This is a realistic simulation of flying. Due to level of concentration required for mastery, not recommended for young children.

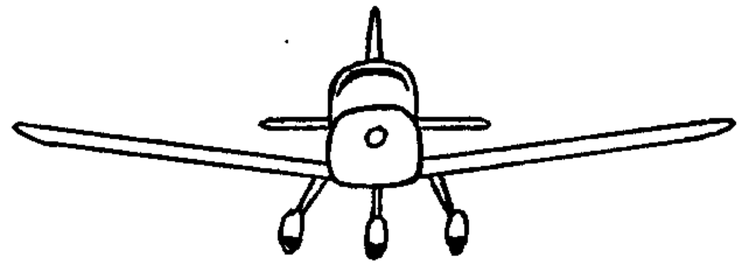
To be used to learn to fly, from simple maneuvers in still or turbulent air to landings and instrument approaches. Aircraft is equipped with a full panel of 10 instruments and 11 indicator lights.

Time to respond to your controls is about once per 1.5 seconds. Sound effects include engine noise, stall warning horn, and crash sounds. Graphics include all instruments updated in real time, and a runway indicator for landing.

DOW AIRCRAFT CORPORATION

Model Dow-4
and Gazelle

OWNER'S MANUAL



Requires TI99/4A Home Computer with joystick.

CONGRATULATIONS!

You are now the owner of a new, Dow-4 aircraft. This is a modern, 4-place single engine, high performance airplane designed for business and pleasure. Manufactured by the Dow Aircraft Company, it is known as the Dow Gazelle when equipped with full instrument panel, plush upholstery, and wheel fairings.

Familiarize yourself with the contents of this manual to ensure hours of safe, pleasurable, and efficient flying.

GETTING STARTED

1) Load the program from cassette.
2) Run it. (The program is large. The first 2 steps will take several minutes.)
3) Select choice "1" from the menu when it appears. This is a take-off.
4) Specify "0" for both wind and chop.
5) After a few seconds the instrument panel will appear. The airplane is sitting on the runway, ready for take-off.
6) Read INSTRUMENTATION AND CONTROLS while you are sitting in the cockpit with the panel before you.
7) Hold down the E key (alpha lock up) to return to the menu.
8) Turn to THE BASICS OF FLYING. Follow the instructions and learn to fly in an easy, step by step sequence.

PRELIMINARY INSTRUCTIONS

If you own the TI-99/4A (not the older 99/4) and do not have a disk drive connected to your computer, you may skip this page entirely.

If you own the TI/99/4 (old) model computer, disregard comments about the alpha lock key and change statements 3680 and 3710 to be:

```
CALL KEY(0,K,AK)
```

Save changed program on side B of tape.

If you own a disk drive (or peripheral expansion box with disk drive), it must be turned off unless you make the following changes...

You must modify the program as follows to load and run it from disk. It will then run about 30% slower. Turn on drive, turn on console, select Basic. Type CALL FILES(1), then type NEW. Load the program from cassette.

Delete statements 440 and 450.
Replace statement 110 with:

```
110 DIM FUEL(2),SV(18),DSV(18)
```

Insert

```
111 DEF AV(Q)=ASC(SEG$(AV$,INT(Q+.5)+1
                -40*INT((Q+.5)/40),1))
```

Replace statement 430 with:

```
430 AV$=AV$&CHR$(A+120)
```

Delete 440 and 450.

Then type SAVE DSK1.DOW4

To run from disk: turn on drive, turn on console, select Basic, type CALL FILES(1), type NEW, load the program with OLD DSK1.DOW4, and type RUN.

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Figures 1-7 follow page 29

Glossary follows figures

OPERATING INSTRUCTIONS

PREFLIGHT CHECK LIST
TI99/4A Home Computer on and running smoothly
Program loaded
Alpha lock off
Joystick operating freely

TAKE OFF - NORMAL
Full throttle
Pitch - 5
Pull back at 60 mph for lift off
After climbing to a safe altitude (500 ft),
  push stick forward to obtain 110 mph,
  set trim
Climb out at 110 mph

TAKE OFF - SHORT FIELD
Full throttle
Pitch - 5
Flaps down at 70 mph
Climb at 70 mph until clear of obstacle
Push stick forward to obtain 90 mph before
  raising flaps, then immediately pull back
  to continue climb with flaps raised
Push stick forward to obtain 110 mph,
  set trim
Climb out at 110 mph

CRUISE
Below 9000 ft, 75% power
Above 9000 ft, full throttle

LANDING - NORMAL
Fuel selector to fuller tank
Trim for 80 mph

LANDING - SHORT FIELD
Fuel selector to fuller tank
Trim for 70 mph with flaps down

PERFORMANCE FIGURES

Speeds			
Never exceed	200 mph		
Top speed (sea level)	174		
Cruise (75%, 9000 ft)	169		
Maneuvering speed	129		
Maximum flap extension	100		
Climb			
Best rate (sea level)	112 mph	900 fpm	
Best angle (sea level)	89	800	
Glide			
Best L/D 10.2	92 mph	760 fpm	
Ceilings			
Service	16,400 ft		
Absolute	18,000		
Stalls			
Flaps up	67 mph		
Warning horn and light	76		
Flaps down	58		
Warning horn and light	65		

CONTROL SUMMARY

Joystick - pitch and bank
1-9 - joystick pitch effectiveness
  (stick force)
A - abort approach or take off and go
  to full power
B - back to airport for ILS approach
C - climb - increase power
D - descend - decrease power
E - exit - return to menu
F - flaps - raise or lower
G - gas - select other tank
H - hold pitch (trim setting)
I - invert nav bearing - 090 or 270 deg
J - jam - pilot in jam, stop everything
K - keep on going (see J)
L - leveler - wing leveler on or off

CAUSES FOR CRASHES

MISSED RUNWAY
Descending to ground level off the runway surface or at too great an angle to the runway alignment (090 or 270 ± 18 deg)

TOTAL WIPEOUT
Impact with ground at high rate of descent.

