In Medicine

our task is to cope with illness and to enable every human being to lead a life as long and free of frailty as science will allow. The steps are often uncertain. The **knowledge** to be mastered is both **vast and incomplete**. Yet, we are expected to act with **swiftness and consistency**, even when the task requires marshaling hundreds of people – from the laboratory technicians to the nurses on each change of shift to the engineers who keep the oxygen supply system working – for the care of a single person. We are expected to do our work **humanely** and with **gentleness and concern**. It's not only the stakes but also the **complexity of performance** in medicine that make it so interesting and, at the same time, unsettling. Atul Gawande "Better: A Surgeon's Notes on Performance"

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Credit: Road to the Horizon (cogdogblog, Alan Levine), Flicker Creative Commons

Agenda

What is Human Factors?	Past, present, systems
Human Error.	Types of error, contributing factors, reducing error
Cognitive Factors.	Information processing, attention, memory, action
Physical Factors.	Workplace design, environmental conditions

Case 34-2010

2008

The most recent year with complete records, **116 wrong-site surgeries**, up from 93 in 2007, were recorded by the Joint Commission, a national hospital accrediting agency.

Preliminary reports logged **137 wrong-site surgeries** from March 2009 through June 2010.

What is Human Factors?

Definition

The study of how humans accomplish work-related tasks in the context of human-machine system operation, and how behavioral and non-behavioral variables affect that accomplishment.

Fundamental Goal

Reduce error, increase productivity, and enhance safety and comfort when the human interacts with a system.

What is Human Factors?

Individual

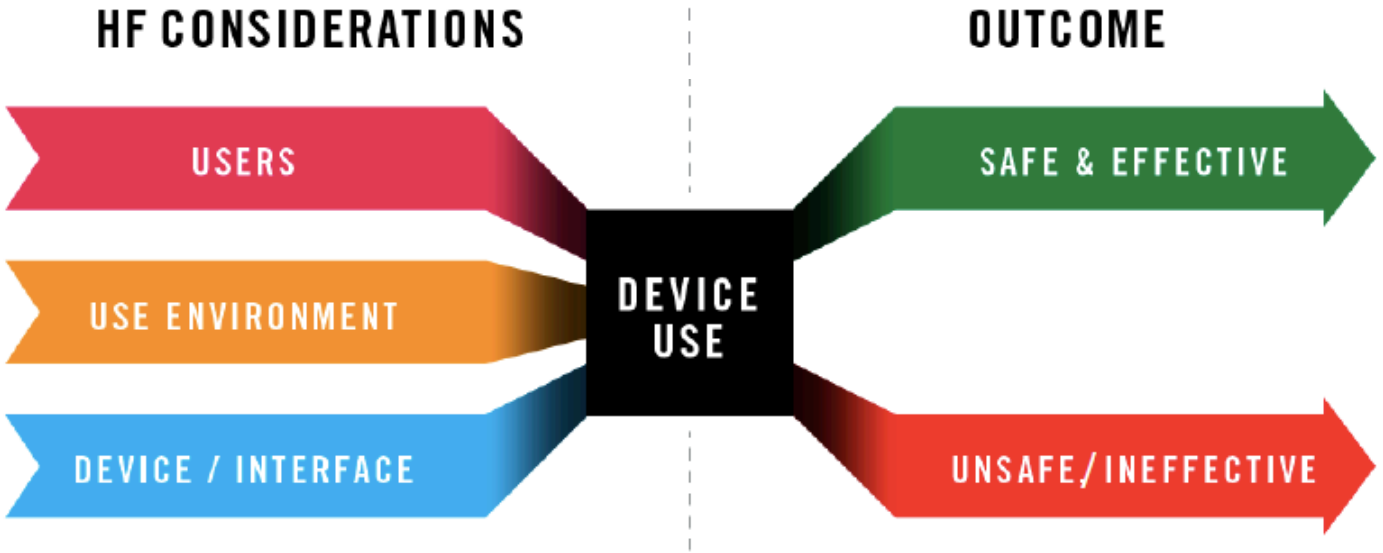
Motivations
Situated Competence

Improved
Patient
Safety

Environment

Organization
Technology
Human Performance

What is Human Factors?



Benefits of Human Factors?

