FIT FOR FLYING

Instructor's & Conference Guide

Educational Programs Directorate
Drug Demand Reduction Program

AUTHOR
Ben Millspaugh, CSMEL

Civil Air Patrol National Headquarters
105 South Hansell Street
Maxwell Air Force Base, Ala. 36112

Published 2010

INSTRUCTOR'S GUIDE

FIT FOR FLYING

Introduction

The Instructor's Guide is offered as a supplement to the *Fit For Flying* text. The guide includes learning outcomes, presentation methodology, and questions for any CAP member or student involved in, or wishing to be involved in, flying. The test questions are designed to evaluate the reader's understanding of the learning outcomes, and are intended to be used in an "open-book" format.

A Conference Guide follows the Instructor's Guide on page 33 and includes additional information and demonstration activities that may prove useful in large group settings.

The objectives to be emphasized throughout are as follows:

- The aerospace industry has a zero tolerance for drug and alcohol abuse.
- The privilege of flying an airplane is directly linked to the FAA's medical certificate.
- Pilot's, flight crews, and support personnel who are impaired by drugs and alcohol endanger the safety of everyone in the air or on the ground.
- A pilot, when operating an aircraft, is expected to be in excellent physical condition.
- The operation of an aircraft in a three-dimensional, high altitude environment requires an ongoing program of study, recurrent training, and physical conditioning. to achieve this level of performance requires a commitment to a lifestyle of physical and mental conditioning which enables a pilot to be "airworthy."

1.1 The eye examination is one of the most important parts of determining airworthiness. (Phoot by Dr. Sancetts)

Part One

– The Airworthy Human –

Learning Outcomes

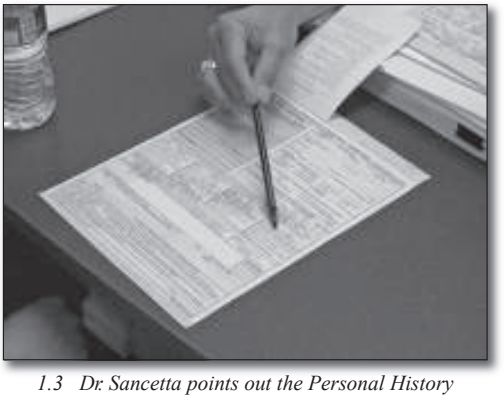
Upon completion of Part One, the learner should know:

- The importance of the FAA-required physical examination for pilots
- The three types of physical examinations
- The framework of the Form 8500-8
- What "airworthy" means
- What "AME" means
- The terms of item 18 in the 8500-8, regarding the history of a pilot's arrest and/or conviction regarding drugs or alcohol
- The duration of the three classes of medical certification
- What Dr. Sancetta means by "Type Ratings"
- The significance of the National Driver Register and the information that can be made available to the FAA in the future
- Dr. Sancetta's philosophy stating, "If they are alive, I can help them fly again!"

1.2 Cadet Schuele is getting a medical examination in preparation for a CAP glider encampment. (Photo by Dr. Sancetta)

Important Terms

- License
- Certificate
- Aviation Medical Examiner
- Third Class
- Second Class
- First Class
- Airworthy
- Debilitating
- Synopsis
- Disposition
- Four synopsis components of vision: distant, near, intermediate, and color
- Incapacitation
- Health maintenance



1.3 Dr. Sancetta points out the Personal History section on the 8500-8 FAA examination form. (Photo by Dr. Sancetta)

Presentation

The presenter should first make the audience understand that the medical certificate is equally as important as the pilot certificate. Most pilots already know the difference, but the general public does not. It should be pointed out that both the pilot certificate and the medical certificate have equal value when it comes to exercising the privileges of operating an aircraft.

The next step is to clarify the meaning of the various medical classes. Start out with the Class III and show the audience the Form 8500-8. Proceed by going over the significance of Dr. Sancetta's professional philosophy. He points out how subjective some of the certificate questions can be and why all details of a pilot's background should or should not be explained.

Preview the first page of the 8500-8 on page 12 of the text and encourage dialogue on the significance of why the FAA wants to know the answer to any or all of these items. Discuss how an issue in any one of these items could eventually be a problem with pilot performance.

In his professional philosophy, Dr. Sancetta made the following statement, "The FAA's goal is to predict, as best they can, the concept of a pilot's sudden incapacitation in the cockpit, and their mandate is to only do that during the duration of the certificate." Encourage the audience to discuss the meaning of this statement.

Dr. Sancetta further states, "The FAA really does want us to promote health maintenance." Conduct a dialogue about "health maintenance." Assuming some members of the audience are pilots, each could be asked to tell others their own personal "health maintenance" program.

1.4 An AME is a medical doctor who specializes in Aviation Medical Examinations.

Motivation

If possible, the presenter should consider inviting a doctor who is an AME to be a guest speaker. This distinguished guest can then answer questions participants may have regarding items listed in the FAA Form 8500-8. It may be helpful that the AME be given the *Fit for Flying* publication prior to the visit. The AME can also bring the audience up-to-date on changes regarding the FAA medical examination and how it may affect a pilot's future. An example of this is the new Sport Pilot certificate. This type of license does not require a pilot to have a medical certificate as long as he or she has never failed a FAA examination and as long as the pilot passed his or her previous medical examination. Having an AME visit a meeting or workshop will also give the audience the chance to ask questions regarding the FAA's position on issues such as over-the-counter substances and how they affect pilot performance.

At the end of a session, the presenter could recommend that all of the audience join together for lunch and just see how "healthy" they could be in their choice of food items. Each member could be asked to submit, to the presenter, a piece of paper that lists the items each had during that lunch. This could be an opportunity to raise awareness of making "healthy" choices.

The presenter should share with the audience that the *Fit for Flying* book is a compilation of approved FAA publications that are readily available to the public. They have been brought together in a publication that was designed to give pilots, potential pilots, and ground support personnel a better understanding of the human element in aviation.

Overview

The presenter should point out that typically a pilot only views the Form 8500-8 for no longer than the time it takes to fill it out. For that reason, Dr. Robert Sancetta, one of America's top AMEs, explains the importance of the medical examination and then, item by item, discusses the details of a candidate's personal history, as outlined on the form. The presenter should also point out that by signing the 8500-8, the examinee gives the FAA permission to have access to his/her personal driving records starting at age 16 and continuing throughout their lifetime. The FAA is making a serious effort to educate pilots regarding substance abuse. Thus, the presenter should also tell the audience that many "innocent" medications, like those used in over-the-counter substances, can adversely affect pilot performance, especially when there is less oxygen or pressure available, as in an airplane at high altitudes.

A lesson plan for each section can be made that emphasizes the various bold-faced subtitles. An example, in Part One would be the figures surrounding the workload of the FAA's Aeromedical Division, known as CAMI. It is hard to imagine that the FAA receives more than 1,800 medical applications per day. An average of 435,000 airman examinations are processed annually and each is unique. The audience should know that the primary objective of the FAA's Aeromedical Division is to ensure that only those pilots who are physically and mentally fit will be authorized to operate an aircraft thereby enhancing aviation safety by eliminating the medical factor as a cause of aircraft accidents. This will drive home the message the presenter is trying to make: the medical certificate is equally as important as the pilot certificate.

Learning Evaluation – Multiple Choice Questions

Part One

– The Airworthy Human –

1. Captain Cory Von Pinnon flies the AvantAir Piaggio Avanti P180. He mentioned in the text that pilots routinely fly at 30,000 to 40,000 feet. What does this mean for the human body?
   A. There is no gravitational pull on the body.
   B. Any loss of pressurization means less than 30 seconds of useful consciousness.
   C. Arms and legs are unable to move freely.
   D. Breathing is difficult, even in pressurized environment.

2. Which of the following is most true?
   A. The pilot certificate and medical certificate are of equal value to a pilot.
   B. The pilot certificate counts much more than the medical certificate.
   C. The medical certificate counts much more than the pilot certificate.
   D. None of the above are true.

3. Which medical certificate is only valid for one year, regardless of age?
   A. First Class
   B. Second Class
   C. Third Class
   D. Student Pilot Certificate

4. What is the name of the medical division of the FAA? (CAMI)
   A. Civil Aerospace Medical Institute
   B. Class Aviation Medical Investigators
   C. Civilian Aviation Medical Industry
   D. Commercial Aviation Medical Institute

5. What is the CAMI civilian physicians group that determines who is "fit to fly?"
   A. Aviation Medical Authority (AMA)
   B. Aerospace Determination Board (ADB)
   C. Aviation Medical Examiners (AME)
   D. Medical Certification Board (MCB)

6. The FAA test instrument of pilot medical certification is known as?
   A. Third Class Medical Certificate
   B. Second Class Medical Certificate
   C. First Class Medical Certificate
   D. Form 8500-8

7. How old must you be to get a medical certificate?
   A. Age 16
   B. Age 14
   C. Age 21
   D. There is no minimum age required to get a medical certificate, but it does not become valid until age 16.

8. Fill in the blanks to this FAA objective: To ensure that only those pilots who are physically and mentally fit will be authorized to operate aircraft, thereby enhancing aviation _____ by eliminating the _____ factor as a cause of aircraft accidents.
   A. Reliability & hazardous
   B. Safety & medical
   C. Reliability & medical
   D. Safety & human

9. From a human physiological standpoint, _____ means fit to fly.
   A. Airworthy
   B. Preflight
   C. Checklist
   D. Redline

10. Passing the FAA medical examination will give the FAA _____.
   A. All of your personal identity information.
   B. A reasonable prediction that within the duration of the medical examination nothing will happen.
   C. A reasonable prediction that within the duration of the medical certificate there will not be a sudden incapacitating event.
   D. A reasonable prediction that you will not use drugs or alcohol.

11. What controversial condition's policies remain in a continuous flux of certainty?
   A. Migraine headaches
   B. Depression
   C. Asthma
   D. ADHD (Attention Deficit Hyperactivity Disorder)

12. What is the most serious problem that pilots face?
   A. Suicide attempts
   B. Alcoholism
   C. Cancer
   D. Motion Sickness

13. What character trait plays the most important part in ensuring medical clearances are accurate?
   A. Honesty
   B. Exercising
   C. Compassion
   D. Responsible

14. Which medical waiver is given for a defect that is not likely to change (such as defective color vision or loss of a limb)?
   A. Permanent Medical Waiver (PMW)
   B. Medical Illness Form (MIF)
   C. Statement of Demonstrated Ability (SODA)
   D. Loss of Health Form (LOHF)

15. Non-prescription drugs, commonly called _____, are not evaluated to determine whether a pilot is safe to fly while taking these drugs.
    A. Aspirin
    B. Over-the-counter medication
    C. Antihistimines
    D. Non-drowsy medications

16. What is the current guideline maximum value for a pilot's blood pressure?
    A. 170/90
    B. 200/80
    C. 155/95
    D. 120/80

17. Which medical waiver is given for conditions that will need ongoing monitoring (such as diabetes)?
    A. Medical Monitoring Form
    B. Special Issuance Authorization
    C. Recurring Check-up Designation
    D. Conditional Medical Waiver

18. Which of the following is not a disqualifying condition for passing the medical examination?
    A. Bipolar disorder
    B. Migraine headaches
    C. Substance abuse
    D. Myocardial Infarction

19. Dr. Sancetta said that his goal was not just to be a pilot medical examiner but also to help pilots_____.
    A. Pass their medical examination without cheating
    B. With health issues before they die
    C. With health maintenance for a long and satisfying flying experience
    D. With early retirement

20. Ultimately, FAR 61.53 places the responsibility to determine whether or not a pilot is safe to fly on whom?
    A. The Aviation Medical Examiner
    B. The airplane mechanics
    C. The FAA
    D. The pilot

Answers to Part One questions:

1. B
2. A
3. B
4. A
5. C
6. D
7. D
8. B
9. A
10. C
11. D
12. B
13. A
14. C
15. B
16. C
17. B
18. B
19. C
20. D

Part Two

– The Flight Environment –

Learning Outcomes

Upon completion of Part Two, the learner should know:

- Air is mostly made up of two basic elements, oxygen and nitrogen.
- The Earth is 75% water and 25% land at the surface.
- The standard pressure at sea level is 14.7 pounds per square inch.
- On December 17, 1903, Orville and Wilbur Wright "conquered" the air by the first controlled, powered, and sustained flight in an aircraft called the Flyer.
- The human element in flight is called aviation physiology.
- At 10,000 feet and above, the human is at risk when flying an airplane.
- Two major factors come into play as a pilot flies higher into the atmosphere: oxygen deprivation and dehydration.
- The FAA requires that all pilots flying their aircraft above 12,500 feet for 30 minutes or longer or at 14,000 feet or above during the entire flight must use supplemental oxygen. The amount required is 1 liter of oxygen per minute for every 10,000 feet. For example, at 18,000 feet there should be a flow of 1.8 liters per minute of oxygen available via a standard breathing device. The FAA requires there should be a device attached to each breathing device that visually shows the flow of oxygen.
- Most private flying is done in the atmospheric layer known as the troposphere.
- A device for measuring pressure changes is called a barometer.
- The physical divisions of the atmosphere are troposphere, stratosphere, ionosphere, thermosphere, and exosphere.
- The physiological divisions of the atmosphere are the physiological efficient zone, physiological deficient zone, and the space equivalent zone.

