1 Thought Experiment

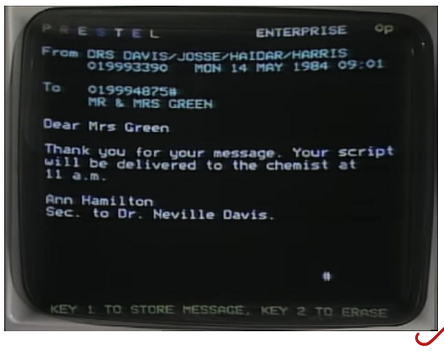
Find an example of an interface from each of the waves of HCI (ideally with similar areas of application). Next, identify the target users and their characteristics for each. What fundamental changes appeared about the user personas? Are there any patterns you could identify in each wave? What could be the next wave of HCI? (Feel free to skip answering the last one, but its worth thinking about. Hint: look at trends in hardware and software, then think about societal trends surrounding the use of technology. What do people like/dislike? What do companies/providers focus on/fight?)

I will discuss interfaces relating to how people communicated over the internet. Firstly, I will discuss old-fashioned email – non-standard email which users manually configured. In relation to second-wave I'll discuss the modernisation of email in the wake of papers such as "why Johnny can't encrypt", which arose after behavioural scientists realised most people weren't using email correctly. Finally, I'll discuss modern communication apps (social media) which people use to communicate now. This leads onto my hypothesis for fourth-wave HCI.

- In first-wave HCI, systems were designed by experts for efficient completion of well-designed tasks by a small subset of target users. The user-interface was designed as a separate system (if at all) sometimes as an afterthought.

  First Wave HCI is characterised by systems which are extremely efficient for experts doing tasks the designers expected them to do, but very difficult for amateur or casual users or anyone trying to do anything unconventional. UIs almost always had little-to-no visual appeal – that wasn't their intention.

  Consider this example of an email UI from 1984



  The interface contains all the information required to send and receive textual information over the phone line. However, if you wanted to encrypt an email or send an image, the system would be unable to easily support this. Furthermore, to send an email, users must use the command-line and do extensive manual configuration.

- In second-wave HCI, designers realised tasks weren't always well-defined and users weren't always who the software developers expected they would be. This led to the ideas of social science and psychology being incorporated into user-interfaces. Designers would visit, watch and talk to the target users of their systems. This led to surprising revelations, for example: not everyone can use the command line and businesses want to encrypt data.

  Second-wave HCI is characterised by design ethnography – systems aligned well with what users wanted them to do. They often supported more complex operations and made goal-oriented searches easy.

  Consider this email interface from 2004 – towards the end of the second-wave of HCI:

A signal is a specific event which may signal a trend or "opposite of a trend"
For example the IPhone was a signal itself (touchscreens on smartphones)
One signal is "VR being the next reality" -- a negative signal -- the more they understand what companies are doing with them, the next they want their entire world to be owned by someone else.

One trend which could be considered a signal (Computers having User Manuals).
The user of first-wave HCI is a domain expert. They are also a computer expert (or a computer system expert). They are a trained operator of these systems. They have a very specific goal in mind.

Ergonomics is: the area of study of how the indirect needs of users are catered to by systems.
Obvious ones are designing a chair so it supports their back (physical ergonomics).

Second area of first-wave ergonomics: Cognitive ergonomics.
Attention / memory / measurable concepts. Chunking -- "people remember 5 / 7 bits of information".
How much attention people can hold. Empirical studies "ie red being do not touch" -- making sure you need to flick a switch so you weren't afraid of pressing the big-red button a lot. Physical ergonomics, you place the big button far away.
Functional grouping: if you do something in a sequence, put them next to each other
Semantic grouping: if buttons do similar things, put them together.

In First-wave you design for the most generic person and assume they know what they're doing.

Third wave is many users to one computers.

Affordance: the resource that users have, which they intend to spend on an interaction. The amount of effort they intend to use. "How muhc do the users want to afford" (regarding ergonomic aspects" ie if a user has one-hand, then don't make them do a shortcut requiring two hands). another affordance is "people will only spend 5s doing this so don't make it too difficult.