LOST CONTROL
Going over 100 mph on the ground (takeoff or landing) or wing tip hits ground during landing due to excessive angle of bank.

TOO HARD
Touched down on runway but too hard. Max safe rate of descent is 300 fpm. Beware of inherent lag in VS indicator.

LOST FLAPS
Extending flaps over 100 mph causes severe structural damage.

LOST WINGS
Pulling more than 3.8 G's may cause wing failure. (See "maneuvering speed".)

LOST TAIL
Exceeding 200 mph may cause severe vibration of tail surfaces, causing structural failure.

TOO LOW
Hit TV transmitter tower, mountain, building, or other obstruction or terrain during ILS approach. Happens when off course, when too low before intercepting glide slope, when going too far below glide slope, or going below decision height or crossing the runway threshold while still in clouds.

INSTRUMENTATION AND CONTROLS

When reading this section you should either have the panel in front of you (on your monitor or TV screen) or else you should refer to Figure 1 as you read about each instrument.

Lights that are on are represented by a red circle; lights that are off are represented by a smaller, white circle. On all dials, a pointer is represented by a dot in the center and a dot at the end. If there are two dots at the end, the end of the pointer is at their midpoint. The pilot controls the plane with the joystick, the digits 1-9, and the lower case letters A-L.

STALL - This indicator light comes on at the same time a horn does; both warn you that the airspeed is getting dangerously low. If the stall actually occurs, the horn becomes more shrill and the nose of the plane falls rapidly. If you do not recover promptly, the plane will go into a steep dive.

A stall will occur at higher than normal speeds if in a steep turn.

Aircraft registration number - This is posted to the right of the stall warning indicator. This number is used in all radio communications and in filing a flight plan with a Flight Service Station. Read TI994A as Tango India Niner Niner Four Alpha. Frequently the air traffic controllers will abbreviate this to Niner Four Alpha.

MKR - Marker beacon lights. Used only for an ILS approach. Left light (inner marker) is not used. Middle light (middle marker) lights 1½ miles from touch down point. Right light (outer marker) lights 4.2 miles from touch down point, at point where glide slope should be intercepted.

AS - Air speed. Reads from 0 to 200 mph. Each tick is 20 mph. Straight up is 0 or 200 mph, straight down is 100 mph. The pointer moves in 5 mph increments.

AH - Artificial horizon. Three dots in a line represent the aircraft as seen from behind. If the plane banks to the left, the left dot goes down and the right dot goes up. Tick marks on the right side mark 30 and 60 degrees of bank. The mark on the left side represents the horizon, relative to the nose of the plane. If the mark is below the center airplane dot, the nose is above the horizon. The horizon line moves in 5 degree increments, the wing dots move in 9 degree increments.

ALT - Altimeter. The two digits in the upper left corner represent the ten thousand and thousand digits, the dial represents thousand foot intervals. For instance, 12,500 feet above sea level (not necessarily above the ground!) would be represented as "12" and the dial pointer straight down. Each tick mark on the dial represents 100 feet and the dial pointer moves in 25 foot increments.

NAV - Navigation radio. This instrument is used either for an ILS approach or to receive the enroute navigation signal from the VOR. The light in the lower left corner, labelled ILS, is on for an ILS approach. Note: when

making an ILS approach and the airplane breaks through the cloud cover into clear air below, the instrument automatically changes from ILS mode to VOR mode and the light goes off. The two lights on the left side are labelled T and F("to" and "from"). When passing over the ground station, the indication changes from one to the other. At the bottom of the display there is the number 270 or 090. This is the bearing to or from the ground station (when in VOR mode only). The face of the instrument has three tick marks; if the needle is aligned with the center mark, the airplane is exactly on course. If the needle is at a tick mark, the airplane is 20 deg off course in VOR mode, 4 deg off course in ILS mode. On the left of the instrument is a mark which indicates whether the plane is above or below the glide slope when making an ILS approach. (It does not move if VOR.) Each increment is 1/10 degree above or below.

TURN - This instrument displays the rate of turn. If the needle is straight up, the plane is not turning. If it points to the first tick from the center, the plane is turning at the rate of 3 degrees/second. This "standard rate"turn requires 2 minutes to make a 360 degree turn. The next tick mark is a 1 minute turn, 6 degrees/second.

DG - Directional gyro. The needle points to the airplane's heading. If there is a wind, the ground track may differ. Up is North (360 degrees), right is East (090), and so forth. Each tick is 36 degrees. The needle moves in 9 degree increments.

VS - Vertical speed. This rate instrument shows how fast the airplane is climbing or descending. Due to the way this instrument is constructed, there is a delay before its reading is accurate. Therefore it should be used to determine the rate only after it has been established. When the needle is pointing to the left, the rate of climb is 0 feet per minute (fpm). When pointing up, the rate is 500fpm up. When pointing down, it is 500 fpm down. Each tick mark represents 200 fpm.

PITCH - Pitch effectiveness. This digit reminds you what effectiveness you have selected. It corresponds to how far and how hard you move the yoke in a real plane. A value of 1 is less effective than 9. The initial value is 4. Use smaller values at high speeds, higher values at low speeds. Full stick movement is a 9. Caution: for values 6-9 it is possible to stall so abruptly that the stall warning indicator does not go on before the actual stall.

