Introduction to
Human Factors in Engineering
&
Ergonomics Research Field

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Content:

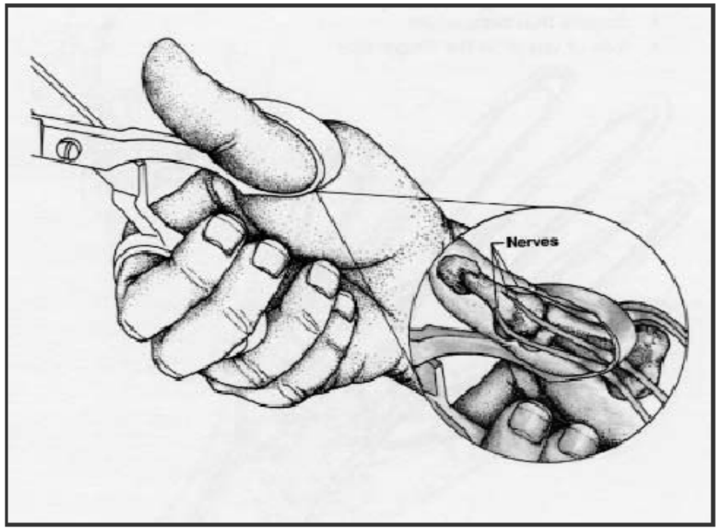
History of Ergonomics: I

The association between **occupations** and **musculoskeletal injuries** was documented centuries ago.

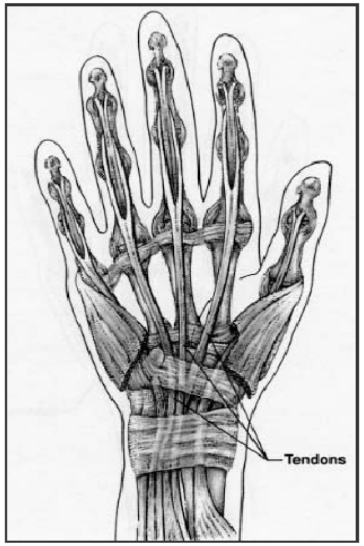
Bernardino Ramazinni (1633-1714) wrote about work-related complaints (that he saw in his medical practice) in the 1713 supplement to his 1700 publication, "De Morbis Artificum (Diseases of Workers)."

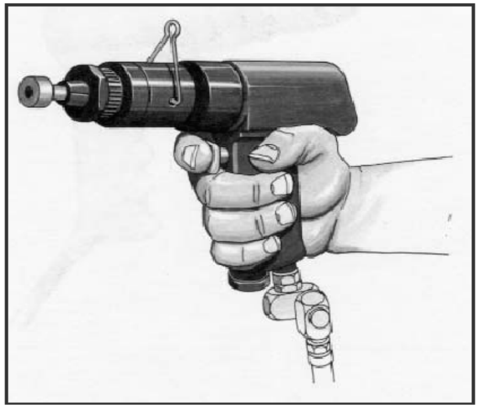
<u>Presently, Work Related to **Musculoskeletal Disorder** and **Human Error** are considered the research challenges in ergonomics field.</u>

Digital Neuritis



Trigger Finger

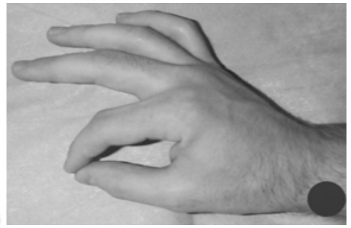




Tendon Damage and Pain

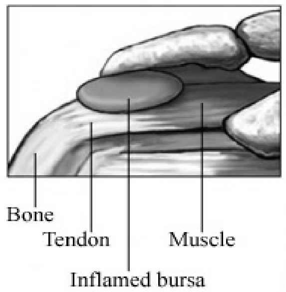
- **Damage:**
  - torn
  - tendonitis
  - tenosynovitis

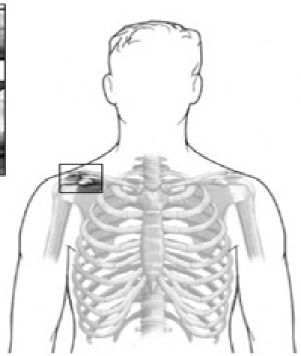
Tenosynovitis

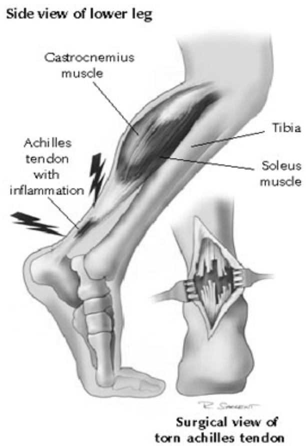


Finkelstein's test; the patient is instructed to grasp the thumb of the affected hand with the other fingers and actively pull the thumb towards the small finger. Sharp pain will be elicited over the area indicated by the red dot if the patient suffers from deQuervain's tenosynovitis.

Tendon Inflammation
Examples



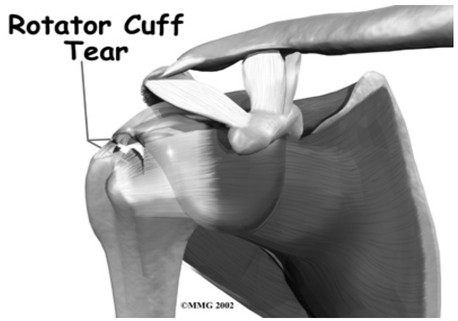




การบาดเจ็บบริเวณหัวไหล่

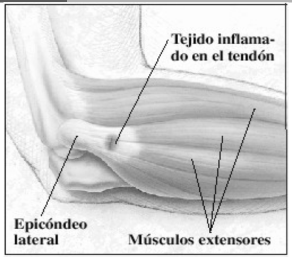
Rotator Cuff Tendinitis

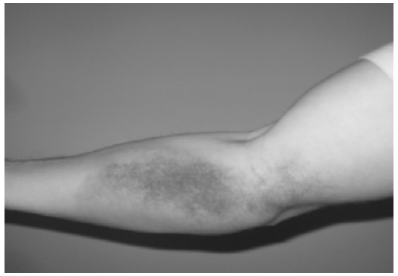
การอักเสบของเอ็นบริเวณข้อไหล่

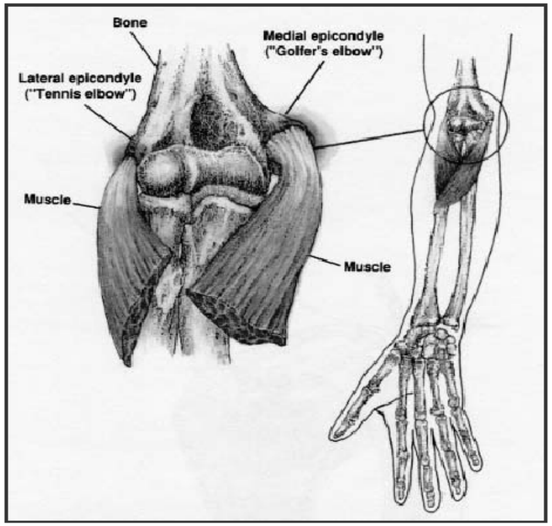


การบาดเจ็บบริเวณข้อศอก: Epicondilitis

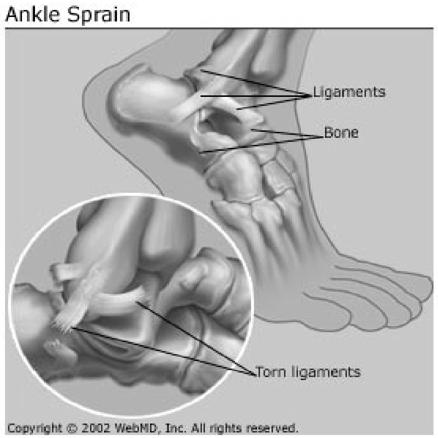
การอักเสบของเอ็นข้อศอกบริเวณ Epicondyle

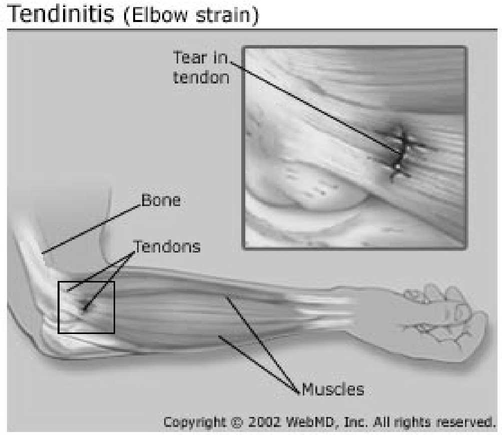




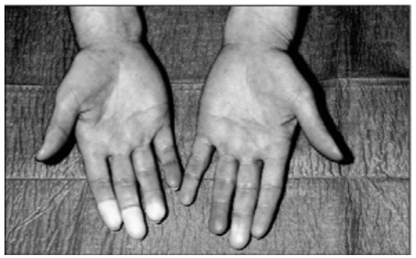


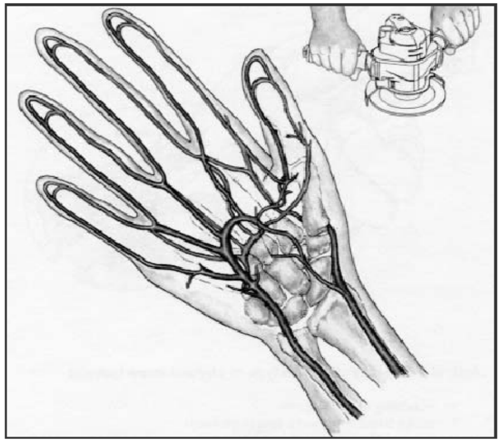
การบาดเจ็บของเอ็นกระดูกข้อเท้า
การบาดเจ็บของเอ็นกล้ามเนื้อข้อศอก