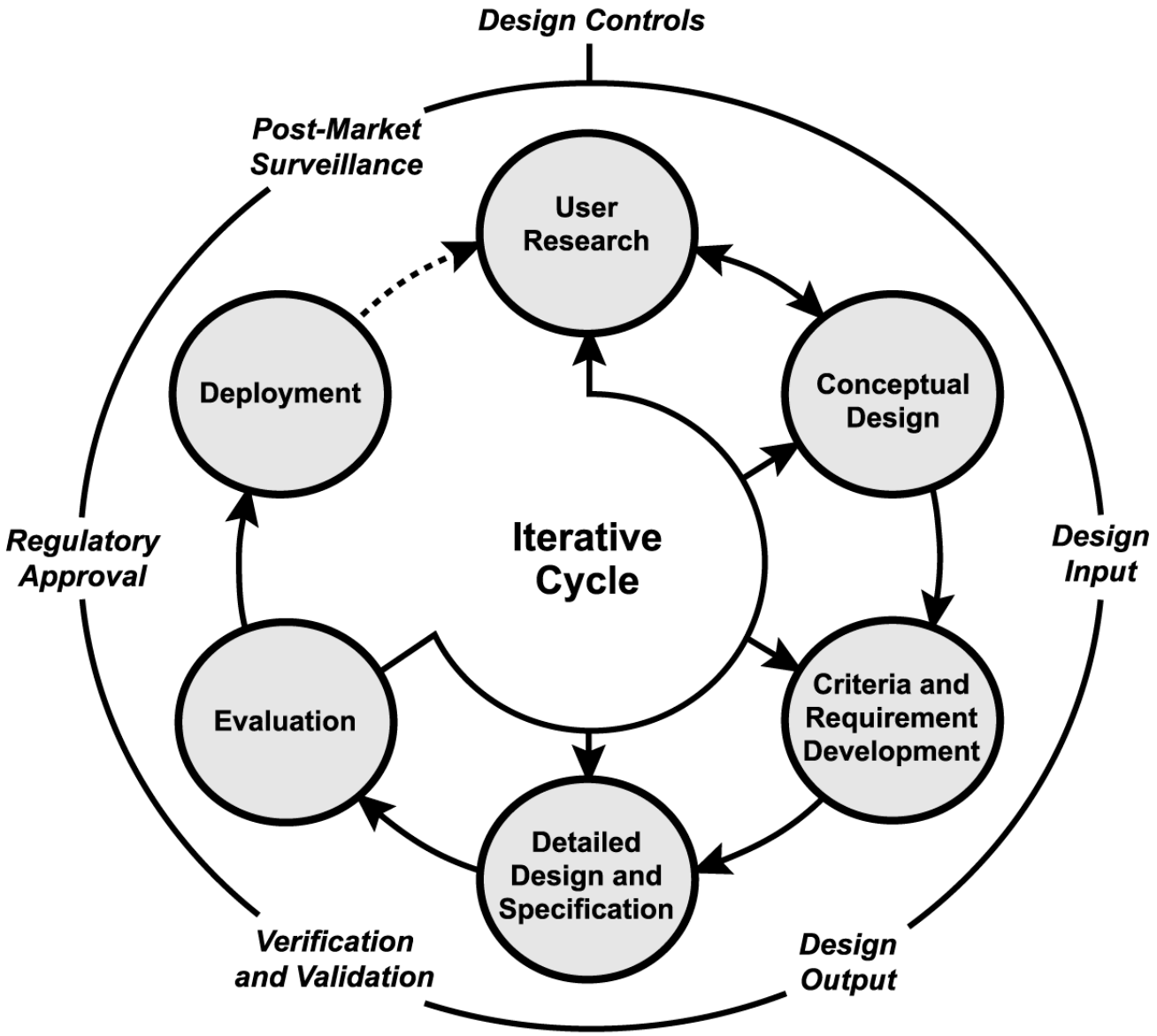
Caregivers	Empowered, more productive, more comfortable, more satisfied, protected from design-induced errors
Manufacturer	Simpler training, greater sales, lower liability exposure, lower customer support requirements
Patients	More comfortable, receive better care
Care Facilities, Insurers	Better worker performance, greater worker satisfaction, fewer mistakes leading to negative outcomes, lower liability exposure, lower cost of care

Human Factors (past)

Motivations

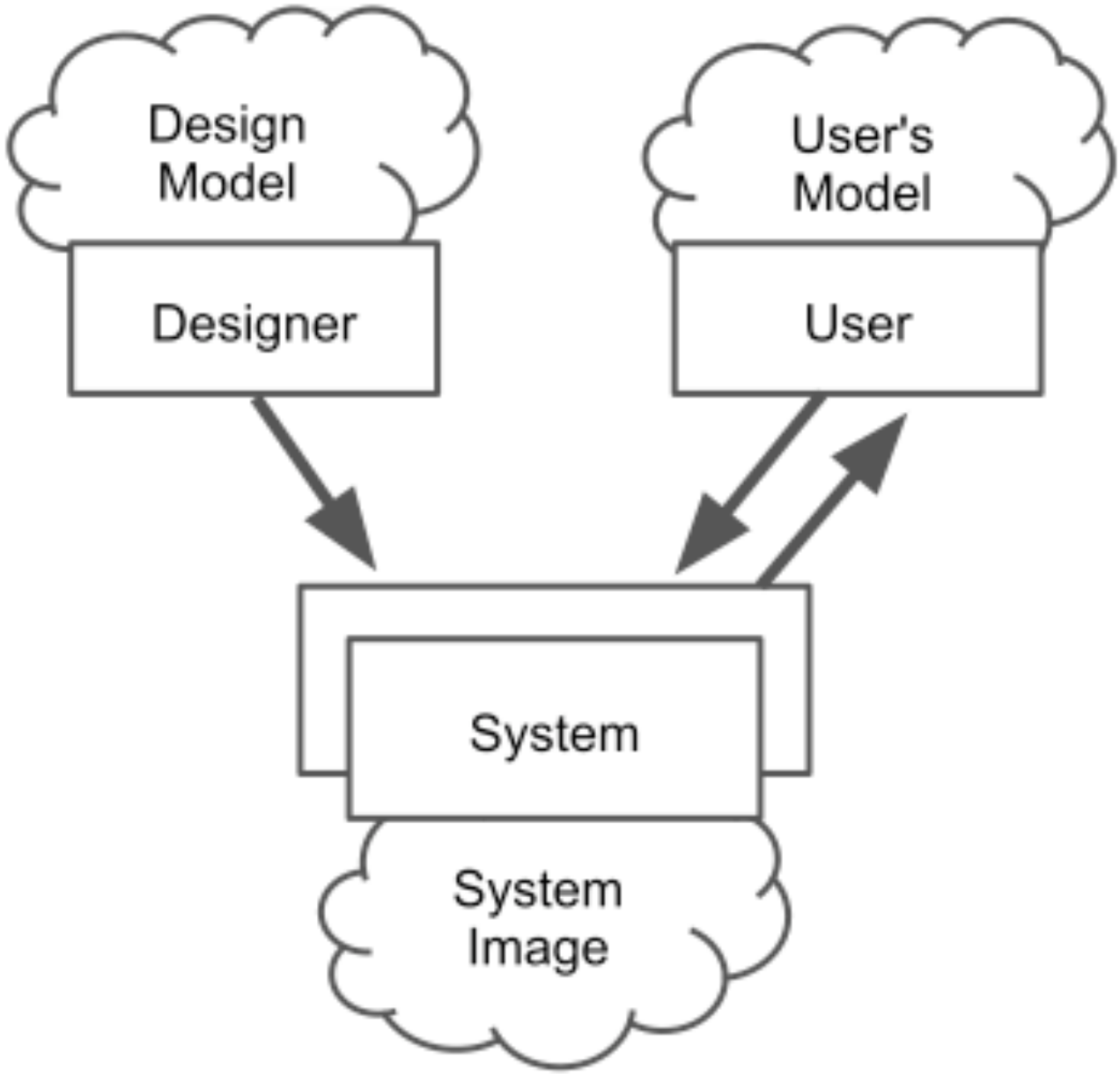
Practical Needs
Technological Advancements
Linguistic Developments