GAS - Fuel gauges. The left gauge is for the left tank (in the left wing), the right gauge is for the right tank. Initially the left tank is selected. If a fuel tank runs dry, the engine will cut out. You must select the other tank and bring back the desired power setting. If one tank has more fuel than the other, the plane will tend to turn toward the heavier side. Each tank holds enough fuel for 1 hour at 75% power.

TACH - Tachometer. This does not actually show revolutions per minute (rpm's) but shows percent power. Up is 0 or 100%, right is 25%, down 50%, left 75%. Each tick mark is 10%.

FLAPS - Indicator lights showing whether the flaps are up or down.

JOYSTICK - Controls aircraft attitude.
Push forward - nose down.
Pull back - nose up.
To right - bank to right.
To left - bank to left.
Nose up and down (pitch) is also affected by the pitch effectiveness setting. The degree of banking is dependent on how long the stick is held to either side. The **plane banks 9 degrees for each second the stick is held to the side. The maximum angle of bank is 63 degrees.**

KEYS - Depressing several keys select options and control various functions of the airplane.

A Aborts landing or approach. If ILS approach, NAV switches from ILS to VOR mode and the clouds disappear. In all cases, **full** power is applied immediately.
B Back to airport for ILS approach. This can only be selected if east of the outer marker. A cloud cover suddenly materializes, obscuring the ground.
C Climb - power is increased, 5% the first second the key is depressed, an additional 10% the next second, 15% the next, and so forth.
D Descend - power is decreased, 5%, 10%, and so on, same as C.
E Exit from flying, go back to menu.
F Flaps are raised or lowered. Do not lower flaps when speed is above 100 mph. Beware of sudden loss of lift when raising flaps.

INSTRUMENTATION AND CONTROLS (cont.)

G Gas tank is selected. Caution: if a tank is run dry, the engine will stop. If one tank has more fuel than the other, the aircraft will tend to turn toward the heavier side.

H Hold trim setting at current pitch position. After the key is pressed, a low tone will sound. At the tone, release the stick and key both to hold that pitch position indefinitely. Subsequent stick movements are in addition to the held position. Trim settings can be accumulated by holding the key and stick for several seconds.

I Invert the NAV bearing from 270 to 090 or vice versa. Although the number changes, for ILS mode the needle display is not affected.

J The pilot is in a jam and needs to "stop the passage of time" momentarily. This can be used to study the manual and instruments, to go to the refrigerator, or to explain to your parents or spouse why you are playing with the computer all day.

K Keep on going. Restarts time after J key was used.

L Wing leveler. When on, the aircraft rolls to wings level position and maintains it. If the stick is used to bank, the plane will return to level as soon as the stick is released. The wing leveler will keep the plane level even though the fuel tanks are uneven, and will return it to level in severe turbulence.

Figure 1 shows: 85mph, nose down, banking and turning to right, heading 90 deg, descending through 3500 ft, 60% power, flaps up, and south of 270 course to VOR station.

OPTIONS

1) TAKE OFF
The aircraft is positioned at the starting position for a take off roll on runway 27 (that is, heading 270). The airport is at sea level.

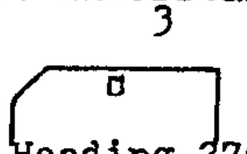
2) IN FLIGHT
You are asked to specify altitude in feet above sea level at which the plane should start, the ground level (also above sea level), and the starting velocity. The power and trim are automatically set to maintain level flight at that speed and altitude. If the altitude is too high, there may not be enough power to maintain level flight at the specified speed. If the altitude is the same as the ground level, you can try taking off from an airport above sea level. The starting direction is selected randomly. The starting position is selected randomly within 5 miles of the primary airport (where the VOR and ILS are located); if you are trying a high altitude take off, you are at a secondary airport from which you can take off but not land.

3) LANDING
You are about to join the down wind leg for a landing on runway 27. See Figure 3. You are heading 045^{0} at an altitude of 1000 ft above sea level at 130 mph. The airport is at sea level and your location is about 1 mile south west of the touch down point. For the landing to be safe, you must touch down on the runway surface and

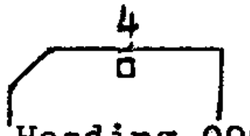
be able to stop within the overrun. This means that the touch down must be within a mile of the threshold. When within several miles of the field, a digit appears on the screen above the panel. The value of the digit and its height above the panel represent the distance to the touchdown point (the east end of the runway). This distance is in the East-West dimension only; it is not affected by being North or South of the touchdown point. Examples:

"4" just above panel = .4 miles east or west
"8" just above panel = .8 miles east or west
"2" one row higher =1.2 miles east or west
"9" two rows above it=2.9 miles east or west

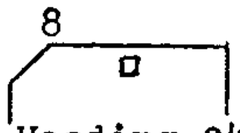
If the digit is exactly above the stall warning light, you are exactly in line with the runway. This is true even if you are not heading 090 or 270. The display makes sense if you imagine turning your head to due east or due west, whichever is closer to your heading. Then, if the digit is to the right of the screen, picture the runway to your right (with your head correctly aligned). Of course, when about to touchdown, the plane should be aligned closely to the runway so then the digit is easy to understand. Here are some examples:



Heading 270
TDP 1.3 mi
and to right



Heading 090
TDP .4 mi
straight
ahead or be-
hind



Heading 045
TDP .8 mi
east and
about .8
miles north

(TDP = touch down point)

When you are 1 mile north or south, the digit will reach the limit of its travel to the side of the panel, even if you

get as far as 3 miles away.