2.1 It can be incredibly beautiful yet deadly in the troposphere.

Important Terms

- Physiology
- Atmosphere
- Troposphere
- Stratosphere
- Ionosphere
- Thermosphere
- Exosphere
- MSL (Mean Sea Level)
- AGL (Above Ground Level)
- PSI (Pounds Per Square Inch)
- AMS (Acute Mountain Sickness)
- HAPE (High Altitude Pulmonary Edema)
- Oxygen Deprivation
- Hypoxia
- Torricelli
- Aneroid
- Density Altitude
- Atmospheric Nitrogen Percentage
- Atmospheric Oxygen Percentage
- Lapse Rate
- HACE (High Altitude Cerebral Edema)
- Partial Pressure
- Aneroid
- Standard Atmosphere
- Differential Heating
- Accute Mountain Sickness (AMS) symptoms
- Accute Mountain Sickness (AMS) treatment

2.2 Above 10,000 feet, humans may be at risk.

Presentation

This unit may look like an earth science text book; however, it is basically a review of the mathematics and scientific principles of our atmosphere. The Flight Environment is a lead-in to the next section, Aerophysiology. This involves the human element and the operation of an aircraft within the "flight environment."

2.3 On days when it is hot and humid, pilots experience the effects of density altitude as the airplane climbs out during takeoff. (Image by Adam Wright)

It is recommended that the presenter take each one of the "bullets" in the Learning Outcomes and using the text, go through and explain these important features. Notice that the first few bullets explain the nomenclature of the Earth itself and what a wonderful habitat it is for human existence; then the airplane is brought into the picture and shows how mankind finally "conquered" the air. The presenter should explain that it wasn't until the technology of the airplane progressed to a point where high altitudes could be achieved that the dangers became an issue. At an altitude of 10,000 feet performance of flying an airplane becomes compro-

mised. The final component of your presentation of this unit should emphasize the risks involved with flight in the upper reaches of the troposphere.

Motivation

It is recommended that the presenter get a copy of the Jeppesen DVD, *Aviation Physiology,* and use it as a motivator in the presentation of this part. The presenter should have a monitor and DVD player ready for the session. The Jeppesen DVD explains how the performance of a pilot starts to decline as the airplane climbs higher and higher.

It is recommended that the presenter consider asking an Air Force pilot to be a guest speaker. USAF flight crews are required to go through high-altitude training and the speaker can tell the class first-hand about the experience. The Air Force pilot can also tell the audience about other factors including hypoxia, disorientation in threatening weather conditions, and other experiences encountered at various levels of the atmosphere. As with the AME, it is recommended that the guest speaker be given the *Fit for Flying* book prior to his/her presentation. Of course, it would be great if the presenter is able to get an astronaut to speak at one of the presentations. The experiences of flight into space are fascinating to any audience.

Overview

This part is about the basics of atmospheric science. The recommended methodology is both lecture and audiovisual in nature. As stated in the Motivation component above, use the Jeppesen *Aviation Physiology* DVD to help the students visually understand the material in the text.

Learning Evaluation – Multiple Choice Questions

Part Two

– The Flight Environment –

1. The percentage of nitrogen and oxygen in our atmosphere is _____.
   - **A.** 50/50
   - **B.** 40/60
   - **C.** 79/21
   - **D.** 60/40

2. The earth has approximately how much water covering its surface?
   - **A.** 25%
   - **B.** 75%
   - **C.** 45%
   - **D.** None of the above

3. What is the average temperature over the surface of the Earth?
   - **A.** 59°
   - **B.** 49°
   - **C.** 0°
   - **D.** 72°

4. The Wright Brothers had to meet three goals before they were said to "conquer" the air. Those "flight" goals are which of the following?
   - **A.** Higher, faster, farther
   - **B.** Upward, onward, outward
   - **C.** Controlled, sustained, powered
   - **D.** Controlled, gliding, powered

5. The Wright "Flyer" aircraft achieved which of the following?
   - **A.** 12 feet altitude, 12 miles per hour, and 12 seconds of flight
   - **B.** 12 feet altitude, 120 feet distance, and 12 miles per hour
   - **C.** 12 feet altitude, 120 miles per hour, and 120 feet distance
   - **D.** 12 feet altitude, 120 feet distance, and 12 seconds of flight

6. The human element in flight is called what?
   - **A.** Aviation technology
   - **B.** Aviation physiology
   - **C.** Aviation medical science
   - **D.** Aeropsychology

7. The percentage of oxygen in all of the atmosphere _____.
   A. Is the same all the way to the top of the atmosphere
   B. Gradually diminishes
   C. Gradually changes to the top of the atmosphere
   D. Gets warmer at higher altitudes

8. FAR 91.21 requires supplemental oxygen at what altitude?
   A. 10,000 feet MSL
   B. 12,500 feet MSL after 30 minutes
   C. 12,500 feet immediately
   D. 6,000 feet MSL

9. Controlled tests where flight conditions can be duplicated are conducted in _____.
   A. An altitude chamber
   B. An altitude replicator
   C. A high altitude cockpit
   D. Hypoxia replication chamber

10. What is the average atmospheric pressure at sea level?
   A. 14.0 pounds per square inch
   B. 15.7 pounds per square inch
   C. 59 pounds per square inch
   D. 14.7 pounds per square inch

11. The body tends to _____with a gain in altitude.
   A. Sweat
   B. Heat up
   C. Cramp
   D. Dehydrate

12. The symptoms of headache, fatigue, nausea, and unconsciousness at altitudes above 10,000 feet are those of _____.
   A. Morning sickness
   B. Motion sickness
   C. Hypxia
   D. Fear of flying

13. Which of the following cities is not above 5,000 feet above sea level?
   A. Denver, Colorado
   B. Aspen, Colorado
   C. Mexico City, Mexico
   D. They are all above 5,000 feet above sea level

14. HACE is a life-threatening condition involving the brain. What does HACE stand for?
   A. High Altitude Cerebral Edema
   B. High Altitude Pulmonary Edema
   C. High Altitude Cardiac Edema
   D. None of the above are correct

15. What are the two major problems facing a human at high altitude?
    A. An increase in stress and rapid dehydration
    B. Rapid dehydration and heat stroke
    D. Kidney stones and migraine headaches
    D. None of the above

16. What is the physical layer in which most general aviation operations take place?
    A. Ionosphere
    B. Stratosphere
    C. Troposphere
    D. Mesosphere

17. The layer of the atmosphere where high-performance aircraft, such as fighter jets, operate is the _____.
    A. Tropopause
    B. Stratosphere
    C. Thermosphere
    D. Mesosphere

18. An airplane's altimeter is based on what kind of barometer?
    A. Aneroid
    B. Mercury
    C. Oxygen
    D. Sea level

19. The density of the air decreases the higher we go in the atmosphere, thus making the airplane's lift performance less. This condition is called _____.
    A. Density altitude
    B. High altitude lapse
    C. Atmospheric decrease
    D. Standard density

20. High, hot, and humid are conditions that affect what aircraft performance issue?
    A. Hypoxia
    B. Climb performance
    C. Density altitude
    D. Diminished performance syndrome

Answers to Part Two questions:

1. C
2. B
3. A
4. C
5. D
6. B
7. A
8. B
9. A
10. D
11. D
12. C
13. D
14. A
15. A
16. C
17. B
18. A
19. A
20. B

Part Three

– Aerophysiology –

Learning Outcomes

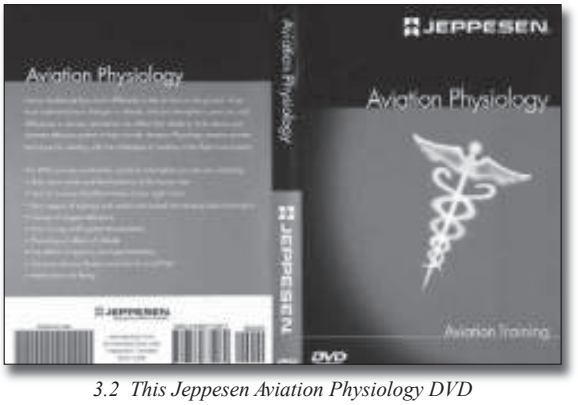
Upon completion of Part Three, the learner should know:

- The definition of aerophysiology
- The layers of the atmosphere
- The meaning of the phrase "time of useful consciousness"
- The definitions of and the four major groups of hypoxia
- The symptoms of hypoxia
- The hypoxic effect of tobacco usage
- The actions needed to stop carbon monoxide poisoning
- The effects of climb and descent upon the components of the hearing system
- The definition of spatial disorientation
- The effects of stress and fatigue
- The correlation between high altitude and dehydration
- The anatomy and function of the human eye

3.1 Aerophysiology is the study of the human element as an integral part of the flying process.

Important Terms

- Aerophysiology
- Consciousness
- Hypoxia
- Hypemic
- Stagnant
- Histotoxic
- Symptoms
- Valsalva
- Acute
- Chronic
- Retina
- Fovea
- Cornea
- Iris
- Optic disk



3.2 This Jeppesen Aviation Physiology DVD is a highly recommended resource.

- Rods
- Cones
- Peripheral
- Types of vision: (1) Photopic; (2) Mesopic; (3) Scotopic
- Adaptation

Presentation

This unit is a comprehensive overview of human physiology as it relates to flight. It is highly recommended that the presenter first show the Jeppesen *Aviation Physiology* DVD at the beginning of this unit. All participants will find the DVD interesting and very informative. It will add a touch of professionalism to the presenter's session as almost all of the learning outcomes and important terms are addressed in the DVD.

3.3 A homemade Barany chair. The Conference Guide that follows shows how to make this educational device. Using automotive rear axle housing, a milk box, and an used office chair. Once a footrest is installed, pilots sit comfortably, blindfolded, and are slowly rotated. The experience is fun, yet sobering. It's an excellent way to gently show the effects of vertigo and disorientation.

Motivation

Since most altitude chambers are located at Air Force bases around the US, it is sometimes difficult to access these other than in approved FAA aviation physiology courses. During these courses, an activity is usually featured that the presenter can use for all of his or her presentations. It's called the Barany chair. NASA uses it; the Air Force uses it; and the FAA uses it. Participants can each learn an important lesson from this activity. In the Conference Guide, it shows how to build this chair. There is an alternative, an adjustable office chair on its own. By carefully pumping up the elevation of the office chair, you can rotate it almost without friction. The person in the chair is given a comfortable blindfold and a pilot's "stick" made from a broom handle. The presenter starts out by slowly rotating the chair in one direction and the student is asked to "fly" the stick in the direction of the rotation. The student moves the stick right or left, and after a gentle rotation of about 1-2 minutes, the chair is allowed to slow to a stop. Almost without exception, the student or pilot will suddenly move the stick to the full opposite direction. When the presenter carefully removes the blindfold, the student will be astonished to see that he/she is sitting still. The other members of the group find this to be quite humorous and everyone will want to try it.

During a Barany chair demonstration with a seasoned airline captain, the blindfold was put in place and he was given a stick and instructions to simply move it in the direction he was "flying." After about 2 minutes, as the chair was gently slowing to a halt, the captain suddenly moved the stick in the full opposite direction. The blindfold was removed and the captain said, "No-o-o-o-o-o! I can't be sitting still!" One of the students sitting in the class said, "The chair got him!" They all learned the meaning of physiological disorientation experienced by pilots in long trips using instrument flying rules.

Overview

This section contains much serious information that is learned in ground school for pilots. It needs to be read as a refresher course to remind each pilot of the threatening physiological conditions involved in flying an aircraft. Conditions ranging from shortness of breath, dizziness, and fatigue at lower altitudes to the boiling of body fluids at extremely high altitudes, clearly show that flight in the upper reaches of the atmosphere can be life threatening.

