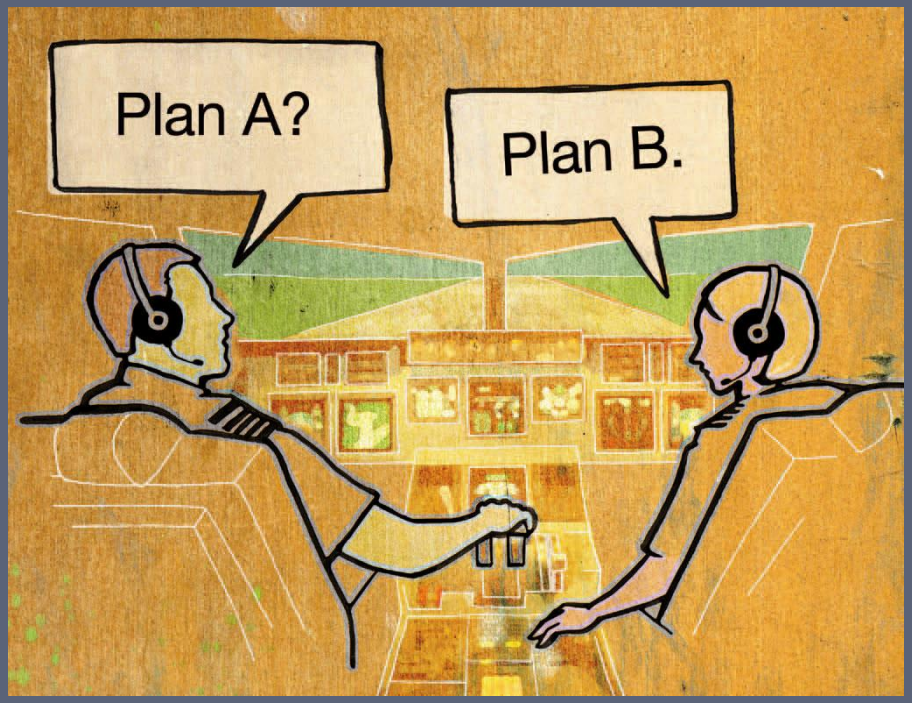


Handling Aircraft Systems Emergencies

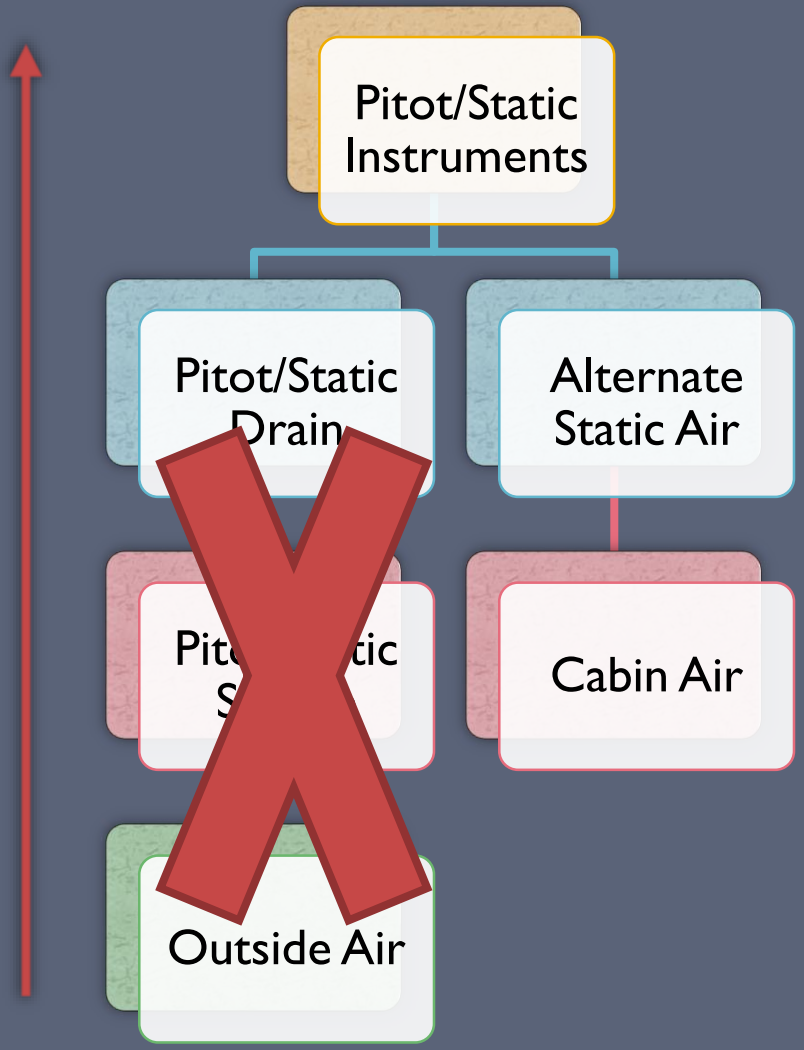
Piper Cherokee-Series

Overview

- Rather than discussing the specifics of each system, we will discuss each system from a high level
  - Knowing the basics of many systems is often more important than knowing the specifics of only a few systems
- Outline
  - Basic Flight Instruments
    - Pitot-Static System
  - Communication & Navigation
    - Electrical System
