2 Basic HCI Principles

Corresponding extension topic:
E1 Fitt's Law

Principles for User Interface (UI) design

- Implementation and technology independent principles
  - Provide a rough guideline for design
  - To be supplemented by more detailed analyses (see later)
- Ben Shneiderman's list of principles:
  (see http://media.pearsoncmg.com/aw/aw_shneiderma_dtui_4/chapter2.pdf)
  - **Principle 1 : Recognize User Diversity**
  - **Principle 2 : Follow the Eight Golden Rules**
  - **Principle 3 : Prevent Errors**
- Similar lists exist in several variants

Principle 3: Prevent Errors - Classical Techniques

Note: Golden rule number 5 discusses same topic on higher level…

A few classical “tricks” to prevent errors (Source: Shneiderman)

- Correct matching pairs
  - Example problems: {} in program text, <B>**bold**</B> in HTML
  - Prevention: insert both brackets in one action; or remind of missing bracket
- Complete sequences
  - Assistance for the user to complete a sequence of actions to perform a task
    - » For advanced users: planning and editing the sequence
  - Examples: Log-on sequences, wizards, scripts
- Command correction
  - Aim: Trying to prevent users entering incorrect commands
  - Examples:
    - » File completion on Unix
    - » Helpful error messages
    - » Menus instead of commands

What is an “error” after all?

2 Basic HCI Principles

Human Error

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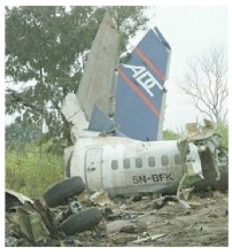
Nigeria Says Human Error May Have Caused Plane Crash

By VOA News
30 October 2006



AP Photo
Wreckage of Nigerian airliner

Nigerian transportation officials say human error may have contributed to an airline crash that killed at least 99 people.

Roland Iyayi, Director General of the Nigerian Airspace Management Agency, told VOA Monday the pilot of the Boeing 727 airliner ignored instructions to delay takeoff because of bad weather. He said two other airlines on the runway obeyed instructions not to fly.

- http://www.voanews.com/english/2006-10-30-voa19.cfm

War on Human Error

Top News

Bombardier 'Stands Down' Against Human Error

Wed, 26 Oct '05

Event Aims To Reduce Pilot Mistakes

More than 420 pilots, crewmembers, safety specialists, industry officials and media representatives have gathered at Bombardier's 9th Annual Safety Standdown in Wichita, KS. The event, billed as the industry's foremost safety event, is being held Oct. 25-27.

The only safety seminar of its kind to be offered by a civil aircraft manufacturer, Bombardier's Safety Standdown is taking clear aim at the cause of 78 percent of all accidents in aviation -- human error.

"The intent of Safety Standdown is to reduce accidents caused by human failure across the aviation industry as a whole, whether they occur during corporate, commercial or military missions," stated Bob Agostino, director, flight operations, Bombardier Business Aircraft. "While we believe current training programs using simulators and other training devices are excellent, we also recognize that accident prevention requires more than simply perfecting technical skills."

This year's event will focus on "Winning The War On Error," enabling aviation professionals to better understand why and how crucial mistakes occur by providing in-depth, knowledge-based training in areas such as fatigue, nutrition and psychological factors.

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Human Error as the Ultimate Explanation (1)

Human Error Blamed in Transrapid Crash

Investigators publish first insights on tragic accident in Germany

Bjoern Sjut (bsjut) CONTACT REPORTER ✉ Email Article 🖶 Print Article

Published 2006-10-06 12:22 (KST)

Law enforcement officers in Germany published the first results of their investigation into the crash of the Transrapid magnetic train, which killed 23 people and injured 10 others.

Related Articles | • What Caused the Transrapid Crash?

Investigators agree so far that the both command center personnel and the train's driver is to blame. Apparently, the command center gave the train a green light, despite the fact that a service wagon was still on the track. It seems that the two workers from the command center forgot about the service wagon. Both men are still under psychological treatment and were unable to comment on the situation. They face a sentence of up to five years for negligent homicide, according to District Attorney Alexander Retemeyer.

