



P_{eople} E_{nvironment} A_{ctions} R_{esources}

The FAA has developed a memory aid called 'PEAR' and it makes recognition and mitigation of Human Factors even easier. 'PEAR' has been used as a memory device for over a decade to characterize HF in aviation maintenance. It prompts recall of the four important considerations for HF programs:

People who do the job;

Environment in which they work;

Actions they perform;

Resources necessary to complete the job.



PEAR is a memory aid for explaining the actions of aviation personnel as they interact with hardware, procedures, test equipment, environmental factors and other people as they perform maintenance duties.



For more in depth explanation of Mental Models consider the book . . .

"The 5th Discipline Field Book" by Peter Senge

PEAR is very similar to the **SHELL** model, but is considered by many to be a more simplified way of recalling the same basic information. **SHELL** stands for

Software - procedures, documents

Hardware - tools, equipment

Environment - physical and social

Liveware - people

Liveware and Liveware - people working with people

PEAR as a mental model. A mental model is an explanation in someone's thought process for how something works in the real world. A mental model is a visual explanation of a thought, a means to better explain and understand complex concepts and systems. Mental models are like schematics, or road maps that leads us to understanding those things that can be shared.

By using these models communication occurs across industry because all of us share in the meaning of something like this - the PEAR model.

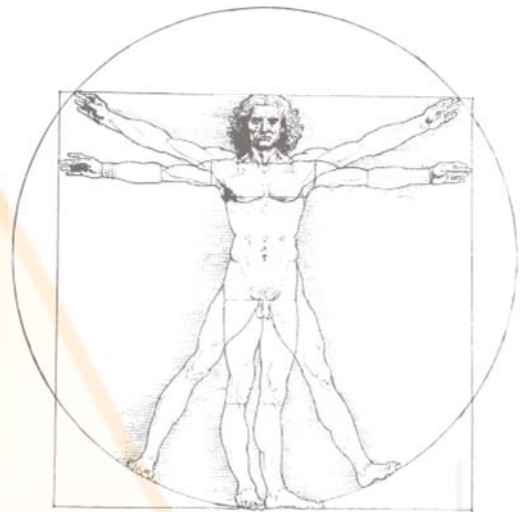
Recognition

Thanks to Dr. Michael Maddox and Dr. Bill Johnson for their work in the development of the **PEAR** model.

Anthropometry (Greek άνθρωπος, man, and μέτρον, measure, literally meaning measurement of humans), in physical anthropology, refers to the measurement of the human individual for the purposes of understanding human physical variation.

Body Size and fitting for tools and equipment.

Groups of people do not have the same body dimensions. For each body dimension, there is an approximate “normal” distribution, sometimes called a bell-shaped curve. Typically we do not design things for the 50th percentile of the population. If we do that, then we ensure that it won’t fit most of the people who do the job. For example, designing doorway heights for the 50th percentile would result in doors that are about 5’6” high. We need to design for the extremes - 5th percentile female to 95th percentile male.



There are no FAA regulations to force you to address sensing and perception in your human factors program. However, EASA rules do require that you address such issues.



5

The **five senses** of smell, touch, hear, see and taste are gateways to our perceptions.

Hearing loss may occur due to exposure to either a sudden, loud noise or exposure to loud noises for a period of time. A dangerous sound is anything that is 85 dB (sound pressure level – SPL) or higher.

Note: Populations of people living near airports or freeways are exposed to levels of noise typically in the 65 to 75 dB(A)

Taking Care of Your Eyes

Of all the senses the sense of sight is vital. Be proactive with your vision, have a regular exam and wear eye protection. Eye protection varies based upon the task you are performing. When in doubt check with your supervisor about safety approved eye protection that is appropriate for the task at hand.



2

Two types of Environment in Aviation Human Factors, physical & organizational (social).

Environment

The physical environment has everything to do with maintenance. Hangars that have poor lighting, or hangars that are exposed to the extremes of heat and cold - may distract workers. Shop culture is the social side of environment. Shop culture that down plays the role of safety at work is building towards an accident - a unsafe work environment is a killer.



