The Human Factors Analysis and Classification System (HFACS)

Scott A. Shappell, Ph.D.
Wiegmann, Shappell, & Associates
“Swiss-cheese” Model of Human Error

Inputs
Organizational Factors
Unsafe Supervision
Preconditions for Unsafe Acts
Unsafe Acts
Failed or Absent Defenses
Accident & Injury

Adapted from Reason (1990)
Human Factors Analysis and Classification System (HFACS)

Unsafe Acts

Errors
- Decision Errors
- Skill-based Errors
- Perceptual Errors

Violations
- Routine
- Exceptional
Unsafe Acts

Errors

Decision Errors

Skill-based Errors

Perceptual Errors

Violations

Routine

Exceptional

DECISION ERRORS

- Rule-based Decisions
- Choice Decisions
- Ill-Structured Decisions
Unsafe Acts

Errors

Decision Errors
Skill-based Errors
Perceptual Errors

Violations

Routine
Exceptional

SKILL-BASED ERRORS

- Attention Failures
- Memory Failures
- Technique Errors

Human Factors Analysis and Classification System

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Unsafe Acts

Errors
- Decision Errors
- Skill-based Errors
- Perceptual Errors

Violations
- Routine
- Exceptional

PERCEPTUAL ERRORS
- Misperceptions
- Misjudgments
Unsafe Acts

Errors
- Decision Errors
- Skill-based Errors
- Perceptual Errors

Violations
- Routine
- Exceptional

ROUTINE VIOLATIONS
(Habitual departures from rules condoned by management)
- Violated training rules
- Failed to comply with departmental manuals
- Violation of orders, regulations, and/or SOPs
Unsafe Acts

Errors

- Decision Errors
- Skill-based Errors
- Perceptual Errors

Violations

- Routine
- Exceptional

EXCEPTIONAL VIOLATIONS
(Isolated departures from the rules not condoned by management)

- Performed unauthorized operation
- Accepted unauthorized hazard
- Not current/qualified
Preconditions for Unsafe Acts

Environmental Factors
- Physical Environment
- Technological Environment

Condition of Employees
- Adverse Mental States
- Adverse Physiological States
- Physical/Mental Limitations

Personal/Interpersonal Factors
- Communication Coordination & Planning
- Fitness for Duty
Preconditions for Unsafe Acts

Environmental Factors
- Physical Environment
- Technological Environment

Condition of Employees
- Adverse Mental States
- Adverse Physiological States
- Physical/Mental Limitations

Personal/Interpersonal Factors
- Communication Coordination & Planning
- Fitness for Duty

Adverse Mental States
- Complacency
- Stress
- Overconfidence
- Mental fatigue
- Distraction
- Confusion
Preconditions for Unsafe Acts

Environmental Factors
- Physical Environment
- Technological Environment

Condition of Employees
- Adverse Mental States
- Adverse Physiological States
- Physical/Mental Limitations

Personal/Interpersonal Factors
- Communication Coordination & Planning
- Fitness for Duty

Adverse Physiological States
- Physical fatigue
- Visual Illusions
- Hypoxia
- Medical illness
Preconditions for Unsafe Acts

Environmental Factors
- Physical Environment
- Technological Environment
- Condition of Employees
  - Adverse Mental States
  - Adverse Physiological States
  - Physical/Mental Limitations

Personal/Interpersonal Factors
- Communication Coordination & Planning
- Fitness for Duty

PHYSICAL/MENTAL LIMITATIONS
- Visual limitations
- Hearing limitation
- Not current/qualified
- Incompatible physical capability
- Incompatible intelligence/aptitude
Preconditions for Unsafe Acts

Environmental Factors
- Physical Environment
- Technological Environment
- Adverse Mental States

Condition of Employees
- Adverse Physiological States

Personal/Interpersonal Factors
- Communication Coordination & Planning
  - Failed to conduct adequate brief
  - Lack of teamwork
  - Poor communication/coordination
  - Failure of leadership

Fitness for Duty
Preconditions for Unsafe Acts

Environmental Factors
- Physical Environment
- Technological Environment
- Condition of Employees
  - Adverse Mental States
  - Adverse Physiological States

Personal/Interpersonal Factors
- Communication Coordination & Planning
- Fitness for Duty
  - Crew Rest Requirements
  - Bottle-to-Brief Rules
  - Self-Medicating
  - Poor Dietary Practice
  - Overexertion While Off Duty
  - Inadequate preparation/skill
Preconditions for Unsafe Acts

