What is HCI and why should we learn about it?

1. A few incidents....

2. Consequences of bad user interfaces

3. How can user interface designers determine whether a user interface will cause problems for users?

4. What is HCI?
A few incidents involving badly designed user interfaces

• A professor loses half an hour ❖
• A professor and three staff lose two hours ❖
• Errors are made in presidential elections ❖❖
• An airliner gets shot down ❖❖❖
• A nuclear power plant gets out of control ❖
• ICS 205 students ... ❖❖❖
Proposal Preparation

Applicants preparing proposals for the International Opportunities for Scientists and Engineers Program Announcement (NSF 96-14) should use the 'Proposal Preparation (New)' system. The 'Proposal Preparation (New)' system contains the International Programs Cover Page Addendum.

Login for PI or Co-PI

Last Name: 

Social Security#: [ ] (9 digits)
Privacy Act

PIN: [ ] (4 digits)

Login for Other Authorized Users

If you are not PI or Co-PI, please enter the following in addition to Last Name, Social Security# and PIN.

Proposal ID: [ ] (7 digits)
Proposal PIN: [ ] (4 digits)

If you do not know what your new PIN is or have other questions related to FastLane User Management contact your Sponsored Research Office or equivalent.
How can this problem be prevented?

WebRoster Login

UCNetID: kobsa
Password: ********
Option: WebRoster
Course Code: ICS20
Quarter: Spring 2000
Login

Sorry..

You were able to login successfully, but you do not have permission to access the course roster for the course (ICS205) for the Spring 2000 quarter.
Ready for Copier access.

User Number

---XXXXX

Enter
Consequences of bad user interfaces

Bad interfaces may cause users to

- need more time for performing their tasks
- make more errors
- feel dissatisfied
- need more time for learning how to use the software
- not learn/use the full functionality of the software
- (if given a choice:) refrain from using the software
Good interface design therefore is important for any kind of interactive software, and of *utmost* importance in

- systems with high costs of failure (e.g., nuclear power plants)
- systems with high demands on operators (e.g., rescue coordination centers, combat aircraft, call centers)
- mission-critical systems (e.g., space mission control)
How can user interface designers determine whether a user interface (element) will cause problems for users?

1. **Analyze the interface using "common sense"** ( ?)

   Intuitions can reveal some obvious omissions, confusing and inefficient interaction.
   Many flaws however are not "intuitively" recognizable, even with experience in user interface design.

2. **Develop a theory of "human cognitive processing"**, and use it to predict problems that users will have with the interface

   Was only successful in limited areas so far.
3. Test the interface with users, and watch whether problems can be observed or are reported by users

Tests with 5-8 users already reveal major problems

Generalize the findings from (3) and develop guidelines of what should not be done

+ "Usability Engineering"

How can user interface designers determine whether a user interface (element) will not cause problems for users?
What is Aim of Human-Computer Interaction?

Narrow definition:
The field of Human-Computer Interaction investigates how (single) users can best interact with computers. Particular emphasis is put on

- software aspects (as opposed to the input and output devices and the physical workplace), and
specifically on the layout and operation of the interface ("User Interface Design", "Interface Engineering").

**Broad definition:**

The field of Human-Computer Interaction studies "the people side" in the interaction with computers, including

- users’ mental processes when interacting with computers
- work practices
- training issues
management of computerized work processes

- collaboration in computerized workgroups

- social/organizational aspects

- health issues

This course focusses on user interface design issues, due to their importance and the availability of other ICS courses that focus on other aspects of HCI.
Elements of HCI

1. What are user interfaces?
2. Users are different
3. Factors in HCI
4. Levels of analysis
5. Measurable human factors
6. Disciplines contributing to HCI
7. Integration of usability testing into the software development process
8. Affordances
What are user interfaces?

User interfaces help users interact with programs. Users employ programs for performing their tasks.

+ User interfaces help users *interact with their tasks*.

