Name:

International SCHOOL OF LONDON Qatar

DP DESIGN TECHNOLOGY

TOPIC 1

HUMAN FACTORS & ERGONOMICS

NOTES & GUIDANCE BOOKLET

2022 - 2023

This booklet contains the Notes, and teaching support material for Topic 1

DP DESIGN WITH

MR MONEEB

Contents Page

Teaching & Learning Presentations

1.1a Anthropometrics

1.1a Anthropometrics

Essential Idea: Designers consider anthropometrics to ensure products meet ergonomic needs.

Concepts and principles:

- Anthropometric data: static and dynamic data, structural and functional data
- Primary data versus secondary data
- Percentiles and percentile ranges
- Range of sizes versus adjustability
- Clearance, reach and adjustability

Guidance:

- Collecting anthropometric data considering reliability and limitations
- Interpreting percentile tables for user populations
- Design contexts where different percentile ranges are used

Aims:

As a designer you need to appreciate how anthropometric data sets can vary significantly between populations. Particularly in the fashion industry, the variance in these datasets impacts the size range of clothes for particular markets.

Nature of Design:

Design is human centred and, therefore, designers need to ensure that the products they design are the right size for the user and therefore comfortable to use. Designers have access to data and drawings, which state measurements of human beings of all ages and sizes. Designers need to consider how users will interact with the product or service. Use and misuse is an important consideration.

Theory of knowledge:

Do the methods of data collection used in design technology have more in common with disciplines in the human sciences or the natural sciences?

Topic 1 Guiding Questions

Compare & contrast Anthropometrics and Ergonomics

State the main aims of Human Factors

Outline how Anthropometric data sets can vary significantly between populations

Compare static data and dynamic data

Comment on the usefulness of dynamic data and the design contexts where this type of data would be more useful.

Distinguish between Primary and Secondary Anthropometric Data

Identify and label the tools used to take anthropometric data (further research is necessary)

Explain the bell curve distribution of anthropometric data

Discuss the advantages and disadvantages of using data within the 5% to 95% percentile range

Describe a design context where the 5th–95th percentile range has been used

Describe a design context where the 50th percentile has been used

Explain the limitations of using the 50th percentile as a means of designing for the “average” person

Identify specific design contexts where the designer would use percentile ranges for particular user groups.

Compare the terms ‘range of sizes’ with ‘adjustability’

TASK: Briefly describe a product you are familiar with such as a chair or games console that is easy and comfortable to use. Can you describe why it is good or easy to use?

TASK: Describe possible hazards that may occur if product is not designed to fit the human form properly

Product analysis – exercise 1 – Mobile phone

Use your mobile phone and discuss and analyse the following:

1. Describe the useful functions
2. Do they function well?
3. Are simple ideograms or pictures used on the buttons or menu?
4. How is colour used on the keys (green and red)
5. How clear are the characters/digits?
6. Are the numbers/letter keys spaced sufficiently to allow easy dialing or texting?
7. What could be better?
8. Are there too many functions?
9. How easy are they to operate?
10. Is size important?
11. How comfortable is it to hold? Does it fit the hand neatly?
12. How do the materials used feel to touch?

Notes / Activities

Human factors

The term Human factors is used for the combination of ergonomics and anthropometrics. Human factors is also known as comfort design, functional design, and user-friendly systems, is the practise of designing products, systems or environments to take proper account of the interaction between them and their users.

Ergon = greek word meaning work
Nomoi = natural laws
Ergonomics is the science of refining design of products to optimise them for human use.

Anthropos = man
Metron = measure
Anthropometrics refers to the measurement of the human body, particularly those in size, strength and physical capacity.

History of human factors

Ergonomics

Ergonomics is the application of scientific information concerning the relationship of human beings to the design of objects, systems and environments. The relationship considers:

1. Shape, form, colour, texture
2. Ease to use
3. Comfort in use
4. Mapping and user interfaces
5. Affordance and logic of user
6. User experience

Ergonomics and design

Ergonomics

Physical ergonomics often deals with the related matters of posture, worksite development, operating layout, material handling, repetitive stress and movement, repetitive stress injuries and musculoskeletal disorders and occupational health and safety.

Cognitive ergonomics is related to mental processes such as perception, memory, reasoning and motor responses - as they affect our interactions with the product, system or environment.

Organisational ergonomics include subjects such as communication, work hours management, virtual organisational, telework and quality management.

Eg: In a steel rolling mill, the management has decided that they need to reduce staff on each shift by 2 people. Can this be done safely, for all the likely operational scenarios in the mill (including the disaster scenarios)? How should the teams of operators be organised? In the new jobs that come out of this, what training will be necessary for each of the team members?

Notes / Activities

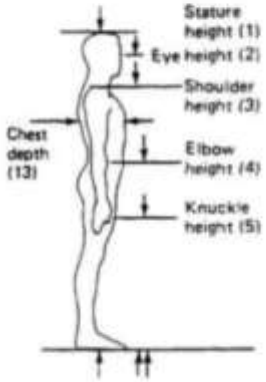
Anthropometrics

Anthropometrics is the study of human body sizes and properties such as height, mass and volume and is used extensively in the design of consumer goods.
Design is human/user centred so designers need to ensure that the products they design are the right size for the user and comfortable to use.

Designers have access to data and drawings, which state measurements of human beings of all ages and sizes. Designers need to consider how users will interact with the product, system or environment. Use and misuse is an important consideration.

Fundamentals on Anthropometry

Anthropometrics



Body dimension	Sex	Dimension, in 5th	50th	95th
1. Stature (height)	Male	63.7	68.3	72.6
	Female	58.9	63.2	67.4
2. Eye height	Male	59.5	63.9	68.0
	Female	54.4	58.6	62.7
3. Shoulder height	Male	52.1	56.2	60.0
Female	47.7	51.6	55.9	
4. Elbow height	Male	39.4	43.3	46.9
	Female	36.9	39.8	42.8
5. Knuckle height	Male	27.5	29.7	31.7
	Female	25.3	27.6	29.9
13. Chest depth	Male	8.4	9.5	10.9
	Female	8.4	9.5	11.7

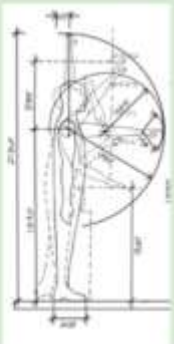
Static and dynamic anthropometric data

Static or structural data
Human body measurements when the subject is still, in a fixed position, eg static, such as height. joint to joint, skin and bulk.
Data is collected using standardised equipment such as callipers, stadiometer or anthropometer
Design contexts include chair height, door width, etc

Stadiometer

Anthropometer

Dynamic or functional data
Human body measurements taken when the subject is in motion related to range and reach of various body movements. E.g. crawling height, overhead reach and the range of upper body movements.
The measurements that relate a range or reach of various types of body movements carrying out a task such reach, grip strength, reaction times, etc
Design contexts in can openers, car console features, book shelving reach, etc



Notes / Activities

Collecting anthropometric data

It is sometimes difficult to collect accurate anthropometric data mainly due to the reliability and limitations which are described below.

Tools used:
Unreliability may have arisen from the tools used to perform anthropometry

Personnel training:
anthropometric techniques are prone to errors that could arise, for example, from the inadequate training of personnel

Time of the day:
because the cartilaginous discs of the spinal column get compressed by body weight throughout the day we tend to be slightly shorter in the evening up to 22mm

Person's body shape:
problems from collecting accurate data from nude or clothed people (people work with shoes and cloth)

Users do not carry tasks in the same way:
so data may be unreliable when observing user behaviour

Obtaining static data is straight forward:
but users interact with products and systems dynamically making accurate data gathering difficult to obtain.

Stadiometer- measures height

Ribbon tape measure- circumferences

Harpenden skin fold caliper

Infant measuring table

Bertillon head calipers

Static and dynamic anthropometric data

TASK: Identify 5 dynamic and 5 static data with a possible design context

Anthropometric data	Possible design context
Static Data 1. 2. 3. 4. 5.	
Dynamic Data 1. 2. 3. 4. 5.	

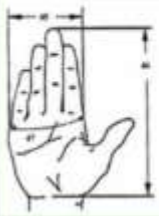
Example
Can opener – requires the dynamic data of grip and torque.

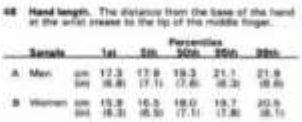
Primary data versus secondary data

Primary data is collected by the designer, who performs anthropometric measurements on the proposed user group. Because it's performed on a user group it relates directly to the intended population.
To design products that fit the Chinese population. Size China offers 3D Scans, to create data that has never been collected before - see video below.

Size China, HKPU

Secondary data is collected from a database of anthropometric measurements. Such databases are usually done by country.
It is important to consider the reliability of the data you are using or generating. Make sure when using data from secondary sources, is it appropriate in terms of age, gender, race or geographic region.





68 **Hand length.** The distance from the base of the hand at the wrist crease to the tip of the middle finger.

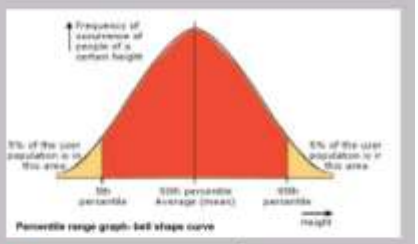
Sample		Percentiles 1st	5th	50th	95th	99th
A Men	cm	17.3	17.9	19.3	21.1	21.8
	(in)	(6.8)	(7.1)	(7.6)	(8.3)	(8.6)
B Women	cm	15.9	16.5	18.0	19.7	20.5
	(in)	(6.3)	(6.5)	(7.1)	(7.8)	(8.1)

Notes / Activities

Percentiles and percentile ranges

Percentiles refer to 100 equal groups to which a sample population can be divided according to the distribution of values of a particular variable.
Percentile ranges are used to measure dispersion within a sample population.

The 50th percentile is the average point where 50% of the population are below the height and 50% are above. The 5th and 95th percentile points are important as they indicate that the majority of people, 90% of the population have heights between these two points.
For example if you are designing a dashboard of a car if you choose the 5th percentile arm length so they could reach the board, then everyone else with longer arms would be able to do so. In the other extreme if you are designing a door you will pick the 95th percentile in stature so you know everyone will be able to fit through the door.



Large sizes
95% percentile
The UK biggest feet

Percentiles and percentile ranges

Design context - crash test dummies
In 1971, General Motors created Hybrid I a 50% percentile male dummy. Was redesigned as a 95% percentile male to be used by the aviation industry. Due to the lack of data of other percentiles, genders and ages dummies new developments include the hybrid III - a family with a male, a smaller female, a 6 year old, a 3 year old and a 12 month old baby. The data generated by these dummies is quite different and very relevant within the design context as all can be occupants of a car for example.

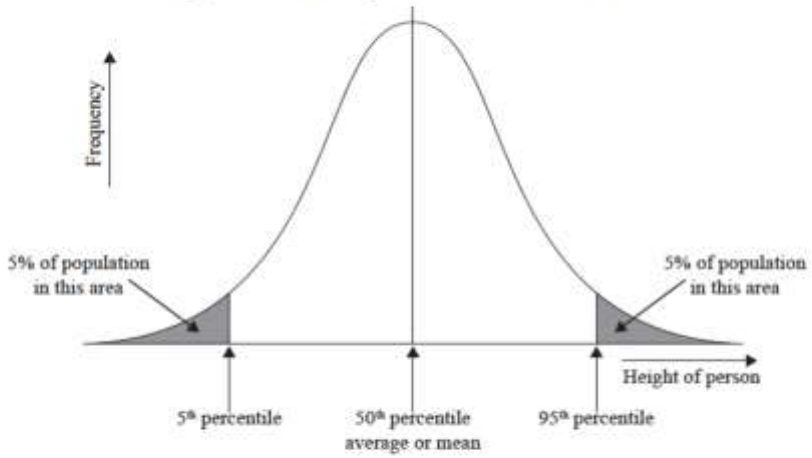
Developing children's products will require careful consideration of anthropometric data due to the large percentile range across genders and also across different age groups like a car seat design for a 3 year old that can be used up to they are 11 to 12 year old.

