

COM2002 / COM3002 / COM6222

Human Centred Systems Design



The
University
Of
Sheffield.

What is Human Centred Systems Design?

“The analysis, design, implementation and evaluation of interactive computing systems for human use”

It covers ...

- users
- developers
- computers

It involves ...

- psychology
- human factors
- software engineering
- interaction design



Aims of the Course

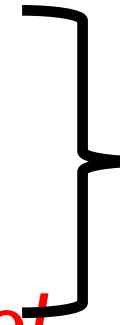
- To provide the **psychological foundations** of human-centred design
 - including abstraction, ergonomics and developer-customer communication
- To develop **group-working skills** in applying software analysis and design methods
 - to create software systems for target customer groups
- To develop technical **software development skills**
 - including heterogeneous systems with graphical or web-based interfaces and databases
- To develop **analytical skills**
 - for measuring the usability and ergonomics of software systems



Lecturers

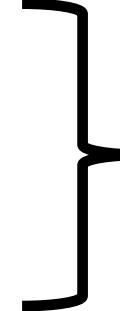


- ***Dr. Heidi Christensen***
 - Next 5 Tuesdays



*Human-Computer
Interaction*

- ***Dr. Mari-Cruz Villa-Uriot***
 - 1st Tuesday + last 4 Tuesdays



*Software
Engineering &
Databases*

- ***Dr. Tony Simons***
 - Thursdays



The
University
Of
Sheffield.

Logistics

- Lectures (*2x 2hr per week*) ...
 - Tuesdays 14:00-15:50 LEC SG-CHURCH
 - Thursdays 13:00-14:50 LEC DIA-LT04
- Assessment *for my part*
 - 100% coursework
 - accessed/submitted through MOLE
 - 5 questions – 100 word answer for each
- Feedback
 - in-class exercises + marked coursework
 - Google group for general questions
- Lecture notes (*slides + myEcho recordings*)
 - on-line (*MOLE*) after the lectures

READING WEEK:
w 7 – no lecture
on Tuesday 31st
Oct



COM 2002/3002/6222 Human Centred Systems Design

Assignment 1: Instructions

Answer all 5 questions covering Heidi Christensen's lectures.

Each question is worth 4%, and each answer should be no longer than 100 words (about five or six lines).

You can cite sources at the end of each answer (not included in the 100 words) if you wish. You may use diagrams but *not* pictures.

Note 1: Please use the provided documents as templates, and fill in your answers beneath each question and then upload it to Mole when you have finished.

Note 2: This is an individual assignment. You must not collaborate with anyone else in preparing your answers. Any submissions which appear to involve any form of collusion will be subject to the University's normal procedures for plagiarism.

In order for it to be fair, please *do not* contact us with questions about the content – it's up to you to interpret each question and to respond appropriately.

COM 2002/3002/6222 Human Centred Systems Design

In order for it to be fair, please *do not* contact us with questions about the content – it's up to you to interpret each question and to respond appropriately.

Name

< your name here >

Answer the following questions in your own words, in 100 words or less.

1. (HC) Using the PACT framework, describe the relationship between a user and a technology of your choice.
2. (HC) Imagine the HCI for a new set of augmented reality sports glasses for elite cyclists. Explain the design choices you would make to create useful and usable interface for the cyclist thinking especially about reducing the gulf of evaluation and the gulf of execution.
3. (HC) You are designing a monitoring system for premature babies in the neonatal ward in hospital. Who are the primary, secondary, tertiary and facilitating stakeholders you will need to involve and why?
4. (HC) You are designing a spelling game to be used as a fun way for children to practice pronouncing words better at home with help from their parents. There are two main user groups: the parents and the children. Write a persona description for the parent.
5. (HC) Specify a Hierarchy Task Analysis for this task: "Measure and plot blood sugar levels of residents in a care home". Must include minimum of two subtasks and associated plans.

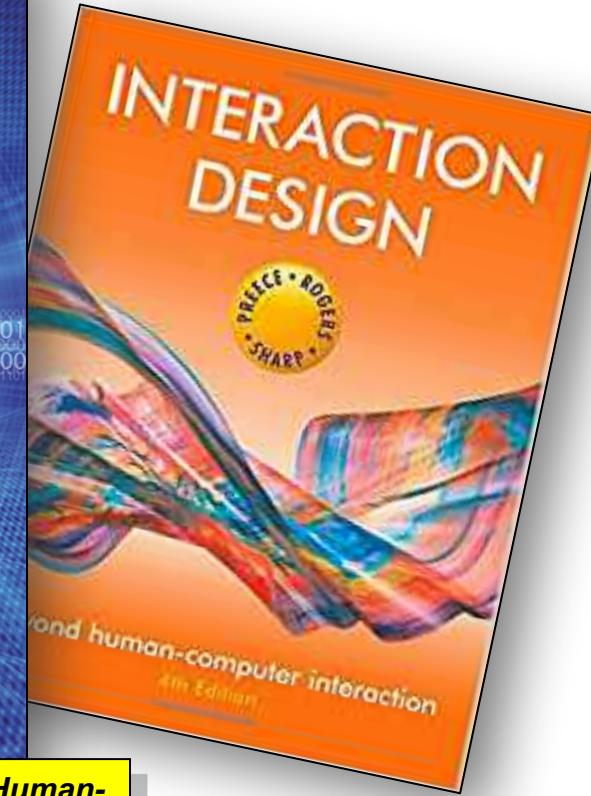
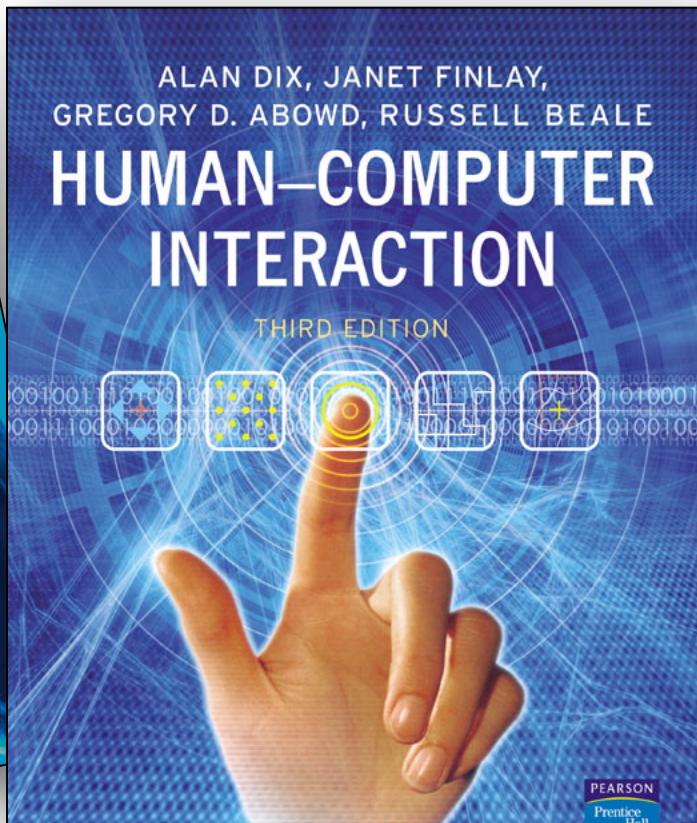
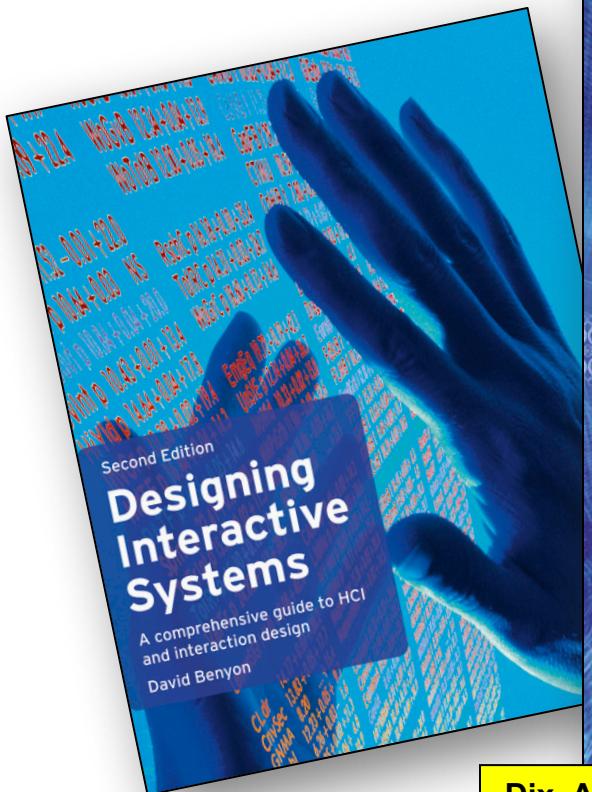
My part – the following 5 Tuesdays*



1. People and Technology
2. Human-Computer Interaction
3. Designing Interaction
4. Guest lecture: Sebastian Conran
5. HCI and Software Engineering



Recommended Texts (*HC part*)



Dix, A., Finlay, J., Abowd, G., & Beale, R. (2004). *Human-Computer Interaction*. Harlow: Pearson Education Ltd.

Benyon, D. (2010). *Designing Interactive Systems* (2nd ed.): Addison-Wesley.

Rogers, Y., Sharp, H., & Preece, J. (2015). *Interaction Design: Beyond Human-Computer Interaction* (3rd ed.): John Wiley & Sons.



The
University
Of
Sheffield.

COM2002/3002/6222

Human Centred Systems Design

HC Lecture 1

People and Technology



The
University
Of
Sheffield.

Q: What is Technology?