- http://english.ohmynews.com/articleview/article_view.asp?menu=c10400&no=319593&rel_no=2

Human Error as the Ultimate Explanation (2)

Reference: http://www.iabg.de/transrapid/download/docs/MAGLEVMT_eng.pdf
Page 2, section 3, paragraph 3:

Quote:

> Errors by the responsible human being during operation and maintenance are expressly assumed, permitted and cushioned by technical organisational and technical process measures.
> That means an error tree for an assumed safetyrelevant incident never ends with the simple explanation "human error" or "single element failure".

- http://www.magnetbahnforum.de

Human Errors and Management

TAIPEI TIMES

Published on TaipeiTimes
http://www.taipeitimes.com/News/taiwan/archives/2003/10/18/2003072381

Fighter pilots find panic button at last

MISTAKE MANAGEMENT: Two crashes blamed on human error have prompted the developers of the IDF to remind the air force about a built-in emergency function

By Brian Hsu
STAFF REPORTER
Saturday, Oct 18, 2003, Page 4

Although Taiwan's Indigenous Defense Fighter (IDF) has an emergency function that minimizes the chance of a plane crash due to human error, pilots have only now found out about it.

The previous two accidents involving IDFs this year were caused by human error, defense sources said yesterday.

"The crash was also caused by the negative G-force which the flight instructor created

…In an attempt to prevent similar accidents in future, the air force has asked the AIDC to help teach pilots how to use the fighter's emergency function.

Human Error and Commercial Success

PITTSBURGH TRIBUNE-REVIEW Back to headlines

tT Larger Text Tt Smaller Text

Barring human error made area firm a health leader

By Rick Stouffer
TRIBUNE-REVIEW
Wednesday, October 19, 2005

More than 30 years ago, bar codes began showing up on the bottoms, backs or sides of everything from blocks of cheese to 2-by-4s.

Medicine, however, was a late arrival to tracking equipment and medications using bar code technology. In the early 1990s, it was a Pittsburgh-based start-up, Automated Healthcare, that jump-started the use of the vertical black and white lines for tracking medicine in hospitals.

"It really was quite amazing that we were bar coding ketchup, but not bar coding things that could kill you if an error was made," said Sean McDonald, who founded Automated Healthcare in 1990, sold it to drug distribution giant McKesson in 1996 for $65 million, then stayed for five years to continue running the company. Today, the company is known as McKesson Automation.

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- http://pittsburghlive.com/x/tribune-review/business/s_385507.html

About (Human) Errors…

- "If an error is possible, someone will make it" (Norman)
- Human Error may also be a starting point to look for design problems.
- Design implications
  - Assume all possible errors will be made
  - Minimize the chance to make errors (constraints)
  - Minimize the effect that errors have (is difficult!)
  - Include mechanism to detect errors
  - Attempt to make actions reversible

Understanding Errors

- Errors are routinely made
  - Communication and language is used between people to clarify – more often than one imagines
  - Common understanding of goals and intentions between people helps to overcome errors
- Two fundamental categories
  - Mistakes
    - » overgeneralization
    - » wrong conclusions
    - » wrong goal
  - Slips
    - » Result of "automatic" behaviour
    - » Appropriate goal but performance/action is wrong

Norman, Chapter 5

Understanding the Types of Slips Users Make

- Capture errors
  - Two actions with common start point, the more familiar one captures the unusual (driving to work on Saturday instead of the supermarket)
- Description errors
  - Performing an action that is close to the action that one wanted to perform (putting the cutlery in the bin instead of the sink)
- Data driven errors
  - Using data that is visible in a particular moment instead of the data that is well-known (calling the room number you see instead of the phone number you know by heart)
- Associate action errors
  - You think of something and that influences your action (e.g. saying come in after picking up the phone)
- Loss-of-Activation error ~ forgetting
  - In a given environment you decided to do something but when leaving then you forgot what you wanted to do. Going back to the start place you remember.
- Mode error
  - You forget that you are in a mode that does not allow a certain action or where a action has a different effect (US: four-way and two-way stop signs)

Norman, Chapter 5

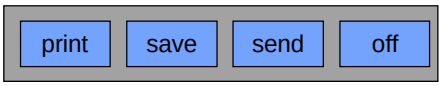
Confirmation is Unlikely to Prevent Errors

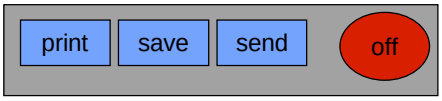
- Example
  - User: “remove the file ‘**`most-important-work.txt`**’”
  - computer: “are you sure that you want to remove the file ‘**`most-important-work.txt`**’?”
  - User: “yes”
  - Computer: “are you certain?”
  - User: “yes of course”
  - Computer: “the file ‘**`most-important-work.txt`**’ has been removed”
  - User: Oops, damn
- The user is not reconsidering the overall action – confirmation only prompts to think about the immediate action (clicking)
- A solution is to make the action reversible
  - What is the potential problem with that?

