## Introductory Comments

Interactive behavior arises from the interplay between people, tasks, and devices.

**Question:** Is this a good interface? (Slide show on iPad).

An interface can only be judged based on how the interaction among the human, task, and device unfold over a sequence of events.

No matter how devices and interfaces evolve, you are still locked into a cycle of establishing a goal, breaking it into subgoals, hypothesizing an action plan to meet those goals and subgoals, issuing commands to the computer, waiting for the computer to respond, deciding whether the response takes you closer to a subgoal, and determining when you have met your top-level goal.

In this class, you should learn a vocabulary, concepts, and methods for applying them.

**Possible Examples to Prepare:**
- “Is this a good interface?” slide show (on iPad).
- “PayPal is Rude in the Lunch Line” (1-page printed out, to read to students.)
- CHI 2008 Presentation.
Chapter 1 - Scenario-Based Usability Engineering

Scenario-based design is an approach to developing software systems that are easier to use, easier to learn, and more satisfying to users.

Scenario-Based Design

The chapter starts with an example scenario: Marissa’s gravity question.

A scenario is simply a story about people carrying out an activity (p.2).

A problem scenario is a story about a problem domain as it exists prior to the introduction of new digital technology.

A design scenario describes a new vision for how a human need might be addressed. Note how it is abstract. It does not discuss any details of how any technology might work.

The design scenario is not the system that you build. Exploration is critical.

Managing Software Development

The process of software development (the full life cycle) is difficult to see but it is easy to modify, sometimes for the better and sometimes for the worse. (Example: Deciding to defer requirements analysis.)

No Silver Bullet (p.6)

Software development is a very complex and wicked problem and there is “no silver bullet”, no magical solution that will change that fact. (Fred Brooks, 1987)

There is no single innovation that will make software development costs drop in the same way that hardware costs will continue to drop.

Software is complex in part because it is so complicated and yet so flexible. It gets conformed and modified at the expense of undermining its own conceptual integrity.

One of the keys to solving the problem—though not a silver bullet—is iterative development with prototyping.

Software Engineering

The goal is to gain and maintain control of the problem, both the process (by following a life cycle model) and the product (with established approaches to organizing problems, such as requirements documents and modular design).
**Waterfall model** (p.5) - an early and influential model for software development that is organized into a series of modular phases, including analysis, design, implementation, testing, and maintenance.

The waterfall model (approximately):

- Requirements Analysis
- Design
- Implementation
- Testing
- Maintenance
- Project Management

**Tradeoffs in Design**

**Tradeoffs** (p.7) - alternatives, and the benefits and problems associated with each alternative. Tradeoffs exist throughout a design process. For example: nail down a design, or keep your options open.

In design, there is almost never a single correct answer. (This is a truism, a statement that is so true that it basically says nothing new.) Some solutions are better than others in different ways, but there are always tradeoffs. (Simplicity versus more features and functionality, iPhone versus Android, electronic calendar versus paper calendar).

A design rationale is a written document that captures the decision-making process, the tradeoffs, and documents why ideas are accepted or rejected.

There are tradeoffs not only in products but in processes. A waterfall model focuses on getting things done, whereas a prototyping approach focuses on revisiting ideas.

**Prototyping**

A *prototype* is a concrete but partial implementation of a system design (p.198). A prototype converts abstract ideas into concrete examples. In system design, they must somehow capture the dynamic aspect of the system.

Prototype (p.8) - an operational model to demonstrate a design idea.

**Prototyping** can be incorporated into a software development process lifecycle, perhaps best to contribute to the requirements analysis. (p.8)

**Iterative development** focuses on looping through

- requirements analysis
- design
- prototyping
- evaluating

as a means of developing and refining a system design.

Iterative Development (p.9) - A process in which designs and design documents are produced as an output of each phase in the design process, but continually modified through prototyping and testing.
Usability in Software Development

Usability is a measure of a system in terms of ease of use, ease of learning, and user satisfaction. (It is also a “software quality” such as reliability, portability, maintainability, security,...)

Usability can be addressed throughout the process lifecycle, but most importantly at the beginning and the end.

Usability Engineering

Usability engineering is a somewhat formalized approach to planning, achieving, and verifying the usability of a system, in which usability refers to ease of use, ease of learning, and user satisfaction. The key idea is that measurable usability goals can be defined early in the process, and pursued and assessed during the process.

