

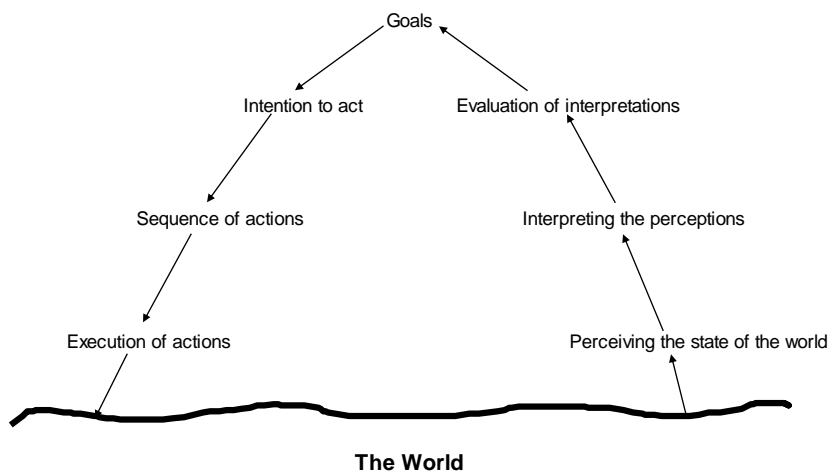
User-centered design

- Theme - “*know thy user, honor thy user*”
- Involves four major components:
 - Early focus on user and task
 - Empirical measurement
 - Iterative design
 - Participatory design

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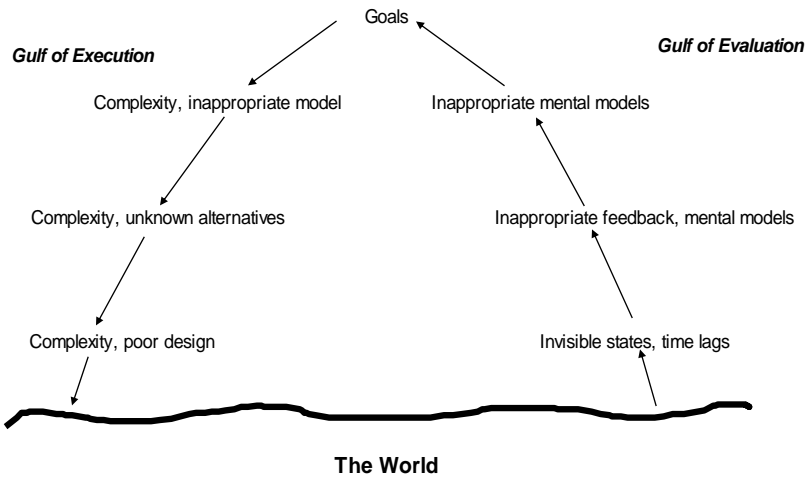
Norman's Theory of Action



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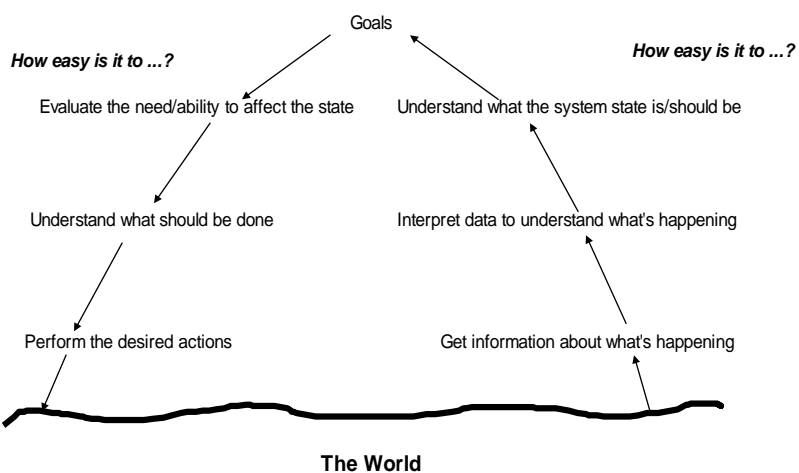
“Gulfs” of evaluation and execution



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Design to “bridge the gulfs”



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To explore further ...

- Norman, D.A. (2005) *Human-Centered Design Considered Harmful*, http://www.jnd.org/dn.mss/human-centered_design.html
- Norman, D.A. (1988) *The Design of Everyday Things*. New York: Doubleday (originally published as *The Psychology of Everyday Things*. NY: Basic Books.)

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Human factors research

- What can we measure?
 - Attitude and motivation
 - Preferences
 - Knowledge
 - Skills and abilities (physical and mental)
 - Aptitude and potential to perform/succeed
 - Emotion (happy, sad, mad, excited, tense)
 - Physiological states
 - Behavior
 - Performance

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Research methods in human factors engineering

- Basic vs Applied

- Definitions:



- In reality, research falls along a continuum ...

