User Interface Design

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Interface Design

- A well-designed graphical user interface decreases the user's learning curve and is able to lessen the user's mental load when using the application

Easy to understand?

Easy to learn?

Easy to use?

Objectives of GOOD HCI Design

- Increase safety
- Improve reliability
- Improve maintainability
- Increase comfort
- Increase user acceptance
- Increase efficiency
- Improve system performance
- Improve working environment

- Reduce errors
- Reduce loss of time
- Reduce fatigue and stress
- Reduce boredom
- Reduce training requirements
- Reduce personnel requirements
- Accommodate disabilities
- Accommodate different nationalities

Typical Design Errors

- Lack of consistency
- Too much memorization
- Too many steps, motions
- Unfriendly
- No guidance / help
- Poor response
- No context sensitivity

Golden Rules

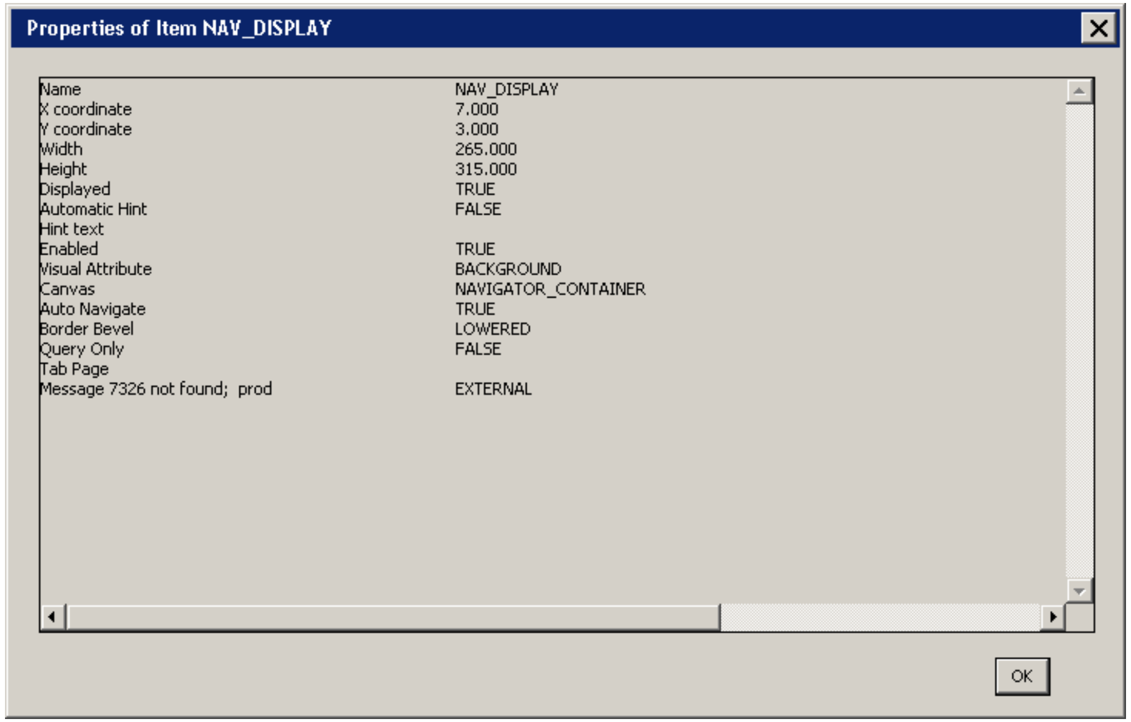
Three golden rules form the basis of UI design principles:

- Place the ***user*** in control
- Reduce the ***user's*** memory load
- Make the interface consistent

Place the User in Control

1. Define interaction modes in a way that does not force a user into ***unnecessary*** or ***undesired*** actions.

Help window of Department of Commerce CBS/CAMS system



Name	NAV_DISPLAY
X coordinate	7.000
Y coordinate	3.000
Width	265.000
Height	315.000
Displayed	TRUE
Automatic Hint	FALSE
Hint text	
Enabled	TRUE
Visual Attribute	BACKGROUND
Canvas	NAVIGATOR_CONTAINER
Auto Navigate	TRUE
Border Bevel	LOWERED
Query Only	FALSE
Tab Page	
Message 7326 not found; prod	EXTERNAL