Since its inception the mid-1980s, usability engineering focused on scenarios, though initially the stories related more to specific task instances, in which the classic human performance measures of speed and accuracy were measured, along with user attitudes. Designers focused on display features and commands. For example, in a command-line text editor, which commands are easiest to learn and use. (sort of like vi, pico, emacs)

Scenario-Based Usability Engineering

Computers do more than just provide information and services to people. They create new opportunities for human activity, and change the way we live. The basic idea of scenario-based usability engineering is that descriptions of people using technology are essential in discussing and analyzing how the technology is (or could be) reshaping these human activities. (pp. 15-16)

A user interaction scenario is a story about people and activities.

Participatory design (p.23) - design work that takes place as a collaboration between developers and the people who will use the system. Very popular in Scandinavian countries. Used by architects, too.

Activity scenarios (p.26) - narratives of typical or critical services that people will seek from the system, deliberately focusing on functionality, refraining from specific details of how the system will work.
Chapter 2 - Analyzing Requirements

Requirements Analysis
The phase of software development in which the needs of clients with respect to a proposed project or technology are analyzed. (p.37)

Analyzing Work Practice
Activities - The personal goals, activities to achieve them.
Artifacts - The physical objects used to carry out the activities.
Social context - The people their relationships, motivations.

Hierarchical task analysis is an approach to studying activities. Individual tasks (pieces of work) and subtasks are organized into a hierarchy, a tree-like structure. (p.39) HTA helps to transform a complex activity into increasingly easier-to-understand steps, so the entire task can be better understood.

But HTA often does not capture the emotional aspects of a task or experience, the important social relationships, the motivations, the psychological experiences.

Ethnography is an analytical technique derived from anthropology in which the analyst becomes intensely involved in a group’s activities as a participant/observer, and collects data about that group, to understand it richly and deeply from the inside out. A debate: Can the ethnographer start with a hypothesis, or must the hypotheses be data-driven? Are they scientists?

Getting Users Involved (p.43)
Different users have different levels of expertise.
The manager often does not know how the employees on the front line really do their job.
   (Mom’s Tektronix story.)
You must talk to many different stakeholders.

Observed on the bus yesterday: One person in a wheelchair says to people on a seat “There’s another wheelchair coming on.... I raised the seat. I offered to help the guy strap in. He said no. The first guy greets the second guy. Who are all the stakeholders there? I’ve wheeled chairs onto Max in the past. Mentally exhausting, trying to think about all the social relationships.

Tacit Knowledge - What is happening that you cannot see? The people in an organization, or community, or common circumstance have some common understandings. How do you as an outsider dig into that tacit knowledge? Did those two guys in wheelchairs know each other? How can you find out?

I used to deejay at clubs in NYC, ages ago. Sometimes when I go and visit NYC I want to get a sense of what the scene is like now. It is totally different. Last summer (2010), I spent about two hours in a store called Turntable Labs, listening to music but just as much listening to the
conversations that customers had with the staff. Such as where people are working, what the crowd is like there.... One guy said how much he liked deejaying at a crappy bar where kids from Long Island (looked down on) just get drunk and have a good time, disparaging a seemingly cooler crowd that analyzes every song that you play. The summer of 2008, I was in Berlin on vacation and I went to a bunch of clubs. A question formed: Why do all of the deejays in Berlin still use vinyl? I asked this question to a lot of people but got no good answers until I talked to a record store owner who explained that there are basically three reasons: (a) as a tribute to the past (“Vinyl is the mother. You don’t kill your mother.”), (b) ergonomics (‘you can just look at the vinyl and you are done.’), (c) socio-economic reasons (government-controlled rent increases make it possible for small record stores to survive).

You can get to the tacit knowledge if you dig and probe, and if you are persistent and patient.

Contextual Inquiry: A requirements analysis method in which people are observed in their normal task environment, and the observer is permitted to interrupt the work with questions. I probably learned a lot about deejaying by conducting some of these analyses with famous deejays such as Frankie Knuckles, Larry T, Justin Strauss, and Dmitri of Delite. It is an apprenticeship. In olden times, you learned by apprenticing yourself to a master.

Preparing for a Field Study

Prepare for Interviews

It is important to generate a number of specific questions that you will ask. (Page 52 has an example.) But depending on the circumstance, you might want to start with one kind of question or another.

