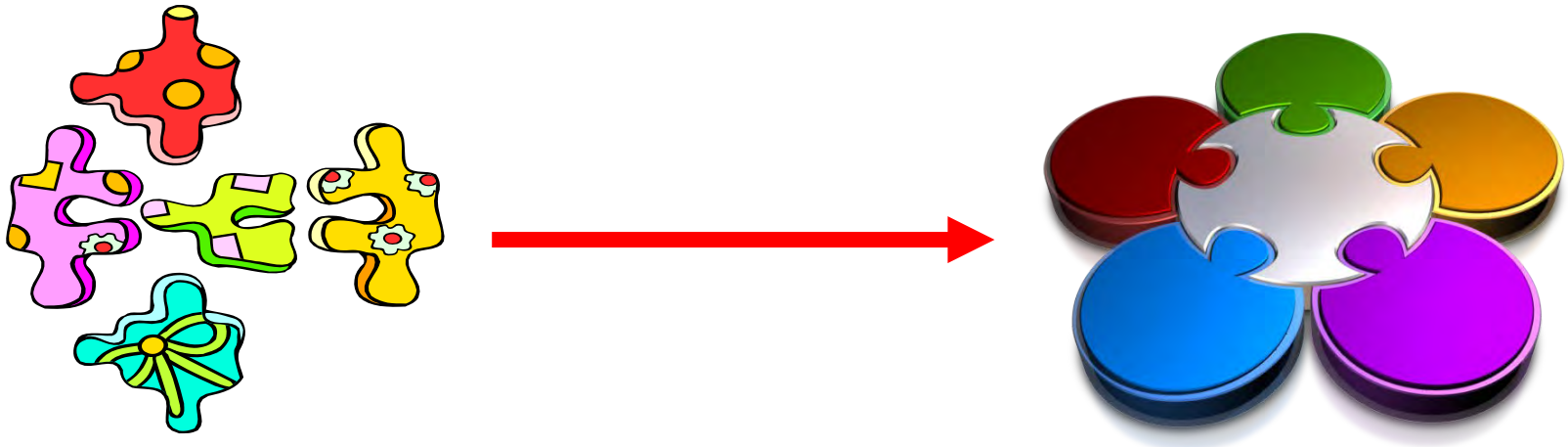


Ageing workforce (2)

True or false??

- 1. Older workers have more accidents.*
- 2. Vision & hearing acuity decrease with age.*
- 3. Older workers recuperate faster following injury / illness.*
- 4. Older workers may be more at risk of sprains and strains.*

The Ergonomist's role



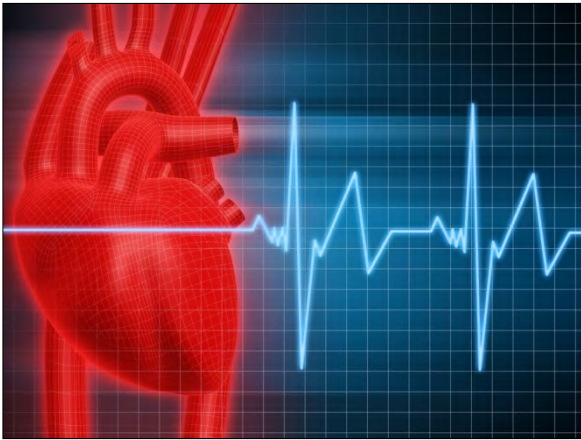
Assist industry to design work systems, equipment and the human-machine interface...

...to promote productivity, efficiency and worker comfort and satisfaction.



Summary

- **Overview of Ergonomics**
 - **Definition**
 - **Scope**
 - **Application**
 - **Human capacities**
 - **Human error**
 - **Teamwork**
 - **Ageing**
 - **Role of the Ergonomist**



BIOLOGICAL ERGONOMICS



M506 – Ergonomic Essentials
Overview of Ergonomics



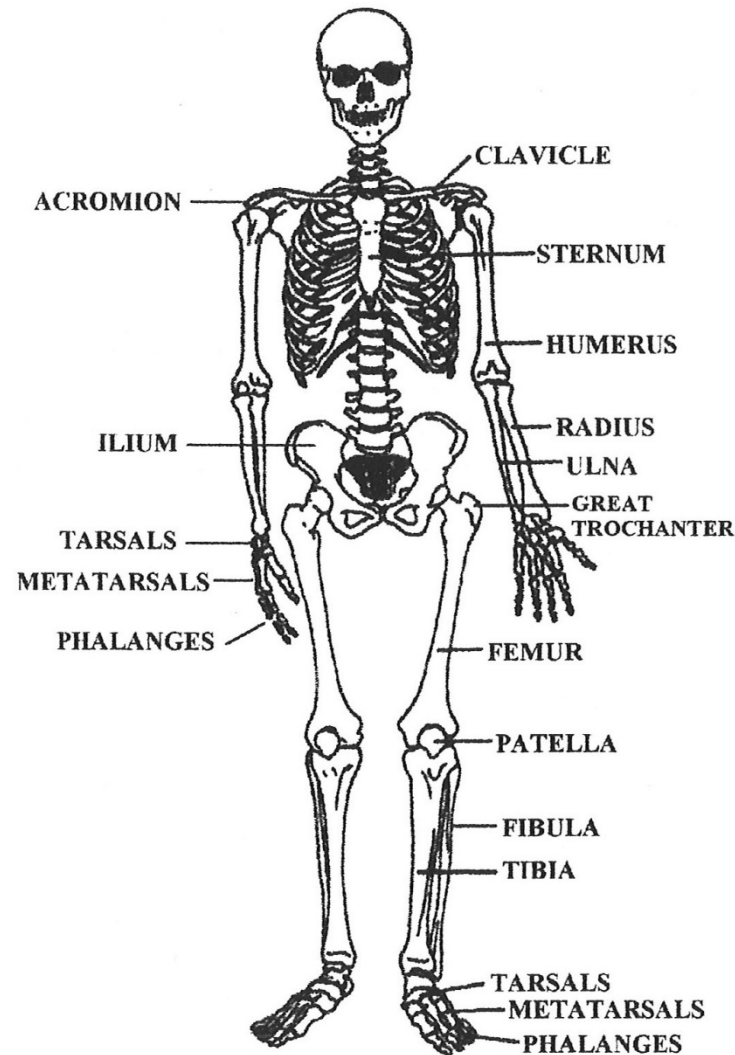
Body Systems & Functions

- Framework
- Moving parts
- Energy conversion
- Movement control
- Feedback systems
- Decision making
- *Skeleton*
- *Joints*
- *Metabolism & physiology*
- *Nervous system*
- *Senses – vision, hearing, touch etc*
- *Brain*



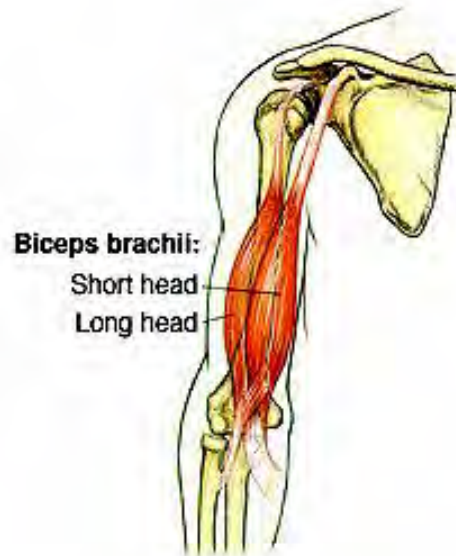


The musculoskeletal system (1)



The musculoskeletal system (2)

Muscles and tendons...

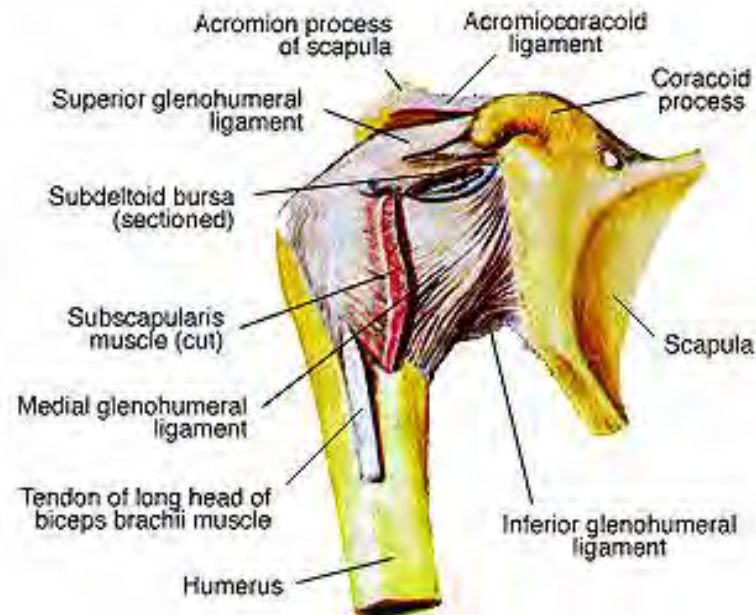


Mosby's Medical Encyclopaedia



The musculoskeletal system (3)