+ A user interface should not reflect the structure of the underlying program, but the structure of the task domain and/or the task solution process. Users should not interact with the computer, but with their tasks.
Users are different

- Physical work environments
- Tasks
- Cognitive and perceptual abilities
- Personality differences
- Cultural differences
- Disabilities
- Age
# Factors in HCI

## Organizational Factors
- training, job design, politics, roles, work organization

## Environmental Factors
- noise, heating, lighting, ventilation

## Health and Safety Factors
- stress, headaches, musculo-skeletal disorders
- cognitive processes and capabilities
  - **The User**
    - motivation, enjoyment, satisfaction, personality, experience level

## Comfort Factors
- seating, equipment layout

## User Interface
- input devices, output displays, dialogue structures, use of colour, icons, commands, graphics, natural language, 3-D, user support materials, multi-media

## Task Factors
- easy, complex, novel, task allocation, repetitive, monitoring, skills, components

## Constraints
- costs, timescales, budgets, staff, equipment, building structure

## System Functionality
- hardware, software, application

## Productivity Factors
- increase output, increase quality, decrease costs, decrease errors, decrease labour requirements, decrease production time, increase creative and innovative ideas leading to new products
Factors in HCI.

(from Preece et al. 1994, p. 31)
Levels of Analysis in HCI

**Figure 2.4** A model of HCI (adapted from Eason, 1991).
Central measurable human factors for user interface evaluation

- **Speed of performance**
  How long does it take to carry out the benchmark tasks?

- **Error/success rate**
  How many and what kind of errors do people make in carrying out the benchmark tasks? How many tasks were successfully completed?

- **Time to learn**
  How long does it take for users to learn what actions are required to achieve the benchmark tasks?
● Retention over time
   How well do users maintain their knowledge and skills over given periods of time?

● Subjective satisfaction
   How much did users like using various aspects of the system?
Disciplines contributing to HCI

Other contributing disciplines:

- Artificial intelligence
- Linguistics
- Ethnology
The star life cycle (adapted from Hix and Hartson, 1993).
"term that refers to the properties of objects -- what sorts of operations and manipulations can be done to a particular object" (D. A. Norman 1988, The Psychology of everyday things).

- A door affords opening
- A chair affords support

"perceived affordance": the extent to which objects suggest their affordance.
Figure 4.5 The affordance of objects (Gaver, 1991). (a) Door handles; (b) scroll bars (© 1991, Association for Computing Machinery, Inc. reprinted by permission).
Cognitive Elements of HCI

1. Gestalt laws
2. Graphical coding
3. Recognition versus recall
4. Mental models
5. Metaphors
6. Affordances
7. Fitts' law (see menu interaction)
8. Color vision (see color)
Gestalt Laws

Gestalt laws describe regularities of human perception (but do not explain them!)

**Proximity**: objects that are close to each other tend to be seen as a group

**Similarity**: objects of the same shape or color are seen as belonging together

**Closure**: Missing parts of an object are filled in to complete it, so that it appears as a whole.

**Continuity**: lines tend to be seen as continuous, even if they are interrupted

**Symmetry**: regions bounded by symmetrical borders tend to be perceived as coherent figures
Example for the Application of Gestalt Laws

Please answer the following questions based solely on Gestalt laws, the upper-case words in the leftmost box and the proper names in the picture.