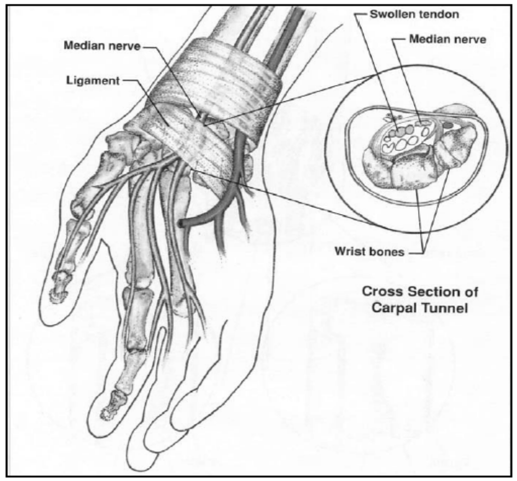


Raynaud's Phenomenon

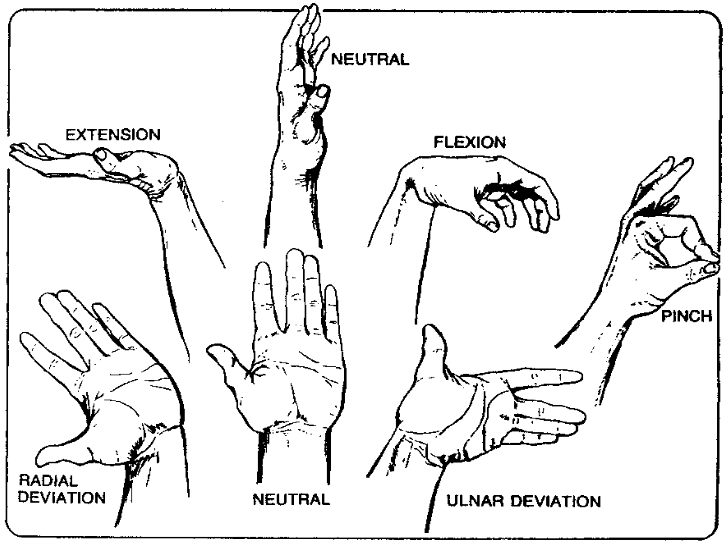




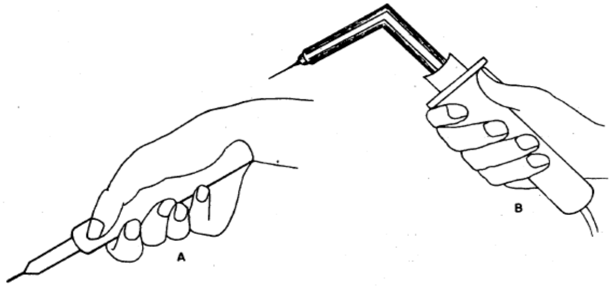
Carpal Tunnel Syndrome

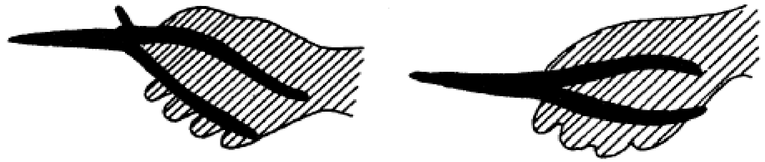


การงอหรือหักข้อมือ จะมีความเสี่ยงต่อการบาดเจ็บมากขึ้น



Reducing Risk of Hand and Wrist





An example of research in Ergonomics

From: Applied Ergonomics

An evaluation of arborist handsaws

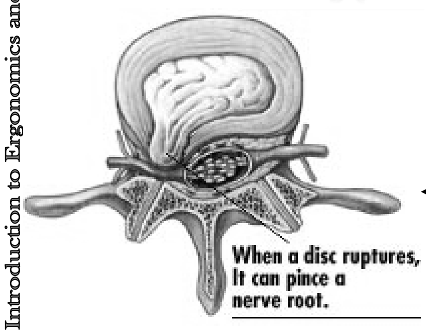
Gary A. Mirka[a,*], Sangeun Jin[b], Jeff Hoyle[c]

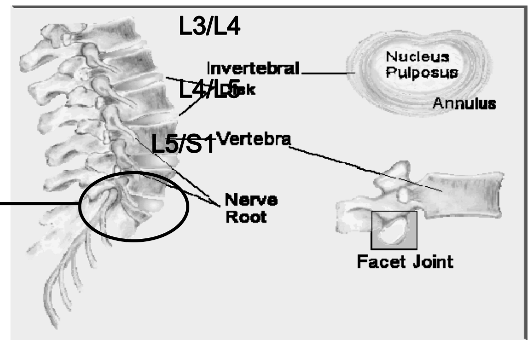
[a]Department of Industrial and Manufacturing Systems Engineering, Iowa State University, Ames, IA 50011-2164, USA
[b]The Ergonomics Laboratory, Department of Industrial Engineering, North Carolina State University, Raleigh, NC 27695-7906, USA
[c]The Ergonomics Center of North Carolina, Raleigh, NC 27606, USA

Form Applied Ergonomics 40 (2009) 8–14

Low Back Problem of a Disc Ruptures

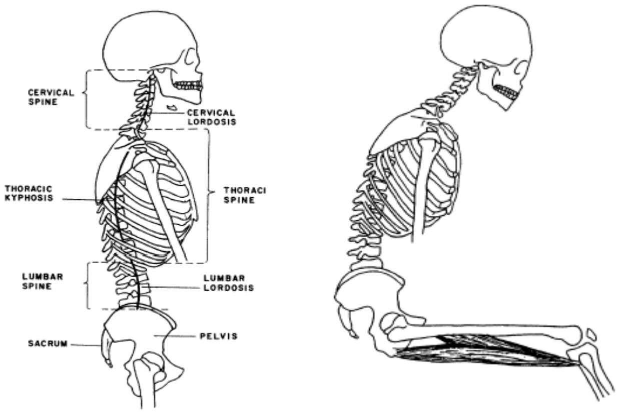
A disc that has been weakened may rupture or herniate. If the annulus ruptures, or tears, the material in the nucleus can squeeze out of the disc, or *herniate*. A disc herniation usually causes compressive problems if the disc presses against a spinal nerve. The chemicals released by the disc may also inflame the nerve root, causing pain in the area where the nerve travels down the leg.

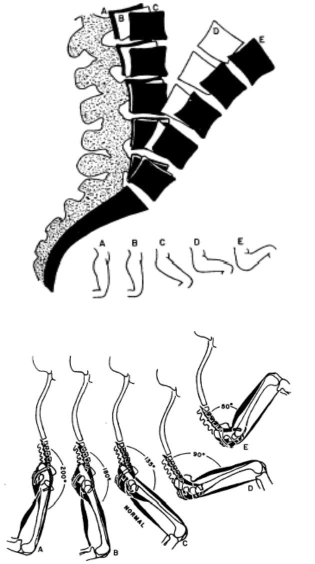




Changes in lumbar spinal curve resulting from pelvis rotation – increase disc pressure

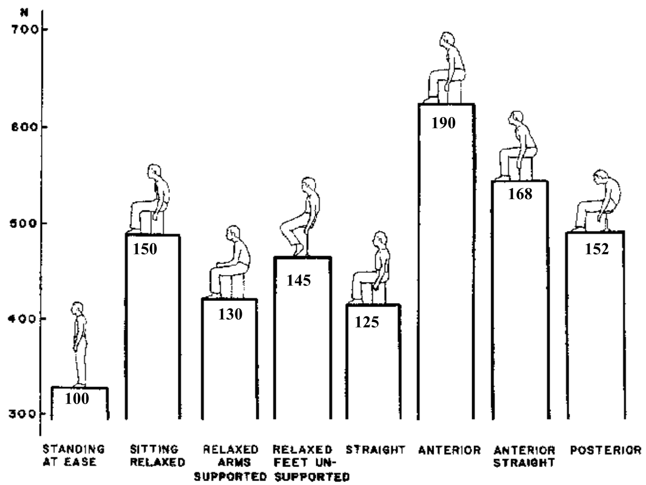
Hamstring muscles cause the rotation of pelvises





Changes in Spinal Disc Pressure at L3/L4 from Different Sitting Postures

Andersson and et.al. (1974)



Changes in Spinal Disc Pressure at L3/L4 from Different Sitting Postures

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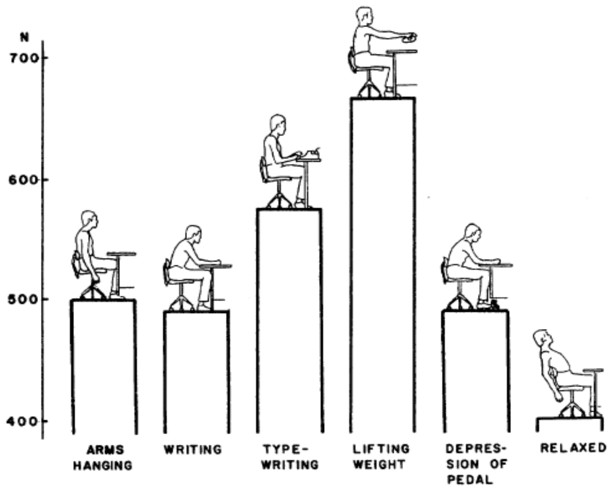


An example of research in Ergonomics

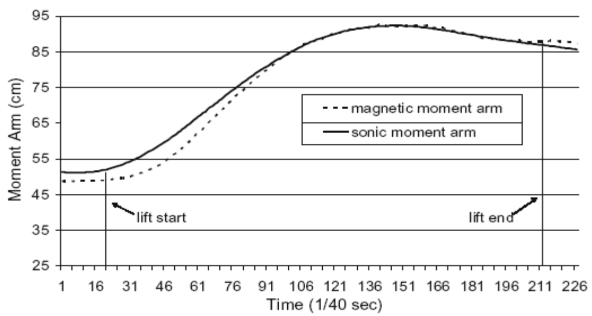
From: Journal of Electromyography and Kinesiology

Instrumentation for measuring dynamic spinal load moment exposures in the workplace

William S. Marras *, Steven A. Lavender, Sue A. Ferguson, Riley E. Splittstoesser, Gang Yang, Pete Schabo

Institute for Ergonomics, Biodynamics Laboratory, The Ohio State University, 1971 Neil Avenue, Columbus, OH 43210, USA

W.S. Marras et al. / Journal of Electromyography and Kinesiology xxx (2009) xxx–xxx



The 18th Congress of the International Society of Biomechanics (ISB2001) , 8-13 July 2001, ETH Zurich, Switzerland

Modelling the nonlinear changes in body height due to external loading

N. Charoenporn[1], C.M. Haslegrave[2] and K. Intaranont[3]

[1]Faculty of Engineering, Thammasat University, Thailand.
[2]School of Mechanical, Materials, Manufacturing Engineering and Management, University of Nottingham, UK.
[3]Faculty of Engineering, Chulalongkorn University, Thailand.

$$\varepsilon(t)=\int_0^t \varphi_1(t_1-\xi_1)\sigma(\xi_1)d\xi_1+\int_0^t\int_0^t \varphi_2(t-\xi_1,t-\xi_2)\sigma(\xi_1)\sigma(\xi_2)d\xi_1 d\xi_2 + \int_0^t\int_0^t\int_0^t \varphi_3(t-\xi_1,t-\xi_2,t-\xi_3)\sigma(\xi_1)\sigma(\xi_2)\sigma(\xi_3)d\xi\, d\xi_2 d\xi_3+\cdots$$

$$H(t)=H^0+H^+\ln(t)$$

$$\frac{H^0}{\sigma_0}+\frac{H^+}{\sigma_0}\ln(t)=\left[R^0+M^0\sigma_0+N^0\sigma_0^2\right]+\left[R^+ + M^+\sigma_0+N^+\sigma_0^2\right]\ln(t)$$

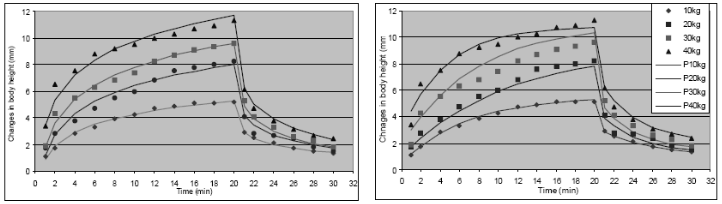


Figure1 Changes in body height (solid points) and the predicted values (solid lines) during both loading and recovery periods, comparing two strain-time functions (a) the natural logarithm function and (b) the exponential function

History of Ergonomics: II

Wojciech Jastrzebowski created the word ***ergonomics*** in 1857 in a philosophical narrative, "based upon the truths drawn from the Science of Nature" (Jastrzebowski, 1857).

