Human Error & Safety

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"Human beings by their very nature make mistakes; therefore, it is unreasonable to expect error-free human performance." (Shappell & Wiegmann, 1997)

- *It is not surprising then, that human error has been implicated in 60-90% of all accidents.*

- *However, the rate of human error accidents has remained relatively stable over the past 20 years, whereas accidents associated with mechanical failures have been virtually eliminated.*

Definition of Human Error

- ··· is an inappropriate or undesirable human decision or behavior that reduces or has the potential for reducing the effectiveness, safety, system performance (Wickens, 2002).

- A human action/decision that exceeds system tolerances.

- An action is taken that was not intended by the actor; not desired by a set of rules or an external observer; or that led the task or system outside its acceptable limits (Senders & Moray, 1991).

Human Characters

- Recklessness

- Stubbornness

- Nervousness

- Slowness to learn

- Fatigue

- Stress

- Psychologies

Human Error

- 1st blame only the individual
- 2nd identify other factors. Eg :
  - badly designed or faulty equipment
  - poor management practices
  - inaccurate or incomplete procedures
  - inadequate or inappropriate training

- **Operator error :**
  - Due entirely to the human operator.
  - You can't eliminate all of these, but a good human factors design will make these virtually impossible.
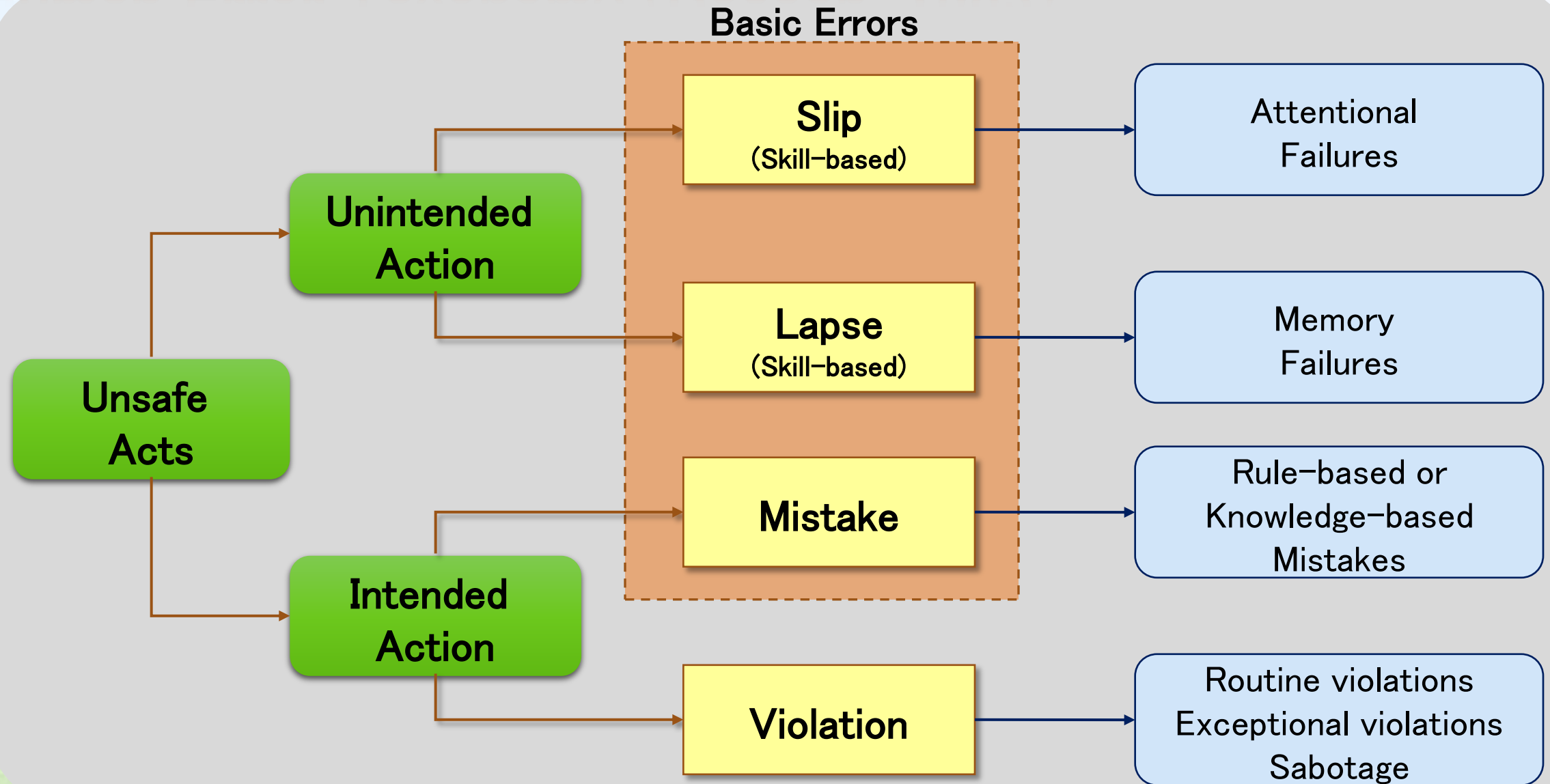- **Design error**
  - Due to poor design.