Your actions have consequences. This is the reason it is important that we bring all of our awareness and skill to every maintenance task we perform.

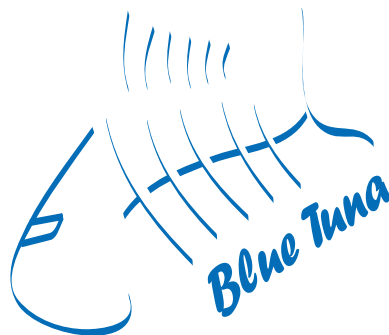
When working together in teams communication is vital. Lack of communication or miscommunication leads to errors.

Actions includes your actions in a maintenance task. What skills, procedures and resources are required in order for you to perform your duties?



The **R** of the PEAR model is Resources. Resources includes documentation, procedures, tools equipment, time, people, materials to name a few. A LACK of resources is very difficult to work around. Without the proper equipment, tools, documents, people and environment - accomplishing maintenance tasks are almost impossible. A lack of parts or a lack of inventory is also a source of frustration that may result in improper workarounds.

A Lack of parts, combined with a can do attitude and a must reach deadline may result in workarounds that later prove to be hazardous even fatal.



The **P.E.A.R.** Model

for Aviation Maintenance Human Factors



The FAA has developed a memory aid called **PEAR** and it makes recognition and mitigation of human factors even easier.

PEAR has been used as a memory device for over a decade to characterize Human Factors in aviation maintenance. It prompts recall of the four important considerations for Human Factors programs.

P is for People who do the job

E is for Environment in which they work

A means Actions they perform

R Resources necessary to complete the job



The Pear becomes a **Mental Model** for the human equation in aviation maintenance.

A mental model is an explanation of someone's thought process about how something works in the real world. It is a representation of the surrounding world, the relationships between its various parts and a person's intuitive perception about his or her own acts and their consequences. Mental models can help shape behavior and set an approach to solving problems (akin to a personal algorithm) and doing tasks.



S, the first letter in the **SHELL** model, applies to Software. Software with regard to SHELL is not necessarily computer software. It refers to such things as the rules and procedures of operation, technical manuals, and information to support system operation. The **H** is the Hardware, which are quite clearly the tools, hangars, aircraft, buildings and other such physical things. **E** represents the Environment, which is actually two distinctly different environments: the physical work environment, including factors like temperature, lighting or humidity, and the political and social environment. That includes abstract factors like corporate communications or company profitability. The **L** in Shell stands for Liveware, and uses 2 L's. The first L represents the individual human characteristics like knowledge, skills, experience, attitude and culture. The second **L** refers to the human in groups, including such factors as teamwork, communication, group norms and leadership. In summary, if you can remember the word SHELL, like the oil company, you can remember key considerations for human factors.

Difference between FAA & EASA

European Aviation Safety Agency (EASA) requires an understanding of the eye, the ear and the nose.