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Dimensions of research methodologies:

- Tradeoff: Experimental Control vs Real-World Relevance

- Degree of Control:

- over conditions of observation
 - over "treatment" (independent) variables

- Degree to which behavioral (dependent) variables are representative of some larger population

- Will the results "scale up" to complex real-life situations?

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Research methodology “in a nutshell”

- Define problem and hypotheses
 - What questions do you want to answer?
 - What cause/effect relationships do you expect to see?
- Specify the experimental plan
 - Independent variables (Treatment):
 - Dependent variables (Effect):
 - Experimental design:
 - Specifics:

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Research methodology “in a nutshell” (cont.)

- Conduct the study
 - follow the plan you defined
 - use a “pilot study” if you are unsure of your plan
- Analyze the data
 - Quantitative/objective data
 - Subjective data
 - Protocol analyses

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Research methodology “in a nutshell” (cont.)

- Draw conclusions
 - Were the hypotheses supported by the results of the experiment?
 - Statistically significant? (Usually use $p = 0.05$ or 0.01 , but these are not carved in stone!)
 - Recall *Type I* and *Type II* errors ...
 - If not significant, are there interesting *trends* in the data?
 - Interaction effects? (e.g., mouse vs keyboard confounded with type of input required when filling out online forms)
 - Can you say why?
 - Will effect the degree to which you can generalize your results.
 - Can you explain interaction effects, trends that are not statistically significant?

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An overview of experimental types:

Laboratory Experiment

- Example: Carter's 1979 study of the effects of various display characteristics on search time using college students in a dark quiet room.

	Experimental Control	Relevance
H i g h		
L o w		

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An overview of experimental types:

Field Experiment / Quasi-Experiment

- Examples: (1) Comparing new ATC interface with existing using real air traffic controllers in real-life settings (field experiment). (2) Comparing "New Math" to conventional instruction by assigning programs to different classrooms (quasi-experiment).

	Experimental Control	Relevance
M o d e r a t e		

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An overview of experimental types:

Simulation Study

- Examples: Flight simulators, power plant control simulators.

	Experimental Control	Relevance
M o d e r a t e		

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An overview of experimental types:

Field Study (Case study)

- Examples: (1) flight crew task analyses conducted in-flight to determine task allocation, workload, etc. prior to specification and design of automated systems; (2) investigators observation and modeling of satellite ground operations
- Investigator observes and records real-life activities without any experimental manipulations.
 - Typically, such a study seeks to articulate how and why some behavioral phenomenon occurs.
- ***Generally, should be the first step in investigating human interaction with complex systems.***

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Descriptive methods

- Survey/Questionnaire
 - Used to gauge attitudes, preferences, etc., often on a numerical scale
 - (e.g., 1=strongly disagree, ..., 5=strongly agree).
 - Amenable to statistical analyses.
 - Problems:
 - how to avoid biased questions
 - Respondents may not be totally truthful

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Descriptive methods (cont.)

- Interview
 - Also used to gauge attitudes, preferences, etc.
 - Can delve into the reasons behind those attitudes.
 - Can be used with a questionnaire to clarify or expand on responses.
 - Problems:
 - Same as with survey/questionnaire.
 - Tricky to analyze.

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Descriptive methods

- Concurrent Verbal Protocols
 - While the subject performs a task (in a laboratory, field, or simulation setting), he/she verbalizes- thoughts, reasons for actions, etc. This is often very illuminating in terms of identifying subject strategies, difficulties, etc. But difficult to analyze and may affect task performance itself.
- Retrospective Verbal Protocols
 - After the subject has performed a task (in a laboratory, field, or simulation setting), he/she verbalizes thoughts, reasons for actions, etc. This may also be quite interesting, but again is difficult to analyze. Also this relies on the subject's memory, which is prone to error.
 - Also: critical incident technique, accident analysis.

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General remarks:

- Before you do any experiment, you should have one or more hypotheses in mind that you want to test or explore.
- If possible, use multiple methods (e.g., field study and interviews and questionnaires).
 - If you obtain converging evidence from a number of separate sources, you can be more confident that the hypothesis is correct.
- Consider reliability and validity issues:
 - Reliability:
 - Construct Validity:

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General Remarks (cont.):

- Reliability and validity issues (concl.):
 - Internal Validity (for causal or explanatory studies):
 - External Validity:
- Ethical Issues:
 - Ethical treatment of human subjects
 - see pg. 37 of Wickens et al.
 - protection from mental and physical harm
 - privacy
 - informed consent
 - Code of Engineering Ethics

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