What's wrong with these designs?
(Left to right : stove, door, refrigerator)
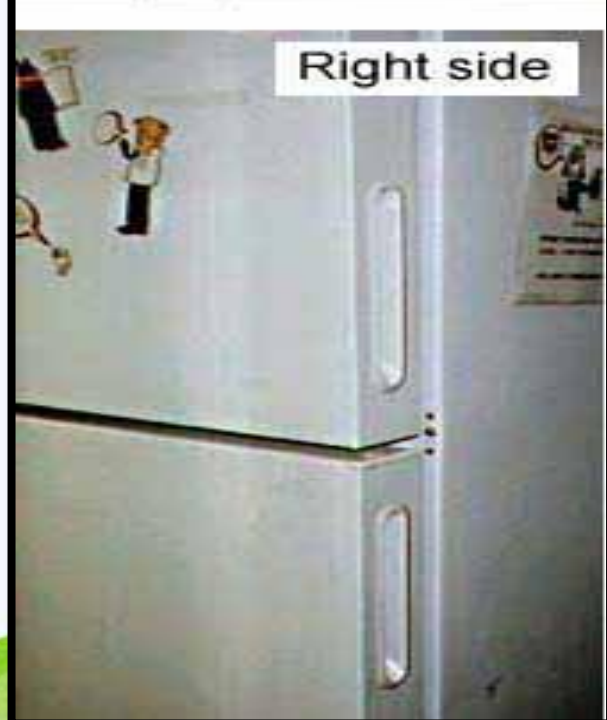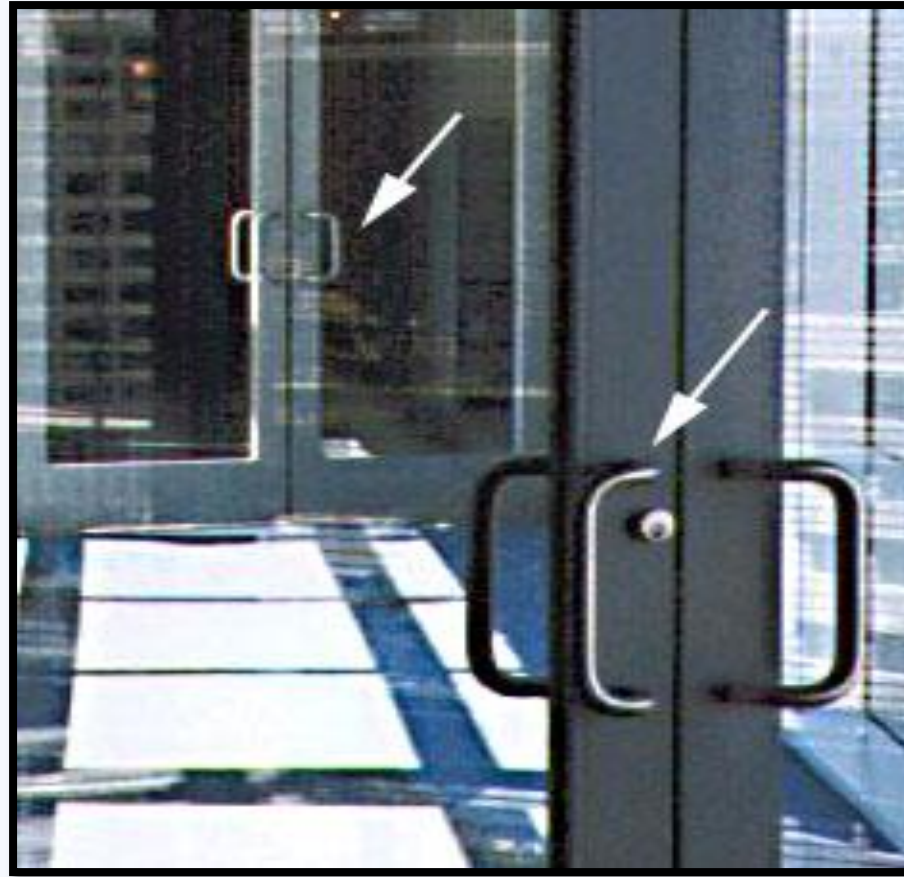
Human Error Classifications (Swain & Guttman, 1983)

