Chapter 8

Studies of error safety in critical industries can estimate the overall probability of errors, but cannot predict where and when an individual error will occur

Maintenance errors can have more serious consequences

TASKS	Errors/1000 Tasks
Install Nuts and Bolts	2
Connect Electrical Cable	3
Install O-ring	3
Tighten Nuts and Bolts	4
Read Pressure Gauge	11
Install Lock-wire	32
Check for error in another persons work.	100

Error models and theories

The PEAR model was developed by Dr. William Johnson and Dr. Michael Maddox.

The Dirty Dozen, developed by Gordon Dupont for Transport Canada, was very briefly referenced to list some of the factors specific to the incidents related to human factors.

The SHELL model was first developed by Elwyn Edwards (1972) and later modified into a 'building block' structure by Frank Hawkins(1984)

Human Factors Analysis and Classification System (HFACS) was developed by Dr Scott Shappell and Dr Doug Wiegmann.

PEAR model: HF influences that should be considered

P: people who do the job

E: Environment in which they work

A: Actions they perform

R: Resources necessary to complete the job

Error models and theories PEAR model

People	DOING	THINKING	INTERACTING
	–Physical Capabilities	–Knowledge	–Team Structure
	–Sensory Capabilities	–Experience	–Role Definition
	–Health	–Attitude	–Leadership
	–Training	–Motivation	–Followership
	–Current	–Confidence	–Supervision Skills vs Needs
	–Competent	–Workload	–Interpersonal Relationships
	–Authorized	–Fatigue	–Communication
	–Briefed	–Stress	–Conflicts

People relates to suitability (physical, cognitive and social) of selected personnel for a particular task

Suitability not only covers technical training but also other human factors considerations such as fatigue, stress and motivations.

Guides the review of competency, supervision abilities, briefing needs, leadership skills and requirements of individuals against the task demands

Environment	DOING	THINKING
	–Weather	–Management Style
	–Location (Inside/Outside)	–Leadership
	–Workspace	–Staffing Levels
	–Lighting	–Size/Complexity
	–Noise	–Priorities
	–Distractions	–Pressures
	–Housekeeping	–Morale
	–Hazards	–Norms
	–Shift (Day/Night/Late)	–Culture

Environment in which the work is done, not just the physical environment, but also the organization itself.

The physical environment includes lighting, temperature, noise level and time of day.

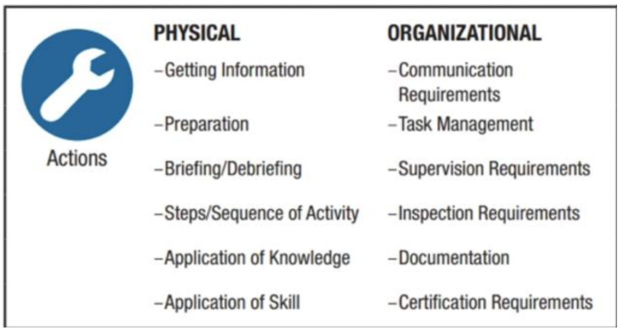
The organizational environment covers:

Supervision (quality and ratios),

pressures (time, commercial and production etc.),

safety culture and existing organizational norms

Leadership shown and the effectiveness of management in supporting positive safety behaviors.

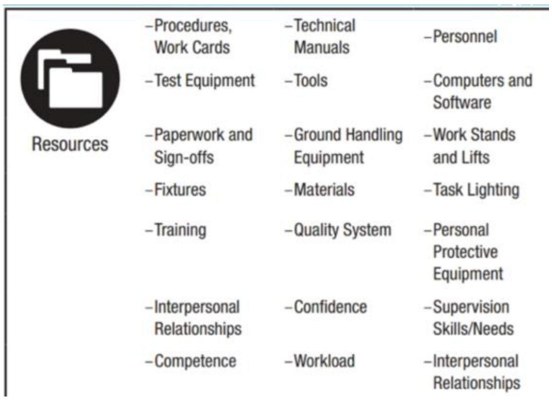


Actions list the requirements of a job in order to identify specific areas that might increase the risk of error, such as:

1 Ambiguous information,

2 or complex tasks that need specialist skills and knowledge.

- List of actions aligned with Job Task Analysis (JTA) :
- Accessing/finding task specific information required
- Preparation and briefing requirements
- Identifying procedures to be followed
- Are those procedures clear and easy to follow?
- Task complexity/application of skills and knowledge
- Communication requirements (headsets required?)
- The level of supervision and inspection required (is a dual inspection needed?)
- The certification and documentation, including the complexity or user-friendly nature of the aircraft maintenance documentation.