Ligaments...an example

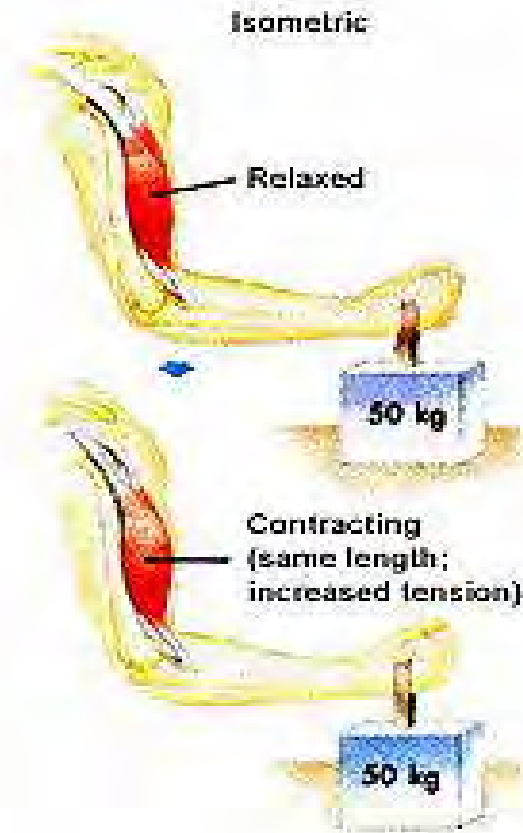
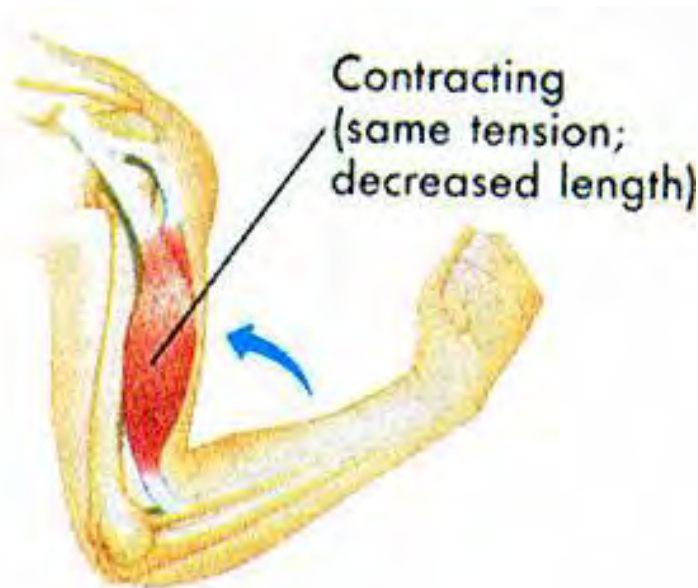


Mosby's Medical Encyclopaedia



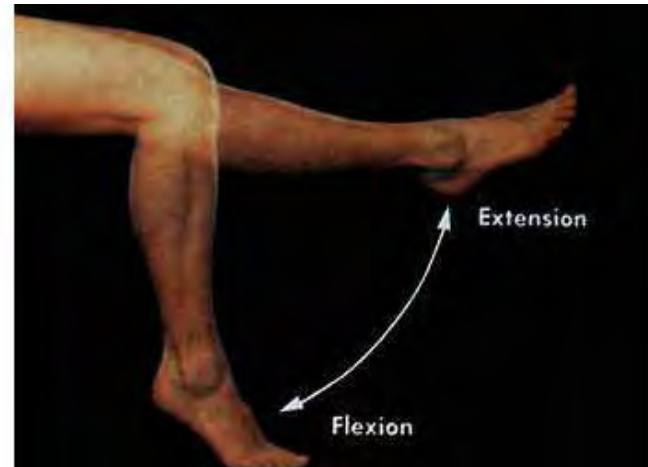
The musculoskeletal system (4)

Muscle work...



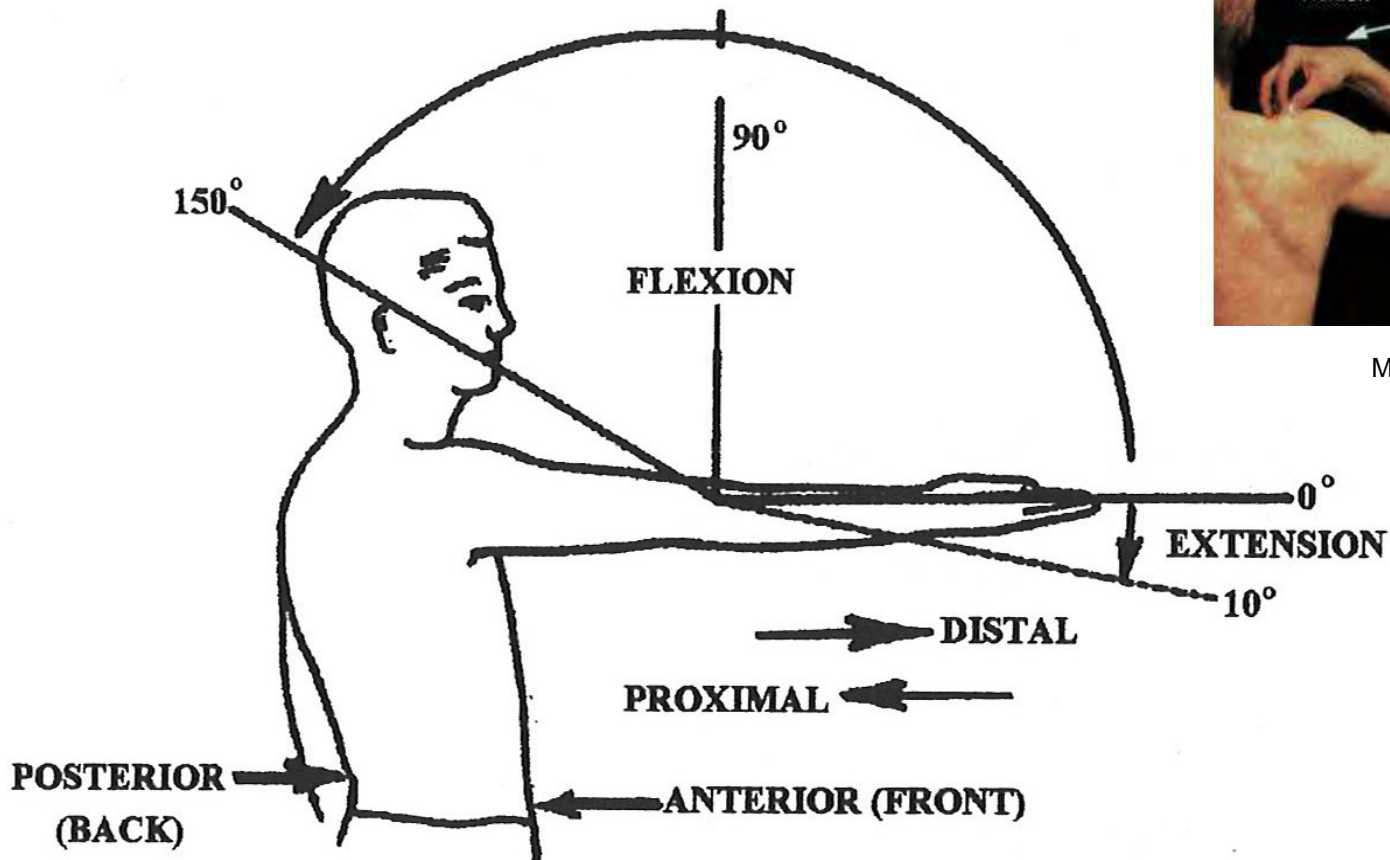
Mosby's Medical Encyclopaedia

Posture & movement (1)

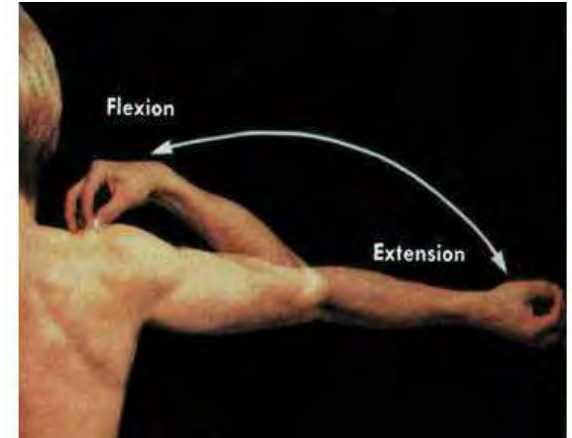


Mosby's Medical Encyclopaedia

Posture & movement (2)