A: The design and use of '**tools**'
(for some benefit)



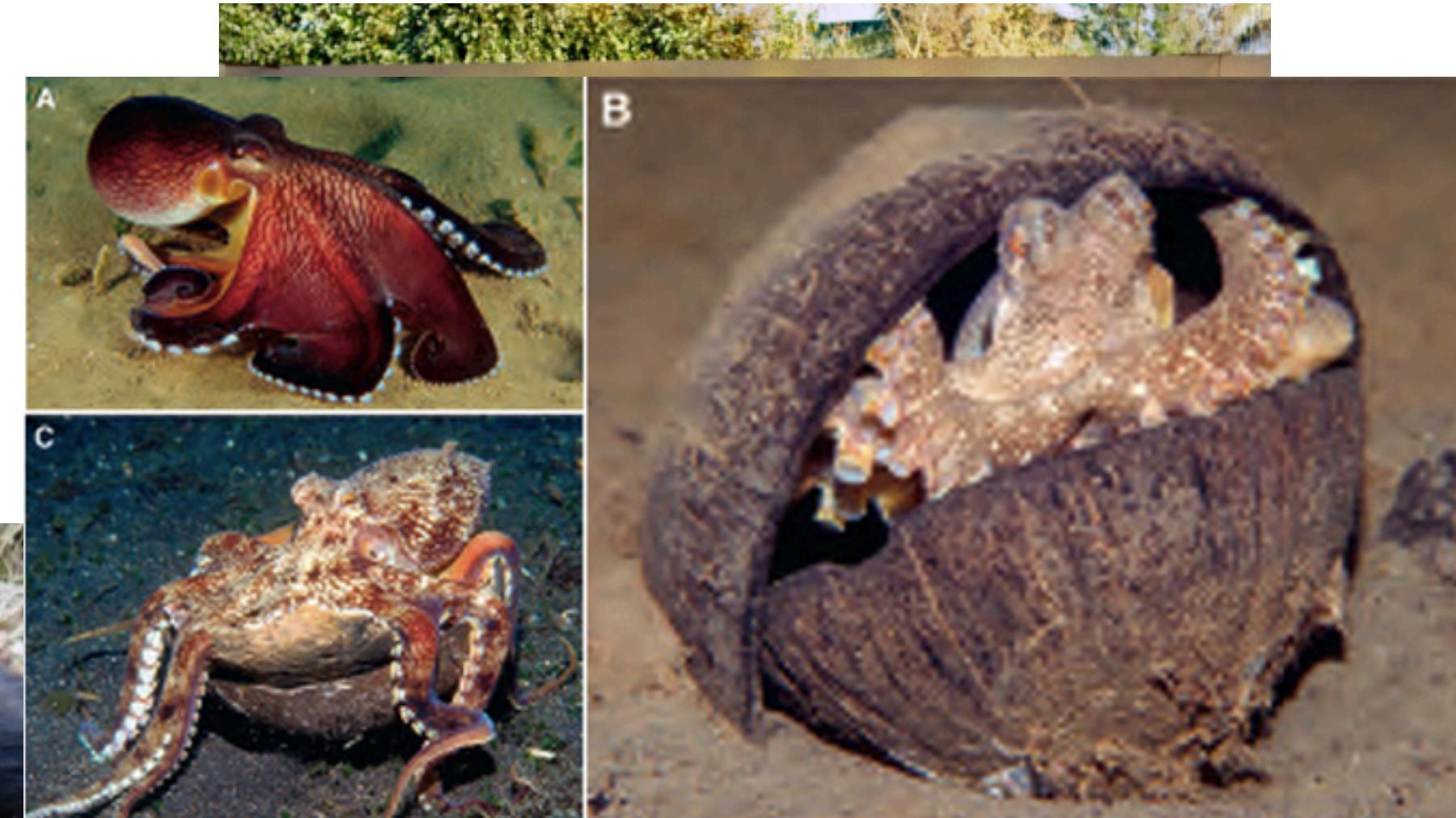
The
University
Of
Sheffield.

Some Early Technologies



The
University
Of
Sheffield.

Not just humans ...

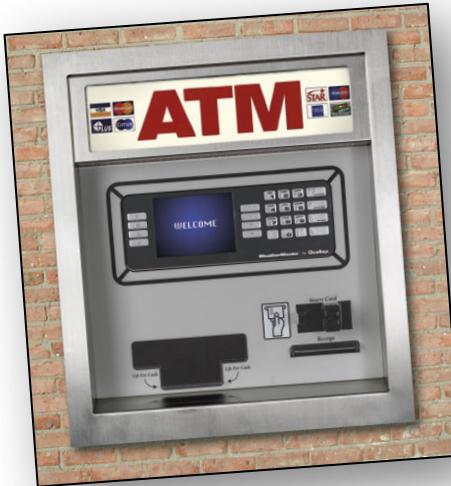


... for our own benefit!



The
University
Of
Sheffield.

Contemporary Technology



The
University
Of
Sheffield.

Evolution of the Mobile Phone



Motorola
8900X-2

Nokia
2146

Nokia
3210

Nokia
6210

Ericsson
T39

Alcatel
OT511

Samsung
E250

Apple
iPhone

BlackBerry
Curve 8900

Samsung
Galaxy S2

Samsung
Galaxy S4

Sony Xperia
Z Ultra



The
University
Of
Sheffield.

Top 10 Strategic Technology Trends for 2017 – Threat or Opportunity?

The world is becoming an intelligent, digitally enabled mesh of people, things and services. Ordinary people will experience a digitally enabled world where the lines between what's real and what's digital truly blur. AI and machine learning will be used to enhance analytics, actions and interfaces of nearly every technology-enabled system. New digital business models are emerging, and new ecosystems are forming to realign business and customer relationships.

Gartner
Research company



Gartner, Inc. is an American research and advisory firm providing information technology related insight for IT and other business leaders located across the world. Its headquarters are in Stamford, Connecticut, United States. [Wikipedia](#)

Stock price: IT (NYSE) US\$124.57 +0.16 (+0.13%)

2 Oct, 16:02 GMT-4 - Disclaimer

CEO: Eugene A. Hall (23 Jul 2004–)

Headquarters: Stamford, Connecticut, United States

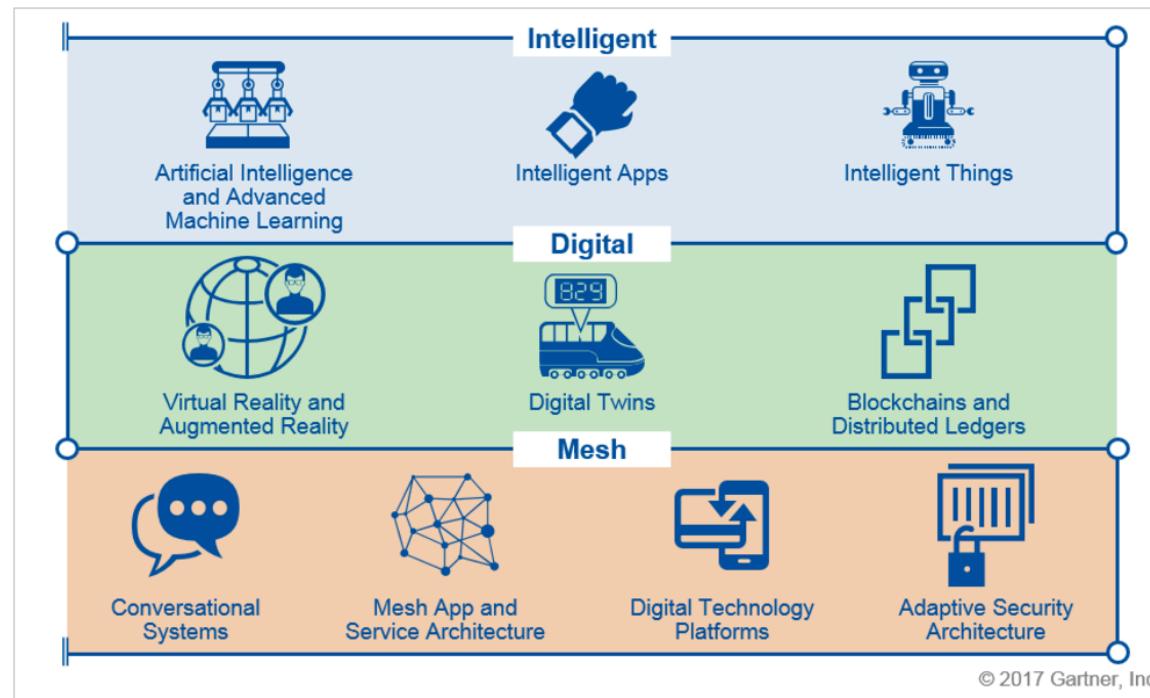
Revenue: 2.44 billion USD (2016)