Affordance =/= Compliance budget

Affordances are situational, they're used as a heuristic.

Users in second-wave HCI:
Third wave is one user to one computer.

Diverse group of stakeholders using computers in a work environment. Computers are used to optimise work (which may not be technical). Users may not be domain experts. However, are still likely trained. Computers are used for a more broad range of tasks.

Accessibility concerns. Ergonomic keyboards to operate on a computer. Interfaces are becoming more learnable and usable.
One of the nice dimensions of comparison between all the waves of HCI are "how many people use a system". In first-wave you have many users for a system. In second-wave a single person has a single system (everyone has their own work station).

Personalisation/Customisation: try to cater to what people like in order to increase their affordances.
Designing with affordances in mind: originally required a perfectly describable user who acts empirically.
In second-wave, we don't need to encode these things into this. Because people are different. The purpose behind customisation/ personalisation was relinquishing the rights of the designer to say "this is the perfect user", and to say that "the user is the only person who knows themselves". This was a massive wave. This brought it away from and brought it towards "having a reliationship" with a computer -- having your own system rather than sharing it. An efficiency built into the user.

The original way was "there is this specific keypress and button press" -- you have to remember the exact vocabulary.

Learnability and usability became prevenant in second-wave.
Microsoft office in the 1990s: all look fundamentally the same. Most buttons have the same behaviour. It was all consistent. Therefore, users started becoming a part of the system. (reference to learnability / usability)

Third wave HCI:
Business software hasn't changed much since second-wave.
Third wave is one user to many computers.

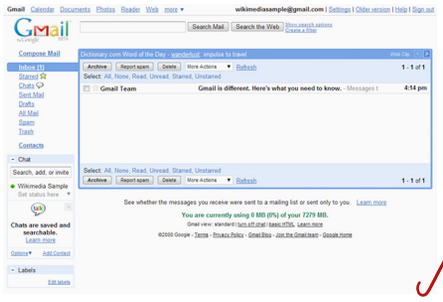
Now usage is discretionary. Efficiency / speed / accuracy / precision is less important. Tasks did not have a strong definition -- ie video sharing, talking to people. No specific goal in mind.
In third wave: "we need science, spreadsheets, social media" etc.
The Internet was the biggest signal in HCI and continues to be in wave 3.5.

People using third-wave HCI are not trained to use systems. There is a learning curve, but you assume they don't need to go through hours and hours of training -- UIs are learnable -- not trainable. Interfaces are now ubiquitous.

Lecture notes describe "art philosophy"... this is wrong. People use nicer colours because there are more colours and there are so many things that you need to start adding colour. More "redundant and non-content elements" start becoming important parts of design.
This isn't new. The idea of non-content advertising has always been there in ie perfumes. This is what happens when everything is practically the same.

Fourth wave HCI:

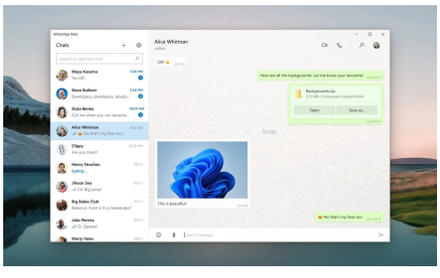
Fourth wave is software-based rather than hardwave based. Computers are now getting closer to many-to-many. Users collaborate. If a product isn't collaborative it doesn't gain traction. Software is the main product. Hardware is not the main product.



Although the underlying technology hasn't changed much, this interface provides far more functionality and aligns far better with what businesses want. Encryption is built-in (when sending internal emails) and users can send files of any sort (with size restrictions). Users can also organise their emails and get notifications when they receive a new email – functionality the old service did not provide. However, it's visually unappealing. The interface is bland.

- Third-wave HCI arose as a result of ubiquitous computing. Once everyone started using computers everywhere, for everything, the focus of UIs was no longer to maximise functionality but to give users the best experience. Designers started to come from artistic backgrounds.