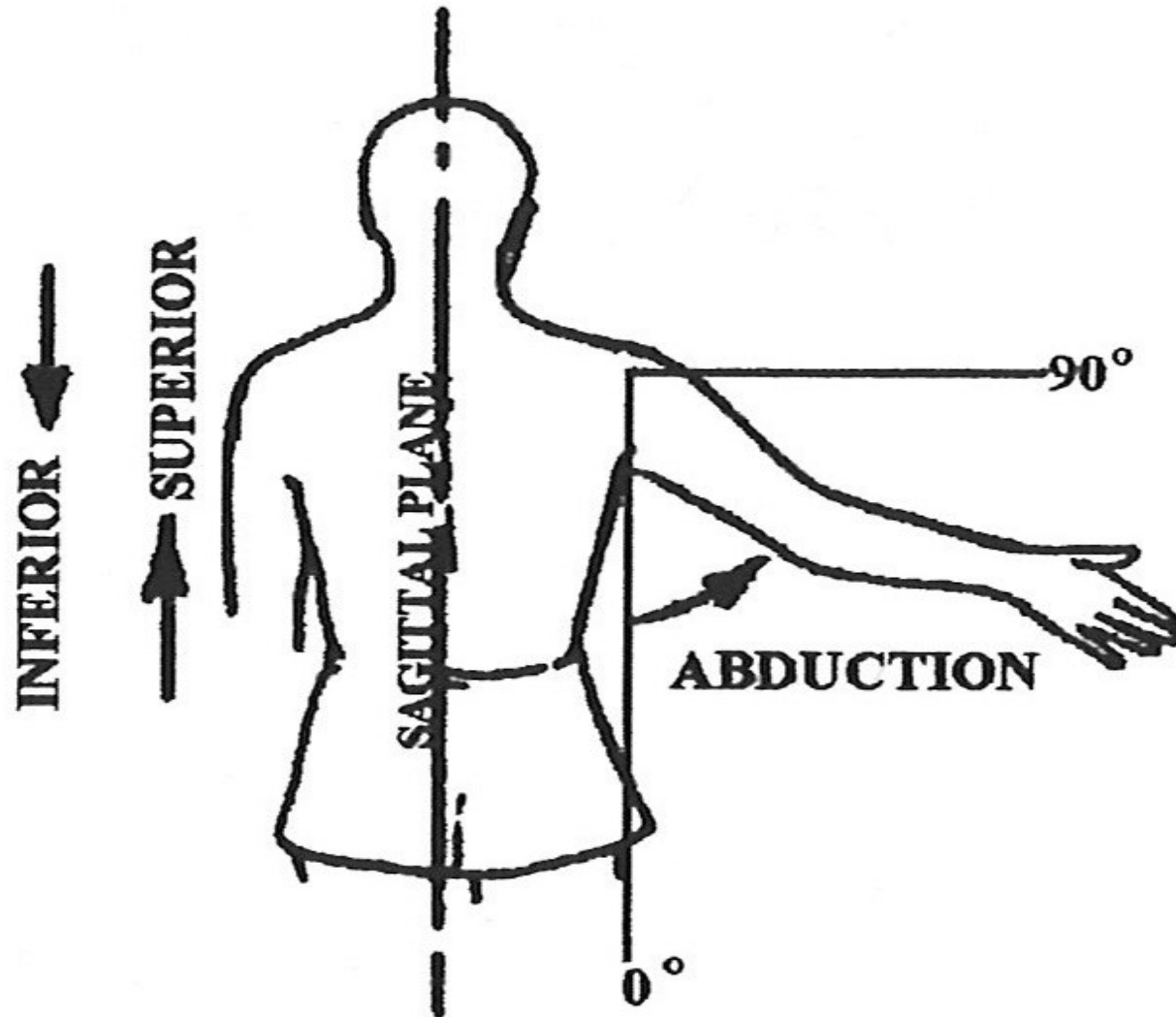


Stevenson

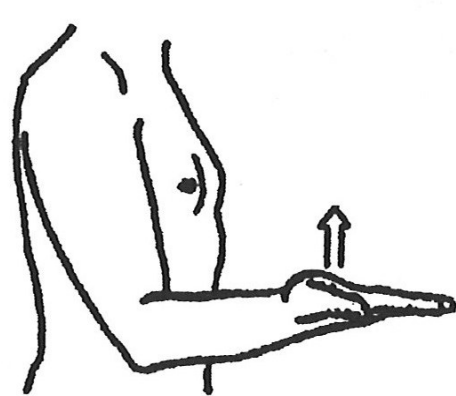


Mosby's Medical Encyclopaedia

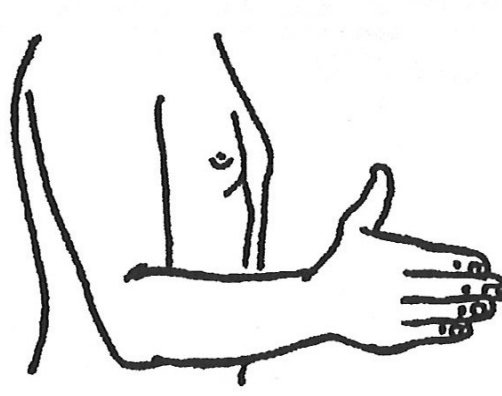
Posture & movement (3)



Posture & movement (4)



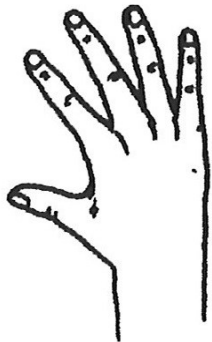
SUPINATION



MIDPOSITION



PRONATION



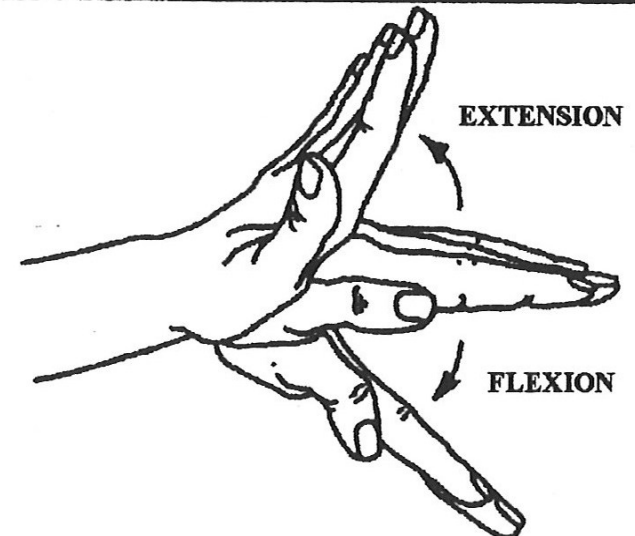
**RADIAL
DEVIATION**



NEUTRAL

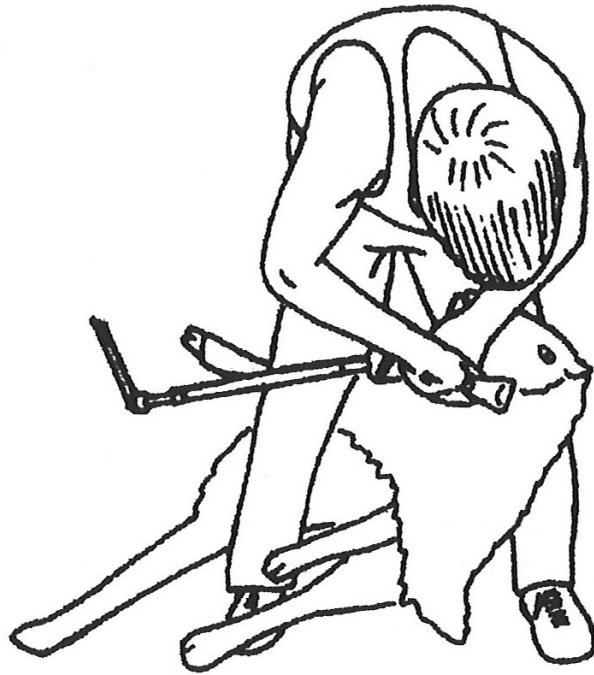


**ULNAR
DEVIATION**



Posture & movement (5)

Static V dynamic muscle work...



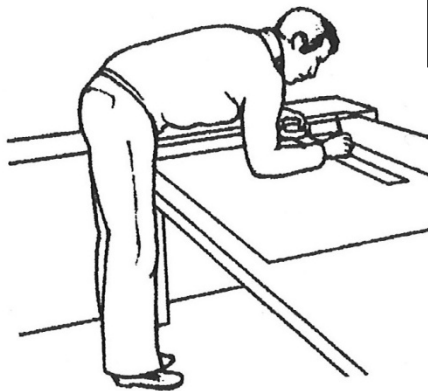
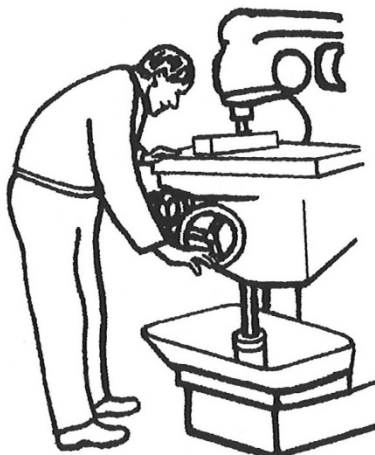
Stevenson



Where will these workers be feeling fatigue?

Posture & movement (6)

Static V dynamic muscle work...



Where will these workers be feeling fatigue?

Stevenson



Biomechanics (1)

*The interaction of human
movement and posture....
..... levers and forces*

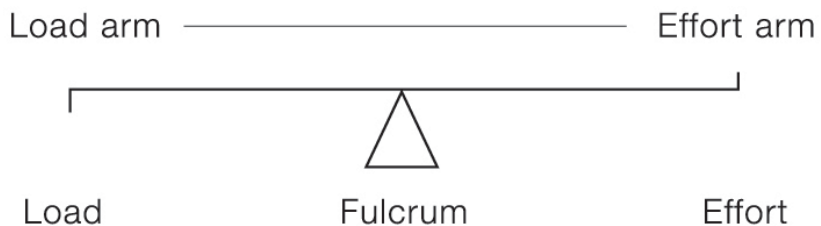


Biomechanics (2)

1st order lever

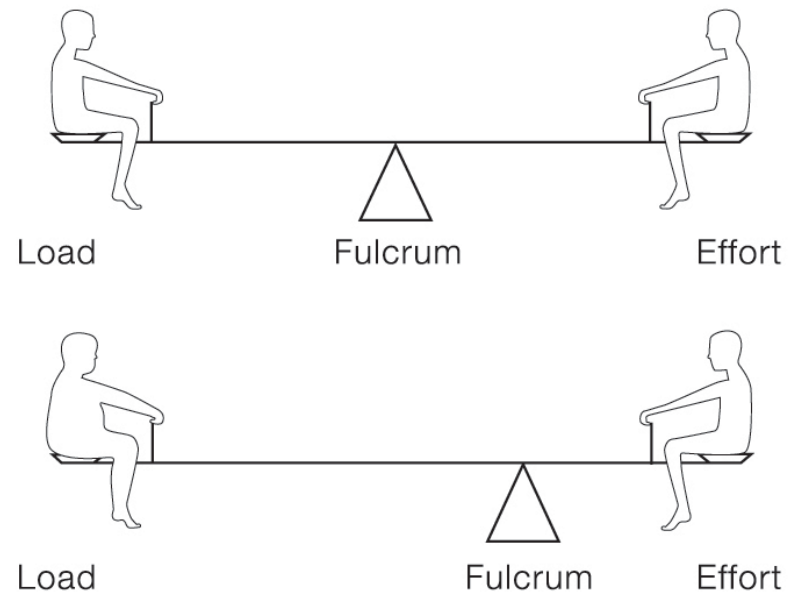
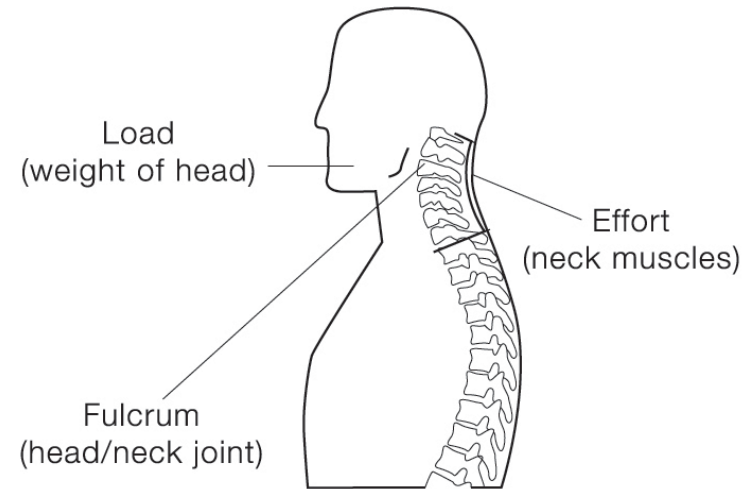
1st order levers

