Research on Human Factors
What are Human Factors?

- Human factors:
  - the practice of designing products, systems, or processes to take proper account of the interaction between them and the people who use them.

- Included in Human Factors and relevant for this course is Cognitive ergonomics
  - Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system

- Goals:
  - user-centered design of human-machine interaction and human-computer interaction (HCI);
  - design of information technology systems that support cognitive tasks (e.g., cognitive artifacts);
  - development of training programs;
  - work redesign to manage cognitive workload and increase human reliability.

Research in Human Factors & “Computer Systems”

Overall Goals

- Enhance Performance
- Increase User Satisfaction
- Increase Safety/Reduce Risk
Research in Human Factors & “Computer Systems”

- Achieving these goals requires looking at multiple parts of the techno-human system.

- Using a systematic approach to answer:
  - How do people and the technology interact?
  - What influences this relationship?
  - Why?

Experimental research

- Deliberating: Changing something(s) to see if it causes an action or result.

- Some factors we can (attempt to) control or change in an experiment are:
  - Time of experiment or observation
  - Equipment used
  - Location
  - Temperature
  - Through selection of study participants:
    - Experience
    - Gender
    - Age
  - Learning/time effects (by using control group)
  - Framing (what participant believes is happening)
  - And many more...
Experimental research

- Primary Steps in an EXPERIMENT:
  - Hypothesis
  - Method
  - Collect Data
  - Analyze Data
  - Draw Conclusion
Hypothesis

- States the purpose
- Identifies the variables
- Testable with observation or experimentation

Experimental Hypothesis (simplified)
- Changing a variable(s) will cause a change in another variable(s) (i.e. changing “X” will cause a change in “Y.”)

Example:
- Providing accurate information on physical activity will improve health conditions.
A variable can be defined as a factor or characteristic that changes.

We identify two types of variables
- Independent variable (IV) - The factor you deliberately change.
- Dependent variable (DV) - The factor that you think will change as a result.

Hypothesis: Providing accurate information on physical activity will improve health conditions.
- IV: Accuracy of physical activity
- DV: Health conditions
- These should be defined more formally...
Confounding variables

- There is a third type of variables, the confounding variables
- CV: Extraneous variables that could impact the dependent variable.
- Hypothesis: Providing accurate information on physical activity will improve health conditions.
- We test our hypothesis on two populations of subjects
- The group with better accuracy had improved health
- Can we conclude that the IV has an impact on the DV?
Confounding variables

- Possible Confounding Variables (variables that could also improve health):
  - Is the same physical activity being performed?
  - Are some subjects naturally more fit than others?
  - Do subjects belong to significantly different groups (age, education, etc.)?
  - Were the subjects on medication?
  - Were the subjects already on a program that could alter their conditions?
  - and so on...

- How do we deal with possible confounds?
Confounding variables

- **How do we deal with possible confounds?**

  - Experimental Method must control (hold constant) as many variables as possible so IV is the only thing being changed. i.e. randomize subjects in each class.

  - **OR** have to **ACCOUNT** for the variables you cannot control for.

  - **Without accounting or controlling for other variables, can’t draw valid conclusion.**
Experimental research

- Primary Steps in an EXPERIMENT:
  - Hypothesis
  - Method
  - Collect Data
  - Analyze Data
  - Draw Conclusion
Method

- Method - Operationalize your construct
  - How will you measure your IV if it is a “construct” such as usability, happiness, aggression?
  - Define what are your metrics
- Examples
  - Stress – Elevated hearth rate?
  - Happiness – number of times smiling during conversation?
  - Ask yourself – could this metrics mean something else?
Method

- The method also include the design of the study
- Two-group – compare two “conditions,” (sometimes called levels) of an IV.
  - Control vs Experimental
  - Old vs New
  - Method A vs Method B
  - Pre vs Post
  - etc.
Method

- Multiple-group – compare more than two “conditions,” of an IV.
  - Control vs Method A, B, C, & D
  - Method A vs Method B, C, & D
  - Time A vs Time B vs Time C
  - etc.