- **Omission** – forget/failure to do something

- **Commission** – doing the task incorrectly

- **Sequence errors** – task or set of task performed in the wrong sequence out of order

- **Timing errors** – person fails to perform the action within the time allotted too slow – too fast – too late

- **Intrusion** – entering a dangerous area / location

- **Reversal** – trying to stop or undo a task already initiated

Human Error Taxonomy (Reason, 1992)

Basic Errors

Unsafe Acts

Unintended Action

Intended Action

Slip (Skill-based) → Attentional Failures

Lapse (Skill-based) → Memory Failures

Mistake → Rule-based or Knowledge-based Mistakes

Violation → Routine violations / Exceptional violations / Sabotage

Human Error Types

- Slips and Lapses
  - Slips and lapses occur in very familiar tasks which we can carry out without much conscious attention, eg driving a vehicle. These tasks are very vulnerable to slips and lapses when our attention is diverted even for a moment.
- Slips
  - ('Whoops') Not doing what you're meant to do.
- Lapses
  - Forgetting to do something, or losing your place midway through a task.

Slips And Lapses

- **Slips and lapses occur when:**
  - the task is very familiar and requires little thought;
  - people confuse two similar tasks;
  - tasks are too complicated and long-winded;
  - the main part is done but the finer details are missed;
  - steps in a procedure don't follow naturally; and
  - there are distractions and interruptions.

- **How to reduce slips and lapses:**
  - make all workers aware that slips and lapses do happen;
  - use checklists to help confirm that all actions have been completed;
  - include in your procedures the setting out of equipment, site layout and methods of work to ensure there is a logical sequence;
  - make sure checks are in place for complicated tasks; and
  - try to ensure distractions and interruptions are minimized, eg mobile phone policy.