Such as start with open-ended questions, or easy questions. Then get into the harder or more personal questions.

Try to not ask leading question, such as “Were you annoyed that you had to give up your seat?” but rather “How did you feel...?”

Perhaps one person asks while the other takes notes. Videotaping and tape recording can be useful, but it can be a little intimidating for people, and it can be very time-consuming for you to transcribe it later.

In-Class Exercise

What are some specific activities that you can partake in to learn more about the context of use of people going to church for fellowship and community, and the experience of all people involved in people in wheelchairs riding on public transportation?

What are some specific sets of questions that you can ask, and contexts for asking them?
Chapter 3 - Activity Design

You are not designing computer programs. You are designing human activities. You are not designing a little app that shows a video of a Bic lighter burning. You are designing the activity of many people in a crowd firing up that app and showing it to the band. And you are also encouraging the delving into the virtual space while trying to help people show appreciation for a "live" event.

“Activity Design” “emphasizes the broad scope of what is being designed: people carrying out activities with the support of computer software. It is essential to design software systems in a usage context, always considering whether and how they will support human goals and activities.

What makes a user interface effective? (p.81) Or good? Or useful? One measure is efficiency, but just because the easiest and most efficient way to get students to fill out teaching evaluations is to withhold their grades if they do not fill them out, does not mean that this is a good user interface.

Being able to dial “0” from any campus phone, and say the name of a faculty, and get connected, is efficient but it only works about 67% of the time.

There are plusses and minuses to every idea for a new activity. Hence you do a cost/benefit analysis, or a “claims analysis”.

Claims Analysis - An analytic evaluation method that identifies the positive and negative consequences to a design. (from glossary on p.374)

Claims analysis plays an important role in SBD. See p.72. Good examples throughout book, such as page 73.

Designing Comprehensible Activities (p.84)
The user has a "mental model," a set of expectations about how to do a task, and how to use use a system to do that task. This phrase is quite common in interface design, but it means slightly different things to different people, so you should define it when you use it. The user's mental model is not going to be the same as the designer's mental model, which the book calls the "designer's model," though this phrase is less commonly used in interface design.

The key idea is that the user's and designer's mental model are very rarely the same. The designer tries to create the user's mental model but it is very difficult to do, and difficult to know if you have succeeded.
Example: Current users have a mental model of a physical store that does not include finding post-it notes on shelves saying what previous customers think of the products on the shelves, but they have a mental model in which they do expect to find such notes posted on online stores.

**Metaphors** are analogies that illustrate one thing by relating it to a second different that is not typically related to the first thing, such as "love is a rose". Analogies provide a framework for creative exploration. Examples: Customer comments on online stores is like putting post-it notes on shelves at stores. A library is like a warehouse, or like a café (or a big office).

There are good examples of metaphors in the book on p.93-94.

**Designing Satisfying Activities** (p.89) How do you motivate people to do their work, and to help them to enjoy their job? Example in book: Librarians want to help people. Automating library systems might actually make it harder for librarians to have special knowledge and abilities to help others. You must examine the tradeoffs between “automation and personal control.” Designers must carefully consider the implications of redesigning a business practice. Example: Requiring students to fill out course evals in order to see their grades.

Using Personal Social Networks to Tailor News to Family and Friends
Can't Attend? Send Your Robot Instead - Video Library - The New York Times
The Kindle 3 - Video Library - The New York Times

Future example: Compare the iPad commercial to my iPad software purchase experience.

### Chapter 4 - Information Design

**Gulf of evaluation:** The “cognitive distance” between what is displayed on the computer and the user’s mental representation of tasks. For example, my task is to enter some parameters about a piece of equipment but the display shows me no visual representation of that piece of equipment.

**Gulf of execution:** The distance between the user’s current task goals and the procedures and actions that the system provides for pursuing these goals. For example, ...

**Gestalt principles** -- relate to the configural properties of visual information, how individual components get grouped together by your perception to create a figure. Grouping, continuation, shapes.

**White space** is a very good way to create visual structure. The eyes do not land on it, but perceptual grouping can be perceived from across the display. The **squint test** can be used to check interface groupings.

Realism versus abstract symbols.

**Consistency** permits the transfer of learning.

A **visual design program** or **system** can contribute to consistent displays.