    - Comm/Nav System
    - Autopilot/Trim System
  - Engine Systems
  - Control Systems

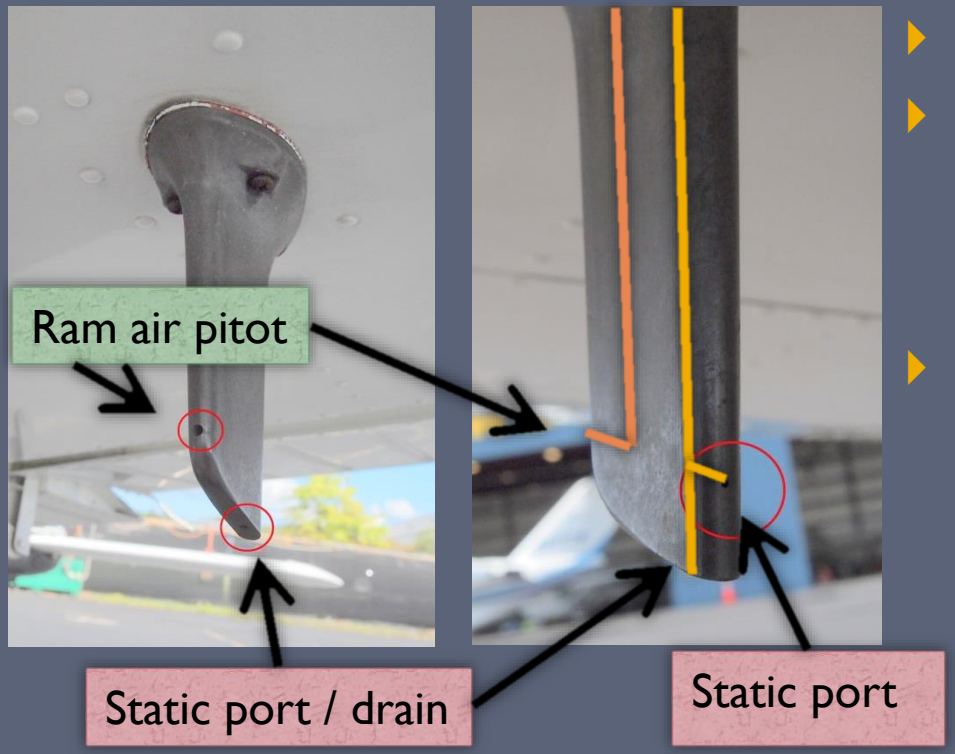
Pitot-Static System

Pitot-Static System Overview

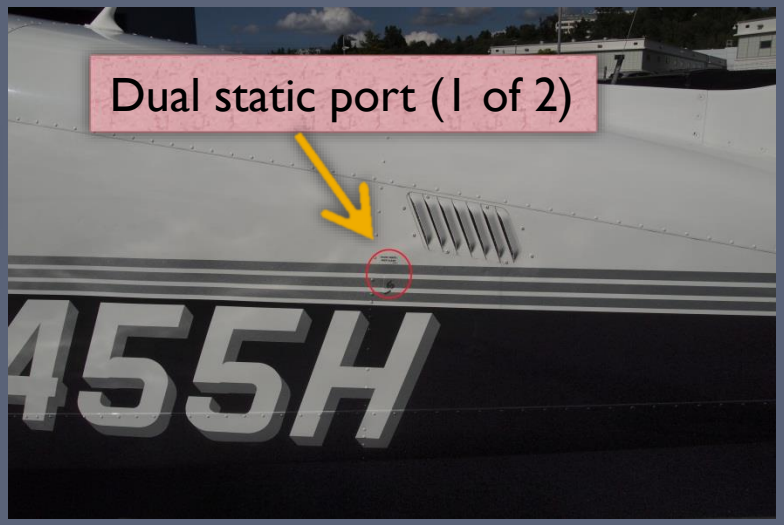


- Completely mechanical system (no electrical power needed)
  - *Excludes digital PFDs (ADAHRS)*
- The static input measures the ambient (non-moving) air pressure
- The pitot input measures the ram-air (moving) air pressure
  - Subject to instrument position error