User Centered Design Process



Credit: ANSI/AAMI HE74:2001

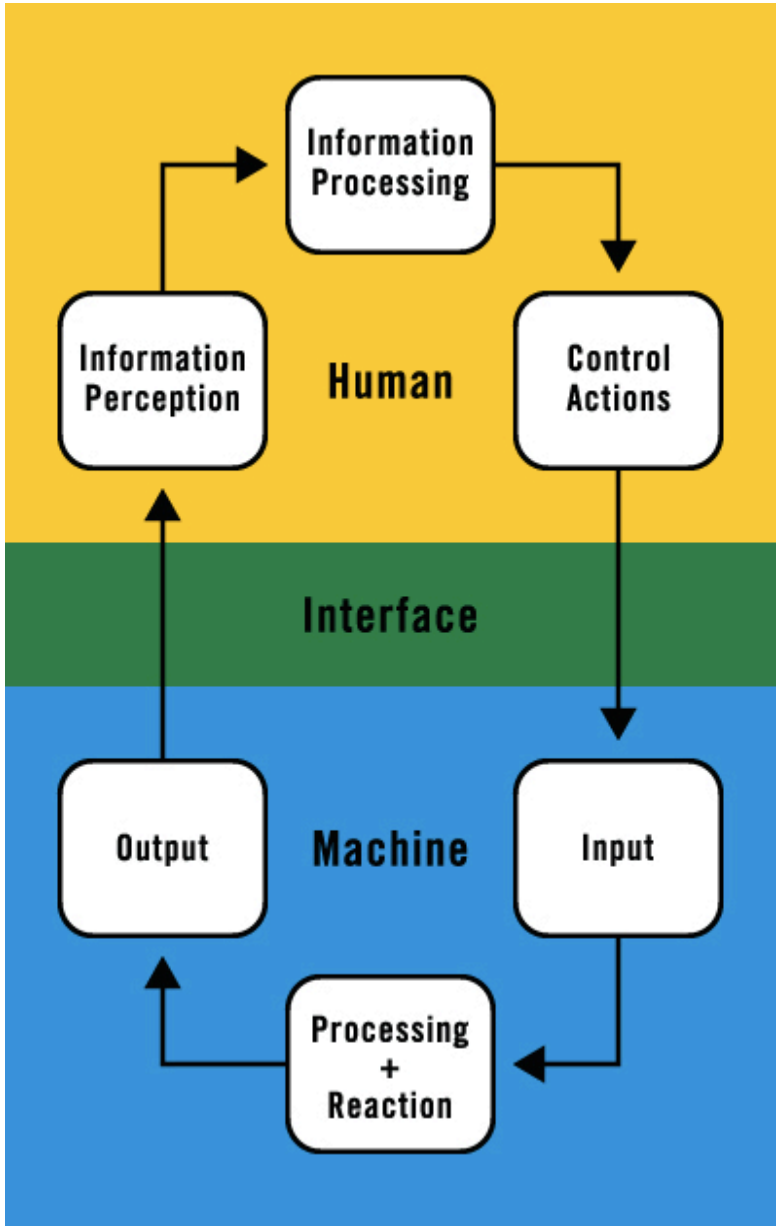
User Centered Design Process



User Centered Design Process

Credit: SonoSite, Inc.