(mechanical advantage/disadvantage depends on the relative length of each lever arms)



McPhee

Head nodding on shoulders



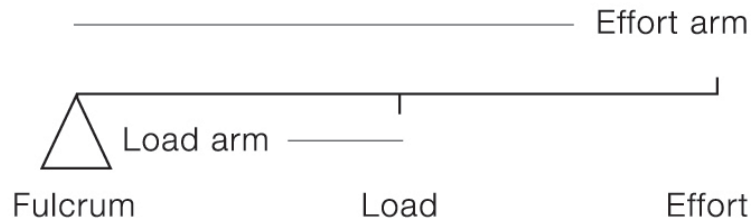


Biomechanics(3)

2nd order lever

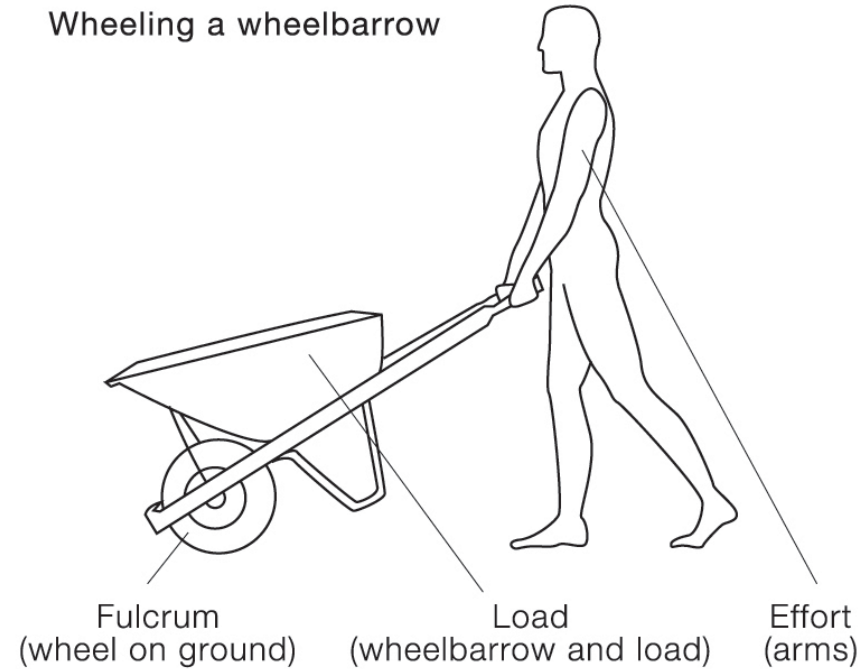
2nd order levers

(always a mechanical advantage – ‘effort arm’ always longer than the ‘load arm’)

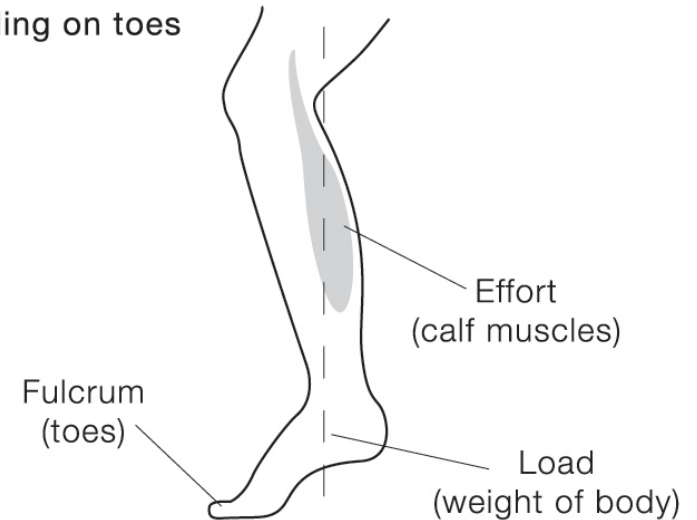


McPhee

Wheeling a wheelbarrow



Standing on toes



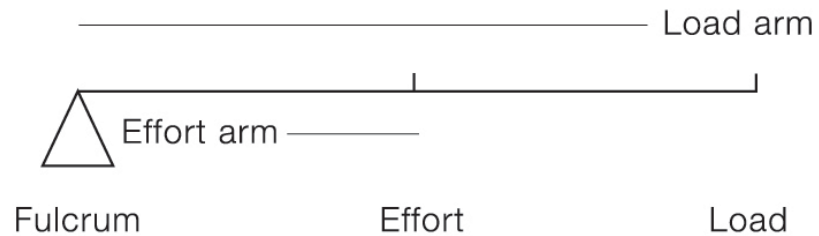


Biomechanics (4)

3rd order lever

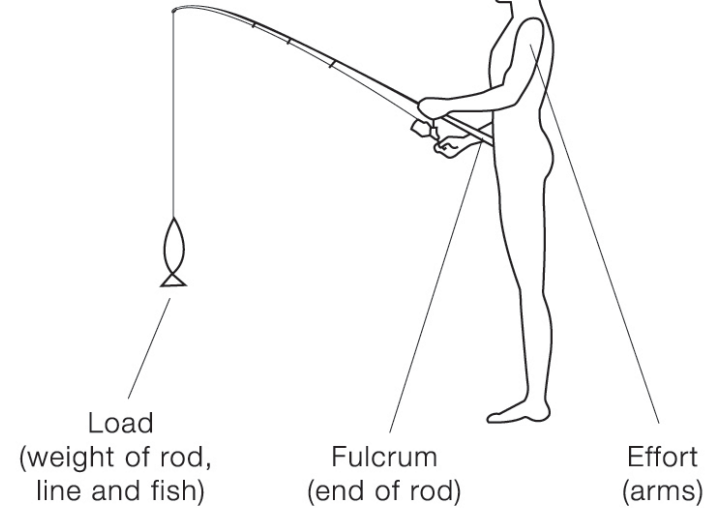
3rd order levers

(always a mechanical disadvantage – ‘load arm’ always longer than the ‘effort arm’)

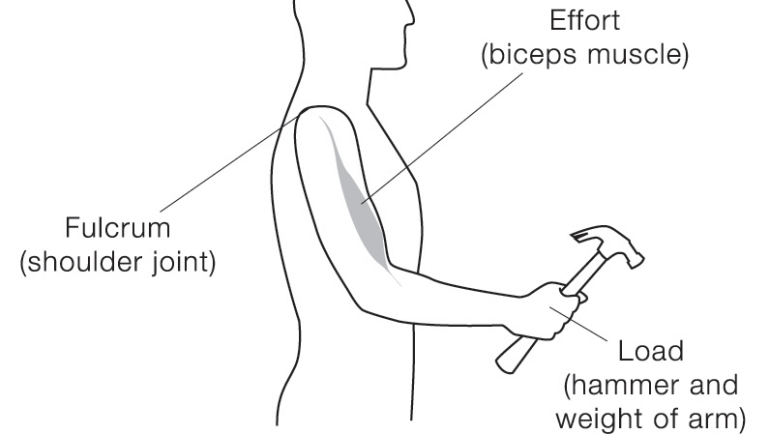


McPhee

Fishing rod



Biceps muscle





Biomechanics & the Musculoskeletal system

Key issues for work design?

- Postures – eg arm, wrist, back?
- Muscle action – static V dynamic?
- Levers?



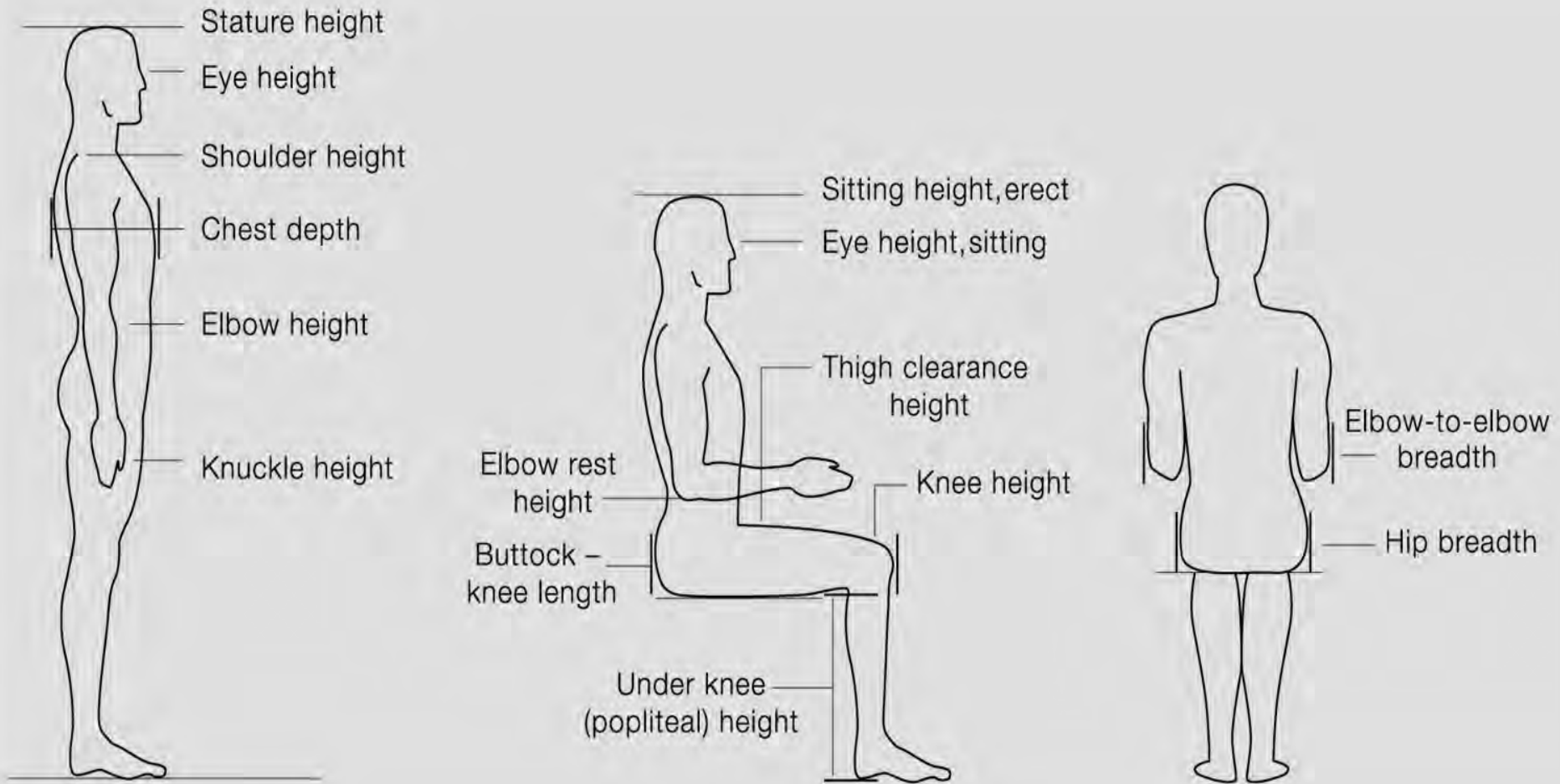
Anthropometry (1)