**Internal consistency** and **external consistency**.

**Visual metaphors**, such as a calculator. (Though they can break down because no divide-by or multiply-by key on the keyboard).
The plan-execute-perceive cycle of human vision

The plan-execute-perceive cycle of human-computer interaction is presented in the next chapter. The same cycle, just on a faster time scale, is followed for moving the eyes around a visual scene to perceive visual information.

A plan is formed and updated in real time about how to interact with a visual scene to reach a goal. The plan draws uses prior knowledge about the scene or similar scenes (and thus expectations), from visual information in the periphery, and from visual information gathered during fixations.

Why do the eyeballs of a human rotate in their sockets?
The eyeballs rotate so that a person can orient the small region of high-resolution (or high acuity, but not "high focus") vision towards objects in the visual scene that a person wants to examine more closely. This region of high-resolution vision is roughly 2° of visual angle, roughly the size of your thumbnail at arm's length. (It corresponds to the foveal region on the retina, where the "rod" nerve cells are most dense.) The eyes typically move with quick jumps called saccades that last roughly 20-40 ms, and then hold steady at locations with fixations that last typically 250-500 ms. If there is a moving object that the eyes can follow, then smooth pursuit eye movements can be made.

During each fixation, the saccade to the next fixation is planned, and then it is executed. For example: Turn on the lights, or open a window, or find an individual in the classroom.

There is a close relationship between good visual design guidelines (such as Proximity, Alignment, Repetition, and Contrast) and these basic characteristics of human vision. In short, a well-designed visual layout permits a person to see the structure and organization of the layout in the near periphery (similar to what you will see in a squint test) and use this structure and organization to determine appropriate destinations to saccade to, such that the high resolution vision is always placed on relevant information.

Information design in auditory displays
Perceiving information (data) is almost always an interactive process. Contemporary auditory interfaces do not adequately consider this.
Chapter 5 - Interaction Design

*Information* design focused on figuring out what task objects and actions to show, and how to represent them. The goal of *interaction* design is to specify the mechanisms for accessing and manipulating task information.

(Don Norman’s example of a wall of doors with identical handles.)

Interaction design tries to make sure that people can do the right things at the right time.

Remember, in Project 2, you were designing activities. The interaction design that you build into the system will dictate, to some extent, the activities that your users will engage in.

The human-computer interaction cycle: Establish a human goal, translate it into a system goal, develop an action plan, execute the plan, perceive the results of the execution, interpret the results, and decide whether the goal has been accomplished.

Interaction design relates to how easily the user’s goals can be converted into system procedures for accomplishing those goals.

Example: Loading Keynote onto iPad.

WIMP user interface: Windows, Icons, Menus, Pointers.

**Direct manipulation** is thought to be easy to use because it reduces the gulf of execution by making screen objects look and sort of behave like things in the world. It also might be easier to use because the design makes it difficult for engineers to assign radically different functions to the same actions (such as dragging a file or a folder to the trash; though not a floppy disk)!

Direct manipulation is taken to an even greater extreme with touch interfaces such as the iPad, iPod touch, iPhone, Androids, and such. But all kinds of inconsistencies are introduced. Direct manipulation is not a magical way to make interfaces easier to use. For example, there is no “right click” to see a number of potential commands for an object.
The plan-execute-perceive cycle of human-computer interaction

Planning an action sequence: People develop and execute task strategies. When interacting with computers, these typically include perceptual and motor. They can also be purely cognitive. They can be planned ahead, prepared. So consistency matters a lot, because they permit a user to plan a few steps in advance based on how they expect the functionality to be accessed, and how the computer will behave. (Such as, when you encounter a couple fields that say “username” and “password,” to be able to type your username, tab, your password, and enter. This was not the case on DuckWeb a few years ago.)

Action sequences, or cognitive strategies, are planned and executed on the micro level (tasks that last a few seconds, such as above) as well as the macro level (tasks that last minutes, such as connecting to a network and sending a print job to a printer).

The UI designer’s challenge is to support the user at every step in their action plan, and to make it clear to them what functionality is available so that the users can map that functionality to their tasks and goals. Such as, if a user wants to print double-sided, make it clear whether that functionality is available, and if it is how to access it.