Norman, Chapter 5

Preventing Description Errors

- Related to Gestalt theory
- Example Car
  - Different openings for fluids, e.g. oil, water, break, …
  - Openings differ in
    - » Size
    - » Position
    - » Mechanism to open
    - » Color
- Design recommendations
  - Make controls for different actions look different





Preventing Mode Errors

- Why use modes in the first place?
  - User interface trade-off (e.g. number of buttons needed can be reduced, actions within a mode can be speeded up)
- Design recommendations
  - Minimize number of modes
  - Make modes always visible
- Example alarm clock
  - Mode vs. mode free
  - Visualization of mode
- What is your solution?
  - Draw the control elements
  - Provide labels

Setting time and alarm with mode?

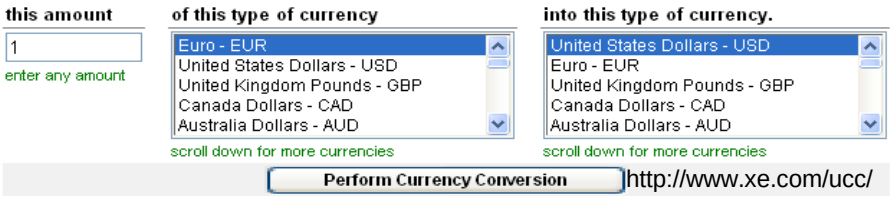
Setting time and alarm without mode?

2 Basic HCI Principles

Models & Theories

- What are models and theories used for?
  - Explanatory
  - Predictive
    - » E.g. Fitt's Law, KLM
  - Descriptive/taxonomy
- Models on different levels
  - concept
  - human action
  - …
  - dialog
  - keystroke
- What is modelled?
  - user
  - task
  - dialogs
  - transitions
  - software
  - input/output
  - system
  - interaction
  - behaviour
  - …
  - combination of these

Example Motivation - Prediction



- Convert 712 GBP into EUR
- Hand is on the mouse to start with

- How long will it take?

A General Warning: Situated Actions and Distributed Cognition

- Example:
  - Bank managers don't type… (Dix et al. P. 154)
- Complex interaction between people
- Interaction with different devices
- Interaction with information in different forms
- Complex interaction with the physical environment
- Interruptions as standard phenomenon of live
- Computer usage can not be seen isolated from that
- Suchman, 1990
  - Human plans are often not orderly executed
  - Plans are often adapted or changed
  - User's actions are situated in time and place
  - User's actions are responsive to the environment
  - Distributed cognition – knowledge is not just in the user's head it is in the environment

This questions many of the modeling approaches…

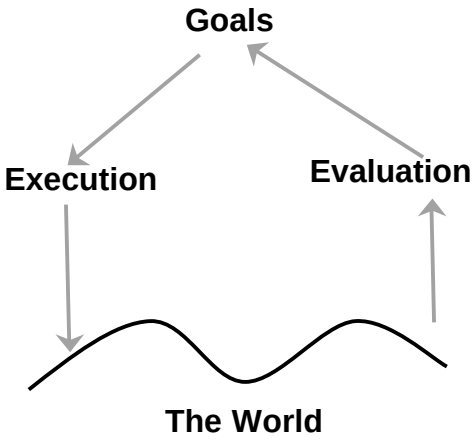
Background: The Psychology of Everyday Action

- People are blaming *themselves* for problems caused by design
  - If the system crashes and the user did everything as he is supposed to do the developer/system is blamed
  - If the system crashes and the user operated the system wrongly the user is blamed
- People have misconceptions about their actions
  - The model must not be fully correct – it must explain the phenomenon
- People always try to explain actions and results
  - Random coincidence may lead to assumptions about causality

(Norman 2002, Chapter 2)

Action Cycle

- The action is goal directed
  - What do we want to happen?
  - What is the desired state?
- Human action has two major aspects
  - Execution:
    what we do to the world
  - Evaluation:
    compare if what happens is what we want