*Dimensions of the human body...
applied to designs*

*Includes: height, circumference,
weight, range of movements*

Static & dynamic measurements

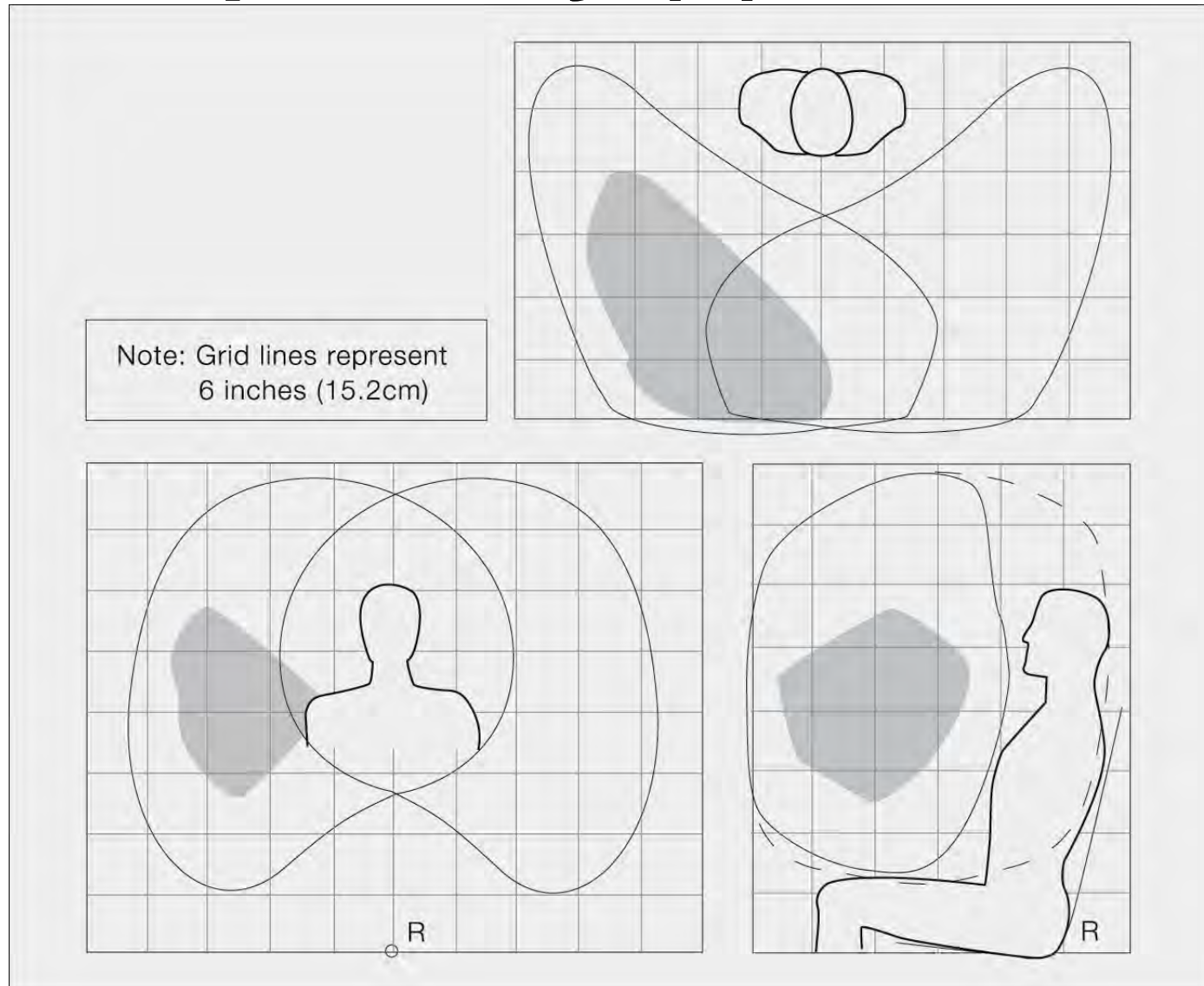
Anthropometry (2)



McPhee

M506 – Ergonomic Essentials
Overview of Ergonomics

Anthropometry (3)



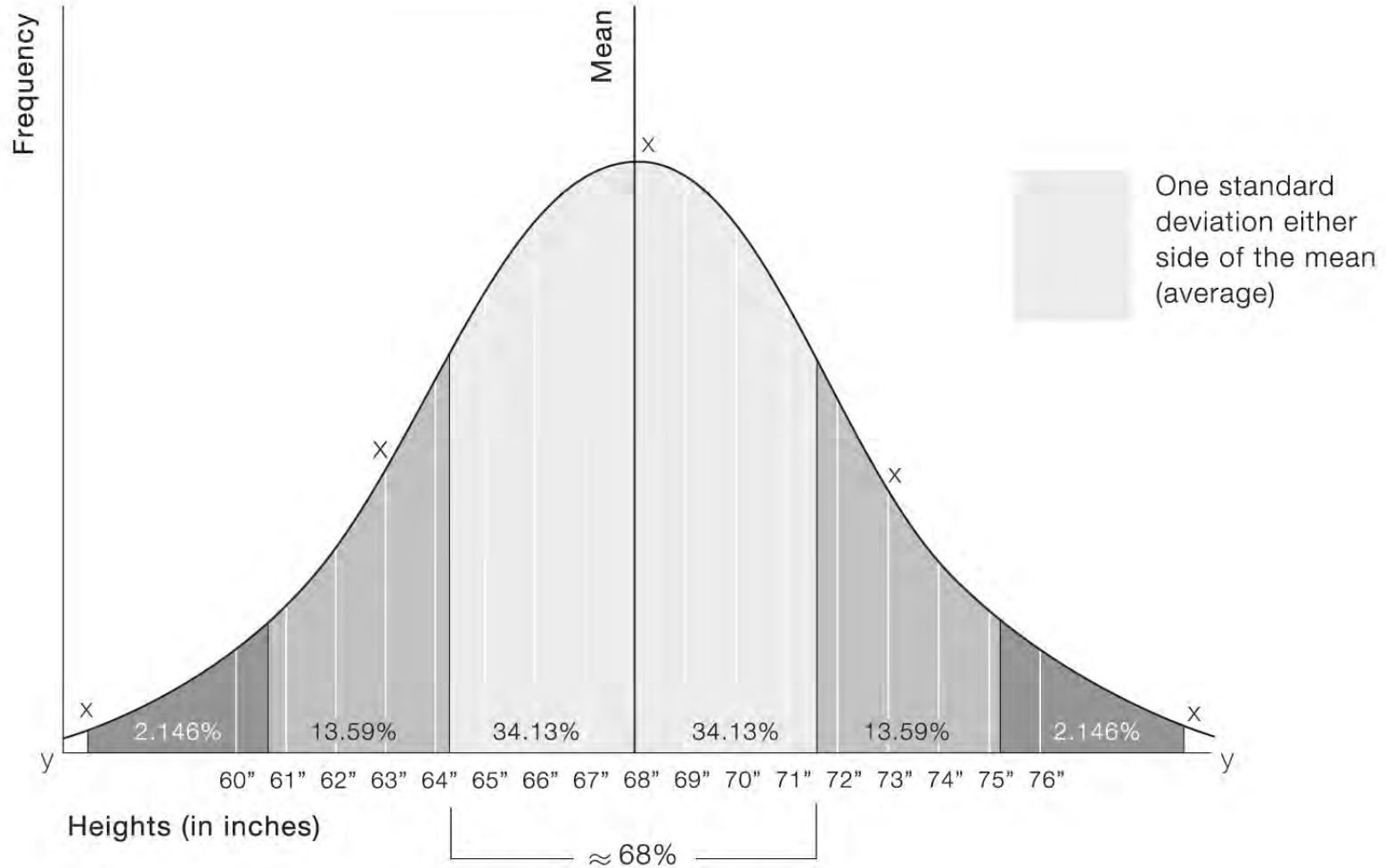
McPhee

Anthropometry (4)



BP

Anthropometry (5)



Stature of British male population (1970)

McPhee



Anthropometry (6)

Factors affecting body size?

