

## *Agenda*

- ✧ Examples taken from
  - ✧ Garmin GNS430
  - ✧ Bendix-King KLN-94
  - ✧ Garmin (UPS AT) Apollo GX60
- ✧ Not a "buttonology" course
  - ✧ Consult your pilot's guide
  - ✧ Use commercial training courses
  - ✧ Practice on the simulator

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## *Flight Plans*

- ✧ Waypoint entry notation
- ✧ Airport vs. navaid vs. waypoint
  - ✧ Early-generation units (GX60)
    - ✧ Identifier type plus identifier
      - ✧ **ARPT** **HWD**
      - ✧ **VOR** **OAK**
      - ✧ **INT** **SUNOL**
  - ✧ Late-generation units (GNS430, KLN-94)
    - ✧ Identifier only
      - ✧ **KHWD** (airport)
      - ✧ **OAK** (navaid)
      - ✧ **SUNOL** (fix, intersection, waypoint)

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## Flight Plans

- ✧ Waypoint entry notation
  - ✧ **ARPT MOD** distinct from **VOR MOD**
  - ✧ **KMOD** distinct from **MOD**
    - ✧ In some cases these similar waypoints can be miles apart
  - ✧ All-alphabetic airports entered via ICAO identifier
    - ✧ **KHWD, KMOD** in conterminous US
    - ✧ **PAXx** in Alaska
  - ✧ Airports containing digits entered via FAA identifier
    - ✧ **E16, 027, 308, 103, 1Q4**
    - ✧ Be careful to distinguish zero from letter O
    - ✧ Ignoring typeface, all above examples are letter O

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## Flight Plans

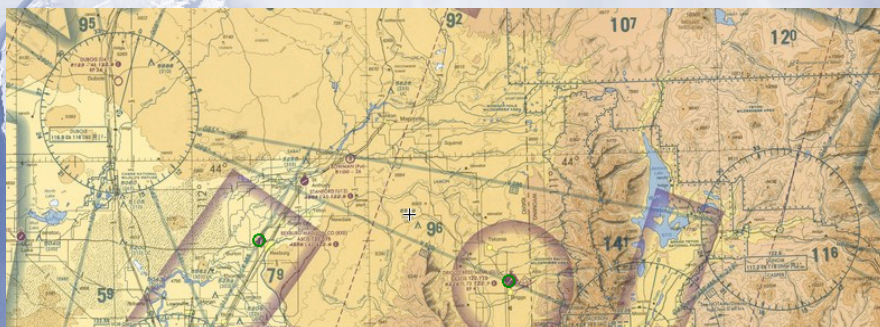
- ✧ When navigating a flight plan:
  - ✧ Called "automatic sequencing" or LEG mode
  - ✧ GPS *sequences* upon passing over a waypoint
  - ✧ GPS always directs you TO the next waypoint
  - ✧ Path between waypoints is a great circle
    - ✧ DTK may change from beginning to end, especially on east-west routings
  - ✧ Remember your navigation instrument (CDI, HSI) course needle is primary, *not the moving map*

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## Flight Plans



- ✧ Airway V298 segment DBS (ID) to DNW (WY)
  - ✧ Great circle
  - ✧ Flight plan: DBS DNW
  - ✧ DTK 085 leaving DBS
  - ✧ DTK 087 approaching DNW

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## OBS Mode

- ✧ Leg mode
  - ✧ GPS selects course
  - ✧ Flight plan waypoint-to-waypoint
  - ✧ Present position to waypoint (DIRECT TO)
- ✧ OBS mode
  - ✧ Pilot selects course
  - ✧ Typically using OBS knob on CDI
  - ✧ CDI must be channelled to GPS
    - ✧ External NAV/GPS button (Cessna)
    - ✧ GNS430 CDI button

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## OBS Mode

- ✧ Leg mode
- ✧ Always TO
- ✧ OBS mode
- ✧ TO or FROM

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## OBS Mode

- ✧ Mode switch
- ✧ Leg to OBS
  - ✧ OBS course set to DTK
  - ✧ OBS knob to change course
- ✧ OBS to leg
  - ✧ If TO waypoint
    - ✧ DTK set to OBS course
    - ✧ DTK not set from flight plan
  - ✧ If FROM waypoint
    - ✧ DTK set from flight plan
    - ✧ Sequence to next flight plan leg