What is it that you are aiming for with your design?	Design examples:	Examples of measurements to consider:	Users that your design should accommodate:
Easy reach	Vehicle dashboards, Shelving	• Arm length • Shoulder height	**Smallest** user: 5th percentile
Adequate clearance to avoid unwanted contact or trapping	Manholes, Cinema seats	• Shoulder or hip width • Thigh length	**Largest** user: 95th percentile
A good match between the user and the product	Seats, Cycle helmets, Pushchairs	• Knee-floor height • Head circumference • Weight	**Maximum** range: 5th to 95th percentile
A comfortable and safe posture	Lawnmowers, Monitor positions, Work surface heights	• Elbow height • Sitting eye height • Elbow height (sitting or standing?)	**Maximum** range: 5th to 95th percentile
Easy operation	Screw bottle tops, Door handles, Light switches	• Grip strength • Hand width • Height	**Smallest** or weakest user: 5th percentile
To ensure that an item can't be reached or operated	Machine guarding mesh, Distance of railings from hazard	• Finger width • Arm length	Smallest user: 5th percentile Largest user: 95th percentile

Notes / Activities

E1. **Figure E1** shows a graph of a normal distribution curve representing the percentile range for height of a population.

Figure E1: A bell-shaped normal distribution curve



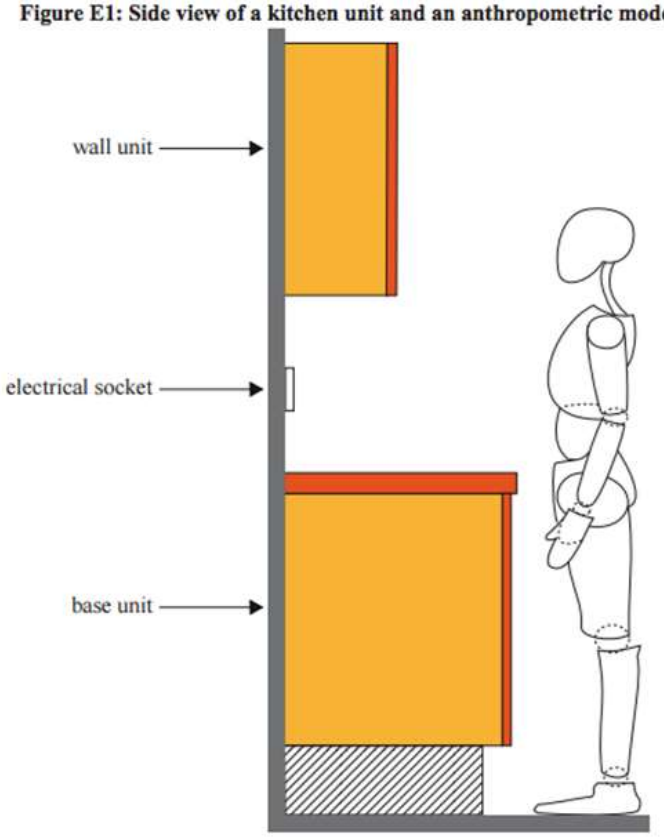
(a) State the percentage of the population that falls between the 5th and the 95th percentile. *[1]*

(b) Outline **one** reason why the shape of the distribution curve would change depending on the user population it represents. *[2]*

(c) Explain the relevance of the shaded areas of the graph to the work of designers. *[3]*

E1. **Figure E1** shows a side view of a standard kitchen unit and an anthropometric model.

Figure E1: Side view of a kitchen unit and an anthropometric model



(a) State the adult percentile which would be used to decide the height of the wall unit. *[1]*

(b) List **two** pieces of anthropometric data required to determine the depth of the base unit to allow users to gain access to the wall mounted electrical socket. *[2]*

(c) Discuss how the user would make best use of the kitchen units for storage in terms of efficiency and safety. *[3]*

Notes / Activities

Interpreting percentile tables

You need to be able interpret percentile tables for user populations in a design context. Sometimes you can't accommodate all your users because there are conflicting solutions to your design. In this case, you will have to make a judgment about what is the most important feature. You must never compromise safety though, and if there is a real risk of injury, you may have to use more extreme percentiles to make sure that everyone is protected (not just 95% of people).
You are expected to be able to

1. Interpret percentile tables in order to calculate dimensions related to a product
2. Consider how products can be adaptable for different markets or adjustable to cater for the market
3. Consider the 5th, 50th and 95th percentiles in particular and percentiles ranges such as 2.5th and 97.5th percentiles
4. Interpret percentile tables based on different national and international populations, gender and age

Task: Sidi - a famous Italian cycle shoe company which originally opened in Italy is now going global

- Outline how anthropometric data can help determine the stock sizes needed if you open shops in the US and Asia.
- Predict what shoe size range would be needed in both shops.
- Explain why increasing globalization and migration of people may make stocking of international shops more difficult in the future.

SIDI cycling shoes

Average Shoe Size Chart

Country	Male	Female
United States	Size 9 (43)	Size 7 (39)
Canada	Size 10 (43.5)	Size 6.5 (38.5)
United Kingdom	Size 9 1/2 (43)	Size 7 (39)
China	Size 8 (41)	Size 5 1/2 (37.5)

System		Sizes																
Europe		35	35½	36	37	37½	38	38½	39	40	41	42	43	44	45	46½	48½	
Mexico							4.5	5	5.5	6	6.5	7	7.5	9	10	11	12.5	
Japan	M	21.5	22	22.5	23	23.5	24	24.5	25	25.5	26	26.5	27.5	28.5	29.5	30.5	31.5	
	W	21	21.5	22	22.5	23	23.5	24	24.5	25	25.5	26	27	28	29	30	31	
U.K.	M	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	10	11	12	13½	
	W	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	9½	10½	11½	13	
Australia	M	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	10	11	12	13½	
	W	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	10½	11½	12½	14	
U.S. & Canada	M	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	10½	11½	12½	14	
	W	5	5½	6	6½	7	7½	8	8½	9	9½	10	10.5	12	13	14	15.5	
Russia & Ukraine *	W	33½	34		35		36		37		38		39					
Korea (mm.)		228	231	235	238	241	245	248	251	254	257	260	267	273	279	286	292	
Inches		9	9⅛	9¼	9⅜	9½	9⅝	9¾	9⅞	10	10⅛	10¼	10½	10¾	11	11¼	11½	
Centimeters		22.8	23.1	23.5	23.8	24.1	24.5	24.8	25.1	25.4	25.7	26	26.7	27.3	27.9	28.6	29.2	
Mondopoint		228	231	235	238	241	245	248	251	254	257	260	267	273	279	286	292	

What do they all have in common?

adjustability

Notes / Activities

Range of sizes versus adjustability

Clothing comes in a range of sizes. For manufacturers to make clothing fit every individual variance would not be economically possible, thus it tends to come in a range of sizes based on percentile ranges.
Design for adjustability means that a provision is made within the design of the product to accommodate the differences in sizes within the user group. Take an ironing board for example. Its adjustability enables a wide range of users to use the products. These adjustments can be performed using mechanical, electrical, pneumatic or hydraulic means. Most cars have ways to
adjust the seat height and the steeping position. Similarly, many office chairs allow height and backrest tilt adjustment.

Range of sizes- clothing is sold based on a range of sizes

Clearance, reach and adjustability

Clearance
For example in a workshop environment people have to move through safely through restricted areas. Clearance can be seen as the minimum distance required to, enable the user group into or through an area. This is especially important when designing emergency exits and safety hatches.

Reach
Reach is also known as the workspace envelope, is a 3 dimensional space within which you carry out physical work activities when you are at a fixed location. The limits of the envelope are determined by your functional arm reach. Most of the things that you need to use to carry out your tasks should be arranged within primary and secondary zones.

Adjustability
Certain features of equipment or facilities can be designed so they can be adjusted to user. From the 5th percentile female to the 95th percentile male of relevant population. An adjustable range is the preferred method of design. Car driver seats have many adjustments that can accommodate many people, eg seat height, distance to sterling wheel, even height of the steering wheel.

Interpreting percentile tables

Task - Which user population and percentile ranges would be required for the following products? Are all of the measurements necessary?

Childs Car Seat

Office Chair

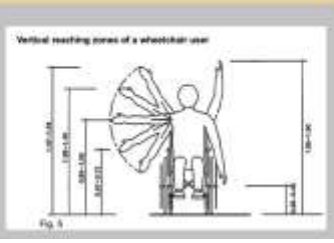
Notes / Activities

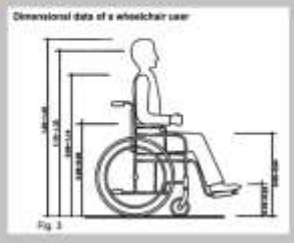
International Mindedness

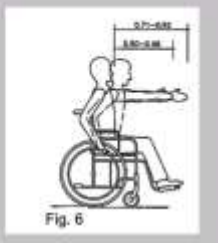
A wide selection of anthropometric data is published and regionalized, for example, Asian data versus western European data. The designer must work with data appropriate to the target market.
See more on page 5 of the textbook

' Historically, anthropometric data comes mostly from sample populations generated for use by the military. These selected sample groups bear little resemblance to the general population.'

' Data produced for designers to cater for people with disability must sample specifically targeted groups...'







TOK/PPS

Do the methods of data collection used in design technology have more in common with disciplines in the human sciences or the natural sciences?
See more on page 6 of the textbook

1. Name the methods of data collection in design and technology
2. What methods are used in natural sciences and human sciences?
3. Are these methods similar to D&T?
4. Consider how the way of knowing take a role in these methods.
5. Are these ways of knowing the same in D&T?
6. Find a scientific method (you will find more than one) and compare it with the design cycle.

Guiding questions

1. Compare and contrast Anthropometrics and Ergonomics
2. State the main aims of Human Factors
3. Outline how Anthropometric data sets can vary significantly between populations
4. Compare static data and dynamic data
5. Comment on the usefulness of dynamic data and the design contexts where this type of data would be more useful.
6. Distinguish between Primary and Secondary Anthropometric Data
7. Identify and label the tools used to take anthropometric data (further research is necessary)
8. Explain the bell curve distribution of anthropometric data
9. Discuss the advantages and disadvantages of using data within the 5% to 95% percentile range
10. Describe a design context where the 5th–95th percentile range has been used
11. Describe a design context where the 50th percentile has been used
12. Explain the limitations of using the 50th percentile as a means of designing for the "average" person
13. Identify specific design contexts where the designer would use percentile ranges for particular user groups.
14. Compare the terms 'range of sizes' with 'adjustability'

Notes / Activities

Exam style questions

Q1 - Which is not an ergonomic consideration in the design of a car? (1 mark)
A. The internal air conditioning system
B. The adjustability of the steering wheel
C. The colour of the car
D. Seat dimensions

Q2 - Which percentile range would be used in designing a seat for a mass-produced car? (1 mark)
A. 5th
B. 5th–95th
C. 95th
D. 50th

Q3 - Which adult percentile for reach would be used to decide the maximum height of a wall-mounted kitchen cupboard? (1 mark)
A. 5th
B. 50th
C. 75th
D. 95th

Q4 - Which design consideration does **not** apply to motorcycle helmets? (1 mark)
A. Range of sizes
B. Adjustability
C. Suitable for 50th percentile
D. Safety

Nov 2019
5. A labelled image of a bicycle is shown in Figure 1.
Which of these bike parts most likely requires the collection of dynamic data rather than static data?
A. Seat length
B. Handlebar grip width
C. Crank length
D. Pedal width

6. Which percentile would be used to calculate the width of a cinema seat?
A. 5th percentile
B. 5th–95th percentile
C. 95th percentile
D. 50th percentile

2019
7. If you were designing a cell/mobile phone which of the following anthropometric data would be relevant?
I. Width of hand
II. Stature
III. Grip diameter
A. I and II
B. I and III
C. II and III
D. I, II and III

Notes / Activities

2019

8. The design and development of a car is a complex process and involves many different teams. One team is responsible for the ergonomics of the interior of the car, see Figure 1 and Figure 2.

Figure 1: Rendering of a car interior

Figure 2: 2D graphics of the ergonomics of an interior

(a) (i) Define the term ergonomics. [1]

(b) (i) Outline why different percentile ranges are used in car design. [2]

(ii) Outline why dynamic data is used in car design. [2]

Nov 2018

9. During World War II, the US Navy called upon Charles and Ray Eames to create a lightweight, inexpensive leg splint. Previous splints had been made from steel or aluminium but these materials were in short supply during war time. The resulting design, see Figure 7 and Figure 8, is modular and can be mass-produced. Development of the Eames splint was made possible by their access to military technology and manufacturing facilities.

(a) Outline the nature of the anthropometric data that would have been collected for the Eames splint. [2]

Figure 7: Eames splint in use

Figure 8: Eames splint

10. List **two** pieces of anthropometric data which would be used in the design of a mobile phone. (2marks)

11. Describe the function of the instrument in the figure below (2 marks)

12. Outline **one** strategy for collecting dynamic anthropometric data that could be used to design a racing car to suit the driver. (2)

13. Compare the primary and secondary anthropometric data a designer would use in a mass produced and a custom made chair. (6 marks)

Notes / Activities

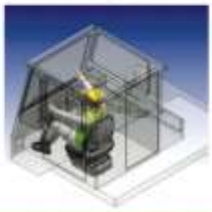
2018

14. There has been a significant increase recently in the number of very tall buildings (skyscrapers). For example, in Hong Kong there are 315 skyscrapers. This has led to a corresponding increase in the number of people required to operate tower cranes, such as the example in Figure 6.