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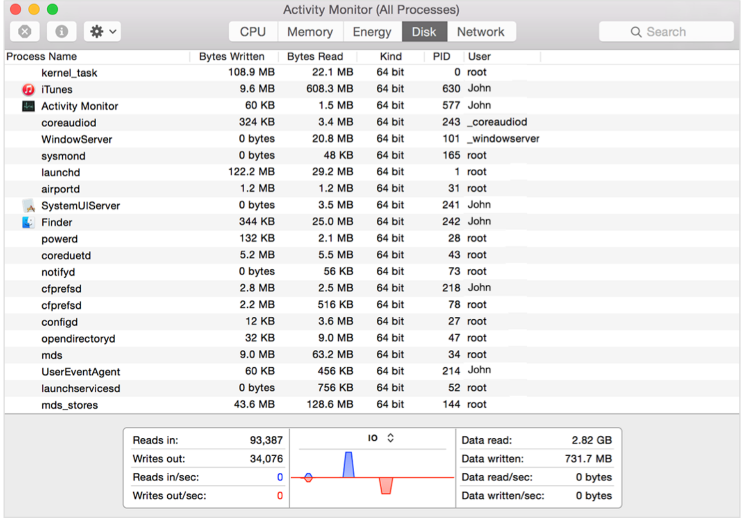
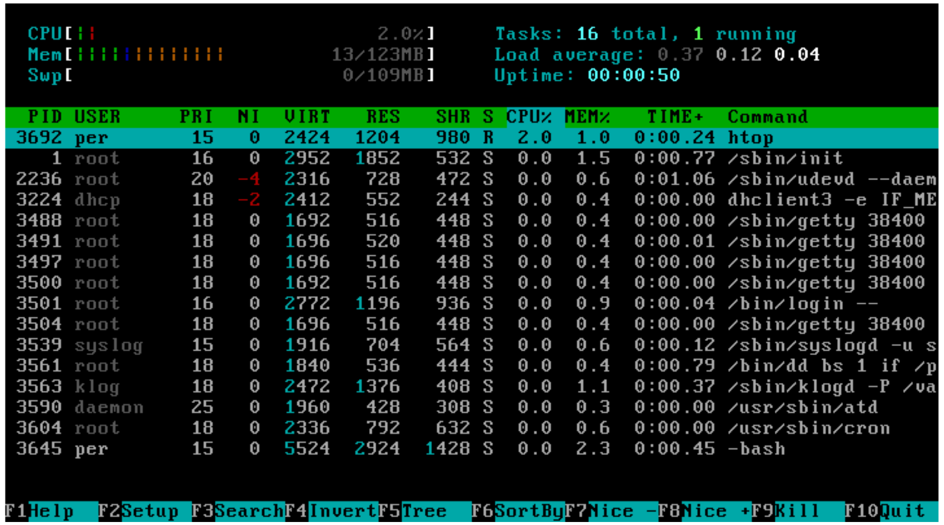
2. Provide for ***flexible*** interaction



Process Name	Bytes Written	Bytes Read	Kind	PID	User
kernel_task	108.9 MB	22.1 MB	64 bit	0	root
iTunes	9.6 MB	608.3 MB	64 bit	630	John
Activity Monitor	60 KB	1.5 MB	64 bit	577	John
coreaudiod	324 KB	3.4 MB	64 bit	243	_coreaudiod
WindowServer	0 bytes	20.8 MB	64 bit	101	_windowserver
sysmond	0 bytes	48 KB	64 bit	165	root
launchd	122.2 MB	29.2 MB	64 bit	1	root
airportd	1.2 MB	1.2 MB	64 bit	31	root
SystemUIServer	0 bytes	3.5 MB	64 bit	241	John
Finder	344 KB	25.0 MB	64 bit	242	John
powerd	132 KB	2.1 MB	64 bit	28	root
coreduetd	5.2 MB	5.5 MB	64 bit	43	root
notifyd	0 bytes	56 KB	64 bit	73	root
cfprefsd	2.8 MB	2.5 MB	64 bit	218	John
cfprefsd	2.2 MB	516 KB	64 bit	78	root
configd	12 KB	3.6 MB	64 bit	27	root
opendirectoryd	32 KB	9.0 MB	64 bit	47	root
mds	9.0 MB	63.2 MB	64 bit	34	root
UserEventAgent	60 KB	456 KB	64 bit	214	John
launchservicesd	0 bytes	756 KB	64 bit	52	root
mds_stores	43.6 MB	128.6 MB	64 bit	144	root

Reads in:	93,387	Data read:	2.82 GB
Writes out:	34,076	Data written:	731.7 MB
Reads in/sec:	0	Data read/sec:	0 bytes
Writes out/sec:	0	Data written/sec:	0 bytes

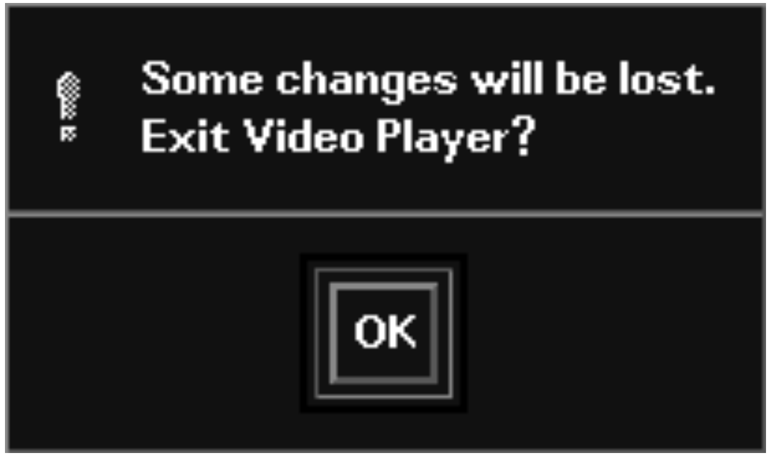


```
  CPU[||                        2.0%]     Tasks: 16 total, 1 running
  Mem[|||||||||||||          13/123MB]     Load average: 0.37 0.12 0.04
  Swp[                        0/109MB]     Uptime: 00:00:50

  PID USER      PRI  NI  VIRT   RES   SHR S CPU% MEM%   TIME+  Command
 3692 per        15   0  2424  1204   980 R  2.0  1.0  0:00.24 htop
    1 root       16   0  2952  1852   532 S  0.0  1.5  0:00.77 /sbin/init
 2236 root       20  -4  2316   728   472 S  0.0  0.6  0:01.06 /sbin/udevd --daem
 3224 dhcp       18  -2  2412   552   244 S  0.0  0.4  0:00.00 dhclient3 -e IF_ME
 3488 root       18   0  1692   516   448 S  0.0  0.4  0:00.00 /sbin/getty 38400
 3491 root       18   0  1696   520   448 S  0.0  0.4  0:00.01 /sbin/getty 38400
 3497 root       18   0  1696   516   448 S  0.0  0.4  0:00.00 /sbin/getty 38400
 3500 root       18   0  1692   516   448 S  0.0  0.4  0:00.00 /sbin/getty 38400
 3501 root       16   0  2772  1196   936 S  0.0  0.9  0:00.04 /bin/login --
 3504 root       18   0  1696   516   448 S  0.0  0.4  0:00.00 /sbin/getty 38400
 3539 syslog     15   0  1916   704   564 S  0.0  0.6  0:00.12 /sbin/syslogd -u s
 3561 root       18   0  1840   536   444 S  0.0  0.4  0:00.79 /bin/dd bs 1 if /p
 3563 klog       18   0  2472  1376   408 S  0.0  1.1  0:00.37 /sbin/klogd -P /va
 3590 daemon     25   0  1960   428   308 S  0.0  0.3  0:00.00 /usr/sbin/atd
 3604 root       18   0  2336   792   632 S  0.0  0.6  0:00.00 /usr/sbin/cron
 3645 per        15   0  5524  2924  1428 S  0.0  2.3  0:00.45 -bash


F1Help  F2Setup F3SearchF4InvertF5Tree  F6SortByF7Nice -F8Nice +F9Kill  F10Quit
```