  Third-wave HCI designs are characterised by pretty, artistic designs which are often less efficient or provide less functionality than either of the two previous waves.



- My prediction for fourth-wave HCI is personalisation and customisation.

  I believe we are at a first-wave HCI point with visual appeal. In first-wave HCI, functionality was designed for a specific target user to maximise their efficiency on very specific tasks. Second-wave HCI realised this model was wrong and resolved this by ethnography to discover who the *real* users were and what they *really* wanted.

  Third-wave HCI designs interfaces to visually appeal to a specific target user who wants specific things. As second-wave HCI can attest to (with regard to functionality), this model is wrong. However UIs work on internet-scale, so it is infeasible to perform ethnography – no user group would be properly represented and many would be completely missed. I believe the solution to this is high personalisation and customisation options. Companies have designed their apps and websites to *feel* how they want them to feel – or feel how a "normal" user would want them to feel. However, everyone is different – allowing high customisation would allow people to feel more comfortable on their own computers and phones – an expression of individuality which makes apps better promotes inclusivity.

  The lecturers suggestions about what fourth-wave HCI could involve included positive computing and accessibility.

  I predict that a HCI movement based on accessibility would fail, consider the case study of Rachael; the American Cancer patient who took on large companies to get herself on a medicine trial for her cancer; only *not* to take the medicine (partially) due

to the symbolism it represented. Many people would not turn on accessibility settings because in doing so, they would admit to themselves they had accessibility needs.

Furthermore, I predict that a HCi movement based on positive computing would fail – while the principles are right, the incentives are wrong. Consider the (widely condemned) 2016 Facebook study into what content users engaged with. The findings were that users engaged most with negative content. This is in total contention with the idealistic positive computing HCI revolution.

Personal expression via customisation is a subset of both ideas – but one which has no stigma or wrong incentives.

I believe fourth-wave HCI is likely to be characterised by customisable UIs which allow users to express themselves and *be* themselves – websites which read system configurations and dynamically create a UI which reflects the users preferences. We've seen the start of this wave in the form of support for both dark and light mode.

2 2018 Paper 7 Question 6

https://www.cl.cam.ac.uk/teaching/exams/pastpapers/y2018p7q6.pdf

(a) Explain in general how the actions that a user takes are related to the users goals. Your answer should make reference to the function of perception and to the nature of the cognitive processing that must occur.

There are two main cases.

- When the user does not know how to achieve their goal.

  In this case, the user follows a goal-oriented search. In Computation Terms, this is a best-first search. The cognitive processing required is a series of linear scans and a tree traversal of the UI. A goal-oriented search has four phases:

  - **Goal**

    Formulate what the goal is – this may be the overall goal ie "change my default microphone" or a smaller sub-goal for example "open the control panel".

  - **Availability**

    The user searches the UI for the best match

  - **Match**

    Once the user has found a match, they click on it.

  - **Feedback**

    The user then sees the results of their action and can evaluate how good a move it was.

  However, Goal-Oriented search can fail a number of cases:

  - If the goal is not achievable – this is a degenerate case. In a goal-oriented search the user can never actually tell that the goal is not achievable without enumerating the whole website.
  - If there is a discoverability problem.

    In the availability stage, the user searches for the "best" match. However, if there *is* no match then the user cannot choose the "best" match.

  - If there is a feedback problem.

    In the final stage of goal-oriented search, the user evaluates the success of the action and considers whether to continue or backtrack. However, if there *is* no feedback then the user cannot evaluate the success of the action.

  - Yak Shaving

    In some cases, the goal-oriented search will segment the original task into so many sub-tasks that the user will go on large tangents and forget what the original task was and what the larger sub-tasks were.

- When the user knows how to achieve their goal

  The user knows how to achieve their goals and can proceed without need for a goal-oriented search. In this case, the user performs the action with minimal cognitive processing.

  If the user has *no muscle memory* and must still search for the item – for example when following a guide. Then the time taken to perform the task can be estimated by Fitts' Law. This forms an expression for the time required to point to something:

$$t \propto k \cdot \ln\left(\frac{2 \cdot D}{W}\right)$$

  Where D is the distance to the object and W is the size of the object. The cognitive processing required is that to point to the correct buttons.