Learning Evaluation – Multiple Choice Questions

Part Three

– Aerophysiology –

1. Which is the main layer of the atmosphere where airplane pilots fly?
   - **A.** Troposphere
   - **B.** Tropopause
   - **C.** Stratosphere
   - **D.** Mesosphere

2. Internationally famous golfer, Payne Stewart, was killed in a 1999 plane crash. What did the NTSB determine the cause of the tragedy to be?
   - **A.** Hypoxia
   - **B.** Diabetic coma of the flight crew
   - **C.** High Altitude Cerebral Edema
   - **D.** Oxygen-related explosion on board

3. The time of useful consciousness at 45,000 feet without oxygen is:_____.
   - **A.** 30 minutes
   - **B.** 3-5 minutes
   - **C.** 9-15 seconds
   - **D.** 5-10 minutes

4. As a pilot climbs higher and higher, the _____ of oxygen remains the same, but the ____ required for oxygen molecules to pass between the membranes of the respiratory system decreases and this can become a threat.
   - **A.** concentration, percentage
   - **B.** percentage, pressure
   - **C.** density, concentration
   - **D.** density, percentage

5. Hypoxia, by definition, means what?
   - **A.** Stagnant oxygen
   - **B.** Reduced oxygen
   - **C.** Contaminated oxygen
   - **D.** Tissue-deprived oxygen

6. What type of hypoxia occurs when the blood is not able to take up and transport a sufficient amount of oxygen to the cells of the body?
   - **A.** Hypoxic
   - **B.** Stagnant
   - **C.** Histotoxic
   - **D.** Hypemic

7. Which of the following symptoms is not that of hypoxia?
   A. Blue fingernails and lips
   B. Headache
   C. Reddening of the face
   D. Drowsiness

8. As hypoxia worsens, the field of _____ begins to narrow and _____ interpretation can become difficult.
   A. Concentration, decision
   B. Vision, instrument
   C. Concentration, hearing
   D. Vision, communications

9. What is a deadly, colorless, odorless gas that can endanger a pilot's performance?
   A. Carbon dioxide
   B. Stagnant oxygen
   C. Carbon monoxide
   D. Systemic nitrogen

10. What occurs when an individual is experiencing emotional stress, intense fear, pain, anxiety, and accelerating breathing?
   A. Hypoventilation
   B. Hyperventilation
   C. Histotoxic hypoxia
   D. Unconsciousness

11. Climbing and descending in an airplane can sometimes cause what physical issues?
   A. Ear or sinus pain
   B. A temporary reduction in one's ability to hear
   C. A collapse of the Eustachian tube
   D. Items A and B are both correct

12. The procedure of pinching one's nose, sealing the lips, and blowing is called what?
   A. The Valsalva maneuver
   B. The decompression maneuver
   C. Induced hypoxia
   D. A blowout

13. _____ refers to the lack of orientation with regard to the position, attitude, or movement of an airplane.
   A. Disabling
   B. Hyperventilation
   C. Hypoxia
   D. Spatial disorientation

14. When visual contact with the horizon is lost when flying, what system may become unreliable?
   A. Respiratory
   B. Excretory
   C. Vestibular
   D. Auditory

15. If contact with the horizon is lost in more than one event while flying, the inner ear may fool the pilot into thinking the airplane has started a bank in the other direction, thus causing a deadly maneuver known as what?
    A. A stall
    B. A graveyard spiral
    C. A spin
    D. A Valsalva spiral

16. When pilots smoke just prior to flying, more than _____ feet of "altitude" is added to the body's effort to conduct the respiration cycle.
    A. 10,000
    B. 12,000
    C. 4,500
    D. 1,000

17. _____ _____ is the process by which the eyes adapt for optimal visual conditions under low ambient illumination.
    A. Dark adaptation
    B. Ocular degeneration
    C. Macular degeneration
    D. Ambient compensation

18. Which of the following factors are an issue with red cockpit lighting?
    A. Negatively affects night vision
    B. Makes reading aeronautical charts easier
    C. Washes out the color of red on the instrument panel
    D. Has no negative effect

19. The night blind spot is located where?
    A. 5-10° around central vision
    B. 0-20° around central vision
    C. 100° in an arc from central vision
    D. About 45° from central vision

20. In the illustration concerning the anatomical blind spot, when a pilot focuses on the "gun sight," what happens?
    A. The gun sight disappears
    B. The airplane in the opposite windscreen gets brighter
    C. The airplane in the opposite windscreen disappears
    D. Both the gun sight and airplane soon disappear

Answers to Part Three questions:

1. A	**8. B**	**15. B**
2. A	**9. C**	**16. D**
3. C	**10. B**	**17. A**
4. B	**11. D**	**18. C**
5. B	**12. A**	**19. A**
6. D	**13. D**	**20. C**
7. C	**14. C**	

Part Four

– Not Fit To Fly –

Learning Outcomes

Upon completion of Part Four, the learner should know:

4.1 Innocent looking over-the-counter medications can compromise a pilot's performance.

- Many readily available, easy-to-buy substances can compromise human performance in the capacity of flying an airplane.
- Many readily available, easy-to-buy substances can have a negative effect upon the outcome of a FAA medical examination.
- Pilots and race drivers operate at speeds that are far above the ordinary, and their physical condition is critical to the performance and safety of racing and flying.
- Most prescription drugs are not tested under the conditions encountered where there is less oxygen and a lower pressure common to flight in the troposphere. The side-effects of these drugs may be a serious problem while flying.
- Medical doctors are not trained in aviation medicine and sometimes can give advice that is not proven under flying conditions.
- Pilots should always consult an AME when they are planning a flight while taking any prescription drug.
- America's most serious drug problem is alcohol.
- A hangover can sometimes have the same effect as being mildly intoxicated.
- Over 100,000 deaths in the US can be directly or indirectly attributed to alcohol.
- Alcohol kills more young people than all illicit drugs combined.
- In the US, alcohol-impaired drivers kill over 50 people per day.
- A pharmacist is a specialist in prescription and nonprescription drug side-effects. They should be consulted before flying; however one must remember most prescription drugs are not tested at high altitudes.
- Many over-the-counter (OTC) medications, such as decongestants, cough suppressants, laxatives, anti-diarrheal drugs, suppressants, sleeping aids, and stimulants are considered to be risk factors when flying.

Important Terms

- OTC
- Self-medication
- Self-imposed stress
- Blood-alcohol level
- Metabolism
- Euphoria
- Impairment
- Apathy
- Muscular incoordination
- Respiratory paralysis
- Adverse reaction
- Antihistamine
- Chronic
- Hangover
- Pharmaceutical
- Suppressant
- Decongestant
- Stimulant

Presentation

The presenter should discuss the differences between a race car driver at 200 mph and an aircraft pilot's duties at 200 mph. The discussion might include:

1. Proximity to other vehicles
2. Complexity of aircraft compared to the complexity of a race car
3. Reaction times in the event of emergencies
4. Medications, drugs, and alcohol on the performance of both operators
5. Fatigue as a problem to pilots and race car drivers

From this point, the presenter might want to discuss over-the-counter substances. The discussion should address various physiological issues, such as excitement, mood swings, pain, fatigue, and anxiety suppression. The presenter may want to discuss trends in various abused substances, such as alcohol, tobacco, steroids, or Internet drugs. The presenter should discuss the issue of blood-alcohol concentration and the resulting effects. At this point everyone should interact on the topic of "Alcohol is One of America's Greatest Killers."

The topic of illegal weight-loss pills can be discussed here and this can be coupled with Dr. Glenn Stout's article in Unit Five, "The Epidemic of Obesity." Americans are turning to pills as a "quick fix" for obesity and this has generated a tremendous market for illegal foreign weight-loss purchases on the Internet. These issues are excellent topics and their importance should be pointed out and discussed, as pertains to pilots, crew members, and ground personnel.

Motivation

It is recommended that the presenter take small groups or request the participants go to local drugstores and have each member compile a list of substances that might affect human performance in the operation of an aircraft. The presenter could locate a pharmacist or doctor who is also a pilot and who would be willing to come to speak to the group regarding drugs and side-effects, especially as pertains to flying. Every pilot has a story of how something, or someone, was affected by a substance-abuse problem in their flying career.

Overview

This section is very important because over-the-counter medications are common to everyone and may involve abuses that happen daily without anyone's knowledge, or intention. Bringing to the forefront the issue of the pervasive alcohol-abuse problem in this country is most important, as well.

Learning Evaluation – Multiple Choice Questions

Part Four

– Not Fit To Fly –

1. In this section two high-performance humans are compared. They are:
   - **A.** Pilots and ground crew members
   - **B.** Pilots and astronauts
   - **C.** Pilots and race car drivers
   - **D.** Pilots and World War II Aces

2. Easily obtained nonprescription medications at local drugstores are known as what?
   - **A.** Illegal drugs
   - **B.** Illicit drugs
   - **C.** Substances
   - **D.** OTC (over-the-counter) drugs

3. Sedatives, pain-relief substances, tranquilizers, anti depressants, and cold and flu medications all have what that could make them dangerous?
   - **A.** Primary and secondary effects
   - **B.** Blood thinners
   - **C.** Psychological effects
   - **D.** Intestinal effects

4. Of the two broad categories of pain-killers, what type reduces pain?
   - **A.** Anesthetics
   - **B.** Analgesics
   - **C.** Asthmatics
   - **D.** Antibiotics

5. Of the two broad categories of pain-killers, what type deadens pain?
   - **A.** Anesthetics
   - **B.** Analgesics
   - **C.** Asthmatics
   - **D.** Antibiotics

6. The side-effects of pain medications can be_____.
   - **A.** Mental confusion
   - **B.** Inability to make quick and accurate decisions
   - **C.** Vision problems
   - **D.** All of the above

7. What type of drugs reduce the body's functioning in many areas?
    A. Amphetamines
    B. Stimulants
    C. Depressants
    D. Antacids

8. Of all the drug problems in today's society, which one is the most serious according to our national health authorities?
    A. Alcohol
    B. Marijuana
    C. Cocaine
    D. Coffee

9. When purchasing any over-the-counter medication, it is highly recommended that buyers always check what?
    A. The company who manufactured the product
    B. The contents label
    C. Price comparisons with generic medications
    D. The other uses for the product

10. Amphetamines, caffeine, and nicotine are all _____ drugs.
    A. Depressant
    B. Hypnotic
    C. Stressful
    D. Stimulant

11. The rate of alcohol absorption depends on which of the following items?
    A. Concentration of alcohol in the beverage
    B. The human's bodyweight
    C. How fast the alcoholic beverage is consumed
    D. All of the above are correct

12. What type of alcohol is most commonly consumed by a human?
    A. Methanol
    B. Ethanol
    C. Isopropanol
    D. Hexane

13. At which level of blood alcohol concentration is there possible death due mostly to respiratory paralysis?
    A. 0.09 - 0.25
    B. 0.18 - 0.30
    C. 0.35 - 0.50
    D. None of the above - the levels are not high enough

14. Many experts believe that _____ may be an even greater threat than mild intoxication for a pilot of flight crewmember?
    A. A hangover
    B. One beer
    C. An alcoholic binge
    D. Drinking hand sanitizer

15. What makes alcohol consumption even more dangerous for flying pilots and passengers?
    A. Other people's discomfort
    B. Not enough time to clear alcohol from the body on a flight
    C. More prone to stagger and fall
    D. High altitude; less presure

16. Using weight-loss products can be especially dangerous when purchased where?
    A. The Internet
    B. Local pharmacist
    C. From friends
    D. From Canada

17. Prescriptions from your primary-care physician may be of concern to pilots. Why?
    A. Because they are not FDA approved
    B. Because they may have side-effects in the flying environment unknown to the physician
    C. Because they are not on the government's list of approved medications
    D. Because they may have dental side-effects

18. Which professional is an expert in drug side-effects?
    A. Dentist
    B. Pharmaceutical salesperson
    C. Pharmacist
    D. Flight instructor

19. Which of the following over-the-counter medication is most likely to have side-effects that could affect pilot performance?
    A. Dramamine
    B. Pepto-Bismol
    C. Carbonated water
    D. Aspirin

20. Who is the person ultimately responsible for determining the pilot's day-to-day "fitness for flying?"
    A. FAA
    B. AME
    C. Pharmacist
    D. Pilot

Answers to Part Four questions:

1. C	**8. A**	**15. D**
2. D	**9. B**	**16. A**
3. A	**10. D**	**17. B**
4. B	**11. D**	**18. C**
5. A	**12. B**	**19. A**
6. D	**13. C**	**20. D**
7. C	**14. A**	

Part Five

– Fitness As A Lifestyle –

Learning Outcomes

Upon completion of Part Five, the learner should know:

5.1 A treadmill is an excellent aerobic exercise. (Ken Graham photo)

- It is recommended that the first step to becoming fit is getting a physical examination.
- It is recommended that personal fitness programs be developed by professionally trained fitness experts.
- A life-long fitness program requires commitment.
- The FAA recommends five basic components to a fitness program for pilots.
- Stretching reduces the risk of physical injury during a fitness program.
- Aerobic conditioning is an outstanding way to keep a healthy heart.
- Anaerobic conditioning helps maintain lifelong muscle strength.
- It is especially important to get professional help when preparing for an anaerobic, weight-training program.
- A cool-down series of exercises is essential to prevent blood from pooling in the extremities and to help the muscles flush out lactic acid.
- Dehydration is a problem for most people who start a fitness program.
- Obesity is a national health crisis within the US.
- Extensive research shows that women are just as likely as men to have a heart attack.
- Walking has been shown to be one of the best exercises for health and fitness.

Important Terms

- Cardiovascular
- Anaerobic
- Aerobic
- Rhythmic
- Dehydration
- Obese
- Body Mass Index
- Food Pyramid
- Calorie
- Sedentary

Presentation

The presenter should first point out that in the media there are literally thousands of options regarding diets, exercise machines, weight-loss programs, and what not to eat. This book uses FAA recommendations as the cornerstone of the Fitness as a Lifestyle section. Since the FAA has a very large staff of aviation-trained medical doctors, their recommendations are tailored to pilots and support flight operations personnel. Although this section is shorter than the others, it does contain some very easy-to-understand information for initiating and maintaining a health maintenance program. A large portion of the information for Fitness as a Lifestyle came directly from the FAA publication "Fit for Flight, Medical Facts for Pilots."

Fit for Flying is based on the importance of health maintenance and its place in the lives of both private and professional pilots, as well as the general public.