4) SHORT FIELD LANDING
You are positioned for a landing just as for option 3. The only difference is that there is now a ridge 400 feet high (above sea level) just ½ mile east of the runway. In other words, if you descend below 400 feet when farther east, you buy the farm. Furthermore, the runway is shorter, so you must be on the ground within ½ mile of the threshold.

5) ILS APPROACH
The letters ILS stand for Instrument Landing System.(See Fig. 2) An ILS has certain equipment on the ground and in the aircraft which together with exact procedures define a safe method of landing at an airport even if visibility is poor or the ceiling (cloud bottoms) is low. The value of the ILS approach is that it locates the airplane precisely in space relative to the runway threshold. At this airport, if you break through the clouds at the decision height (DH), which is only 300 feet above the ground, you will be just 1 mile from the runway and in a position to "make a landing of it" (if you are in practice). This approach can be selected with the key B, provided you are east of the outer marker. (A) If you choose option 5, you will automatically be positioned 8 or so miles east of the airport and within 1 or 2 miles north or south of the center line. You will be at an altitude of 2000 feet, heading west, at 140 mph. The ceiling is not

known; it is probably above the 300 ft DH, but it may be below it. (B) Your first task is to turn as necessary to center the needle. You should also slow down to a more reasonable approach speed, since you could not make a landing at 140 mph when you break through the clouds at about 300 ft and a mile out. It is too difficult to slow down during the actual approach. Do not go below 1200 feet until past the outer marker! (C) As you approach the outer marker, located 4.2 miles east of the runway, the outer marker light will go on. Once past the transmitter the light will go out. (The transmitter sends a fan shaped signal straight up from the ground.) At this time you should be established on the glide slope; that is, the glide slope needle on the left side of the NAV display should be centered. (D) Now concentrate on keeping both needles as close to the center as you can. If things get out of control, call "missed approach" on the radio and execute the missed approach procedure: abort the approach and apply full power (A key), climb straight ahead to 1500 ft, then climbing right turn to 2000 ft, heading 090. (E) The middle marker is 1.5 miles out. Its light will not stay on as long because you are closer to the transmitter on the ground. Your altitude passing over it should be 450 feet. (F) You could break into the clear at any moment. You must not go below 300 feet in the clouds. If in the clouds still at 300 feet you must call missed approach. (G) The signal to you that you are below the clouds will be the ILS light on the

NAV display going out. (In a real airplane you would begin to see the ground.) (H) Once forward visibility improves as you get a little lower below the cloud bottoms, you will see the digit showing your distance to the runway and whether you must correct north or south before touching down.

You must break into the clear or call missed approach before passing the threshold of the runway. If you cross it in the clouds, regardless of how high you may be, you will crash with the message "TOO LOW".

One final note: if you can bring your plane down to a safe landing using an ILS approach, particularly if you have any wind or chop, you can consider yourself a skilled pilot.

WIND AND CHOP

After you select your choice from the menu, you specify wind and turbulence (chop) strength. Each can be in the range 0 to 3, meaning none at all to severe or strong.

RESULTS

After you have landed, crashed, or stopped flying by using the E key, several values may be displayed. These are:

WIND	Direction and speed.
FPM	Rate of descent in ft/min.
CEILING	Height of cloud base above ground level. For ILS only.
G FORCE	The ratio of lift to weight, times 10. If lift equals weight, the value displayed is 10. If lift is twice weight, the value is 20. The wings come off at 6, displayed as 60.
MPH	Speed in miles per hour.
FT	Altitude in feet above sea level.
DEG	Heading in degrees from North. For a successful landing, this must be within 18 degrees of the runway alignment. Landing to the west, the runway is number 27 and the alignment is 270 degrees. To the east, the runway is 9 and the alignment 90.

THE BASICS OF FLYING

TURNING

To make a shallow or slow turn, select the IN FLIGHT option with ALT 1000 ft and GL at 0 ft. Start with V equal to 100. (When practicing, always set wind and chop to 0.) Then follow these steps:
1) Hold the stick to the right for 1-2 sec.
2) The AH now shows wings banked to the right.
3) TURN shows turn to right.
4) DG slowly turns clockwise as plane does.
5) To stop the turn, hold stick to left until AH shows wings are level.
6) TURN is now straight up (no turn).
7) DG is no longer turning.

Try a turn to the left also. Then try it at a higher speed (eg 150 mph) and a lower speed (eg 80 mph). (Use the E key to return to the menu to start at a different V.) Notice that for the same degree of bank, the rate of turn is greater when V is lower.

Practice turning to a particular heading (eg North), trying to stop exactly at the heading without turning too far or too little.

DESCENDING

Set up the plane as above, with V at 100.
1) Hold down the D key for about 3 seconds.
2) Listen as the power is reduced.
3) Also notice the TACH change.
4) Because power has been reduced, the plane initially slows down a little as drag continues to pull on it. As the plane slows down, the wings produce a little less lift. This causes the nose to drop a little. Because the nose went down, the plane is now "coasting down-hill". Going down hill brings its speed

back to its original value. Because the plane was trimmed for this value, the plane stabilizes at a constant speed in a descent. All of this only takes a few seconds.

5) The VS dial now shows the rate of descent. (Allow several more seconds for it to reach its final position.)
6) The ALTimeter will now be unwinding.

Try it again, but reduce the power all the way to 0%. The initial drop in airspeed will be more clearly seen, and the final rate of descent will be faster. Also try descents starting from different initial values of V.

CLIMBING

This is exactly the reverse of descending. Start in level flight again, but increase power this time. The engine noise will increase in frequency and volume, the TACH will show the increase, the speed will initially increase followed by a climb, the VS dial will show the climb, and the altimeter will show the gain.