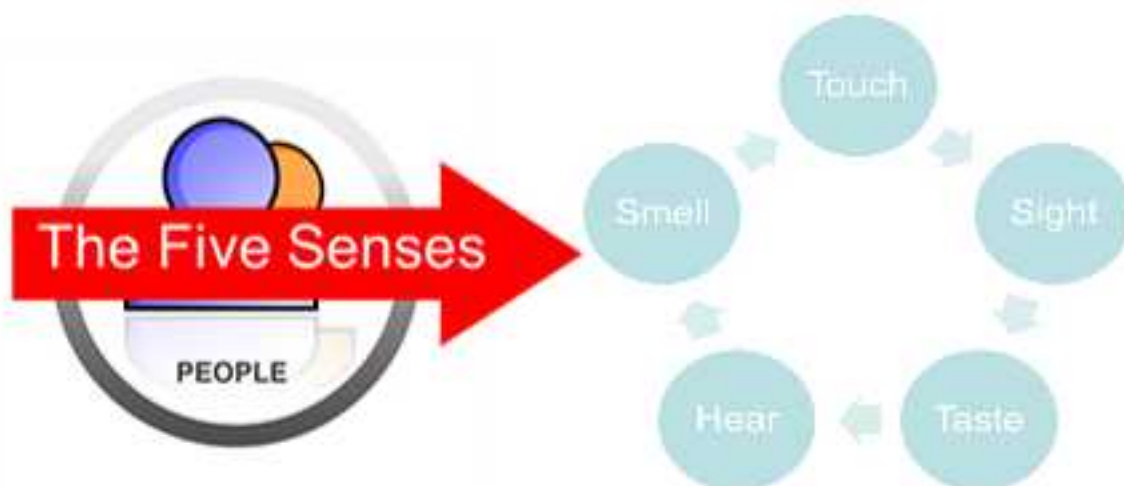
Protection
Knowledge
Regulation



There are few **FAA** regulations to force you to address sensing and perception in your human factors program. However, the European Aviation Safety Agency (**EASA**) rules do require that you understand the working of the eye, ear and nose and how to this relate this knowledge the overall function of the maintenance environment. *Increasing your knowledge of the senses will result in a greater degree of protection.* Regulatory guidelines are in place to ensure companies and individual workers address the senses within the context of human performance and the workplace.



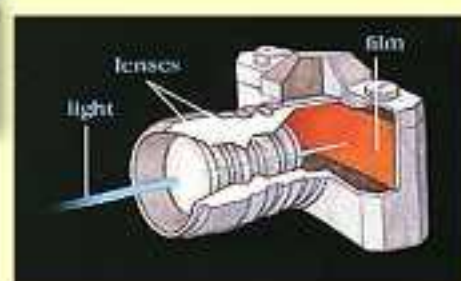
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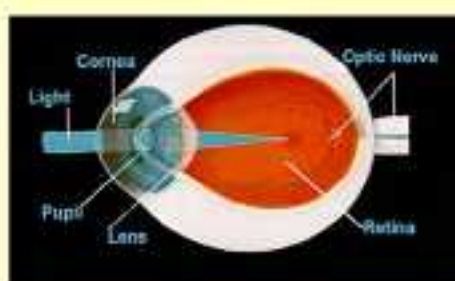
The five senses of smell, touch, hear, see and taste are gateways to our perceptions. In a closed loop system as our sensory inputs change it has a cascading effect on our perception and comprehension. Sensory inputs are impacted by the aging process. Understanding how our systems works contributes to our ability to adapt.

The P.E.A.R. Model

for Aviation Maintenance Human Factors



The Camera



The Human Eye

The individual components of the eye work in a manner similar to a camera. Each part plays a vital role in providing clear vision. So think of the eye as a camera with the cornea, behaving much like a lens cover. As the eye's main focusing element, the cornea takes widely diverging rays of light and bends them through the pupil, the dark, round opening in the center of the colored iris. The iris and pupil act like the aperture of a camera. Next in line is the lens which acts like the lens in a camera, helping to focus light to the back of the eye. The very back of the eye is lined with a layer called the retina which acts very much like the film of the camera. The retina is a membrane containing photoreceptor nerve cells that lines the inside back wall of the eye. The photoreceptor nerve cells of the retina change the light rays into electrical impulses and send them through the optic nerve to the brain where an image is perceived.

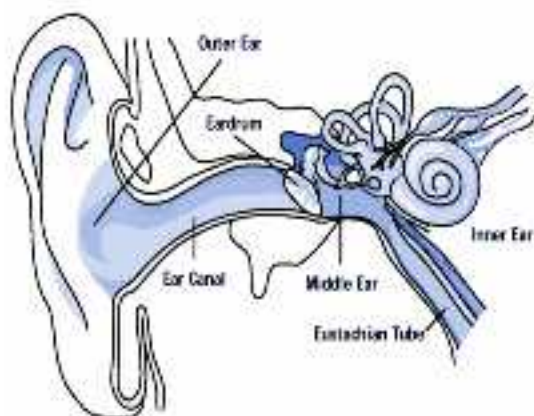
Fact

Thousands of people are blinded each year from work-related eye injuries that could have been prevented with the proper selection and use of eye and face protection. Eye injuries alone cost more than \$300 million per year in lost production time, medical expenses, and worker compensation.