Place the User in Control

1. Define interaction modes in a way that does not force a user into ***unnecessary*** or ***undesired*** actions
2. Provide for ***flexible*** interaction
3. Allow user interaction to be ***interruptible*** and ***undoable***

How do you cancel?



Some changes will be lost.
Exit Video Player?

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4. Streamline interaction as ***skill*** levels advance and allow the interaction to be ***customized***.

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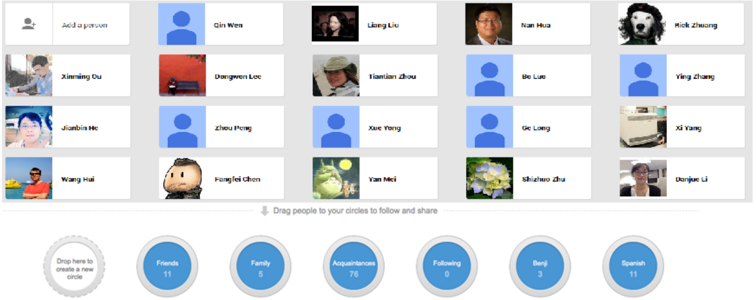
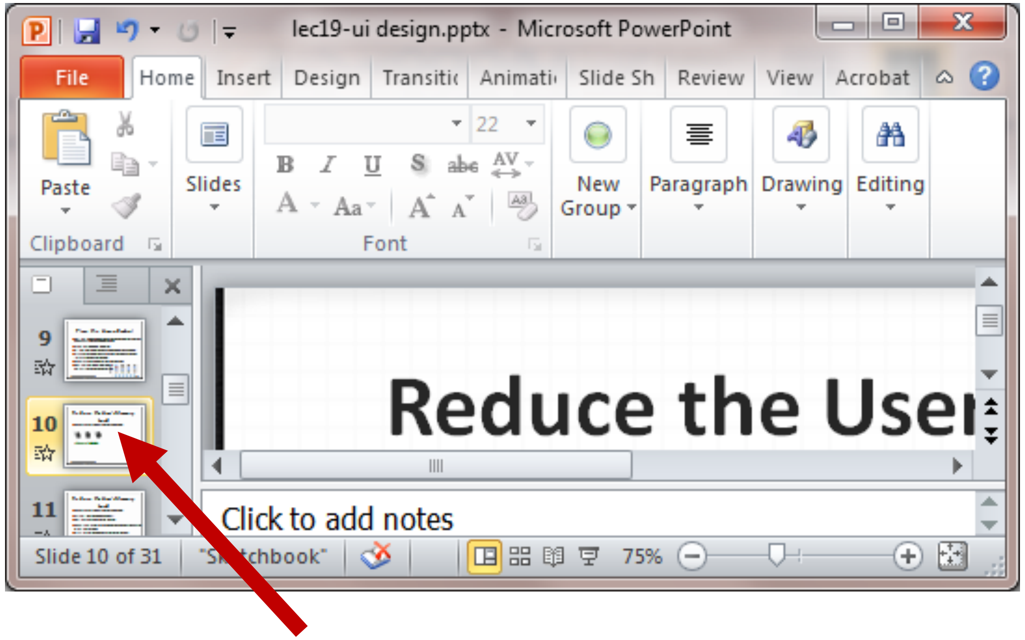
5. ***Hide*** technical internals from the casual user
6. Design for ***direct*** interaction with objects that appear on the screen



Reduce the User’s Memory Load

1. Reduce demand on ***short-term memory***

e.g., three-clicks rule (unofficial web design rule that states that a user should be able to find any information with no more than three mouse clicks)



visual cues

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2. Establish ***meaningful defaults***
    - Make sense to average users, allow customize and reset

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3. Define ***shortcuts*** that are intuitive
    - *Ctrl+C* and *Ctrl+V*
    - **F** for **File**, **E** for **Edit**, **V** for **View**, and **H** for **Help**