SOME THEORY

In order to use the stick (elevator), you should understand the role that lift plays for your airplane. Lift is the term used to refer to the forces acting on the wing that enable the plane to stay up. When you go out on a windy day, you feel the force of moving air very directly. The wings on your plane are shaped to take advantage of this force. They control and direct the force to keep the plane aloft.

Here is an experiment to try, if you haven't already at some time. Make your hand flat and stick it out the window of a moving car. If your hand is perpendicular to the air flow, you simply feel a lot of resistance. If you hold it level, there is little resistance. Now, tilt it back some from the level. You can feel a force that lifts your hand. This is just what an airplane wing or helicopter rotor blade or bird wing does.

There are two important things to notice from this experiment.

1) The faster the car goes, the greater the force on your hand.
2) The more you tilt your hand back, the more lifting force you feel. (Until you tilt it so far that you feel no lift at all.)

Pulling back on the stick in the airplane is the same as tilting your hand back. It actually tilts the plane back, and with the plane go the wings also.

One more fact: if the plane is not turning and if it is in equilibrium (that is, not speeding up or slowing down), the lift produced by the wings is exactly equal to the weight of the plane.*

Now to put all this together into practical terms. To maintain level flight, if the plane slows down the nose must come up; hence you must pull back on the stick. Similarly, if the plane speeds up, you must push on the stick to put the nose down to maintain level flight. You will probably

---

* Actually, the vertical component of the lift equals the weight of the plane.

need to use the pitch effectiveness (the digits 1-9) and trim (the H key) to control the nose smoothly.

Set the plane up in flight at 1000 ft and at 100, 135, and 170 mph. Note the different positions of the nose relative to the horizon line on the AH at each of the speeds. It is: above, on, and below the horizon.

Now, back to work in the cockpit!

SLOWING DOWN

Get set up at 100 mph, as before when practicing maneuvers. Now reduce the power as if about to descend. However, when the instruments show the descent has just begun, pull back on the stick. (You can watch first the AH for the nose to drop, then the VS, then the ALT.) Pulling back will create more lift because it tilts the wings back. This will slow the descent, bring the nose back to level, or even cause a little climb, depending on the pitch effectiveness.

If you reduced power enough, even though the stick is held back, the nose will again fall. Hold down the H key to "crank in some trim". This will pull the nose up again. As you make these adjustments, notice that the speed is falling and, if you do it right, your altitude stays just about the same.

When you have slowed down to to the desired speed, such as 80 mph for a landing, you may increase power again to maintain your altitude. Notice that less power will be required once you have slowed down.

SPEEDING UP

This is just the opposite of slowing down. Increase power, and when the climb starts, push the nose down. Use trim as needed. When the desired speed has been reached, decrease power as necessary to maintain altitude.

LEVELING OFF FROM A CLIMB OR DESCENT

Transitioning from a climb or descent is simple if you wish to maintain the same airspeed. Just change the power setting. For instance, if climbing at 100 mph, reducing power the right amount will cause the plane to fly level at 100 mph. However, usually you climb at much slower speeds than you cruise at because the plane can climb faster at the slower speed. That means that at the same time that you stop climbing because you have reached the desired altitude, you simultaneously want to increase your airspeed.

Set up the plane at 100 mph, then increase to full power to make it climb. Let it climb a few hundred feet, choosing a target altitude to level off at. As you near the altitude, push down on the nose. The plane will begin to speed up and the rate of climb will lessen. Use trim to continue pushing the nose down to stop the climb. The excess power no longer needed because the plane is no longer climbing is now being turned into a higher airspeed. When the plane is level and the desired speed has been reached, reduce power to maintain airspeed and altitude.

To level off from a descent, you would pull back and increase power.

HOLDING ALTITUDE WHILE TURNING

Perhaps you noticed when practicing turns that the airplane would descend a little when you were turning. This becomes much more pronounced when the plane is banked steeply in order to turn rapidly. The reason is that the lift from the wings is partially used to pull the plane around the turn, much as a yo-yo on a string whirled about your head is kept from flying off by the string. This means that not all the lift is available to counteract the weight of the plane, hence it starts to go down. The solution is to increase lift enough so that it can fulfill the double demand of staying up and turning.

In practical terms, if you are turning and the bank is steep enough that the plane begins to descend, pull back on the stick. You may have to experiment with the pitch effectiveness to keep from going into a climb instead.

If you have to pull back enough because the bank is quite steep, the plane will slow down (due to increased drag caused by having the nose up). In very steep banks you will have to increase power just to stay at the same altitude.

Note that if you bank steeply but do not pull back or increase power, the plane will speed up as it descends rapidly toward terra firma.

STALLS

Many people only know of stalls as what the engine in their car does on a cold

winter morning in the middle of the busiest intersection on the way to work. However, with airplanes the term refers to the flow of air across the top of the wing. In order for the wing to develop lift, the air must flow smoothly around the wing, top and bottom. As more lift is required for a turn or to pull out of a dive, or as the same lift is required but at a lower airspeed, the wing is tilted back and back and back. Eventually there comes a point where the air can no longer flow smoothly across the top of the wing; at this point, it breaks away from the wing, becoming turbulent, changing the pressure patterns, and (here's what's critical) seriously reducing lift so that the airplane begins to fall rapidly.

Stalling an aircraft can be disastrous, particularly at low altitudes. Therefore planes are built with sensing devices in the wing which turn on an indicator for the pilot <u>before</u> the wings have actually stalled.