The cabins of these tower cranes may be as much as 200 metres above the height of the street. The designer must consider not only the safety of the worker, but also their comfort as this may affect their performance. Some designers have used virtual prototyping, such as in Figure 7, in the development of these cabins.

Figure 6: A cabin in a tower crane

Figure 7: A virtual prototype of a crane cabin



(a) Outline how anthropometric data can be used in the computer aided design (CAD) ergonomic software. [2]

(d) Explain how the use of a digital human in Figure 7 can help improve the design of the crane cabin with respect to comfort, safety and performance. [9]

2019

15. Designed for, and largely operated in London, the original Routemaster buses were built between 1956 and 1968. Despite safety issues with passengers falling from the rear platform, low levels of comfort and no wheelchair access, the Routemaster outlasted newer buses intended to replace it. The Routemaster remained in use until 2005. Transport for London were seen as laggards in adopting the new Routemaster bus.

The new Routemaster, see Figure 7, Figure 8 and Figure 9, is a hybrid diesel-electric double-decker bus operating in London. Designed by Heatherwick Studio, it is manufactured by Wrightbus, and is notable for featuring a "hop-on hop-off " rear open platform similar to the design of the AEC Routemaster, but updated to meet requirements for modern buses to be fully accessible.

Following an initial order of 272 buses, the first bus entered service on 27 February 2012. The driver's cockpit is similar to other modern buses with comfortable seating, easy access for the driver and does not obstruct passenger entry.

(d) Explain how the design of the driver's cockpit of the new Routemaster bus considers clearance, reach and adjustability. [9]

32. Suggest **two** reasons why dimensions in anthropometric data tables are stated as estimates. *[6]*

*Award **[1]** for each of three distinct correct points in a suggestion of each of two reasons why dimensions in anthropometric data tables are stated as estimates **[3 max]** per reason, **[6 max]** total.*

sample size of users;
may not be representative of all the user population/people of different ethnicity;
so measurements taken may not be totally accurate;

date when the measurements were taken;
dimensions of the user population may have changed since that date;
due to diet/nutrition;

difficult to measure people/reliability of the measuring;
a tolerance is included to allow for a small amount of error;
measuring instruments may not have been very accurate;

dimensions are stated in whole numbers;
actual measurements taken may have included decimal figures;
numbers are rounded up for ease of use; ***[6 max]***

Notes / Activities

E3. **Figure E2** shows an instrument used to collect anthropometric data.

Figure E2: Instrument for collecting anthropometric data

[Source: www.rosscraft.ca. Used with permission.]

(a) Describe the function of the instrument in Figure E2. *[2]*

(b) Outline **one** limitation of the use of the instrument in Figure E2 for collecting anthropometric data. *[2]*

Figure E4 shows The Butterfly Stool designed by Sori Yanagi. The stool is manufactured from moulded plywood with brass fittings.

Discuss **two** human factor considerations in the design of The Butterfly Stool in **Figure E4.** *[6]*

Figure E2 shows a door handle. **Figure E3** shows a door knob. Both products are manufactured from polished metal.

Figure E2: Door handle

Figure E3: Door knob

[Source: www.royallensupplies.co.uk]

(a) Outline **one** advantage of the door handle in relation to human factors. *[2]*

. . . . . .
. . . . . .
. . . . . .

(b) Outline **one** advantage of the door knob in relation to human factors. *[2]*

Notes / Activities

1.1b Psychological Factors

1.1b Psychological factors

Concepts and principles:

- Psychological factor data
- Human information processing systems
- Effect of environmental factors
- Alertness
- Perception

Guidance:

- Data in relation to light, smell, sound, taste, temperature and texture as qualitative or quantitative (ordinal/interval)
- Methods of collecting psychological factor data
- Representing the human information processing system using flow diagrams
- Applying the human information processing system to a common task
- Evaluating effects and reasons for a breakdown in the human information processing system
- User responses to environmental factors
- How environmental factors induce different levels of alertness
- The importance of optimizing environmental factors to maximize workplace performance
- Assessing the impact of perception in relation to the accuracy and reliability of psychological factor data

Aims:

The analysis of the human information processing system requires you as a designer to critically analyse a range of causes and effects to identify where a potential breakdown could occur and the effect it may have.

Nature of Design:

Human beings vary psychologically in complex ways. Any attempt by designers to classify people into groups merely results in a statement of broad principles that may or may not be relevant to the individual. Design permeates every aspect of human experience and data pertaining to what cannot be seen such as touch, taste, and smell are often expressions of opinion rather than checkable fact.

Theory of knowledge:

How might the collection and interpretation of data be affected by the limitations of our sense perception?

Psychological factor data

Psychological ergonomics is an interdisciplinary field which discovers and applies information about **human** behavior, abilities, limitations, and other characteristics to the design and evaluation of products, systems, jobs, tools, and environments for enhancing productive, safe, and comfortable human use.

Good user-product interfaces including **simplicity, ease of use**, **intuitive logic** and **organization**, **low memory burden, visibility**, **feedback**, **affordance**, **mapping** and constraints provide opportunity for designers to ensure that their products are logical and easy to use.

Psychological factor data contribute to good user interfaces are commonly influenced by environmental factors such as **light, smell, sound/noise, taste, temperature and texture.**

Collecting data through observation and recording this data will enable designers to think about the issues and use the data to improve their products.User reactions whilst engaging with designed products have an impact on user experience.

User interface - light sound and texture provide feedback to the user

Light: provides ease of visibility making reading text easier whether ambient, directed or on screens.

Smell: An olfactory response to an environment, being one of the most powerful sense a human possesses.

Noise: Being able to hear sound adequately so users can receive feedback from the product.

Taste: Important for young children's products who explore their world with their mouths. Toxins are an issue.

Temperature: Hot or cold conditions affect humans productively.

Texture: provides valuable feedback, and information related to touch & grip

Psychological factor data: human factor data related to physical characteristics used to optimise the user's safety, health, comfort and performance

Notes / Activities

Methods of collecting psychological factor data

Psychology is a science; therefore, it relies upon scientific research to study behaviors and mental processes. Research in psychology is based on the scientific method and involves: conceptualizing a problem, **collecting data**, analyzing the data and drawing conclusions. Designers need to use a variety of methods of representing psychological data and these can be broken down into the four main scales used when collecting ergonomic data: **Nominal, Ordinal, Interval** and **Ratio** data scales.

Nominal scales are used for labeling variables, without any quantitative value. "Nominal" scales could simply be called "labels." Here are some examples, below. Notice that all of these scales are mutually exclusive (no overlap) and none of them have any numerical significance. A good way to remember all of this is that "nominal" sounds a lot like "name" and nominal scales are kind of like "names" or labels.

Nominal scale: used for labelling

Ordinal scales place an importance on the order of the values is what's important and significant, but the differences between each one is not really known.Ordinal scales are typically measures of non-numeric concepts like satisfaction, happiness, discomfort, etc.

Ordinal scale: used for labelling

Interval scales are numeric scales in which we know not only the order, but also the exact differences between the values. The classic example of an interval scale is Celsius temperature because the difference between each value is the same.

Interval scale: difference between values

Ratio scales are the ultimate nirvana when it comes to measurement scales because they tell us about the order, they tell us the exact value between units, AND they also have an absolute zero–which allows for a wide range of both descriptive and inferential statistics to be applied.

Scales of measurement

Ratio scale: weight & height, km/h and mph

Ordinal (Qualitative) – taste, smell and texture, Interval (Quantitative) – sound, temperature and light

Methods of collecting psychological factor data

Research in psychology is based on the scientific method and involves the collection of human factor data.Psychology as a science uses a scientific methods by which it collects data.

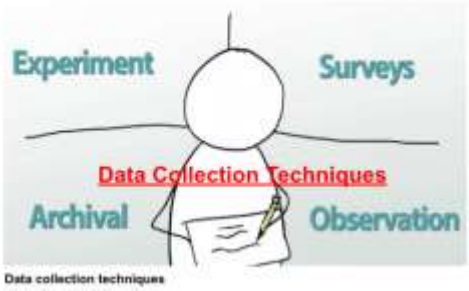
The type of psychological data that is collected is based on the conceptualization of the problem, the researcher selects a research method that will be appropriate to explore the issue or test the proposed hypothesis or hypotheses. An important aspect of collecting data is selecting an appropriate sample that is representative of the population of interest.

Methods of collecting data.

Interviews. An interview involves asking people questions to find out about their experiences and attitudes.

One problem of interviewing people is the concern of participants to tell the interviewer what they think is socially acceptable or desirable.

Surveys or questionnaires. These require subjects to read questions and mark their answers. Some psychologists observe behavior and mental processes by administering standardized tests.



Data collection techniques

Observation. In naturalistic observation, the psychologist observes behavior in real-world settings and makes no attempt to manipulate or control the situation. However, many of the observations that take place in psychology occur in the laboratory, which gives the psychologist control over factors; for this reason, there are several drawbacks to this method, such as the unnatural behaviors that result from people knowing that they are being observed.

Standardized tests. Allow the researcher to measure some aspect of the participant's behaviors and/or mental processes, and compare each individual's outcome to others that have also performed the same test.

Case Studies. Provides an in-depth examination of a single individual, from which the results may not be easily generalized to other people.

Interview - 1:1

Questionnaire/Survey

Observation

Notes / Activities

Human information processing systems

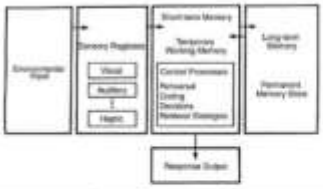
Human Information Processing System related to the human and how they deal with the information that surrounds them and is supplied through the senses of **sight, hearing, touch smell** and **taste.**

Human information processing system theory compares the human mind to a computer, suggesting that we too are information processors and that it is possible and desirable to study the internal cognitive processes that lie between the stimuli (in our environment) and the response we make.



HIPS - rehearsal secures accurate outputs

The computer gave cognitive psychologists a metaphor, or analogy, to which they could compare human mental processing. The use of the computer as a tool for thinking how the human mind handles information is known as the computer analogy.



Input → Sensory → Process → Control → Output

HIPS -theory and examples

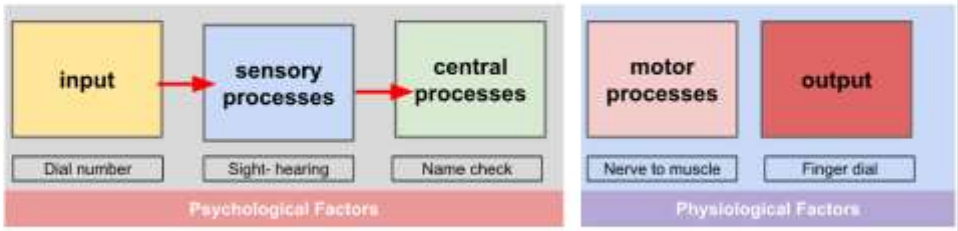
Information processing approach characterizes thinking as the environment providing input of data, which is then transformed by our senses. The information can be stored, retrieved and transformed using "mental programs", with the results being behavioral responses.

An automatic system that a person uses to interpret information and react. It is normally comprised of inputs, processes (which can be sensory, central and motor), and outputs

Human information processing systems

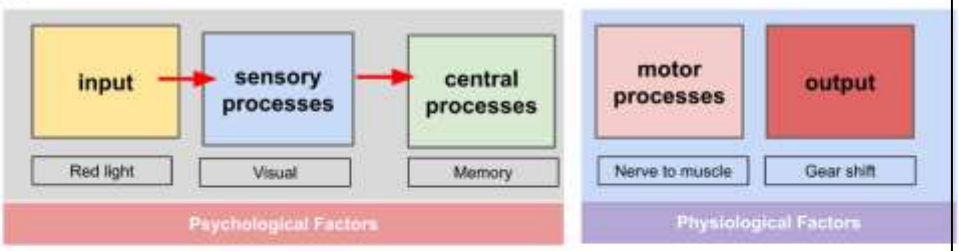
Scenario 1: Using a mobile handphone. When using a mobile phone, the information flow diagram to make a telephone call

Mobile phone: interface



Scenario 2: Driving a Car. A car driver processes information from the road and the car and produces various control responses such as braking or changing gear.

Motor skills: changing gear



An automatic system that a person uses to interpret information and react. It is normally comprised of inputs, processes (which can be sensory, central and motor), and outputs.

