DEA3250/6510:

Ergonomics, Anthropometrics, Biomechanics

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Ergonomics and Design

Ergo everything!

- Ergonomic spoon?
  - Manufactured with state-of-the-art methods; so this product is ergonomic, comfortable, inexpensive and easy to use.
  - Ergonomically designed to reduce tension, in consultation with occupational therapists.

Ergo everything!

- Nike® Ergonomic Carry Bag
  - It's a tool bag. A touring duffel. An ergonomic arsenal outfitted for treks through high grass and hungry sand.
  - Featuring anatomic contours that snug the bag close to your body to lighten your load from the first tee box to the final cup.

Ergo everything!

- "Ultimate" Ergonomic push-rake?
  - Do you dread having to rake the yard because it hurts your back? Here's the ergonomically correct solution! Instead of leaning over to rake with a long handle, you can push the rake in front of you. It's quick and easy, and the adjustable handle fits anyone's height.

Ergo everything!

- Ergonomic Stein
  - This Stein is our biggest mug, with a wide bottom tapering up to a narrower top. The handle is made to fit a hand perfectly for comfort.

Ergo everything!

- **BUTTERFLY STEERING WHEEL**
  A DIFFERENCE YOU CAN FEEL
  - Ergonomic design provides comfortable finger grooves

Ergo everything!

- Ergonomic ice-skates?
  - Innovative ergonomic sidecut design reduces sidewall resistance to deliver unprecedented mobility and agility.

Ergo everything!

- "Ergonomic Writing Pen"
  - For thousands of years man has used everything from pointed reeds to bird quills to author his written correspondence.
    We proudly offer the … pen with its ergonomically correct shape and refillable cartridges.

Ergo everything!

- Ergonomic pen?
  - Ring pen

Ergo everything!

- Ergonomic glasses cord?

Ergo everything!

- Ergonomic laser pointer?

Ergo everything!

- Ergonomic clock?

Ergo everything!

- Ergonomic stapler?

Ergo everything!

- Ergonomic Gatorade Bottle – “Ergonomically Designed Gatorade Experience”?

Ergo everything!

- Ergonomic wheels?

Ergo everything!

- Ergonomic corn chips?

Ergonomic Design?

- What makes a product or system an "ergonomic" design?
- If ergonomics is merely “common sense”, why is it so rare?

Ergonomic Design

- Ergonomics is not an inherent attribute of products
- Ergonomics is more than “common sense”
- To be “Ergonomic” a design must:
  - Fit the user
  - Be easy to use
  - Improve comfort
  - Improve performance (speed, accuracy, reliability)
  - Improve health and safety

Ergonomics

What is Ergonomics?

"Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among human and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.“

(IEA Executive Council 2000)

Origins of Ergonomics

- Ergonomics is derived from the Greek words:
  - Ergon/ergos (work)
  - Nomikos (adj.)/ nomos (n.) (law - control and orderly assignment)
- Ergonomics is the “science of work”.

Ergonomics: Foundations

- Bernardino Ramazzini (1633-1714).
- Founder of occupational/ industrial medicine.
- Studied occupational diseases and advocated of protective measures for workers.
- Encouraged eventual passage of factory safety and workmen’s compensation laws.
- In 1700 he wrote De morbis artificum diatriba (Diseases of Workers) describing the health hazards of irritating chemicals, dust, metals, other abrasive agents and repetitive motions for workers in 52 occupations.

Bernardino Ramazzini, 1700.

- **"[I have seen] workers in whom certain morbid affections gradually arise from some particular posture of the limbs or unnatural movements of the body called for while they work."**

- **"Such are the workers who all day stand or sit, stoop or are bent double, who run or ride or exercise their bodies in all sorts of [excess] ways."**

- **"". . . the harvest of diseases reaped by certain workers . . .[from] irregular motions in unnatural postures of the body."**

Bernardino Ramazzini, 1700.

Standing:

- "Those who work standing ...carpenters, sawyers, carvers, blacksmiths, masons . . .are liable to varicose veins. . . [because] the strain on the muscles is such that the circulation of the blood is retarded."
- "Standing even for a short time proves exhausting compared with walking and running though it be for a long time. . . . Nature delights and is restored by alternating and varied actions."

Bernardino Ramazzini, 1700.

- Sitting
  - "Those who sit at their work suffer from their own particular diseases. [As noted back in Roman times by the learned slave] Plautus, 'sitting hurts your loins, staring, your eyes.' "
  - "All sedentary workers...suffer from the itch, are a bad color, and in poor condition.. . . for when the body is not kept moving the blood becomes tainted, its waste matter lodges in the skin, and the condition of the whole body deteriorates."

Bernardino Ramazzini, 1700.

- Repetitive hand motions
  - " I have noticed bakers with swelled hands, and painful, too; in fact the hands of all such workers become much thickened by the constant pressure of kneading the dough."

Bernardino Ramazzini, 1700.