CAA Standards

"A reasonable standard of eyesight is needed for any aircraft engineer to perform his duties to an acceptable degree. Many maintenance tasks require a combination of both distance and near vision. In particular, such consideration must be made where there is a need for the close visual inspection of structures or work related to small or miniature components. The use of glasses or contact lenses to correct any vision problems is perfectly acceptable and indeed they must be worn as prescribed. Frequent checks should be made to ensure the continued adequacy of any glasses or contact lenses. In addition, colour discrimination may be necessary for an individual to drive in areas where aircraft manoeuvre or where colour coding is used, e.g. in aircraft wiring.

Organisations should identify any specific eyesight requirement and put in place suitable procedures to address these issues."



The ear has two main tasks - to provide hearing and balance. Both are important for our occupation. The ear is made up of the outer, middle and inner ear. The three sections transform sound waves into nerve impulses, which the brain recognizes as sounds. The sound waves are directed to the eardrum through the auditory canal. The vibrations are "mechanically" transferred to the membrane of the cochlea, which is filled with liquid, by small bones in the ear. The liquid oscillates, stimulating millions of tiny hairs, which in turn stimulate the nerves. The hearing range of a healthy, young individual is from 20 Hz (Hertz) to 20,000 Hz. It is most sensitive at about 3,000 Hz. Care must be taken with the ears, the ear does not adapt to high pitches well and over time may suffer damage. This is an accumulated effect. This is of special importance in the aviation industry where maintenance personnel may be exposed to loud and pitched noises from the everyday operation of aircraft. Damage to our hearing is an accumulated effect. Rules concerning ear protection should be carefully followed.

Impact of Noise on Performance

3.6.1 Noise can have various negative effects in the workplace. It can:

- be annoying (e.g. sudden sounds, constant loud sound, etc.);
- interfere with verbal communication between individuals in the workplace;
- cause accidents by masking warning signals or messages;
- be fatiguing and affect concentration, decision making, etc.;
- damage workers' hearing (either temporarily or permanently).

CAA Standards

The noise environment in which the aircraft maintenance engineer works can vary considerably. For instance, the airport ramp or apron area is clearly noisy, due to running aircraft engines or auxiliary power units (APUs), moving vehicles and so on. It is not unusual for this to exceed 85 dB - 90 dB which can cause hearing damage if the time of exposure is prolonged. The hangar area can also be noisy, usually due to the use of various tools during aircraft maintenance. Short periods of intense noise are not uncommon here and can cause temporary hearing loss. Engineers may move to and from these noisy areas into the relative quiet of rest rooms, aircraft cabins, stores and offices.