To practice stalls, set up as if you were going to practice slowing down. However, reduce power to a very low value or shut it off entirely. Then continue to apply trim as the plane gets slower and slower. When it gets close to stalling speed, the stall warning light in the top center of the instrument panel will light and you will hear the stall warning tone. If you continue to apply trim, the tone will change to a very high pitched tone, your signal that the stall has actually happened. At this point release the H key. If you push the stick forward the plane should come out of the stall. (You may

have to hold down the H key or increase the pitch effectiveness to make the nose drop enough to get flying again.)

To really see the effect of a stall, do not let the plane recover for a number of seconds. Watch the air speed rise and the altimeter "unwind." Recovery will be difficult if not impossible if the speed builds up too high. You have to put the nose down to recover from the stall, but once recovered there is the danger of exceeding the 200 mph upper limit, causing the tail surfaces to break off. But if you try to recover from the dive too fast you can pull the wings off by exceeding 3.8 G's and you can even go into another stall.

Stalls should be avoided. If one occurs, push the nose down and recover as soon as possible. NO MATTER HOW CLOSE TO THE GROUND, IF A STALL OCCURS YOU MUST PUT THE NOSE DOWN.

Obviously if you stall close to the ground there is no chance of recovery unless you act immediately. Therefore, when landing be very careful with airspeed and stick force (pitch effectiveness). If landing in rough air, play it safe and keep the speed a little higher.

LANDINGS

Refer to Figure 3 for a diagram of the runway and landing pattern. The pattern is rectangular, with the long sides parallel to the runway. The down wind leg (see step 3 in the figure) is at an altitude of 1000 feet above the runway. Aircraft should approach the field from the direction shown, then join any other traffic in the pattern. While on down wind, the plane should be slowed to the proper approach speed, with flaps if needed, and then trimmed to maintain that speed. Having the plane already flying the correct speed makes the rest of the landing much easier.

Start the descent at some point east of the touch down point. The rate of descent should be moderate, perhaps 500 fpm. How far east you fly must be timed with your altitude and rate of descent at any point. In a tight pattern you may only go 1 mile east, while in a wide pattern you may go 3 miles east. Do not hesitate to apply power if you get too low.

The turn on to final is important. If you turn too soon or too late you will not be aligned with the runway when you roll out heading 270^{o}. Try to correct any error as soon as possible so that you are not making course corrections as you are about to touch down.

If all has gone well, you will pass over the threshold at perhaps 100 ft. Wait until about to touch down, then pull back on the stick and regulate your power to touch down softly.

NAVIGATION

The navigation radio enables you to locate yourself relative to the VOR transmitter located on the airport next to the touch down point. (VOR stands for very high frequency omnidirectional radio range.) This plane is not equipped with DME (distance measuring equipment), so you cannot determine your distance to the VOR.

In a real airplane you would be able to select any bearing, but with the simulated nav radio you are limited to 090 and 270 degrees. Follow these steps to locate yourself relative to the VOR.

1) Turn the airplane so that its heading is the same as the bearing (090 or 270) that is displayed. Use the I key to change the bearing if it means you don't have to turn as far. (You may also imagine this turn if your spatial awareness is good enough.)
2) Now picture a line running East-West through the VOR; that is, extend the runway to infinity in both directions.
3) If the needle is on the right, the runway (extended) is on your right. If the needle is on the left, the runway (extended) is on your left.
4) If the "to" light is on, the VOR is in front of you. If the "from" light is on, the VOR is behind you.

Note: turning the plane is done only to make it easier for you to visualize the meaning of the nav display. It has no effect whatsoever on the to/from light or the needle! Try it: fly to a location several miles from the VOR (eg take off and fly northwest for several minutes) then fly in circles and watch how little the display changes.

See Figure 4 for examples.

NAVIGATION (cont.)

Once you have determined where you are (eg northeast), turn to fly toward the extended runway (eg south). Watch the needle: as it begins to center, turn 90° toward the VOR (eg west).

Once positioned on or close to the extended runway, and heading roughly 090 or 270, make small corrections in course to keep the needle centered. IMPORTANT: Do not keep turning toward the needle until it centers. Instead, turn until the DG indicates that you are on a course which will intercept the extended runway, then hold that heading until the needle centers. Do not intercept it at more than 30° intercept angle or you will fly across the selected bearing and have to approach it from the other side.

To summarize tracking, if the needle is to one side, try turning a few degrees to that side, then hold the heading until the needle centers. If it does not move, try a few more degrees.

When tracking with a wind, the heading which will keep you on course may be a little different than 090 or 270. If so, you are crabbing. Simply experiment, making corrections of a few degrees at a time, until you keep the needle from moving.

When making an ILS approach, use the same technique as for tracking with the VOR. However, remember that the ILS needle is far more sensitive than the needle is in VOR mode. Also, although the I key will change the bearing display (090 vs 270), the to/from indicator will not change and the needle will not change because the ILS is always 270°.

CHALLENGES FOR THE ADVANCED PILOT

STEEP TURNS - Try making two complete circles at 60° bank, rolling out at the same heading that you started at. Do not gain or lose more than 100 feet of altitude.

TIMED CLIMBS AND DESCENTS - Use a stop watch to see if you can climb or descend 1000 feet in exactly 2 minutes, or 500 feet in 1 minute.

TIMED TURNS - Try turning 360° in exactly 1 minute or exactly 2 minutes. (When flying under instrument conditions, the 2 minute turn is standard.)

TIMED CLIMBING OR DESCENDING TURNS - Try to climb or descend 500 feet while turning 180° in exactly 1 minute.

PARTIAL PANEL - Cover one of the instruments, then see if you can do the above maneuvers or fly an approach, etc. For instance, cover the AH or DG. This will demonstrate the extent to which the various instruments provide similar information to the pilot. Although none is exactly like another, there is enough redundancy that you can fly even though one of the instruments has failed.