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## Waypoint Terminology

- ✧ Per AIM and Instrument Flying Handbook
  - ✧ *Fix*: bearing and distance
    - ✧ e.g., VOR radial + DME
  - ✧ *Intersection*: crossed VOR radials
  - ✧ *Waypoint*: RNAV latitude/longitude
- ✧ From GPS perspective, all are called "waypoints" and represented identically in database as five-letter (occasionally digit) identifiers

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## VFR Waypoints

- ✧ On VFR charts
  - ✧ Intersections
  - ✧ VFR waypoints
    - ✧ **VPxxx**
    - ✧ VFR terminal area charts (TAC)
    - ✧ Tabulated on end panel
    - ✧ Typically correspond to well-known (and charted) *visual* checkpoints
      - ✧ This means if you are unfamiliar with the visual appearance of a checkpoint from the air, you can still navigate to it via GPS




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## VFR Waypoints



✧ "Remain south and west of the Pruneyard enroute to South County"

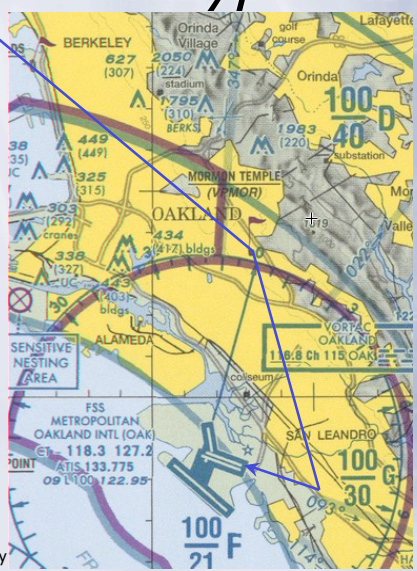
✧ What the heck does "The Pruneyard" look like?

✧ FPL

✧ KPAO  
VPPRU  
E16

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## VFR Waypoints



✧ "Fly to the Mormon Temple for sequencing to runways 27"

✧ Where the heck is "The Mormon Temple"?

✧ FPL

✧ KUKI  
VPMOR  
KOAK

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## *User Waypoints*

- ✧ Creating
  - ✧ Latitude/longitude
  - ✧ Bearing/distance
  - ✧ Moving map

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## *Creating User Waypoint*

- ✧ Latitude/longitude
- ✧ VFR sectional
- ✧ Other chart



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## Creating User Waypoint

✧ Reference bearing/distance

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## Creating User Waypoint

✧ Moving map  
✧ Pointer  
✧ Present position


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## Airspace

✧ How are you going to avoid Class B airspace:

✧ SFO?

✧ LAX?



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## Airspace

✧ SFO?

✧ Easy



✧ SFO VOR/DME

✧ Radial/distance

✧ DIRECT TO SFO

✧ OBS mode

✧ Select course (DTK) 090°

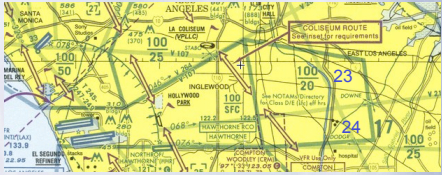



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# Airspace

- ✧ LAX
- ✧ Hard
- ✧ Arbitrary corners
- ✧ Sparse use of VOR
- ✧ Class B tabulation
  - ✧ Reverse chart side
  - ✧ Latitude/Longitude
  - ✧ VOR radial/distance
- ✧ Solution
  - ✧ User waypoint



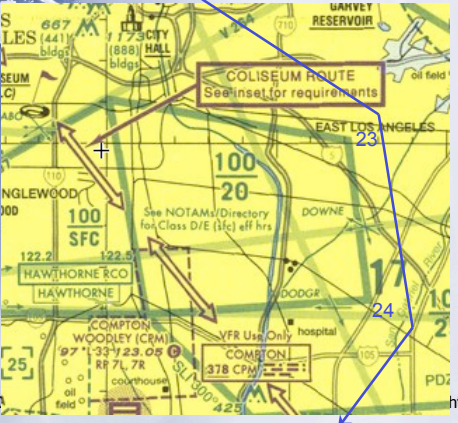
23 N34°00.02' W118°07.97'