Founder: Gideon Gartner

Founded: 1979

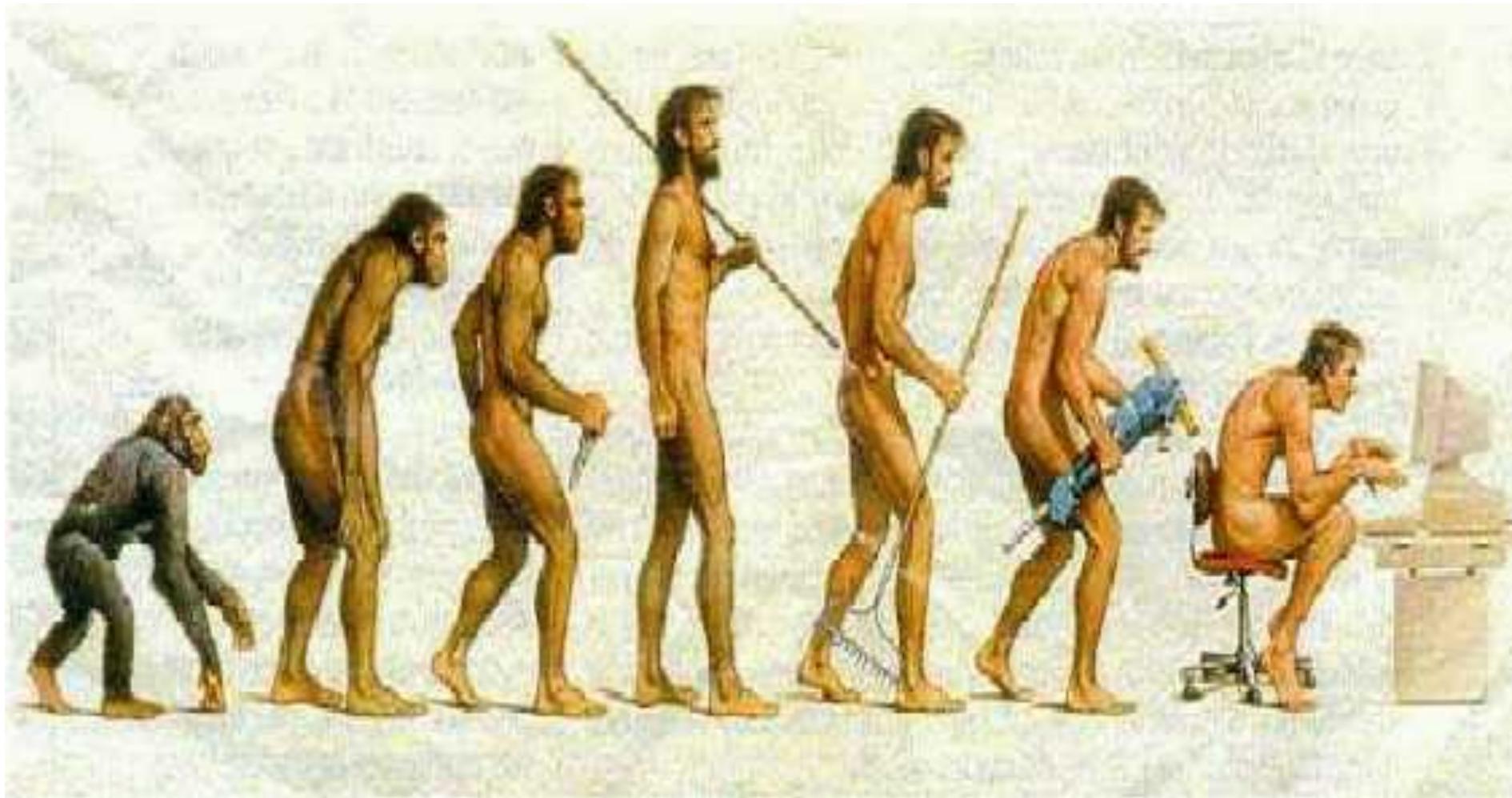
Subsidiaries: CEB Inc., Capterra, Software Advice, AMR [MORE...](#)

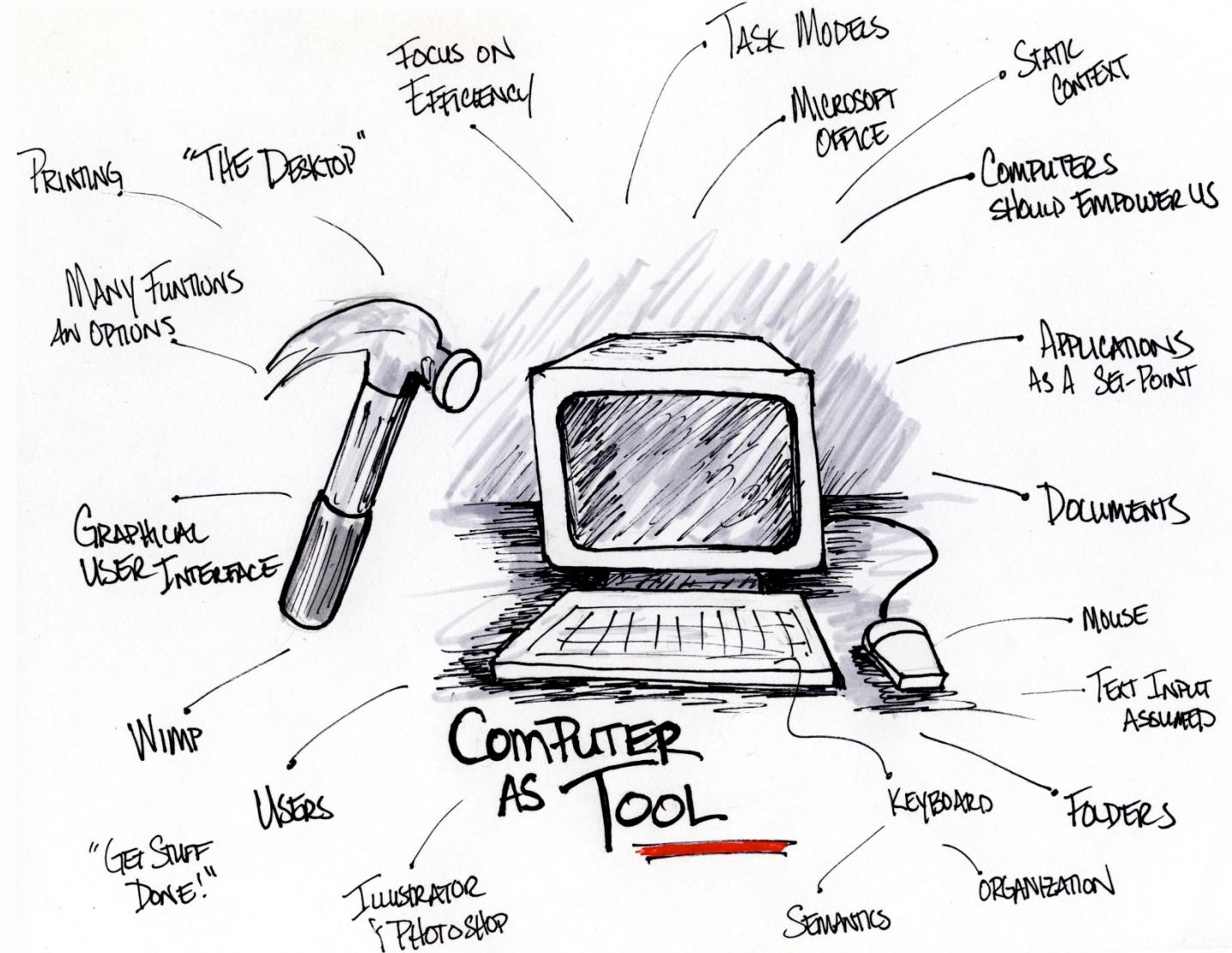
Disruption – It's great when you're the disruptor, but it's scary when you're the one being disrupted.



© 2017 Gartner, Inc.

Technology: *Tools* \Rightarrow *Computers*

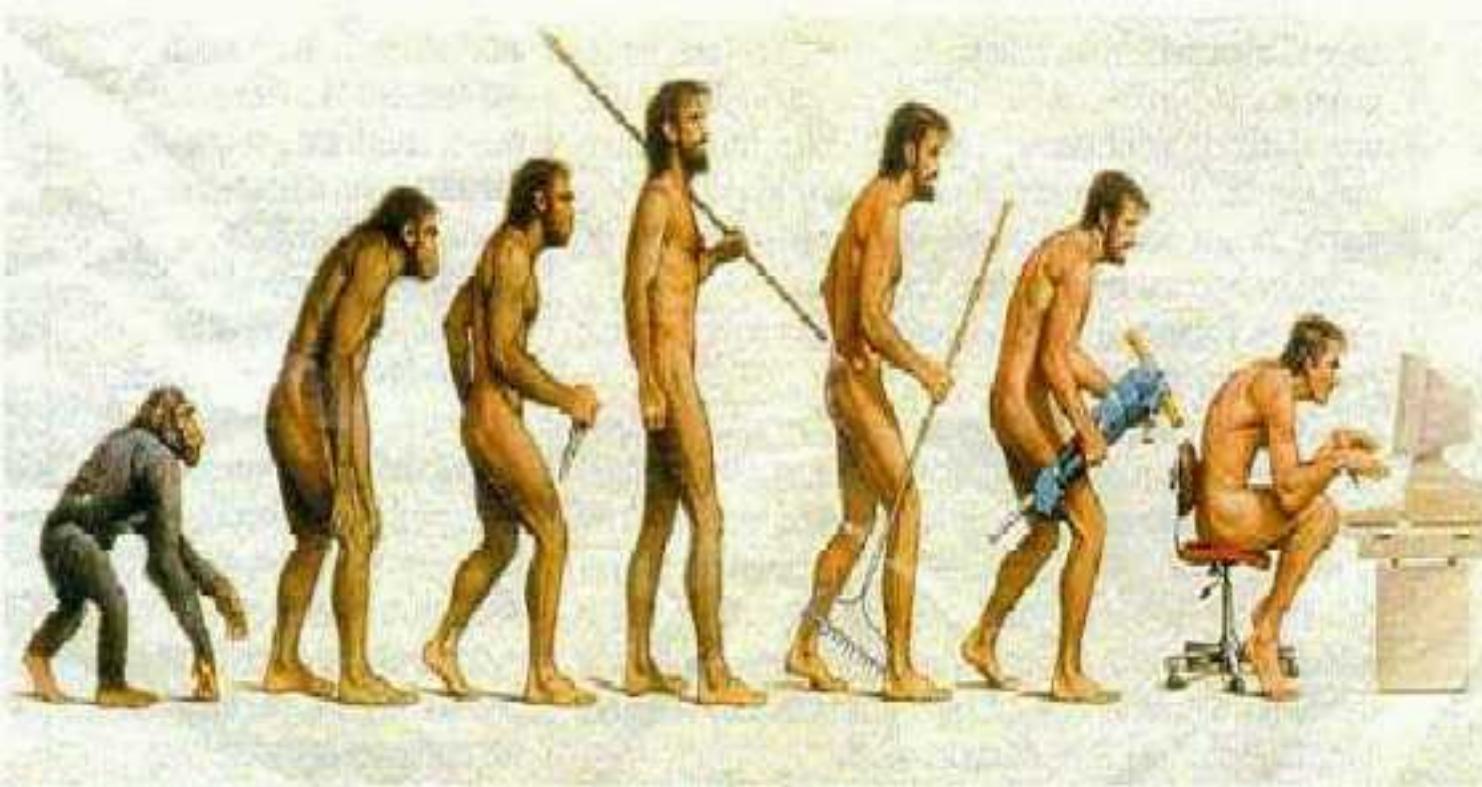




<http://www.flickr.com/photos/rhinman/>



Tools Deliver Benefits



- All tools have an interface





The
University
Of
Sheffield.

© 2017 The



systems Design: HC lecture 1, slide 19



The
University
Of
Sheffield.