Remember, simply adding more training will not eliminate slips and lapses. Effective procedures are required. Ask yourself: 'How can I make sure my workers understand that they are vulnerable to slips and lapses?'
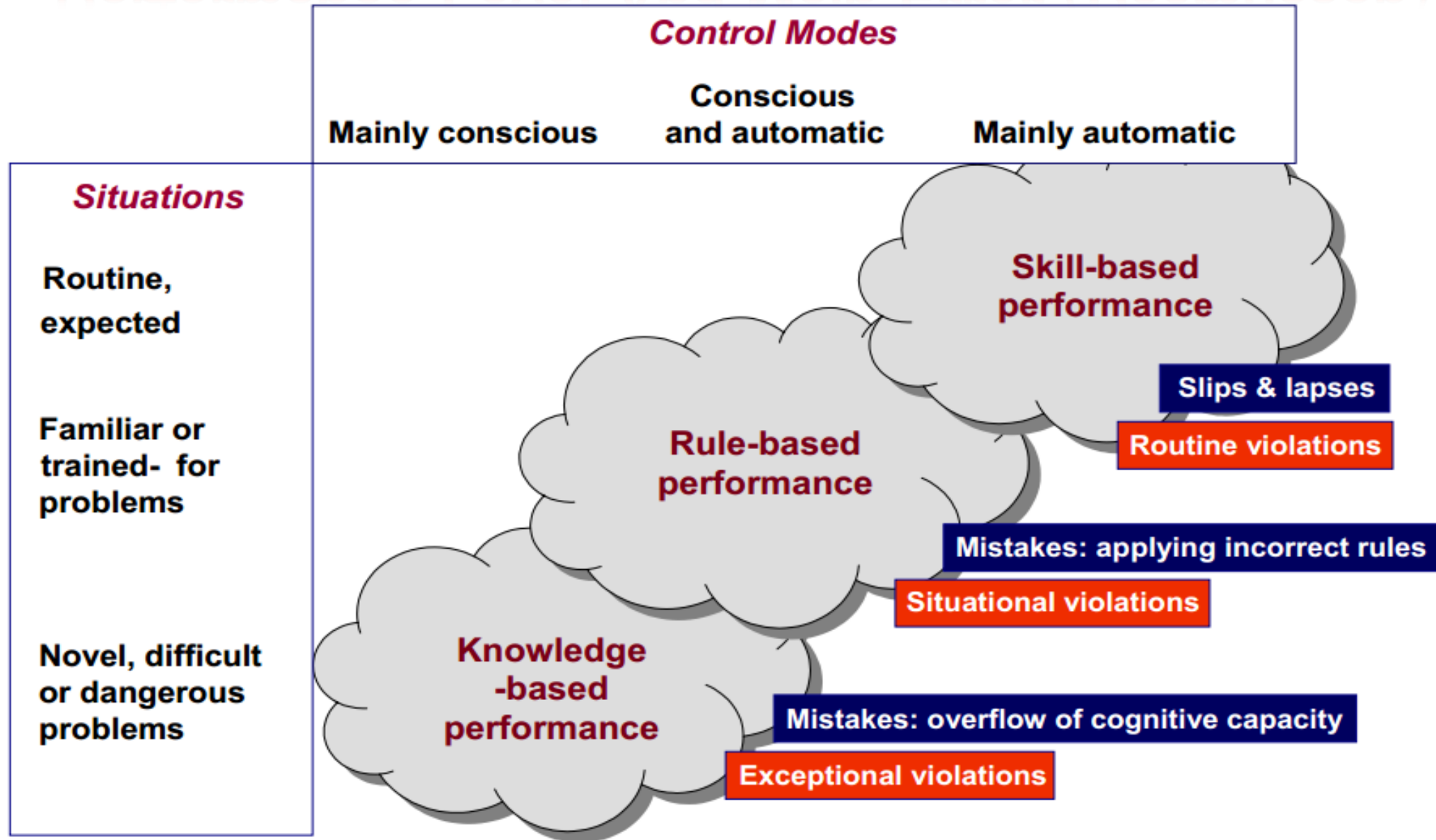
Mistakes

- Mistakes are decision-making failures. The two main types of mistake are rule-based mistakes and knowledge-based mistakes. They arise when we do the wrong thing, believing it to be right.
- Examples of mistakes include :
  - making a poor judgment when overtaking, leaving insufficient room to complete the maneuver in the face of oncoming traffic; and
  - an operator misinterpreting the sound of a machine breakdown and failing to switch off immediately.
- Why do mistakes occur?
  - Doing too many things at the same time.
  - Doing too many complex tasks at once.
  - Time pressures.