The presenter should emphasize that it has been shown that a healthy, fitness-oriented person can better cope with many of life's problems by maintaining a lifestyle of exercise and healthy diet. The presenter should emphasize these points:

1. Being trim, lean, and athletic vastly improves one's self-esteem.
2. Working out helps people cope with stress.
3. Working out helps the body produce endorphins which are nature's pain killers.
4. Weight training helps release aggression and build muscle tone and strength.
5. A good low-fat, low-cal diet can also be less expensive.

5.2 Free weights are an example of anaerobic exercise. (Ken Graham image)

Motivation

It is recommended that the presenter research the Internet and find some very high profile celebrities who, having maintained a lifetime of physical fitness, and are able to continue playing the game into their "golden years." In the text, the Federal Air Surgeon cites the example of golfer Gary Player.

It's common knowledge in the world of aviation that John Travolta is an accomplished pilot. He has a private Boeing 707 that sits beside his home. He also holds an ATP and is a captain with one international airline. His home is located in Ocala, Florida on Greystone Airport. John Travolta, as an avid aviation enthusiast, maintains a strong athletic presence by using a daily fitness program.

Another movie icon is Harrison Ford, who is both a fixed-wing and a helicopter pilot. Harrison is 66 years old and still stars in movies, like "Indiana Jones," which are very action oriented. He has a personal fitness trainer, Jamie Milnes, who is a well-known physical training expert. In an article in a British publication, he goes into great detail explaining how Ford "…insisted on doing many of his own stunts, saying 'I'm probably as fit, or possibly fitter, than I was 18 or 20 years ago.'" He continues, "Ford is extremely strong, very active, and disciplined about working out regularly." Milnes said, "We can't all look like Harrison Ford, but it's perfectly possible to get fitter and look better by consistently doing some exercise."

NASCAR driver Carl Edwards is an outstanding role model and he is also a supporter of the Civil Air Patrol. Carl is a strong advocate for physical fitness and the presenter can greatly enhance a presentation by discussing Edwards's background and his dedication to a healthy, drug-free lifestyle.

Overview

Although there is a sizeable movement toward a "lifestyle of fitness," America is still the fattest nation on earth. Estimates are that 40% (or higher) of our population is overweight. The presenter can address this and many other issues concerning good health, fitness, exercise, and a long, productive life.

It is highly recommended that the presenter also use as many of the pilot safety brochures as possible in workshops and learning labs. The FAA brochure will go a long way to validating presentations, especially to an audience of pilots. **(See page 34 of the follow-on Conference Guide for details on how to order the FAA Pilot Safety Brochures.)**

5.3 A dedication to exercise, good diet, and staying drug-free will keep this cadet "fit for life." (CAP photo)

Learning Evaluation – Multiple Choice Questions

Part Five

– Fitness as a Lifestyle –

1. The FAA recommends that before anyone starts a fitness program he/she should do what?
   - **A.** Find a good health club
   - **B.** Get a physical examination
   - **C.** See a fitness professional trainer
   - **D.** Buy a quality weight training machine

2. One of the first steps is to also change your attitude toward a lifestyle. After that, the main thing is what?
   - **A.** Don't quit
   - **B.** Change your diet
   - **C.** Change your primary care physician
   - **D.** Start warming up by doing the aerobic conditioning first

3. Warming up does what for your exercise program?
   - **A.** Lengthens your muscles
   - **B.** Gives your body a chance to deliver nutrient-rich blood to muscles to be exercised
   - **C.** Lubricates the joints
   - **D.** Both B and C are correct

4. In your daily routine, the FAA recommends what?
   - **A.** Take the stairs instead of using an elevator
   - **B.** Walk rather than drive
   - **C.** Eat appropriate foods
   - **D.** All of the above are correct

5. Which of the following is not part of an "aerobic" conditioning?
   - **A.** Jumping rope
   - **B.** Stair climbing
   - **C.** Cycling
   - **D.** Lifting free weights

6. A resistance-band machine is what?
   - **A.** Not effective
   - **B.** A form of an anaerobic exercise machine
   - **C.** Banned in Europe
   - **D.** A way to get rid of lactic acid in the muscles

7. Exercising with free-weights, resistance, and band machines is called what?
   A. Aerobic conditioning
   B. Anaerobic conditioning
   C. Cardiovascular
   D. None of the above

8. Which of the following is one of the least expensive, yet one of the most effective methods of exercising?
   A. Squats
   B. Dead-lifts
   C. Walking with a dog
   D. Military press

9. Free weights are more effective, but weight training machines are _____.
   A. Safer
   B. Slower
   C. Faster
   D. Easier

10. The "finishing touch" to any workout is called what?
   A. Burnout
   B. Cool down
   C. Painful
   D. Warm down

11. Proper nutrition, fluid intake, rest, and recuperation are all important for what purpose?
   A. Passing your flight medical examination
   B. Getting a private pilot's certificate
   C. Becoming a student pilot
   D. A healthy lifestyle

12. The average sedentary person needs how much water in a 24-hour period?
   A. 16 ounces
   B. 2-4 quarts
   C. 2-4 gallons
   D. 2 quarts

13. Dr. Glenn Stoutt, MD, states in his article that _____.
   A. Obesity is not a problem
   B. Obesity is not curable
   C. Obesity is a national crisis
   D. Obesity will keep you from passing your aviation medical examination

14. Dr. Glenn Stoutt, MD, refers to the BMI to identify obesity. What is the BMI?
   A. Basal Metabolism Index
   B. Basic Mass Index
   C. Body Mass Index
   D. Body Motion Indicator

15. According to Dr. Stoutt, what percentage of our population is now overweight?
    A. 40%
    B. 32%
    C. 10%
    D. 50%

16. Every major health organization endorses the _____.
    A. BMC
    B. The Food Pyramid
    C. The FAA workout schedule
    D. Ketosis factor

17. Most men lose weight on how many calories per day in a normal lifestyle?
    A. 1500
    B. 2000
    C. 2500
    D. 5000

18. Rapid weight loss diets will usually cause a person to lose _____ instead of fat.
    A. Muscle
    B. Water
    C. Bone mass
    D. Cholesterol

19. Is there a known food that "melts fat?"
    A. Yes
    B. No

20. According to Dr. Stoutt's article, "On Exercise and Heart Disease," cardiovascular disease is a disease of lifestyle and therefore largely _____.
    A. Related only to men
    B. Incurable
    C. Fatal
    D. Preventable

Answers to unit five questions:

1. B
2. A
3. D
4. D
5. D
6. B
7. B
8. C
9. A
10. B
11. D
12. B
13. C
14. C
15. A
16. B
17. A
18. B
19. B
20. D

5.4 To be a Civil Air Patrol pilot, you're going to have to be "fit for flying." It takes commitment to a program of good health maintenance throughout your life.

CONFERENCE GUIDE

FIT FOR FLYING

Getting The Word Out

The objective of the Drug Demand Reduction Program is to **educate** adults and youth about drug and alcohol use and abuse issues. The *Fit For Flying* publication was created as an aviation physiology guide for pilots, flight crews and support personel. It also contains information about health maintenance and living a drug-free lifestyle. Presenters are encouraged to make the *Fit For Flying* program available not only to CAP functions, but to school and youth organizations as well.

The Conference Guide

This ***Conference Guide*** will help the presenter plan and present a meaningful ***Fit for Flying*** session that goes beyond the intimate sessions with a small group of youth. The presenter doesn't have to be a medical professional or a pilot to make an excellent presentation to a larger group of people. The ***Fit for Flying*** text and accompanying guide and resources were all designed to help the presenter impart knowledge, such as:

1. The importance of the FAA's medical certificate and what the standards are for being an "airworthy" pilot.
2. The content of the FAA's Form **8500-8**.
3. Perspectives of America's top Aviation Medical Examiners toward the Form 8500-8.
4. The FAA's 15 disqualifying conditions.
5. The fundamentals of the atmosphere in which we fly.
6. The fundamentals of aviation physiology, the human element in flying.
7. Some of the risks to a pilot of over-the-counter medications.
8. Some guidelines for a fitness program suggested by the FAA.
9. The answers to some 100 questions that can be used to evaluate learning outcomes.
10. The availability of Jeppesen's ***Aviation Physiology*** DVD to supplement presentations.
11. The availability of a list of downloadable FAA videos on aviation physiology.
12. Instructions on how to build a "hands-on" aeromedical spatial disorientation simulator, known as the Barany Chair.

Getting Organized

The presenter must first make arrangements with appropriate stakeholders to present a ***Fit for Flying*** session. This should be done months in advance to make sure that all of the details are approved. Once a session is accepted, the presenter should plan the presentation with the following in mind:

1. What is the location of your presentation? Is it local, in another city, or in another state?
2. What is the size of the assembly room?
3. What will be the room set up? (Tables/chairs or just chairs for lecture type presentation)
4. Will there be a LCD projector and screen available?
5. Who is the target audience? Will it be cadets, students, adults, or a combination?
6. What is the number of attendees you can accommodate?
7. Will there be a space available for a Barany Chair demonstration?
8. Will there be *Fit for Flying* books available for your audience to use during your presentation?
9. How will you advertise the presentation for optimum attendance?
10. How much time will you need for the concepts you wish to present?
11. Will you need refreshments for the group? Is there a fund for this, if needed?
12. Will the date you select be in conflict with any other events going on in the area?

When all of these answers are determined, you should proceed to make plans and begin advertising the event. Solicit assistance of friends, co-workers, family, and fellow CAP members to ensure all areas are covered to make this a professional and worthwhile event.

Plan Ahead To Get FAA Pilot Safety Brochures

What are the FAA Safety brochures and why get them? These very professional FREE brochures produced by the Federal Aviation Administration can be used as stand-alone group discussion items and as supplements to the text. There are 20 brochures in all, thus, if you plan to have an audience of 50 or so, then you should order 1000 brochures well in advance. These brochures should be extremely valuable to everyone in attendance. At the time of this publication, the FAA contact person is:

Attn: Mr. Gary Sprouse (or FAA Safety Brochure Supplier)
Aerospace Medical Education Division
AAM-400, P.O. Box 25082
Oklahoma City, Oklahoma 73125

You can also go online and find these brochures in a PDF format at www.faa.gov/pilots/safety/pilotsafetybrochures/. They can be printed out; however, this can be very time-consuming and expensive. Thus, planning ahead to order these brochures would be the best route to take. The following list of brochures is what you should request:

AM-400-94/2 ***Alcohol and Flying: A Deadly Combination***
AM-400-95/2 ***Altitude –Induced Decompression Sickness***
OK05-0270 ***Carbon Monoxide; A Deadly Threat***
AM-400-03/2 ***Deep Vein Thrombosis and Travel***
AM-400-98/3 ***Hearing and Noise in Aviation***
OK-06-148 ***Information for Pilots Considering Laser Eye Surgery***
AM-400-97/1 ***Introduction to Human Factors in Aviation***
0K-05-0005 ***Medications and Flying***
AM-400-01/1 ***Physiological Training Courses for Civil Aviation Pilots***
OK-06-002 ***Pilot Medical Certification***
AM-400-98/2 ***Pilot Vision***
AM-400-91/2 ***Seat Belts and Shoulder Harnesses***
AM-400-95/1 ***Smoke!***

AM-400-00/1 ***Spatial Disorientation Visual Illusions***
AM-400-03/1 ***Spatial Disorientation: Why You Shouldn't Fly By the Seat of Your Pants***
AM-400-05/1 ***Sunglasses for Pilots: Beyond The Image***
Hypoxia
Over The Counter Medications and Flying
Fatigue in Aviation
Oxygen Equipment—Use in General Aviation Operations
Hearing & Noise in Aviation

Presentation Opening Remarks

Aerospace vehicles and support equipment must be manufactured with the finest materials and assembled with the greatest precision. Once this equipment is tested and approved, its operation depends on the skill of a highly-qualified, healthy team of humans. This kind of human performance requires a high degree of physical fitness. Thus, one who wishes to fly needs to live a life of being drug-free, staying fit, and living a healthy lifestyle.

In the past decades, there has been a big media push to "Just Say No" to drugs. Everyone's heard it, and for the average young American between the ages of 12-18, their reaction is usually, "I know, I know!" They do know, yet peer pressure is still incredibly strong to experiment. Alcohol is a classic example. With very few exceptions, teenage parties will have alcohol available somewhere. Alcohol is a dangerous drug and rather than "just say no," a young person who wants to be a pilot has to stay true to the belief that drugs and alcohol are unacceptable in an industry that has a zero tolerance for substance abuse.

In several interviews with professional pilots in the *Fit for Flying* text, virtually every one said that they made a commitment early in their lives to not abuse drugs and alcohol. One said, "Flying was my high…I didn't need anything else!"

Every professional pilot has to take a very serious physical examination, with a duration ranging from 6 months to one year, for the rest of their lives while pursuing the maintenance of a clear medical certificate. This one fact should make a big impression on the decision-making process of a young person considering becoming a pilot. Aviation is a magnet that has a way of changing lives in young people to a more fulfilled and purposeful life. Once a young man or woman sees the rewards of an aviation career, whether being a fighter pilot, flying important business executives in corporate jets to exotic places around the world, or flying an airliner with passengers of all ages, it makes it easier to say "no" when offered drugs or alcohol.

Showtime!