Consistency is key. People can “chunk” interaction sequences such as typing in a username and password, copying and pasting, opening applications. To “chunk” is to organize several interrelated pieces of data into a single piece of data. I recently created a new action sequence for opening applications, using command-space, though it conflicts with the spatial association I
have with typing sequences into Google. I often make a “slip” and look on my hard drive for something that I really want to look for on the web.

The UI designer's difficult task is to design these activities so that they complement, and do not compete or conflict with, existing action sequences.

Mistakes: An inappropriate intention is established and pursued. More common among novice users. Buying a copy of “Garage Band” because you want to start a band in your garage. Slip: The correct goal is attempted, but a problem arises along the way. More common among experts. Example: The goal is to get cash from an ATM; you do it but you leave your ATM card. Can often be avoided by improving the interaction design, such as by giving back the card before the cash.

More examples on page 169, with design approaches to avoid the problems.

Modes should, in general, be avoided in UI design. Modes are restricted interaction states in which only certain actions are possible. Such as a “modal” dialog box that requires a response before you can do anything else with your computer; some reminders software work this way, such as to alert you of a scheduled event. A pop-up window on a web page asking you to take a survey is a modal dialog box within the context of that web page.

Articulatory directness—how directly a device maps to its input requirements—is interesting to think about in terms of touch-displays. Spreading your fingers is surely like stretching something, to zoom, but a four-finger versus a three-finger click would seem to have articulatory directness with any particular functionality.

Give the user feedback with regards to how they are progressing towards their goals, at multiple time scales, including responding to any input within 100 ms, just to show that the system received your command, but also on the time scale of seconds, showing progress towards the goal. (Unix does not give great feedback. Many direct manipulation interfaces do.)

Fitts' law predicts pointing time as a function of distance and width. There is a logarithmic relationship between d/w and pointing time. \[ MT = a + b \log (d/w) + 1 \]. The main upshot is that tiny targets are very slow and difficult to click on, and the edges of the screen have certain advantages. But overall pointing-and-clicking is quite slow for time-pressured practiced tasks. You should learn keyboard shortcuts, even for responding to dialog boxes. (It is sort of foolish not to.) A good interface design should support keyboard shortcuts. One of the big differences between software for the masses like iPhoto and software for the pros such as Lightroom is that the pro versions support lots of keyboard shortcuts, such as to rate a photo and advance to the next photo with a single keystroke. (My friend Mark in NYC took my advice.)

How can you represent interaction sequences? Remember, a screenshot is not an interface. You must show how an interface evolves over time, such as with a storyboard. “Here is what the user sees. If they click here, then they see this....” The challenge is to represent a dynamic artifact.
Chapter 6 - Prototyping

A **prototype** is a concrete but partial implementation of a system. A prototype can evaluate many different aspects of a system design, such as speed, interconnections among components, or usability with a **user interface prototype**.

A prototype can be high fidelity and expensive (in time and money) or low fidelity and inexpensive.

The design questions that you want to answer will influence what level of fidelity is needed. If you just want to make sure people will be able to understand the commands that are available, and how to use them, a low fidelity prototype may suffice. But if you need to understand precisely how a device would perform in a high performance task environment, a high fidelity prototype may be needed. For example, a low fidelity prototype could be used to evaluate the arrangement and labeling of buttons on a home phone, or on AV equipment in a classroom. But a high fidelity prototype may be needed to evaluate how a new fire fighter communication device would work in a high-stress emergency situation, or how a device intended to track nutritional intake would be used in a real-life day-to-day setting.

A prototype should focus on some aspect of a system design. It is a **partial** implementation. Focus on the aspects that are most important to explore, such as what is novel. For EyeDraw, our first prototype was to just get the cursor to appear where the eyes are looking. If we couldn't do this, then we couldn't do anything.

Types of prototypes (p.199): Storyboard, paper, Wizard of Oz, computer animation (such as with Macromedia Director), scenario machine, rapid prototype, working partial system.

Storyboard: One or more pictures narrate a scenario. Figure 5.7 on p.191 shows the dynamic aspects of a system. Storyboards can also be hand-drawn (like Figures 4.16 and 4.17 on pp. 150-151), or like a comic strip using stick figures. (They are used when making movies.)