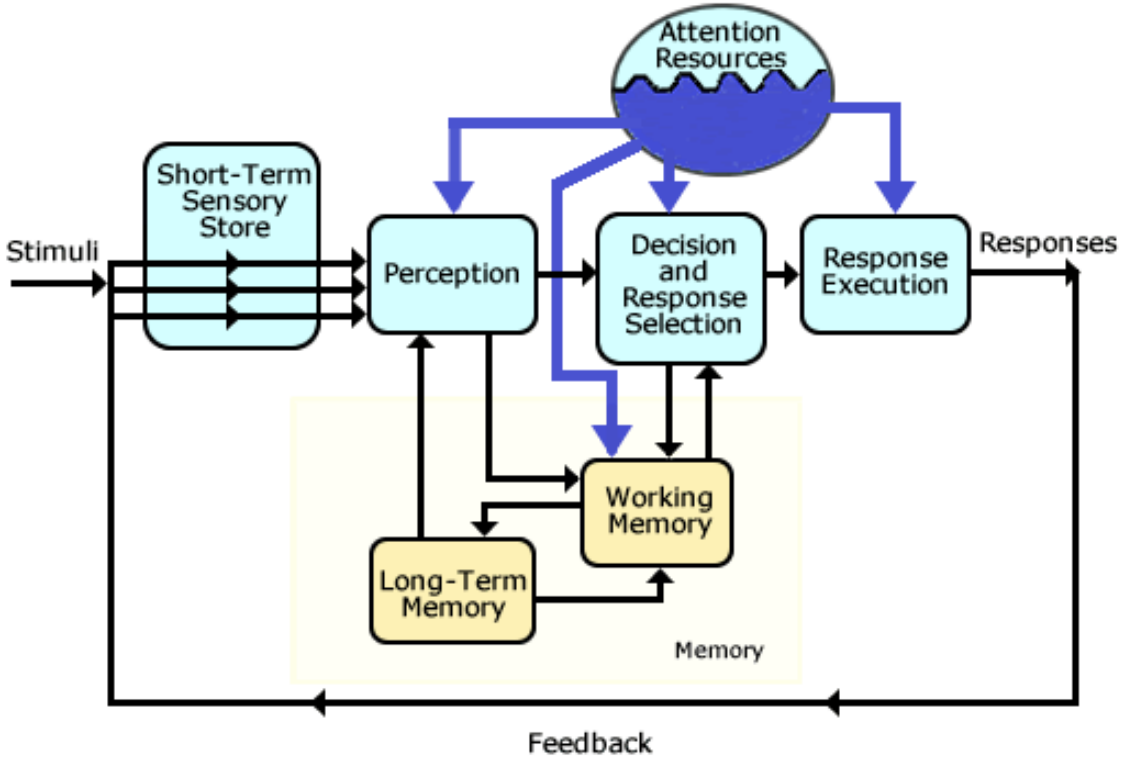
Human – Machine System



Human – Machine System

Credit: SonoSite, Inc.

Human Information Processing



What is the big deal with human factors?

- Estimated that there are **98,000 deaths per year** in the US hospital system due to medical error[1].

- Annually, medical error costs the US healthcare system **$29 billion**[1].

- Medical error is the **5th leading causes of death** in the United States (above motor vehicle accidents, diabetes, kidney disease, breast cancer, and influenza).
  Sources: (1) *To Err is Human*, (2) *WrongDiagnosis.com*

- FDA estimates **30,000 deaths per year are related to medical device error.**

- Application of Human Factors to the design of medical devices reduces use error and improves the use-safety.

Most Common Mistakes (FDA)

- HF/Usability work is not provided in submission
- No HF/Usability work prior to validation testing
- **"Explaining away" use-related issues (blame training, user … anything but the device)**
- Lack of follow up on residual risk in device and performance issues
- Not identifying and focusing on tasks with highest degree of risk
- **No or inadequate characterization of use errors**
- No systematic collection of users subjective assessment of use safety
- Not testing with representative users
- **Not objectively assessing behavioral performance**
- Use of "usability" objectives that are derived arbitrarily, not related to risk