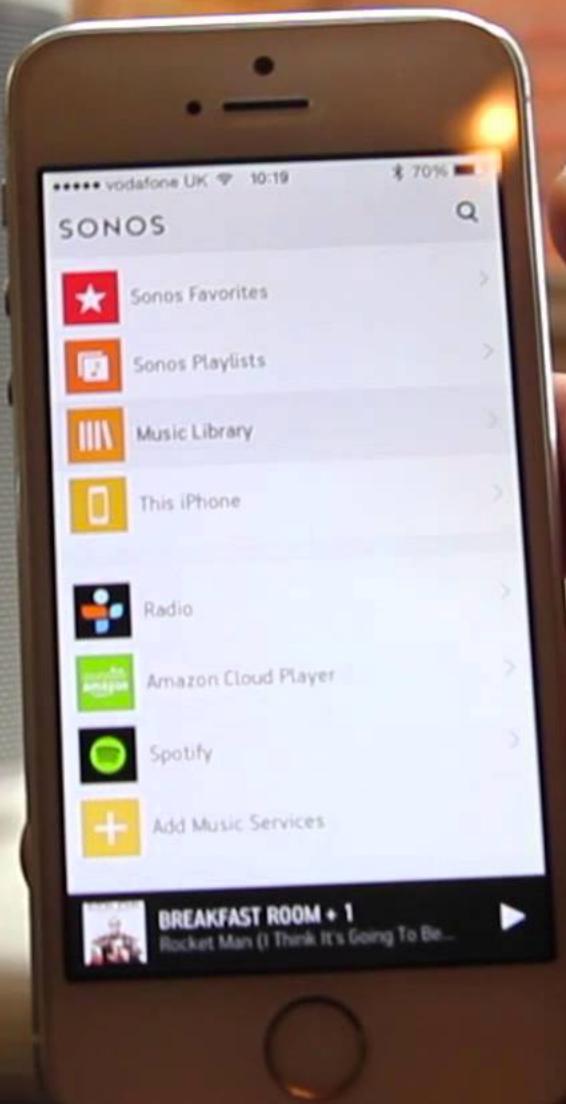
The
University
Of
Sheffield.



The
University
Of
Sheffield.



The
Universi
ty
Of
Sheffield.



amazon echo

Volume ring

Reflex port

Enhances the woofer's output for deeper sounds without distortion

2.5 inch woofer

Delivers deep bass response

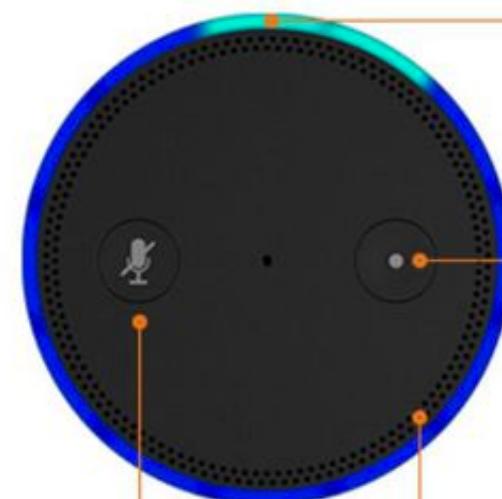
2.0 inch tweeter

Crisply hits the high notes



3.27 in

9.25 in



Light ring

Action button

7-microphone array

Microphone off button



Power adapter

Echo also includes a remote with a built-in microphone and music playback and volume controls.

Some user interfaces



The
University
Of
Sheffield.

Some Modern Interfaces



The
University
Of
Sheffield.

Fitting the Interface to the User



'ergonomic' keyboards

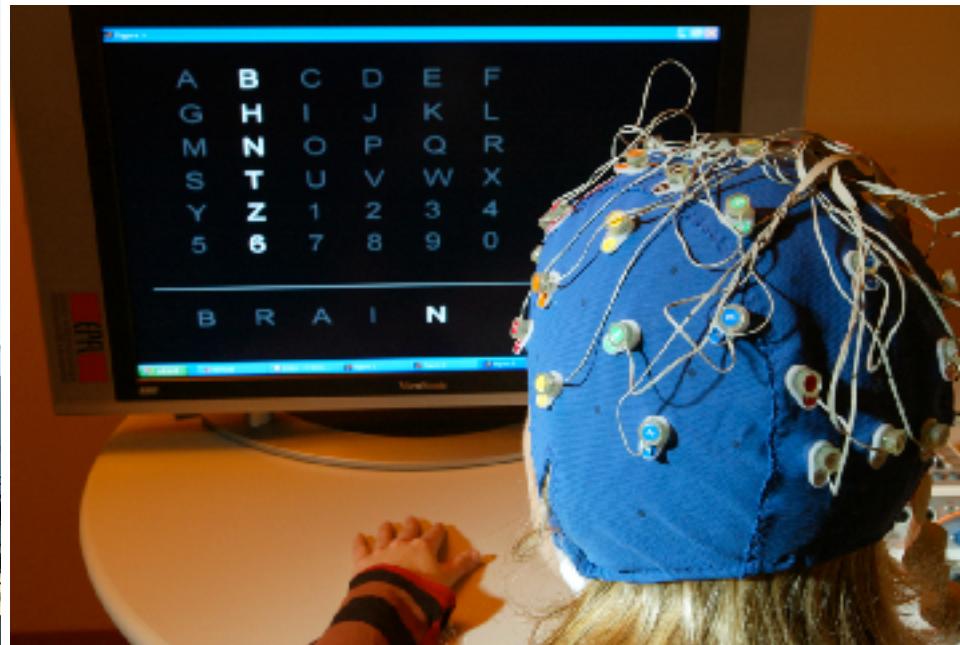


The
University
Of
Sheffield.

Assistive technology



Eye gaze control



Brain computer interface



The
University
Of
Sheffield.

Assistive technology



Voice-control of your environment



The
University
Of
Sheffield.

The Paro Seal



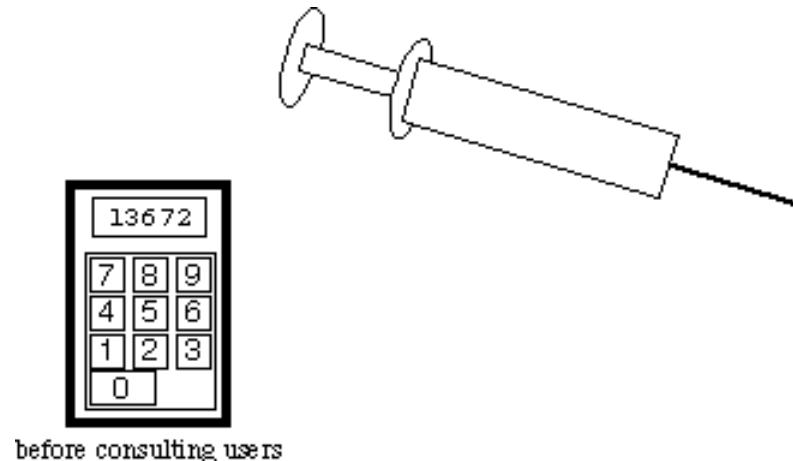


The
University
Of
Sheffield.



Human Centred Design

- For a technology to be successful, it must be:
 - ‘useful’ (*do what’s required*)
 - ‘usable’ (*do it easily and naturally without error*)
 - ‘used’ (*make people want to use it*)
- All *three* must be true
- Basic design steps ...
 - think ‘user’
 - try it out
 - involve the users
 - iterate





The
Universi
ty Of
Sheffield.

Human error



The
University
Of
Sheffield.



Designing for people

- Don Norman: “The behavior we call human error is just as predictable as system noise, perhaps more so: therefore, instead of blaming the human who happens to be involved, it would be better to try to identify the system characteristics that led to the incident and then to modify the design, either to eliminate the situation or at least to minimize the impact for future events”

http://www.jnd.org/dn.mss/commentary_human_er.html





The
University
Of
Sheffield.

Exercise (*work in pairs*)



1. Identify an item which you use that has a *good* user interface design
2. Identify another item which you use that has a *poor* user interface design
3. List the features that make them *easy/hard* to use
4. Be prepared to share your insights with the class