  Most humans are satisficers. This means they find a solution which is good enough and never improve upon it. This means many people who "know" how to perform a task don't know the optimal solution. One part of the theory of Bounded Rationality is Attention Investment Theory – this states that people make decisions not based on the overall outcome, but on how much time they have to put into it before they get any benefit. Most people will never learn the most optimal way of doing things even if doing so would increase their overall utility. For example, most users will spend thousands of hours on the web – but never learn shortcuts, instead taking time (determinable by Fitts' Law) to linearly scan through webpages for information rather than learning to use `CTRL-F`.

(b) Describe a class of problems for which it is not possible to formulate goals. Give a specific example of a problem in this class, and with reference to that example, explain how it illustrates *two* significant attributes of the class.

Wicked Problems are a class of (primarily societal and global problems) which cannot be defined due to contradictory, conflicting or changing requirements.

The characteristics of a wicked problem are:

- A Wicked Problem cannot be formulated definitively
- Wicked problems have no stopping rule
- Solutions to wicked problems are not true-or-false but good-or-bad
- Wicked problems have "one-shot-solutions" – there is no opportunity for trial and error as every attempted solution counts signficantly and changes the problem
- Wicked problems do not have an enumerable list of potential solutions
- Wicked Problems are unique
- Wicked Problems are symptoms of another problem
- The cause of discrepancies in wicked problems are open to interpretation; and the interpretation defines the resolution
- Planners have no "right to failure"

A classical example of a Wicked Problems is "solving climate change".

Consider the problem of solving climate change from the perspective of a world leader. The world-leader must implement a policy which will "solve" climate change. However,

Assumptions of goal-oriented search
- the user has a specific goal
- users know how to control the system
  - useful assumption in 1st wave, reasonable in 3rd wave, unreasonable in 3rd wave

Goal-oriented search fails:
- when the description of the user is not good
- when the user "runs out of memory" (yak-shaving)
- affordances comes back -- when the interaction costs more than what the users can afford, failure happens
- When there isn't a goal, it fails
- When there isn't availability (no match) it fails
- when the user DOESN'T UNDERSTAND the feedback

If there was an error in early systems, it was perceived to be the users fault.
In 2nd wave, an error is partially user error, partially systems.
In 3rd wave, if there is an error it's the systems fault. (if the system didn't account for a specific users behaviour it's the systems fault).

Heuristics:

Availability heuristics "what do people understand" -- how do people scan. How do people make sense of information (ie recognisability)

Affective heuristisc: "how do people feel", are they frustrated, does this frustration affect their usage, are they more likely to make mistakes.

Representativeness: When I'm looking at something, does it represent the function I want to do.

A wicked problem:
A problem with no good formulation so no good solution.

Wicked problems are examples of where goal-based approaches don't work. We can't specific a goal-state.
A good counterexample to goal-oriented search working.

People try to solve socio-economic wicked problems by modelling the situation in great depth.
You assume the model is "good enough". Assume this model describes it "well enough" so you can hypothesise about what will / might happen.
Wicked problems are mostly used for socio-economic problems. Within design, the wicked problem is the user. A user fits this description -- the solution is a design that works for the user -- but this is undefinable.
This approach to the design led to the "no model will perfectly design the user".
This allows for multiple models to be true even if they are contradictory.

Bayes Theorem question (and lecture content) is about a recommender system without saying a recommender system.

Systems are defaulted to recommender systems.
Scope:
How many people are considered in the previous events?
Google search uses a generalisable model.
Scope in terms of memory (does your system have short-term or long-term memory).
This comes down to how well you know your user.
A nice example would be youtube video feed.
What makes youtube video feed good is its memory is short. It forgets easliy.
If you go away on holiday and you watch videos it'll show you the same content.
Youtube forgets easily because its deisgned to satisfy people.
This isn't great for email -- you will write multiple styles of emails -- you'd want long-term with a larger scope so you can send both formal and informal emails.