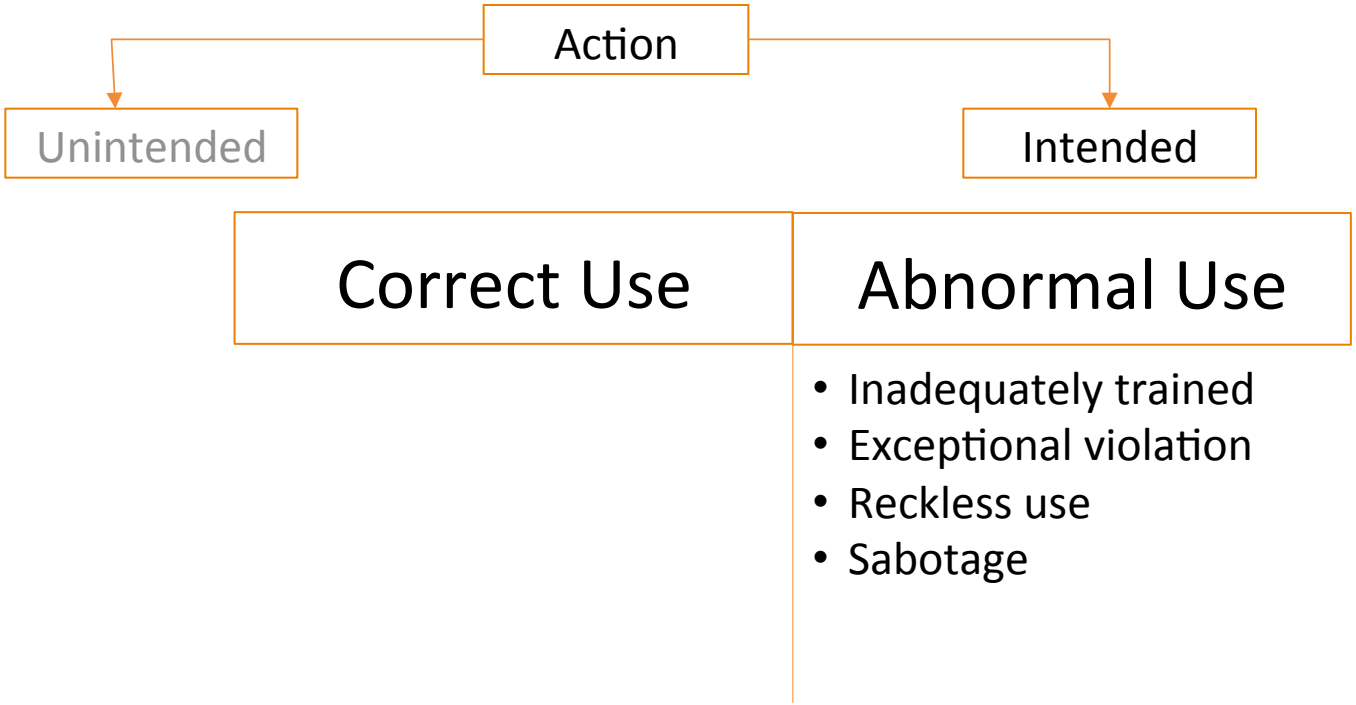
Human Error

Categories of Foreseeable User Action

- **Action**
  - **Unintended**
    - **Slip**
      - Attentional Failure:
        - Intrusion
        - Omission
        - Reversal
        - Misordering
        - Mistiming
    - **Lapse**
      - Memory Failure:
        - Omitting planned item
        - Place-losing
        - Forgetting intentions
    - **Mistake**
      - Rule-based
      - Knowledge-based
      - Skill-based
  - **Intended**
    - **Correct Use**
    - **Abnormal Use**
      - Inadequately trained
      - Exceptional violation
      - Reckless use
      - Sabotage

Credit: EN62366:2008

Categories of Foreseeable User Action



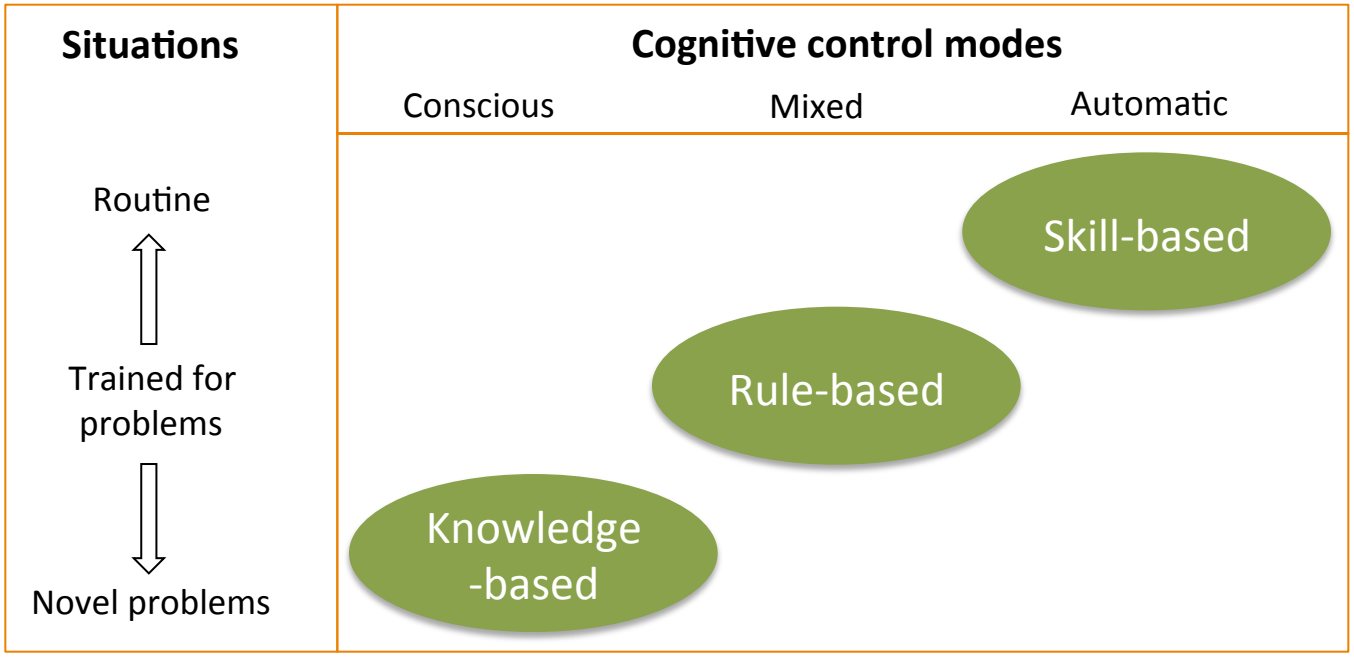
Credit: EN62366:2008

Categories of Foreseeable User Action

Slip	Lapse	Mistake
Attentional Failure: • Intrusion • Omission • Reversal • Misordering • Mistiming	Memory Failure: • Omitting planned item • Place-losing • Forgetting intentions	Rule-based Knowledge-based Skill-based

Credit: EN62366:2008

Three Levels of Performance Control



Credit: James Reason, The Human Contribution (2008)

Contributing Factors

- Management
- Physical Environment
- Equipment Design
- Work Itself
- Social/Psychological Environment
- Worker/Coworker