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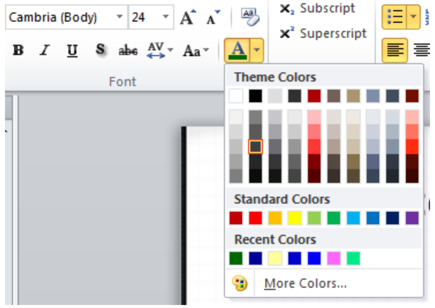

4. The visual layout of the interface should be based on a ***real-world metaphor***

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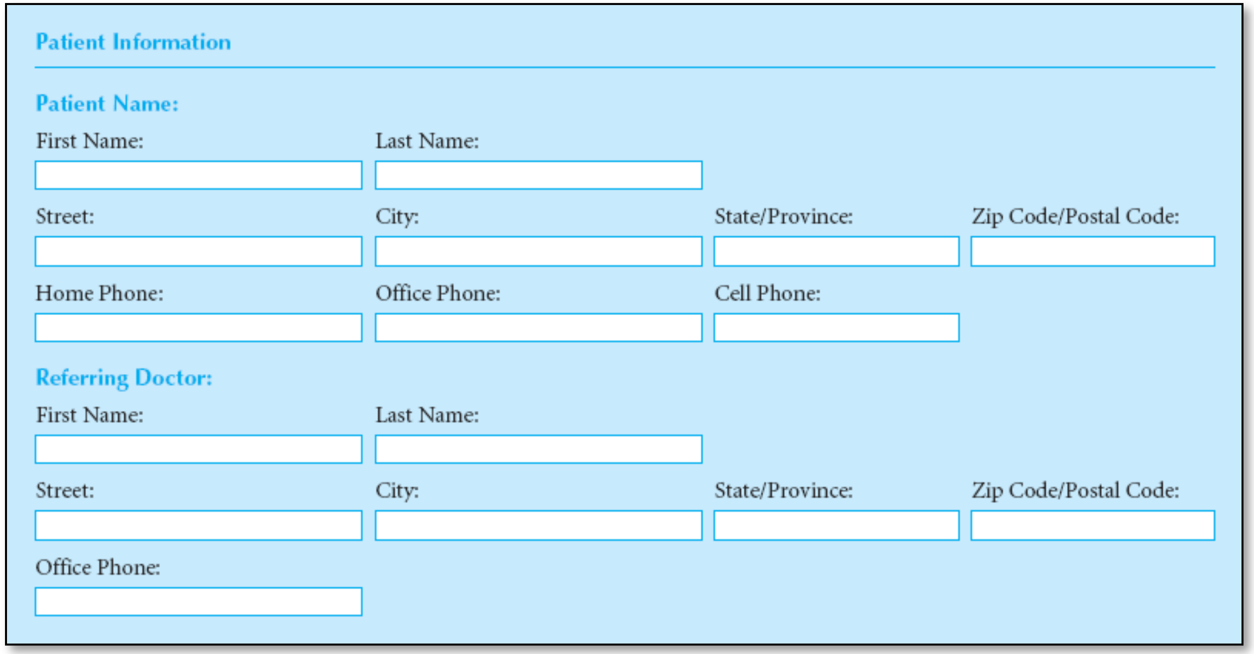
   - Ctrl+P
   - **F** for **File**, **E** for **Edit**, **V** for **View**, and **H** for **Help**
4. The visual layout of the interface should be based on a ***real world metaphor***
5. Disclose information in a ***progressive*** fashion

Make the Interface Consistent

Consistent in visual, input, and navigation mechanisms

1. Allow the user to put the current ***task*** into a meaningful ***context***
   - Indicators



Patient Information

Patient Name:

First Name: Last Name:

Street: City: State/Province: Zip Code/Postal Code:

Home Phone: Office Phone: Cell Phone:

Referring Doctor:

First Name: Last Name:

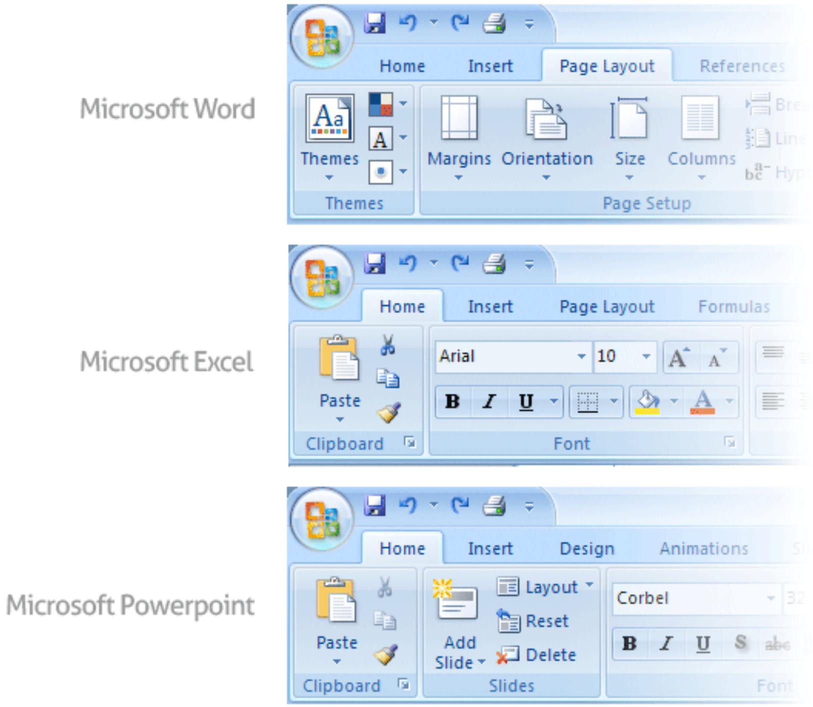
Street: City: State/Province: Zip Code/Postal Code:

Office Phone:

Make the Interface Consistent

Consistent in visual, input and navigation mechanisms

1. Allow the user to put the current ***task*** into a meaningful ***context***.
   - Indicators
2. Maintain consistency across a ***family*** of applications.