1. Have all of the projection equipment ready and show the ***Fit for Flying*** PowerPoint Presentation. (If you do not have this, request it by e-mailing ddr@capnhq.gov.) Or, as an option and time permitting, acquire and show the Jeppesen DVD, *Aviation Physiology.* Discuss each, as is appropriate.
2. Distribute the FAA Pilot Safety brochures. Divide in groups to read and discuss these and then bring the group back together to share knowledge learned.
3. If you can prepare a Barany Chair, unveil it for the audience and prepare for the demonstration, as outlined below. The FAA brochures and the excitement of the Barany Chair will make your presentation one that your attendees will long remember.

The Science Behind The Barany Chair — A Review Of Aviation Physiology

The presence of sensory and response systems is a universal attribute of life as we know it. All living organisms on Earth have the ability to sense and respond appropriately to changes in their internal and external environment. Organisms, including humans, must sense accurately before they can react, thus ensuring survival. If our senses are not providing us with reliable information, we may take an action which is inappropriate for the circumstances and this could lead to injury or death.

How Many Senses?

C-1 – This is a completed, homebuilt Barany Chair. It is essentially an office chair that is mounted on a milk box. The chair rotates on an automotive axle housing and when properly installed, the chair will rotate quietly, and with very little friction. The pilot sits blindfolded holding a joystick. When the chair is slowly rotated, the pilot moves the joystick to show the direction in which he/she is rotating. As the chair is allowed to slowly come to a stop, the inner ear mechanism will tell the pilot he/she is still moving, but in the opposite direction. The text gives the construction details and explains how the disorientation occurs. This is not a toy and the presenter should not allow it to be rotated at high speed.

We are all familiar with the question, "How many senses do humans have?" The answer we hear most often is five: sight, taste, smell, hearing, and touch. Actually, there are many other senses — hunger, thirst, kinesthetic, etc. One of the most powerful of the other senses is the **vestibular sense**, provided by the *vestibular system*. It is our ability to sense body movement combined with our ability to maintain balance (equilibrium). The human body has a remarkable ability to sense and determine the direction and speed in which it is moving and maintain appropriate balance for this movement (postural equilibrium).

Human beings have the ability to walk a tightrope, do repeated pirouettes in a ballet performance, combine twists and turns when diving, or perform triple toe loops while ice skating…all (usually) without losing balance and while keeping track of the relative position of arms and legs with respect to the rest of the body. Incredible!

How does the human body sense and control the movement so precisely? How do we maintain balance while putting ourselves through a wide variety of spinning and tumbling activities that are inherently "unbalancing?" When we are in motion, how do we know in what direction and at what speed we are moving? How do these important body senses change or adapt when we fly in an aircraft or enter the microgravity environment of low Earth orbit? Can these sensory and response systems, which work so well here on Earth, provide us with inaccurate and potentially harmful information when we fly as pilots or astronauts? Let's find out!

C -2 – Flying: It doesn't get much better than this. (Image courtesy of Alex McMahon)

Maintaining postural equilibrium, sensing movement, and maintaining an awareness of the relative location of our body parts requires the precise integration of several of the body's sensory and response systems including visual, vestibular, *somatosensory* (touch, pressure, and stretch receptors in our skin, muscles, and joints), and auditory. Acting together, these body systems constantly gather and interpret

sensory information from all over the body and usually allow us to act on that information in an appropriate and helpful way.

Body movements undertaken in our every day "Earth-normal" environment usually do not upset our sense of balance or body orientation. However, we have all experienced dizziness and difficulty walking after spinning around in a circle. How does the unique gravitational condition encountered in space flight affect an astronaut's sense of body orientation, movement, and balance?

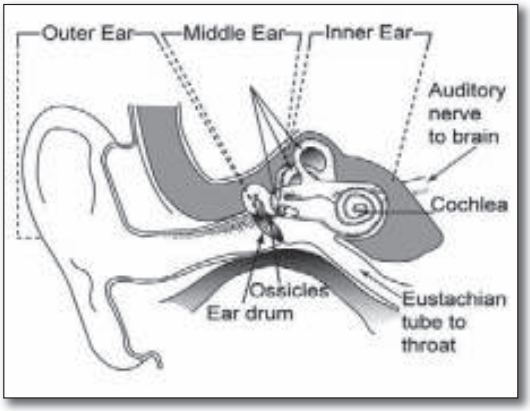
Astronauts experience similar sensations of dizziness and disorientation during their first few days in the microgravity environment of space. Upon returning to Earth after prolonged exposure to microgravity, astronauts frequently have difficulty standing and walking upright, stabilizing their gaze, and walking or turning corners in a coordinated manner. An astronaut's sense of balance and body orientation takes time to re-adapt to Earth-normal conditions.

Something about the vestibular system obviously adapts to changing conditions, but what? Why? How? Might a better understanding of this microgravity-induced vestibular function help people back on Earth prevent the dizziness, disorientation, and susceptibility to falling that some older people experience? Answers to these important and interesting questions require us to know more about the anatomy (structure) and physiology (function) of the human vestibular system on Earth, as well as in space.

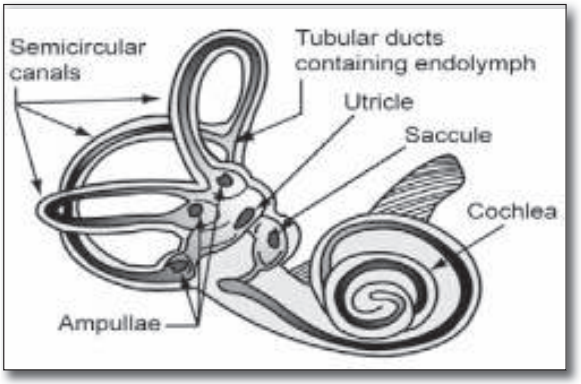
For many years, NASA has been investigating the human vestibular system's adaptation to the space environment. Important experiments were performed on STS-40 (Spacelab-1), STS-58 (Spacelab-2), and STS-90 (Neurolab). Future flight experiments will help us to better understand the physiology of our vestibular system by building on what we have learned from previous missions and ground-based research.

Vestibular Anatomy and Physiology

Please refer to Illustration C-3 as we learn some important and interesting facts and terms about the ear and vestibular anatomy and physiology. The ear is made up of several smaller structures that can be organized into three distinct anatomical regions: an outer ear which extends from outside the body through the ear canal to the tympanic membrane (ear drum); a middle ear, an air-filled cavity containing three tiny bones (ossicles) that transmit and amplify sound between the ear drum and the cochlea (where the sense of hearing is located); and the inner ear, composed of the cochlea and the vestibular system. The vestibular system (Illustration C-4), which is the key to our sense of balance, motion, and body position, is comprised of three semicircular canals connected to two membranous sacs called the *saccule* and *utricle*. The saccule and utricle are often referred to as the *otolith organs*. The otolith organs allow us to sense the direction and speed of *linear acceleration* and the position (tilt) of the head. The semicircular canals allow us to sense the direction and speed of *angular acceleration*.

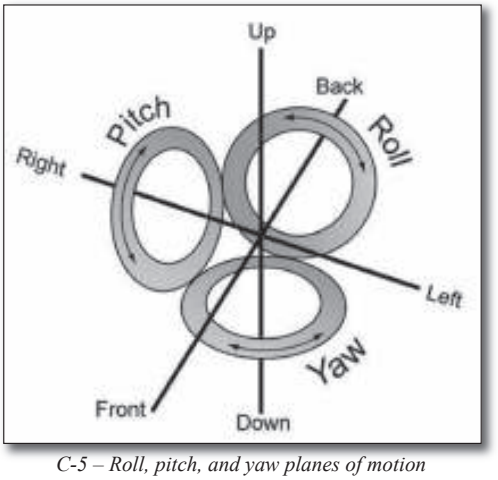


C-3 – The outer, middle, and inner ear



C-4 – The vestibular systems – semicircular canals and otolith organs

The semicircular canals are oriented along three planes of movement with each plane at right angles to the other two. Pilots and astronauts call these three planes of rotation *pitch* (up and down; nodding your head "yes"), *roll* (tumbling left or right; moving your head from your left to your right shoulder or vice versa), and *yaw* (lateral movement left and right; shaking your head "no"). See Illustration C-3.

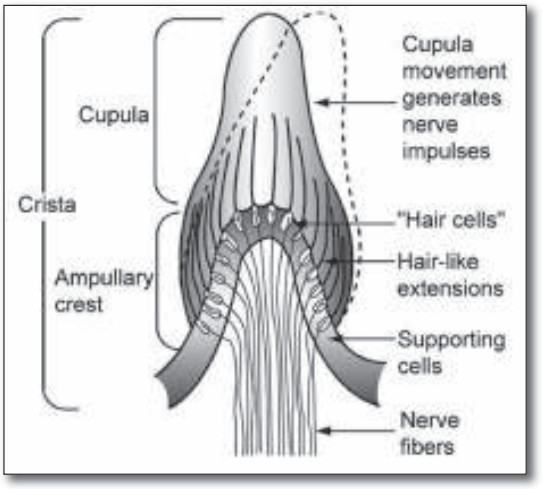


C-5 – Roll, pitch, and yaw planes of motion

What's the difference between angular and linear acceleration? Linear acceleration is a change in velocity (speed increasing or decreasing over time) without a change of direction (straight line). Angular acceleration is a change in both velocity and direction at the same time. For example, imagine you are in a stopped car. The driver of the car steps on the accelerator and you accelerate straight ahead. The driver steps on the brake pedal and you decelerate to a stop. Then the driver puts the car in reverse and you accelerate straight backwards, and then the driver slams on the brakes once again. You have just experienced linear acceleration and deceleration in both forward and backward directions. Your movement was along a straight line and your otolith organs helped you sense these linear accelerations and decelerations.

Imagine yourself on a roller coaster. You start out accelerating straight ahead, just like in the car. Suddenly, the track dips almost straight down and you "pitch" forward. Then the nose of your car (and you) comes almost straight up. You have just experienced downward and upward pitch. The roller coaster, while staying perfectly flat on the track, now takes a severe left turn followed by a right turn. You have just "yawed" to the left and right. Now comes the really fun part. Your roller coaster and the track do a complete 360-degree roll, first to the left and then to the right. Makes you dizzy just thinking about it, right? You have just experienced the three planes of angular acceleration; pitch, yaw, and roll. An aircraft, a spaceship, or any vehicle operating in three-dimensional space can accelerate in these three planes of rotation and often along more than one plane at the same time. Your semicircular canals enable you to sense these angular accelerations. Although they are both located within the vestibular apparatus of your inner ear, are interconnected, and operate using similar physical principles, the sensory mechanisms which allow you to detect linear acceleration (otolith organs) are structurally and functionally different than those which allow you to detect angular acceleration (semicircular canals).

The vestibular system also helps you maintain a fixed gaze on a stationary or moving external object while you are undergoing complex head and body movements. Look at the clock on the wall. Now move your head sideways or up and down, or even in a circle. Your eyes stay fixed on the clock. With slow movement, the eyes are kept stationary by visual mechanisms only. As the speed of movement increases, the vestibular system takes over the image stabilization process. This reflexive eye movement, *nystagmus,* can be demonstrated by using a *Barany Chair*. Robert Bárány was a Nobel Prize winning physiologist, recognized for his research on the vestibular system.



C-6 – Crista (cupula and ampullary crest). When movement of the endolymph causes cupula to bend, sensory hair cells generate nerve impulses which the brain perceives as angular acceleration.

How Structure Supports Function

Now that you understand the location and overall design of your vestibular system and its role in providing you with reliable sensory input, let's investigate the structure and functions of its two different components.

Look at Illustration C-4 and C-6 for detailed views of the structures within the vestibular system. You will notice that all vestibular organs (semicircular canals, saccule, and utricle) functionally rely on a common type of receptor cell, called a *hair cell.*

The Semicircular Canals

The semicircular canals are a set of three membranous tubes embedded within a bony structure of the same shape. The central cavity of each canal is filled with a fluid called *endolymph.* Each endolymph-filled canal has an enlarged area near its base called an *ampulla*.

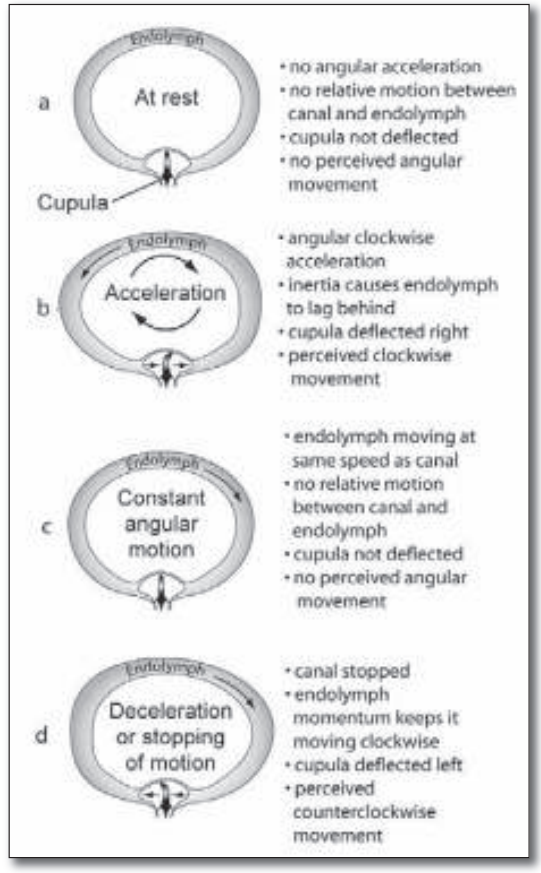
Parts of the vestibular nerve penetrate the base of each ampulla and terminate in a tuft of specialized sensory hair cells. The hair cells are arranged in a mound-like structure called the ampullary crest. Rising above the ampullary crest is the *cupula*, consisting of the hair-like extensions of the hair cells surrounded by a gelatinous material arranged into a wedge-shaped structure. This structure consisting of the ampullary crest and the cupula is called a *crista*.