Pitot-Static System - Components



- Heated pitot-static vane
- No external pitot drain
  - Cabin pitot-static drain valves must be opened prior to each flight
- Some aircraft have separate dual static ports



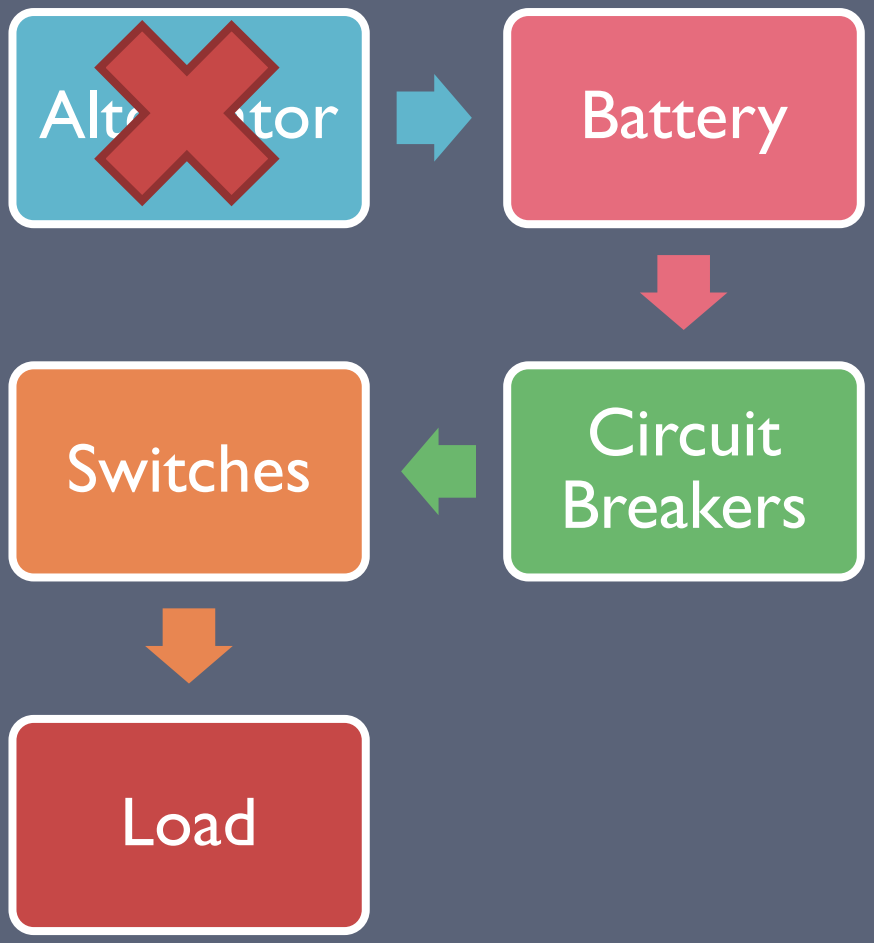
Pitot-Static Problems

- Signs of blockage
  - Airspeed indicating higher or lower than expected *for the given pitch & power setting*
  - Altimeter and/or VSI not behaving as expected *for the given pitch & power setting*
  - Large discrepancy between GPS altitude and altimeter

- Pitot Blockage
  - Affects *only* ASI
  - If icing/moisture, use pitot heat
- Static Blockage
  - Affects ASI, VSI, altimeter, transponder, A/P Alt/VS Hold
  - Use alternate static air
    - Also try pitot heat (combined pitot-static vane)

Electrical System

Electrical System Overview



- Under normal operation, the battery feeds the electrical loads, and is continually charged by the alternator
- Circuit breakers protect against over-currents
  - Protects the devices connected to the breaker
  - Protects the wiring from overheating and melting

Electrical System

- 14v vs 28v system
  - Older aircraft: 14v
  - Newer aircraft: 28v
  - 28v advantages: lower current (amperage) means smaller (lighter) wires
- Battery voltage
  - For 14v systems: 12v
  - For 28v systems: 24v
  - Battery voltage is less than the total system voltage so there is excess capacity to *charge the battery*.
- Normal Voltages
  - 14v system: 13.8-14.2
  - 28v system: 27.5-28.5
- Typical battery life: 3-5 years
  - Older than that, the battery most likely won't pass a load test

Electrical Troubleshooting

Troubleshooting

- Check annunciators
- Check electrical indicators
  - Volt-meter
  - Ammeter/Load meter
- Check alternator
  - Reset alternator
- Check for popped circuit breakers
  - Only reset a popped CB in flight if it is *flight critical*
  - Only reset a popped CB *once*