24 N33°56.17' W118°07.35'



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# Airspace



Point    Lat/Long

23    N34°00.02' W118°07.97'

24    N33°56.17' W118°07.35'



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## Navigation

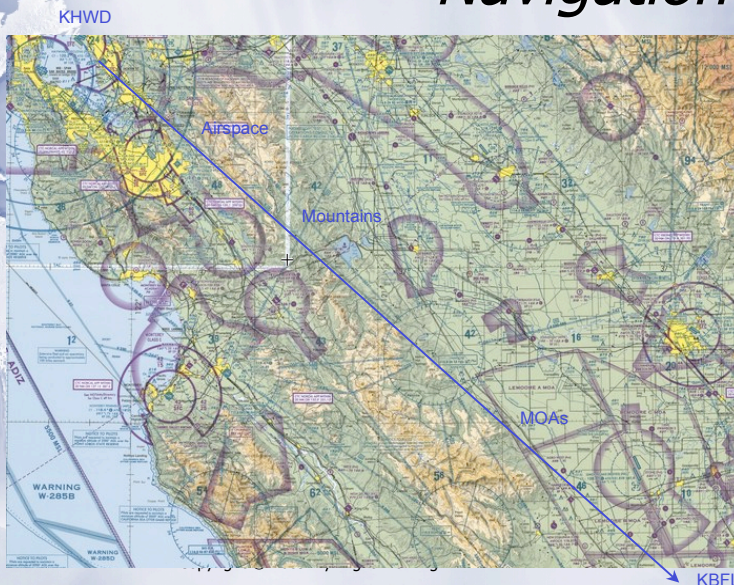
- ✧ Why not just go DIRECT TO?
  - ✧ Terrain
  - ✧ Airspace
  - ✧ Pilotage and dead reckoning backup
    - ✧ You *do* remember how to do those, don't you?
  - ✧ Winds aloft
  - ✧ Situational awareness
    - ✧ You can't be in the loop if all the smarts are in the GPS

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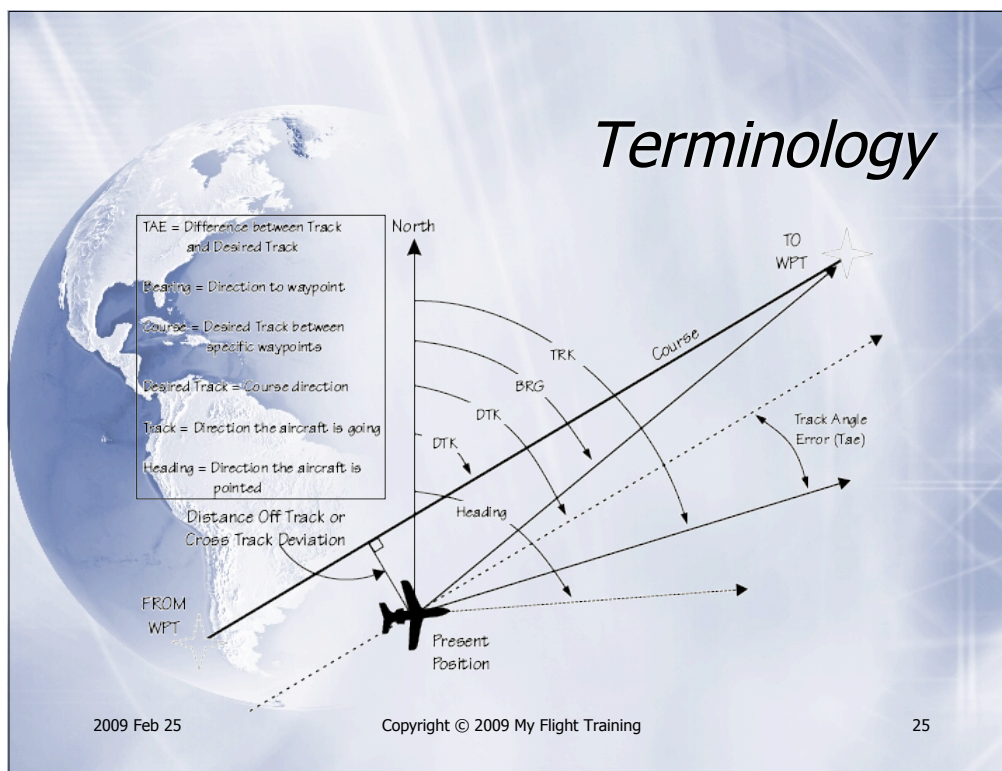
## Navigation