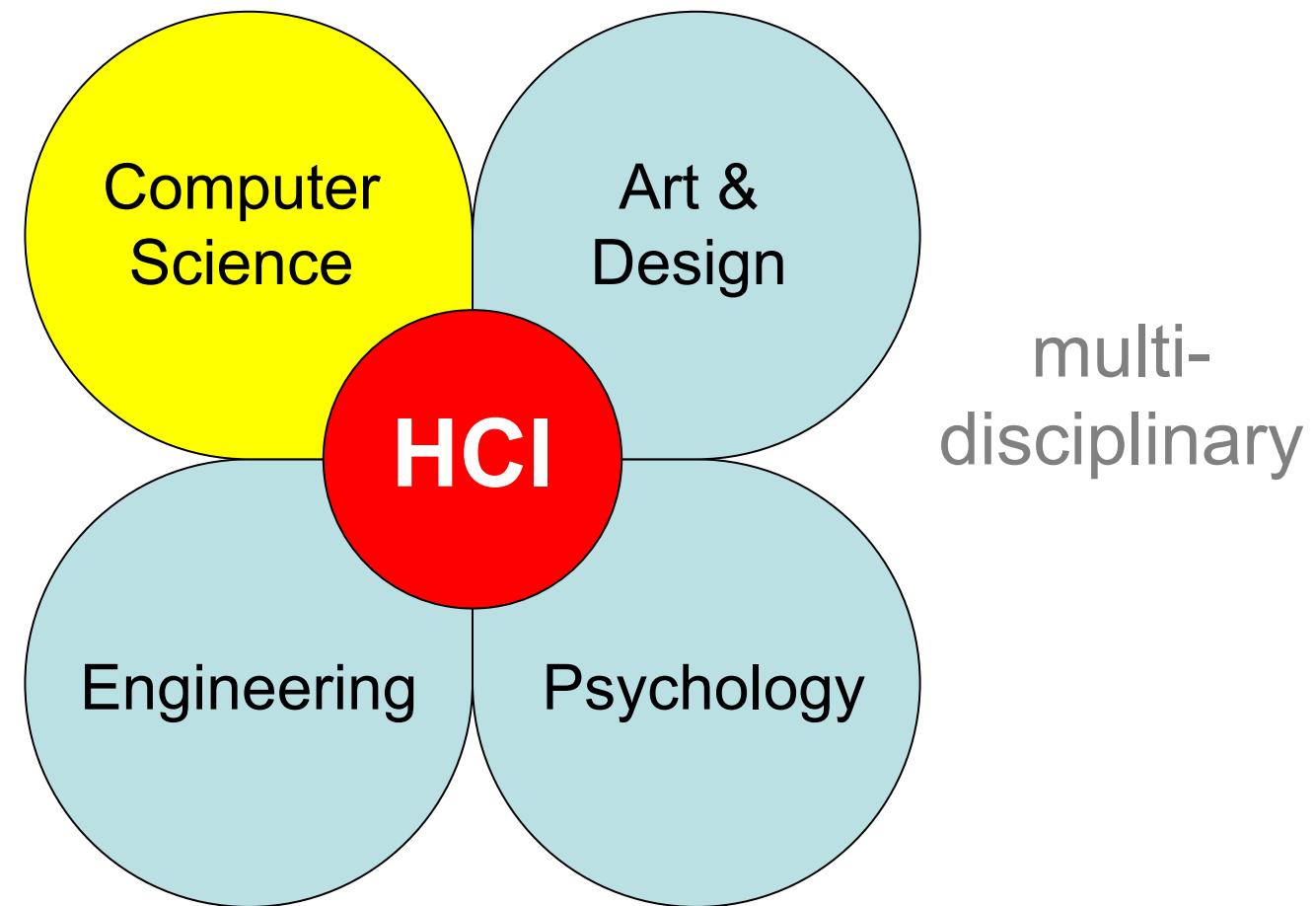


User Interaction Design

- Human-Computer Interaction (*HCI*)
 - Man-Machine Interaction (*MMI*)
 - Human-Machine Interaction (*HMI*)
 - Human-Robot Interaction (*HRI*)
- HCI is related to ...
 - ergonomics
 - human factors
- HCI is ...
 - a **science** (*functional, utilitarian*)
 - a **craft** (*imaginative, aesthetic*)



User Interface Design



The
University
Of
Sheffield.

Like architecture?

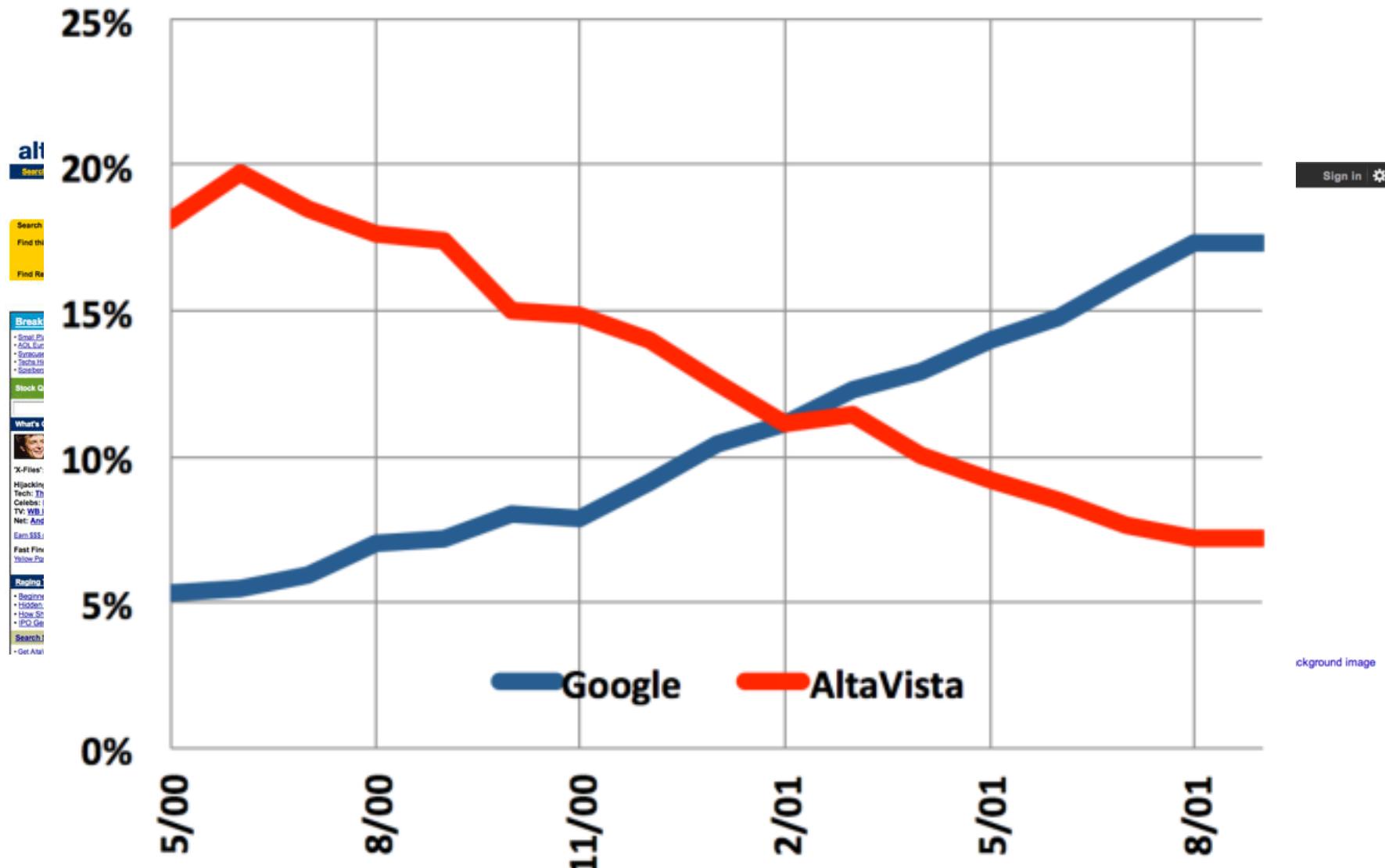


Øresund Bridge



The
University
Of
Sheffield.

Search engine history



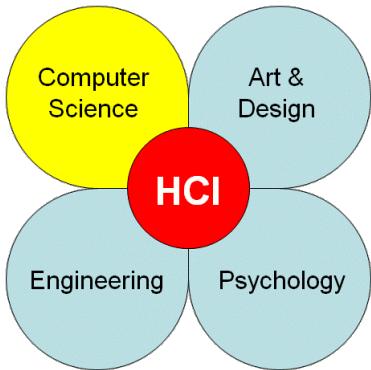
The
University
Of
Sheffield.

5 minutes break



The
University
Of
Sheffield.

User Interface Design

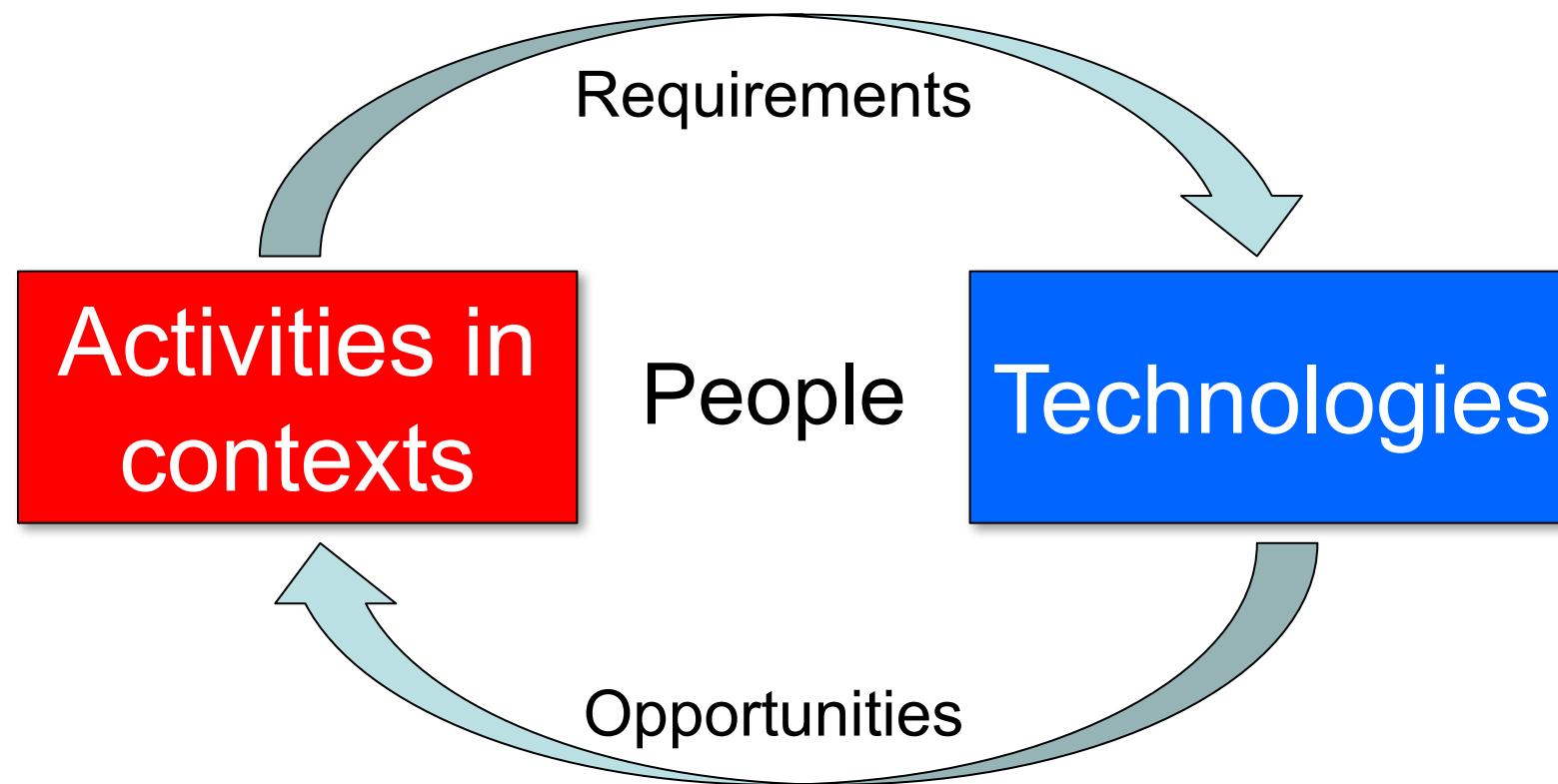


- There is no general unified theory of HCI
- An underlying principle ...
 - people use technologies to accomplish **tasks**
- The '**PACT**' design framework ...
 - People
 - Activities
 - Context
 - Technologies
 - *"People use Technologies to undertake Activities in Contexts"*



PACT Framework

“People use technologies to undertake activities in contexts”



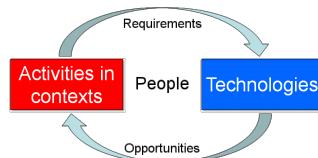
Carroll, J. M. (2002). *HCI in the New Millennium*. Harlow: Addison-Wesley.