Ergonomics Meaning

- The word "Ergonomics" comes from the following two Greek words:

Ergonomics = Ergos + Nomos

Ergos which means "work"

Nomos which means "laws"

Useful work or Harmful work

History of Ergonomics: III

In the early 1900's, the production of industry was still largely dependent on <u>**human power/motion** and ergonomic concepts were developing to improve worker productivity</u>.

Scientific Management, a method that improved worker efficiency by improving the job process, became popular.

Frederick W. Taylor was a pioneer of this approach and evaluated jobs to determine the "One Best Way" they could be performed.

An example of research in Ergonomics

From: Ergonomics

Estimation of hand force in ergonomic job evaluations

STEPHEN BAO* and BARBARA SILVERSTEIN

SHARP Program, Department of Labor and Industries, P.O. Box 44330, Olympia, WA 98504, USA

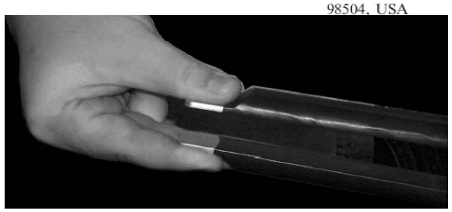


Figure 1. Pinch grip strength test.

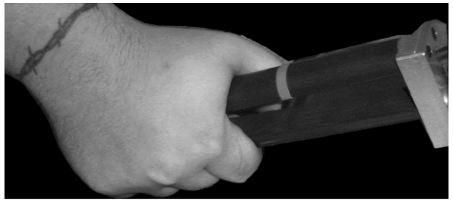


Figure 2. Power grip strength test.

Table 2. Pinch and power grip strength (in N)

Gender	n	Mean	SD	95% Confidence interval
		Pinch Grip		
Female	64	89.2	20.6	84.1 – 94.4
Male	56	125.1	23.9	118.7 – 131.5
		Power Grip		
Female	64	294.0	65.9	277.8 – 310.7
Male	56	470.0	76.1	449.6 – 490.4

Introduction to Ergonomics and Its Importance

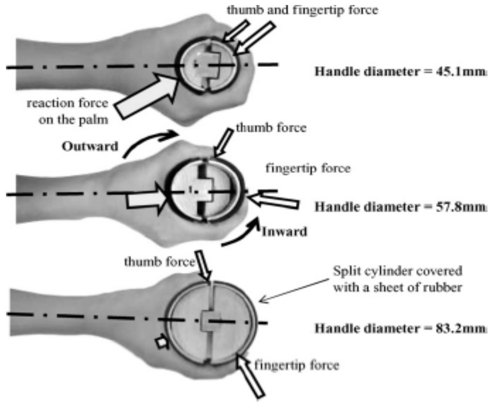
An example of research in Ergonomics

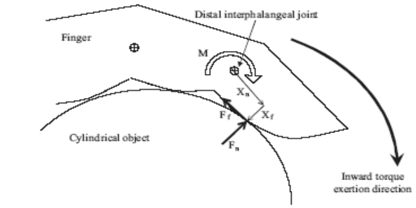
From: Journal of Biomechanics

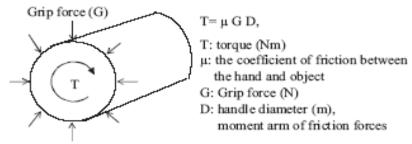
The effect of torque direction and cylindrical handle diameter on the coupling between the hand and a cylindrical handle

Na Jin Seo[a,*], Thomas J. Armstrong[a], James A. Ashton-Miller[b], Don B. Chaffin[a]

[a]*Department of Industrial and Operations Engineering, University of Michigan, Ann Arbor, MI 48109, USA*
[b]*Department of Mechanical Engineering, University of Michigan, Ann Arbor, MI 48109, USA*







Introduction to Ergonomics and Its Importance

An example of research in Ergonomics

From: International Journal of Industrial Ergonomics

The effects of work height, workpiece orientation, gender, and screwdriver type on productivity and wrist deviation

Patrick G. Dempsey*, Raymond W. McGorry, Niall V. O'Brien

Liberty Mutual Research Center for Safety & Health, 71 Frankland Road, Hopkinton, MA 01748, USA

Fig. 1. Phillips screwdriver (bottom) and flat-he
used (top).

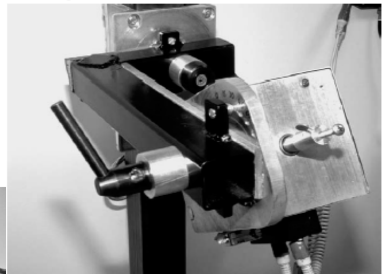


Fig. 2. Apparatus with adjustable workpiece carriage.

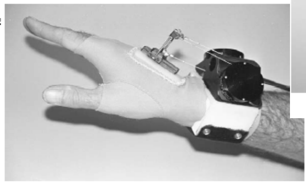


Fig. 3. Wrist goniometer.

Introduction to Ergonomics and Its Importance

An example of research in Ergonomics

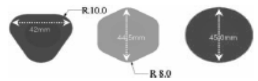
From: Ergonomics

Evaluation of handle design characteristics in a maximum screwdriving torque task†

Y.-K. KONG‡, B. D. LOWE*§, S.-J. LEE¶ and E. F. KRIEG§

‡Department of Systems Management Engineering, SungKyunKwan University, Suwon, Korea
§National Institute for Occupational Safety and Health, Cincinnati, OH, USA
¶The College of Medicine, Hanyang University, Seoul, Korea

Table 2. Dimensions of screwdriver handles (mm) (the nominal cross-sectional diameter is 45.0 mm).

			Longitudinal (cross-sectional) shape		
					
			Triangular	Hexagonal	Circular
Lateral shape		Cylindrical	42.0[w]	44.5[w]	45.0[w]
			42.0[n]	44.5[n]	45.0[n]
		Reversed double frustum	42.0[w]	44.5[w]	45.0[w]
			33.5[n]	35.5[n]	36.0[n]
		Double frustum (DF)	42.0[w]	44.5[w]	45.0[w]
			33.5[n]	35.5[n]	36.0[n]
		Cone	42.0[w]	44.5[w]	45.0[w]
			33.5[n]	35.5[n]	36.0[n]

[w] = widest cross-section dimension; [n] = narrowest cross-section dimension, i.e. for the DF shape, 45 mm is the diameter at the centre of the DF handle, whereas 36 mm is the diameter at the end of the DF handle; R = radius of curvature.

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Y.-K. KONG‡, B. D. LOWE*§, S.-J. LEE¶ and E. F. KRIEG§

‡Department of Systems Management Engineering, SungKyunKwan University, Suwon, Korea
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¶The College of Medicine, Hanyang University, Seoul, Korea

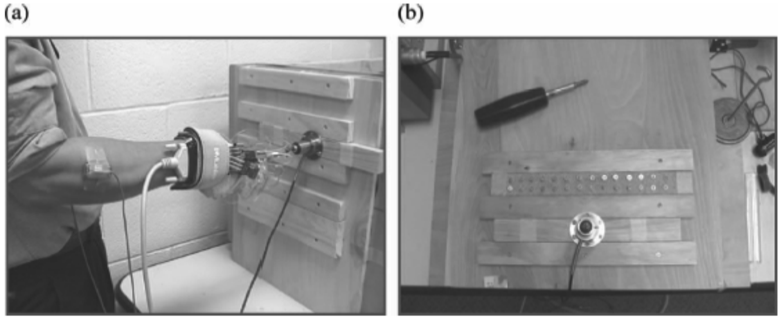


Figure 1. Workplace for maximum torque task. (a) vertical workpiece orientation taken from a side view; (b) horizontal workpiece orientation taken from a top view.

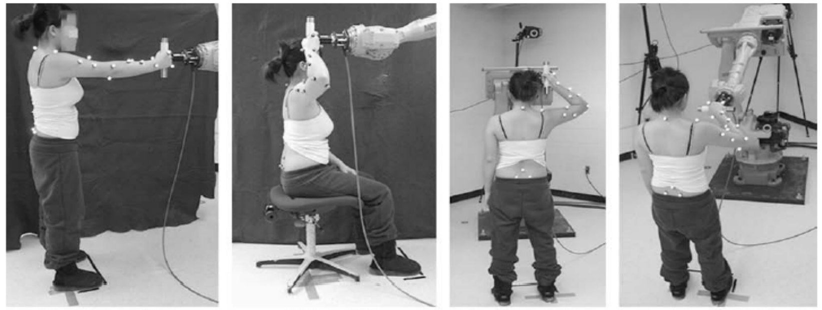
An example of research in Ergonomics

From: Applied Ergonomics 40 (2009), 303-308

Shoulder strength of females while sitting and standing as a function of hand location and force direction

Amy Y. Chow, Clark R. Dickerson*

Department of Kinesiology, University of Waterloo, 200 University Avenue West, Waterloo, Ontario, Canada N2L 3G1



Standard exertion | Sitting: 90° | Standing: 90° | Standing: 0°

Fig. 2. Experimental set-up for four test conditions.