Notes / Activities

Effects of environmental factors

Uncomfortable work environments can affect productivity and impact upon physical and mental health. Incorporating psychological physiological and cognitive ergonomics in the workplace can remedy an uncomfortable environments . These simple changes help decrease stress levels, improve employee performance, reduce absenteeism and contribute to the well being of individuals.

Light

Lighting can determine the visual sharpness that objects that can bee seen. Contrast provides the acuity of an object, along with sufficient light levels. Alertness, productivity and performance can be affected by light and their sources, particularly at night time.

Task lighting: Tizio lamp. Sapper 1972

Ambient lighting: LED non flicker

Noise

Excessive noise in the workplace can cause workers to lose their hearing and/or to suffer from **tinnitus** (permanent ringing in the ears).

Ear defenders

The level at which employers must provide hearing protection and hearing protection zones in, for example, the UK is now 85 decibels and the level at which employers must assess the risk to workers' health and provide them with information and training is now 80 decibels.

Headphones

Spatial issues

Space, colour and smell can affect personal productivity and performance. Open plan offices encourage communication but defensible spaces are often required for focussed thinking. Colour can is related to aesthetic preference and neutral smells are preferable.

Defensible space- focused thinking

Air quality: temperature & humidity

Thermal comfort describes a person's psychological state of mind and involves a range of environmental factors which contribute to thermal comfort in office and other working environments.

- **Air temperature** (the heat radiating from the Sun, fires and other heat sources)
- **Radiant temperature** (the heat transfer from human body)
- **Air velocity** (the movement of air, still air makes people feel stuffy, moving air increases heat loss)
- **Humidity**

Open plan- encourage discussion

Open plan- comfortable environment

Environmental factors: A set of psychological factors that can affect the performance of an individual that come from the environment that the individual is situated.

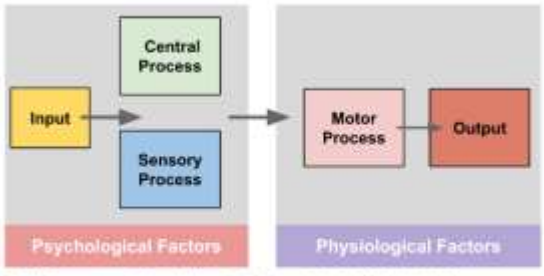
Breakdown with the human information processing systems

It is worth investigating the effects and reasons for a breakdown in the human information processing system. The flow process may break down when the information inputs may be incompatible with the sensory receptors. At the **process stage**, the incoming information may be incorrect or no suitable responses to it are available. The **output stage** may be unable to perform the actions specified by the central processing unit.

Psychological & physiological - breakdown

Breakdown at a psychological and physiological level can be attributed to the ability of human to adequately centrally process sensory information. This may be due a change in the ability to recognise particular sound frequencies or visual capabilities.

If the sensory information is compromised then information coming into the central processing stage suitable cognitive responses may be lost, and at the output stage the body may well fail to respond at the the physiological stage where physical actions are required to achieve the desired output response.



Cognitive ergonomics: breakdown - linked to psychological & physiological

Deadly Amtrak Crash Blamed On Human Error

Investigators examine why excavating equipment was on the same track as autopsies for the two victims are set to be held

Human Error

Human error has been cited as a primary cause or contributing factor in disasters and accidents in industries.

Cognitive ergonomics: human error attributed to a cognitive breakdown

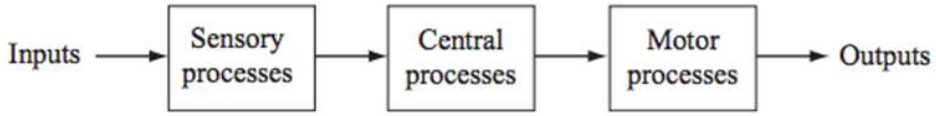
Flow process may break down due to the following:

- Age, skills level, disability, infirmity or frailty
- Young children: may not have the size, strength, fine motor control or skill to perform the tasks.
- Older people: may not have the strength
- People with disabilities: arthritis or Parkinson's disease, may also not have the fine motor control required.
- Physical conditions: multiple sclerosis, arthritis, partial paralysis, repetitive strain injury, blindness, hearing reduced sense of feeling

Notes / Activities

Figure E2 shows a flow diagram identifying the stages in a human information-processing system. The flow diagram can be applied to the context of receiving and responding to a text message on a mobile phone.

Figure E2: Human information-processing system flow diagram



[Source: © International Baccalaureate Organization 2014]

(a) Describe the function of the sensory input when receiving a text message on a mobile phone. *[2]*

.....
.....
.....
.....

(a) *Award **[1]** for each of two distinct correct points in a description of the function of the sensory input when receiving a text message on a mobile phone and **[1]** for a brief explanation **[2 max]**.*
visual/audible/vibratory alert;
nerve impulse sent to central processes/brain from sensory organ/eyes/ears/skin; ***[2]***

Breakdown with the human information processing systems

Human error has been seen as a key factor associated with almost every major accident, with catastrophic consequences to people, property and the environment.

Accidents with major human contributions are not limited to any particular parts of the world, or any particular industry, and include the Bhopal chemical release (1984), the Chernobyl melt-down and radioactivity release (1986), the Piper Alpha platform explosion (1988) and the Kegworth air disaster (1989).

The Bhopal disaster, also referred to as the Bhopal gas tragedy, was a gas leak incident in India, considered the world's worst industrial disaster.

It occurred on the night of 2–3 December 1984 at the Union Carbide India Limited pesticide plant in Bhopal, Madhya Pradesh. Over 500,000 people were exposed to methyl isocyanate (MIC) gas and other chemicals.

The Chernobyl disaster was the worst nuclear power plant accident in history in terms of cost and casualties, and is one of only two classified as a level 7 event (the maximum classification) on the International Nuclear Event Scale (the other being the Fukushima Daiichi nuclear disaster in 2011).

Human error by a train controller was to blame for a crash in Bavaria, Germany, last week that killed 11 people, prosecutors said.

An area controller opened the track to the two trains and tried to warn the drivers, according to the prosecutors.

Mistakes made by users, some of which can result in catastrophic consequences for people, property and the environment, as they are considered key contributors to major accidents.

Notes / Activities

Alertness & Perception

Alertness has been recognized as a critical, foundation for successful decision-making across a broad range of complex and dynamic systems including aviation, air traffic control, ship navigation health-care, emergency response and military command to more ordinary but nevertheless complex tasks such as driving an automobile or bicycle.


Alertness- being aware of what's happening around you

Alertness is the key term and means being aware of what is happening in the vicinity, in order to understand how information, events, and one's own actions will impact goals and objectives, both immediately and in the near future.

One with an adept sense of situation awareness generally has a high degree of knowledge with respect to inputs and outputs of a system, i.e. an **innate** "feel" for situations, people, and events that play out due to variables the subject can control. Lacking or inadequate alertness has been identified as one of the primary factors in accidents attributed to human error.

Alertness: The level of vigilance, readiness or caution of an individual.

Perception is the organization, identification, and interpretation of sensory information in order to represent and understand the environment.

The mind is programmed and designed to create order when confronted with many objects. The consequence of this is that human beings when using a product or service generally do not really see objects; they see classes, groups or patterns of controls and feedback.

Professional drivers, air traffic controllers, and firefighters are some of the employees required to have total and accurate situation awareness. They need to know what is going on and they have to understand what to do next in all circumstances.



Perception- understanding of the environment around you

Perception is part of situation awareness that involves three levels:

Perception refers to awareness of relevant objects, people, systems and other environmental factors.

Comprehension is related to understanding the meaning of what was perceived: recognizing, interpreting and evaluating the significance.

Projection refers to the ability to predict the situation in the near future, based on perceiving and understanding the dynamic elements of the environment. Situation awareness is a complex phenomenon that depends on several basic and higher level cognitive processes.

Perception: The way in which something is regarded, understood or interpreted.

Notes / Activities

1.1c Physiological Factors

Essential Idea: Designers consider physiological factors to ensure products meet ergonomic needs. Designers study physical characteristics to optimize the user's safety, health, comfort and performance.

Concepts and principles:

- Physiological factor data
- Comfort and fatigue
- Biomechanics

Guidance:

- Types of physiological factor data available to designers and how they are collected
- How data related to comfort and fatigue informs design decisions
- The importance of biomechanics to the design of different products considering muscle strength, age, user interface and torque

Aims:

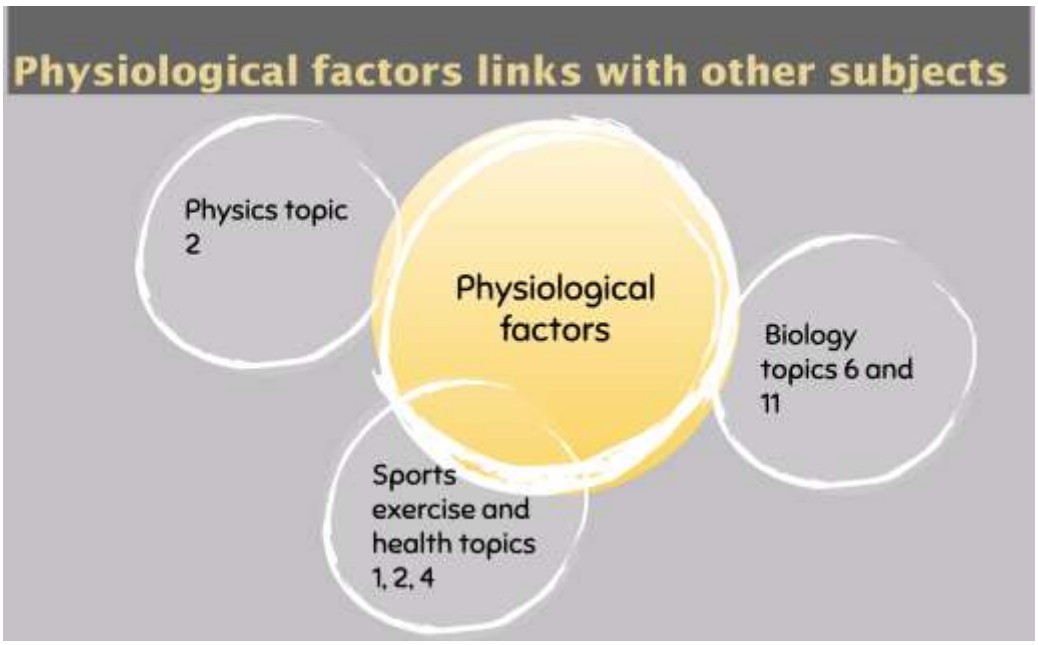
Understanding complex biomechanics when designing products to enable full functionality of body parts can return independence and personal and social well-being to an individual.

Nature of design:

Designers study physical characteristics to optimize the user's safety, health, comfort and performance.

Theory of knowledge:

This topic is about human factors. How do ethical limitations affect the sort of investigations that can take place where human subjects are involved?



Physiological factor data

Physiological factors encompass the *physical* aspect of the body. Designers use a range of physiological data to inform their design decisions. Some physiological factors that they may consider are:

- **Muscle strength** in different positions: How strong a muscle is in different positions.
- **Endurance in different positions** (how long a position can be maintained before discomfort sets in)
- **Visual acuity** (how well the user can see under different conditions)
- **Tolerance to hot or cold** temperatures
- **Range of frequencies that can be heard** by humans
- **Hand/eye coordination**

There are a variety of different ways to collect data including:

- performance testing
- user trials and observations
- collection of anthropometric data

Testing fatigue in pilots flying

Ideal Sofa Custom Comfort (TESTING CHAIR)

Notes / Activities

Comfort

How pleasing it feels to use a product, is one of the first things a human will notice if something is not pleasant to the touch, people will not want to touch it or ultimately use or operate it.
Comfort is of primary concern to designers. It determines how effective a design is and how well a human can interact with a product.
Designers engineer products to be comfortable, prevent or mitigate injury and enhance human performance. The study of BIOMECHANICS allows this.

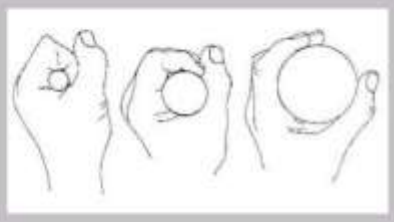
Design for discomfort is a recent approach in design to create a situation that provides comfort for only a limited amount of time. This approach has been adopted by airports, fast food chains, shopping malls, supermarkets and bus stations.
The design is to facilitate movement, to avoid loitering and to discourage people resting or stopping for long periods of time. This conversely will encourage movement to retails facilities.