- Age
- Sex
- Ethnicity
- Fitness & health
- Occupation
- Posture & body position



Work physiology (1)

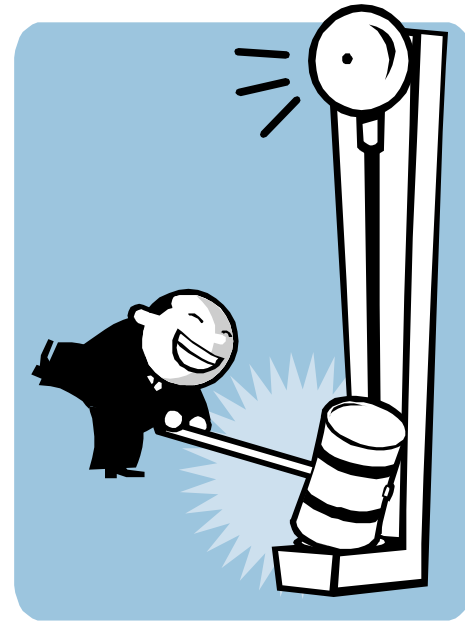
Human physical abilities also affected by:

- Strength
- Work capacity
- Endurance
- Fatigue

Work physiology (2)

Strength is affected by:

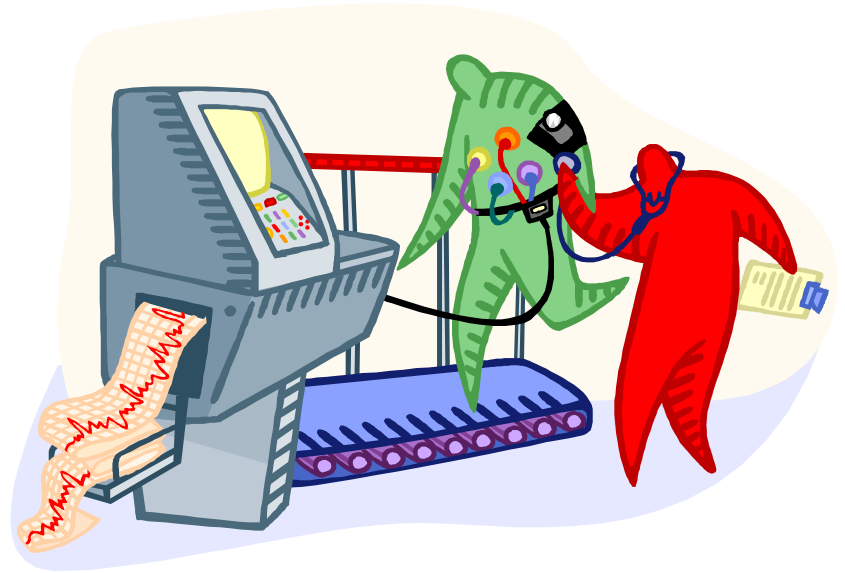
- Gender
- Age
- Training



Work physiology (3)

Work capacity is measured in:

- maximum O₂ uptake
- heart rate



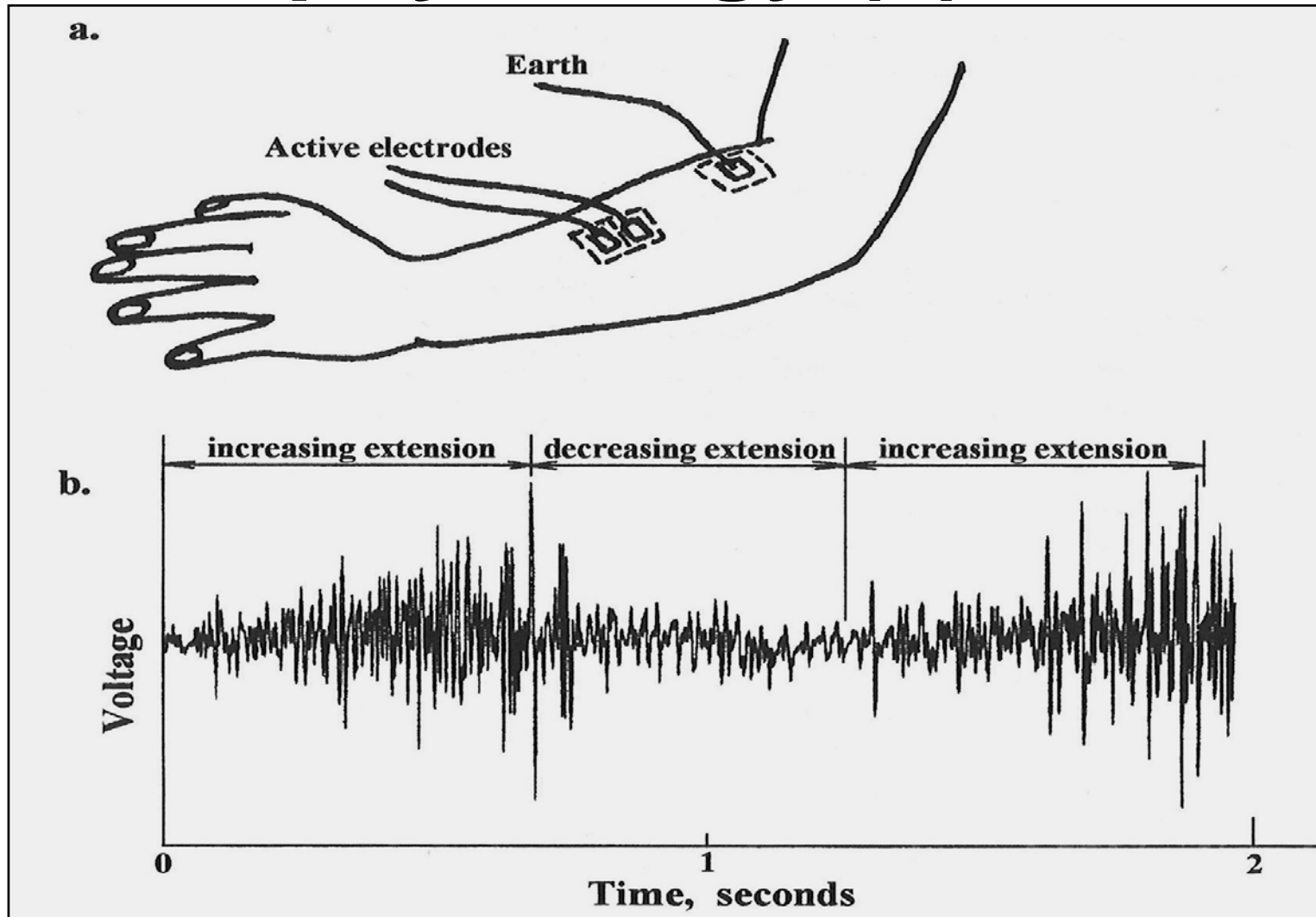


Work physiology (4)

Endurance & muscle efficiency is enhanced by:

- Eliminating unnecessary movements
- Using muscles according to their function
- Use of body weight & momentum & gravity
- Balance
- Vary movements & postures
- Postures that allow maximum torque
- No. of movements
- Provide practice

Work physiology (5)



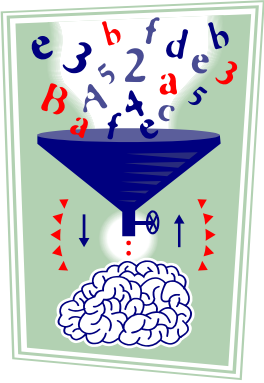
Stevenson



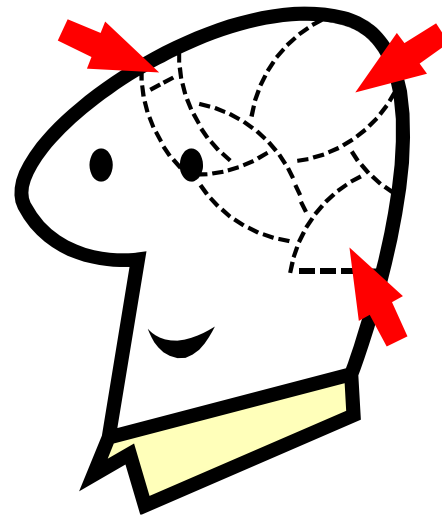
Work physiology (6)

Fatigue from:

- Static muscle work
- Work at outer range of joint movement
- Use high forces
- Long duration