The
University
Of
Sheffield.

PACT Framework

“People use technologies to undertake activities in contexts”

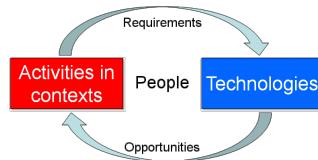


- Teenagers use mobile phones to send text messages to their friends while sitting on a bus
- Secretaries use Microsoft Word to write documents in a firm of solicitors
- An elderly woman presses various buttons to set an intruder alarm in her house
- A university lecturer clicks on a computer keyboard to move to the next slide while giving a lecture



PACT Framework

“People use technologies to undertake activities in contexts”

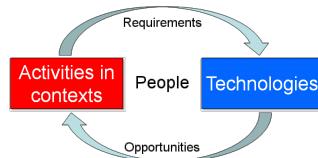


- **Teenagers** use mobile phones to send text messages to their friends while sitting on a bus
- **Secretaries** use Microsoft Word to write documents in a firm of solicitors
- **An elderly woman** presses various buttons to set an intruder alarm in her house
- **A university lecturer** clicks on a computer keyboard to move to the next slide while giving a lecture



PACT Framework

*“People use technologies to undertake **activities** in contexts”*

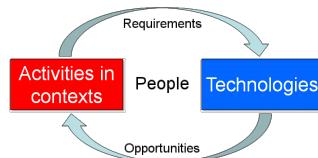


- Teenagers use mobile phones to **send text messages** to their friends while sitting on a bus
- Secretaries use Microsoft Word to **write documents** in a firm of solicitors
- An elderly woman presses various buttons to **set an intruder alarm** in her house
- A university lecturer clicks on a computer keyboard to **move to the next slide** while giving a lecture



PACT Framework

“People use technologies to undertake activities in contexts”

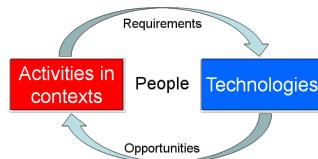


- Teenagers use mobile phones to send text messages to their friends while **sitting on a bus**
- Secretaries use Microsoft Word to write documents **in a firm of solicitors**
- An elderly woman presses various buttons to set an intruder alarm **in her house**
- A university lecturer clicks on a computer keyboard to move to the next slide while **giving a lecture**



PACT Framework

*“People use **technologies** to undertake activities in contexts”*



- Teenagers use **mobile phones** to send text messages to their friends while sitting on a bus
- Secretaries use **Microsoft Word** to write documents in a firm of solicitors
- An elderly woman presses various **buttons** to set an intruder alarm in her house
- A university lecturer clicks on a **computer keyboard** to move to the next slide while giving a lecture



Top 10 Technologies for 2015



1. Computing everywhere
2. The Internet of Things
3. 3D printing
4. Advance, pervasive and invisible analytics

“ ... Gartner predicts an increased emphasis on serving the needs of the mobile user in diverse contexts and environments, as opposed to focusing on devices alone.”

<http://www.gartner.com/newsroom/id/2867917>



The
University
Of
Sheffield.

PACT Framework

“People use technologies to undertake activities in contexts”

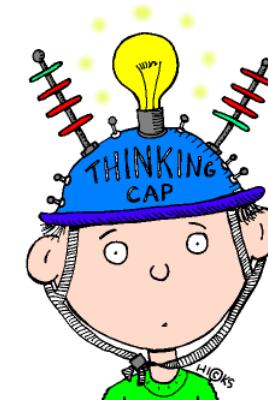
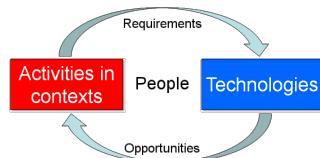
- Activity ...
 - watching a film
- The people involved ...
 - individuals
 - couples
 - families
- New technologies ...
 - VCRs ⇒ DVDs ⇒ 3D ⇒ Mobiles
- The changed context ...
 - in the cinema ⇒ at home ⇒ in the cinema



Exercise (*work in pairs*)

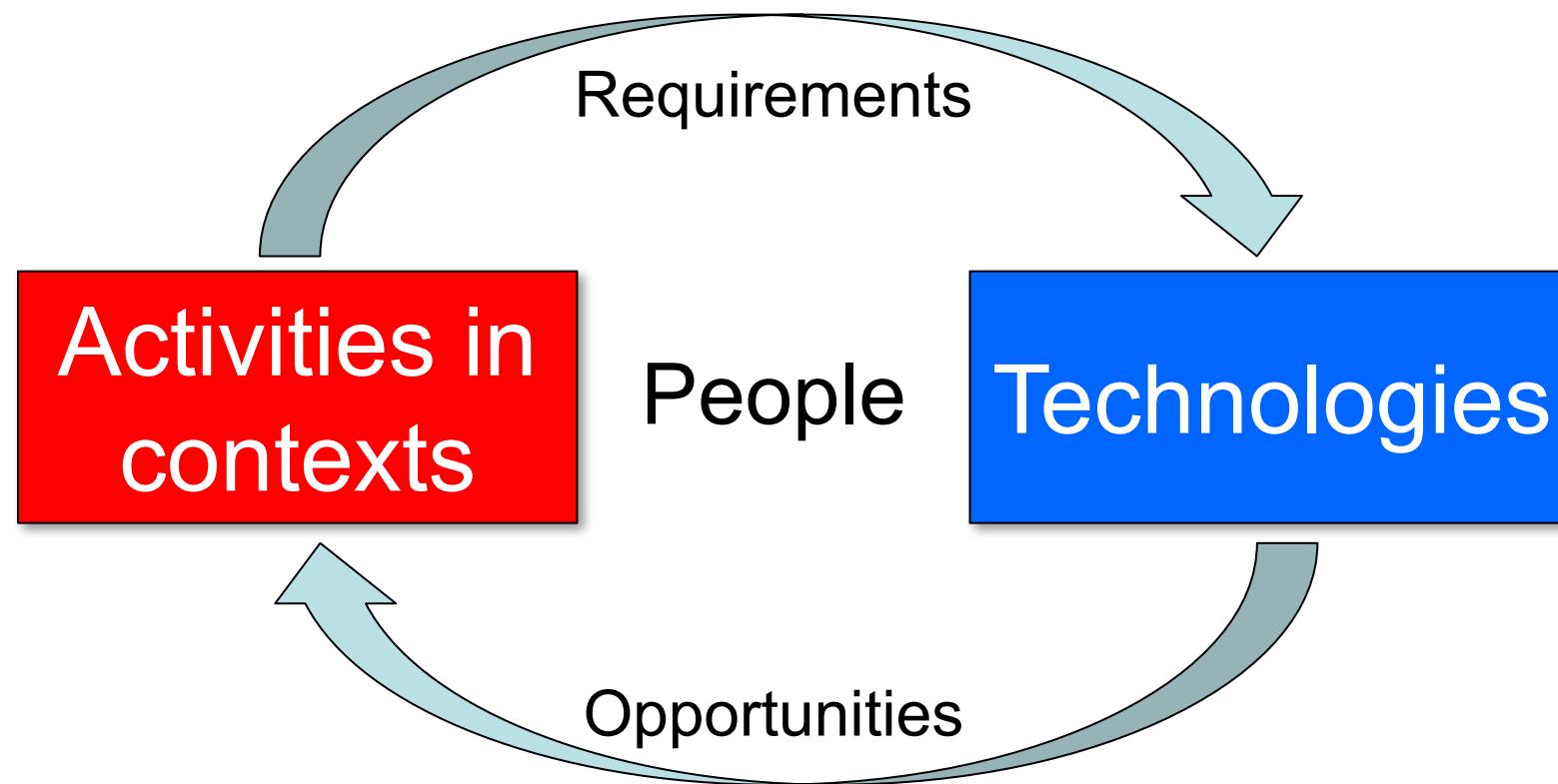
“People use technologies to undertake activities in contexts”

1. Think of an **activity**
2. Who are the **people** involved?
3. List some ways in which the activity has changed with the introduction of new **technology**
4. How has the **context** changed? What new opportunities have arisen?
5. Be prepared to share your insights with the class



PACT Framework

“People use technologies to undertake activities in contexts”



Carroll, J. M. (2002). *HCI in the New Millennium*. Harlow: Addison-Wesley.



Colour and sound...full-size moving-key keyboard...

16K or 48K RAM...high-resolution graphics...

```
TI BASIC READY
>10 PRINT "HELLO WORLD!"
>RUN
  HELLO WORLD!
 ** DONE **
>■
```

compared to £125 for the 16K RAM model.

available now
usively for use
range of
ter offers
the full ASCII
cluding lower-case
resolution

re is COPY,
ctly what is on
without the
uctions. Printing
ers per second,
per line and
ach.
connects to the
trum and a roll of
(in wide) is
full instructions.
paper are avail-
rolls.

interface board
0, this interface
ear—will enable
ZX Spectrum to a
ers, terminals and
the astonishingly
only because the
are already
OM.