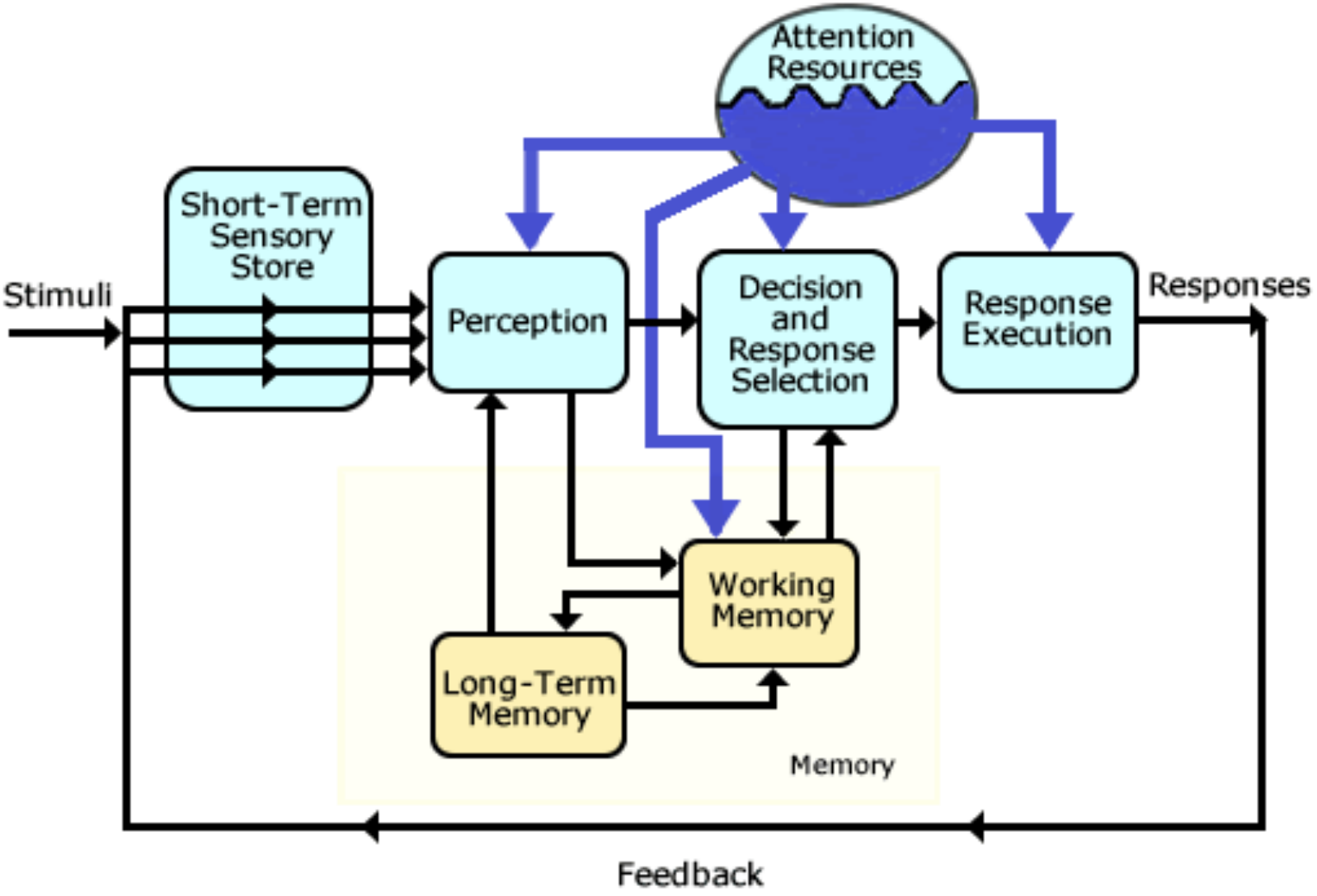
Credit: Sanders and Shaw, 1988

Reducing the Likelihood of Error

- Simplify the process; reduce hand-offs
- Standardize
- Reduce reliance on memory
- Improve information access
- Use constraints and forcing functions
- Design for errors
- Adjust work schedules
- Adjust the environment
- Improve communication
- Decrease reliance on vigilance
- Provide adequate safety training