When the endolymph moves (or the cupula moves and the fluid remains stationary), the gelatinous tip of the cupula and the hair cell extensions embedded within it are displaced to one side or the other. When the embedded hair cells bend, they send a signal via the vestibular nerve to the brain where the information is evaluated and appropriate action is initiated.

The mechanics of how the semicircular canals actually function to "sense" angular acceleration may be more easily understood by reviewing the physics of *inertia*. The Law of Inertia states that "a body at rest remains at rest unless acted upon by an unbalanced force." This is important because angular acceleration and deceleration primarily affect the semicircular canals and entirely depend on the relative movement of endolymph with respect to the cupula.

This means that if you were to begin accelerating along one of the three planes of rotation (pitch, roll, or yaw), structural components of the corresponding semicircular canal would begin moving immediately since they are attached to the rest of your head. However, the endolymph within that particular semicircular canal would tend to "remain at rest" due to inertia. See Illustration C-7a. It would lag behind the structural components, deflecting the cupula and generating a nerve impulse to the brain.

Initially, the membranous tubular and cellular structures move, but the fluid does not. Thus, there is relative movement between the fluid and the rest of the semicircular canal. See Illustration C-7b. Eventually, due to friction and the drag it induces, the fluid begins to move at the same speed as the components within which it is contained. When this occurs, the cupula is not deflected and, even though your body is continuing to angularly accelerate, the acceleration is not



C-7 – The effects of angular acceleration on the semicircular canals

"sensed." You incorrectly perceive that you are stationary. Illustration C-7c.

Without any jolting or sudden deceleration, stop your angular acceleration. What happens? The moving fluid now has momentum and so it continues to move until friction and drag bring it to a stop. In other words, fixed structures of your semicircular canal stop immediately (since they are still attached to your head which is still attached to your body) but the endolymph fluid continues to move in the direction of the previous movement. The Law of Inertia also states that "a body in motion will continue in motion in a straight line unless acted upon by an unbalanced force." Now, the cupula and the embedded hair cells are bent in the opposite direction. This causes you to incorrectly sense that you are accelerating in the direction opposite to your previous acceleration, even though you are completely stopped! See Illustration C-7d.

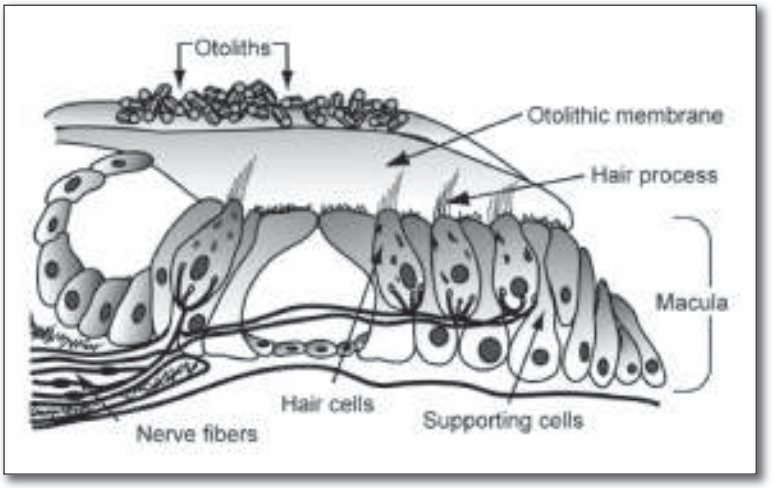
Saccule and Utricle

The saccule and utricle are referred to collectively as "the otolith organs." They sense linear acceleration and are affected by gravity. They also provide you with information concerning changes in head position (tilt). Because of the way they are situated within the vestibular apparatus, the saccule is more sensitive to vertical acceleration (like riding in an elevator) and the utricle is more sensitive to horizontal acceleration (riding in a car). Illustration C-8.

Both the saccule and the utricle contain a thickened patch of specialized cells called a *macula* that consists of sensory hair cells interspersed with "supporting" cells. The free hair-like tufts extending from the hair cells are embedded in a gelatinous otolithic membrane which supports small piles of calcium carbonate crystals on its surface. Collectively, these calcium carbonate crystals are called *otoliths.* The otoliths increase the mass of the otolithic membrane and give it more inertia. On Earth, when the head is tilted to the left or right, or forward or back, the otoliths tend to move along the gravity gradient (downwards). Even a slight movement of the otolithic membrane is enough to bend hair cells and send sensory information to the brain. A similar inertia and gravity-dependent process occurs when you accelerate linearly— up or down; forward or backward.

The underlying physiology and functioning of the otolith organs are remarkably similar to those of the semicircular canals. Both systems depend upon inertia and the mechanical deflection of hair cells to initiate nerve impulses that are sent to the brain and interpreted as body movement. The brain then reflexively initiates appropriate "corrective" actions within the nervous, visual, and muscular systems to ensure that situational awareness and balance are maintained.

Let's reexamine our previous example of rapidly accelerating straight ahead in a car. During forward acceleration, inertia causes the utricle's otolithic membrane and its associated otoliths to lag behind the portion of the utricle that is firmly attached to the head. This, in turn, causes the hair cells, whose hair-like extensions are embedded within the otolith membrane, to be deflected backwards. This backward deflection stimulates sensory nerves to fire and this provides the brain with information on the direction and speed of acceleration. A similar process occurs within the saccule when you are in an elevator and it either begins to rise or descend rapidly.



C-8 – Otolith organ (saccule or utricle) senses linear acceleration

Vestibular Sensing

Humans sense position and motion in three-dimensional space through the interaction of a variety of body proprioceptors, including muscles, tendons, joints, vision, touch, pressure, hearing, and the vestibular system. Feedback from these systems is interpreted by the brain as position and motion data. Our vestibular system enables us to determine body orientation, senses the direction and speed at which we are moving, and helps us maintain balance.

When there is no visual input, as is common in many flight situations, we rely more heavily on our vestibular sense for this information. However, in flight and in space, our vestibular system, which is designed to work on the ground environment, often provides us with erroneous or disorienting information.

Some of these spatial disorientation effects result in illusions that can be induced for the purpose of scientific research, or even just for fun. Filmmakers and designers of high-tech amusement park rides often use these techniques to pull us into the action and give us a more thrilling adventure. In the laboratory, scientists can use a special rotating seat, called a Barany Chair, to intentionally induce spatial disorientation in their test subjects. This allows the researcher to study how the vestibular system adapts to and functions in various conditions and situations. The next section of this guide describes vestibular experiments that can be done in the conference and are similar in approach to research that is currently being conducted by NASA.

Understanding the workings of the various organs that comprise this system will lead to improved adaptation strategies for astronauts entering a microgravity environment and returning to an Earth-normal environment. It will also help military and civilian pilots and people on Earth who are prone to dizziness and disorientation. We all benefit from NASA's scientific research on the vestibular system.

The Barany Chair — Creating Vestibular Illustions

The following activities use a Barany Chair to isolate the vestibular sense so that motion is interpreted solely on the basis of vestibular feedback. Four powerful vestibular illusions (spatial disorientation phenomena) are described here and can be performed in the presentation setting. The illusions provide a fun, hands-on opportunity to demonstrate the physiology of the semicircular canals. In these experiments, how the volunteer positions his or her head while the chair is being rotated determines which of the illusions is experienced. Among other effects, the test subject should falsely sense motion when none is taking place, perceive motion in a different direction from that which is actually taking place, or fail to detect motion at all.

By removing or lessening visual and auditory clues, vestibular inputs dominate. To aid in isolating the vestibular system, for illusions, a blindfold is placed over the volunteer's eyes and all observers remain silent. These conditions are necessary because the failure to sense motion is a difficult illusion to achieve. The illusions are easily interfered with by unintended feedback from other sensory systems. For example, a person whispering will provide auditory cues to the test subject that the chair is or is not rotating. If the room you are using has light and dark areas, the volunteer will see changes in brightness through the eyelids during rotation.

Preparation

Although the vestibular illusions that will be described work best with a Barany Chair, acceptable results can be obtained by using an old office chair that has a pump lever. To effectively create the illusions, it is essential that the pushes used to rotate the chair be smooth and uniform. Whether using the Barany Chair or a standard office chair, it is recommended that you practice pushing the chair and bringing it to a rapid, but gentle, stop.

When using a Barany Chair at a conference, first clear central area of your presentation room large enough to accommodate the chair with observers in a circle several feet back. Ideally, the room will be windowless or have room-darkening shades. Place the chair in the middle of the room and make sure it is level.

Selecting Test Subjects

The vestibular illusions created by the Barany Chair **can produce nausea in some test subjects**. Ask volunteers if they are able to ride spinning amusement park rides without becoming sick. Even though the Barany Chair moves much more slowly than the rides, it can produce sickness. Most people should be able to experience the illusions with only momentary disorientation. **Important Safety Note: The presenter should remain near the chair and be ready to offer physical assistance in case the "test pilot" loses balance and risks falling off the chair. ALWAYS have a spotter as an assistant.**

Illusion 1 – Sensing Yaw Motion

The volunteer sits on the chair with head upright and fists on his or her thighs in the "two thumbs up" position. Tell him/her to rotate their wrists so that the thumbs point in the direction of movement felt. If the movement changes to a different direction, the wrists should be rotated so that the thumbs point in that direction. If the volunteer does not perceive any motion, the thumbs should be pointed upwards. Cover the volunteer's eyes with the blindfold, and, touching only the seatback of the chair, give the chair a spin. Push the chair hard enough to rotate it eight to ten times. If necessary, give the chair an additional gentle push to keep it rotating. Grip the chair back and slow it to a rapid but smooth stop. Wait a few moments to observe thumb movements and then remove the blindfold. Tell the volunteer to stare at a fixed point on the wall.

At first, the volunteer will point thumbs in the same direction the chair is rotating. After stopping the chair, the volunteer will reverse the direction of the thumbs, indicating a feeling of movement in the opposite direction. Upon opening his/her eyes, the volunteer will experience rapid side-to-side flicking motions of the eyes that can be observed by staring directly at the volunteer's face.

The rotation of the chair causes the endolymph within the yaw axis semicircular canal to begin moving. At first, the inertia of the fluid causes it to lag behind the motion of the subject's body. This causes the cupula and its hair cells to bend. Now stimulated, the hair cells send signals to the brain telling it that motion has been initiated and in what speed and direction. When the chair is stopped, the momentum of the now moving endolymph causes it to continue moving even though the volunteer's head and semicircular canals have stopped. The hair cells are now bent in the exact opposite direction as before. This sends a false signal to the brain that the direction of motion has reversed. Nystagmus, an involuntary flicking eye movement, shows the link between the vestibular and visual systems. This reflex occurs when the brain mistakenly believes the body is still moving in this illusion and instructs the eyes to "look ahead." The eyes track objects that the brain believes are coming into the field of vision even though the view isn't changing.

The volunteer will perceive the start of motion by pointing his/her thumbs in the direction of rotation. After a number of rotations, the volunteer will point the thumbs upward even though the chair is still rotating. Finally, the volunteer will point thumbs the opposite direction from the first movement to indicate counter rotation.

C-9 – In this illustration, the test subject indicates the perceived direction of movement by pointing his or her thumbs.

As with the first illusion, endolymph in the yaw semicircular canal will lag behind the initial motion. Signals sent to the brain will be interpreted as bodily rotation in a particular direction. Gradually, the endolymph in the yaw semicircular canal will catch up with the motion, and stimulation of the hair cells in this canal will stop. The brain will falsely interpret the lack of hair cell stimulation to mean that the chair has come to rest. Later, when the chair actually does slow down or stop, the momentum of the endolymph will cause it to continue to flow through the yaw canal. This generates false signals and the disorientation creates a false illusion to the individual.

Barany Chair Construction

C-10 – This is the hardware and finishing parts used to build the Barany Chair.

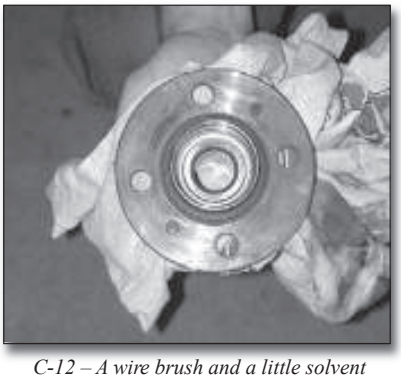
The conference version of the Barany Chair consists of a pedestal base, a bearing mechanism, and a chair with armrests. The one shown in the photography featured an office chair seat donated by Office Depot. Any kind of office chair can be used, but one with arm rests makes it more comfortable.

The construction plans in this guide will enable you to construct a Barany Chair using regular power and basic hand tools. Most materials for the chair are available from hardware and general home repair stores.