Mistakes

- Factors which contribute to people making mistakes
  - The work environment – eg too hot, too cold, poor lighting, restricted workspace, noise.
  - Extreme task demands – eg high workloads, boring and repetitive jobs
  - Social issues – eg conflicting attitudes of workers on how to complete work
  - Individual stressors – eg drugs and alcohol, lack of sleep, family problems, ill health.
  - Equipment problems – eg inaccurate or confusing instructions and procedures.
  - Organizational issues – eg failing to understand where mistakes can occur and implement controls,

- How you can reduce mistakes
  - To avoid rule-based mistakes, increase worker situational awareness of high-risk tasks on site and provide procedures for predictable non-routine, high-risk tasks.
  - To avoid knowledge-based mistakes, ensure proper supervision for inexperienced workers and provide job aids and diagrams to explain procedures.

Ask yourself: 'How can I reduce the likelihood of mistakes occurring on this site?'

Performance Level And Main Error (Rasmussen)

	Characteristics	Failure Type	Examples	Typical Control Measures
Action Errors	Associated with familiar tasks that require little conscious attention. These 'skill-based' errors occur if attention is diverted, even momentarily. Resulting action is not intended: *'not doing what you meant to do'.* Common during maintenance and repair activities.	**Slip** (Commission)	A simple, frequently-performed physical action goes wrong: • flash headlights instead of operating windscreen wash/wipe function • move a switch up rather than down (wrong action on right object) • take reading from wrong instrument (right action on wrong object) • transpose digits during data input into a process control interface	• human-centred design (consistency e.g. up always means off; intuitive layout of controls and instrumentation; level of automation etc.) • checklists and reminders; procedures with 'place markers' (tick off each step) • independent cross-check of critical tasks (PTW) • removal of distractions and interruptions • sufficient time available to complete task • warnings and alarms to help detect errors • often made by experienced, highly-trained, well-motivated staff: additional training not valid
		Lapse (Omission)	Short-term memory lapse; omit to perform a required action: • forget to indicate at a road junction • medical implement left in patient after surgery • miss crucial step, or lose place, in a safety-critical procedure • drive road tanker off before delivery complete (hose still connected)	
Thinking s	Decision-making failures; errors of judgement (involve mental processes linked to planning; info. gathering; communication etc.) Action is carried out, as planned, using conscious thought processes, but wrong course of action is taken: '*do the wrong thing believing it to be right*'	Rule-Based **Mistake**	If behaviour is based on remembered rules and procedures, mistake occurs due to mis-application of a good rule or application of a bad rule: • misjudge overtaking manoeuvre in unfamiliar, under-powered car • assume £20 fuel will last a week but fail to account for rising prices • ignore alarm in real emergency, following history of spurious alarms	• plan for all relevant 'what ifs' (procedures for upset, abnormal and emergency scenarios) • regular drills/exercises for upsets/emergencies • clear overview / mental model (clear displays; system feedback; effective shift handover etc.) • diagnostic tools and decision-making aids (flow-charts; schematics; job-aids etc.) • competence (knowledge and understanding of system; training in decision-making techniques) • organisational learning (capture and share experience of unusual events)
		Knowledge-Based **Mistake**	Individual has no rules or routines available to handle an unusual situation: resorts to first principles and experience to solve problem: • rely on out-of-date map to plan unfamiliar route • misdiagnose process upset and take inappropriate corrective action (due to lack of experience or insufficient / incorrect information etc.)	
Non-Compliance	Deliberate deviations from rules, procedures, regulations etc. Also known as 'violations' Knowingly take short cuts, or fail to follow procedures, to save time or effort. Usually well-meaning, but misguided (often exacerbated by unwitting encouragement from management for 'getting the job done').	**Routine**	Non-compliance becomes the 'norm'; general consensus that rules no longer apply; characterised by a lack of meaningful enforcement: • high proportion of motorists drive at 80mph on the motorway • PTWs routinely authorised without physical, on-plant checks	• improve risk perception; promote understanding and raise awareness of 'whys' & consequences (e.g. warnings embedded within procedures) • increase likelihood of getting caught • effective supervision • eliminate reasons to cut corners (poor job design; inconvenient requirements; unnecessary rules; unrealistic workload and targets; unrealistic procedures; adverse environmental factors) • improve attitudes / organisational culture (active workforce involvement; encourage reporting of violations; make non-compliance 'socially' unacceptable e.g. drink-driving).
		Situational	Non-compliance dictated by situation-specific factors (time pressure; workload; unsuitable tools & equipment; weather); non-compliance may be the only solution to an impossible task: • van driver has no option but to speed to complete day's deliveries	
		Exceptional	Person attempts to solve problem in highly unusual circumstances (often if something has gone wrong); takes a calculated risk in breaking rules: • after a puncture, speed excessively to ensure not late for meeting • delay ESD during emergency to prevent loss of production	