Resources the broadest component of PEAR

Anything needed to get the job done: Personnel, spares, technical manuals, tooling, and personnel protective equipment (PPE)

Important is focusing on identifying the areas where resources are deficient including:

Design (work stands, tools etc.)

Application (e.g. available, accurate procedures)

Where additional resources (time, personnel, training, lighting, PPE and consumables) are required.

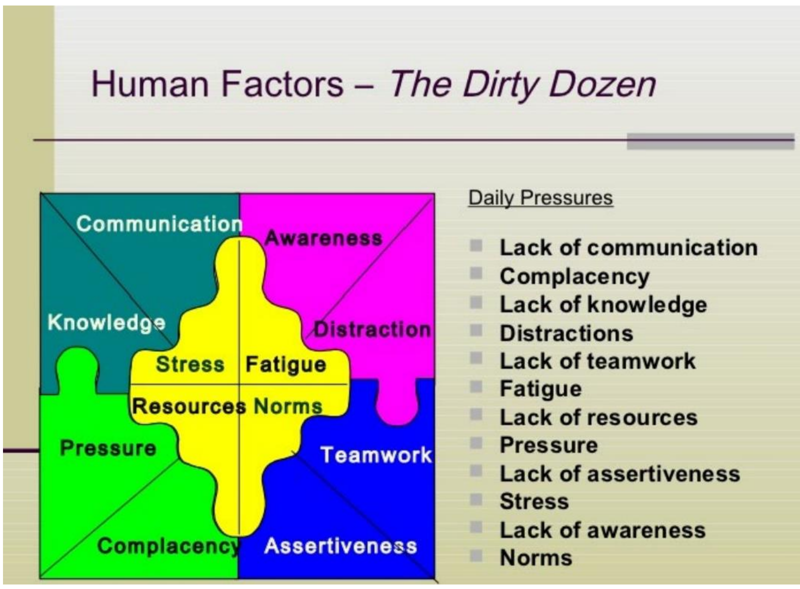
Error models and theories Dirty Dozen

twelve factors that degrade people's ability to perform effectively and safely, thus leading to maintenance errors

Twelve factors, known as the "dirty dozen".

Important to know Dirty Dozen, to recognize their symptoms, and most importantly, how to avoid or contain errors produced by the Dirty Dozen

Understanding the interaction between organizational, work group, and individual factors that may lead to errors and accidents



Lack of communication: maintainers must communicate with one another and explain what work has and has not been completed when changing shifts.

MITIGATING THE RISK		
Properly use logbooks and worksheets to communicate work accomplishments.	Ensure that maintenance personnel are discussing exaclty what has been and needs to be completed to the next shift.	Never assume that the work has been completed.

Complacency: people tend to become overconfident after becoming proficient in acertain task which can mask the awareness of dangers.

MITIGATING THE RISK		
Always expect to find something wrong.	Never sign off on something that you did not fully check.	Always double check your work.

Lack of knowledge: maintenance must remain up to date on current equipment and how to fix it.

MITIGATING THE RISK		
Only fix parts that you are trained to fix.	Ensure that the maintenance manual you are using is up to date.	If you do not know how to fix something, ask for help from someone who does.

Distraction: any thig that takes your mind off the task any distraction while working can cause us to think we are further ahead in the process than we actually are.

MITIGATING THE RISK		
Once returning to the job, go back through all of the steps to ensure where you left off.	Use a detailed checklist.	Never leave tools or parts lying around. Secure them before leaving the area.

Lack of teamwork: can ultimately effect the safety of maintenance work.

MITIGATING THE RISK		
Ensure that lines of communication are open between personnel.	Discuss specific duties when jobs require more than one person to eliminate any questions.	Always look out for co-workers with safety in mind.

Fatigue: can cause decrease of attention which can be very dangerous when conducting maintenance.

MITIGATING THE RISK		
Be aware of the symptoms and look for them in yourself and coworkers.	Forfeit complex tasks if you know you are exhausted.	Eating healthy, exercising and regular sleep patterns can prevent fatigue.

Lack of resources: don't have enough resources to finish the task.

MITIGATING THE RISK		
Maintain a sufficient supply of parts and order any anticipated parts before they are required.	Never replace a part with one that is not compatible for the sake of getting the job done.	Preserve all equipment through proper maaintenance.