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KBFL





## Navigation

- ✧ TRK vs DTK
- ✧ If TRK is maintained equal to DTK, you will stay on course
- ✧ TRK is heading with wind correction

COH	120.200	133.975	109.10	110.20
DIS	198°	DTK 116°	BRG 116°	
TRK	144%	ETE 01:22		
GPS	NAV	00000		

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## *Navigation*

- ✧ Terrain avoidance
  - ✧ Terrain map
    - ✧ Red: terrain above or below aircraft –100 ft
    - ✧ Yellow: terrain below aircraft –1000 ft
    - ✧ Uncolored: aircraft clears terrain by  $\geq 1000$  ft
  - ✧ MSA/ESA display
    - ✧ Terrain clearance along your flight plan path
    - ✧ Uses IFR terrain rules
    - ✧ View on navigation pages

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## *Vertical Navigation (VNAV)*

- ✧ Motivation
  - ✧ Descend to selected altitude at waypoint
    - ✧ Descent planning (airport)
    - ✧ Descent planning (airspace)
    - ✧ Passenger comfort (500 fpm)
    - ✧ Comply with regulations (traffic pattern altitude)

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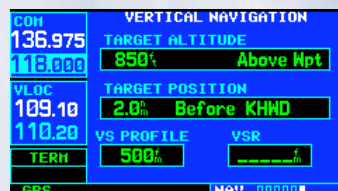
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## Vertical Navigation (VNAV)

- ✧ Descend to airport
- ✧ Traffic pattern altitude
  - ✧ AGL
  - ✧ 2–3 nm prior



END ALT: 850'  
2NM FROM HWD  
500'/MIN 120KTS  
A121.10 S119.10

HER DE FPL EYS COH

27.9nm Unv Alt 7500'  
KDBQ 7500 to : 1900  
DTK093° KDBQ : -02nm  
TK 092° GS:140 -0500fpm

\*CRSR\* ALT 2 \*CRSR\* LEG

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## Vertical Navigation (VNAV)

- ✧ Descend below airspace
- ✧ Class B shelf floor altitude
  - ✧ MSL
  - ✧ FPL
  - ✧ KSAC  
F4000  
VPCSH  
KHOW



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## Vertical Navigation (VNAV)

- ✧ Descend below airspace
- ✧ Class B shelf floor
  - ✧ SFO 20.0 nm < 4000 MSL
  - ✧ SFO 15.0 nm < 1500 MSL
  - ✧ MSL
- ✧ FPL
  - ✧ KSAC F4000 VPCSH KHWD



ACTIVE FLIGHT PLAN			
WAYPOINT	DTK	DIS	
KSAC	190°	6.3%	
VPCSH	223°	4.8%	
KHWD	255°	3.0%	

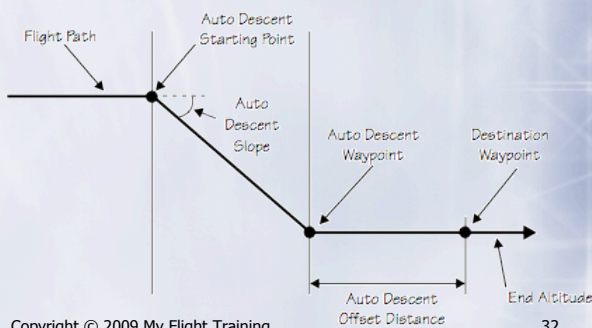
VERTICAL NAVIGATION			
COH	136.975	TARGET ALTITUDE	1500' MSL
VLOC	109.10	TARGET POSITION	0.0% Before VPCSH
TERH	110.20	VS PROFILE	500%
GPS		VSR	