ZX Microdrive – coming soon
Designed exclusively for use
with the ZX Spectrum, the new
ZX Microdrives will revolutionise
personal computing.

Each Microdrive can hold up to
100K bytes on a single interchangeable
microfloppy – with a transfer
rate of 16K bytes per second. And
you'll be able to connect up to 8
ZX Microdrives to your ZX Spectrum –
they're available later this year, for
around £50.

**Professional performance
for only £125 – how's it done?**

Quite simply, by commitment
and design. Timex and ICL are
adopting Sinclair technology and
Sinclair BASIC under licence for
future products. Sinclair is now
world leader in personal computer
production.

Key features of the Sinclair ZX Spectrum

ASCII character set – with upper-
and lower-case characters.
Teletext-compatible – user software
can generate 40 characters per line
or other settings.
High speed LOAD & SAVE – 16K in
100 seconds via cassette, with
VERIFY and MERGE for programs
and separate data files.
Sinclair 16K extended BASIC –
incorporating unique 'one-touch'
keyword entry, syntax check, and
report codes.



Sinclair ZX Spectrum

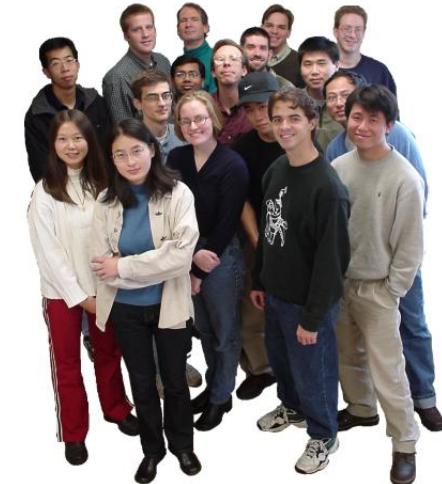
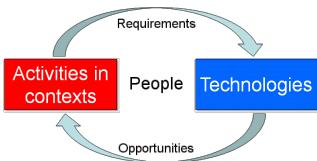
From only £125!



The
University
Of
Sheffield.

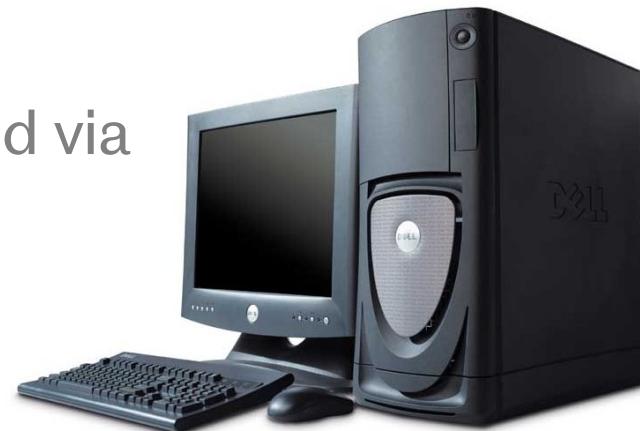
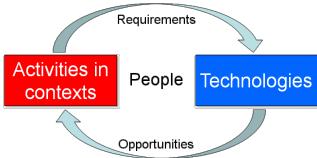
‘People’ (users)

- Human beings are *limited* in their capacity to process **information**
- Information is ...
 - transmitted and received via a range of **sensorimotor** channels
 - stored in memory
 - processed
- Human behaviour can be ...
 - influenced by other factors (e.g. *emotion*)
 - highly **individual**



‘Technology’ (*computers*)

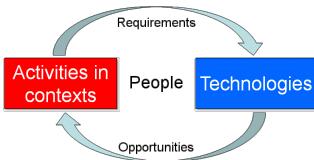
- Computer-based systems are *designed* to process **information**
- Information is ...
 - transmitted and received via a range of **input/output** channels
 - stored in memory
 - processed
- Computer behaviour can be ...
 - reliable and predictable
 - highly **complex**



'Activities'

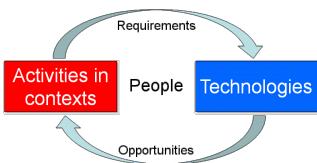
Designers need to consider the following characteristics of an activity ...

- temporal aspects
 - regular vs. infrequent
 - time pressure
 - one-off vs. continuous
 - response time
- cooperation
 - alone vs. with others
- complexity
 - well defined vs. vague
- safety-critical
 - mistakes by users vs. mistakes by system
- the nature of the content
 - large vs. small data requirements



'Contexts'

- Physical
 - location of the activity
 - characteristics of the environment
- Social
 - training manuals, tuition or experts available
 - privacy issues
 - social norms
- Organisational
 - effect on workflow
 - effect on jobs



‘People’

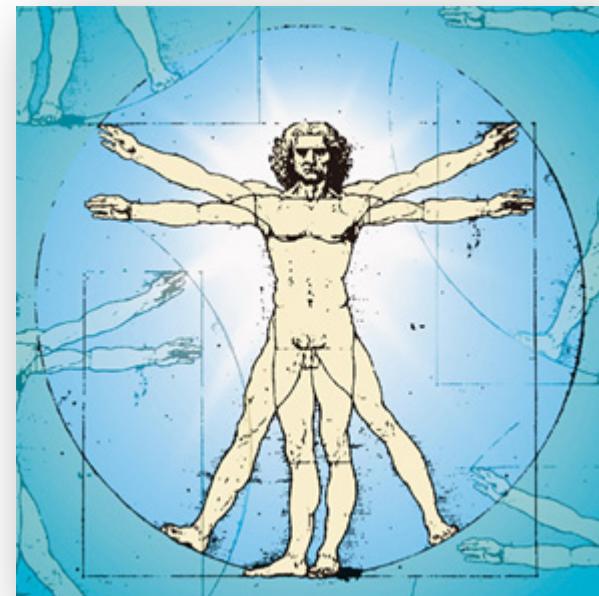
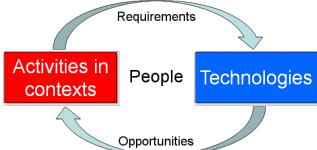
Human sensorimotor channels

– ‘**sensors**’ ...

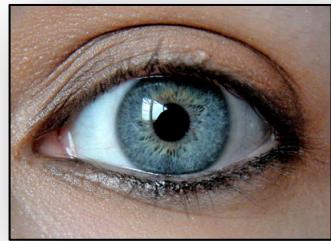
- sight
- hearing
- touch
- taste
- smell

– ‘**effectors**’ ...

- body
- limbs
- fingers
- eyes
- head
- vocal system



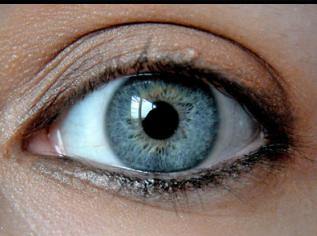
Human Visual Perception



- The ability to read falls off inversely as the distance from the point of focus, so there is a limit on what can be read without moving the eyes
A B C D E F • G H I J K L
- The outer parts of the visual field are very sensitive to movement/change
- There are limits to visual acuity:
 - can detect a line $>0.5'$ of arc
 - can detect a space between lines $>30'$ of arc
- Visual acuity increases with increased luminance (*as does flicker*)
- Flicker is noticeable under 50Hz, and more noticeable in peripheral vision (*so a larger display more likely to be seen to flicker*)



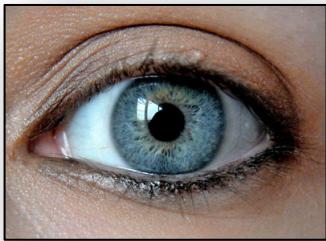
Human Visual Perception



- The perception of an object's size stays constant even if its visual angle changes (*law of size constancy*)
- 8% of males and 1% of females are **red-green** colour blind
- Negative contrast (*dark characters on a light screen*) provides higher luminance (*hence higher acuity and legibility*) than positive contrast (*light characters on dark screen*), but it is more prone to flicker
- People often see what they expect to see (*e.g. the centre of a page is perceived as slightly above the actual centre*)



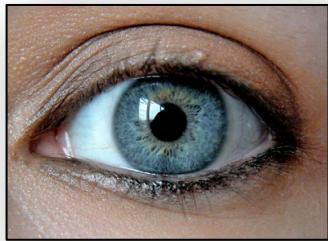
Human Visual Perception



*The quick brown
fox jumps over the
the lazy dog*



Human Visual Perception



- During reading, the eye makes jerky movements called **saccades** followed by **fixations**
- Perception occurs during fixations (*94% of time*)
- The eyes moves backwards (**regressions**) as well as forwards over text; in more complex text, there are more regressions
- Adults read at ~250 wpm, but not letter by letter – they use word shape
- Reading speed is an indication of legibility
- Reading from a screen is slower than reading from a book

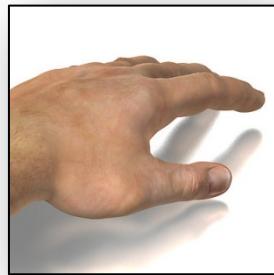


Human Auditory Perception

- The auditory system has evolved for ...
 - acoustic sensing
 - sound localisation
 - communication
- Its main function is **frequency analysis** giving rise to percepts of ...
 - pitch
 - loudness
 - timbre
- The frequency range of human hearing lies between ~20 Hz and ~20,000 Hz
- The ability to discriminate different frequencies varies ...
 - 0.2 Hz at 100 Hz
 - 1.5 Hz at 2000 Hz
 - 30 Hz at 12,000 Hz



Human Touch Perception



- Also known as '**haptic**' perception
- Skin contains three types of sensory receptor ...
 - thermoreceptors (*heat/cold*)
 - nociceptors (*intense pressure, heat, pain*)
 - mechanoreceptors (*pressure*)
- *Rapidly adapting mechanoreceptors* respond to immediate pressure
- *Slowly adapting mechanoreceptors* respond to continuously applied pressure
- Some areas (e.g. *finger tips*) have greater acuity than others (e.g. *forearm*)
- Awareness of the position of limbs is called '**kinesthesia**'



Human Movement



- It takes time for a human being to press a button or pull a lever (*and they may get it wrong*)
- Measures of motor skill ...
 - reaction time
 - accuracy
- There is a trade-off between speed and accuracy (*small distal objects are harder to manipulate than large proximal objects*)
- This is formalised quantitatively by '**Fitts' Law**'





The
University
Of
Sheffield.