Read through the small grid. The website exam question is about that table.
This is a taxonomy -- a set of graphical resources and a description of how they hold meaning.
This was created as a taxonomy to evaluate designs.
However, this is the LEAST useful way to use this taxonomy.
There is this table. It's a taxonomy to evaluate interfaces (interactive interfaces). It says there are different categories of graphical symbols. It states what modes of correspondence these symbols are.
This means "why does an arrow mean what an arrow means", why does "a symbol mean what it means". It has this symbol because metaphorically "lying in the sky means you put verticality to it". For example there could be qualitative meaning to it. IE you don't inherantly know what a mathematical symbol means.

It describes the use of colours, symbols, surfaces etc.

Originally they thought "this is a great way to evaluate systems".

What might this be better suited to?
Better for designing users (not interfaces). If you can identify what modes of correspondences your user has to understand, your system can be made usable.
Goal-oriented assumes users can use the system.
Modes of correspondences mean you can define what the langauge your user can use is. From this point onwards, everything becomes adjustments. It's so much more effective to "design your user" rather than design the interface.

This aplies to software engineering as well -- don't make sure your comments make sense to you -- they make sense to peple who use it.
When you design an API, you need to make sure the people who will use your API can use it.

it's impossible to evaluate whether or not the policy works – the amount by which the planet warms up is continuous – policies will address climate change to a certain extent. So policies to solve climate change are "good" or "bad". If the policy is deemed to have been "bad", then the world leader will be voted out – therefore they have no "right to failure".

A more computation example of a Wicked Problem would be "setting up Linux without using a guide or wizard". Enumerating the possible layouts of files is impossible. You've got one chance to uninstall Windows and install Linux and if you fail, your computer is permanently damaged and the process of installing Linux has changed. Once a solution is done, there may be arbitrary parts of the Linux Kernel which are not set up – and this may not be discovered for years.

(c) If an interaction system has several alternative models to describe the user's goal, how can Bayes theorem be used to improve the system usability?

Bayes Theorem is:

$$\Pr(x \mid \overrightarrow{x}) = \frac{\Pr(\overrightarrow{x} \mid x) \cdot \Pr(x)}{\Pr(\overrightarrow{x})}$$

We could use each of these models to estimate the probability of the users final goal being x given their inputs $\overrightarrow{x}$. These probabilities could then be aggregated to form a combined metric estimating the probability of the users final goal being x. The system would order these and present the user with a sidebar containing several of the most likely final goals.

Under the "goal-oriented search" model, users linearly scan the page until they find a match for their goal. They then click on it, observe the feedback and repeat, backtracking where necessary. Systems face usability problems when there is no match or there is no feedback. By providing suggestions on the side, we increase the probability of the user finding a match and make usability failures less likely. If the models describing the users final goal were sufficiently advanced, they could take account the users backtracks and failed searches; in this way *every* input would provide feedback and increase the probability of a match (in the form of the sidebar changing).

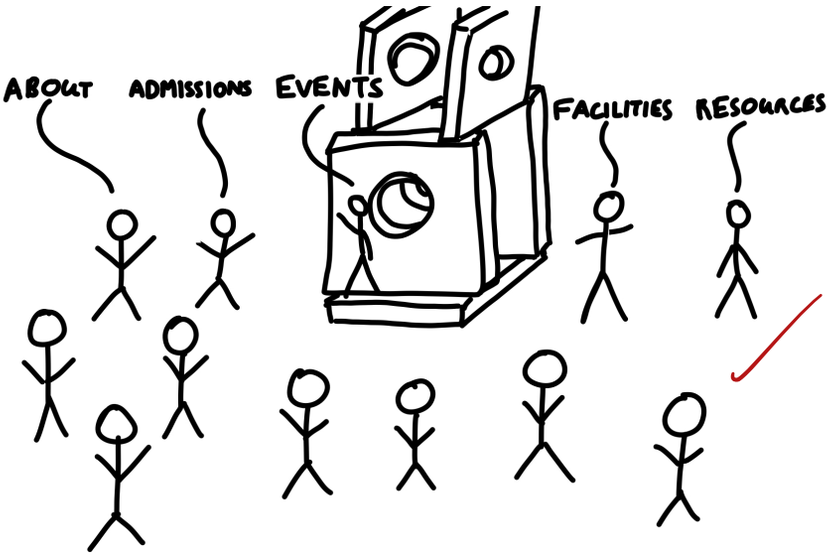
However, this sidebar may appear nondeterminstic from the perspective of a user. So, while it increases usability for amateur users who perform goal-oriented search; the sidebar may decrease usability for experienced users. This could be solved be by adding shortcuts or a "favourites" sidebar for experienced users.