Human Reliability

- The goal of human reliability analyses is to apply the same principles to the human operator that we apply to the machine/device to prevent error that leads to system failure.

- Human Error Probability – the ratio of errors made with respect to the number of opportunities for error;

  - P (error) = 1 – Human Reliability

  - Human reliability = 1 – operator error probability.

Techniques & Methods (For HE Identification)

- Technique for human error rate prediction (THERP)
- Hazard and operability study (HAZOP)
- Skill, rule and knowledge model (SKR)
- Systematic human error reduction and prediction approach(SHERPA)
- Generic error modeling system (GEMS)
- Potential Human Error Cause Analysis (PHECA)
- Murphy Diagrams
- Critical Action and Decision Approach (CADA)
- Human Reliability Management System (HRMS)
- Influence modeling and assessment system (IMAS)
- Confusion Matrices
- Cognitive Environment Simulation (CES)

# Safety and Accidents

Human Error and Accidents

- A key objective of HF is to reduce accidents and improve safety

- **INCIDENT** – An incident is an unplanned, undesired event that adversely affects completion of a task.

- **ACCIDENT** – An undesired event that results in personal injury or property damage.

- **NEAR MISS** – Near misses describe incidents where no property was damaged and no personal injury sustained, but where, given a slight shift in time or position, damage and/or injury easily could have occurred.

Contributing Factors in Accident Causation (CFAC) (Sanders And Shaw, 1988)