Environmental Factors
- Physical Environment
- Technological Environment

Personal/Interpersonal Factors
- Condition of Employees
- Communication Coordination & Planning
- Fitness for Duty

Physical/Environmental Limitations
- Adverse Physiological States
- Adverse Mental States

PHYSICAL ENVIRONMENT
- Weather
- Lighting
- Noise
- Heat
- Vibration

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Preconditions for Unsafe Acts

- **Environmental Factors**
  - Physical Environment
  - Technological Environment

- **Personal/Interpersonal Factors**
  - Condition of Employees

- **Fit for Duty**
  - Communication Coordination & Planning

- **Adverse Physical/Mental Limitations**

**TECHNOLOGICAL ENVIRONMENT**

- Equipment and controls
- Automation reliability/complexity
- Task and Procedure Design
- Manuals and Checklist Design
- Interfaces and Displays
Unsafe Supervision

- Inadequate Supervision
- Planned Inappropriate Operations
- Failed to Correct Problem
- Supervisory Violations
Unsafe Supervision

- Inadequate Supervision
- Planned Inappropriate Operations
- Failed to Correct Problem
- Supervisory Violations

INADEQUATE SUPERVISION
- Failure to Administer Proper Training
- Lack of Professional Guidance
- Failure to Provide Oversight
Unsafe Supervision

- Inadequate Supervision
- Planned Inappropriate Operations
- Failed to Correct Problem
- Supervisory Violations

**PLANNED INAPPROPRIATE OPERATIONS**

- Risk outweighs benefits
- Excessive tasking/ workload
- Poor Crew Pairing
Unsafe Supervision

- Inadequate Supervision
- Planned Inappropriate Operations
- Failed to Correct Problem
- Supervisory Violations

FAILED TO CORRECT A KNOWN PROBLEM
- Failure to Correct Inappropriate Behavior
- Failure to Correct a Safety Hazard
Unsafe Supervision

- Inadequate Supervision
- Planned Inappropriate Operations
- Failed to Correct Problem
- Supervisory Violations

SUPERVISORY VIOLATIONS
- Failed to enforce the rules
- Authorized unnecessary hazard
- Authorized unqualified crew for flight
Organizational Influences

- Resource Management
- Organizational Climate
- Operational Process
Organizational Influences

- Resource Management
- Organizational Climate
- Operational Process

RESOURCE MANAGEMENT
- Human
- Monetary
- Equipment/Facility

Human Factors Analysis and Classification System

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Organizational Influences

- Resource Management
- Organizational Climate
- Operational Process

ORGANIZATIONAL CLIMATE

- Structure
- Policies
- Culture
Organizational Influences

- Resource Management
- Organizational Climate
- Operational Process

OPERATIONAL PROCESS
- Operations
- Procedures
- Oversight
Unsafe Acts

Preconditions for Unsafe Acts

Environmental Factors
- Physical Environment
- Technological Environment

Condition of Operators
- Adverse Mental States
- Adverse Physiological States
- Physical/Mental Limitations

Communication/Coordination Planning
- Fitness for Duty

Unsafe Acts
- Errors
- Violations

Errors
- Decision Errors
- Skill-based Errors
- Perceptual Errors

Violations
- Routine
- Exceptional

Operational Process

Inadequate Supervision

Supervisory Violations

Resource Management

Organizational Climate

Organizational Influences
Hazard Identification & Prioritization
Human Factors Analysis and Classification System (HFACS®)

Unsafe Acts

Errors
- Decision Errors
- Skill-based Errors
- Perceptual Errors

Violations
- Routine
- Exceptional
Percentage of Human Error Mishaps Associated with Violations (FY 91-97)

- U.S. Army Mean
- U.S. Navy/Marine Corps Mean
- U.S. Air Force Mean

**Fiscal Year**

- 91
- 92
- 93
- 94
- 95
- 96
- 97

**Percentage**

- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80

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OK Doc, Go Fix It!
Hazard Identification
And Prioritization
Traditional Intervention Approaches

- Human-Centered
- Technology-Centered
- Environment-Centered
- Task-Centered
- Organization-Centered
<table>
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<tr>
<th>Decision Violations</th>
<th>Human</th>
<th>Technology</th>
<th>Environment</th>
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<tr>
<td>Skill-based Errors</td>
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</table>
“How can I change the way I select individuals for the job, so that I don’t have “rule-breakers” or excessive risk-takers?”

“How can I change the way I train employees to change people’s attitudes about violation rules?”

