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.

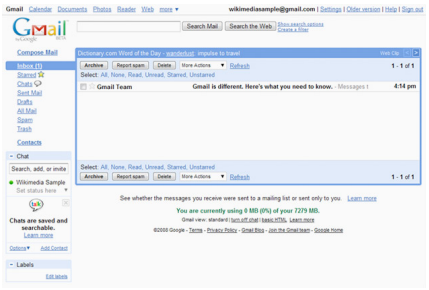
  Consider this example of an email UI from 1984

  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.

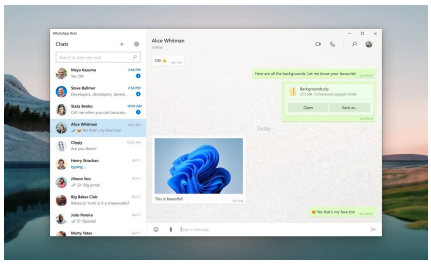
  Consider this email interface from 2004 – towards the end of the second-wave of HCI:



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,

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).

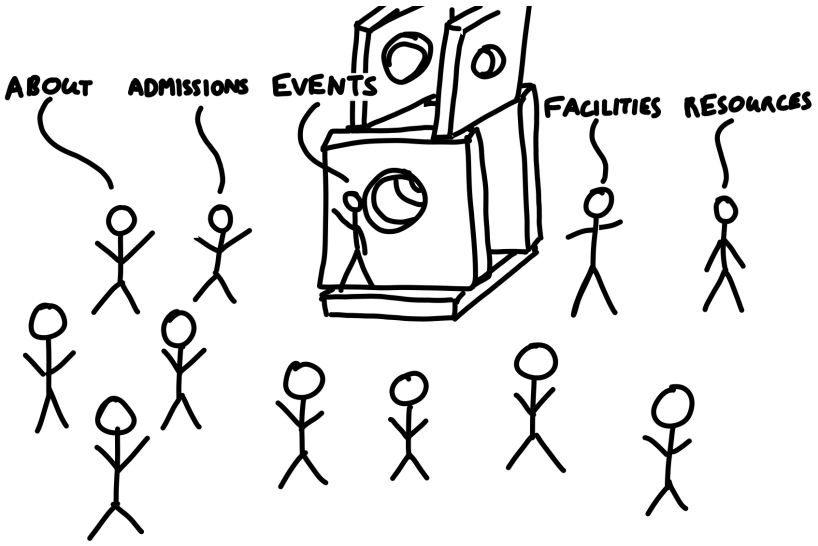
However, this sidebar may appear nondeterminstic from the perspective of a user. So, while it increases usability for amateur users who perform goal-oriented search; the sidebar may decrease usability for experienced users. This could be solved be by adding shortcuts or a "favourites" sidebar for experienced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