Low-fidelity prototypes are more likely to generate more ideas (Wendy Marsh from Intel). In the virtual science fair example: "The roughness of these prototypes convey that the design ideas are tentative and that wide-ranging input is needed." (p.210)

High-fidelity prototypes are more likely to mislead clients to think that major components of a system are completed, or to cause premature commitment to specific design ideas.

Paper-based mockups can work great. (See the DuckTix example.) In one form of a paper prototype, a separate sheet of paper is used for each screen and mode, and you add an extra little label to each button telling the person running the prototype which page to turn to after the user "clicks" on that button.

In a **Wizard of Oz** prototype, the user is presented what looks and acts like a real system, but in fact a human on the design team triggers the system responses, like the man behind the curtain in
the movie. But the team member triggering the responses needs to follow a strictly-defined set of rules, so as to not pretend that impossible-to-program human intelligence would be built into the system.

**Usability Testing**

"Usability testing is the core of usability engineering practice: Representative users are asked to interact with system prototypes, and their behavior and subjective reactions are studied." (p.204)

The ideal usability test would use the actual completed system but this is not the best use of resources if the goal is to explore potential interface alternatives.
Chapter 7 - Usability Evaluation

7.1 - Usability Specification for Evaluation

A usability evaluation is a study to determine the ease of use and ease of learning of a system. **Ease of use** is a measure of how well a system supports users accomplishing tasks.

**Formative Evaluation** vs. **Summative Evaluation**

<table>
<thead>
<tr>
<th>Formative Evaluation</th>
<th>Summative Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>takes place during the design process—how are we doing?</td>
<td>takes place after the design process—how did we do?</td>
</tr>
</tbody>
</table>

How usability evaluation fits into a software development process model:

```
Identify tasks
 Specify/Revise design
    Build prototype → Analytic evaluation
    User test
    Problems? Yes No
    Build system
    Final user test
```

7.3 - Analytical Methods

**Analytic Evaluation** vs. **Empirical Evaluation**

<table>
<thead>
<tr>
<th>Analytic Evaluation</th>
<th>Empirical Evaluation</th>
</tr>
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<tbody>
<tr>
<td>Studying or modeling the interface without users. Cheaper, faster, sometimes can help to show what is wrong.</td>
<td>Observe real users doing real tasks. Slow, expensive, does not always reveal why better or worse. Follows the pattern of a psychological experiment.</td>
</tr>
</tbody>
</table>

**Examples**

1. Usability inspection (Heuristic Evaluation) Ten guidelines on p.233. (Read them.)
2. Cognitive Modeling (KLM/GOMS)
3. Cognitive Walkthrough

**KLM Operators** Adapted From Card, Moran and Newell (1983)

<table>
<thead>
<tr>
<th>Operator</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home hand to mouse (H)</td>
<td>0.4s</td>
</tr>
<tr>
<td>Press &lt;keyname&gt; (K)</td>
<td>0.28s</td>
</tr>
<tr>
<td>Press or release mouse button (B)</td>
<td>0.1s</td>
</tr>
<tr>
<td>Click mouse button (BB)</td>
<td>0.2s</td>
</tr>
<tr>
<td>Type &lt;string of characters&gt; (T(n))</td>
<td>0.3n s</td>
</tr>
</tbody>
</table>
Cognitive Walkthrough

Slightly biased towards ease of learning (not routine use, as is KLM). But ease of use and ease of learning are probably correlated.

Good for: ATMs, web sites with lots of new users (e.g., IRS, USPS, etc.), games, any “walk up and use” software.

Not good for: Air traffic control consoles, power plan control rooms, telephone switchboards.

Interesting detail: Cog. Walkthrough seems to assume the user will not be reading the manual.

Relates to the cycle of human information processing: Can users easily (1) perceive the state of the system, (2) determine the commands that are available for forming an action plan, (3) execute those commands, (4) perceive the results of those actions, (5) determine whether the user moved closer to their task goals, and (6) if the task is not completed, understand the next subgoal that needs to be accomplished?

Preparation Phase
Who are the users of the system?
What are the tasks?
What is the correct action sequence for each task?
How is the interface defined?

Analysis Phase: Walk through the interaction telling a credible story.
At every step or prompt, consider:
Will the user know the correct subgoal or subtask?
Will the user know that the correct action is available?
Will the user associate the correct action with the subgoal?
If the correct action is performed, will the user know progress is being made toward the goal?