HOLDING PATTERN - Figure 5 shows how to fly a holding pattern. Once you can do it, try it with a strong wind.

ACCELERATED STALLS - Put the airplane into a steep turn, then stall it. Notice that it stalls at a higher airspeed than if flying straight.

CHALLENGES FOR THE ADVANCED PILOT (cont.)

HIGH ALTITUDE FLYING - Start the plane in flight at a high altitude. Notice the difference in top speed, in stalling speed, in power at full throttle, and in handling. Try a landing at 10,000 feet (set ground level to 10,000 and altitude to 11,000). Notice how rate of climb is affected and how the plane is more sensitive to turbulence.

BEHIND THE POWER CURVE - Figure 6 shows the amount of power required for level flight at sea level at various speeds. When flying at low speeds, the only way to go slower is to apply more power (unless you can descend). If you have no more power and cannot go down, being behind the power curve is very dangerous because you cannot go faster (no power), you cannot go slower (no power), and you cannot go up (no power). You can't even turn (because this requires more lift). The only solution is to go down enough to get more speed so that you can then go even faster or else climb a little.

TAKE A TRIP - Map out a route that starts at the airport and returns there. For example, take off, fly west 5 minutes, then north 5, then southeast. You should return to the field. Try it with some wind. If you track outbound from the VOR you can guess what the wind is and try to allow for it when flying by "dead reckoning" (that is, not tracking on the VOR).

PROCEDURE TURN - When not being "vectored" by an approach controller, it is sometimes necessary to turn 180° preparatory to making an approach. Figure 7 shows how.