Airport Design Secrets You Don't Know The Purpose Of

Comfort - Designers considerations

Adjustability: For designers, being aware of these different preferences could influence how they incorporate adjustability into their designs. Users could choose to adjust the product (i.e. the softness of the chair) or select options that address their preferences (i.e. choosing a firm over a soft mattress).

Pleasure: Comfortable products are pleasurable to use. Focusing on the comfort will increase user acceptance of a product. If something is not comfortable to touch, users will not want to interact with it.

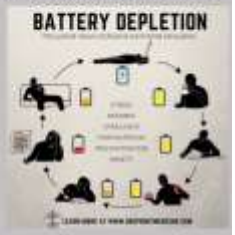


Tool handle design can influence comfort and fatigue. The ideal diameter is dependent on a number of variables.

Fatigue

Because fatigue happens over time, it is important for designers to consider the impact of prolonged use of their designs on the human body. Fatigue can also lead to Musculoskeletal disorders (MSDs) which the muscles, nerves, blood vessels, ligaments and tendons. Risk factors can include:

- lifting heavy items
- bending
- reaching overhead
- pushing and pulling heavy loads
- working in awkward body postures
- performing the same or similar tasks repetitively



Fatigue can also affect decision making and performance. In short, you are simply too tired to perform at your best.

Notes / Activities

Fatigue - Designers considerations

Performance: Designs should reduce fatigue as much as possible, and enable the user to perform at an expected level for as long as possible.
Health and Safety: Fatigued users are more likely to injure themselves or other. In addition, injuries can be permanent, or cause chronic (consistent) pain.
A poorly designed tool handle may encourage the user to hold it or use it in a manner that is unsafe or harmful.

1) Traditional stainless steel vegetable peeler

2) Examples of handles developed for user research

3) The Oxo Good Grips Vegetable Peeler

Biomechanics

Biomechanics in human factors includes the research and analysis of the mechanics (operation of our muscles, joints, tendons, etc.) of our human body and animals.
The importance of analysing the biomechanics in the use of a product of a given artefact is crucial to ensure the well-being of the user. Factors to consider include posture, muscle strength and age of the target user and how they interact with the product which might include the handle size, surface texture, and torque required.
If we need to increase the force of human power, designers need to consider mechanical advantage with the use of levers and incorporate these into the design.
Biomechanics in human factor design deals with four key criteria:

- Force
- Repetition
- Duration
- Posture

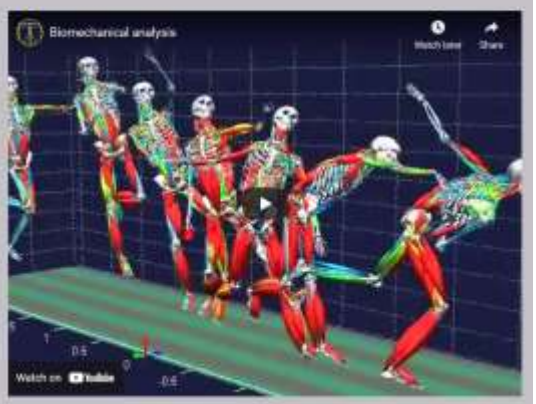
Orthotics and Prosthetics - Medicine, Biomechanics, and Design

What is Biomechanical Engineering?

Biomechanics

For designers, understanding the range and ability of the human body can help us design products that can comfortably, safely, and efficiently meet the needs of users.
Examples of www.bob-biomechanics.com software being used to analyze movements in humans doing different sports.

- Muscles in red are high activated
- Muscles in blue are low activated



Biomechanical analysis

Notes / Activities

Wheelchair case study

Below is an analysis of the biomechanics related to the use of a wheelchair

Force
Excessive impact jolts the user's joints and causes their muscles to tense in response.
Wheelchair: Users snap their arms at the end of a push which puts force on the shoulder joints.

Duration
Refers to continuous muscular effort. Small exertions continuously held are as stressful to the human tissues.
Wheelchair: Leaning on armrests – often because of a poor relationship to the seat and back – putting continuous load on shoulders is an example of doing "static" exertions.

Repetition
Many tasks are repetitive and and high task repetition can contribute to MSD (Musculoskeletal disorder). A job is considered highly repetitive if the cycle time is 30 seconds or less.
Wheelchair - How many pushes does it take them to travel a given distance? Coasting and going a little slower, taking less pushes to maintain speed.

Posture
Posture refers to the carriage of the body as a whole. It is the position you hold your body upright against gravity while standing, sitting or lying.
Wheelchair: The optimal posture is more upright, allowing the spine to act as main support as it is a structural column. Seat depth is involved here, too and if the seat is too short for the legs, then there is a loss of greater stability that comes with full contact between the seat and legs.

Biomechanics and the design of products

In the design of products you need to consider muscle strength, age, handle size, surface texture, and torque (for example, in a can opener, valve wheel, corkscrew, door handle, jam jar lid).

Within the design of any device or product are a number of assumptions made by the designer regarding the biomechanical capacities of the user population. That is to say, that successful operation assumes that sufficient pressure will be able to be brought to bear to push and activate a button, or toggle a switch on a control panel, or that sufficient force can be applied to turn the handle of a can opener or corkscrew.

While assumptions are made in designs, these assumptions are based on anthropometric measurements establishing the population distributions for capabilities such as strength, dexterity and fine motor control..

Biomechanics and the design of products

Age related muscle weakness and a number of medical conditions such as Arthritis, Parkinson's disease, Multiple Sclerosis, etc. exist that significantly impact on the assumed capabilities. In order to accommodate these groups of users, special adaptations or modifications may be required, either to the original design, or through the development of adaptive technologies that amplify biomechanical capabilities.

Biomechanical engineers design products to feel comfortable, prevent or mitigate injury and enhance human performance - a good example is these biomechanical aids to open jar lids.

Both aids below are designed to help open a range of jar lids. The force required to open a jar as lessened through the mechanical advantage produce by the length of the utensil lever arm. The frictional grip force required by the hand has also been enhanced the the texture edges on both designs

Notes / Activities

International Mindedness

It is important that the physiological factor data are either regional/national data or great care is taken when applying data from one source to a potentially inappropriate target market.
See more on page 14 of the textbook

Regional and national data could be affected by several factors such as nutrition, lifestyle, socio-economic conditions, immigration and ethnic composition.
Regular and targeted updating of anthropometric databases is crucial to keep up to date with market directions and trends in human factors relate specifically to product innovation, ergonomics and product development.

TOK/PPS

This topic is about human factors. How do ethical limitations affect the sort of investigations that can take place where human subjects are involved?
See more on page 14

Any of the methods of collecting data for evaluation may cause concern to participants and issues of privacy. GDPR laws must be followed. A number of ethical guidelines and protocols exist to protect the rights of individuals and guide researchers on testing/evaluation. Important examples are highlighted below

- Nuremberg code (1949) - developed as response to nazi experiments on human during WWII
- Declaration of Helsinki (1964) - a code of research ethics based on medical research
- The common rule (1991) - ethical standard for biomedical and behaviour research
- APA ethics code - the American Psychological association (APA) regulates psychology and associated research

Task - What responsibilities do data managers have to respect the privacy of individuals when personal information is freely volunteered?

Guiding questions

1. What is the purpose of Physiological Factors data?
2. List the types of physiological factor data available to designers
3. List the ways to collect Physiological Factors data
4. Explain the consequences in the workplace of workers suffering from fatigue
5. Detail the causes of fatigue, giving examples of scenarios that might lead to fatigue
6. Outline how data related to comfort and fatigue has informed design decisions of a product
7. Define Biomechanics
8. Analyse the Biomechanics related to the factory worker pictured. Focus on the four key criteria:

- Force
- Repetition
- Duration
- Posture

Notes / Activities

Exam style questions

2018

1. What physiological factor are the designers attempting to address in the creation of the Wow-pen mouse shown in Figure 1?

A. Endurance
B. Biomechanics
C. Tolerance
D. Comfort and Fatigue

Figure 1: A Wow-pen mouse

Nov 2017

2. Figure 1 shows information gathered from an athlete in a sports laboratory. Muscle strength, age and coordination are examples of which type of factors considered by designers?

A. Psychological factors
B. Biomechanical factors
C. Static factors
D. Primary factors

Figure 1: Athlete in sports laboratory

2016

3. What is a physiological factor that should be considered when designing a car seat for a child?

A. Alertness
B. Dematerialization
C. Convergence
D. Comfort

Nov 2016

4. What factors need to be considered when designing a can opener for an elderly person with arthritis?

I. Physiological
II. Biomechanics
III. Anthropometric

A. I and II only
B. I and III only
C. II and III only
D. I, II and III

2019

5. The design and development of a car is a complex process and involves many different teams. One team is responsible for the ergonomics of the interior of the car, see Figure 1 and Figure 2.

Figure 1: Rendering of a car interior

Figure 2: 2D graphics of the ergonomics of an interior

a(ii) Outline why biomechanics is important in car design. [2]

Notes / Activities

Nov 2018

6. During World War II, the US Navy called upon Charles and Ray Eames to create a lightweight, inexpensive leg splint. Previous splints had been made from steel or aluminium but these materials were in short supply during war time. The resulting design, see Figure 7 and Figure 8, is modular and can be mass-produced. Development of the Eames splint was made possible by their access to military technology and manufacturing facilities.

(b) Explain one physiological factor the designers of the Eames splint would have considered in its development. [3]

Figure 7: Eames splint in use

Figure 8: Eames splint

2016

7. Many bottles and cartons are sealed with screw caps as in Figure 3. Designers pay a great deal of attention to the force needed, torque, to turn the screw cap.

Torque is calculated as follows: $T = F \times d$

Where:

T – torque or turn necessary to open the screw cap, in Newton-metres (Nm)

F – handgrip force necessary to create friction to create torque, in Newtons (N)

d – diameter of the screw cap, in metres (m), see Figure 4.

Package designers assume that users with no physical disability can produce a torque of 6.3 Nm.

(a) Calculate the handgrip force applied as shown in Figure 4, to the screw cap if the required torque to open it is 6.3Nm.

(b) Outline one physiological factor related to the design of the screw cap. [2]

Figure 3: Opening a screw cap carton

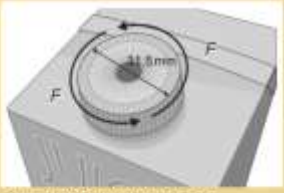


Figure 4: Dimensions of the screw cap and indication of the direction of force applied

Notes / Activities

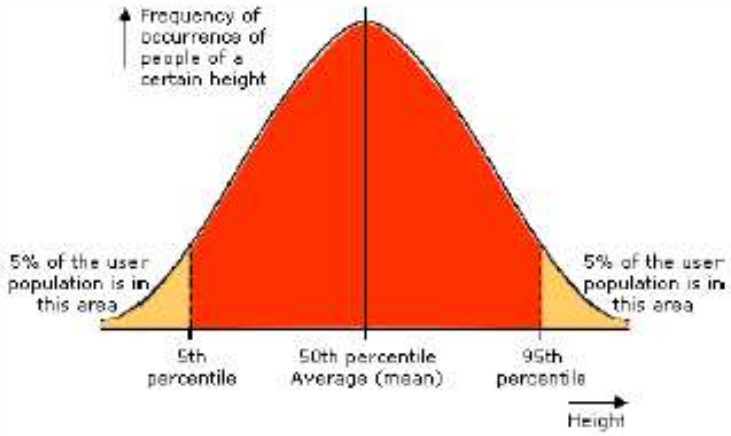
Notes / Activities

Summary Notes
Q&A

1.1 Anthropometrics

Design is human centred and, therefore, designers need to ensure that the products they design are the right size for the user and therefore comfortable to use. Designers have access to data and drawings, which state measurements of human beings of all ages and sizes. Designers need to consider how users will interact with the product or service. Use and misuse is an important consideration. Anthropometric data sets can vary significantly between populations. Particularly in the fashion industry, the variance in these data sets impacts the size range of clothes for particular markets.