The chair bearing is obtainable from an auto salvage yard. It is a rear axle bearing from a front wheel drive vehicle. The bearing specified in this guide is from a 1995 Nissan *Sentra*. Any similar bearing can be used, but you may need to adjust the diameters of the holes at the top of the chair pedestal. If you tell the person at the wrecking yard that the rear axle assembly is for a Civil Air Patrol anti-drug program, there is a good possibility you can get it free or much less than normal. It helps if you take the *Fit for Flying* text along with you. This gives visual proof of what you're working on and will help get a discount or a freebie! The same applies for hardware and home repair depots.

C-11 – The studs are first removed from the axle bearing assembly.

CAP Captain Ryan Kubichek, an Aerospace Education Officer from a CAP squadron, and Dr. Millspaugh built a Barany Chair for an Aerospace Education Day at an airport. The pedestal used was a discarded milk box. It has worked well and has taken a considerable beating by numerous demonstrations. If you contact a local milk company that has neighborhood delivery and explain what you're doing, there is a very good possibility that a useable one will "show up" very soon. When companies know that you're trying to work with youth on meaningful projects, it's amazing how much help they will render.



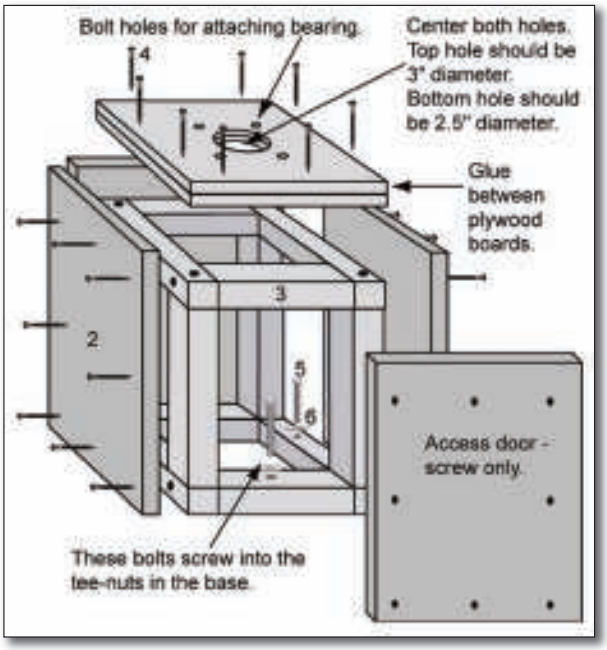
C-12 – A wire brush and a little solvent will make it "presentable."

C-13 – An old milk box worked well for the pedestal. The door made it easy to work with the axle housing and securing it to the base.

The NASA Version Of The Pedestal

The bearing and the chair seat will be attached to a pedestal mounted on top of the base. The NASA version of the pedestal consists of a square set internal frame made from 2″ x 2″ or 2″ x 4″ lumber. The frame is held together with screws and glue. Plywood or 3/4″ clear pine boards are used to cover the outside of the frame. This facing provides additional strength and improves the appearance of the pedestal. Glue and screw three of the facing sides, but use screws only for the fourth side. This leaves you an access door so you can complete the assembly and tighten bolts and nuts when necessary.

The top of the NASA pedestal is made of two layers of 3/4″ plywood that are glued together. Before gluing, the main hole for the bearing mechanism must be drilled. To accommodate the bearing, use a hole saw to cut two different sized holes in the plywood sheets that will form the top of the pedestal. The lower plywood boards must have a 2 1/2″ hole and the upper sheet must have a 3″ hole. The two holes must be concentric to fit the bearing. If a different bearing is used, cut the mounting holes to fit its size. Drill the bolt mounting holes for the bearing. Insert the bearing and bolts and tighten the nuts to hold it firmly.



C-14 – The construction of the NASA base unit

The pedestal can be mounted permanently to a base with screws and glue, or made removable (for mobility) by attaching it to the base with nuts and bolts. Tee-nuts can be inserted into drilled holes from the bottom of the platform. These remain in place even when the chair is disassembled.

Office supply and furniture stores offer a wide range of office chairs. A “task chair” with arms is recommended. Before selecting a chair, check to make sure it does not have a seat tilt adjustment. While a chair with tilt adjustment will work, the method for mounting the pipe nipple and lock nuts may have to be modified. Task chairs without tilt adjustments have simpler seat brackets and are easier to mount.

Office chair seat brackets usually consist of a metal plate with a hole for inserting the tubular pedestal that extends upward from the legs and casters. The custom-made 3/4″ galvanized pipe nipple substitutes for the tubular pedestal.

If you purchase a new chair, do not attach the pneumatic tube to the bracket. The pipe nipple will be used instead. If using an existing chair, the tube has to be removed. Remove the chair seat and tap the bracket until the tube slips out of the bracket. The tubular pedestal, legs, and casters are not needed for the Barany Chair.

Building The Bearing Mechanism And Attaching The Chair To The Pedestal

A 3/4″ pipe nipple has to be specially made to fit the chair and the bearing. The nipple can be cut and threaded for a modest charge at a hardware store. The exact length of the nipple will depend upon the design of the seat bracket of the office chair you use. Before gluing the top together and assembling the rest of the pedestal, make sure that the automotive bearing fits snugly.

Thread two 3/4″ galvanized lock nuts onto the long threaded end of the nipple. Insert the nipple into the hole for the pneumatic tube and thread a third lock nut onto the nipple to tighten the nipple in place. Be sure to use at least one lock nut immediately beneath the bracket. The bracket is now attached to the seat bottom.

Set the rigid coupling, shown in the mechanism diagram, over the bearing. Lower the chair over the pedestal until the pipe nipple slides through the coupling and into the hole of the bearing. Hold the nipple in place with another lock nut underneath the bearing. When tightened properly, the chair should have no wobble and be able to spin freely.

Construction Notes

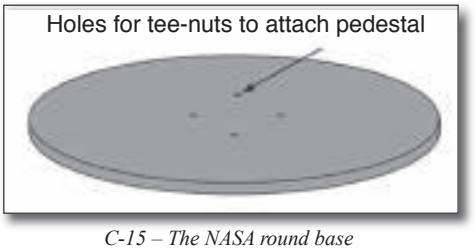
- Make sure to follow all manufacturer instructions for safe operation of tools and use of materials employed in the construction of the Barany Chair.
- Unfinished wood tabletops are available from hardware and lumber stores.
- Drill four holes in through the top to match the bolt holes in the pedestal. Slip tee nuts into these holes from the bottom of the base. When the bolts from the pedestal are screwed into the nuts, the flange on the nuts will draw the base and the pedestal together snuggly.
- Attach rubber feet to the bottom of the pedestal around the rim. Feet are available from hardware stores and come with screws or nails to mount them to the bottom.

Materials List

Number	Quantity	Item	Specifications
1	1	round table top	30″ diameter
2	4	tee-nuts	3/16″
3	4	lumber	8′ x 2” x 4″
4	4	rubber feet	screw or nail type

Tools

Electric hand drill - 3/8″ or 1/2″
Drill bit for tee-nut holes
Screw driver or hammer to attach feet



C-15 – The NASA round base
(Feet can be installed on this one.)

- Make sure to follow all manufacturer instructions for safe operation of tools and use of materials employed in the construction of the Barany Chair.
- The interior square set frame should be constructed from 2″ x 2″ or 2″ x 4″ lumber. The finished size of the pedestal should be 12″ wide, 12″ deep, and 12″ to 15″ high depending upon the height of your students. The lengths of the frame pieces you cut will depend upon the size of the wood you use.
- Screw and glue the square set frame together. Be sure to countersink the holes so that the screw heads are flush with the wood. Offset the pilot holes of intersecting screws so that they do not hit each other.
- Face the frame with 3/4″ clear pine or plywood. Screw and glue three of the sides but attach the fourth side with screws only. This becomes an access door for tightening bolts.
- The top platform is made from two 3/4″ plywood pieces glued together. Before gluing, determine the center of each board. Drill a 2 1/2″ hole with a hole saw through the center of the lower board. Drill a 3” hole through the center of the top board. Align them carefully before gluing.

• This design shows 3/16″ by 3 1/2″ hex bolts used for attaching the pedestal to the base. The bolts extend downward from the pedestal frame into tee-nuts in the base. This permits easy removal of the pedestal from the base. If preferred, the pedestal can be permanently fixed to base with glue and screws.

Materials List

Number	Quantity	Item	Specifications
1	1	wood glue	carpenter grade
2	2	plywood	48″ x 48″ x 3/4″
3	4	lumber	8′ x 2″ x 4″
4	56	wood screws	#10, 3″ Phillips
5	4	hex bolts	3/16″ x 3 1/2″
6	4	cut washers	3/16″

Tools

Electric hand drill - 3/8″ or 1/2″
Hole saws - 3″ and 2 1/2″ with drill attachment
Drill bit for pilot holes
Countersink bit
Phillips screwdriver or Phillips drill bit
Crosscut hand saw
Ruler
Carpenter's square

C-16 – This is the NASA version of the Barany chair. Note the round base, the varnished finish, and the seat belt.

Barany Chair - Bearing Mechanism

• Be sure to follow all manufacturer instructions for safe operation of tools and use of materials employed in the construction of the Barany Chair.

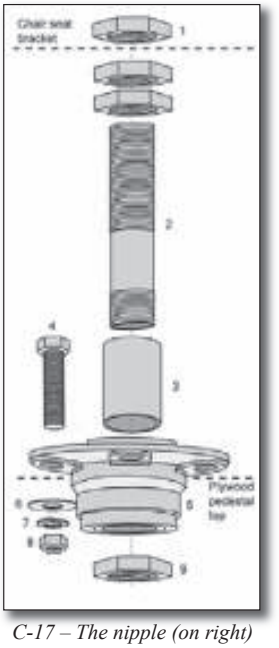
• Except for the bearing, all metal parts are available from hardware stores.

• The bearing is available from auto wrecking yards. It is a free-spinning rear axle bearing from a front-wheel drive automobile. The underside of the bearing is tapered, necessitating two different sized holes in the plywood bearing platform. (NASA version)

• The horizontal dashed lines indicate where the mechanism is attached to the seat bracket of the chair and to the plywood platform.

• The rigid coupling comes from hardware electrical departments. It serves as a spacer.

• The galvanized pipe nipple has to be made especially for the Barany Chair. Hardware stores will cut and thread a pipe for you for a small charge. Before specifying the final length and threading, examine the seat bracket of the office chair you are using. You may require a slightly longer or slightly shorter nipple than called for here. The upper end of the nipple will require about 4" of thread while the lower end should require only about 1".



C-17 – The nipple (on right) for round base

Number	Quantity	Item	Specifications
1	3	lock nuts	3/4″ galvanized
2	1	pipe nipple	6″ x 3/4″ galvanized
3	1	rigid coupling	1″ (to fit 1” conduit)
4	4	hex bolts	5/16″ x 2 1/2″
5	1	rear axle hub bearing	BCA hub bearing #512025 (1995 Nissan Sentra)
6	4	lock washers	5/16”
7	4	cut washers	5/16”
8	4	hex nuts	5/16”
9	1	lock nut	3/4” galvanized

Rotational Mechanism Assembly

Construction Notes:

• Be sure to follow all manufacturer instructions for safe operation of tools and use of materials employed in the construction of the Barany Chair.

• Remove the seat bracket from the bottom of the seat.

• Twist two lock nuts onto the long threaded end of the pipe nipple. Keep them loose and below the point where the bracket will rest.

• Insert the nipple into the seat bracket hole and twist another lock nut on the upper end of the nipple. Tighten the first and the second lock nut to the bottom of the bracket. The two lock nuts working together will resist later loosening.

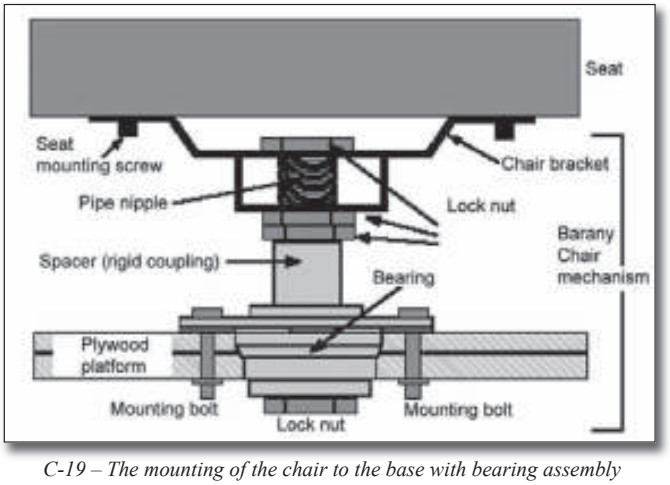
• Reattach the seat bracket to the seat.

• Slide the other end of the pipe nipple through the spacer and then into the hole of the bearing. (The bearing should already be firmly attached to the wooden pedestal of the Barany Chair.) Make sure the chair rotates freely above the pedestal.

• Reach through the access door of the pedestal and tighten the remaining lock nut onto the lower end of the pipe nipple. The chair should now rotate freely with no wobble. Close the access door.

• Attach the safety lap belt to the back or the rear of the arms of the chair. The Barany Chair is now finished and ready to be used.