Pressure: MT must not let the pressure of time get in the way of safely finishing a repair.

MITIGATING THE RISK		
Ensure that pressure is not self induced.	Communicate if you think you will need more time to complete a repair rather than rush through it.	Ask for extra help if time is an issue.

Lack of assertiveness: when something dose not seem right can RESULT in many fatal accidents.do not let any thing that you no is wrong continue by ignoring that it is there.

MITIGATING THE RISK		
Provide clear feedback when a risk or danger is perceived.	Never compromise your standards.	Allow co-workers to give their opinions and always accept corrective criticisms.

Stress: is the subconscious response to the demand placed on a person.

MITIGATING THE RISK		
Take time off or a short break if you are feeling stressed.	Discuss with a co-worker and ask them to monitor your work.	Healthy eating, exercise, and a sufficient amount of rest can reduce stress levels.

Lack of awareness: common sense and vigilance tend to not be present because they have completed the same task many times.

MITIGATING THE RISK		
Check to see if what you are working on conflicts with an existing modification or repair.	Always ask co-workers to check your work.	Even if you are highly proficient in a task, always have someone check your work.

Norms: is a short for normal the way things are normally done they are unwritten rules that are followed by most of the organizations negative norms can detract from establishing safety standard's and cause accidents.

MITIGATING THE RISK		
Ensure that everyone follows the same standard.	Be aware that just because it seems normal does not make it correct.	The easiest way of accomplishing something may not be the standard.

SHELL Model

S: Interpretation of procedures, illegible manuals, poorly designed checklists, ineffective regulation, untested computer software ('S')

H: Not enough tools, inappropriate equipment, poor aircraft design for maintainability ('H')

E: Uncomfortable workplace, inadequate hangar space, variable temperature, noise, poor morale, ('E')

L: Relationships with other people, shortage of manpower, lack of supervision, lack of support from managers ('L')

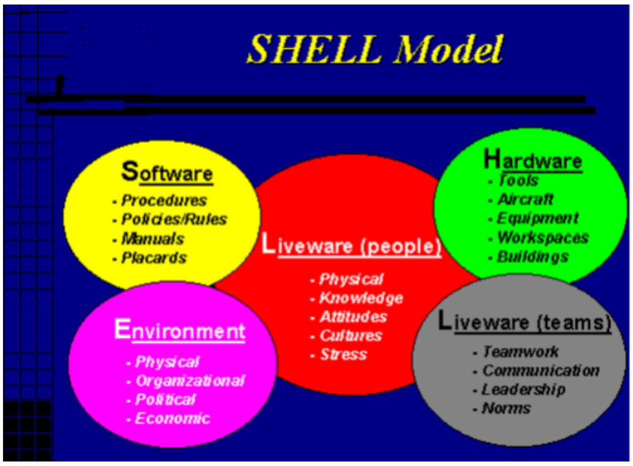
L: 'L' in the center box can stand alone and problems associated with a single individual

SHELL Model

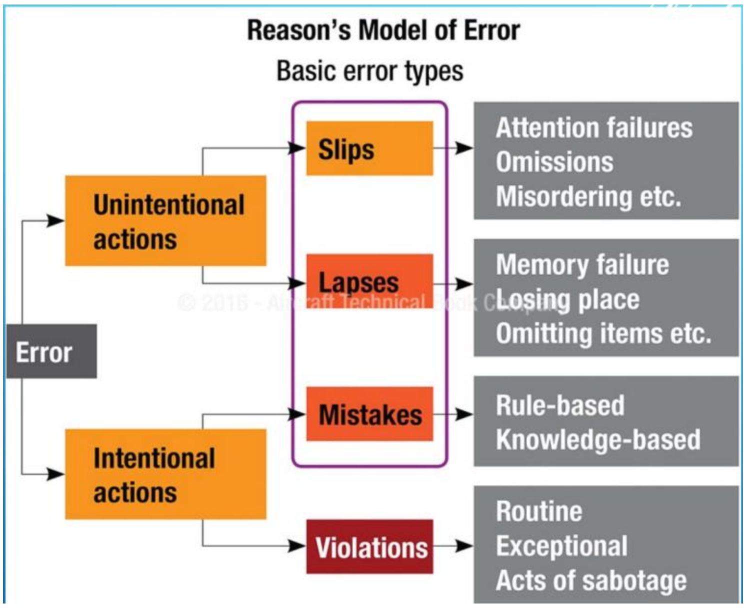
Any linkage between Human and the other four blocks Software, Hardware, Environment and Liveware is a HUMAN FACTOR Interface

Interfaces outside Human Factors not covered in this model

communication Breakdown between pilots is Liveware – Liveware problem



Reasons model of error:



Slips: Occur when performing a routine action that was out of place in the situation, usually because distracted and habit taking over

Lapses: Occur when forget to complete an action intended to perform

Mistakes.: Error where the problem has occurred during thinking rather than doing

Rule Based Mistakes: The mistake happens when the rule no longer fits the situation, or the AMT misidentifies the situation.