“How can I change incentives to change an individual’s motivation to break the rules?”

“How can I change the way teams work together to increase peer pressure to follow the rules?”
“How can I use automation to reduce violations of the rules?
“How can I change the displays or other technology to reduce rule-breaking?”
“How can I redesign checklists, manuals, handbooks, etc. to reduce violations?”
“How can technology to better monitor pilot behavior in the cockpit or track violations of the rules?”
“How can I change the environment to prevent individuals from breaking the rules?”

“How can I change the environment to prevent people from becoming hurt, if they do break the rules?”
“How can I change the task/mission to prevent violation of the rules?”

“How can I improve oversite of the work process to reduce violation of the rules?”

“How can I improve enforcement of the rules to reduce violations?”
“How can I change the **structure** of the organization (e.g., chain of command, communication channels, line of authority, etc.) to reduce violations?”

“How can I change the **culture** of the organization (e.g., goals, values, norms, policies, etc.) to reduce violations?”

“How can I change organizational processes (e.g., ops tempo, incentives, pressures, procedures, etc) to reduce violations?”
<table>
<thead>
<tr>
<th>Proposed Intervention</th>
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<td>Flight Data Recorders</td>
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<td>Training in Restricted Ranges Only</td>
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Intervention Assessment (FACES)

Feasibility – can it be done?.
Acceptability – will operators accept it?
Cost – can we afford it?
Effectiveness – will it work?
Sustainability – will it last?
HFIX Cube (HFIX³)

Decision Errors

Skill-based Errors

Perceptual Errors

Violations

Human | Technology | Environment | Task | Organizational

Sustainability | Effectiveness | Cost | Acceptability | Feasibility
## INTERVENTION PRIORITIZATION

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Initial Intervention Strategy

- Professionalism
- Accountability
- Enforcing the Rules
- Detachment Supervision
Percentage of Human Error Mishaps Associated with Violations (FY 91-00)

Data-driven Intervention

Previous U.S. Navy/Marine Corps Mean
But what about other errors?
Percentage of Human Error Mishaps Associated with Decision Errors (FY 91-00)

**Interventions**
- Focus on tactical decision-making
- Improved procedure development
- Scenario-based training
- Approach Magazine – Increased awareness
Percentage of Human Error Mishaps Associated with Skill-based Errors (FY 91-03)

Interventions:
- Improve instrument scan
- Prioritizing attention
- Recognizing extremis situations
- Refine basic flight skills (Stick-and-Rudder)
- Practice procedures
- Review the mishap database!
METHOD

- Analyzed all (over 20,797) FAR Part 91 – “GA accidents” occurring between 1990 and 2000
  - Eliminated
    - 14 CFR Part 91 F (Ferry flight)
    - 14 CFR Part 137 (Agricultural Flights)
    - 14 CFR Part 91 (Blimps, balloons, ultra-lights, gliders)
  - Remaining 18,531 accidents were then screened for aircrew error
- The remaining 14,436 accidents were associated with over 34,000 human causal factors, as reported by the National Transportation Safety Board (NTSB).
- The NTSB human causal factors were classified into HFACS causal categories independently by seven GA pilots.
  - All were certified flight instructors
  - Mean flight hours = 3,530
Skill-based Errors
Perceptual Errors
Decision Errors
Violations

Overall

Percentage of Accidents
Year

Fatal

Percentage of Accidents
Year

Percentages do not add up to 100%
COMMERCIAL AVIATION
METHOD

- **Data Sources**
  - NASDAC
  - NTSB Narrative Summary (long narrative if available)

- **Data Analysis**
  - 1020 “Commercial Aviation” accidents occurring between 1990-2002 were examined.
    - 181 Air Carrier accidents
    - 839 Commuter accidents
  - The human causal factors were classified into HFACS causal categories independently by seven pilot-raters
    - All pilot raters had a minimum of 1000 hours of flight time and were instructor pilots.
    - No new cause factors were created during the coding process and consensus between coders was achieved on all classifications.
  - Human factors quality assurance
  - Additional demographic factors (e.g., weather conditions, lighting, and fatalities were transcribed from the source documents verbatim
• Given the small number of air carrier accidents (n=181) it was not possible to do an annual comparison. Instead blocks of 3 and 4 years were used.

• With few exceptions the unsafe acts committed by commercial (air carrier and commuter) pilots has remained relatively consistent across the years of this study.

• There may have been a slight increase in violations after the 1993-1995 time frame.