Fitts' Law

$$\text{movement time} = a + b \cdot \log_2(1 + \text{distance}/\text{width})$$

So, how long would it take to type a 140 character Tweet on this Blackberry?



Fitts' Law

$$\text{movement time} = a + b \cdot \log_2(1 + \text{distance}/\text{width})$$

$$a = 176, b = 64$$

$$\text{distance} = 1.5 \text{ cm}, \text{width} = 0.5 \text{ cm}$$

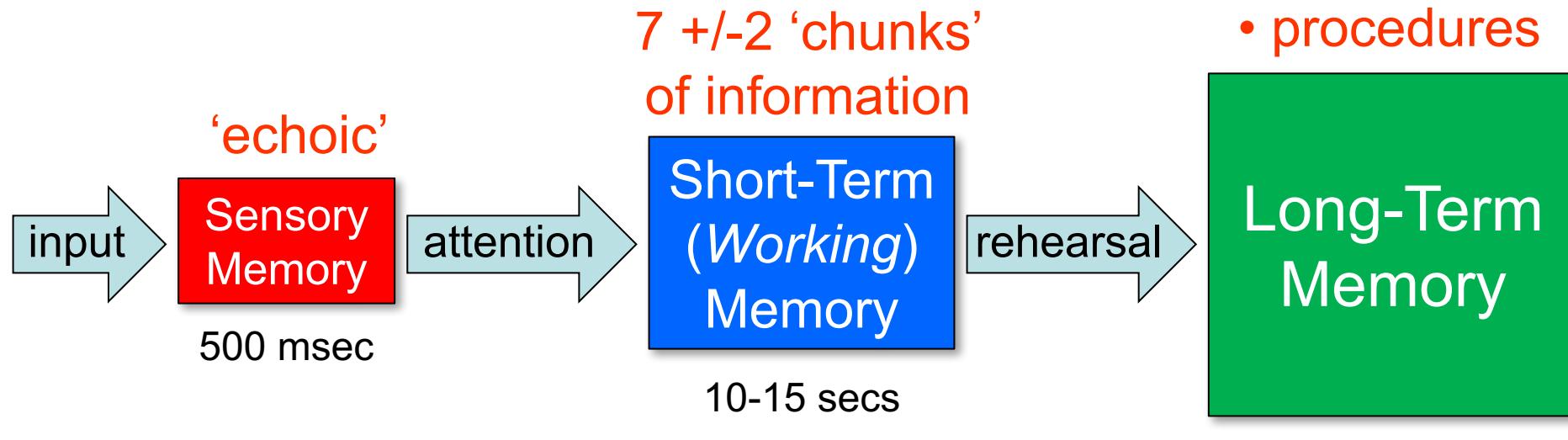
$$\begin{aligned}\therefore \text{time per keystroke} &= 176 + 64 \cdot \log_2(1+1.5/0.5) \text{ msec}s \\ &= 304 \text{ msec}s\end{aligned}$$

$$\begin{aligned}\therefore \text{time per message} &= 140 * 0.304 \text{ sec}s \\ &= \underline{\underline{43 \text{ sec}s}}\end{aligned}$$



Human Memory

- facts
- experience
- procedures



265397620853

0114 222 1950

HEC ATR ANU PTH ETR EET
THEC ATR ANU PTH ETR EE
THE CAT RAN UP THE TREE



Human Memory



“The engines roared above the noise of the crowd. Even in the blistering heat people rose to their feet and waved their hands in excitement. The flag fell and they were off. Within seconds the car pulled away from the pack and was careering round the bend at a desperate pace. Its wheels momentarily left the ground as it cornered. Coming down the straight the sun glinted on its shimmering paint. The driver gripped the wheel with fierce concentration. Sweat lay in fine drops on his brow.”

What colour was
the car?

If you can answer, then you have visualised the scene and embellished it with additional information!



The
University
Of
Sheffield.

Human Reasoning



- Types of reasoning ...
 - ‘deductive’ (*logical reasoning*)
 - ‘inductive’ (*generalisation, inference*)
 - ‘abductive’ (*inferring causes*)
- Problem solving
- Learning
- Mental models
 - incomplete (*some parts understood better*)
 - unstable (*details are forgotten*)
 - difficult to distinguish (*similar devices get confused*)
 - unscientific (*motives attributed to inanimate objects*)



Emotion



- Emotion can colour judgement
- People may perform less well under stress
- Negative '**affect**' can make it harder to perform even easy tasks
- Positive affect can make it easier to perform difficult tasks
- Recent years have seen a growth in '**affective computing**'



Picard, R. W. (1997). Affective Computing: MIT Press.



The
University
Of
Sheffield.

Individual Differences



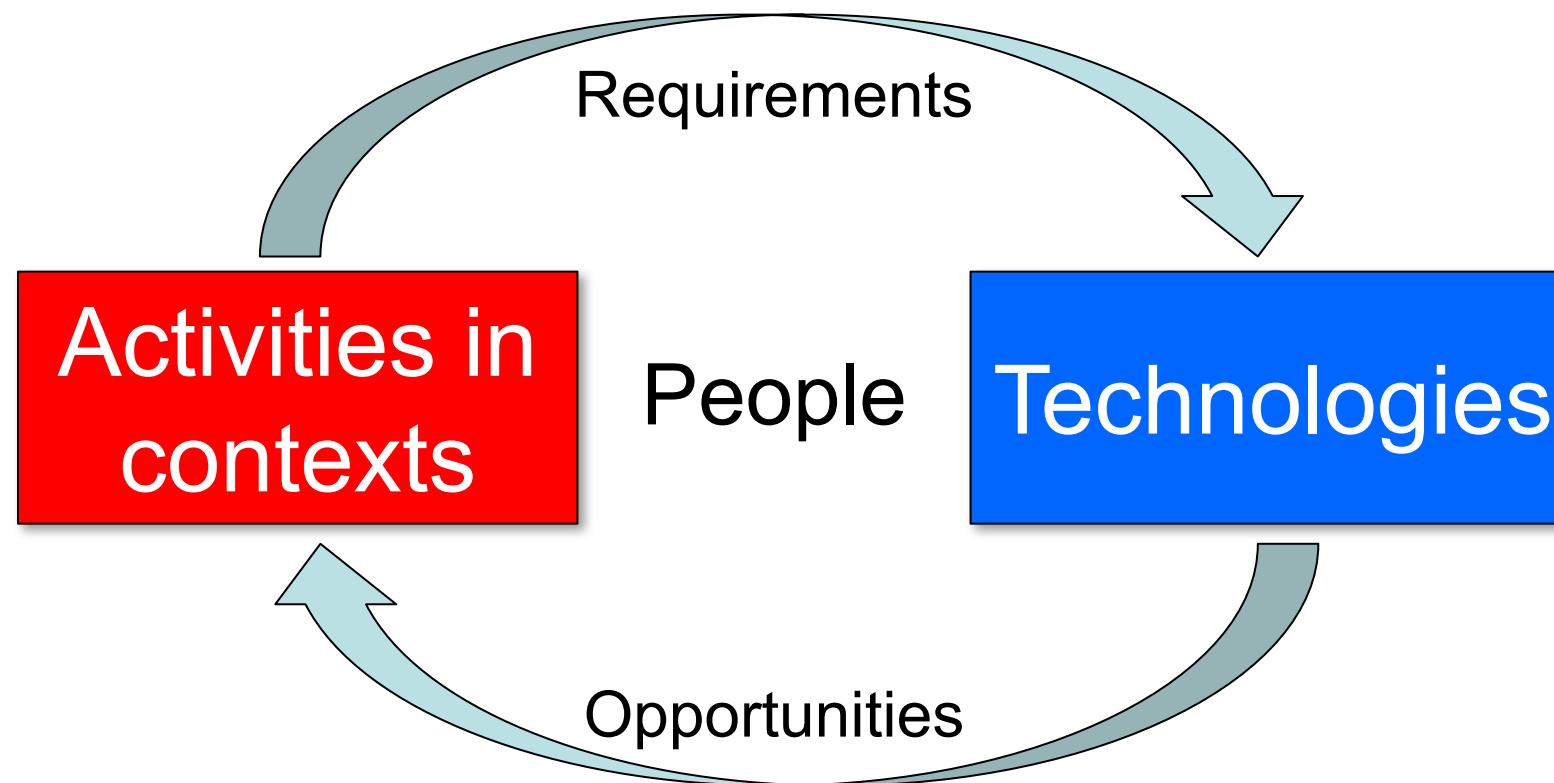
People (*users*) are not all the same ...

- ‘culture’ differences
- ‘gender’ differences
- ‘physical’ differences
(e.g. *age, height, disability*)
- ‘intellectual’ differences
(e.g. *knowledge, skills*)
- ‘psychological’ differences
(e.g. *personality*)
- ‘physiological’ differences
(e.g. *illness*)



Human Centred Design

“People use technologies to undertake activities in contexts”

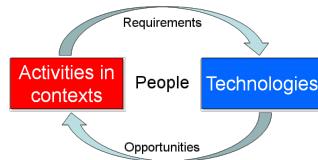


Carroll, J. M. (2002). *HCI in the New Millennium*. Harlow: Addison-Wesley.



Exercise (*work in pairs*)

“People use technologies to undertake activities in contexts”



1. Imagine that you have been asked by the Department to consider developing a system for controlling access to the research laboratories
2. Perform a **PACT** analysis ...
 1. who are the **people** involved?
 2. what is the key **activity**?
 3. what is the social/organisational **context**?
 4. what **technology** would be appropriate?
3. Be prepared to share your insights with the class



This lecture has covered ...

- Technology & tools
- Interfaces
- User interface design
- The PACT framework
- Human information processing
 - sensorimotor channels
 - Perception
 - movement
 - memory & reasoning
 - emotion & individuality



Any Questions ?

(heidi.christensen@sheffield.ac.uk)



The
University
Of
Sheffield.

Next time ...

Human-Computer Interaction



The
University
Of
Sheffield.