VERTICAL NAVIGATION			
COH	136.975	TARGET ALTITUDE	4000' MSL
VLOC	109.10	TARGET POSITION	0.0% Before F4000
TERH	110.20	VS PROFILE	500%
GPS		VSR	

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## Vertical Navigation (VNAV)

- ✧ How to fly
  - ✧ Maintain aircraft actual vertical speed (VSI) equal to VNAV descent profile vertical speed
  - ✧ Vertical Speed Required (VSR)
    - ✧ Feedback about how good you are doing your job
    - ✧ Increase/decrease aircraft vertical speed to make VSR equal descent profile



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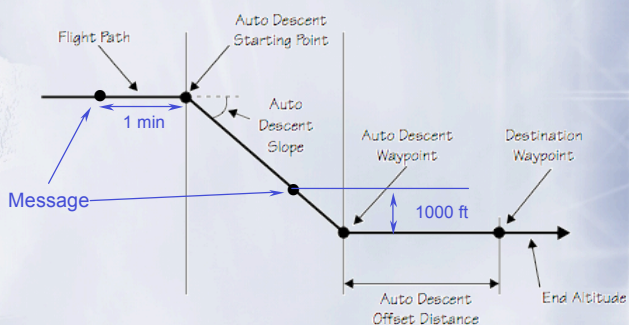
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## Vertical Navigation (VNAV)

- ✧ How to fly
  - ✧ Message one minute prior to top-of-descent
  - ✧ Message 500–1000 ft prior to reaching bottom-of-descent



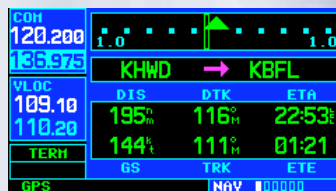
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## Flight management

- ✧ ETE, ETA
- ✧ Flight plan
- ✧ Position reporting
- ✧ ADIZ crossing



1. U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION		(FAA USE ONLY) <input type="checkbox"/> PILOT BRIEFING <input type="checkbox"/> VNR		TIME DATED		SPECIALS INITIALS	
FLIGHT PLAN				<input type="checkbox"/> STOPOVER			
1. TYPE X IFR	2. AIRCRAFT IDENTIFICATION N1234A	3. AIRCRAFT TYPE SPECIAL EQUIPMENT C172/G	4. FUEL RESERVED 120	5. DEPARTURE POINT KHWD	6. DEPARTURE TIME 2100	7. CRUISE ALTITUDE 2130	8. ARRIVAL TIME 5500
9. ROUTE OF FLIGHT							
10. DESTINATION (NAME OF AIRPORT) KBFL		11. EST. TIME ENROUTE 01 30	12. REMARKS				
13. FUEL ON BOARD HOURS MINUTES		14. ALTERNATE AIRPORTS		15. PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE		16. NUMBER ASSIGNED	
17. DESTINATION CONTACT TELEPHONE (OPTIONAL)		18. COLOR OF AIRCRAFT					

CIVIL AIRCRAFT PILOTS: FAR PART 91 requires you file an IFR flight plan to operate under instrument flight rules in controlled airspace. Failure to file could result in a civil penalty not to exceed \$1,000 for each violation (Section 901 of the Federal Aviation Act of 1958, as amended). Filing of a VFR flight plan is recommended as a good operating practice. See also Part 91 for requirements concerning VFR flight plans.