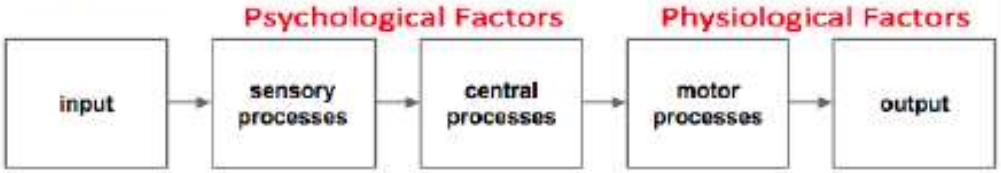
Define the term '**Human Factors**'	The term **Human Factors** is used for the combination of **ergonomics** and **anthropometrics**
What are the **aims** of Human Factors?	**Human Factors aims** to: • Reduce stress and fatigue on people, as they will be able to do things faster, more easily, more safely and make fewer mistakes (reduce errors) • Increase safety • Increase ease of use • Enhance operational comfort • Improve system performance, reliability and maintenance
What is **Ergonomics**?	The application of scientific information concerning the relationship of human beings to the design of objects, systems and environments.
What do we mean by the term **physical ergonomics**? Give an example.	**Physical ergonomics** most often deals with the work related subjects of: posture; worksite development operating layout; material handling; repetitive stress and movement; repetitive stress injuries and musculoskeletal disorders; and occupational safety and health. The aspect of ergonomics that deals with **body measurements**, particularly those of size, strength and physical capacity.
What do we mean by the term **cognitive ergonomics**? Give an example.	**Cognitive ergonomics** is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system.
What do we mean by the term **organisational ergonomics**? Give an example.	**Organizational ergonomics** subjects include communication, work design, shift (work hours) management, crew resource management, teamwork, virtual organizations, telework, and quality management.
What is **Anthropometric data**?	Anthropometric Data is sub-classified as **Static Data** and **Dynamic Data**.
What is **Structural** Anthropometric data?	**Static Data** (also known as **Structural data**) refers to measurements taken while while the subject is in a fixed or standard position, e.g. height, arm length. **Static data** is much easier to gather, as people are asked to remain still while measurements are taken.
What is **functional** Anthropometric data?	**Dynamic Data** (also known as **Functional data**) refers to measurements taken during physical activities, e.g. crawling height, overhead reach and a range of upper body movements. **Dynamic data** involves people carrying out tasks. People carry out tasks in many different ways. While static data is more reliable, dynamic data is often more useful.
What **tools** can be used to collect Anthropometric Data?	Sliding Callipers,Cloth Tape, Sitting height meters, Stadiometer
Percentiles and percentile ranges	Percentiles are shown in anthropometry tables and they tell you whether the measurement given in the tables relates to the 'average' person, or someone who is above or below average in a certain dimension.

	 There is a great deal of anthropometric data available. You are expected to be able to: -interpret percentile tables in order to calculate dimensions related to a product and consider how products can be adaptable for different markets or adjustable to cater for most -consider the 5th, 50th and 95th percentiles in particular, and percentile ranges such as 2.5th to 97.5th and 5th to 95th -interpret percentile tables based on different national and international populations, gender and age.
What do we mean when we discuss **clearance** in Human Factors?	**Clearance** can be seen as the minimum distance required to, enable the user group into or through an area. This is especially important when designing emergency exits and safety hatches
What do we mean when we discuss **reach** in Human Factors?	**Reach** is also known as the **workspace envelope.** A 'workspace envelope' is a 3-dimensional space within which you carry out physical work activities when you are at a fixed location. Workspace envelopes should be designed for the 5th percentile of the user population, which means that 95% of users will be able to reach everything placed within the envelope.
Why does a designer need to consider **adjustability** when designing seating?	Certain products tend to be available in different **sizes** or with **adjustability** built in as there really is no 'one size fits all'. E.g. Ironing tables can be adjusted to allow for people of a different height to use comfortably. This has an effect on the design of the legs, as this is how the board is adjusted in height.
Explain what is meant by the **range** of sizes versus **adjustability**	Clothing comes in a **range** of sizes. For manufacturers to make clothing fit every individual variance would not be economically possible, thus it tends to come in a range of sizes based on percentile ranges. Children's car seats are **adjustable** to allow for a range of sizes and a growing child.
What is an **ergonome** and when are they used? What are the advantages and disadvantages?	A **2D scaled** physical anthropometric model based on a specific percentile human forms are called **ergonomes**. The ergonomes have been scaled from data taken from specific percentile ranges to form a standard human form. **Ergonomes** are used with drawings of the same scale as the model to consider the relationship between the size of an object and people. They are used with 2D drawings, mainly for orthographic drawings and also modelling to view field of reach, field of vision, etc.
What is a **manikin**? What are the advantages and disadvantages?	A **manikin** is an anatomical **3D model** of the human body. A jointed model of the human body used by artists, especially to demonstrate the arrangement of drapery. Also called lay figure. They are useful for assessing the relationship of body parts to spatial arrangements represented by a 3D model, for example, a chair to a desk. Full scale manikins are generally more expensive than ergonomes and they give a better representation of the overall ergonomics in the design context (such as crash test dummies).

1.2 Psychological factors

Human beings vary psychologically in complex ways. Any attempt by designers to classify people into groups merely results in a statement of broad principles that may or may not be relevant to the individual. Design permeates every aspect of human experience and data pertaining to what cannot be seen such as touch, taste, and smell are often expressions of opinion rather than checkable fact. The analysis of the human information processing system requires a designer to critically analyse a range of causes and effects to identify where a potential breakdown could occur and the effect it may have.

What is **Cognitive psychology** / cognitive ergonomics concerned with?	**Cognitive ergonomics** is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. • mental processes- such as perception, memory and reasoning • motor response- as they affect interactions among humans and other elements of a system.
What **methods** are there for collecting Psychological factor data?	1. Observation 2. Surveys & Interviews 3. Standardized Testing 4. Case Studies
What is a **Nominal Data Scale**?	Nominal means 'by name'. Used in classification or division of objects into discrete groups. Each of which is identified with a name. The scale does not provide any measurement within or between the categories
What is an **Ordinal Data Scale**?	Deals with the order or position of items. Words, letters, symbols or numbers arranged in a hierarchical order. Quantitative assessment can not be made
What is a **Interval data scale**?	Organised into even divisions or intervals. The intervals are of equal size. There is no zero
What is a **Ratio data scale**?	The difference between a ratio scale and an interval scale is that the zero point on an interval scale is some arbitrarily agreed value, whereas on a ratio scale it is a true zero. For example, 0°C has been defined arbitrarily as the freezing temperature of water, whereas 0 grams is a true zero, that is, no mass. A ratio scale allows you to compare differences between numbers.
What are examples of **Psychological factors**?	**Smell:** important in food, perfumes, candles, deodorants, chemicals. Unpleasant odors are added to chemicals to warn people. **Light:** the level of illumination should increase as the tasks becomes more precise; for example the illumination required for a surgeon is brighter than the illumination needed for a corridor. Lighting in workplaces, safety. For example effects of florescent lighting and rotating parts on machinery. Lighting effect on ambience and mood, e.g. lighting in restaurants – gentle, calming, stimulating. **Sound:** can be used to: • Provide information such as warning signal (fire alarm or alarm). • Sound for reassurance that the product is working ex. Watches • Feedback , whistling kettles, reversing trucks Sound can be positive in the environment such as playing music in an exhibition. Noise can also be negative in a workspace, that's why open plan offices use screens to reduce noise. **Taste:** important in food, it must have a good taste to sell well. Responses to taste are also a factor of culture and experience. **Texture:** shapes and textures improve products and make them easier to use, for example bottle tops, handles fabrics and non-slip floors, smooth worktops in kitchen. **Temperature:** Clothing is an important part of a comfortable work environment but the

	environment must be controlled regardless of the outside climate. How the user responds to different environmental factors, for example, how warm or cold work environments can affect the performance of an individual. A range of comfort zones will exist based on body mass, manner of dress or even physiological changes that can be developed from exposure to a particular temperature or environment over time. **Value:** May be perceived as a function of cost, features, prestige, rarity etc. or a combination of these factors.
What is the **Human information processing systems**?	Human information-processing systems, considering inputs, processes (sensory, central and motor) and outputs. A simple representation of a human information-processing system is below. 
What are examples of **Environmental factors**?	Environmental factors such as noise, lighting, temperature, humidity, vibration may affect: hearing, vision, general comfort and health.
What are examples of a **breakdown** with the Human information processing systems?	Some examples of how the flow process may break down are dependent on the following: • Age, skills level, disability, infirmity or frailty • Young children may not have the size, strength, fine motor control or skill to perform the tasks. • Older people may not have the strength • People with disabilities, such as arthritis or Parkinson's disease, may also not have the fine motor control required. • A physical condition which can include: ALS: Amyotrophic lateral sclerosis, MS: Multiple Sclerosis, Arthritis, Partial paralysis, Parkinson's disease, Repetitive Strain injury, Blindness, Hearing, Reduced sense of feeling
How can you **maximise workplace** performance?	An important role in maximising workplace performance and reducing the possibilities of accidents. **Management** — Policies, safety education, decision centralization **Physical environment** — Noise, temperature, pollutants, trip hazards, signage **Equipment design** — Controls, visibility, hazards, warnings, safety guards **The work/job itself** — Boredom and repetitiveness, mental and physical workload, musculoskeletal impacts such as force, pressure and repetition) **Social and psychological environment** — Social group norms, morale **The worker** — Personal ability, alertness, age, fatigue
What is **Alertness?**	**Alertness** is the key term and means being aware of what is happening in the vicinity, in order to understand how information, events, and one's own actions will impact goals and objectives, both immediately and in the near future.

What is a **Human error?**	**Human error** come in several forms but two fundamental categories are **slips** and **mistakes**. Slips result from automatic behaviour, when subconscious actions that are intended to satisfy our goals get waylaid en route. Mistakes result from conscious deliberations.
What are possible ways of **optimizing environmental factors** to maximize workplace performance?	**Lighting:** best lighting is natural lighting or low frequency/brightness depending on task. In medical surgery it would be opposite- bright and sharp to optimise the task **Thermal comfort:** Male and Female have different body temperature. Having the right temperature air/humidity and flow of air/circulation to get best work performance. **Working space**: Space, working envelope, safe **Noise:** Protection of excessive noise (above 85 decibels) **Vibration**: Machines, etc. create vibration and sound and can be annoying
What are some **perception** effects in products?	This principle maintains that the human mind considers objects in their entirety before the perception of their individual parts; **suggesting the whole is seen rather than the sum of its parts.**

1.3 Physiological factors

Designers study physical characteristics to optimize the user's safety, health, comfort and performance. Understanding complex biomechanics and designing products to enable full functionality of body parts can return independence and personal and social well being to an individual.

What is **Physiological factors** concerned with?	Physiological factors have more to do with **bodily tolerances** (how much can the body withstand) such as **comfort and fatigue.** When users interact with products, they may put **stress** on their bodies.
What is **Physical ergonomics** concerned with?	Physical ergonomics is concerned with human anatomy, and some of the anthropometric, physiological and biomechanical characteristics as they relate to physical activity. Physical ergonomic principles have been widely used in the design of both consumer and industrial products.
What are some **human values** with types of physiological factors?	It also considers which activities can be carried out and how **human values** (for example, quality of life, improved safety, reduced fatigue and stress, increased comfort levels and job satisfaction) are enhanced.
What is **Fatigue**?	When people get tired they react in different ways. Fatigue is the temporary diminishment of performance. Fatigue can be physical and/or mental. Fatigue can inform design decisions and can affect users.
What is **Comfort**?	**Comfort**: is a qualitative consideration and differs massively between different people. **Comfort** is a physiological factors that inform design decisions and can affect users.
How can designing ergonomically enhanced work environments and products have advantages for the employer and employee?	**Healthy Workforce:** Instead of workers adjusting to standard tools and equipment, ergonomics promotes product designing based on human body structure and requirements. Therefore, these products drastically reduce the strain workers experience due to repetitive use of machines, computers, scanners, industrial apparatus and related instruments. Less strain equates to reduced instance of occupational illnesses and therefore healthier employees. **Enhanced Productivity**: A healthy workforce translates to enhanced productivity. Easy to use equipment keeps the work momentum going on for longer durations. Workers experience less fatigue and are happy to use tools designed especially for them. **Reduced Number of Sick Days Reported:** People with reduced instance of work associated ailments implies they take fewer days off due to sickness and work more number of days in a year. This means lesser number of workdays is lost. **Savings**: By using ergonomic workstations, employers save huge amounts of money otherwise spent in compensation claims, treatments and litigation.
What is **biomechanics** in human factors concerned with?	Biomechanics in human factors includes the research and analysis of the mechanics (operation of our muscles, joints, tendons, etc.) of our human body. With biomechanics, measuring the amount of force put on the muscles and joints of people when working in different positions can be tested by determining which positions make use of an individual's muscular strength. Biomechanics in human factor design deals with four key criteria: • Force • Repetition • Duration • Posture
What are some **factors affecting muscle strength** with human factors?	• Gender • Age - - Greatest around 20's - 5% less in 40's - 20% less in 60's • Pain, Physical training schedule, Immobilization or bed bound

Topic Questions & Exam Practice

End of Topic Questions

Answer the questions in this section as best as you can. The marks are shown in brackets next to each question. All multiple-choice questions hold 1 mark each.