Emergency Procedures

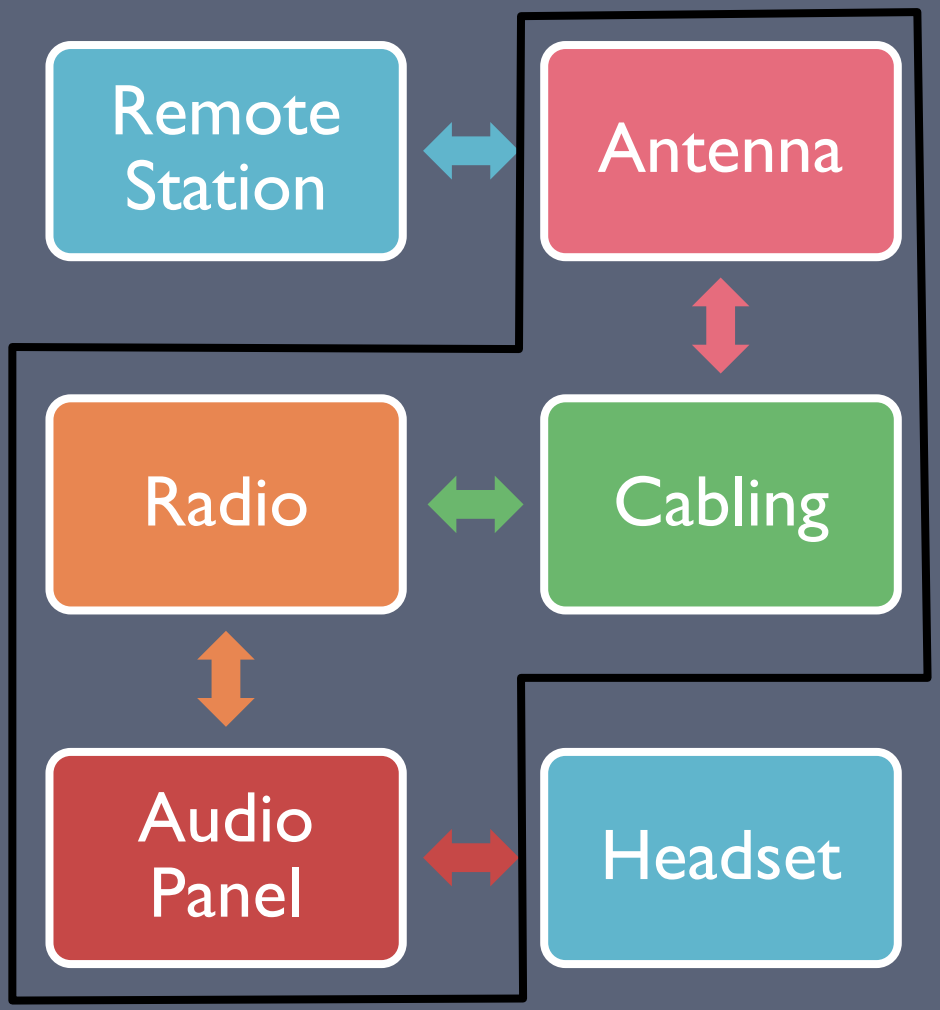
- Reduce electrical load
  - Turn off non-essential equipment
  - Limit radio transmissions
- Use a hand-held radio
  - Preferably one with comm & nav capabilities
- Land as soon as practical

Electrical Problems

- Alternator Offline
  - Indications
    - Alternator warning lamp
    - Low bus voltage
      - Failing avionics
      - Difficulty transmitting/receiving
    - Ammeter showing a discharge
  - Causes
    - Voltage regulator tripped
      - Transient trip
      - Overload/short
    - Alternator field CB
    - Failed alternator
- Overload
  - Over-voltage
    - Faulty voltage regulator
  - Over-amperage
    - Faulty equipment
    - Too much electrical load
    - Electrical short