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## *Flight management*

- ✧ Flight timers, general timers, scheduler
  - ✧ Starts automatically at takeoff (30 knots)
  - ✧ Scheduler
    - ✧ Fuel-tank switching
    - ✧ Position reporting
- ✧ Fuel monitor
  - ✧ Substitute for fuel-flow totalizer (Shadin)
    - ✧ Program fuel flow (gallons per hour)
    - ✧ Program initial fuel load
  - ✧ Some units receive actual fuel-flow

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## *Aeronautical Information*

- ✧ Aeronautical database contains much information equivalent to
  - ✧ Airport/Facility Directory (A/FD)
  - ✧ Sectional
  - ✧ Terminal Area Chart (TAC)
- ✧ Can be used to place this information quickly at hand
  - ✧ Good CRM practice: all available resources

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## *Aeronautical Information*

### ✧ Caveats

- ✧ This is not a recommendation to abandon or not to carry paper charts or A/FD
- ✧ Does not absolve requirement to check NOTAMs
  - ✧ Issued on a much more rapid cycle than charts or databases
- ✧ Electronics can fail
  - ✧ But a battery-operated GPS is good backup

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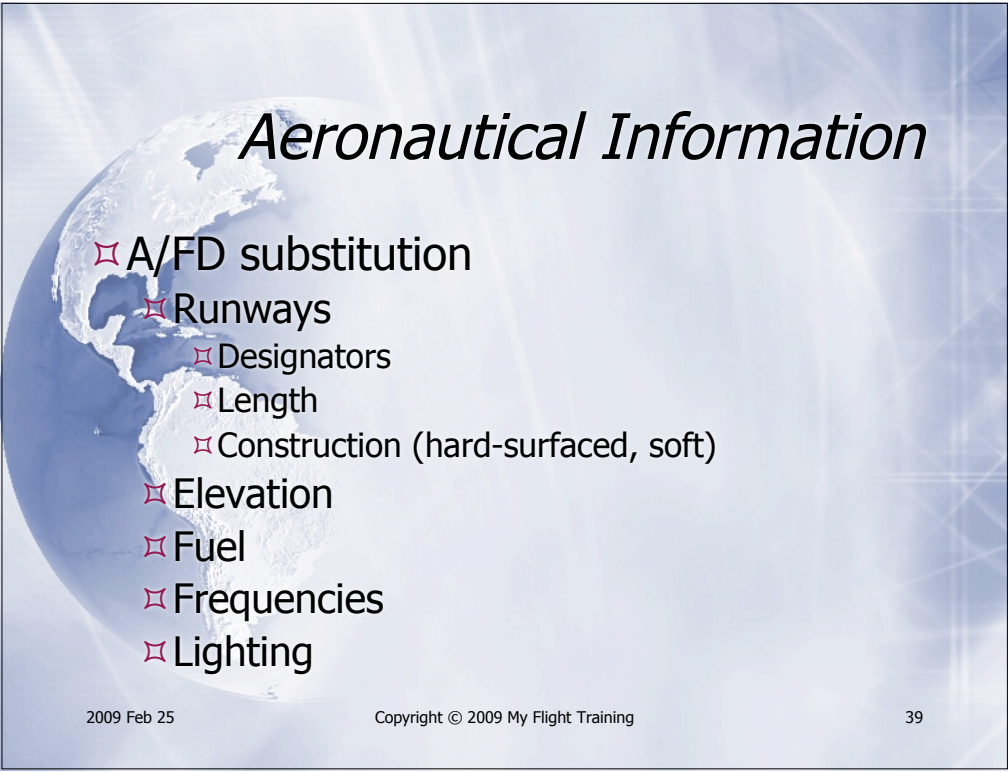
## *Aeronautical Information*

- ✧ A current GPS database is only required for IFR
  - ✧ But if you are going to depend on the database for chart substitution, it should follow IFR rules and be up-to-date
  - ✧ Most fleet (e.g., rental) airplanes are flown IFR and have regularly-updated databases
  - ✧ Get in the habit of checking the database date at power-on
  - ✧ Have paper charts ready as backup
  - ✧ Remember there is no currency rule for portables

