Alternative (effectively interchangeable) terms

- Ergonomics (UK and spreading to North America)
- Human Factors [Engineering] (USA and some UK)
- Engineering Psychology (Pacific Rim, some UK)

The first two are now often combined, for example, in the name of the American Human Factors and Ergonomics Society or the UK's Institute of Ergonomics and Human Factors.

Background and definition of “Ergonomics”

The fundamental observation that work and the working environment has an impact upon the person undertaking that task was, I am sure, first recognised thousands of years ago. However, Ramazinni, writing in 1713, is widely credited with describing some of the specific medical implications associated with work; thus establishing the “specialism” of Occupational Medicine. The wider integrative, systemic, perspective was first formally codified a hundred and fifty years ago in Poland (Jastrzebowski 1857). Over fifty years ago, in 1948, the UK’s Ergonomics Research Society was founded (which became The Ergonomics Society in the early 1970s and in October 2009 The Institute of Ergonomics and Human Factors). The American Human Factors Society (now The Human Factors and Ergonomics Society) was founded ten years later in 1957. This growth has continued ever since. Today the International Ergonomics Association has member organisations throughout the world.

You may (I do) regard the profession of ergonomist as much to do with an inclusive questioning state-of-mind as it is with a mastery of, and a desire to apply, an agreed body of knowledge to situations for the improvement of human well-being. However, with a broad, multi and inter-disciplinary conceptual framework such as forms the concept of ergonomics may also come confusion, imprecision and the possibility of an overwhelming complexity. The need to draw a boundary around ergonomics has, over the years, led to many attempts at definition, either by distillation or inclusively arguments that result in a matrix construction. In preparation for the new millennium, the December 2000 issue of the Journal Applied Ergonomics, was an attempt to resolve the task of definition and clarification of conceptual ergonomics. In my view there has never been an acceptable, comprehensive definition – being a professional ergonomist is, largely, a state of mind and a willingness to adopt an systematic, all inclusive approach to understanding and interpreting the desires and experiences of people; whatever they are doing! Holding to that view I regard any definition as too restrictive! However, here is John Wilson’s definition from his editorial polemic in that 2000 issue of Applied Ergonomics and International Ergonomics Association definition.

“Ergonomics is the theoretical and fundamental understanding of human behaviour and performance in purposeful interacting socio-technical systems and the application of that understanding to the design of interactions in the context of real settings” (Wilson 2000)

“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 other methods to design in order to optimize human well-being and overall system performance.” (IEA2000)

A range of other definitions may serve to establish the scope of the subject and how different people interpret the term, ergonomics, in different ways.

1 Just try using a flint knife to skin a rabbit – the handle is neither comfortable or yielding to the grip!
“Ergonomics is an amalgam of physiology, anatomy, and medicine as one branch; physiology and experimental psychology as another; and physics and engineering as a third. From these areas an ergonomist takes and integrates data to maximise the operators safety, efficiency, and reliability of performance, to make his task easier to learn, and to increase his feelings of comfort.” (Oborne 1982)

“The scientific study of the efficiency of man in his working environment”

“The scientific study of the interaction of human beings and their working environment and the exploitation of this interaction in the interests of efficiency; the application of the human sciences to the design of machines”


“Ergonomics is the study of how working conditions, machines, and equipment can be arranged, in order that people can work with them more efficiently. Ergonomics could be called the science of good design.”

(BBC English Dictionary 1992)

“Ergonomics is the scientific study of human work” (Pheasant 1991)

“Ergonomics is the science of work: of the people who do it and the way it is done; the tools and equipment they use, the places they work in, and the psychosocial aspects of the working situation.” (Pheasant 1996)

“The term Ergonomics can be defined in a number of ways:

- the scientific study of the interrelationships between people and their work
- the study of the relationship between man, the equipment with which he works and the physical environment in which this ‘man-machine’ system operates.