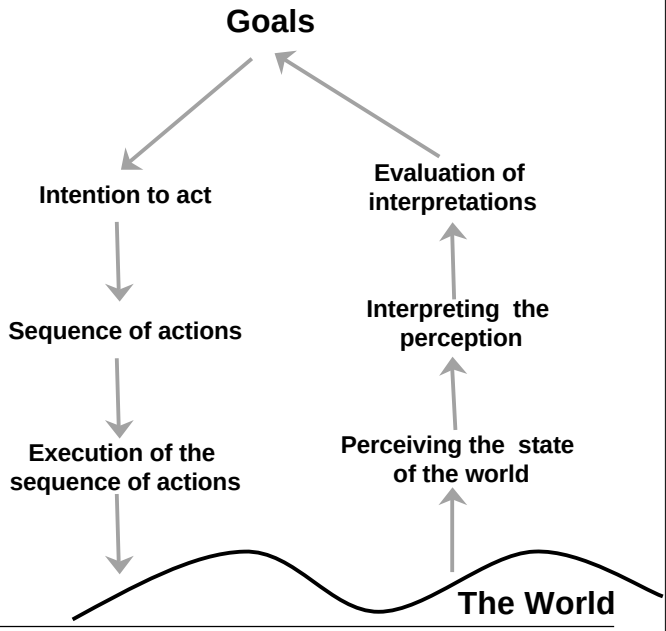
Action Cycle
Stages of Execution

- Goal
  translated into
- An intention to act as to achieve the goal
  translated into
- The actual sequence of actions that we plan to do
  translated into
- The physical execution of the action sequence

Action Cycle
Stages of Evaluation

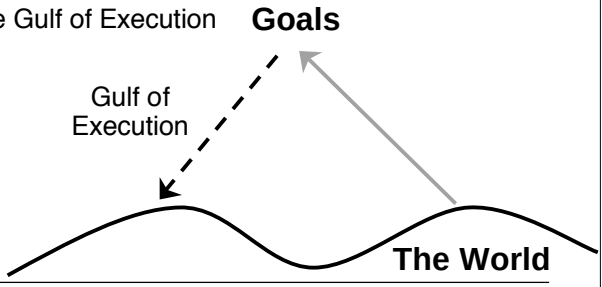
- Perceiving the state of the worlds
  followed by
- Interpreting the perception according to our expectations
  followed by
- Evaluation of the interpretations with what we expected to happen (original intentions)
  followed by
- Goal

Seven Stages of Action



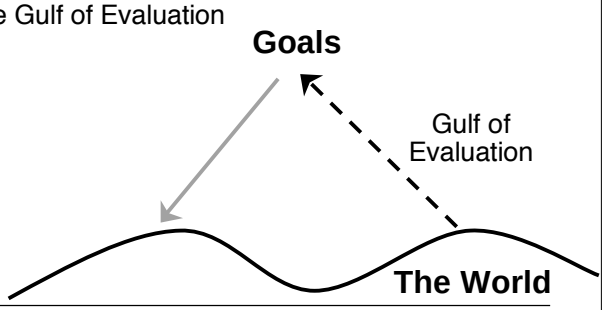
Gulf of Execution

- The difference between the intentions and the allowable actions is the Gulf of Execution
  - How directly can the actions be accomplished?
  - Do the actions that can be taken in the system match the actions intended by the person?
- Example:
  - The user wants a document written on the system in paper (the goal)
  - What actions are permitted by the system to achieve this goal?
- Good design minimizes the Gulf of Execution



Gulf of Evaluation

- The Gulf of Evaluation reflects the amount of effort needed to interpret the state of the system how well this can be compared to the intentions
  - Is the information about state of the system easily accessible?
  - Is it represented to ease matching with intentions?
- Example in GUI
  - The user wants a document written on the system in paper (the goal)
  - Is the process observable? Are intermediate steps visible?
- Good design minimizes the Gulf of Evaluation



Evaluation and Design Questions

- Execution
  - Can the user tell what actions are possible?
  - Does the interface help with mapping from intention to physical movement?
  - Does the device easily support required actions?
- Evaluation
  - Can the user tell if the system is in the desired state?
  - Can the user map from the system state to an interpretation?
  - Can the user tell what state the system is in?