Make the Interface Consistent

Consistent in visual, input and navigation mechanisms

1. Allow the user to put the current ***task*** into a meaningful ***context***
2. Maintain consistency across a ***family*** of applications
3. If past interactive models have created user ***expectations***, do not make changes unless there is a compelling reason to do so

User Interface Analysis & Design

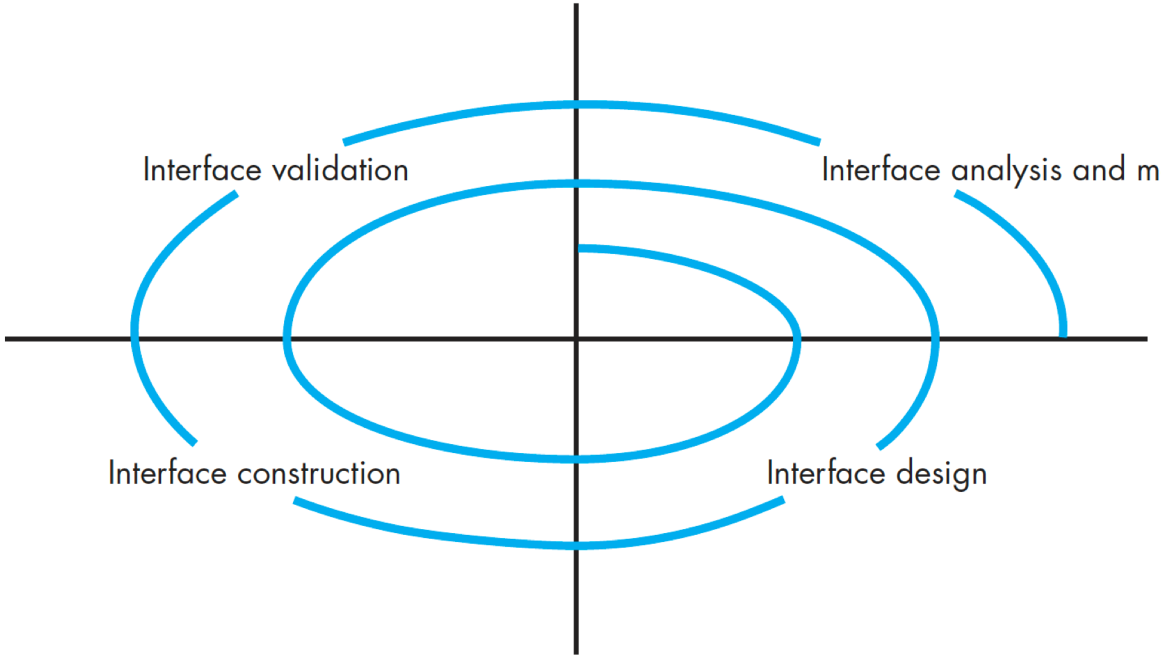
User Interface Design Models

- ***User model***
  - A profile of all end users of the system
- ***Design model***
  - A design realization of the user model
- ***Mental model (system perception)***
  - The user’s mental image of what the interface is
- ***Implementation model***
  - The interface’s “look and feel” and the supporting information that describe interface syntax and semantics