Comm/Nav System

Comm/Nav System



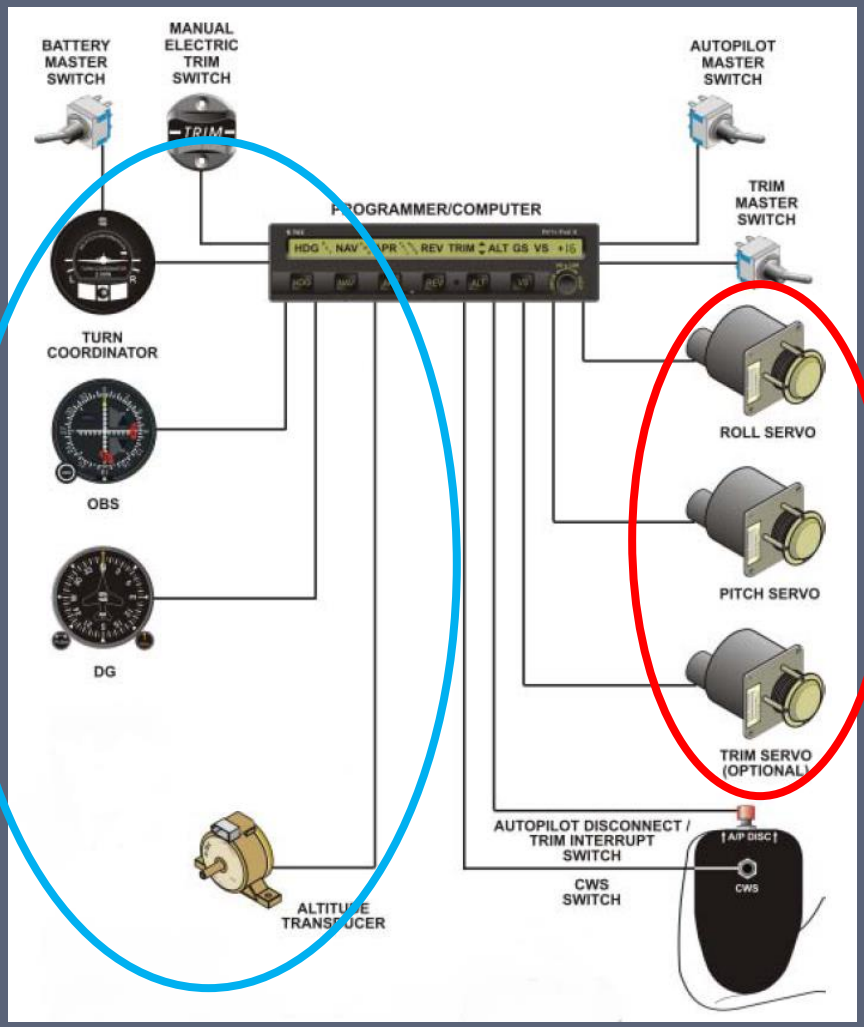
- Factors affecting transmission & reception
  - Radio power
    - Transmission power
    - Distance from station
  - Antenna quality
    - Poor grounding
    - Poor connection
    - Antenna damage
  - Electrostatic interference
    - Static discharge
    - Atmospheric phenomena
  - Antenna positioning
    - Terrain / airframe attenuation

Comm/Nav Problems

- Poor transmission/reception
  - Check radio, audio panel, and headset volume
    - Can you hear yourself / passengers ok?
  - Check tuned frequency
  - Check squelch
  - Try the other radio
  - Check mic connection
  - Try another mic jack
  - Audio panel fail-safe
  - Check electrical system
- Alternative Comm
  - Handheld radio
  - Cell phone
  - Transponder (7600/IDENT)
- Alternative Nav
  - Pilotage/Dead-reckoning
  - VOR or GPS
  - Cell phone/tablet GPS
  - Handheld nav/com radio
  - Climb
    - Better reception, terrain avoidance, and view

Autopilot/Trim System

Autopilot-Trim System



- General operation
  1. Pilot selects autopilot mode
  2. Autopilot receives inputs
     - Aircraft attitude & altitude
     - Navigation data
  3. Servos command the control surfaces
  4. Autopilot compares flight path to desired flight path
     1. Servos are adjusted as needed