Implications on Design

- Principles of good design (Norman)
  - Stage and action alternatives should be always visible
  - Good conceptual model with a consistent system image
  - Interface should include good mappings that show the relationship between stages
  - Continuous feedback to the user

- Critical points/failures
  - Inadequate goal formed by the user
  - User does not find the correct interface / interaction object
  - User many not be able to specify / execute the desired action
  - Inappropriate / mismatching feedback

2 Basic HCI Principles

Corresponding extension topic:
E1 Fitt's Law

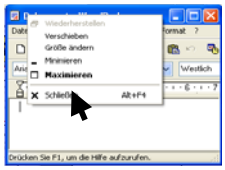
GOMS
Goals, Operators, Methods, Selection Rules

- Card, Moran, Newell, 1980: GOMS
- GOMS techniques produce quantitative and qualitative predictions of how people will use a proposed system
- Basics:
  - Goals – goal a user wants to accomplish (in real scenarios hierarchical)
  - Operators – operations (at a basic level) that are used to achieve a goal
  - Methods – sequence of operators to achieve a goal
  - Selection Rules – selection of method for solving a goal (if alternatives are given)
- John, B. & Kieras, D. (1996). Using GOMS for user interface design and evaluation: which technique? *ACM Transactions on Computer-Human Interaction, 3,* 287-319.

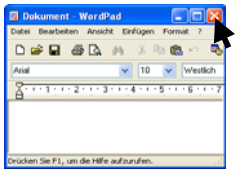
Example (adapted from Dix 2004, p. 423):
Close the window that has the focus (Windows XP)

- Compare three options:

ALT + F4 Key-shortcut



Context-menu



Close-button

```
GOAL: CLOSE-WINDOW
. [select    GOAL: USE-KEY-SHORTCUT-METHOD
.            .     hold-ALT-key
.            .     press-F4-key
.            GOAL: USE-CONTEXT-MENU-METHOD
.            .     Move-mouse-win-head
.            .     Open-menu (right click)
.            .     Left-click-close
.            GOAL: USE-CLOSE-BUTTON-METHOD
.            .     Move-mouse-button
.            .     Left-click-button]

Rule 1: USE-CLOSE-BUTTON-METHOD if no other rule is given
Rule 2: USE-KEY-SHORTCUT-METHOD if no mouse is present
```

Example (adapted from Dix 2004, p. 424):
copy a journal article

GOAL: PHOTOCOPY-PAPER
. GOAL: LOCATE-ARTICLE
. GOAL: COPY-PAGE repeat until no more pages
. . GOAL: ORIENT-PAGE
. . . OPEN-COVER
. . . SELECT-PAGE
. . . POSITION-PAGE
. . . CLOSE-COVER
. . GOAL: PRESS-COPY
. . GOAL: VERIFY-COPY
. . . LOCATE OUTPUT
. . . EXAMINE COPY
. GOAL: COLLECT-COPY
. . LOCATE OUTPUT
. . REMOVE-COPY
(outer goal satisfied!)
. GOAL: RETRIEVE-ORIGINAL
. . OPEN-COVER
. . TAKE-ORIGINAL
. . CLOSE-COVER

Likely that the users forget this
(closure problem)

Example (adapted from Dix 2004, p. 430):

Example of a Cash-Machine
Why you need to get your card before the money.

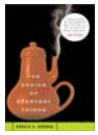
- Design to lose your card...

GOAL: GET-MONEY
. GOAL: USE-CASH-MACHINE
. . INSERT-CARD
. . ENTER-PIN
. . SELECT-GET-CASH
. . ENTER-AMOUNT
. . COLLECT-MONEY
(outer goal satisfied!)
. . COLLECT-CARD

- Design to keep your card...

GOAL: GET-MONEY
. GOAL: USE-CASH-MACHINE
. . INSERT-CARD
. . ENTER-PIN
. . SELECT-GET-CASH
. . ENTER-AMOUNT
. . COLLECT-CARD
. . COLLECT-MONEY
(outer goal satisfied!)

References



- D. A. Norman. The Design of Everyday Things. Basic Books 2002. ISBN: 0465067107
- B. Shneiderman. Designing the User Interface: Strategies for Effective Human-Computer Interaction , Third Edition. 1997. ISBN: 0201694972
- L. Suchman, Plans and situated action. 1990
- Alan Dix, Janet Finlay, Gregory Abowd and Russell Beale. (204) Human Computer, Interaction (third edition), Prentice Hall, ISBN 0130461091