- Multi factor – compare more than one IV, each having two or more conditions.
  - We look at each possible combination of variables
Method

- Example - (2x2 factorial design)
  - IV 1 – has two levels
  - IV 2 – has two levels

<table>
<thead>
<tr>
<th>Independent Variable 2</th>
<th>Independent Variable 1</th>
<th>V1- Level A</th>
<th>V1- Level B</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2 – Level A</td>
<td>V1- Level A &amp; V2 – Level A</td>
<td></td>
<td>V1- Level B &amp; V2 – Level A</td>
</tr>
<tr>
<td>V2 – Level B</td>
<td>V1- Level A &amp; V2 – Level B</td>
<td></td>
<td>V1- Level B &amp; V2 – Level B</td>
</tr>
</tbody>
</table>
Method

- Example – does screen contrast affect sleep quality?
  - IV 1 – Sleep: 4 hours & 8 hours
  - IV 2 – Contrast Colors on Screen: High & Low

<table>
<thead>
<tr>
<th>Independent Variable 1 (Sleep)</th>
<th>4 hours Sleep</th>
<th>8 hours Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Contrast Colors</td>
<td>4 hr Sleep High Contrast</td>
<td>8 hr Sleep High Contrast</td>
</tr>
<tr>
<td>Low Contrast Colors</td>
<td>4 hr Sleep Low Contrast</td>
<td>8 hr Sleep Low Contrast</td>
</tr>
</tbody>
</table>
Method

- The method also includes the organization of your participants into each cell/level/group of your design
  - Between Subjects: different sample populations used for each condition or set of conditions
  - Within Subjects: same sample populations used for each condition or set of conditions. Also called “repeated measures”
Experimental research

- Primary Steps in an EXPERIMENT:
  - Hypothesis
  - Method
  - **Collect Data**
  - Analyze Data
  - Draw Conclusion
Collecting Data

- Choose representative sample for your research question (e.g. don’t test contact lenses on people who mostly do not need glasses)

- Potential Biases:
  - Over-incentivizing
  - Social desirability bias
  - Demand characteristics (interpretation)
  - Experimenter effect (expectations)
Collecting Data

- When possible, collect data at same time, location, circumstances, etc.
- Do not assume your participants know what you mean!
  - E.g. on a scale of 1 to 5 how happy are you right now? What is 5?
- Dry-run to identify problems
- IRB approval
- Go forth and gather data
Institutional Review Board (IRB)

- An IRB is an appropriately constituted group that has been formally designated to review and monitor research involving human subjects.

- The purpose of IRB review is to assure, both in advance and by periodic review, that appropriate steps are taken to protect the rights and welfare of humans participating as subjects in the research.

- To accomplish this purpose, IRBs use a group process to review research protocols and related materials (e.g., informed consent documents and investigator brochures)

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* https://www.fda.gov/RegulatoryInformation/Guidances/ucm126420.htm
Institutional Review Board (IRB)

- Do I need IRB approval?
  - Human participants are defined as: living individual(s) about whom an investigator conducting research obtains (1) data through intervention or interaction with the individual; or (2) identifiable private information.

- Data collected via the Internet and computers involves human subjects and is intended for eventual publication purposes, then it requires IRB review and approval.

- If yes, complete the Mandatory Online Certification for Researchers

- Complete the IRB Research Project Application...

* https://www.bellevuecollege.edu/irb/review/*
IRB Research Project Application

There are two forms:

- **Expedite**
  - Present no more than minimal risk to human subjects
  - Review by the IRB chairperson or by one or more experienced reviewers

- **Full review**
  - Expedite case does not apply
  - Takes longer...

**Typical information to be provided**

- A description of the subject selection criteria and rationale for selection in terms of the scientific objectives and proposed study design;
- A compelling rationale for proposed exclusion of any sex/gender or racial/ethnic group;
- The proposed dates of enrollment (beginning and end);
- The proposed sample composition of subjects.
- You may reference grant application/sponsor’s relevant protocol pages and attach as an appendix.
Experimental research

- Primary Steps in an EXPERIMENT:
  - Hypothesis
  - Method
  - Collect Data
  - Analyze Data
  - Draw Conclusion
Analyze Data & Draw Conclusion

- Hypothesis testing can be used to verify the initial hypothesis
- Be careful that: Correlation does not imply causation!!
Analyze Data & Draw Conclusion

- There are several formal methods to analyze causality
- Let’s consider Granger causality
- Given two variable X1 and X2, we want to know if X1 “causes” X2
- X1 and X2 are two time series that evolve over time
- The model assumes
  - Covariance stationarity
  - Data can be described accurately by a linear model
- Let’s continue on the blackboard...
Challenges

- Challenges with Experimental Research in Human Factors Field
  - REALLY tough to control variables in the “real world.”
  - Going to “lab” means findings not always ecologically valid