An example of research in Ergonomics

From: Applied Ergonomics

Biomechanical assessment of new hand-powered pruning shears

Yves Roquelaure[a,*], Fabian D'Espagnac[b], Yves Delamarre[b], Dominique Penneau-Fontbonne[a]

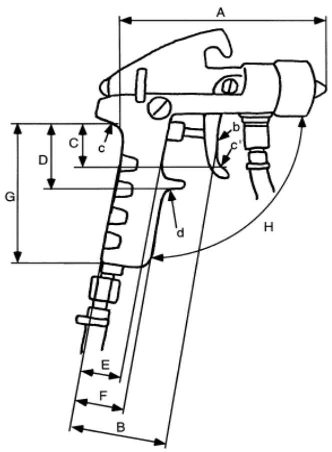
[a] *Department of Occupational Health and Ergonomics, University Hospital, Angers, France*
[b] *Devillé SA, ZI de Beauregard, Baugé, France*

An example of research in Ergonomics

From: International Journal of Industrial Ergonomics

The ergonomics of spray guns – Users' opinions and technical measurements on spray guns compared with previous recommendations for hand tools

Gunnar Björing[a,b,*], Göran M. Hägg[a]



An example of research in Ergonomics

From: International Journal of Industrial Ergonomics

Understanding work productivity and its application to work-related musculoskeletal disorders

Reuben Escorpizo[a,b,*]

[a] *Department of Physical Therapy, Leesburg Regional Medical Center, 700 N Palmetto St., Leesburg, FL 34788, USA*
[b] *College of Health Sciences, Des Moines University, 3200 Grand Avenue, Des Moines, IA 50312 4198, USA*

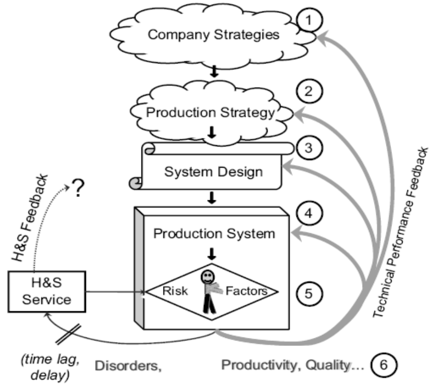
An example of research in Ergonomics

From: Applied Ergonomics

Integrating ergonomics into production system development – The Volvo Powertrain case

W. Patrick Neumann[a,*], Marianne Ekman[b], Jørgen Winkel[c,d]

[a] *Department of Mechanical and Industrial Engineering, Ryerson University, 350 Victoria St., Toronto, ON, Canada M5B 2K3*
[b] *The Swedish Royal Institute of Technology, Stockholm, Sweden*
[c] *National Research Centre for the Working Environment, Copenhagen, Denmark*
[d] *Department of Work Science, University of Gothenburg, Sweden*



ตัวอย่างงานวิจัยทางด้านการยศาสตร์

From: การประชุมวิชาการเครือข่ายวิศวกรรมอุตสาหการ IE NETWORK 2006

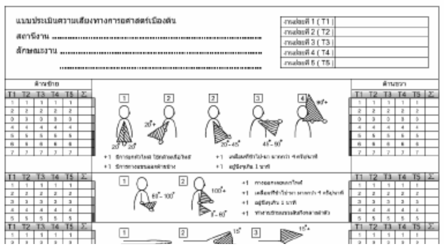
การพัฒนาระบบประเมินความเสี่ยงเพื่อการออกแบบทางด้านการยศาสตร์ กรณีศึกษาในอุตสาหกรรมประกอบรถยนต์

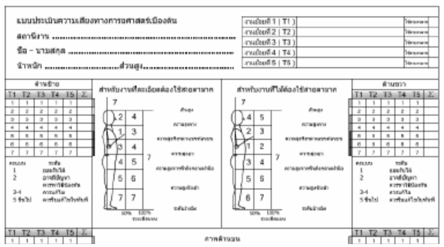
The development of risk evaluation system for ergonomics design: A case study of welding shop in automotive industry

นริศ เจริญพร* ฌานนท์ พูนกวิน จิรายุ ยุวธานนท์

ภาควิชาวิศวกรรมอุตสาหการ คณะวิศวกรรมศาสตร์ มหาวิทยาลัยธรรมศาสตร์ อ.คลองหลวง จ.ปทุมธานี 12120

E-mail: cnaris@engr.tu.ac.th





ตัวอย่างงานวิจัยทางด้านการยศาสตร์เชิงประยุกต์

From: การประชุมวิชาการเครือข่ายวิศวกรรมอุตสาหการ IE NETWORK 2009
21-21 ตุลาคม 2552

การปรับปรุงสถานีงานตรวจสอบคุณภาพโดยใช้หลักการยศาสตร์ : กรณีศึกษาโรงงานอุตสาหกรรมกระเบื้องเซรามิค

พุทธิพร ปุรณวัฒนกุลชัย และ นริศ เจริญพร*

ภาควิชาวิศวกรรมอุตสาหการ คณะวิศวกรรมศาสตร์ มหาวิทยาลัยธรรมศาสตร์

History of Ergonomics: IV

Frank and Lillian Gilbreth made jobs **more efficient** and **less fatiguing** through **<u>time motion analysis and standardizing tools, materials and the job process</u>**.

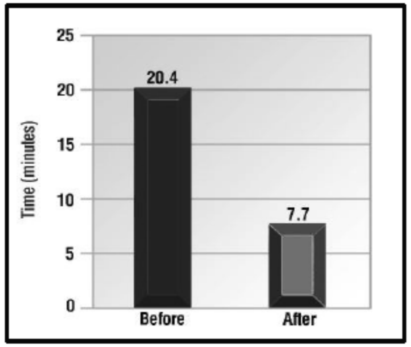
By applying this approach, the number of motions in bricklaying was reduced from 18 to 4.5 allowing bricklayers to increase their pace of laying bricks from 120 to 350 bricks per hour.

Case Study III

Ref: Humantech, Inc (2004) by McGowan

Toyota – Georgetown, KY

62% Reduction in Cycle Time



Ergonomic risk reduced by 65%

An example of research in Ergonomics

From: Applied Ergonomics

Cost effectiveness of ergonomic redesign of electronic motherboard

Rabindra Nath Sen[a,*], Paul H.P. Yeow[b]

[a] *Ergonomics Centre, Faculty of Management, Multimedia University, Jalan Multimedia, 61300 Cyberjaya, Malaysia*
[b] *Ergonomics Centre, Faculty of Business and Law, Multimedia University, Jalan Ayer Keroh Lama, 75450 Melaka, Malaysia*

The motherboard was redesigned to correct the design errors, to allow more components to be machine soldered and to reduce MC. This eliminated rejects, reduced repairs, saved US $581,495/year and improved operators' OHS. The customer also saved US $142,105/year on loss of business.

An example of research in Ergonomics

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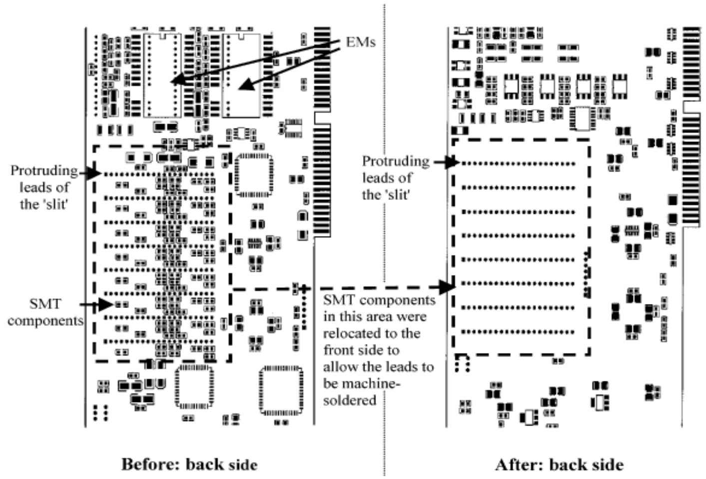


History of Ergonomics: V

World War II prompted greater interest in **human-machine interaction** as the efficiency of sophisticated military equipment (i.e., airplanes) could be compromised by bad or confusing design.

Design concepts of fitting the machine to the size of the soldier and logical/understandable control buttons evolved.

An example of research in Ergonomics

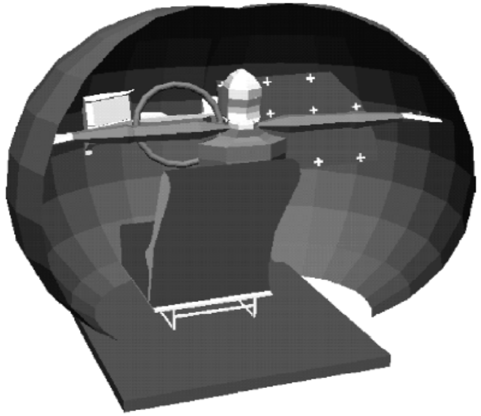
From: International Journal of Industrial Ergonomics

A control handling comfort model based on fuzzy logics

Lars Hanson[a,*], Willfried Wienholt[b], Lena Sperling[c]

[a] *Division of Ergonomics, Department of Design Sciences, Lund University, P.O. Box 118, 22100 Lund, Sweden*
[b] *Neural Computation, Information and Communications, Siemens AG, Munich, Germany*
[c] *Division of Industrial Design, Department of Design Sciences, Lund University, Lund, Sweden*

Fig. 1. In human simulation tools reach zones are normallyvisualiz ed bymeans of spheres around the shoulder joint. The ANNIE–Ergoman-manikin shows maximum reach with upper bodymovement.



History of Ergonomics: VI

After World War II, the focus of concern expanded to include **worker safety** as well as **productivity**. Research began in a variety of areas such as:

* Muscle force required to perform manual tasks
* Compressive low back disk force when lifting
* Cardiovascular response when performing heavy labor
* Perceived maximum load that can be carried, pushed or pulled

Case Study I

Ref: Humantech, Inc (2004) by McGowan

Point of Motion Constraint Example

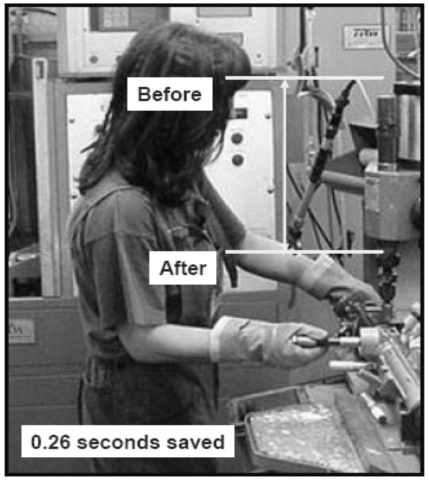
There were ergonomic issues when reaching to a torque wrench in this assembly operation. Because there was no previous injury, management didn't see the urgency to improve the job and lower the torque wrench.

Case Study I

Ref: Humantech, Inc (2004) by McGowan

Point of Motion Constraint Example

Lowering the tool 12" will save 0.26 second of wasted motion time, in addition to improved working postures. The reach is performed three times during a 45 second cycle for 8 hours resulting in a time savings of approximately 8+ minutes/shift.