1. How many ballots are there?

2. Can George Bush and Art Olivier together be elected for president and vice president?

3. Name all people who can be elected for president and vice president.
Comparison of coding methods (Maguire, 1987)

<table>
<thead>
<tr>
<th>Coding method</th>
<th>Maximum number of codes</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphanumerics</td>
<td>Unlimited</td>
<td>Highly versatile. Meaning can be self-evident. Location time may be longer than for graphic code.</td>
</tr>
<tr>
<td>Shapes</td>
<td>10-20</td>
<td>Very effective if code matches object or operation represented</td>
</tr>
<tr>
<td>Color</td>
<td>4-11</td>
<td>Attractive and efficient. Excessive use confusing. Limited value for the color-blind.</td>
</tr>
<tr>
<td>Line angle</td>
<td>8-11</td>
<td>Good in special cases, for example, wind direction.</td>
</tr>
<tr>
<td>Line length</td>
<td>3-4</td>
<td>Good. Can clutter display if many codes displayed.</td>
</tr>
<tr>
<td>Line width</td>
<td>2-3</td>
<td>Good</td>
</tr>
<tr>
<td>Line style</td>
<td>5-9</td>
<td>Good</td>
</tr>
<tr>
<td>Object size</td>
<td>3-5</td>
<td>Fair. Can take up considerable space. Location time longer than for shape and color</td>
</tr>
<tr>
<td>Brightness</td>
<td>2-4</td>
<td>Can be fatiguing, especially if screen contrast is poor</td>
</tr>
<tr>
<td>Blink</td>
<td>2-4</td>
<td>Good for getting attention but should be suppressible afterwards. Annoying if overused. Limit to small fields.</td>
</tr>
<tr>
<td>Reverse video</td>
<td>No data</td>
<td>Effective for making data stand out. If large area is in reverse video, flicker is more easily perceived.</td>
</tr>
<tr>
<td>Underlining</td>
<td>No data</td>
<td>Useful but can reduce text legibility.</td>
</tr>
<tr>
<td>Combination of codes</td>
<td>Unlimited</td>
<td>Can reinforce coding but complex combinations can be confusing</td>
</tr>
</tbody>
</table>
Mental models

Mental models are representations of the function and/or structure of objects in peoples' minds.

- may be incorrect or incomplete
- can be "executed"
- are analogical representations, or a combination of analogical and propositional representations
- are dynamically constructed when required

Two main types:

- Functional models (good for everyday use)
- Structural models (good for breakdown situations; difficult to acquire from usage experience only)

* Computer systems should be designed in such a way that users can quickly acquire a good functional model of the system which is in accordance with their task model.
Important interaction metaphors

Metaphors constitute the user's *initial* mental model of the system's structure and operation. They should relate to users' past experiences and should be consistent.

- **(Typewriter metaphor):** Evoked easily due to physical similarities. Should be avoided
- **Desktop metaphor:** Currently the predominant metaphor.
- **Book metaphor:** For [hypertext](http://www.ics.uci.edu/~kobsa/courses/ICS205/course-notes/metaphors.htm), hypertext-like online documentation.
- **Filing cabinets:** For online documentation, [system settings](http://www.ics.uci.edu/~kobsa/courses/ICS205/course-notes/metaphors.htm).
Important interaction metaphors

- **Office metaphor**: For collections of documents
- **Library metaphor**: For large collections of documents
- Building metaphors, city metaphors, etc.: for virtual worlds
- **Composite metaphors**
  Combine 2 or more metaphors (like office, file cabinet and desktop)

*The learning and retention of a system's functionality is considerably facilitated by meaningful and consistent metaphors.*
ICS 205

Winter 2001
City metaphor
Input and Output Devices

1. Output devices

2. Input devices

3. Requirements for input and output devices
Output devices

- Desk-bound displays (CRT, LCD, Plasma)
- Portable displays
- Displays in helmets, eye glasses, projections onto retina
- Wall-mounted displays (projections), whiteboards
- Speech Audio
- Non-Speech Audio
- Force output
- Special output devices for people with disabilities (Braille display, speech, etc.)
Cater to variety of possible output devices
Input devices

- Keyboards (QUERTY, Dvorak, chord, numeric)
- Cursor keys
- Mouse (1-3 keys)
- Trackballs, trackpads, joystick, 3D-mouse
- Touch screens
- Speech input
- "Graffiti", handwriting, gestures
- Data gloves, data suits, 3D trackers
- Gaze
• Special input devices for people with disabilities (e.g., foot mouse, head mouse, lip readers, etc.)

+ *Cater to variety*
Requirements for I/O Devices

- Must match the physiological and psychological characteristics of users, their training and their expertise (consider age, impairments, and computer skills)

- Must be appropriate for the user's tasks

- Must be suitable for the intended work environment.
Interaction Styles and HCI Guidelines

1. Interaction Styles
2. Interaction style independent design principles
3. Command interfaces
4. Menu-based interfaces
5. Direct-manipulative interaction