Autopilot-Trim Issues

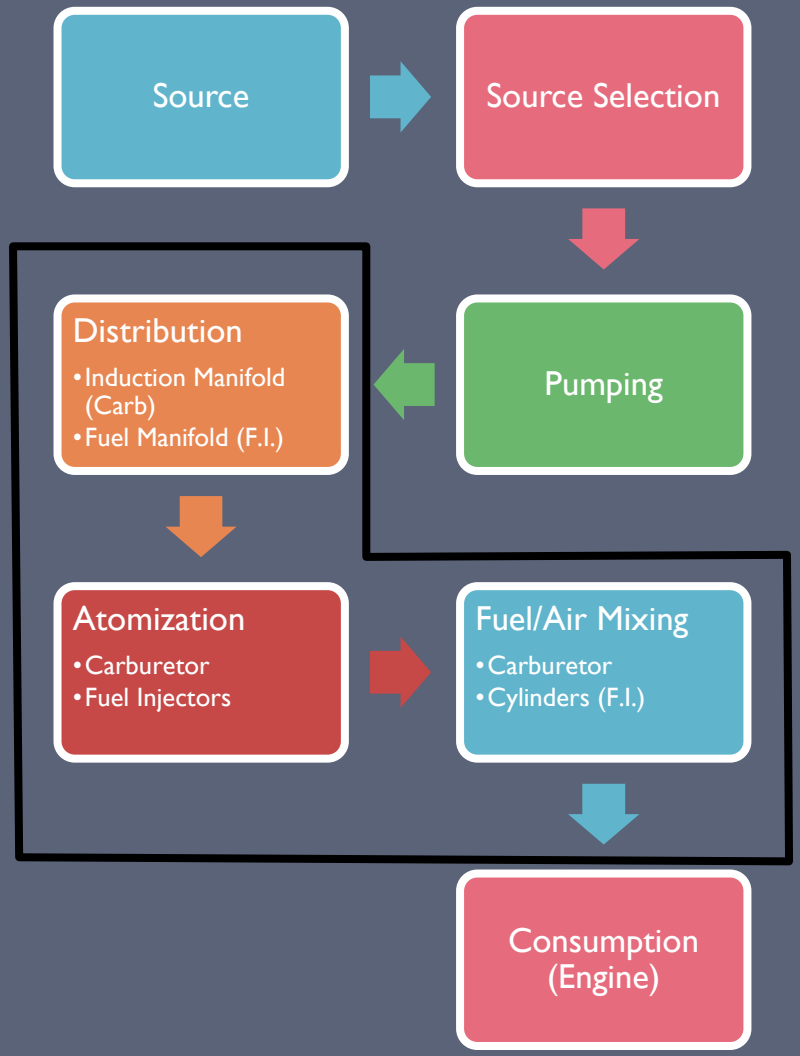
- Un-commanded pitch
  - First reaction: disconnect A/P
  - Be prepared to counter heavy trim forces
- Unexpected turn
  - First reaction: disconnect A/P
  - Then determine problem
- Ways to disable A/P
  - Disconnect button
  - Use of manual electric trim
  - A/P master switch
  - A/P circuit breaker
  - Avionics master switch
- Ways to disable trim
  - Trim master switch
  - Trim circuit breaker
  - Avionics master switch

Miscellaneous Emergencies

- Runaway pitch trim
  - What would you do?
    - Disconnect autopilot
      - Yoke disconnect
      - Autopilot master switch
      - Pull circuit-breaker
    - Disable electric pitch trim
      - Electric pitch trim master switch
      - Pull circuit-breaker
    - Turn off avionics master switch
    - Turn off master switch
- Autopilot servos are designed to be overpowered by the pilot
- There is also a speed sensor that disables the electric trim over 140 KIAS (Archers)