User Interface Analysis & Design

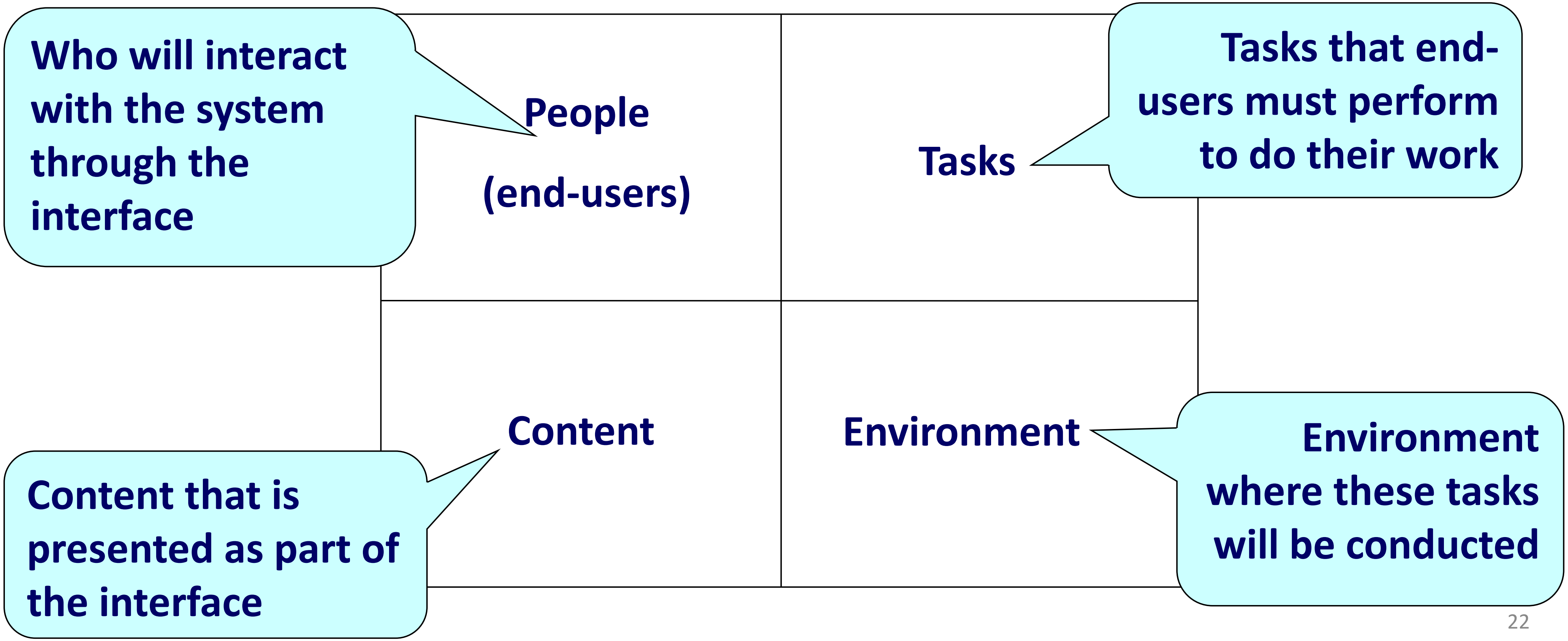
A spiral process

- Iterative: each of the four tasks occurs more than once



Interface Analysis

… means understanding …



People (end-users)	Tasks
Content	Environment

Who will interact with the system through the interface

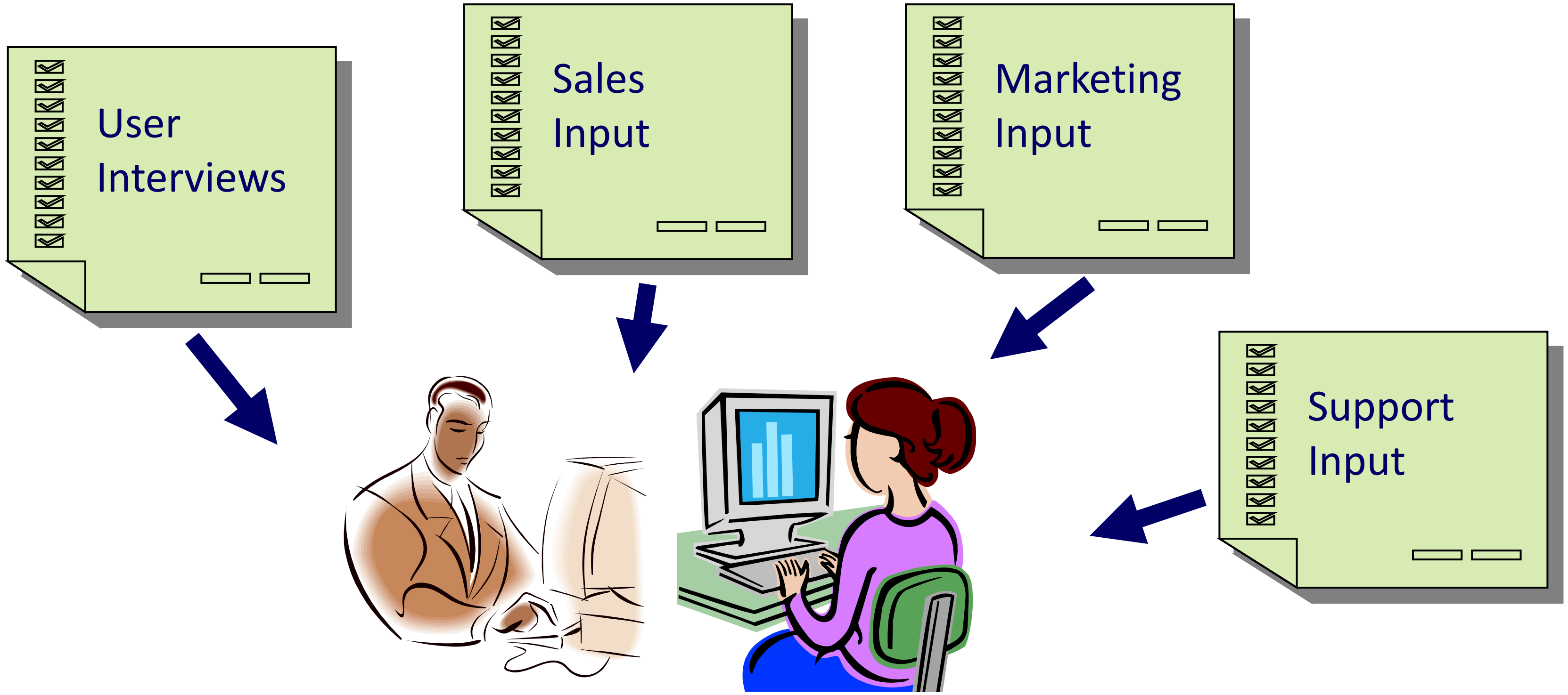
Tasks that end-users must perform to do their work