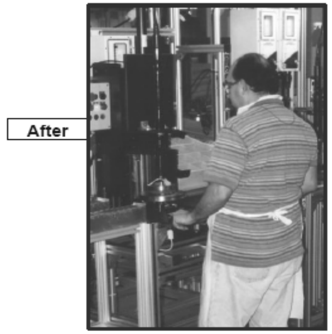
Case Study II

Ref: Humantech, Inc (2004) by McGowan

Honeywell – Torrance, CA

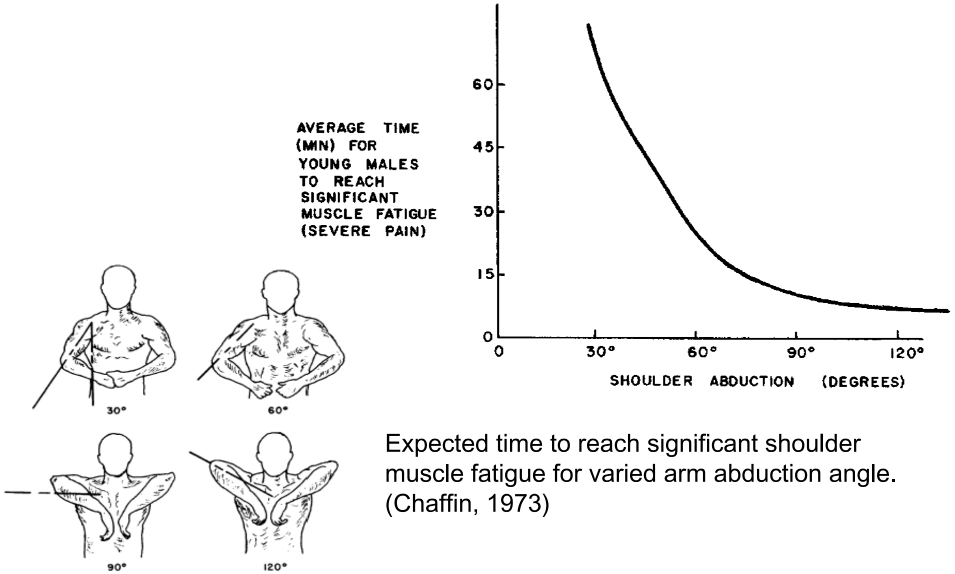
Line Redesign Project

- Eliminated highest risk tasks
- 37% increase in productivity
- Operators very satisfied



Plant Workers' Compensation Reduced by $2 Million Per Year

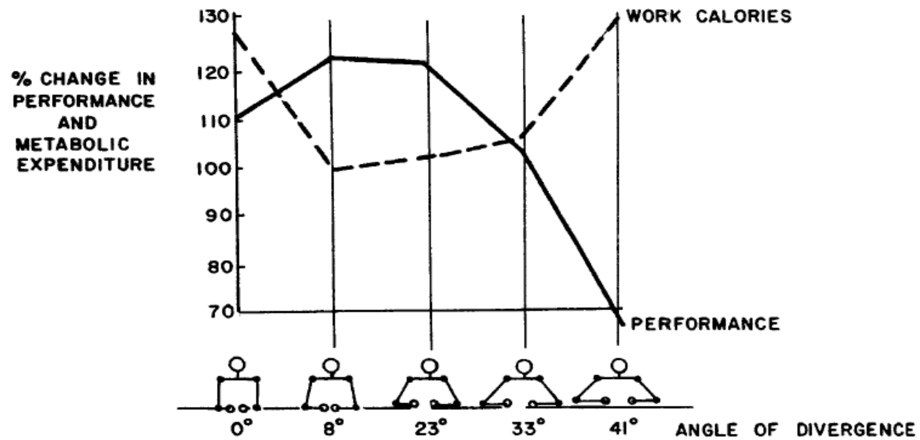
Postures effecting on shoulder muscle fatigue



Expected time to reach significant shoulder muscle fatigue for varied arm abduction angle. (Chaffin, 1973)

Addition

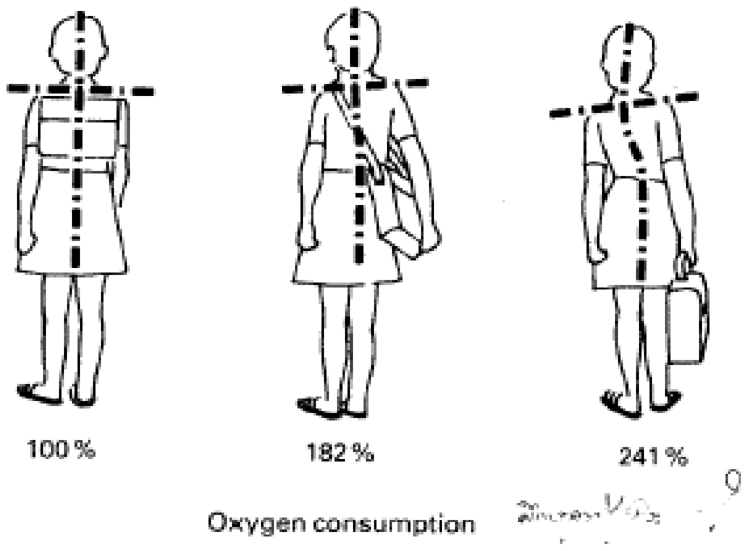
Shoulder abduction effecting on fatigue and performance



Performance and metabolic energy expenditure rates from study of 12 female grocery packers (Tichauer, 1978), from Chaffin (1991)

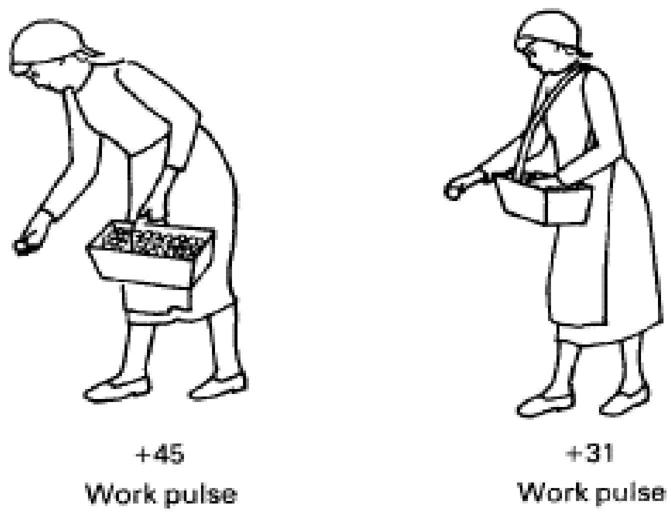
Back

Effects of static effort on energy consumption (measured by oxygen consumption) for three ways of carrying a school satchel. Ref: Malhotra and Sengupta (1965)



Static muscular effort in the left arm during potato planting. Ref: Hettinger (1970)

Introduction to Ergonomics and Its Importance



History of Ergonomics: VII

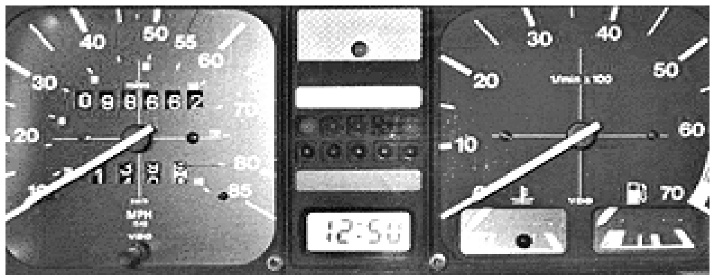
Introduction to Ergonomics and Its Importance

Areas of knowledge that involved **human behavior** and attributes (i.e., decision making process, organization design, **human perception** relative to design) became known as **cognitive ergonomics** or **human factors**.

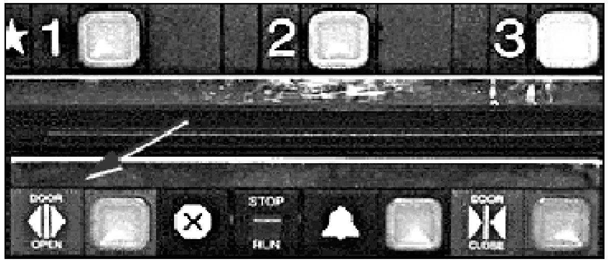
Areas of knowledge that involved **physical aspects** of the workplace and human abilities such as force required to lift, vibration and reaches became known as **industrial ergonomics** or **product design ergonomics**.

Ergonomics: Man-Machine Interaction

Introduction to Ergonomics and Its Importance



Ergonomics: Man-Machine Interaction



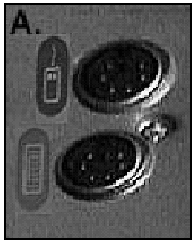
Labels that look like pushbuttons

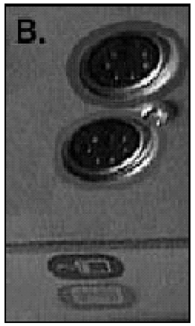
www.baddesigns.com

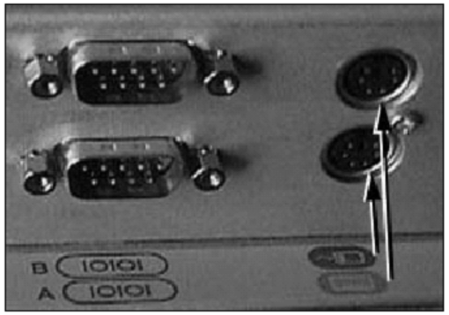
Ergonomics: Man-Machine Interaction

www.baddesigns.com

Ergonomics: Man-Machine Interaction







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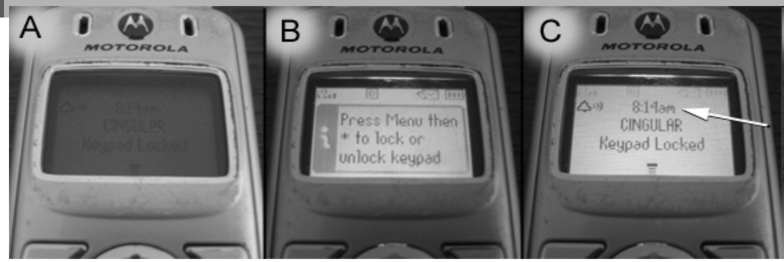
Ergonomics: User Friendly Design



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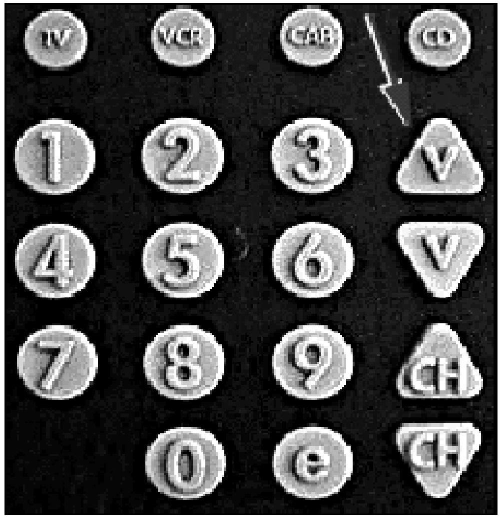
Ergonomics: Human Error



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Ergonomics: Human Error

Introduction to Ergonomics and Its Importance

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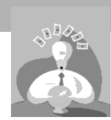
Definition of Ergonomics

Introduction to Ergonomics and Its Importance

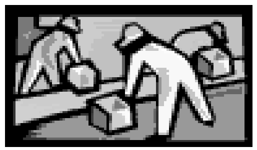
a "good fit" between humans and all components in a working system

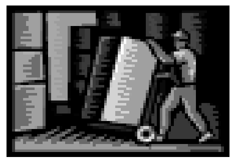
What is Ergonomics?

Introduction to Ergonomics and Its Importance





Ergonomics: Definition

The Discipline of Ergonomics by IEA

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.

Ref: IEA (International Ergonomics Association) <www.iea.cc>

Ergonomics: Definition

Who is an ergonomist?