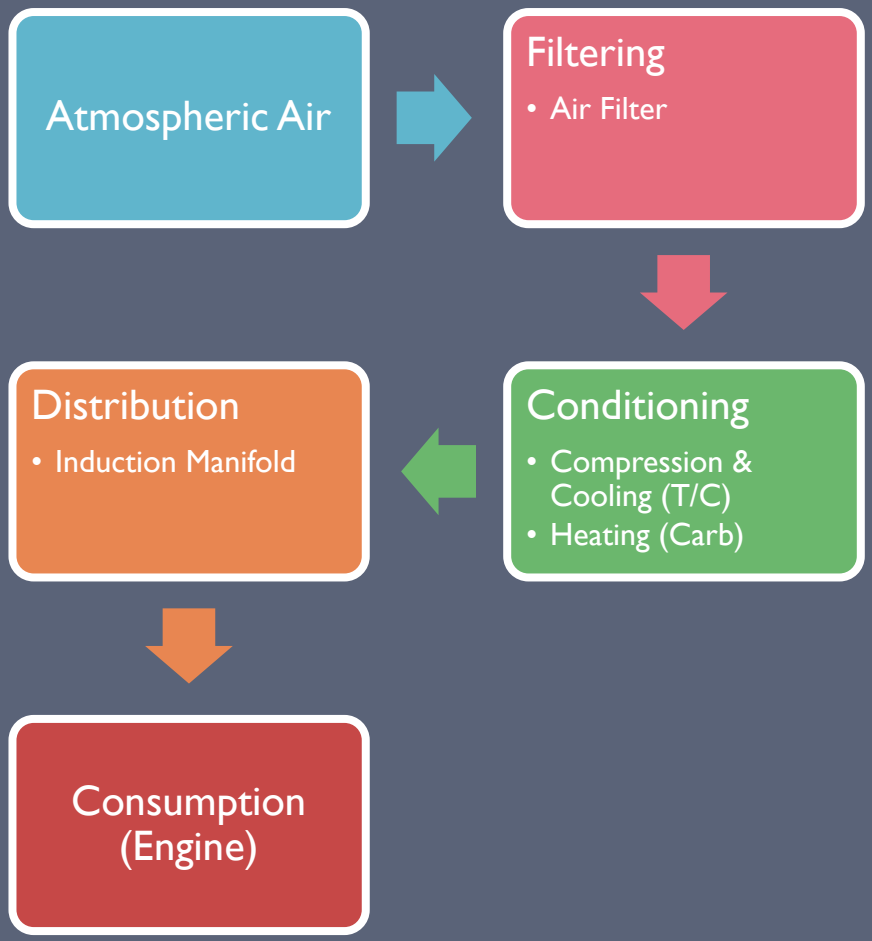
Engine Components

Fuel System



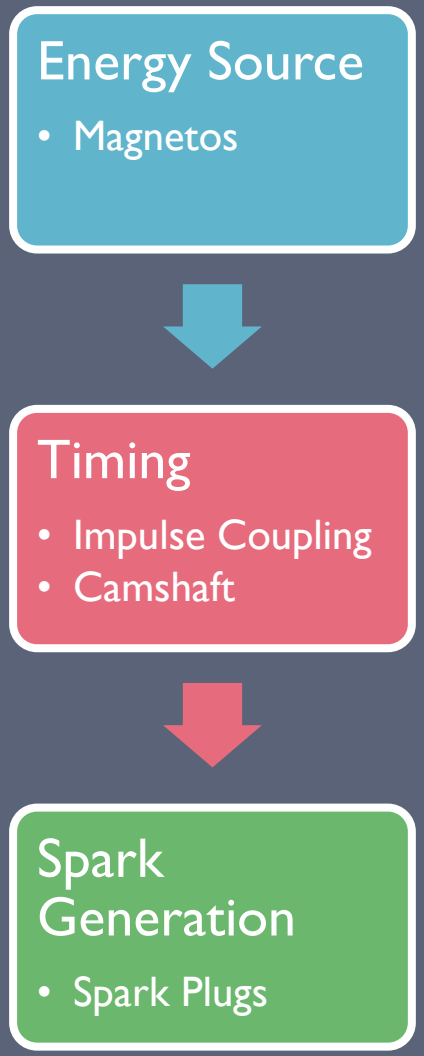
- Primary purpose of the fuel system
  - To transfer fuel from one or more sources to each cylinder of the engine in a useable (atomized) form
- Secondary purpose of the fuel system
  - To maintain horizontal (and in some cases, lateral) CG balance

Induction System



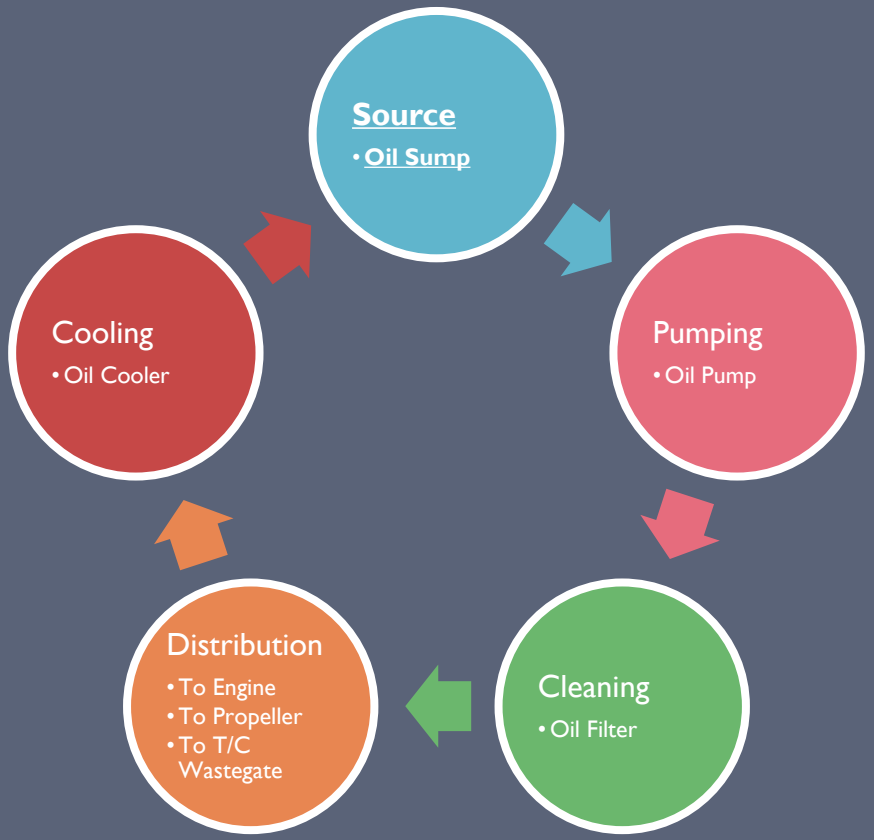
- Primary purpose of the induction system
  - To transfer air (oxygen) from the atmosphere to each cylinder of the engine
- Secondary purpose of the induction system
  - To condition the air to an appropriate form for combustion