PSYCHOLOGY AT WORK

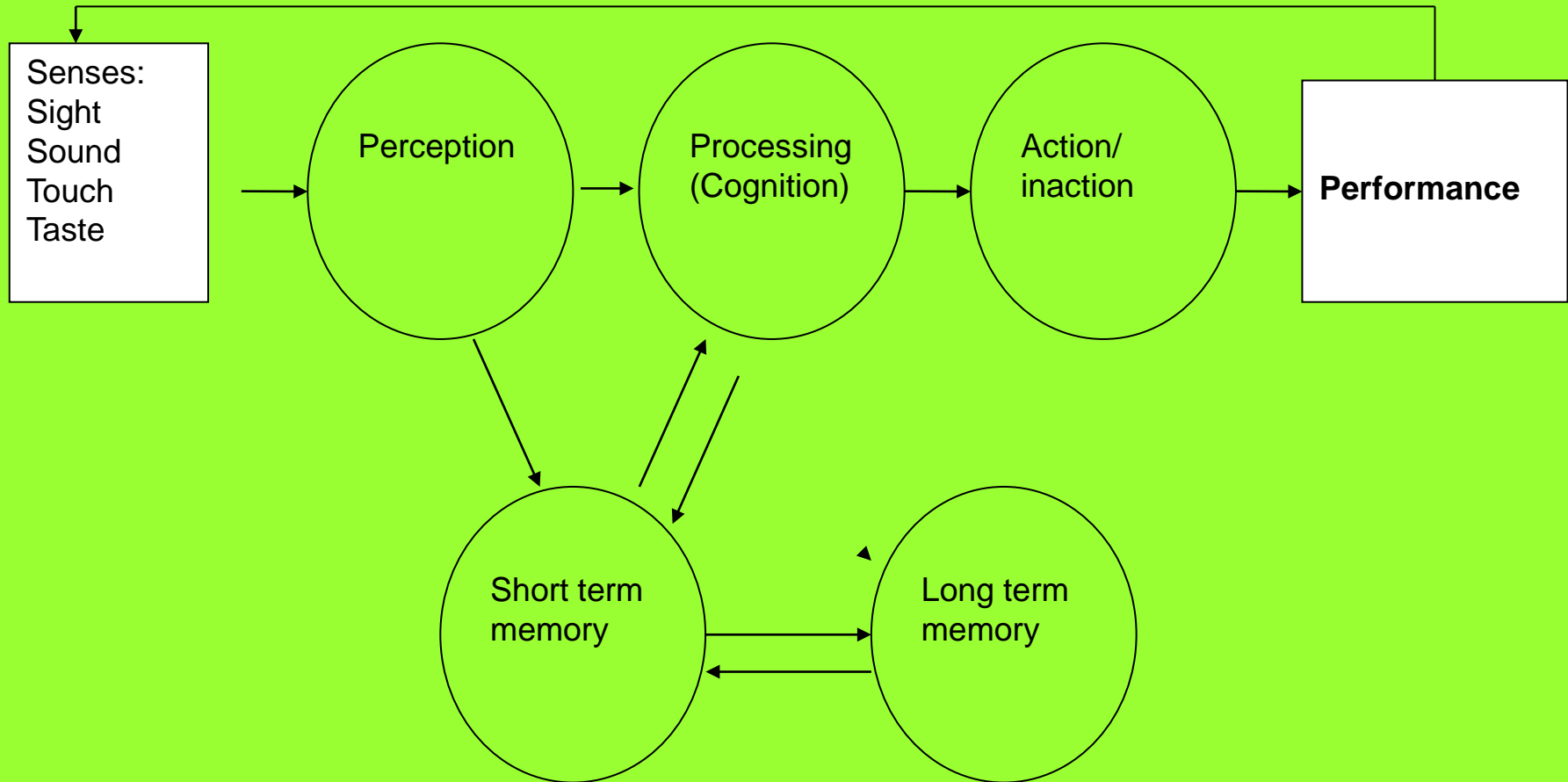




Issues to consider:

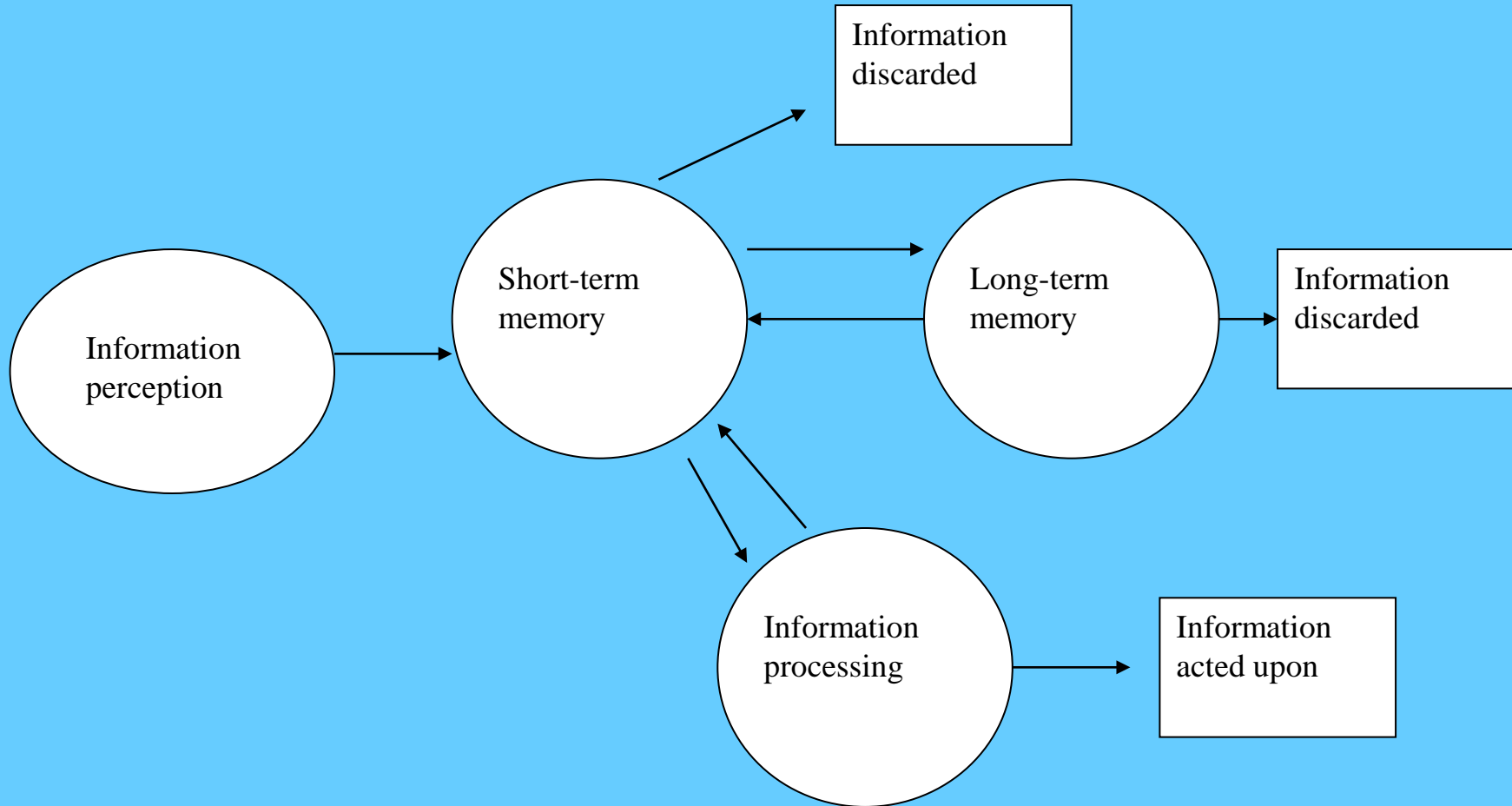
- Perception
- Motivation
- Memory
- Risk perception
- Work stress
- Work organisation

Perception & cognition





Memory



Information processing in short & long term memory



Decision making

Perceive information > Make decision

Features of decision making:

- Uncertainty
- Familiarity & expertise
- Time

Perception of risk (1)

Experience on task → Perceive *low* level of risk

Perception of risk is generally much ***lower*** than actual risk



Can you think of your own workplaces or own experience with risk?



Perception of risk (2)

Lower risk is perceived when hazard is:

Familiar

Controllable

Forgettable

Preventable

Cumulative

Consequential

Understood

& exposure is voluntary.



Perception of risk (3)

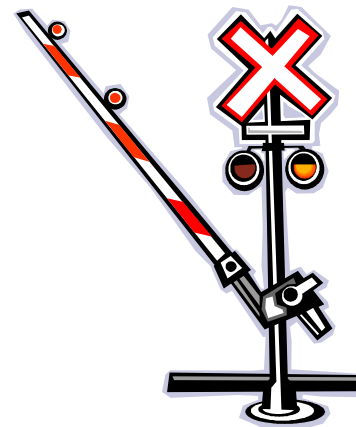
Risk compensation:

People adjust behaviours to compensate for changes in perceived risk.

The lower risk perception, the more and greater the risks that will be taken....

Signal detection theory (1)

Humans detecting change/ signals at work and responding appropriately.



Examples from your work?



Signal detection theory (2)

		Condition	
		Signal IS Present	Signal is Absent
Operator's Response	Signal IS Present	HIT	FALSE ALARM
	Signal is Absent	MISS	CORRECT REJECTION



Signal detection theory (3)

How can workplaces improve correct responses & reduce errors?

- Reducing noise
- Reducing distractors
- Reducing extraneous information
- Increasing the strength of the signal
- Presenting information clearly & simply

Vigilance (1)

Monitoring equipment or processes at work

Examples:



- Free response
- Inspection task
- Successive task
- Simultaneous
- Sensory
- Cognitive





Vigilance (2)

Methods to enhance vigilance performance:

- Mix of signals – eg visual & auditory
- Ensure signal stands out
- Make signal dynamic
- Provide 2 operators for monitoring
- Provide 10 mins rest or other activity per 30 mins of monitoring
- Install artificial signals that require response



Vigilance (3)

Methods to enhance vigilance performance (contd.):

- Refresher training
- Vary stimulation inversely to task stimulation
- Avoid over or underload
- Require operator to report all signals, even those signals in doubt



Motivation & behaviour (1)

Workplace motivation –

Individual's intention or willingness to perform a task

Extrinsic V intrinsic

.....wide variation in 'rewards'

What 'rewards' have & have NOT worked in your workplace? Why?



Motivation & behaviour (2)

Setting goals & selecting rewards

Goals are effective if:

- Element of challenge
- Realistic / attainable
- Feedback re performance towards goal



Rewards are best if:

- Workers are consulted re options

Work stress (1)

Demands exceed ability to cope

Most likely if individuals experience:

- Lack of control
- Lack of social support
- Lack of direction
- Lack of information
- Conflict with others
- Physical work environment problems
- Violence or aggression





Work stress (2)

Signs of stress...