Credit: Patrice Spath,, Error Reduction in Health Care

Cognitive Factors



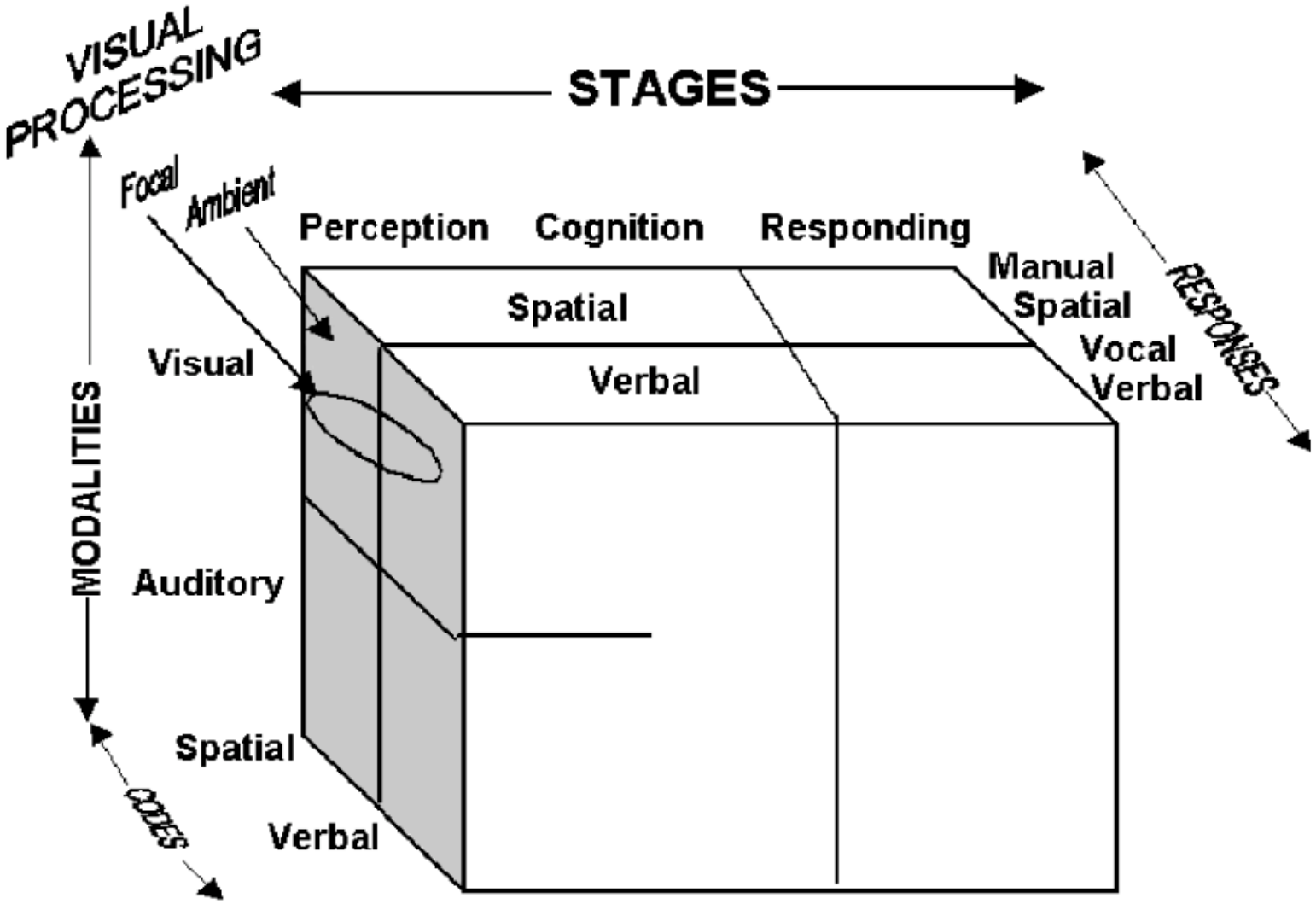
Cognitive Factors

needle	window	color / name	display / dial	push button

Attention

Selective	Monitoring several sources of information to perform a single task.
Focused	Attending to one source of information while excluding others.
Divided	Two or more separate tasks must be performed simultaneously, and attention must be paid to both.
Sustained	Maintain attention and remain alert to stimuli over prolonged periods of time (vigilance).

Attention



Credit: Christopher Wickens, Multiple Resource and Mental Workload (2008).

Memory

Sensory

Temporary storage mechanism.