Knowledge Based Mistakes: Lack of necessary knowledge, or a lack of awareness of where to find the necessary information.

Violations: Intentional deviations from procedures or good practice In most cases because the AMT is trying to get the job done, not because they want to break rules

Routine Violations: are the everyday deviations from procedures to keep things moving and get the job done efficiently.

Exceptional Violations: Often well-intentioned attempts to get the job done despite problems such as missing documents or a shortage of parts.

Sabotage Violations: Extremely rare event in aircraft maintenance

Professor Reason’s “Swiss Cheese” Model

Known as "The Window of Opportunity“, a theoretical model illustrating how accidents occur in organizations

Typical accident occurs because several (human related) errors occurred at various levels in the organization in a way that made the accident unavoidable

♣ Every step in a process has the potential for failure

♣ Model represents a stack of slices of Swiss cheese

♣ Holes represent opportunities for a process to fail, and each of the slices as "defensive layers" in the process

♣ Error allows a problem to pass through a hole in one layer, but in the next layer the holes are in different places, and the problem should be caught.

♣ Each layer is a defense against potential error impacting the outcome.

For example:

• Decision makers may have made poor decisions when purchasing the aircraft (fallible decisions)

• Line management may have pushed for faster turnarounds (line management deficiencies)
• Pilots may have felt pressured by a stressful climate (distraction)

• An unsafe culture of limited rest exists (preconditions)

• The pilot in the accident may have gotten distracted with other tasks prior to the accident (unsafe act)

• The aircraft systems fail in providing unmistakable warnings of the danger (inadequate defenses)

Active errors (also called unsafe acts): central cause of the accident: the pilot got distracted. Had the pilot not been distracted, she/he would have prevented the accident

Latent errors, remaining elements in the organization which contributed to the accident: senior managers purchasing decisions, line management pressures, unsafe climate and culture coupled with fatigue and confusing warnings Had not any of these latent errors occurred, the accident would have been prevented

Windows of opportunity, opportunity for those active and latent errors to contribute to an accident Had the pilot not been distracted, he would have prevented the accident; this time. Yet, the latent errors remain unresolved, waiting for their opportunity (thus a "window of opportunity") to strike

Causation chain, alignment of all necessary windows of opportunity at all levels in the organization, thus leading to the occurrence of a particular accident The causes of most accidents can be traced back to windows of opportunity" opened at all levels in the organization

Implications of errors

In Professor Reason's Swiss Cheese Model, not all errors or omissions lead to accidents

Errors that do not cause accidents, but still cause a problem are known as incidental

Some incidents are more high profile than others, such as errors causing significant in-flight events that, fortunately or because of the skills of the pilot, do not become accidents • Other incidents more mundane and do not become serious because of defenses built into the maintenance system • All maintenance incidents have to be reported • These data used to disclose trends, and where necessary implement action to reduce the likelihood of future errors.

List (of United Kingdom Civil Aviation Authority (CAA)) of the most common occurring errors

• Incorrect installation of components

• Fitting of wrong parts

• Electrical wiring discrepancies to include cross connections (Example #1)

• Forgotten tools and parts

• Failure to lubricate (Example #2)

• Failure to secure access panels, fairings, or cowlings

• Fuel or oil caps and fuel panels not secured • Failure to lock pins

Avoiding and managing errors

Proper error management system should strive to prevent errors from occurring and eliminate or mitigate the possible negative effects of errors that do occur

To prevent errors from occurring necessary to predict where they are most likely to occur and put in place preventative measures in an Error Management System (EMS).