1. **Human factors design is also known as:**

   A Ergonomic design
   B Ergonome design
   C Workplace design
   D Anthropometric Design

1. **Ergonomics involves:**

   A designing new products
   B designing for aesthetic appeal
   C testing products in extreme environments
   D designing for people and their interaction with products

1. **4 types of data measurement scales are:**

   A Nominal, ordinal, interval, ratio
   B normal ordinary scattered ratio
   C natural ordinal relative comparative
   D categorical continuous nominal ordinal

1. **Designing for adjustability provides:**

   A for arthroscopic investigations
   B caters for ergonomic adjustability
   C designs that consider anthropometric variations
   D means for adjustments to accommodate anthropometric variability

1. **Design for comfort is aimed primarily at:**

   A older population groups
   B individuals with a disability
   C products that are difficult to use
   D improving productivity or efficiency

1. **Compare and contrast static and dynamic data gathering techniques (2)**

Answer the questions in this section as best as you can. The marks are shown in brackets next to each question.

7. Explain/Define the following;

Ergonomics (2)

Anthropometrics (2)

Percentile Range (2)

8. What to the letters PDS stand for? (2)

9. State 2 physiological factors that can inform design decisions? (2)

10. State 3 considerations that need to be taken into account when designing products for use in biomechanics. (3)

10. Explain how culture might influence psychological responses to product design. (3)

11. Explain how perception can affect the reliability of psychological human factors data. (3)

12. Under what circumstances could a breakdown in human information processing systems occur? (3)

13. **State a context where the 5^{th}-95^{th} percentile range has been used? (1)**

14. **How can Body Tolerances affect the design of;**

a. Car seats (2)

b. Controls for Machinery (2)

15. **State 2 limitations of collecting Ergonomic Data (3)**

16. **List 6 Psychological ergonomic factors (6)**

17. Describe the difference between User Trial and User Research

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18. Define Fashion

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19. Define Planned Obsolescence

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20 Compare the influence of Fashion and Planned Obsolescence in terms of the Product Cycle – explain your answer.

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21 Define Field Trial

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22 Define Quality Control

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23 Define Quality Assurance

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24 Explain the relevance of Quality Assurance to consumers.

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25 Explain how aesthetic considerations affect the design of products.

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26 List 5 moral and social responsibilities of designers in relation to green issues.

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Exam Practice Questions

2. (a) Define *percentile range*. *[1]*

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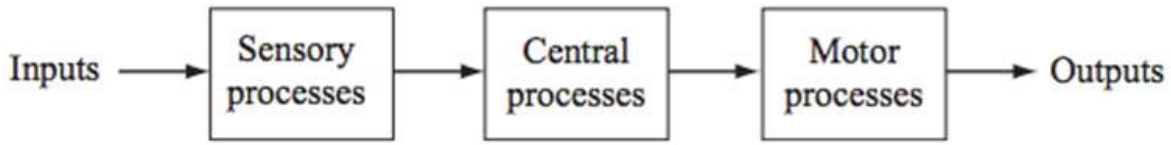
. . . . . .

(b) Explain the limitations of using the 50th percentile as a means of designing for the "average" person. *[3]*

Figure E2 shows a flow diagram identifying the stages in a human information-processing system. The flow diagram can be applied to the context of receiving and responding to a text message on a mobile phone.

Figure E2: Human information-processing system flow diagram



[Source: © International Baccalaureate Organization 2014]

(a) Describe the function of the sensory input when receiving a text message on a mobile phone. *[2]*

. . . . . .

. . . . . .

. . . . . .

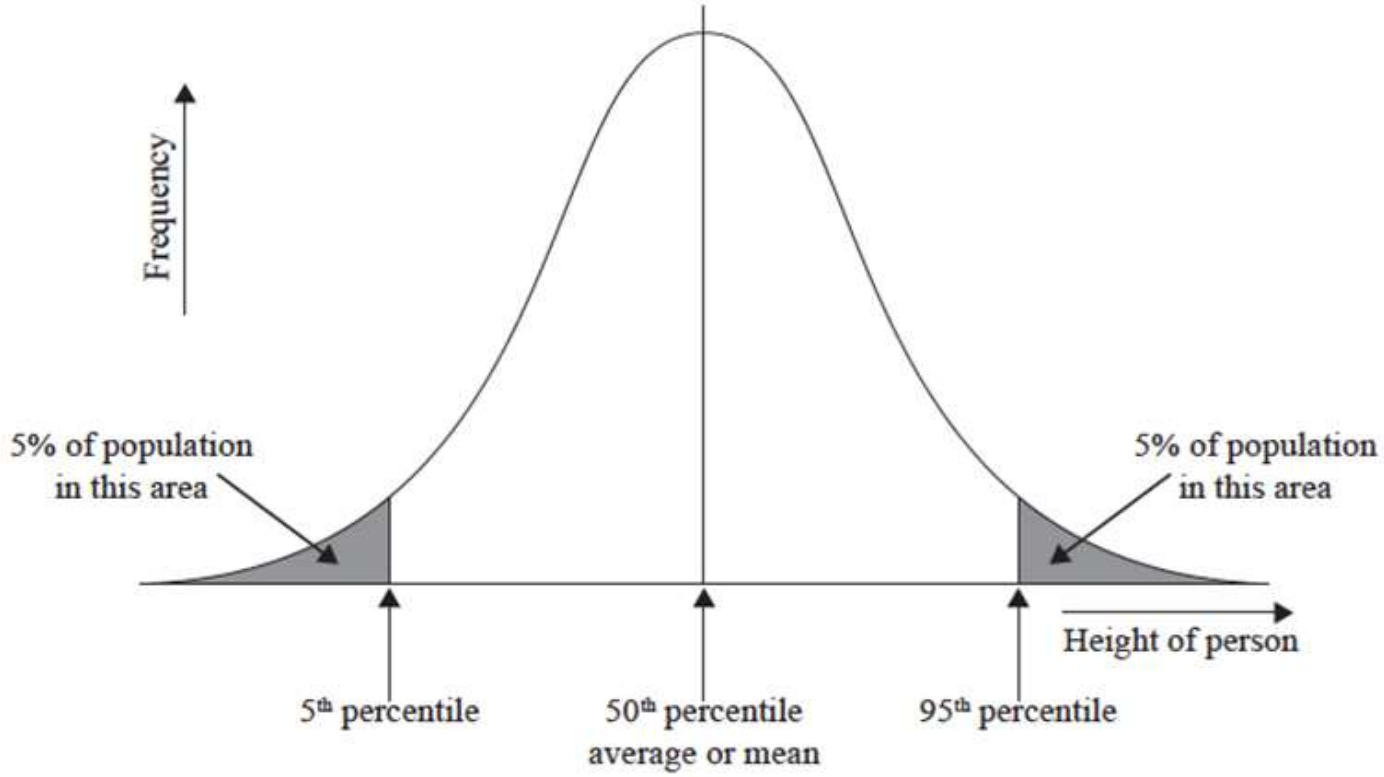
. . . . . .

(b) Outline **one** reason why the motor processing stage may lead to errors in writing a response to the received message. *[2]*

32. Suggest **two** reasons why dimensions in anthropometric data tables are stated as estimates. *[6]*

E1. **Figure E1** shows a graph of a normal distribution curve representing the percentile range for height of a population.

Figure E1: A bell-shaped normal distribution curve



(a) State the percentage of the population that falls between the 5th and the 95th percentile. *[1]*

(b) Outline **one** reason why the shape of the distribution curve would change depending on the user population it represents. *[2]*

(c) Explain the relevance of the shaded areas of the graph to the work of designers. *[3]*

Figure E3: Prima home office

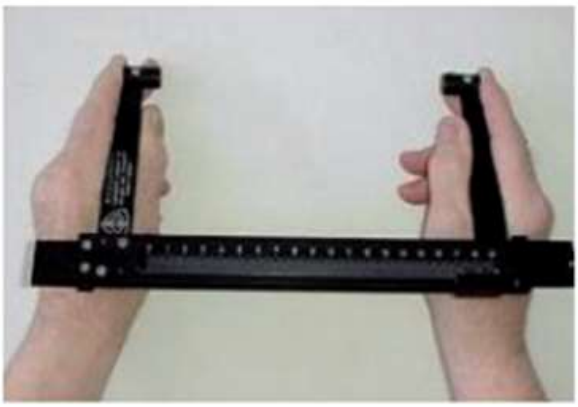
[Source: www.strachan.co.uk. Used with permission.]

Compare **two** human factor considerations for a home office such as that shown in Figure E3 with the human factor consideration for a commercial office. *[6]*

Discuss human factor considerations in the design of a car seat belt for a volume-produced car in relation to anthropometrics, psychological and physiological factors. *[9]*

E3. **Figure E2** shows an instrument used to collect anthropometric data.

Figure E2: Instrument for collecting anthropometric data



[Source: www.rosscraft.ca. Used with permission.]

(a) Describe the function of the instrument in Figure E2. *[2]*

(b) Outline **one** limitation of the use of the instrument in Figure E2 for collecting anthropometric data. *[2]*

E4. Discuss how adjustability and range of sizes impact on the global market for clothing. *[6]*

E5. (a) Outline **one** reason why the concept of *design for discomfort* may be used in the design of public seating in railway stations. *[2]*

(b) Outline **one** piece of dynamic human factors data which is important to the designer of public seating. *[2]*

(c) Outline **one** security issue which has affected the design of seating in airports. *[2]*

E7. Explain why feedback, mapping and affordance are important in human factors design. *[9]*

Mens' shirt sizes can be expressed in a number of ways, for example as small, medium or large or in terms of the collar size, generally expressed in inches. **Table E1** shows the expression of shirt sizes as small, medium, large (row 1) and collar sizes in inches (row 2).

Table E1: Alternative ways of expressing shirt sizes

Shirt size	S	M	L
Collar (inches)	14.5 and 15	15, 15.5 and 16	16.5 and 17

[Source: adapted from www.cottontraders.co.uk]

(a) State the type of measurement scale used for shirt sizes in the first row of **Table E1**. *[1]*

.....

.....

(b) Outline **one** reason why some manufacturers choose to produce shirts in the sizes small, medium and large. *[2]*

Figure E1 shows a Kitchencraft butterfly can opener. **Figure E2** shows a can being opened using the can opener.

Figure E1: Kitchencraft butterfly can opener

[Source: http://smithandwebbcookshop.com]

Figure E2: Opening a can

Removed for copyright reasons

(a) Outline **one** human factor reason why the flat handle of the can opener has a twist in it. *[2]*

(b) Outline **one** human factor reason for including the holes in the rotating head part of the can opener. *[2]*

Before the development of the QWERTY keyboard in 1873 by Christopher Sholes the keys of mechanical typewriters often jammed if two adjoining keys were struck rapidly in succession. Sholes rearranged the keys so that the most commonly-used letter sequences were spread out which meant typing took longer.

Discuss memory burden and mapping in relation to the use of the QWERTY keyboard. *[6]*

Outline **one** benefit of seating which is an example of design for discomfort for the owner of a fast food restaurant. *[2]*

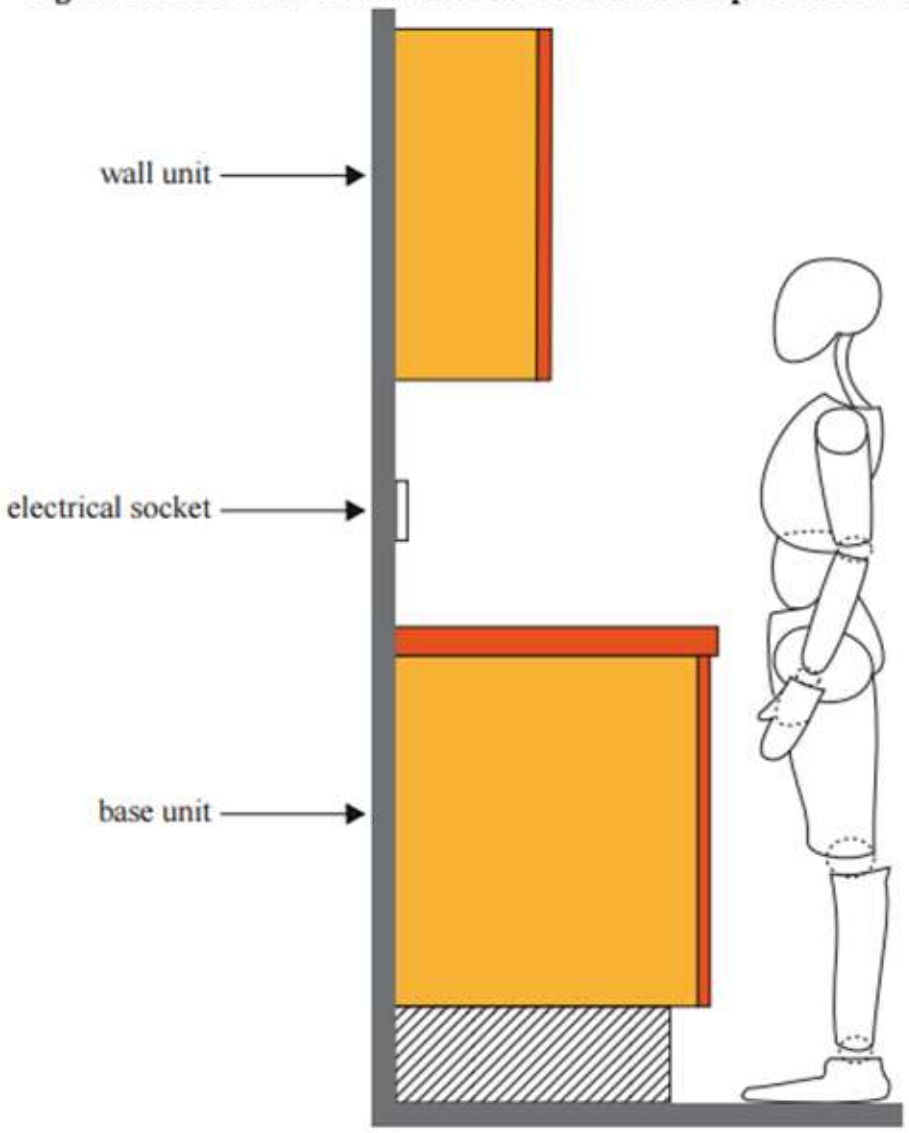
Outline **one** benefit of design for discomfort for the user of a fast food restaurant. *[2]*