Ignition System



- Primary purpose of the ignition system
  - To control the combustion of the fuel-air mixture in each cylinder
- Secondary purpose of the ignition system
  - To start the engine

Oil System



- Primary purpose of the oil system
  - To lubricate, clean, cool, seal, and preserve the engine
- Secondary purpose of the oil system
  - To provide hydraulic control for controllable-pitch propellers and turbocharger wastegates

Engine Overview

- Primary purpose of the internal combustion engine
  - To convert a source of chemical energy into rotational energy
- Primary needs of the internal combustion engine
  - Fuel
  - Air (oxygen)
  - Spark (ignition)
- Byproducts of combustion
  - Heat
    - From internal engine friction
    - From combustion
  - Water
  - Waste gasses
  - Energy
    - Only about 20% of the energy of combustion is converted into useful energy
    - Even less energy is converted into useful thrust

Engine Components

- Crankcase
  - The skeleton of the engine
- Cylinders
  - Converts the chemical energy of the fuel-air mixture into linear motion
- Crankshaft
  - The "back bone" of the engine
  - Converts the linear motion of the cylinders into rotational motion for the propeller & accessories
- Driven Accessories
  - Fuel Pump
  - Magnetos
  - Oil Pump
  - Vacuum Pump
  - Alternator(s)
- Static Accessories
  - Fuel-Air Controller
    - Carburetor
    - Fuel Injectors
  - Turbocharger
    - Driven by exhaust gasses

Types of Engine Problems

Loss of Power

- Fuel / Mixture
- Induction Restriction
- Ignition System Problem
- Internal Problem

Roughness / Vibration

- Fuel / Mixture
- Induction Restriction
- Ignition System Problem
- Internal Problem
- *Propeller Problem*

Overheating

- Mixture Incorrectly Set
- Detonation / Preignition
- Baffling
- Oil System Problem

Types of Propeller Problems

Vibration

- Static Imbalance
- Icing (weight imbalance)
- Damage

Overspeed

- Lack of Oil Pressure
- Governor Problem
- Propeller / Engine Internal Problem

Control Systems

Control System Failures

- FAR Part 23
  - 23.2135 – Controllability
    - *Summary:* The airplane must be safely controllable within the approved operating envelope even with a flight control or propulsion system failure.
  - 23.2140 – Trim
    - *(C) Summary:* Residual control forces must not fatigue or distract the pilot during normal operations of the airplane *and likely abnormal or emergency operations*, including a critical loss of thrust on multiengine airplanes.

Control Problems

- Loss of primary pitch control
  - One direction: use opposite trim
  - Both directions: use trim and power
- Loss of primary roll control
  - Use rudder
- Loss of yaw control
  - Use ailerons – be careful of stalling!
- Jammed trim
  - Disable electric trim
  - Manually oppose trim forces
    - Try changing airspeed
    - Try changing flap/gear configuration

Control Problems

- Broken throttle cable
  - Adjust power using the mixture & propeller control
  - Can also use carb heat and a single magneto to reduce power
    - Consider switching mags if operating on a single magneto for an extended period of time to prevent fouling of the unused plugs
- Controllability anomalies
  - Disable A/P & electric trim
  - Out of CG range?
  - Wing contamination
  - Try different flap / gear / power settings at altitude
    - Always experiment with more than enough altitude than you think you'll need

Summary & Questions

Closing Comments

- Always consider the big picture
  - What is the most flight-critical issue to deal with?
  - Does it require *immediate* action?
  - What are your options?
- Start from a high level and work towards the details
  - Don't start flipping switches or changing configuration until you have identified the problem
- Don't lose your situational awareness while troubleshooting an issue
  - Above all else, *fly the airplane!*

Questions?

More Information

- AFM or POH
  - **Dakota: 761-689**
  - **Archer II: 761-722**
  - **Archer III: 761-868**
  - Arrow II: 761-493
  - Warrior II: 761-649
- Operator's Manual
  - Lycoming O/IO-360: 60297-12
  - Lycoming O-540
- Airplane Maintenance Manual
- Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25A)
- Type Certificate
  - Aircraft
    - Piper PA-28
  - Engine
    - Lycoming O-360
    - Lycoming O-540
  - Propeller
    - Sensenich 76E-series
    - Hartzell F2YR-series

Open Sky Aviation, LLC.
http://openskyaviation.biz
gbaluha@openskyaviation.biz