How to fix the breakdowns:
If the user does not know...
Which subgoal to accomplish
• Eliminate the required action
• Prompt the use to make the action
• Re-organize the interface to more closely support the users’ anticipated task hierarchy
The action is available
• Make the controls more obvious, as with a prompt or a menu
The action is appropriate
• Provide labels and descriptions for actions that incorporate the users’ vocabulary
• Reword labels selected in error
Progress is being made
• Prompt for the next correct action.
• Provide feedback regarding what happened, ideally in the users’ vocabulary.
7.3 - Empirical Methods

This section in the textbook provides a very accurate and relevant discussion of how to conduct a usability study. This is perhaps the most important section in the textbook for you to learn. All of the terms that are in bold in this section are very important terms. (The Appendix on "Inferential Statistics" is also very good, on p.363.)

“The gold standard for usability evaluation is empirical data.”
Empirical: Based on observation (not theory or conjecture).

You are looking to establish a cause-and-effect relationship between characteristics of the system and ease of use. You want to claim that your interface causes a task to be easy to perform for a population.

... You want your experiment to have good “validity”.

Validity (Figure 7.3 gives examples of questions that relate to validity.)
Validity refers to the best available approximation to the truth of propositions.

External validity is the extent to which the experiment measures and shows something that is true about the world.
Internal validity is the extent to which the experiment truly measures what it tries to measure; that is, within the context of this particular experiment.

Example script for a usability study

Roles: Test monitor, technicians, users or “participants”.

Recruitment criteria (for this example):
1. Users who have never used an iPad, iPhone, or iPod touch.
2. Users who have used the iPhone (or iPod touch) calendar (at least once a day for at least a year? month? And who find it relatively easy to use). And who love their iPhone?

Purpose of observation: I am trying to learn how people might use the iPod Touch (or iPhone) to enter an appointment in a calendar.
This study should take about five to ten minutes. Feel free to quit any time. I would like to ask you to think-aloud while you do the task. By this I mean to say what comes to your mind as you are working. To help you do this, I am going to ask the two of you to work together and to agree on every action that you take, and to make sure that both of you understand what is happening all the time. (The think-aloud protocol can be facilitated by two users doing “co-discovery.”)
Your first task is to create an appointment this Saturday from noon to 4PM to grade papers. Your second task is create an appointment on June 13 to attend commencement.

**Debriefing questions:**
1. What did you think?
2. How did you do the tasks?
3. How did you figure out how the calendar worked?
4. Did the system respond as you expected? Always?
5. Was there anything about the task that seemed particularly easy or difficult?
6. What were some of the feelings that you had as you did the task?
7. Do you think the calendar is easy or difficult to use?
8. Is there anything else that you would like to share about this?
9. Those are all of my questions. The study was designed for the hypothesis below. Do you have any questions for me?

My hypothesis, as you know, is that the iPhone calendar interface causes difficulty in recording appointments. (I have told you before that this is an unnecessarily difficult task.) I will operational my hypotheses to be:

**H1:** In order to enter an appointment, a novice user will require at least twenty screen touches (in which a swipe will count as two screen touches) in addition to the appointment’s text string.

**H2:** In order to enter an appointment, even an expert user will require at least twenty screen touches (in which a swipe will count as two screen touches) in addition to the appointment’s text string. And at least one error will occur for every appointment entered, in which an “error” is any undesired system response that requires the user to make an extra movement.

**Important Topics in Empirical Methods**

Think-aloud protocol - prompting a user to verbalize what they are doing as they proceed.
Co-discovery - having two users work together and agree on each step aloud.

Controlled experiments versus field studies.

Independent variable - characteristic that is manipulated to create different experimental conditions.
Dependent variable - an experimental outcome.
Hypotheses - predictions of causal relationships between dependent and independent variables.
Classic human performance measures are speed and accuracy. There is a tradeoff between them.
Experimental design - the details of how a cause-and-effect relationship is explored between independent and dependent variables.
Within-subject - all participants see all conditions.
Between-subject - different groups see different conditions.
Random assignment to remove order effects.
A major goal in experimental design is remove alternative explanations as to why the dependent variables changed when you changed the independent variables.
Informed consent - confidentiality, can quit any time without penalty. This is to protect participants.

The VSF examples are very good. The assistance policy, for example.
Chapter 8 - User Documentation

User documentation is stored information about how to use a system.