Outline **one** moral responsibility for a designer when using the concept of design for discomfort in the design of seating for a fast food restaurant. *[2]*

Explain **three** ways in which the use of a kitchen work triangle at the design development stage can improve human factors considerations. *[9]*

E1. **Figure E1** shows a side view of a standard kitchen unit and an anthropometric model.

Figure E1: Side view of a kitchen unit and an anthropometric model



(a) State the adult percentile which would be used to decide the height of the wall unit. *[1]*

(b) List **two** pieces of anthropometric data required to determine the depth of the base unit to allow users to gain access to the wall mounted electrical socket. *[2]*

.....

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.....

.....

(c) Discuss how the user would make best use of the kitchen units for storage in terms of efficiency and safety. *[3]*

Figure 5 shows the SPLAT Child's chair designed by Spinifex. The chair is designed for creative youngsters who like to paint and draw. Compartments in the back hold art materials while paper is stored under the seat. It is also ideal for holding games and small toys. It is made from laminated cardboard sheets threaded on postal tubes (see **Figure 6**). The chair is biodegradable, it is recommended for ages 3–6 years and has dimensions 50 cm × 30 cm × 50 cm. Each chair is made to order.

Figure 5: SPLAT Child's chair

Figure 6: Postal tubes

E2. **Figure E2** shows taps produced by the company Cupree for the disabled market sector.

Figure E2: Cupree taps

[Source: www.cupree.com]

(a) State **one** visual aspect of the design which has been employed to assist the user. *[1]*

.....

.....

(b) Outline **one** way in which the design of the taps assist users with limited hand movement. *[2]*

Airlines charge increasingly large penalties for overweight luggage. The penalties and the rules on penalties vary from airline to airline. The Balanzza Digital Luggage Scale (see **Figure 9**) has been designed to help avoid such penalties. The scale is designed to be compact (13×7×2.5 cm), lightweight (229 g) and cheap. A strong strap secures it to the bag. To weigh the bag it should be lifted by the scale, wait for the beep and then set down so the digital scale can be read (see **Figure 10** and **Figure 11**).

Figure 9: The Balanzza Digital Luggage Scale

Figure 11: Scale in use

(ii) Discuss **three** evaluation activites (tests, models and experiments) that would be used to evaluate ideas for the Balanzza Digital Luggage Scale at the "developing the chosen solution" stage of the design cycle. *[9]*

E5. Car designers need to run tests to gather data relating to the protection of occupants in a collision.

(a) Outline **one** way in which the use of digital humans can contribute to the tests. *[2]*

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(b) Outline **one** limitation of using digital humans for the tests. *[2]*

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(c) Outline **one** way in which digital humans can increase the speed of the product cycle. *[2]*

E7. **Figure E5** shows an "Eye Level Cooker" manufactured by Flavel. By positioning the grill at eye-level the cooker was seen as a radical new design 40 years ago.

Figure E5: An "Eye Level Cooker"

Discuss **three** safety issues concerning the use of the grill shown in Figure E5. *[9]*

State the percentile which would be used to decide an appropriate height for the tallest shelf in a supermarket. [1]

Explain why there is no specific anthropometric data available for the "average" person. [3]

Figure 8 shows the Water Craft life-saving aid designed by Ross Kemp as his final year project for his design degree. As a student, Ross undertook a lifeguard training course and realized that it was difficult to move a body through water single-handedly. Existing aids were either a paddle board or jet skis but these need two people to launch them. He based his new design on the jet ski but with a sloping back to make it easier to pull someone on it. After graduation, Ross decided to try and create a marketable version of his idea so he produced a number of prototypes to test. The initial testing with the Royal National Lifeboat Institution (UK) was not a great success so further prototypes were done to get to the pre-production stage. Funding for more testing at Bondi beach in Australia was gained after the Water Craft won first prize of £10 000 in the Lloyds TSB Enterprise competition and sponsorship was raised from the media attention. **Figure 9** shows a scale model of the Water Craft.

Figure 8: Water Craft prototype

Figure 9: Ross Kemp and scale model

(ii) Outline **one** physiological ergonomic consideration which contributed to the idea for the Water Craft. [2]

Explain the relationship of quantitative and qualitative data to the concept of perception when considering ergonomics. *[3]*

E3. **Figure E2** shows the Ad-specs. They are "adaptive spectacles" which have been designed for use by people in developing countries. The focal length of the lenses is easily adjusted by filling the lens with fluid using the adjustment wheels and pump. No sight test is required. For everyday use (once the focal length of the lenses has been adjusted) the pump can be removed (see **Figure E3**).

Figure E2: Ad-specs

Figure E3: Ad-specs in use with pump removed

(a) Outline **one** reason related to human factors for the size of the lenses of the Ad-specs. *[2]*

(b) Outline **one** aspect of the design of the spectacles which has been compromised by the size of the lenses. *[2]*

E4. **Figure E4** shows the Forest chair manufactured by Fast Italy. It is made from metal and is designed for use in the garden.

Figure E4: Forest Chair

Fast Italy forest garden armchair, designed by Robby and Francesca Cantarutti
www.gomodern.co.uk. Used with permission.

Discuss **two** physiological human factors issues in relation to the Forest chair. *[6]*

E6. (a) Explain **one** human factors issue in relation to the design of a railway carriage for a wheelchair user. *[3]*

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(b) Explain **one** limitation of relying on information from the Internet for the purchase of a new wheelchair. *[3]*

(a) State the name of the rotational force employed when unscrewing the lid of a jar. *[1]*

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(b) Outline **one** reason why a jar is manufactured with a tightly-fastened lid even though the manufacturer knows that it will be difficult to open for some consumers. *[2]*

(a) State the percentile range used for adult shoe sizes in volume production. *[1]*

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(b) Compare the use of qualitative and quantitative data when considering the ergonomic aspects of a design. *[3]*

Figure E2 shows a door handle. **Figure E3** shows a door knob. Both products are manufactured from polished metal.

Figure E2: Door handle

Figure E3: Door knob

[Source: www.royallensupplies.co.uk]

(a) Outline **one** advantage of the door handle in relation to human factors. *[2]*

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(b) Outline **one** advantage of the door knob in relation to human factors. *[2]*

Figure E3 shows a range of cutlery called Sure grip bendable cutlery. The cutlery has large rubber handles and can be bent to suit the user (see **Figure E3** inset). **Figure E4** shows the Baroque range of cutlery manufactured from stainless steel.

Figure E3: Sure grip bendable cutlery

[Source: www.redlandhealthcare.co.uk]

Figure E4: Baroque cutlery

[Source: www.procook.co.uk]

Compare **two** human factor design features of the Sure grip bendable cutlery with those of the Baroque cutlery range. *[6]*

Figure E4 shows The Butterfly Stool designed by Sori Yanagi. The stool is manufactured from moulded plywood with brass fittings.

Discuss **two** human factor considerations in the design of The Butterfly Stool in **Figure E4.** *[6]*

Glossary of Terms

Glossary of Terms

Topic 1 : Human factors and ergonomics

Term	Definition
Adjustability	The ability of a product to be changed in size, commonly used to increase the range of percentiles that a product is appropriate for.
Alertness	The level of vigilance, readiness or caution of an individual.
Anthropometrics	The aspect of ergonomics that deals with body measurements, particularly those of size, strength and physical capacity.
Biomechanics	The research and analysis of the mechanics of living organisms. Biomechanics in Human factors includes the research and analysis of the mechanics (operation of our muscles, joints, tendons, etc.) of our human body. It also includes Force (impact on user's joints), Repetition, Duration and Posture.
Clearance	The physical space between two objects.
Cognitive ergonomics	How mental processes, (memory, reasoning, motor response and perception), affect the interactions between users and other components of a system.
Comfort	A person's sense of physical or psychological ease.
Dynamic data	Human body measurements taken when the subject is in motion related to range and reach of various body movements. E.g. crawling height, overhead reach and the range of upper body movements.
Environmental factors	A set of psychological factors that can affect the performance of an individual that come from the environment that the individual is situated.
Ergonomics	The application of scientific information concerning the relationship between human beings and the design of products, systems and environments.
Fatigue	A person's sense of physical or psychological tiredness.
Functional data	Functional data includes dynamic data measurements while performing a required task e.g. reaching abilities, manoeuvring and aspects of space and equipment use.
Human error	Mistakes made by users, some of which can result in catastrophic consequences for people, property and the environment, as they are considered key contributors to major accidents.
Human factors	A scientific discipline concerned with understanding how humans interact with elements of a system. It can also be considered the practice of designing products, systems or processes to take account of the interaction between them and their users. It is also known as comfort design, functional design and user-friendly systems.
Human information processing system	An automatic system that a person uses to interpret information and react. It is normally comprised of inputs, processes (which can be sensory, central and motor), and outputs.
Interval data	Interval data are based on numeric scales in which we know the order and the exact difference between the values. Organised into even divisions or intervals, and intervals are of equal size.

Nominal data scale	Nominal means 'by name' and used in classification or division of objects into discrete groups. Each of which is identified with a name e.g. category of cars, and the scale does not provide any measurement within or between categories.
Ordinal data	A statistical data type that exists on an arbitrary numerical scale where the exact numerical value has no significance other than to rank a set of data points. Deals with the order or position of items such as words, letters, symbols or numbers arranged in a hierarchical order. Quantitative assessment cannot be made.
Percentile range	That proportion of a population with a dimension at or less than a given value. For a given demographic (gender, race, age), the 50th percentile is the average.
Perception	The way in which something is regarded, understood or interpreted.
Physiological factor data	Human factor data related to physical characteristics used to optimise the user's safety, health, comfort and performance
Primary data	Data collected by a user for a specific purpose.
Psychological factor data	Human factor data related to psychological interpretations caused by light, smell, sound, taste, temperature and texture.
Qualitative data	Typically descriptive data used to find out in depth the way people think or feel - their perception. Useful for research at the individual or small (focus) group level.
Quantitative data	Data that can be measured and recorded using numbers. Examples include height, shoe size, and fingernail length.
Range of sizes	A selection of sizes a product is made in that caters for the majority of a market.
Ratio data scale	A ratio scale allows you to compare differences between numbers. For example, use a rating scale of 1-10 to evaluate user responses.
Reach	A range that a person can stretch to touch or grasp an object from a specified position.
Secondary data	Data collected by someone other than the user.
Static data	Human body measurements when the subject is still.
Structural data	Refers to measurements taken while the subject is in a fixed or standard position, e.g. height, arm length.
Workplace environmental factors	These factors can be considered to maximise performance of a user in a role and reduce the risk of accidents. They can be categorised as: • Management (policies, safety education) • Physical environment (noise, temperature, pollutants, trip hazards, signage) • Equipment design (controls, visibility, hazards, warnings, safety guards) • The nature of the job (repetitiveness, mental or physical workload, force, pressure) • Social or psychological environment (Social group, morale) • The worker (personal ability, alertness, age, fatigue)

DP DESIGN TECHNOLOGY

WITH

Mr Moneeb

TOPIC 1: Guidance and Notes Booklet
2020 - 2022