C-18 – Capt. Kubichek shows how the nipple is attached to the chair



C-19 – The mounting of the chair to the base with bearing assembly

C-20 – The rigid coupling spacer is shown between the chair and the axle bearing.

C-21 – The nut is tightened to secure the assembly.

C-22 – Using a little "ingenuity," build a footrest to keep the legs from swinging during slow rotation.

C-23 – Cadet Joseph Spiegel prepares for his first "flight" in the Barany chair. Notice that Capt. Ryan added a seat belt to the chair. Later a footrest was also added. It's fun and educational for both adults and young people.

Materials List

Quantity	Item	Specifications
1	chair seat	from office chair, non-tilt, with armrest
1	safety lap belt	wide hook-and-loop tape or webbing and buckles, available from an outdoor or sporting goods store

Tools

Set of wrenches
Screwdriver

Aviation Physiolology – Additional Dr Supplementary Teaching Aids

Several other hands-on items may help you at a conference. The ones shown help participants visualize the principles and concepts of the vestibular system. Directions are shown here for building and using three models of the semicircular canal functions.

- Three axis canal model
- Gelatin ring mold model
- Semicircular canal demonstration model

Three Axis Canal Models

Materials List

Quantity	Item	Specifications
1	9' vinyl hose	clear, 1" diameter
3	plastic hose connectors	size to fit vinyl hose
1	plastic tape	clear
1	water and basin	
1	glitter, ~3 teaspoons	

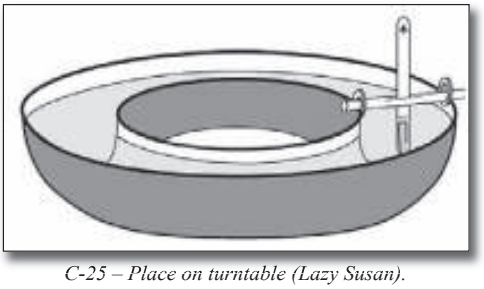
C-24 – Three axis canal model

1. Cut the hose into three equal lengths.
2. Put about a teaspoon of glitter in a length of hose and immerse the hose in water. Remove all air from the hose.
3. Firmly attach the hose ends to a connector to form a loop. Be careful not to introduce air.
4. Remove the hose from the water and repeat the process with the other two hoses.
5. Join the hose rings together as shown

To use: Place the model on the seat of the Barany Chair and rotate. Only the fluid in the yaw plane canal will move. The glitter will help your audience see the motion. Try different orientations of the model on the chair to see what effects it has on the different canals. Compare these orientations to the vestibular illusions.

Gelatin Ring Mold Canal Model

1. Glue the two washers on the rim of the mold as shown in the diagram below.
2. Cut a slit through the sides of the straw at the midpoint.
3. Slide the straw through the two washers.
4. Slip the craft stick through the slits in the straw so that the lower end almost touches the bottom of the mold.
5. For ballast, attach a paperclip to the lower end of the craft stick.
6. Place the model on the turntable and fill halfway with water.



C-25 – Place on turntable (Lazy Susan).

To use: Slowly rotate the mold. Inertia causes movement of the water to lag behind. This will tilt the stick so that it is pointing in the direction of motion. As friction with the mold walls causes the water to begin to move, the stick will return to the upright position. When the mold is stopped, the momentum of the water will cause the stick to point in the opposite direction. This is a visual demonstration of what happens during Vestibular Illusion 2.

Materials List

Quantity	Item
1	gelatin ring mold
2	metal washers
1	plastic soft drink straw
1	wooden craft stick
1	hot glue gun and glue stick
1	paper clip
1	sharp knife
1	Lazy Susan turntable
	water

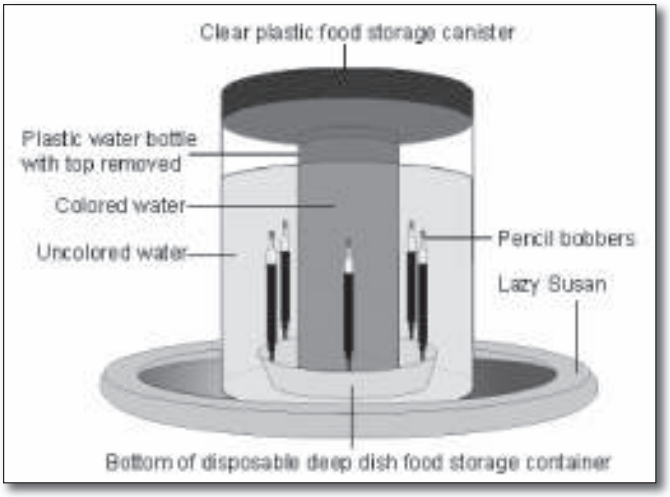
The Semicircular Canal Model - Construction

1. Punch six small holes equally spaced around the rim of the disposable food container.
2. Feed and knot short pieces of thread or fishing line to each hole and attach the bobbers to upper end of each line.
3. Adjust the position of the bobbers so that their lower ends almost touch the container rim.
4. Cement the food container to the inside center of the bottom of the large canister. Make sure no cement gets on the bobbers.
5. Cut off the upper end of the plastic water bottle. Cement the bottom of the bottle into the center of the storage container. Allow the cement to dry over night.
6. Set the Lazy Susan in the center of a table and place the semicircular canal model in the exact center.
7. Fill the water bottle almost to the top and sprinkle in several drops of food color to darken the water. This reduces visual distraction of bobbers on the opposite side of the model.
8. Add water to the canister until the bobbers are floating vertically.

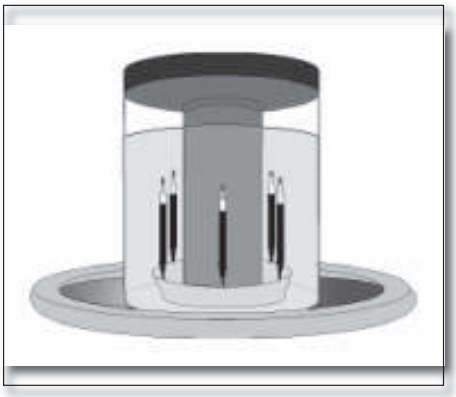
To use: Rotate the model at a constant speed in one direction. The bobbers will first lean in the opposite direction and then return to vertical. Stop the model and the bobbers will lean to the opposite direction. Explain to your students that the space between the interior water bottle and the inside wall of the canister represents the inside of a semicircular canal. The clear water represents endolymph fluid and the bobbers represent hair cells.

Quantity	Item	Specifications
1	clear plastic food storage canister	large round, 2-4 quart
1	disposable plastic food storage container	shallow round dish
1	clear plastic water or soda bottle	20-ounce or 1 liter
6	pencil bobbers	small (fishing supplies)
1	line	thread or fishing line
1	waterproof cement	aquarium sealant
1	scissors or sharp knife	
1	paper punch	
1	Lazy Susan turntable	
1	water	
1	food coloring	green or blue

The Semicircular Canal Model - Demonstration

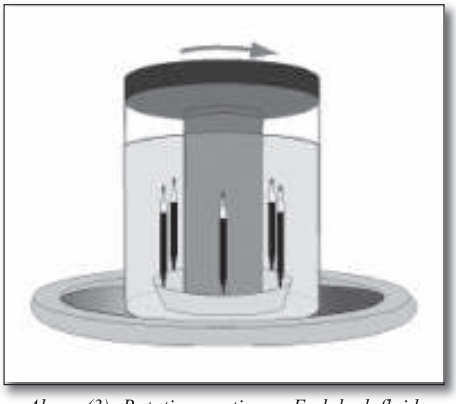


C-26 – The semicircular canal model

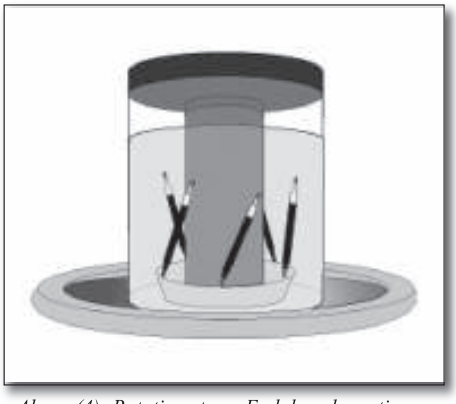


Above (1):No rotational motion. Hair cells vertical. Brain senses no motion.

Above (2): Counterclockwise rotation. Endolymph fluid lags behind. Hair cells lean in clockwise direction. Brain senses counterclockwise motion.



Above (3): Rotation continues. Endolyph fluid catches up. Hair cells vertical. Brain no longer senses rotation.



Above (4): Rotation stops. Endolymph continues moving. Hair cells lean in counterclockwise direction. Brain falsely senses clockwise rotation.

Wrapping It Up

The conference presentation can be a resounding success if you plan ahead and have everything ready when your audience is seated. The FAA Safety Brochures are very professionally done and the PowerPoint presentation should help you go through the textbook step-by-step. At the conclusion, the Barany Chair will be the "star" of your show. This program will be exciting for all participants. You now have the tools to do an outstanding presentation. Good luck!

Internet Resources

Space Research - NASA's Office of Biological & Physical Research
Latest Biological and Physical Research news, research on the International Space Station, articles on research activities, educational resources
http://SpaceResearch.nasa.gov

Web of Life
Articles and information about the experiments and engineering behind NASA's Fundamental Space Biology research
http://weboflife.nasa.gov

Space Biology - An Educator's Resource
Geared toward high school and undergraduate college students and instructors. Topics cover research, resources, and images
http://www.spacebio.net

Neuroscience Laboratory at the NASA Johnson Space Center
Facility description and latest research programs
http://www.jsc.nasa.gov/sa/sd/facility/labs/Neuroscience/neuro.htm

NASA Spacelink
One of NASA's electronic resources specifically developed for the educational community. Spacelink serves as an electronic library to NASA's educational and scientific resources, with hundreds of subject areas arranged in a manner familiar to educators. Using Spacelink Search, educators and students can easily find information among NASA's thousands of Internet resources. Special events, missions, and intriguing NASA web sites are featured in Spacelink's "Hot Topics" and "Cool Picks" areas.
http://spacelink.nasa.gov

NASA CORE
Established for the national and international distribution of NASA-produced educational materials in multimedia format. Educators can view the catalogue and order materials through the Central Operations of Resources for Educators (CORE) web site.
http://core.nasa.gov

NASA Education Home Page
NASA's Education Home Page serves as the education portal for information regarding educational programs and services offered by NASA for the American educational community. This high level directory of information provides specific details and points of contact for all of NASA's educational efforts, Field Center offices, and points of presence within each state
http://education.nasa.gov

NASA Life Sciences Data Archive
Space flight experiment results and photo gallery
http://lsda.jsc.nasa.gov

National Space Biomedical Research Institute
Education materials
http://www.nsbri.org/Education/index.html

Barany Chair History
http://www.nobel.se/medicine/laureates/1914/

Glossary

Ampulla - expanded area within each semicircular canal which contains a crista; detects angular acceleration

Angular acceleration – a simultaneous change in velocity and direction (as in spinning); sensed by the semicircular canals

Barany Chair - a chair with a special bearing mechanism that rotates very smoothly; used for performing tests of the vestibular system

Crista - within ampullary region of semicircular canal; name given to structure composed of ampullary crest (hair cells) combined with the cupula

Cupula - one component of a crista; sits atop ampullary crest and is composed of hair-like extensions of sensory hair cells embedded within a gelatinous mass

Endolymph - fluid within semicircular canals which, when moving, deflects the cupula and initiates the sensation of angular acceleration

Hair cells - common name given to sensory cells located within the ampullary crest of semicircular canals and the macular region of saccule and utricle (otolith organs)

Inertia - the fundamental property of inert material tending to resist changes in its state of motion

Linear acceleration – a change in velocity without a change in direction (up and down or side to side); sensed by the otolith organs

Macula - thickened area within saccule and utricle consisting of hair cells and supporting cells.—in both the saccule and utricle, the macula is covered by the gelatinous otolithic membrane containing otoliths

Momentum - tendency of a body in motion to resist a change in that motion

Nystagmus - repeated eye movement designed to stabilize gaze during head movement

Otoliths - calcium carbonate crystals adhering to and embedded within the otolithic membrane of saccule and utricle (otolith organs)

Otolith Organs - comprised of the saccule and utricle; sense linear acceleration and head position (tilt)

Pitch - rotational motion carried out along a front-to-back vertical plane

Roll - rotational motion carried out along a lateral vertical plane

Saccule - one of the two types of otolith organs of the vestibular system; senses linear acceleration and position (tilt) of the head; especially sensitive to vertical movement

Semicircular Canals – three fluid-filled circular tubular structures within each inner ear which are arranged at right angles to each other and sense angular acceleration

Somatosensory - integrated sensory system which combines individual inputs from skin, muscles, tendons, and stretch receptors throughout the body

Utricle - one of the two types of otolith organs of the vestibular system; senses linear acceleration and is more sensitive to horizontal movement (as in riding in a car)

Vestibular System - senses body movement and helps maintain equilibrium; comprised of the semi-circular canals and the otolith organs which sense angular and linear acceleration

Yaw - rotational motion carried out along a horizontal plane

Notes