1. Management (organization/policies)

2. Environment (physical conditions)

3. Equipment (design)

4. Work (task characteristics)

5. Social/psychological environment (culture)

6. Worker/coworkers (personal attributes)

The Domino Theory (Heinrich, 1931)
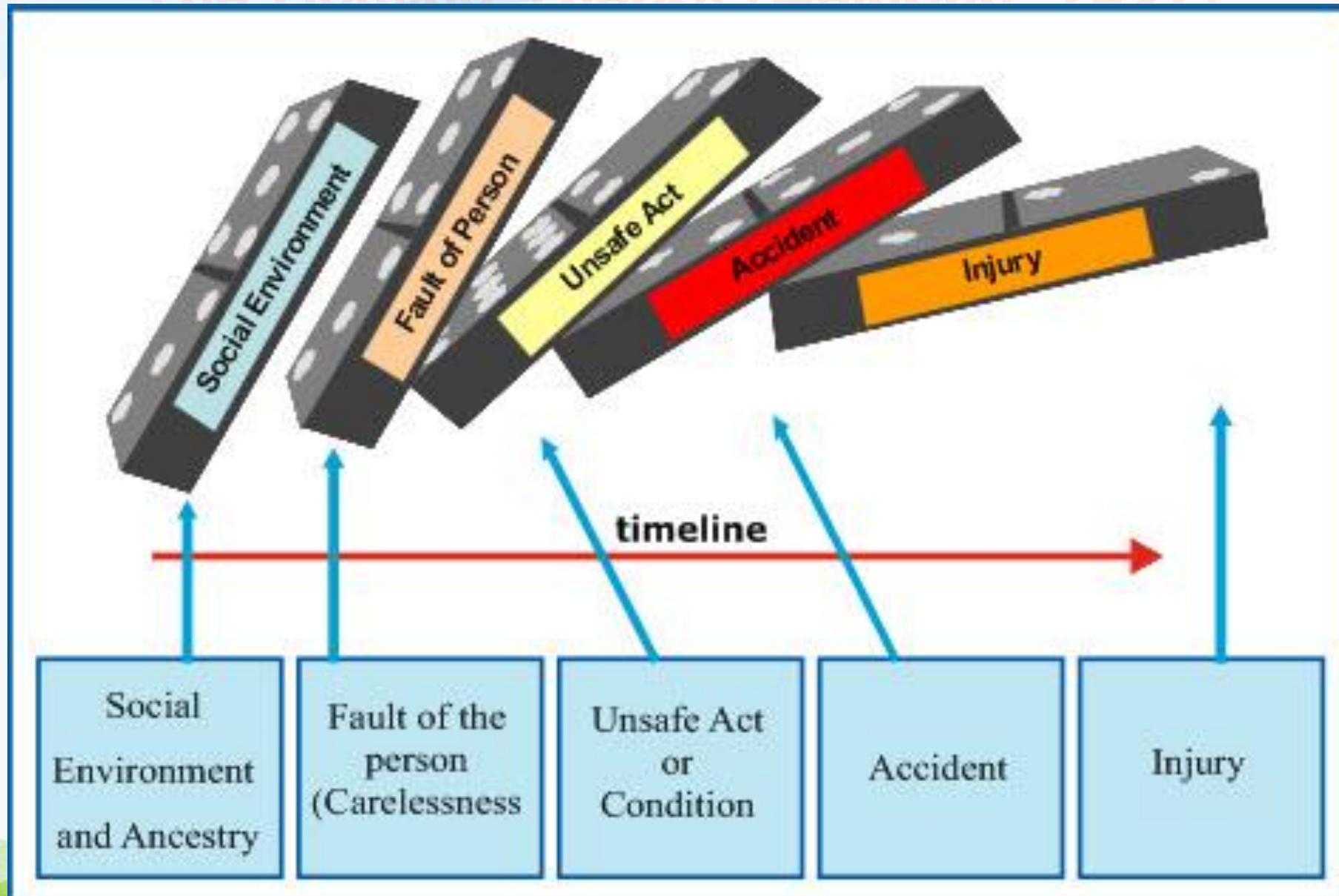
The Domino Theory (Heinrich, 1931)

Social Environment / Ancestry
- A person's social environment (the worker's family or life)

Fault of person
- Undesirable personality traits, such as stubbornness, greed, and recklessness