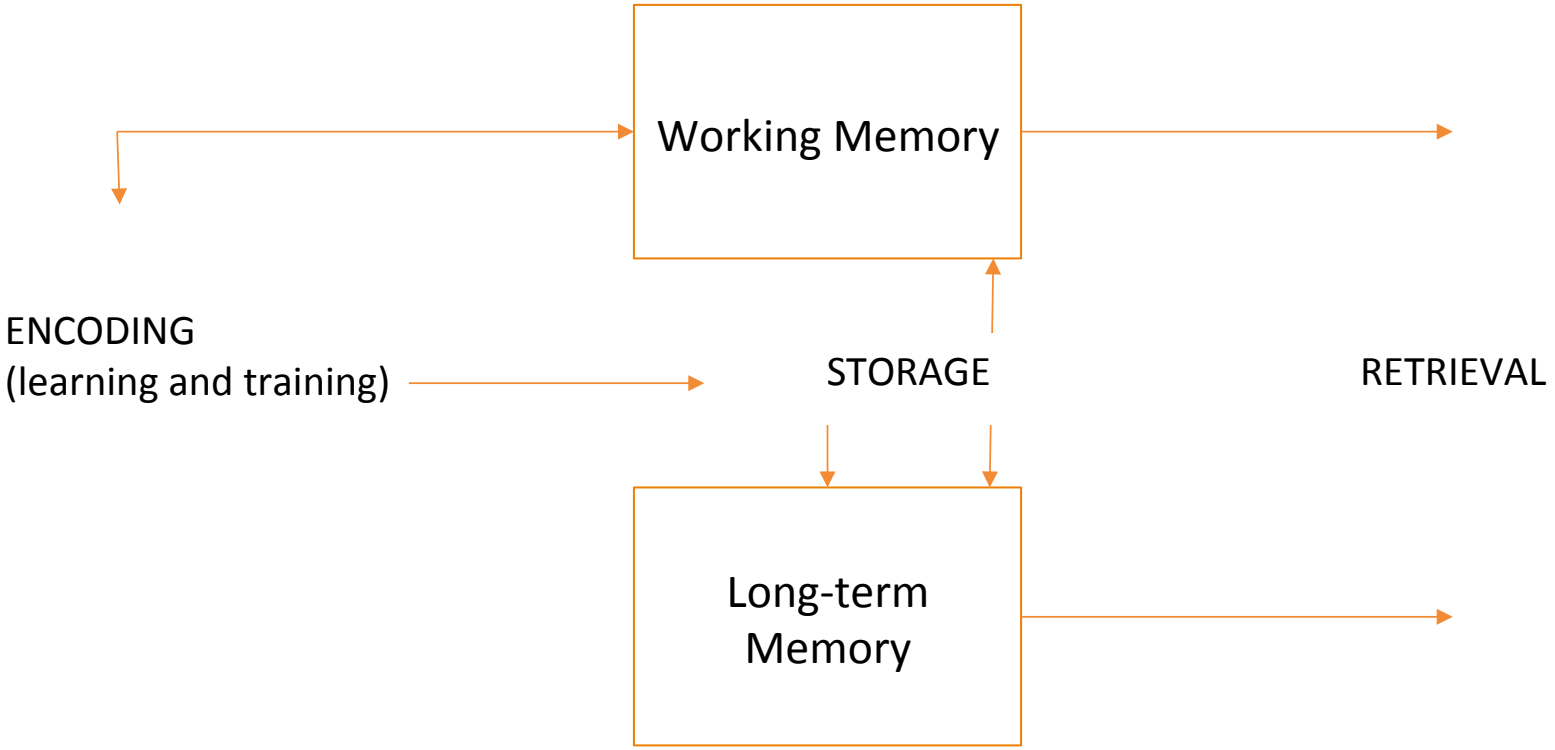
Working

Encode and transfer information from sensory to long-term memory; to hold information in working memory requires that the person directs attention to the process (short-term memory).

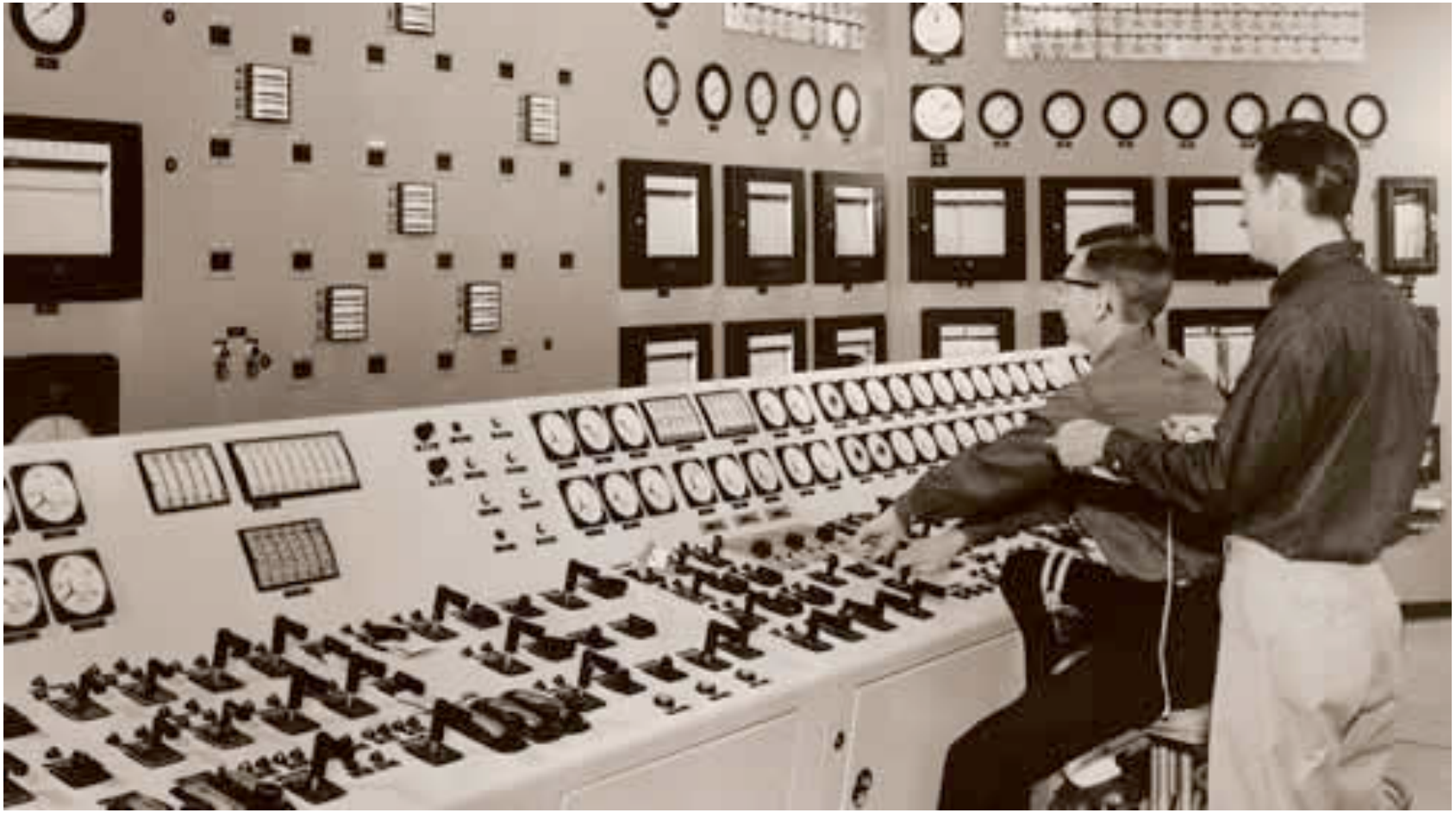
Long-term

Storehouse of facts about the world and about how to do things.

Memory


Working Memory
ENCODING
(learning and training)
STORAGE
RETRIEVAL
Long-term
Memory

Action



Physical Factors

Physical Work and Manual Materials Handling

Motor Skills

Environment

- Illumination
- Climate
- Noise

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Application

Thinking

Human performance is embedded in, and systematically connected to the situation (e.g., device, environment, organization, other people) in which it takes place.

Systems

Complex systems cannot be reduced to their individual components, and are better modeled after their relationships rather than component behavior.

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