Errors

An action or omission of action yielding an unintended result.

Most accidents are thought to be caused by what is referred to as *human error*, yet most accidents are actually due to design errors rather than errors of human operation. An understanding of the causes of errors suggests specific design strategies that can greatly reduce their frequency and severity. There are two basic types of errors: slips and mistakes.[1]

Slips are sometimes referred to as *errors of action* or *errors of execution,* and occur when an action is not what was intended. For example, a slip occurs when a person dials a frequently dialed phone number when intending to dial a different number. Slips are the result of automatic, unconscious processes, and frequently result from a change of routine or an interruption of an action. For example, a person forgets their place in a procedure when interrupted by a phone call.[2]

Minimize slips by providing clear feedback on actions. Make error messages clear, and include the consequences of the error, as well as corrective actions, if possible. Position controls to prevent accidental activation of functions that may have detrimental consequences. When this is not possible, use confirmations to interrupt the flow and verify the action. Consider the use of affordances and constraints to influence actions.

Mistakes are sometimes referred to as *errors of intention* or *errors of planning*, and occur when an intention is inappropriate. For example, a mistake occurs when a nurse interprets an alarm incorrectly and then administers the incorrect medicine. Mistakes are caused by conscious mental processes, and frequently result from stress or decision-making biases. For example, a person is biased to select only from visible options.

Minimize mistakes by increasing situational awareness and reducing environmental noise. Make key indicators and controls visible within one eyespan whenever possible. Reduce stress and cognitive load by minimizing the auditory and visual noise. Provide just enough feedback to accomplish warnings and other functions, and no more. Consider the use of confirmations that require multiple steps to verify the intention of highly critical tasks. Train on error recovery and troubleshooting, emphasizing communication with other team members.

Finally, always incorporate the principle of forgiveness into a design. Forgiveness refers to the use of design elements to reduce the frequency and severity of errors when they occur, enhancing the design's safety and usability.

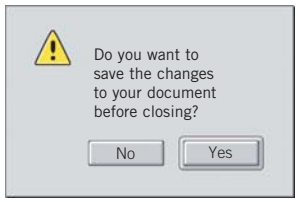
See also Affordance, Confirmation, Constraint, and Forgiveness.

[1] The seminal work on errors is "Categorization of Action Slips" by Donald A. Norman, *Psychological Review*, 1981, vol. 88, p. 1–15; and *Absent Minded? The Psychology of Mental Lapses and Everyday Errors* by James Reason and Klara Mycielska, Prentice-Hall, 1982.

[2] Note that there are many different error taxonomies. A nice review and discussion regarding the various taxonomies is found in *Human Error* by James Reason, Cambridge University Press, 1990. A very readable and interesting treatment of human error is *Set Phasers on Stun and Other True Tales of Design, Technology, and Human Error* by Steven Casey, Aegean Publishing Company, 1998.

Two Types of Slips

Action

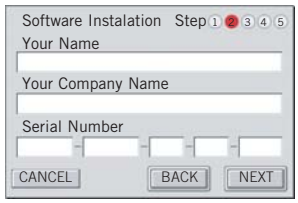


CAUSES Changes to repetitive tasks or habits

SOLUTIONS Provide clear and distinctive feedback
Use confirmations for critical tasks
Consider constraints, affordances, and mappings

◂EXAMPLE Confirmations are useful for disrupting behaviors and verifying intent

Attention



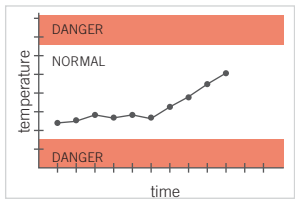
CAUSES Distractions and interruptions

SOLUTIONS Provide clear orientation and status cues
Use highlighting to focus attention
Use alarms to attract attention for critical situations

◂EXAMPLE Clear orientation and status cues are useful for enabling the easy resumption of interrupted procedures

Three Types of Mistakes

Perception

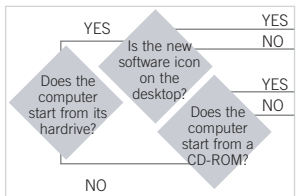


CAUSES Incomplete or ambiguous feedback

SOLUTIONS Improve situational awareness
Provide clear and distinctive feedback
Track and display historical system behaviors

◂EXAMPLE Historical displays are useful for revealing trends that are not detectable in point-in-time displays

Decision

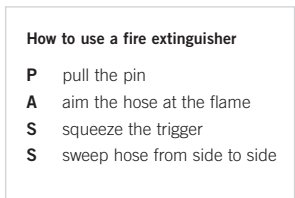


CAUSES Stress, decision biases, and overconfidence

SOLUTIONS Minimize information and environmental noise
Use checklists and decision trees
Train on error recovery and troubleshooting

◂EXAMPLE Decision trees and checklists are useful decision-making and troubleshooting tools, especially in times of stress

Knowledge



CAUSES Lack of knowledge and poor communication

SOLUTIONS Use memory and decision aids
Standardize naming and operational conventions
Train using case studies and simulations

◂EXAMPLE Memory mnemonics are useful strategies for remembering critical information in emergency situations