Unsafe Act / Conditions
- The central factor in preventing incidents, and the easiest causation factor to remedy. Caused by improper attitude, lack of knowledge or skill, physical unsuitability, or improper mechanical or physical environment.
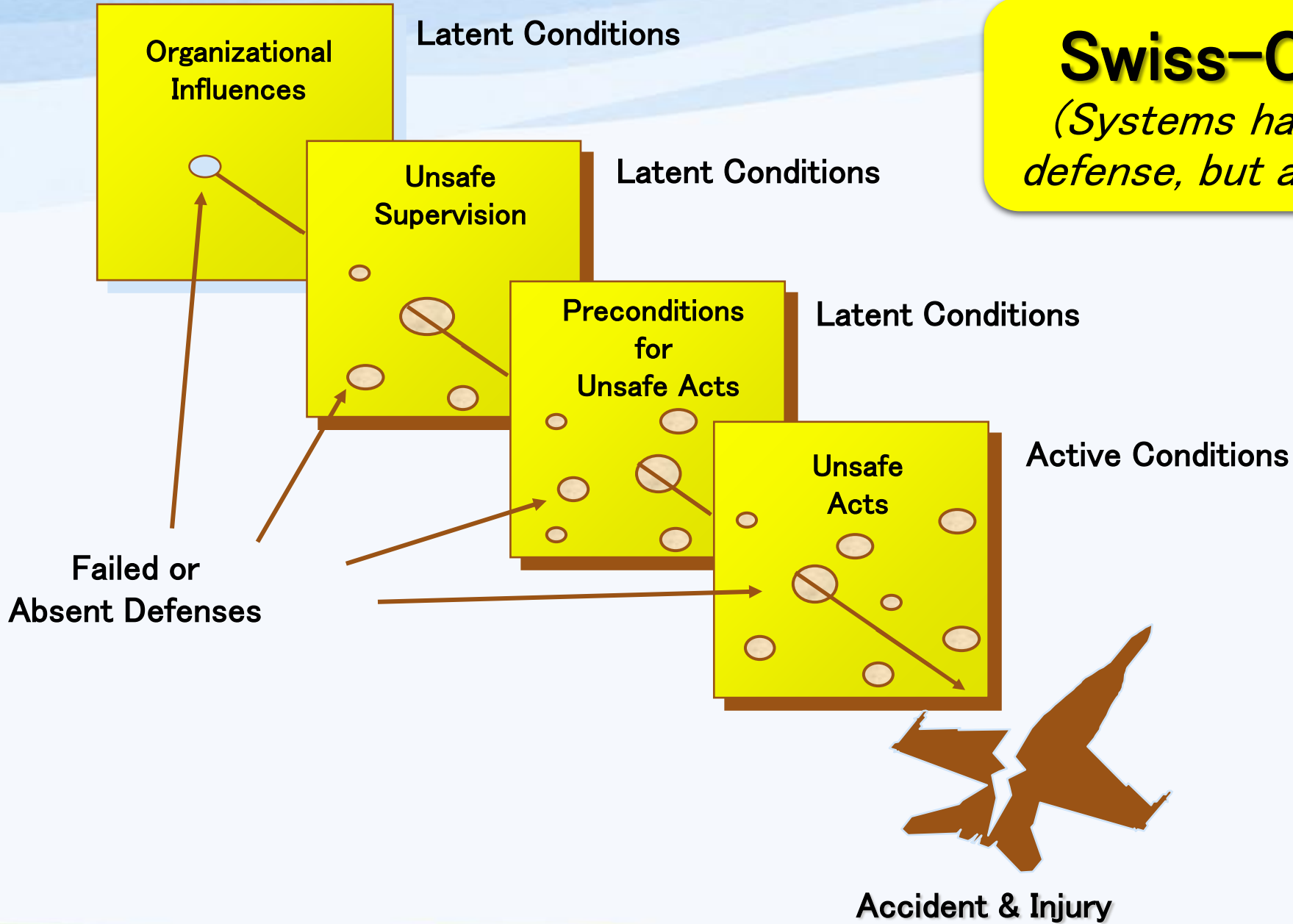
Accident
- Events, such as falls of persons, striking of persons by flying objects are typical accidents, that cause injury

Injury
- Injury results from accidents

Risk Perception of Accidents

- Fail to perceive hazard

- Underestimated hazard

- Fail to respond to recognized hazard

- Respond to hazard, but ineffectively

Reducing Accidents

- Apply human factor principles to design
- Provide procedural checklists
- Provide training
- Provide appropriate & meaningful feedback
- Incentive programs
- Eliminate/reduce risk through design

KEEP CALM AND STUDY HARD