Professor Reason believes EMS should include measures that would:

• Minimize the error liability of the individual or team

• Reduce the error vulnerability of particular tasks or task elements

• Discover, assess and eliminate error producing (and violation producing) factors within the workplace

• Diagnose organizational factors that create error producing factors within the individual, the team, the task or the workplace

• Enhance error detection

• Increase the error tolerance of a workplace or system

• Make latent conditions more visible to those operating/managing the system

• Improve organization's intrinsic resistance to human fallibility

ERROR MANAGEMENT SYSTEMS (EMS)

Typical problem responses of the past EMS's included:

Blame and Train: Discipline the individual; tell them to "be more careful", and then, if necessary institute further training

Write another procedure: All industries tend to write procedures to prohibit actions that have been implicated in some event or incident

Search for the "missing piece". When these measures fail (and they usually do), managers start looking for psychological ways of finding the piece that will remove violations and errors

Comprehensive EMS focuses most of its efforts on:

- Identifying and correcting error prone tasks.
- Improving error producing work situations.
- Identifying and correcting latent organizational conditions.

Avoiding and managing errors Maintenance Error Decision Aid (MEDA)

Developed by Boeing Commercial Airplanes and designed to investigate maintenance errors and reduce/eliminate the errors by redesigning procedures

Boeing developed the MEDA process to help maintenance organizations identify why these errors occur and how to prevent them in the future

- Based on three principles:
  - o Mechanics don't intend to make mistakes.
  - o Errors result from a variety of workplace factors, such as unclearly written manuals, poor communication between workers or improperly labeled parts
  - o Management can fix the factors that contribute to errors

The MEDA philosophy is based on these principles:

- Positive employee intent (maintenance technicians want to do the best job possible and do not make errors intentionally)
- Contribution of multiple factors (a series of factors contributes to an error)
- Manageability of errors (most of the factors that contribute to an error can be managed)

The MEDA process:

1, Event: responsibility of Maintenance Organization to explore what problem caused the event

2, Decision: after fixing the problem, make decision if event was maintenance related, if yes perform investigation

3, Investigation, carried out about the event, the error that caused it, the factors contributing to the error, and list of possible prevention strategies

4, Prevention Strategies, review, prioritize, implement and track the prevention strategies to avoid same error in the future

5, Feedback, provide feedback to know changes made and sharing investigation results

Management Resolve

The resolve of management at the maintenance operation is key to successful MEDA implementation. Long term commitment from top management for its implementation

Implementing MEDA

Many operators have decided to use MEDA initially for investigations of serious, high visibility events, such as in flight shut downs and air turn backs

MEDA is good to be implemented for identifying factors that could produce an accident before they cause such a bad event

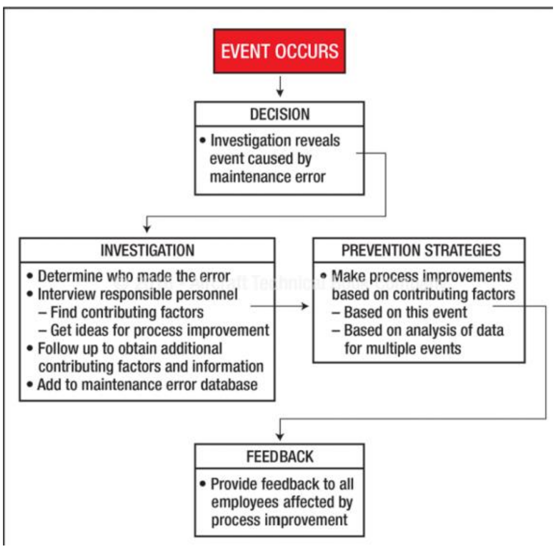
Benefits of MEDA:

• 16% reduction in mechanical delays

• Revised and improved maintenance procedures and airline work processes A reduction in airplane damage through improved towing and headset procedures

• Changes in the disciplinary culture of operations

• Improvements in line maintenance workload planning A program to reduce on-the-job accidents and injuries based on the MEDA results form and investigation methods



What does the PEAR Model acronym stand for?

People; –

– Environment;

– Actions;

. – Resources

What are two kinds of intended errors?

.Two kinds of intended errors are mistakes and violations

Lack of Communication; Lack of Knowledge; Complacency are factors in which error model?

.factors in the Dirty Dozen error model

Which model explains how liveware (humans) interact with three other elements?

.he SHEL Model explains how liveware interact with Software, Hardware and Environment

What are two kinds of unintended errors?

.Two kinds of unintended errors are Slips and Lapses

WHAT dose the window of opportunity stand for in the swiss cheese model?

Window of Opportunity refers to mistakes that align at all levels in the organization, leading to the occurrence of an accident

MEDA is based on what three principles?