3 2018 Paper 7 Question 7

https://www.cl.cam.ac.uk/teaching/exams/pastpapers/y2018p7q7.pdf

Imagine that you have been asked to implement a radical new design of your college website. The Senior Tutor has decided that, to make the college seem friendlier, the home page and navigation should be implemented using a group photograph of all members of the college that was taken last summer. Your task is to design graphical content that will be overlaid onto the photograph to provide all necessary information and navigation.

(a) Draw a sketch showing the main graphical features of your proposed design. (A few stick figures will be adequate to represent the original photograph. No additional marks will be given for realistic depictions of members of your college.)



(b) Explain how the display pane of the photograph has been segmented in your proposed design, including explanation of any visual marks that were used to achieve this segmentation.

The design pane of the photograph is naturally segmented in two due to the sky and the ground. The website design exploits this natural division by considering the sky to be navigation and the ground to focus on the image – so as not to obscure the friendly faces of college members. Further exploitation of the Gestalt Principle of similarity by making all the labels in the same font helps reinforce to the user that these labels are related to each other and are distinct from the image. Furthermore, this follows *existing conventions* and so users are expecting to find headers – users are used to seeing a natural segmentation between headers and content and this is exploited.

In many interfaces, text is arranged in a grid-like system. Since the website is based around an image, it's impossible to enforce a proper grid without segmenting the image in a visually unappealing way. As a workaround to this restriction, the webpage uses connecting lines (c.f. node-and-link diagrams) to connect the faces of the people involved in a particular aspect of college life to the label linking to the page about that aspect. This aids in horizontal segmentation of the page.

The whitespace between the labels on the top segments the page – inspired by early encyclopedias, this usage of whitespace not to represent a physical aspect of the college; but as a divider increases usability of the page as users are naturally divided. Because English is read left-to-right, top-to-bottom users of the system are likely to perform a linear scan of the page starting in the top-left. It's therefore essential to ensure the page is well-segmented and the usage of whitespace aids this.

(c) Choose *five* specific visual aspects of your proposed design, and for *each* of these five:

(i) Describe the graphical property used to implement this aspect (by reference to your sketch); and

(ii) Explain the mode of correspondence between this graphical property and the meaning that is intended in this aspect of your design.

- Node and Link Diagrams

  The primary visual aspect on the design are node-and-link diagrams. Their usage is a subtle nod towards the technical side of the college (which could hopefully

encourage more applicants). This is intended to connect the labels to the faces in the image and make the college seem more approachable.

- Visual metaphor

  I've decided to literally connect faces to concepts to help work with the visual metaphor of "going up to ask someone about something". Connecting a face to a concept will help cement that the college is comprised of real people and make it less intimidating and more friendly to people considering applying.

- Typography and text

  An essential part of the website is text – while metaphor and revolutionary designs may make the website more appealing and approachable; people accessing the website will be technically adept and creating a conceptually new website would greatly decrease usability. Therefore, I've made sure to layout the labels for concepts across the top – following *established conventions* for typography. This will increase navigability, accessibility and usability.

- Grid Structure

  The main feature which the page relies on for usability is the grid-like structure – even though the main focus is on the webpage, and the labels do not initially appear to be organised (by intentional design), the page itself is segmented into a grid-like structure. This dramatically increases usability – people know where to look for things.

How is this in terms of accessibility?