Ergonomics, frequently referred to as ‘human factors engineering’ or the ‘scientific study of work’, fundamentally seeks to create working environments in which people receive prime consideration.” (Stranks 1994)

Ergonomics is... (1) That branch of science and technology that includes what is known and theorised about human behaviour and biological characteristics that can be validly applied to the specification, design, evaluation, operation and maintenance of systems to enhance safe, effective and satisfying use @ individuals, groups and organisations; and (2) The study of human abilities and characteristics which affect the design of equipment, systems and jobs ... and its aims are to improve safety and ... well-being. (Stranks 2007)

“Ergonomics can be defined as the study of human abilities and characteristics which affect the design of equipment, systems and jobs. It is an interdisciplinary activity based on engineering, psychology, anatomy, physiology and organisational studies. Its aims are to improve efficiency and operator well-being.” (Corlett and Clark 1995)

Ergonomics is, of course, a complex multi, inter and cross disciplinary subject. A definition that I frequently use is:

**Ergonomics is:**
A practical philosophy concerned with the collection of data and the application of this information to the creation, design and modification of components and systems with the desires, characteristics, abilities and the health of people (primarily but not exclusively, the “users”) as the frame of reference and comfort, safety and the promotion of well-being as the focus. (Porter 1988 revised)
However, although this definition included some of the significant aspects of the discipline it loosens the notion of inter-connectivity. I find it easier to establish ergonomics pictorially as a diagram permits the necessary description of theses relationships and interactions and encourages a holistic perspective. Indeed, the description of complex of a multi, inter and cross disciplinary subjects and their various interacting components are usually best described in this way. Sentences of involved phases, long lists of topics and statements just do not work!

These complex entities are often known as systems and are best investigated by the application of specialist paradigms and methodologies. The notion of “Hard” and “Soft” systems is introduced on page 6 – successful ergonomist will, of course, considers both!

Of course the overall term ergonomics has been subdivided and among the vast number of different sections the following are common:

- Consumer ergonomics
- Environmental ergonomics
- Interface ergonomics
- Usability ergonomics
- Ergonomic Design
- Engineering Psychology
- Meta or systems ergonomics
- Macro ergonomics
- Participatory ergonomics
- (Marketing by ergonomics)
Figure 2. General Paradigm - Meta Ergonomics/Organisational Interaction Model

A non-exhaustive, framework of the factors/interaction of particular interest to ergonomist an amenable to analysis from a systematic ergonomics perspective.

**Individual/Group Factors**
Gender, intelligence, age, physique, body size, training, experience, individual motivation (eg Maslow\(^2\)), work group behaviour, including internal stressors (eg sleep debt, “position” on circadian and other rhythms, effects of alcohol, tobacco, pharmaceuticals and *street drugs*, individually or in combination)

**Person-Machine Factors**
Task type, Information in/out format, quality and quantity, mode, image, display/control design, individual and group stereotypes, display/action/control compatibility, cognitive engagement with software/hardware

**Person-Workspace Factors**
Anthropometrics, biomechanics and personal/defensible space
Built and filled environment, spatial layout, machine size and positioning, furniture dimensions, “obstructions”

**Person-Environment Factors** (especially to include these factors in combination)
Physical
- Light, colour, sound, vibration, heat, ventilation,
- movement, electromagnetic radiation, pressure

Chemicals
- Dusts, fumes gas, liquids,

Biological
- Microbes, animals, insects

(Socio)Psychological
- Work team behaviour, command structure, pay, welfare,
- shift conditions, urban/village location, cultural factors

**Person-System factors**
Legal, regulatory, organisational, strategic, corporate, and cultural, *groupthink*\(^3\), emergent properties, group/team motivational and technological issues, weltanschauung effects, accidents, catastrophic failures and counter-intuitive behaviour, feedback -> feedforward

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\(^2\) Maslow A (1954) *Motivation and Personality*. Harper Row. Maslow proposed a, much quoted, *climbable* linear hierarchy of motivational factors from the need to satisfy a desire for food to possibilities of “self actualisation”.

\(^3\) Irving Janis’s theory is 30 years old but still applicable today. It offers a framework with which to analysis everyday situations; for example, media observations that some exam boards, apparently, just chose to modify marks and hence change the “A Level” grades awarded or the group of supporter
Finally ergonomics are generally “T” people – they have both generic breadth and specific depth of knowledge (Kelley 2005, for example). The former is especially important when they refer mates – they need to know what they don’t know; where/how to find the people that have the necessary specialist knowledge/skill and the language/fundamental knowledge to be able to communicate with these “experts”!

which has formed to defend the office of the Prime Minsters. Mr Blair in particular; against accusations of an unpleasant enthusiasm for going to war in Iraq.) (Janis 1972)
A comparison of “Hard” and “Soft” systems

The fundamental concept of “Hard Systems” and “Soft Systems” as the pure (theoretical/abstract) ends of a continuum along which all situations can be placed is well established. No complex situation, of course, will ever exist at these pure, theoretical extremes. “Systems” contain variety, are complex, holistic, purpose & context dependant, and analyst influenced; thus personal perspectives/nous is also important. For example, the client will have a view that, even if not expressed explicitly, may influence the brief/contract agreed; client and “contractor” may share perspectives (weltanschauung) but also they may not!