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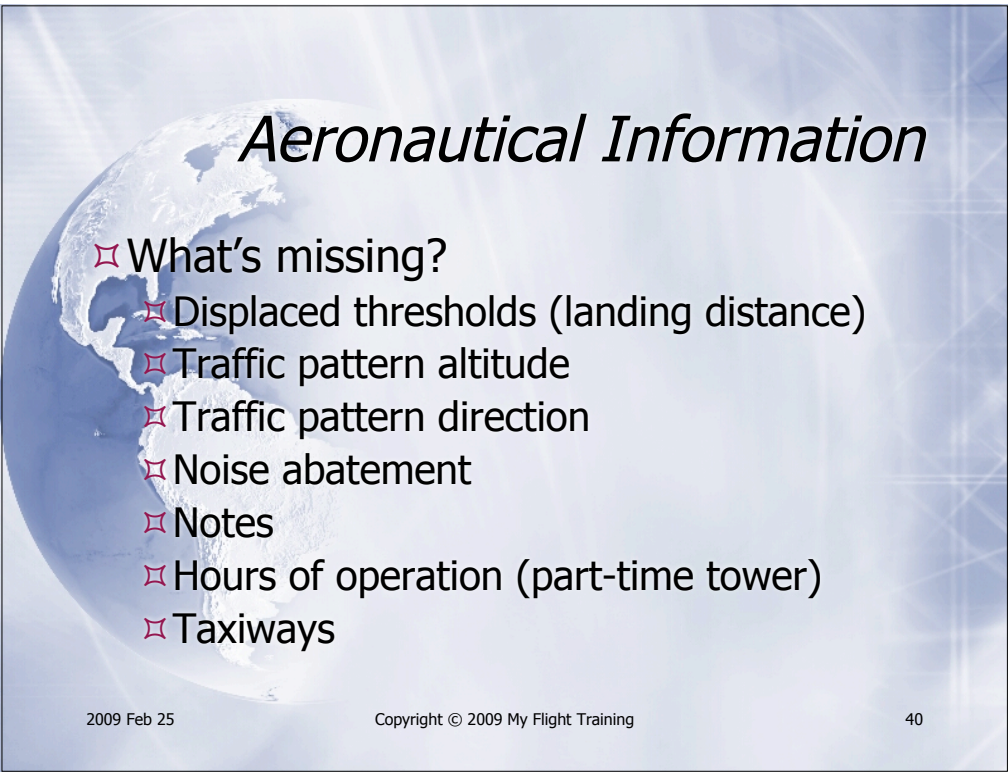
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## *Aeronautical Information*

- ✧ A/FD substitution
- ✧ Runways
  - ✧ Designators
  - ✧ Length
  - ✧ Construction (hard-surfaced, soft)
- ✧ Elevation
- ✧ Fuel
- ✧ Frequencies
- ✧ Lighting

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## *Aeronautical Information*

- ✧ What's missing?
  - ✧ Displaced thresholds (landing distance)
  - ✧ Traffic pattern altitude
  - ✧ Traffic pattern direction
  - ✧ Noise abatement
  - ✧ Notes
  - ✧ Hours of operation (part-time tower)
  - ✧ Taxiways

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## Aeronautical Information

- ✧ Airport frequencies and tuning
  - ✧ Know how to find the frequencies page(s) for an airport
  - ✧ Know how to load a frequency into a comm radio automatically

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## Aeronautical Information

- ✧ Auto comm radio tuning: GNS430
  1. Cursor on
  2. Highlight frequency with large knob
  3. ENT to load frequency to standby
  4. Flip-flop ↓ to activate

CDR	APT	KHWD	Public	Done?
136.975				
120.200				
VLOC				
109.10				
110.20				
ENR				
GPS				

CDR	APT	KHWD	Public	Done?
120.200				
136.975				
VLOC				
109.10				
110.20				
ENR				
GPS				

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## Aeronautical Information

✧ Auto comm radio tuning: KLN-94, KX-155

1. Cursor on
2. Highlight frequency with large knob
3. ENT to select
4. Change target navcom (1, 2) with small knob
5. ENT to send frequency to navcom
6. Flip-flop to activate



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## Aeronautical Information

- ✧ Lighting, logging, currency
  - ✧ Sunrise/sunset
    - ✧ Position lights
    - ✧ Civil twilight
    - ✧ Night experience
  - ✧ Sunrise – 1 hour/sunset + 1 hour
    - ✧ Night passenger carrying
- ✧ AUX page
  - ✧ Present position
  - ✧ Selected waypoint

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## *Questions?*

- ✧ GPS pilot's guide
- ✧ Simulator
- ✧ Dual instruction

*Thanks,*  
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