Content that is presented as part of the interface

Environment where these tasks will be conducted

User Analysis

- User’s mental model should be consistent with the design model



User Interviews

Sales Input

Marketing Input

Support Input

Know the users

User Analysis Questions

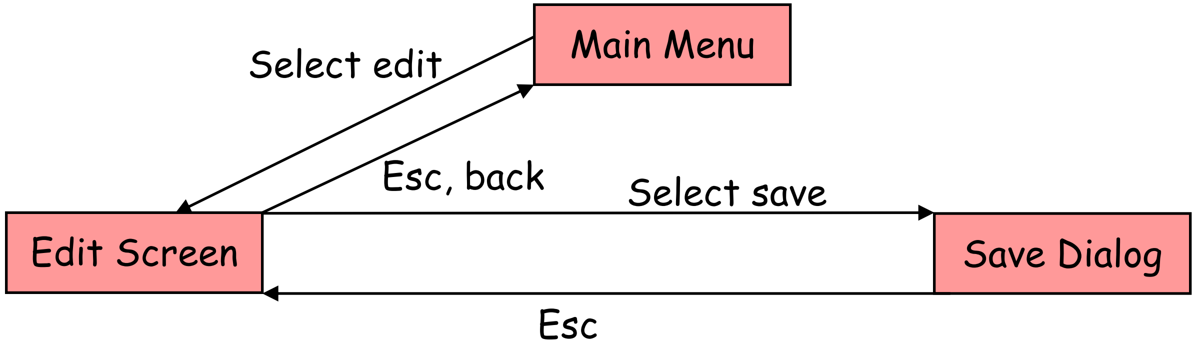
- Are users trained professionals, technician, clerical, or manufacturing workers?
- What level of formal education does the average user have?
- Are the users capable of learning from written materials or have they expressed a desire for classroom training?
- Are users expert typists or keyboard phobic?
- What is the age range of the user community?
- Will the users be represented predominately by one gender?
- How are users compensated for the work they perform?
- Do users work normal office hours or do they work until the job is done?
- Is the software to be an integral part of the work users do or will it be used only occasionally?
- What is the primary spoken language among users?
- What are the consequences if a user makes a mistake using the system?
- Are users experts in the subject matter that is addressed by the system?
- Do users want to know about the technology the sits behind the interface?

Task Analysis

- Task analysis strives to know and understand
  - The ***work*** the user performs in specific circumstances
  - The ***tasks*** and ***subtasks*** that will be performed as the user does the work
  - The specific problem domain ***objects*** that the user manipulates as work is performed
  - The ***sequence*** of work tasks (i.e., the workflow)
  - The ***hierarchy*** of tasks

Task Modeling

- **Use-cases** define basic work tasks
  - Extract tasks, objects and the flow of interaction
- **Task elaboration** refines interactive tasks
  - Stepwise refinement



Task Modeling

Screen	Main Menu	Edit Screen	Save Dialog
Main Menu	N/A	Select Edit	------
Edit Screen	Esc, back	N/A	Select save
Save Dialog	------	esc	N/A

- **Object elaboration** identifies interface objects
  - Categorize into classes (include *attributes* and *operations*)
- **Workflow analysis** defines how a work process is completed when several people (and roles) are involved
  - Swimlane diagram
- **Hierarchical representation** is defined for each user type

Content Analysis

- ***Displayed content*** range from character-based reports, to graphical displays, to multimedia information
  - Generated by components in other parts of the application
  - Acquired from data stored in a database that is accessible from the application
  - Transmitted from systems external to the application
- ***Format*** and ***aesthetics*** of the content (as it is displayed by the interface) needs to be considered
  - A set of questions should be answered

Analysis of Display Content

- Are different types of data assigned to consistent geographic locations on the screen (e.g., photos always appear in the upper right-hand corner)?
- Can the user customize the screen location for content?
- Is proper on-screen identification assigned to all content?
- If a large report is to be presented, how should it be partitioned for ease of understanding?
- Will mechanisms be available for moving directly to summary information for large collections of data?
- Will graphical output be scaled to fit within the bounds of the display device that is used?
- How will color be used to enhance understanding?
- How will error messages and warnings be presented to the user?

Work Environment Analysis

- The physical characteristics of the work place
- The type of equipment used
- The work relationships with other people

Interface Design Steps

Many UI design models suggest the common steps:

1. Using information developed during interface analysis, define interface ***objects*** and ***actions***.
2. Define ***events*** that will cause the state of the user interface to change. Model this behavior.
3. Depict each interface ***state*** as it will actually look to the end-user.
4. Indicate ***how the user interprets*** the state of the system based on the information provided through the interface.

Interface Objects and Actions

- Interface objects and actions are obtained from a grammatical parse.
- Three types of objects: source, target, and application
  - A source object is dragged and dropped into a target object such as to create a hardcopy of a report
  - An application object represents application-specific data that are not directly manipulated as part of the screen interaction such as a list
- After identifying objects and their actions, perform a screen layout:
  - Graphical design and placement of icons
  - Definition of descriptive screen text
  - Specification and titles for windows
  - Definition of major and minor menu items
  - Specification of a real-world metaphor to follow

Interface Design

- During the four steps, the designer must
  - Always follow the three golden rules of user interfaces
  - Model how the interface will be implemented
  - Consider the computing environment

    e.g., display technology, operating system, development tools that will be used

Design Issues

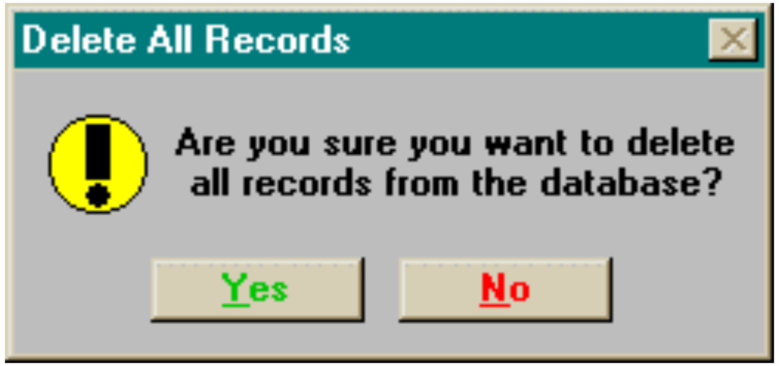
Four common design issues in any user interface:

- System response time
  - Length and variability
- Help facilities
  - When is it available, how is it accessed, how is it represented to the user, how is it structured, how to return to normal interaction
- Error handling
  - How meaningful to the user, how descriptive of the problem
- Menu and command labeling
  - Consistent, easy to learn, accessibility, internationalization

- The issues are often not addressed until late in the design, and result in unnecessary iterations, project delays, and frustration

Good or Bad Designs

- Dialog box to ask if you want to delete
  - Yes
  - No
- Problems?
  - Color deficiency
  - Cultural mismatch
    - Western: green for good, red for bad/stop
    - Eastern and others may differ

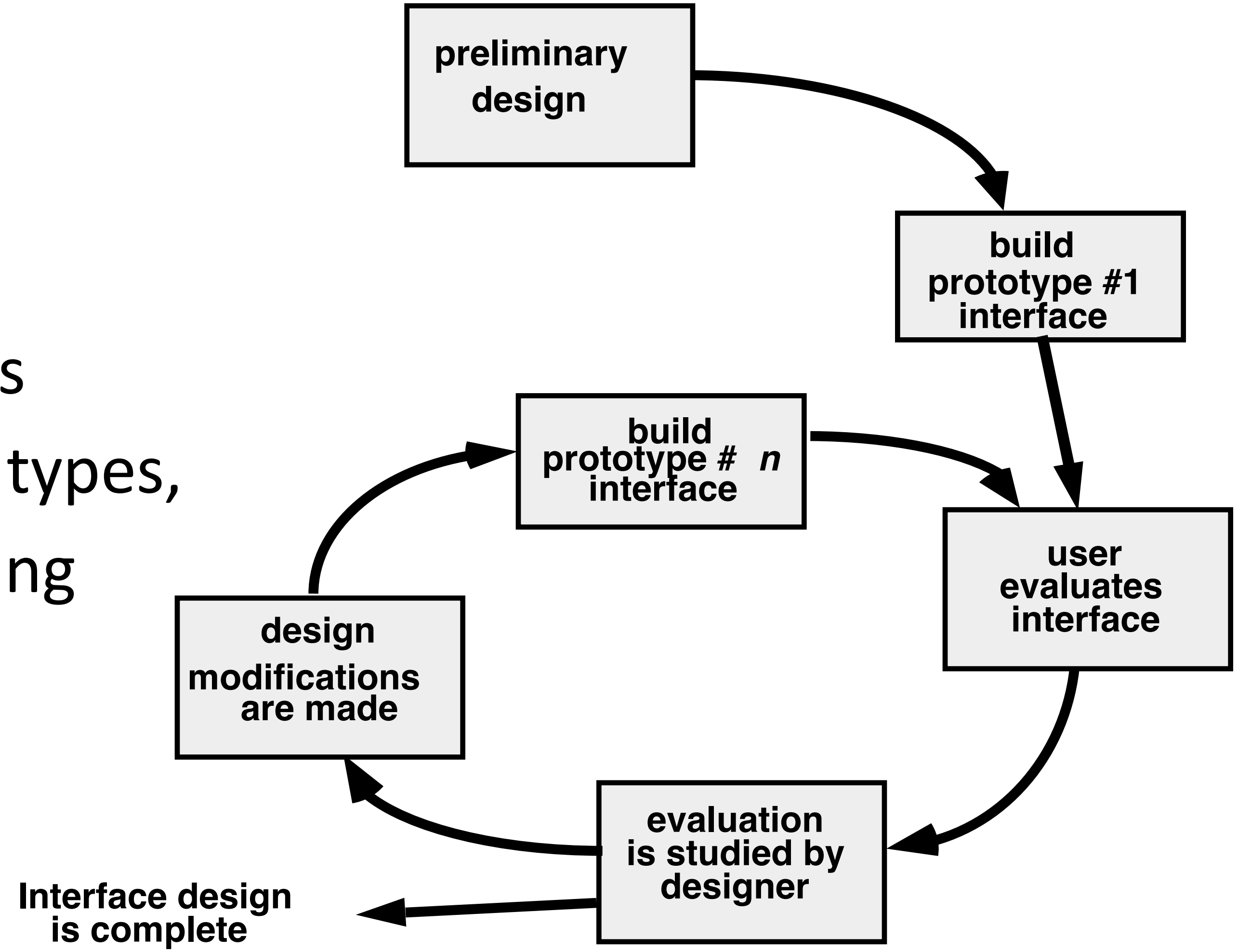


Delete All Records

Are you sure you want to delete all records from the database?

Design Evaluation Cycle

- Early evaluation criteria
  - Length and complexity
  - # of tasks, actions, states
  - Choices about interface types,
    help facility, error handling
- Questionnaire or
  time-study analysis


preliminary design
build prototype #1 interface
build prototype # n interface
user evaluates interface
design modifications are made
evaluation is studied by designer
Interface design is complete

References

- Prof. Fengjun Li’s EECS 448 Fall 2015 slides

- This slide set has been extracted and updated from the slides designed to accompany *Software Engineering: A Practitioner’s Approach, 8/e* (McGraw-Hill 2014) by Roger Pressman