Psych:

- Anxiety
- Depression
- Aggression
- Confusion

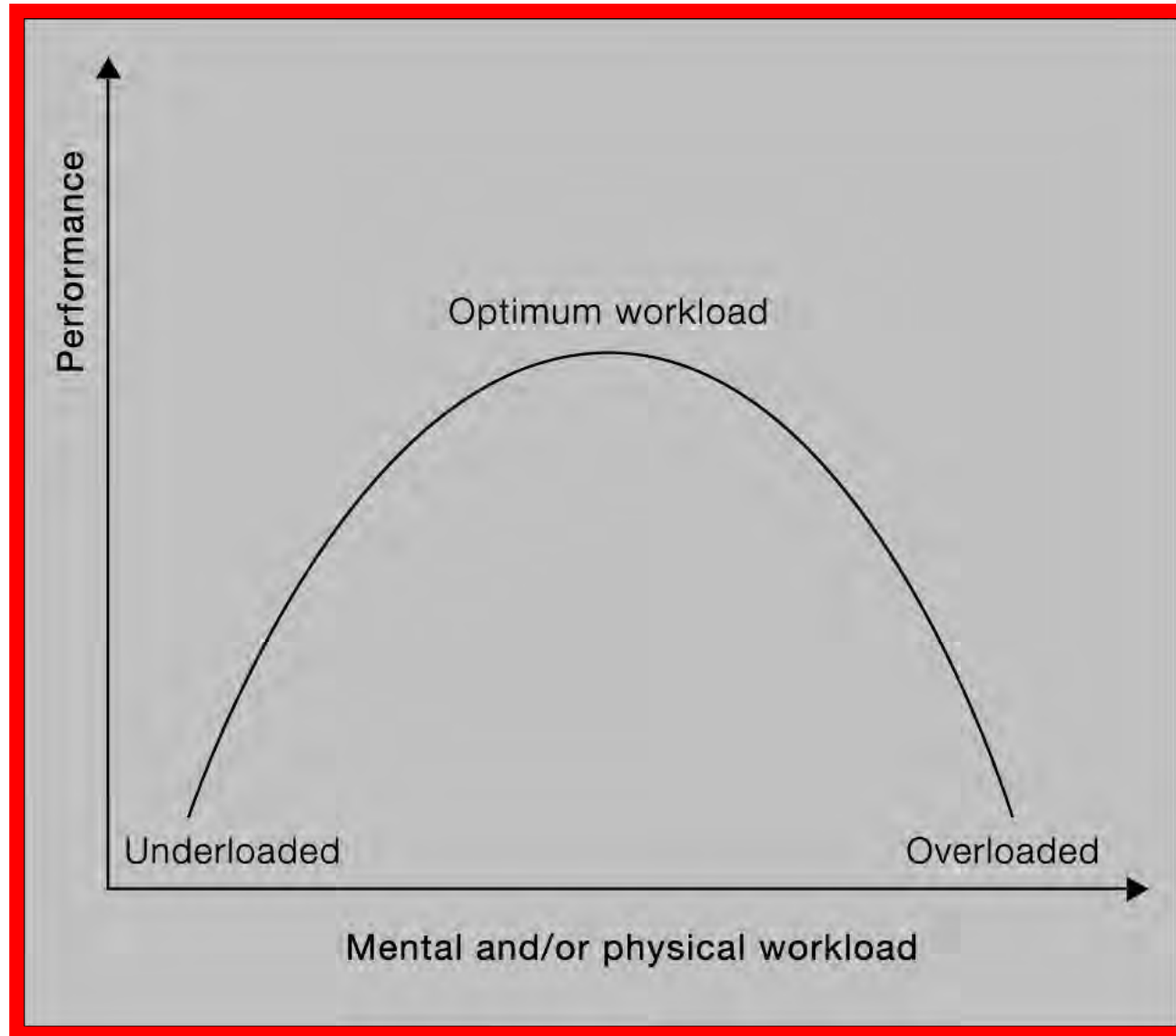
Physical:

- Increased blood pressure
- Increased heart rate
- Muscle tension
- Headaches

Behavioural:

- Smoking
- Alcohol abuse
- Drug abuse
- Absenteeism
- Poor performance

Work stress (3)



McPhee



Work stress (4)

How should organisations manage stress at work?

What's it got to do with ergonomics?



Work organisation (1)

Workplace culture and way the workplace functions

- management style
- organisation of work groups
- industry norms & history
- work hierarchy
- work hours etc



Work organisation (2)

Work shifts

Flexible

V

Shiftwork

V

Extended hours



Work organisation (3)

Managing shiftwork:

- Reduce consecutive night shifts – eg max. 3x8hr/wk or 2x12hr/wk
- Rapidly rotate rosters – eg each 2-3 days
- Forward rotations – day>afternoon>night
- Compressed weeks
- Personal coping strategies



Rest & work breaks (1)

Work pauses

Spontaneous & often unplanned breaks
in a task

Examples from your work?

Rest & work breaks (2)

Work breaks

Definition: meal breaks and other breaks where people can take time to recover from a task

How long to break? How often?

Examples from your work?



Rest & work breaks (3)

Average amount of sleep required...?

Each 24 hours:	>No less than 5.5hrs
Each week:	>No less than 49 hrs
Each month:	>No less than an av. of 7.7hrs/day (i.e. 210hrs/mth)



DEVELOPING AN ERGONOMICS STRATEGY





Issues to consider

- **Workplace culture**
- **Types of teams used in workplace**
- **Ergonomics at the design phase**
- **Competence of Ergonomics advice**



Workplace culture & systems (1)

- **Systems**

- structures made up of sets of inter-related and inter-dependent parts

- **Organisations**

- sub-systems within society

- **Work teams/departments**

- sub-systems in organisations



Workplace culture & systems (2)

Managing change

Has your team/organisation undergone major change?

What factors hindered peoples' acceptance?

What factors helped the process and made it work?



Workplace culture & systems (3)

- Consultation
 - Sharing information and exchanging views
 - Central to efficient management systems.

Who?
What?
When?
Where?
How?



Macro-ergonomics

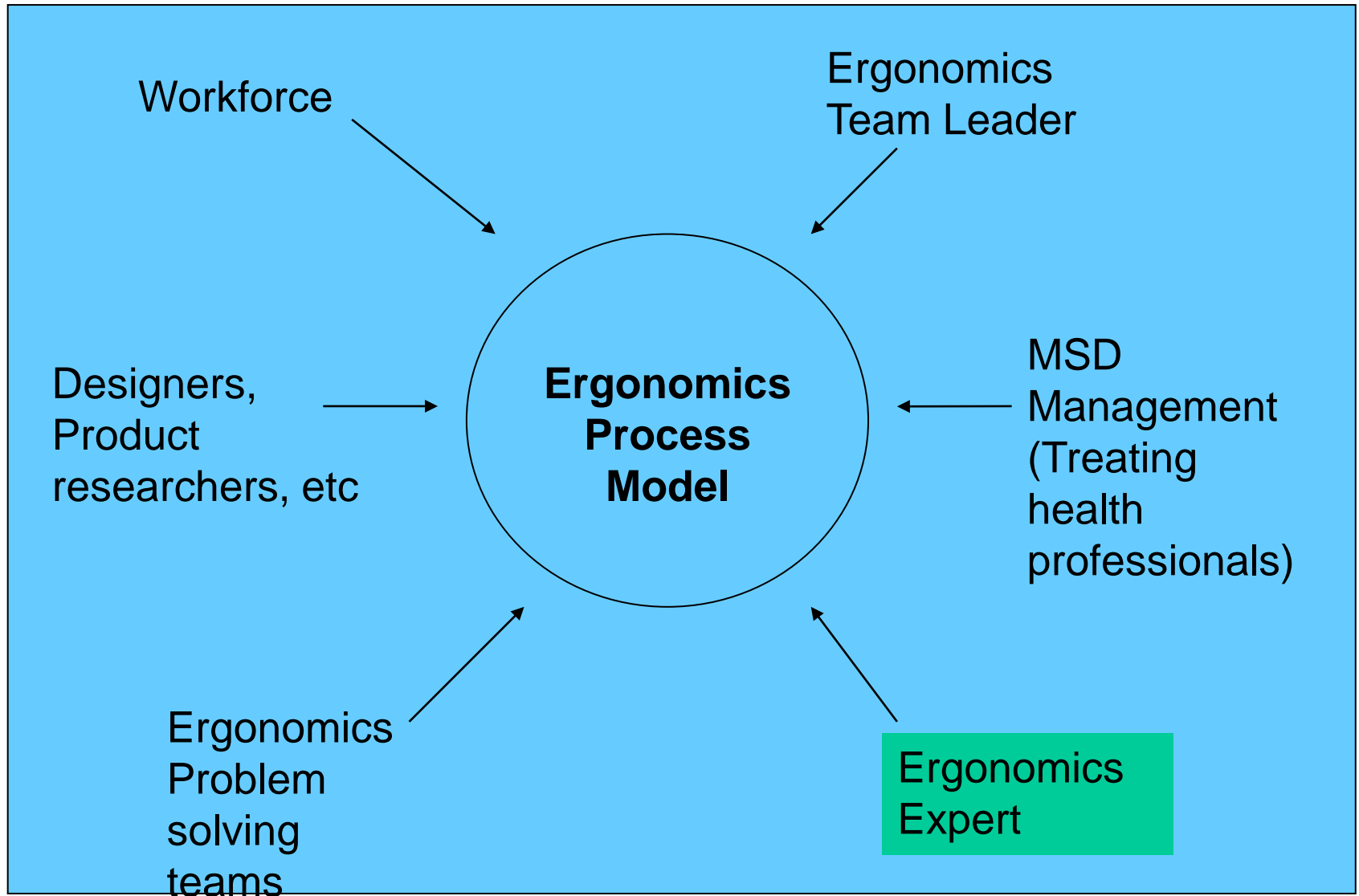
Also known as...

...Systems ergonomics

...Organisational design and management (ODAM)

Participatory ergonomics teams in organisations often focus on the *macro-ergonomics* issues.

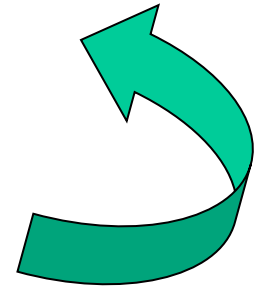
Participatory ergonomics



Ergonomics in design



- Design for user and potential user population
- Iterative design
 - Mock-ups
 - Prototypes
 - Trial
 - FEEDBACK





Ergonomics in design

How do we reduce design errors?

What designs have you been involved with that worked well?

What steps did you take to achieve success?

Professional Ergonomists



...“facilitates practical application of ergonomics in industry and other areas

Encourages scientific research by qualified persons in the field of study and practice...”



IEA Technical committees include:

Aerospace	Gender & work	Process control
Ageing	Healthcare	Psycho-physiology
Anthropometry	Human reliability	Quality management
Auditory ergonomics	Musculoskeletal disorders	Safety
Building & construction	O.D.A.M	Slips, trips & falls
Children	Primary industry	Computers



IEA provides:

- Criteria for assessing and endorsing certifying bodies & programs
- List of competencies for Ergonomists

e.g. '*Certified Professional Ergonomist*' (CPE)
& similar titles



Ergonomics: seeing the whole picture