Positive employee intent –

; – Multiple contributions cause accidents;

. – Manageability of errors

What is the MEDA PROCESS?

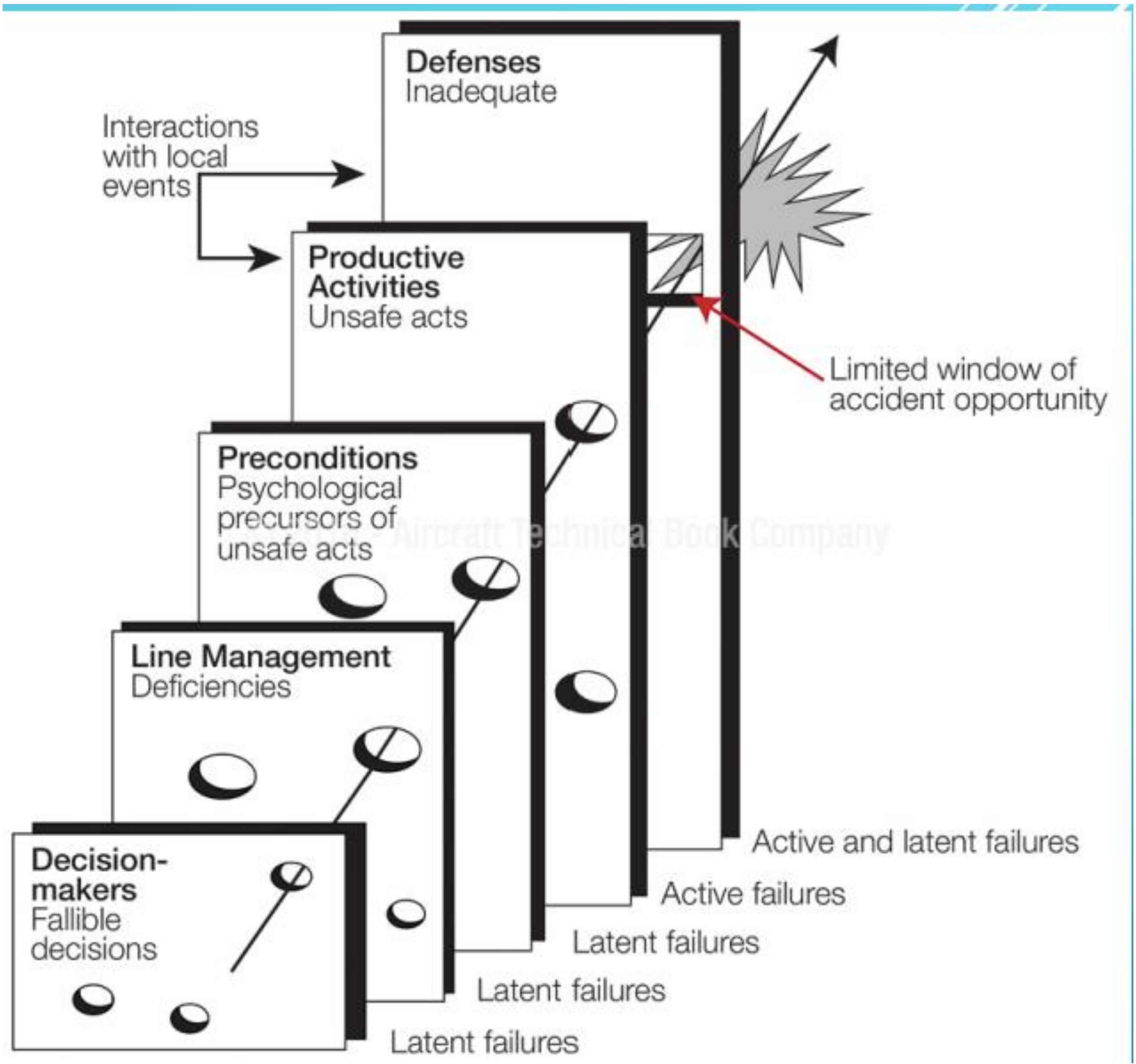
Event.

Decision;

Investigation;

Prevention Strategies;

. Feedback


Defenses
Inadequate
Interactions with local events
Productive Activities
Unsafe acts
Limited window of accident opportunity
Preconditions
Psychological precursors of unsafe acts
Line Management
Deficiencies
Decision-makers
Fallible decisions
Active and latent failures
Active failures
Latent failures
Latent failures
Latent failures