It takes many forms: paper or PDF document, online help, online tutors, and user forums.

User forums, as I am sure you have observed, are very mixed. Yes, Googling your question will often help you find an answer. But it also often just helps you to learn that lots of other people have the same question, and sometimes someone suggested an answer. But you do not know if it is correct. Such as how to uninstall a piece of software. How do you know if it is right?

"Socially mediated documentation can be fun and empowering, BUT the offered advice may be wrong or suboptimal...." (p.288)

Video documentation makes no sense to me even if just for the single reason that its content cannot be visually skimmed anywhere nearly as easy as pages of text and pictures to find what you need, or to figure out that your question is not answered here. Part of the problem is that the videos often start with company logos or talking heads rather than just jumping as quickly as possible to showing the task. They are modeled after TV shows or commercials, not a friend very quickly showing you how to do something.

Production Paradox: People want to be productive, to get things done, to achieve goals and subgoals. But in order to do this, they need to carry out activities that undermine their short-term progress towards the goal, that seem to prevent the production. (A paradox is a seemingly self-contradictory statement.)

Users often try to learn by doing. This might work for a photo organizing software like iPhoto, but not for the software that runs a space station. Most "power users" probably read manuals.

One solution is to try to put the documentation where the user will see it as they are doing a task with help that is built into the system so that users can "walk up and use" the system. But it is still difficult to know how much help to give, and whether they will even know that it is there. Tooltips can potentially help a user to learn by doing, but they can also get in the way of doing.

Documentation should support the human tasks, not just list the system functions.

User manuals should be organized by task. Hierarchical task analysis (HTA)—the same analysis that you did to help you understand user requirements and design your system—can also be used to organize your user manual.

Organize the manual hierarchically, following the HTA that evolves from (a) your initial requirements analysis, (b) the intended use of your system and how it fits into the intended use context, and perhaps also (c) how you observe participants using it during your user observation studies.
There are two kinds of knowledge (in many ways; this is just one):
1. How to use it—only what is needed to accomplish a task, such as how to use your turn signal.
2. How it works—the internal mechanics of the system, such as what makes the lights flash.
   (A lot of Apple's systems try to hide the second of these, such as in iPhoto, iMovie.)

Most users only need to know how to do a task. They only need to know how something works when they want to do an unusual task (such as synchronizing file systems), or to troubleshoot an unexpected system behavior (such as when a PDF got was deleted from an iPad—file transfers through iTunes works differently than Pages than for ReaddleDoc).

Use the user's language. Don't explain the internal error codes or mechanisms. Tell them what they need to do to fix the problem and continue with their task. "You need to quit some applications to open another" rather than "Insufficient memory".

Advantages of Different Types of Documentation

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<thead>
<tr>
<th>Paper-Based</th>
<th>On Hard Drive with App</th>
<th>Internet Forums</th>
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<tbody>
<tr>
<td>• Parallel viewing</td>
<td>• Searchable</td>
<td>• Sometimes easy to get suggestions.</td>
</tr>
<tr>
<td>• Can use anywhere</td>
<td>• Always there</td>
<td>• Can ask very obscure questions.</td>
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<td>• Easy to annotate</td>
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<td>• Can study deeply</td>
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Creating a standalone application with a help system that requires an Internet connection seems very odd to me. At least some of these applications also permit a PDF to be downloaded as well. But you still need to plan ahead to make sure you have the PDF when you need it. It seems much more useful to just ship it with the application.

Interactive tutorials walk you through using the software. The Macintosh for a period of time had a help system that would open dialog boxes and circle appropriate buttons for the user to push to do a task.

Scaffolding is interface elements that try to guide new users through tasks, elements that are eventually removed as the user is able to do the project without the help, like scaffolding that is removed from a new building after it is built or maintained.

A "minimal manual" can be extremely helpful. It is action-oriented, builds on the user's task knowledge, and anticipates and manages errors. (Example: Codewarrior QuickStarts.) Many pieces of hardware come with both long comprehensive manuals as well as "Quick Starts".

Mixed initiative interfaces try to predict the user's task that is currently underway and tries to help them with it. They may have potential but, because of the colossal failure of Microsoft's Clippy, we may need to skip a generation to try it again. People hated it.

User documentation should be organized around, and should support, the user's task.