*Ergonomists contribute to the **design** and **evaluation** of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people.*

Ref: IEA (International Ergonomics Association) <www.iea.cc>

IEA
(International Ergonomics Association)

The main goal of IEA:

To elaborate and advance the science and practice of ergonomics at the international level

To improve the quality of life by expanding the scope of ergonomics applications and contributions to global society

IEA International Ergonomics Association

IEA Technical Committee

Aging	Human-Computer Interaction
Agriculture	Human Reliability
Auditory Ergonomics	Musculoskeletal Disorders
Building and Architecture	Organizational Design and Management
Building and Construction	Process Control
Consumer Products	Psychophysiological in Ergonomics
Cost-Effective Ergonomics	Quality Management
Ergonomics for Children and Educational Environment	Rehabilitation Ergonomics
Hospital Ergonomics	Safety and Health
Human Aspects of Advanced Manufacturing	Standards

Ergonomist in US.

Board of Certification in Professional Ergonomics

The Certified Professional Ergonomist (CPE)
Certified Human Factors Professional (CHFP)

Associate Ergonomics Professionals (AEP)
Associate Human Factors Professionals (AHFP)
Certified Ergonomics Associate (CEA)

www.bcpe.org

Professional in Ergonomics

United States:
BCPE (Broad of Certification in Professional Ergonomics)
http://www.bcpe.org
Certified Professional Ergonomist (CPE)
Certified Human Factors Professional (CHFP)

Canada :
CCCPE – Canadian certification Council for Profesionnal ergonomists
http://www.ace-ergocanada.ca

Europe :
CREE - Centre for Registration of European Ergonomists
http://www.eurerg.org/index.htm

Introduction to Ergonomics and Its Importance

Professional in Ergonomics (cont.)

Australia :
Register of Certified Professional Ergonomists
http://www.ergonomics.org.au

New zealand :
BCNZE - Board for Certification of New Zealand Ergonomists
http://www.ergonomics.org.nz

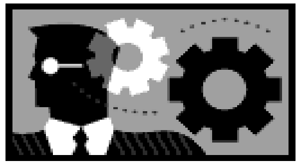
Japan : JES (Japan Ergonomics Society)
JES Certification Programm for Profesionnal ergonomists
http://www.ergonomics.jp/cpe/index_e.html

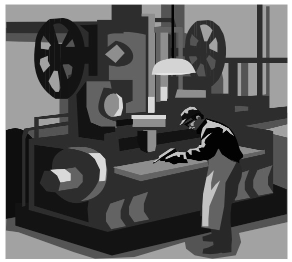
Thailand:
EST (Ergonomics Society of Thailand)
http://www.est.or.th

Introduction to Ergonomics and Its Importance

Similar Words in Ergonomics

- Human Factors in Engineerng
- Human Engineering
- **Work Physiology**
- Sport Physiology
- **Occupation Biomechanics**
- Sport Biomechanics
- **Cognitive Engineering**
- Engineering Psychology





Introduction to Ergonomics and Its Importance

Ergonomics Concept

Inappropriate Design

↓

Ergonomics Problems

- Effect on health
- Effect on performance/ productivity
- Effect on quality
- Effect on error, accident and safety

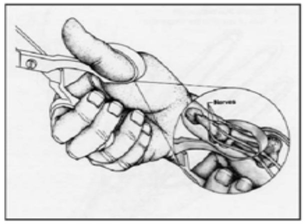
Where ergonomics knowledge come from:

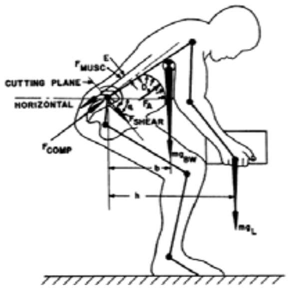
- ❑ **Common Sense**
  - human experience learning
  - trial and error performing

- ❑ **Sophisticated Science**
  - scientific proof by measuring and experiments

Scientific Basics of Ergonomics

- ❑ Physics, Mechanics,
- ❑ Biology, Physiology
- ❑ Engineering psychology, behavior
- ❑ Statistics and epidemiology
- ❑ Anthropometry
- ❑ Job Analysis, Work Design





Ergonomics Philosophy

- ❑ Fit the job to the man
- ❑ Fit the man to the job

What are the differences between the two philosophies above?

Others philosophies in ergonomics design

- ❑ Human centered thinking
- ❑ User friendly design

Ergonomics Consideration

- ❑ Understanding human characteristics both in capacity and limitation
- ❑ Using the characteristics for new designs and improving existing design
- ❑ Evaluating the designs by the following criterions:
  - **Easier** : the design easy and shorten to learn
  - **Better** : the design convenient to use
  - **Safer** : the design safer than the previous

Ergonomics : Main Goals:

Introduction to Ergonomics and Its Importance

- ❑ Provide a safe and healthful working environment engineered to the capabilities of the human body
- ❑ Decrease worker fatigue and discomfort through the elimination of **excess effort**
- ❑ Increase efficiency and productivity by reducing worker fatigue
- ❑ Improve quality by providing designs that reduce the potential for human error
- ❑ Enhance customer service through improved worker morale
- ❑ Elevate job satisfaction
- ❑ Reduce injuries/illness
- ❑ Reduce costs

The Scope of Ergonomics

Introduction to Ergonomics and Its Importance

- ❑ Consumer products
- ❑ Office workplace
- ❑ Manufacturing process
- ❑ Transportation

Manufacturing Ergonomics

Introduction to Ergonomics and Its Importance

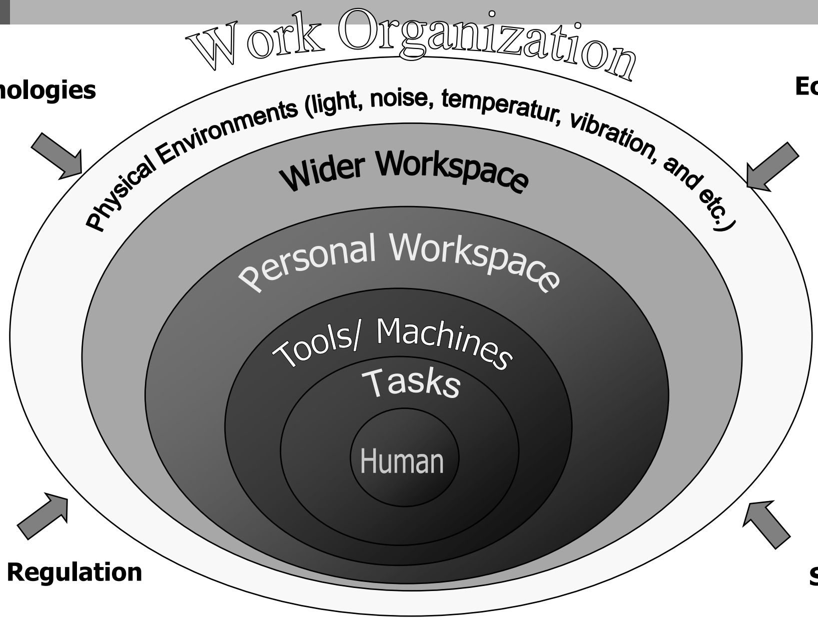
- ❑ Product Design
- ❑ Manufacturing Process Design
- ❑ Production System Design
- ❑ Personal Assignment
- ❑ Work Organization

An Ergonomics Model

All factors related to ergonomics consideration in design

Technologies

Economics



Law & Regulation

Social

A visual inspection task

Stress

- Physical workload
- Environmental workload
- Psychological/Mental workload
- Other psychosocial effects

Ergonomic Stressors:

- Force
- Repetition
- Awkward Postures
- Static Postures
- Vibration
- Contact Stress
- Environmental Factors

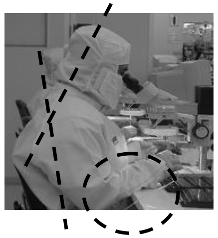
Physical Strain

Physiological Strain

Psychological/ Mental Strain

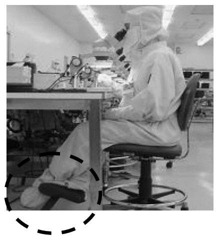
Epidemiology

Physical stress from awkward postures



- Incorrect **head** and **neck** position.
  - Tension in the neck muscles can lead to headaches.

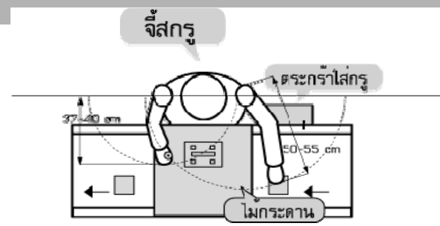
- Slouching causes the spine to curve outwards which puts pressure on the discs in spine.

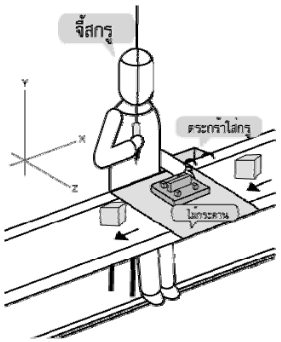


- **Feet** not firmly on a footrest, pressure can build up.

- **Wrists** and **hands** out line with forearms causes a static load in
  - Shoulders
  - Arms
  - Can lead to Upper back and Neck

A toy assembly operator





Sawing Operators

A sawing operator

Stress
- Physical workload
- Environmental workload
- Psychological/Mental workload
- Other psychosocial effects

Ergonomic Stressors:
- Force
- Repetition
- Awkward Postures
- Static Postures
- Vibration
- Contact Stress
- Environmental Factors

→ **Physical Strain**

→ **Physiological Strain**

→ **Psychological/ Mental Strain**

→ **Epidemiology**

How to identify the job stress

- ❑ Subjective methods
- ❑ Objective methods

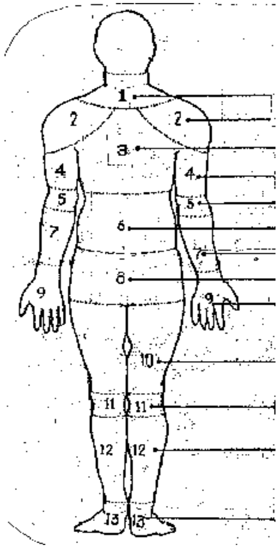
Ergonomic Stressors:
- Force
- Repetition
- Awkward Postures
- Static Postures
- Vibration
- Contact Stress
- Environmental Factors

How to measure job stress and evaluate risk?