- **Office work**
  - **"The maladies that affect the clerks arise from three causes: first, constant sitting; secondly, incessant movement of the hand and always in the same direction; and thirdly, the strain on the mind…"**
  - **"The incessant driving of the pen over paper causes intense fatigue of the hand and the whole arm because of the continuous . . . strain on the muscles and tendons."**
  - **"An acquaintance of mine, a notary by profession, who, by perpetual writing, began first to complain of an excessive wariness of his whole right arm which could be removed by no medicines, and which was at last succeeded by a perfect palsy of the whole arm. . . . He learned to write with his left hand, which was soon thereafter seized with the same disorder."**

Origin of Ergonomics

- Ergonomics is derived from the Greek words:
  - ergon (work)
  - nomos (law)

- "Work is an uplifting force by which all things can be moved."
  (Wojciech Jastrzebowski, 1857)

- Ergonomics is
  "the science of work".

Productivity – Motion Study

- Frank Bunker Gilbreth (July 7, 1868 in Fairfield, Maine, – died June 14, 1924) .
  - He was a bricklayer, a building contractor, and a management engineer
- Lillian Moller Gilbreth (May 24, 1878 in Oakland, - died January 2, 1972)
  - University of California graduated with a B.A. and M.A. and a Ph.D. from Brown.
- University Married 1904, had 12 children.
- Pioneers and prolific authors, from 1908 onwards, on motion study, motion study for the handicapped, fatigue study etc.

Productivity – Scientific Management

- Frederick Winslow Taylor (March 20, 1856,– March 21, 1915, Philadelphia)
- Wrote "The Principles of Scientific Management" (1911)
  - The development of a true science.
  - The scientific selection of the workman.
  - His scientific education and development.
  - Intimate friendly cooperation between the management and the men.

UK Ergonomics

- Environmental ergonomics began in research studies of heavy industries at the turn of the century
  (e.g. UK Industrial Fatigue Research Board, 1917).

US Ergonomics

(Meister, 1999)

- Environmental ergonomics began ~1900 when Simon Lake selected submariners based on their ability to withstand lack of oxygen and toxic gases.

Ergonomics, 1900-1930s

- Telephones revolutionized communication.
- Automobile assembly lines revolutionized industrial production methods in the early 1900s.

Ergonomics, 1900-1930s

- Typewriter technology and 'assembly line' work processes reshaped offices in the early 1900s.

A Century of Office Design!

Ergonomics, 1930s

- Typewriter Design:
  - Keyboard layout
  - Poor neck posture
  - Ulnar deviation

Ergonomics, 1940s

- WWII issues:
  - Radio
  - Radar
  - Sonar
  - Airplanes
  - Simulators

Birth of Modern Ergonomics

1949 – The name “Ergonomics” accepted at a meeting of the British Admiralty (July 12), by Prof. Hugh Murrell. Ergonomics research society formed in UK.

Birth of Modern Ergonomics

1952 – Ergonomics Society formed with members from psychology, biology, physiology, and design.
1957 – Journal “Ergonomics” started.
1957 – Human Factors Society founded in USA. Emphasis on "human factors engineering" by the US military with concentration on human engineering and engineering psychology. 1958 – Journal “Human Factors” started.
1992 – Human Factors Society renamed Human Factors and Ergonomics Society (~5,000 members).

HFES Membership by Degree

HFES Membership by Subject

International Ergonomics

June 2001 – 36 federated Ergonomics societies
1 affiliated society

Ergonomics

- Ergonomics is the scientific study of how people interact effectively with products, equipment, facilities, procedures and environments used at work and in everyday living.
- Ergonomics seeks to match the design of machines, jobs and workplaces with the capabilities, limitations and needs of people.
- Ergonomics seeks to maximize ease of use and optimize operator productivity, comfort and health.
- The terms “Ergonomics” and “Human Factors” can be used interchangeably.
- Ergonomics is a multidisciplinary, applied science.

Scope of Ergonomics

- Work Environment
  1. Physical demands (e.g. lifting limits)
  2. Skill demands (e.g. typing at 100 wpm)
  3. Risk demands (e.g. driving on ice)
  4. Time demands (e.g. deadlines)
- Physical Environment
  1. physical agents
  2. chemical agents
  3. biological agents

Scope of Ergonomics

- Technology
  1. Product design (anthropometrics, biomechanics)
  2. Hardware Interface design
  3. Software interface design
- Psychosocial Environment
  1. Social
  2. Cultural
  3. Lifestyle

Ergonomic Considerations

- Physical factors - ambient conditions; objects (tools, furniture, etc.)
- Biological factors - body dimensions, body capabilities, physiological processes
- Psychological factors - mental workload, information processing, training, motivation
- Work factors - job demands (time, rate, etc.), job design
- Organizational factors - organization type/climate, management regimes

Ergonomics:

a multidisciplinary applied science

Person-Machine System

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