<table>
<thead>
<tr>
<th>“Soft” (Checkland) situations are...</th>
<th>&quot;Hard&quot; situation are...</th>
</tr>
</thead>
<tbody>
<tr>
<td>• unbounded</td>
<td>• bounded</td>
</tr>
<tr>
<td>• long with uncertain time-scales</td>
<td>• limited with defined time-scales</td>
</tr>
<tr>
<td>• without a known clear solution</td>
<td>• with a clear, known solution(s)</td>
</tr>
<tr>
<td>• unclear and it is not even certain what the problem might be (often outputs are described as “unwanted”/ “undesirable”- the situation will not be well understood)</td>
<td>• known and the problem involves selection between a number of known/possible solutions</td>
</tr>
<tr>
<td>• such that it is not known what needs to be known</td>
<td>• such that it is known what needs to be known</td>
</tr>
<tr>
<td>• full of people and not machine based/ technical</td>
<td>• mainly without people and is machine based/ technical</td>
</tr>
<tr>
<td>• tangled with its context/environment</td>
<td>• easily isolated from its context/environment</td>
</tr>
<tr>
<td>• uncertain, but the general implications are worrying</td>
<td>• limited, applications/solutions are positive, exciting</td>
</tr>
<tr>
<td>• full of priorities which are called into question</td>
<td>• full of clear, unambiguous priorities</td>
</tr>
<tr>
<td>• attitude, belief or weltanschauung based</td>
<td>• numerical, generally statistically or financially based</td>
</tr>
<tr>
<td>• readily identified as a “human activity system”</td>
<td>• readily identified as a “machine based system”</td>
</tr>
</tbody>
</table>

Table 1. “Soft” and “Hard” situations compared.

References

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Ergonomics Source Material: A bibliography

This, brief, introductory selection can, many may be found in Northumbria’s Library (620.82) but as the subject is multi-inter-disciplinary material will be found in other locations. Use the catalogue and search systems to trace material, texts, Journals and electronic resources including Ergonomics Abstracts. All links checked 10/09/11 unless otherwise noted.

An essential reminder – one that never must not be forgotten!
MESSING K (1998)
One-Eyed Science, Temple University Press (Philadelphia)

Basic Texts, which comprehensively cover the topics that make-up ergonomics
BRIDGER R (2009)
Introduction to Ergonomics (3rd Edition). Taylor & Francis (London)
DUL J and WEERDMEESTER B (2008)
GUASTELLO SJ (2006)
Human Factors Engineering and Ergonomic. Lawrence Erlbaum Associates (Mahwah, NJ)
KROEMER K (2009)
Fitting the Human. CRC Press (Boca Raton)
KROEMER K, KROEMER H and KROEMER-ELBERT K (2001)
Ergonomics: How to Design for Ease and Efficiency. Prentice Hall (Upper Saddle River, NJ)
LEHTO MR and BUCK JR (2008)
Human Factors and Ergonomics for Engineers. Lawrence Erlbaum Associates (New York)
PHEASANT ST (1991)
Ergonomics, Work and Health. Macmillan (Basingstoke)

Texts which cover much of the subject but usually with a specific application/focus
BHISE, VD (2011)
Ergonomics in the Automotive Design Process CRC Press (Boca Raton)
BUSH, PMcc (2011)
Ergonomics: Foundational Principles, Applications and Technologies (Design Mgmt,) CRC Press (Boca Raton)
GOSNAY, A (2011)
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Pleasure with Products. Taylor & Francis (London)
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Ergonomics for Therapists (3rd Edition). Mosby (Boston)
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Introductory Anthropometrics/Biomechanics etc.
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*Anthropometry for designers.* (Revised Edition). Batsford (London)  [NB: Good basics but data now datedl]

JÜRGENS HW, AUNE, IA and PIEPER U (1990)
*International Data on Anthropometry.* ILO (Geneva)

(Previous editions by Pheasant alone still contain applicable and useful data.)

TILLEY A (Henry Dreyfus Associates) (2001)
*The Measure of Man and Woman.* John Wiley & Sons (New York) (The 1992 edition is still useful.)

Musculoskeletal Issues (inc. so called RSIs, CTDs & WRULDs)
DELLEMAN NJ, HASLEGRAVE CM & CHAFFIN DB (2008)
*Working Postures and Movements.* CRC (Boca Raton)

KAPANDJI AI (2007)  
[Translated by HONORE L]
*The Physiology of the Joints – Volume 1, Upper Limb (6th Edition).* Churchill Livingstone (Edinburgh) [This is a series of descriptive texts that cover the body. Dates & editions vary, not least as they are translated from French.]