Subjective methods
- **Body Discomfort Mapping**
- Standard Nordic Questionnaire,
- Abnormal Index
- Biomechanical model
- **NIOSH lifting equations**
- **RULA**, **REBA**, OWAS
- Strain index
- Others

Objective methods
- Electromyography (EMG) ……….
- Oxygen consumption
- Heart rate ……..
- Body temperature
- Goniometer …….
- CFF
- Reaction time
- Others

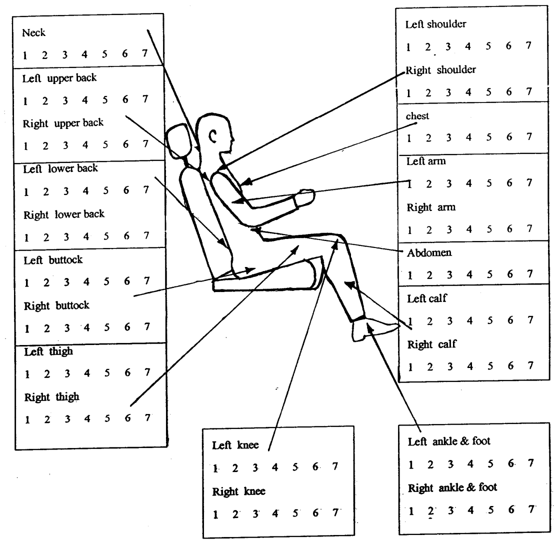
Job stress studied in a sewing operation
(% of body part discomfort reported by workers, N=410)



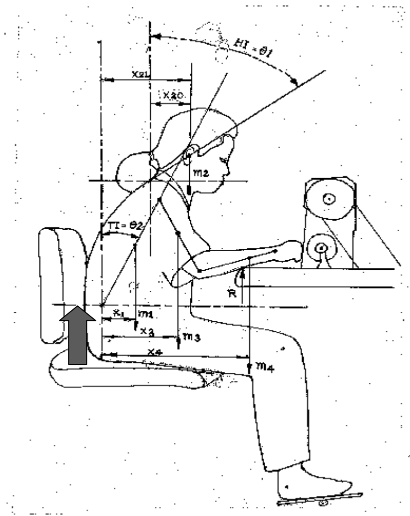
Neck **(43.9%)**
Shoulders **(53.2%)**
Upper back **(51.5%)**
Upper arms (22.0%)
Elbows (4.4%)
Lower back **(61.5%)**
Lower arms/Forearms (7.8%)
Buttock **(38.3%)**
Hands and wrists (13.2%)
Upper legs (25.1%)
Knees (26.6%)
Lower legs **(44.6%)**
Feet (19.8%)

From : N. Charoenporn (1994)

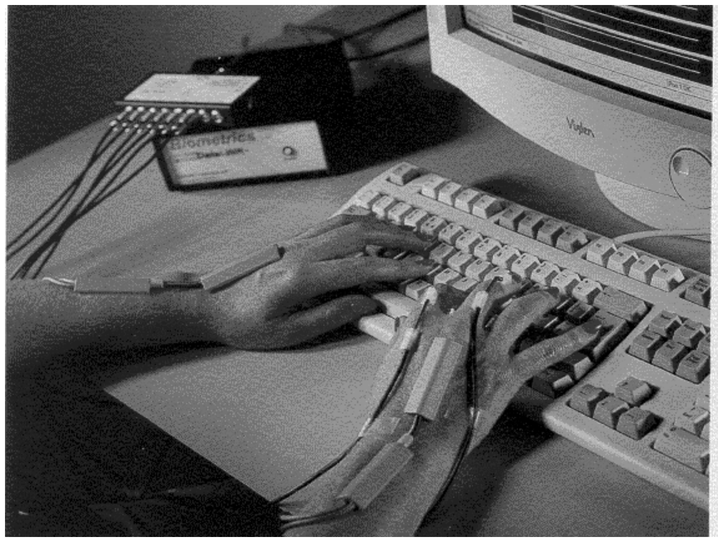
Example of a body discomfort check



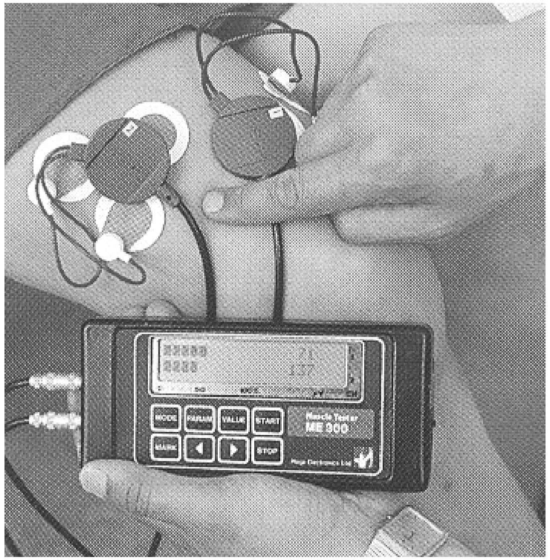
A simple biomechanical model
(to calculate spinal load)



Goniometer



Electromyography (Surface EMG)



Heart Rate Monitor

Introduction to Ergonomics and Its Importance

Purpose of Manufacturing Ergonomics

Introduction to Ergonomics and Its Importance

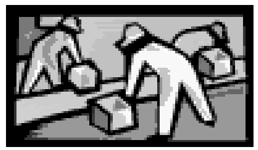
- ❑ To match the Design of Equipment, Tools and Work Assignments to the Capabilities and Limitations of the Operators

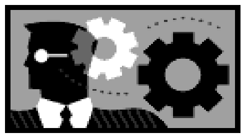
- ❑ To optimize Human Performance, Product Quality, Productivity, Health and Safety

Human Characteristics

Introduction to Ergonomics and Its Importance

1. Physical Characteristics:
2. Physiological Characteristics:
3. Psychological/ Psychophysical/ Cognitive Characteristics
4. Behavioral Characteristics





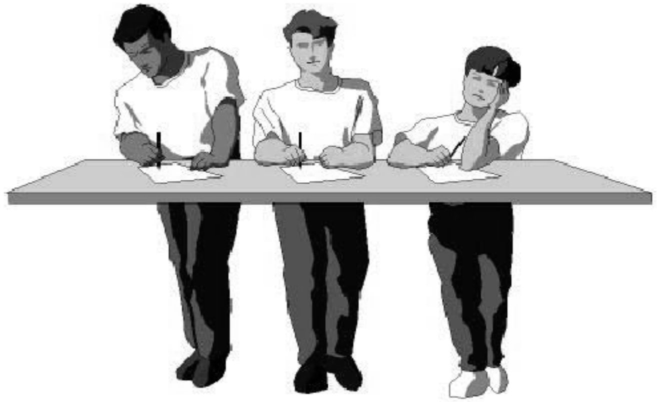
1. Physical Characteristics

- Static anthropometric data:
  size, length, width, weight, others
- Dynamic Anthropometric Data :
  area or length of motions, reach

Physical Characteristics: Example

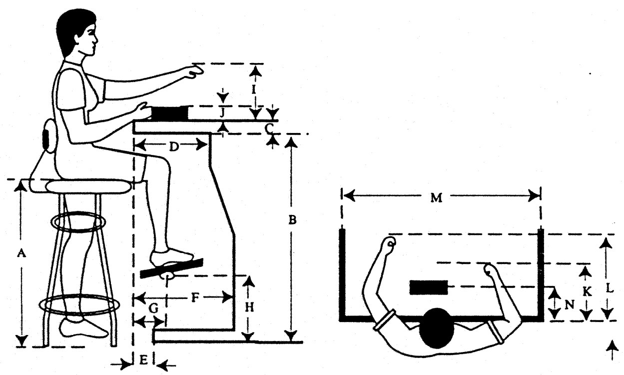
Introduction to Ergonomics and Its Importance

- Different body height



Anthropometric Data & Workstation Design

Introduction to Ergonomics and Its Importance



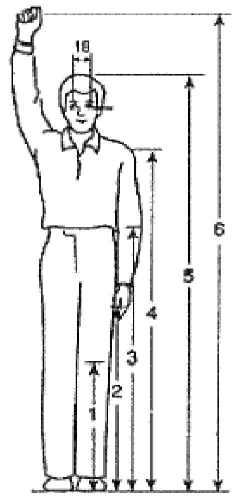
(a) (b)

A: Seat height (reach)	70-80 cm (28"-32")	H: Vertical location of foot-rest center (adjustable)	20 cm (8")
B: Table-top height (reach)	90-95 cm (36"-38")	I: Maximum work height over the work surface	30 cm (12")
C: Table-top thickness (max.)	10 cm (4")	J: Fixture height	10 cm (4")
D: Knee clearance	38 cm (15")	K: Normal work area	15 cm (6")
E: Kick room (min.)	10 cm (4")	L: Maximum work area	30 cm (12")
F: Leg room at toe level	48 cm (19")	M: Working width	76 cm (30")
G: Horizontal location of foot-rest center	28 cm (11")	N: Fixture location	7.5-12.5 cm (3"-5")

Anthropometric Data: Example Standing

Introduction to Ergonomics and Its Importance

	Female			Male		
	5th	50th	95th	5th	50th	95th
Standing						
1. Tibial height	38.1	42.0	46.0	41.0	45.6	50.2
2. Knuckle height	64.3	70.2	75.9	69.8	75.4	80.4
3. Elbow height	93.6	101.9	108.8	100.0	109.9	119.0
4. Shoulder (acromion) height	121.1	131.1	141.9	132.3	142.8	152.4
5. Stature	149.5	160.5	171.3	161.8	173.6	184.4
6. Functional overhead reach	185.0	199.2	213.4	195.6	209.6	223.6

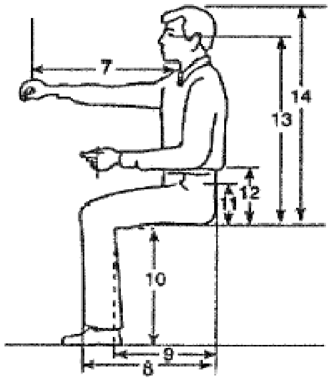


Do we need more handles for users with different heights?

- How can we select a suitable handle height?
- How can we locate the handle height for different size of people ?
- How many should handles be installed?