The P.E.A.R. Model

for Aviation Maintenance Human Factors

Physical Environment

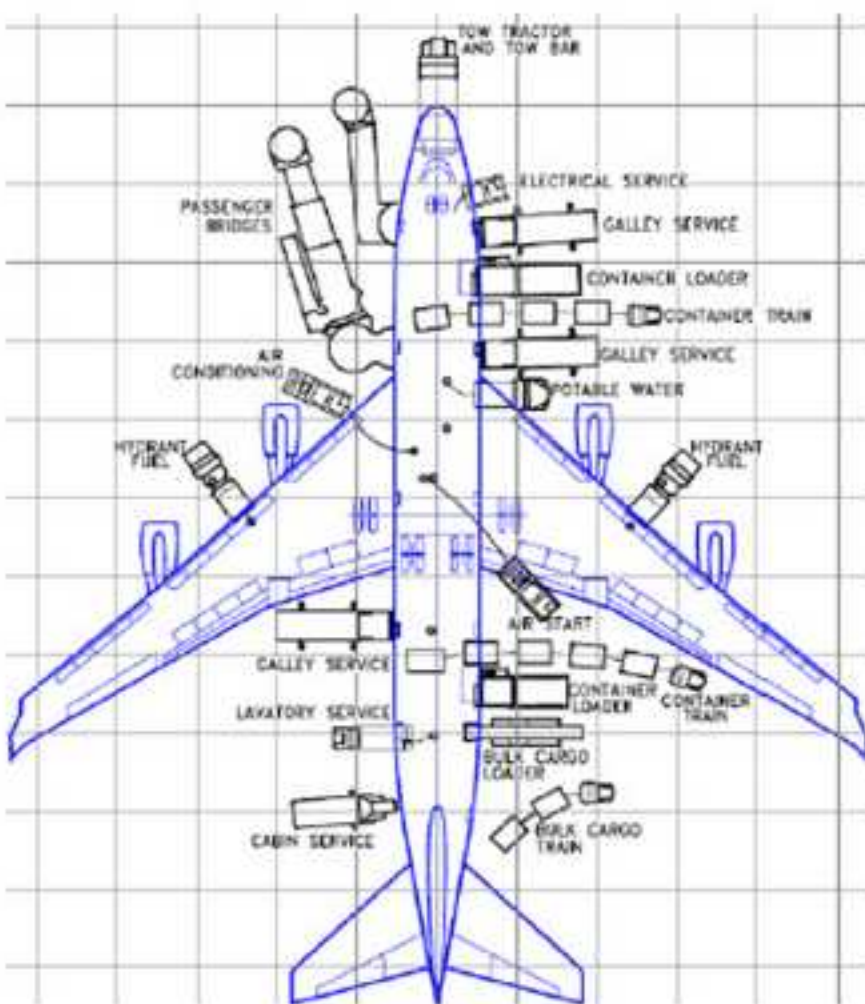
The ramp is a work environment that is constantly changing. The ramp environment may be a dangerous environment where employees are exposed to stored energy, moving vehicles, natural elements of heat, cold, rain and ice. In this environment self awareness is a key element.

Company Culture

Company culture plays a significant role in how we feel about our job and where we work. As an example consider a company's Safety Culture. A large number of accidents and cost for repairs occur when the aircraft is in the ramp position docked. Perhaps a mechanic makes a mistake that compromises the airworthiness of the aircraft. The incident goes unreported because other employees self reported and they lost their job. This would be considered an unjust culture where reporting important safety information is punished. This could be considered a hostile work environment.

Environmental Controls

Complexity and Criticality of aircraft maintenance demands focus and commitment in the workplace. Environmental controls whether physical or organizational are typically under the control of management. Cultural environment is often overlooked because it is an unseen factor. However a negative cultural environment is distracting and is difficult to change because it is embedded in the way people think as a larger whole.



The P.E.A.R. Model

for Aviation Maintenance Human Factors



Action

Action is the heart of the human factor framework. There is no compensation or accommodation for a lack of skill.

Many maintenance tasks may be highly proceduralized through job cards or maintenance manuals. Each step may be spelled out through procedures, however the variable of skill level shows up in the level of detail from one person to the next.



Resources

- It's how we get objective information
- A "must have" for proper diagnosis
- Can have a good or bad user interface
- Might require significant training use properly.

Test equipment is a vital resource *there are no work arounds for equipment calibrated and in good working order.*

Everything in aviation maintenance is proceduralized

- FAA Regulations (Part 43) requires technicians and mechanics to follow approved procedures. - Some procedures don't work as written as a result they are
- sometimes ignored rather than changed
- Most common violation is a "failure to follow procedures"

Action is Systemic



Just as changes in your body have an impact on other body parts, the same can be said of an organization.

Poor performance of just one person in your organization can have a cascading effect on the other members.

Documents as a Resource

Working from memory rather than working from data compromises the integrity of maintenance and the organization.