SHRAWAN K (Ed) (2008)
*Biomechanics in Ergonomics* (2nd edition). CRC (Boca Raton)

*Cumulative trauma disorders: A manual for musculoskeletal diseases of the upper limbs.* Taylor & Francis (London)  
[Warning: Good basics but now rather dated on detail]

VIOLANTE F, ARMSTRONG T and KILBOM A (2000)
*Occupational Ergonomics: Work Related Musculoskeletal Disorders.* Taylor & Francis (London)

Introductory texts concerning environmental factors and contexts (A very small selection only)
CHARTERED INSTITUTE OF BUILDING SERVICES ENGINEERS (CIBSE) (1994)
*CIBSE Code for Interior Lighting.* CIBS: (London)  
(Previously CIBS)

A wide range of authoritative guides are produced for specific circumstances, light in schools, sport centres, shipyards, etc.

*The complete Guide to Colour.* ILEX (Lewis, W. Sussex)

FULTON JS and IDEO (2005)

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*Lighting at work (HS(G)38) (2nd edition).* HMSO for Health and Safety Executive (London)

*Occupational exposure limits 2005 (EH40/05).* Health and Safety Executive (London)

PARSONS KC (2003)

Three of the HSE “Six Pack” are particularly relevant with the UK  
[Similar guidance applies throughout the EC]

HEALTH AND SAFETY EXECUTIVE (various))

a.  

b.  
*Personal protective equipment at work - Guidance on Regulations (L25)* (2nd Ed. 2004)

c.  
*Display screen equipment work - Guidance on Regulations (L26)* (2nd Edition 2004)  
[All current editions HSE, previous editions HMSO for Health and Safety Executive]

The Legal Imperative - how the wider system influences

DEWIS M (2011) (Published annually in early autumn and dated the following year)
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Key Journals

<table>
<thead>
<tr>
<th>Applied Ergonomics</th>
<th>Behaviour and Information Technology</th>
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<tr>
<td>Ergonomics</td>
<td>Ergonomics in Design</td>
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<td>Health &amp; Safety at Work</td>
<td>Human Factors</td>
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<tr>
<td>International Journal of Industrial Ergonomics</td>
<td>Occupational Medicine Journal</td>
</tr>
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</table>

(Indexed Database) *Ergonomics Abstracts*  
WHICH? (Consumers Association)
If you need a source of assistance when dealing with ergonomic problems then one route is via the professional society. The web sites contain listing of Practitioner, members and many useful links.

The Institute of Ergonomics & Human Factors, The Elms Court, Elms Grove, Loughborough. LE11 1RG UK.
+44/0 1509 234904 (voice and fax)
ergsoc@ergonomics.org.uk (email)
www.ergonomics.org.uk (web)
www.ergonomics4schools.com (school focus)

Human Factors and Ergonomics Society, P.O. Box 1369, Santa Monica, CA 90406-1369. USA.
+01 310 394 1811 (voice)
+01 310 294 2410 (fax)
info@hfes.org (email)
www.hfes.org (web)

The European Agency for Safety and Health at Work is based in Bilbao (Spain). This agency provides a work based Health and Safety oversight for the whole of the EU and may be contacted at: Gran Via 33, E-48009 Bilbao Spain. +34 944 794 360 (voice) or +34 944 794 383 (fax), Information@osha.eu.int (email) and http://agency.osha.eu.int (web)

The European Trade Union Technical Bureau for Health and Safety which publishes and distributes many useful documents/reports as well as organising campaigns can be contacted at: Bd Emile Jacqmain 155, B-1210 Brussels, Belgium. +32 2224 0560 (voice) or +32 2 224 0561 (fax), tutb@etuc.org (email) and http://www.etuc.org/tutb (web)

The HSE (Health and Safety Executive) has a wide range of reports, guidance downloadable from http://www.hse.gov.uk/index as well as priced publications. Often a good place to start especially for products intended for commercial or industrial use. Run the Occupational Safety Consultants Register (OSCR) register. [http://www.hse.gov.uk/oshcr/index.htm – 2/10/11]

The TUC [ http://www.tuc.org.uk ] and the Hazards Centre in Sheffield [http://www.hazards.org/organisations.htm] both produce many useful documents and guidance notices; as do most Trade Unions but they often limited access.