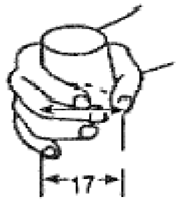
The solution for locating handles of the cupboards and cabinets

Anthropometric Data: Example Sitting



	Female			Male		
	5th	50th	95th	5th	50th	95th
Sitting						
7. Functional forward reach	64.0	71.0	79.0	76.3	82.5	88.3
8. Buttock-knee depth	51.8	56.9	62.5	54.0	59.4	64.2
9. Buttock-popliteal depth	43.0	48.1	53.5	44.2	49.5	54.8
10. Popliteal height	35.5	39.8	44.3	39.2	44.2	48.8
11. Thigh clearance	10.6	13.7	17.5	11.4	14.4	17.7
12. Sitting elbow height	18.1	23.3	28.1	19.0	24.3	29.4
13. Sitting eye height	67.5	73.7	78.5	72.6	78.6	84.4
14. Sitting height	78.2	85.0	90.7	84.2	90.6	96.7
15. Hip breadth	31.2	36.4	43.7	30.8	35.4	40.6
16. Elbow-to-elbow breadth	31.5	38.4	49.1	35.0	41.7	50.6

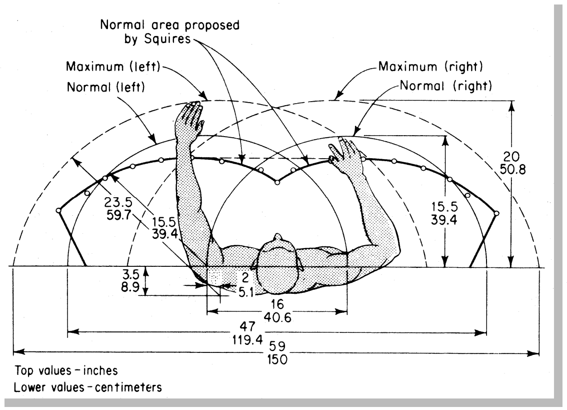
Anthropometric Data: Example Grip breadth

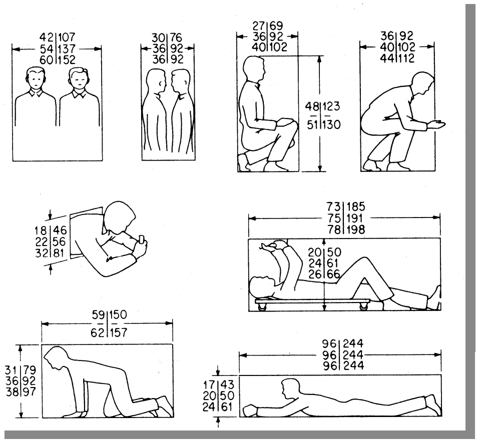


	Female			Male		
	5th	50th	95th	5th	50th	95th
Other dimensions						
17. Grip breadth, inside diameter	4.0	4.3	4.6	4.2	4.8	5.2
18. Interpupillary distance	5.1	5.8	6.5	5.5	6.2	6.8

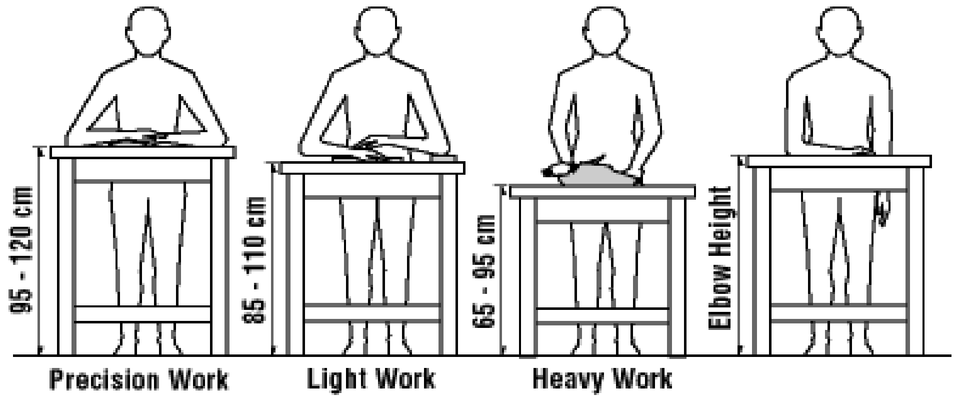
1 in. = 2.54 cm.

Special Anthropometric Data for Workspace





Recommendation of Working Height



Different heights of working surface & Different works

2. Physiological Characteristics

- **Functional Characteristic**
  - Muscle neural control system
  - Muscle contraction and effort
  - Metabolism process and the system related to create energy in human body

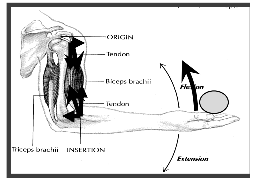
- **Load Characteristic:**
  Muscle strength, endurance and fatigues

Human Work & Physiology

Posture & Motion

Muscular effort

} Biomechanics & Strength



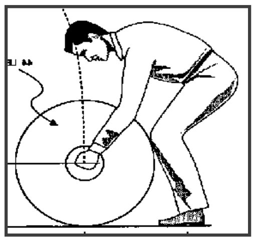
Energy, Heat & Metabolism

Blood need & flow

Heart rate

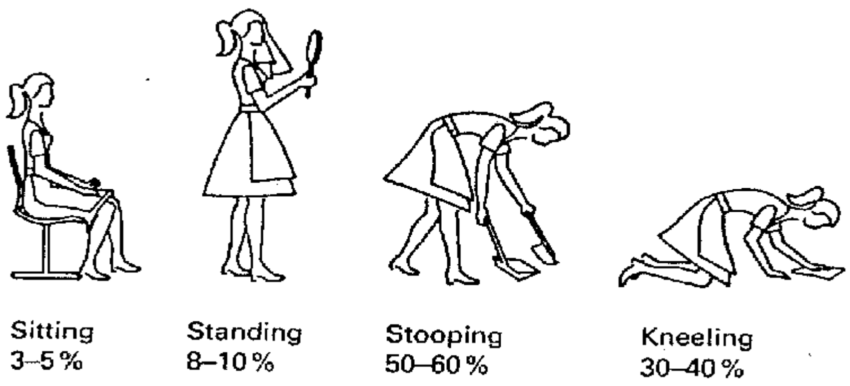
Others

} Physiology & Fatigue

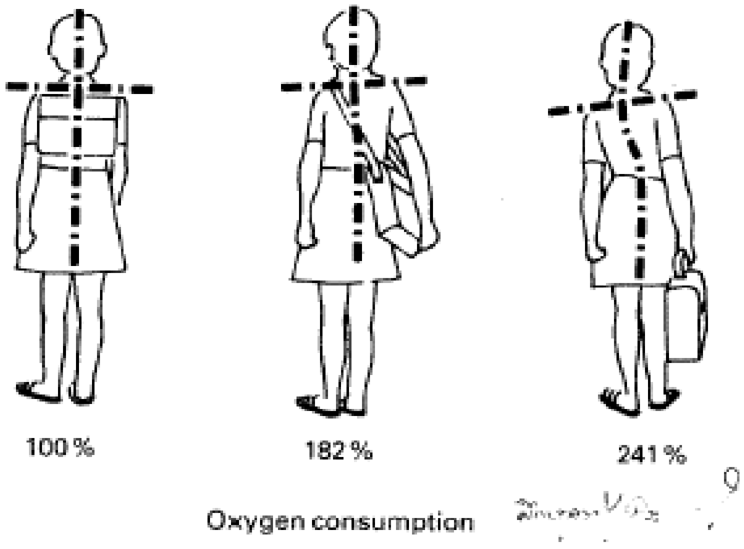


Percentage increase in energy consumption for different bodily postures. (Grandjean, 1998)

Compared with energy consumption lying down



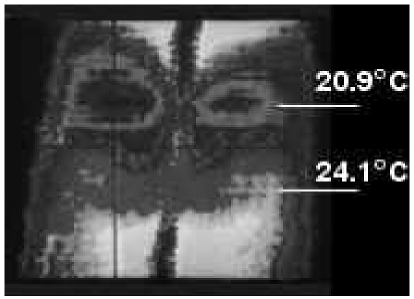
Effects of static effort on energy consumption (measured by oxygen consumption) for three ways of carrying a school satchel. Ref: Malhotra and Sengupta (1965)

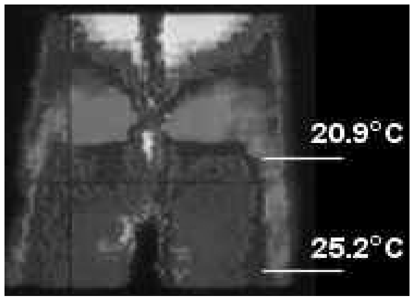


Physiological measurement: Example

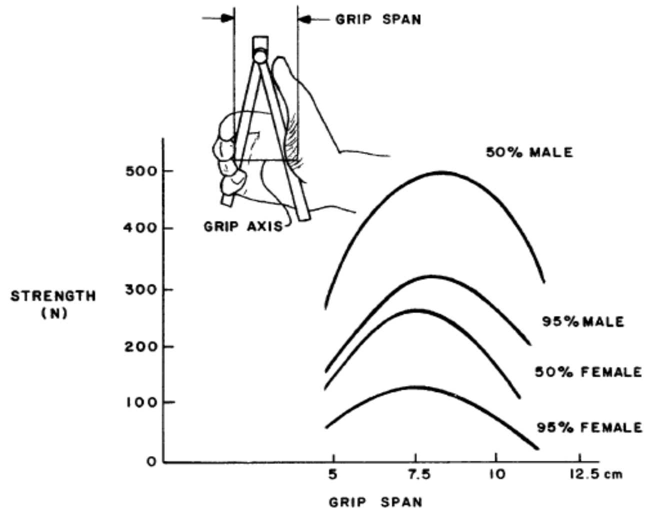
Red area shows higher temperature because of higher blood flow.

White area presents lower temperature because lack of blood flow



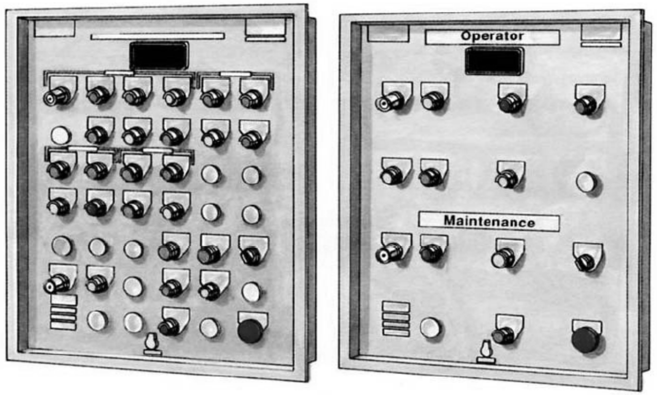


Hand Strength & Grip Span



3. Psychological/ Psychophysical/ Cognitive Characteristics

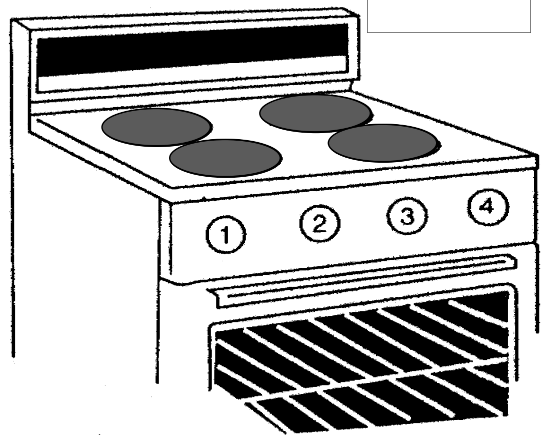
- ❑ Sensory
- ❑ Perception
- ❑ Decision
- ❑ Emotion
- ❑ Cognitive



Poor Better

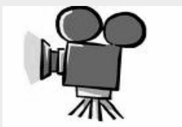
3. Psychological/ Psychophysical/ Cognitive Characteristics

- ❑ Sensory
- ❑ Perception
- ❑ Decision
- ❑ Emotion
- ❑ Cognitive



4. Behavioral Characteristics

- ❑ Spacious behavior characteristic
- ❑ Operating behavior characteristic
- ❑ Information behavior characteristic



Video to present a case study of human behavior in usability testing

แบบจำลองการพิจารณาความเสี่ยงทางการยศาสตร์ โดยพิจารณาจากคุณลักษณะของมนุษย์