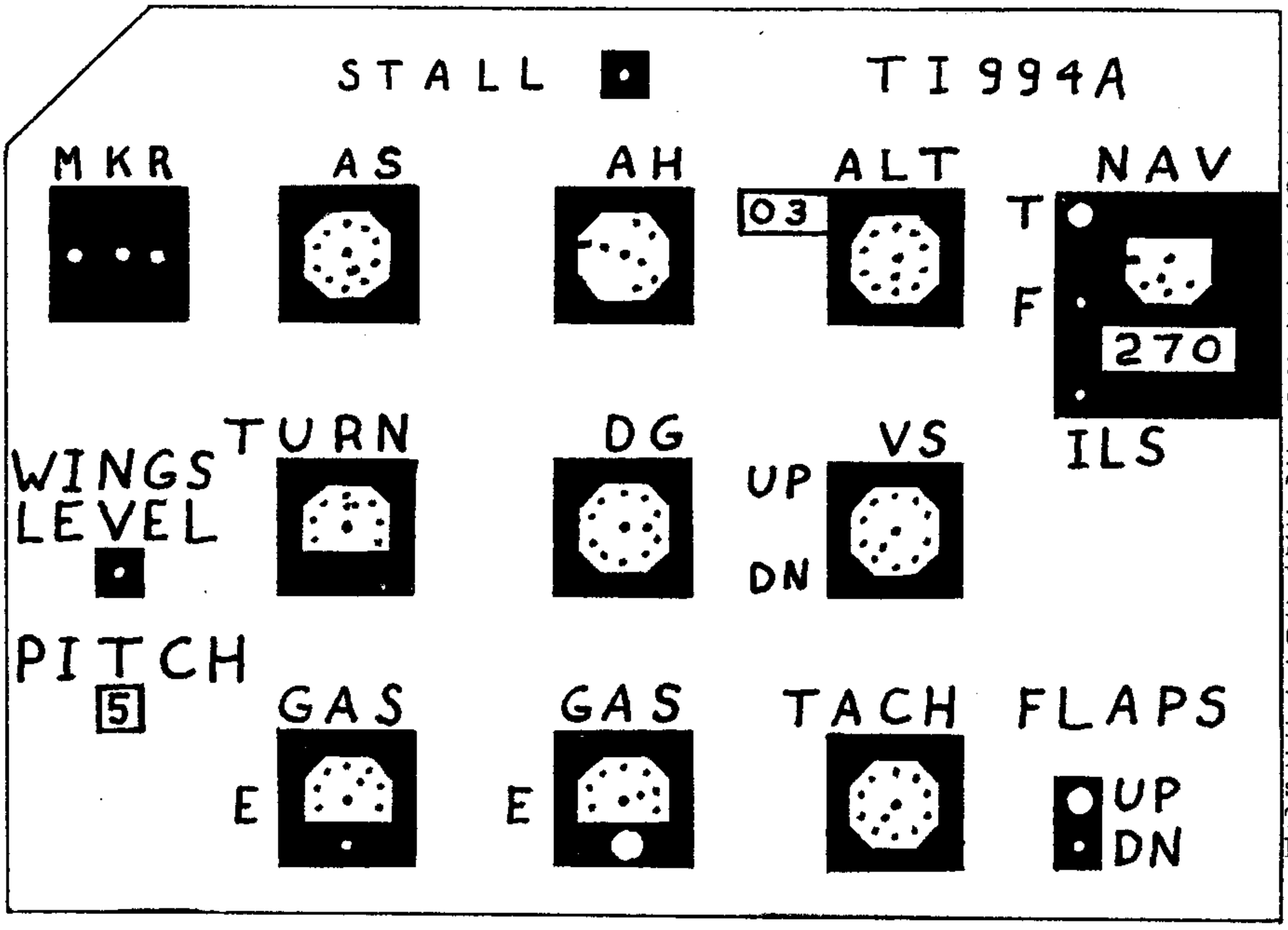


Figure 1: Panel

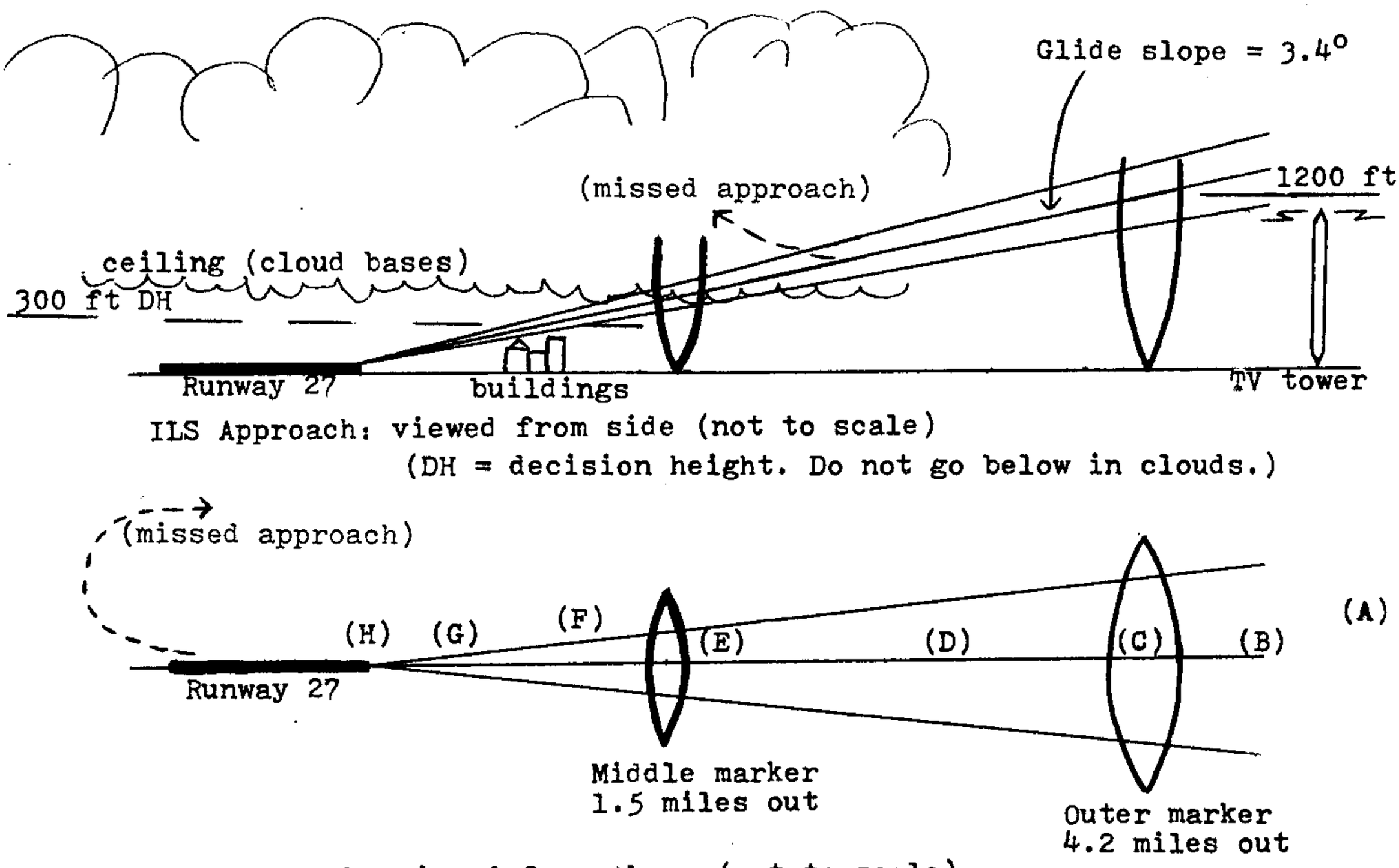
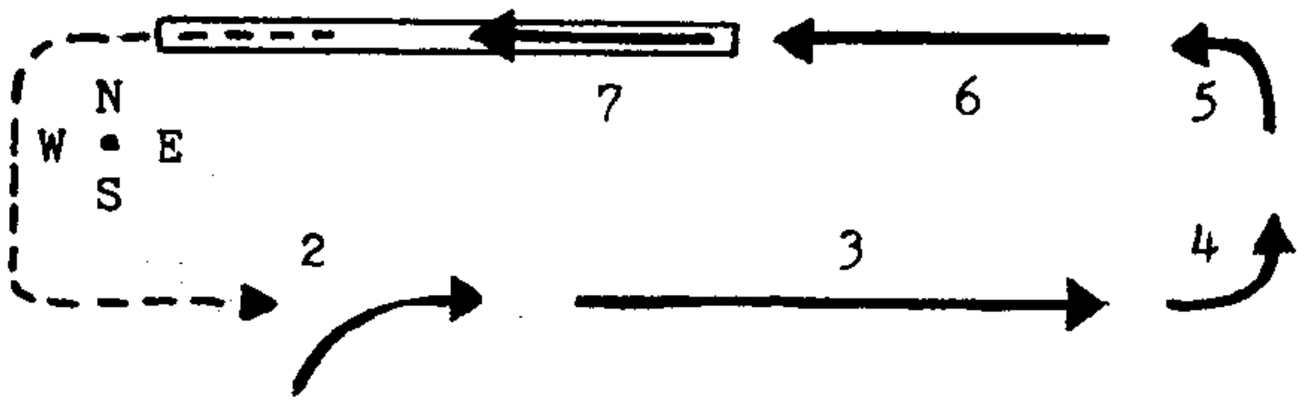


Figure 2: IIS

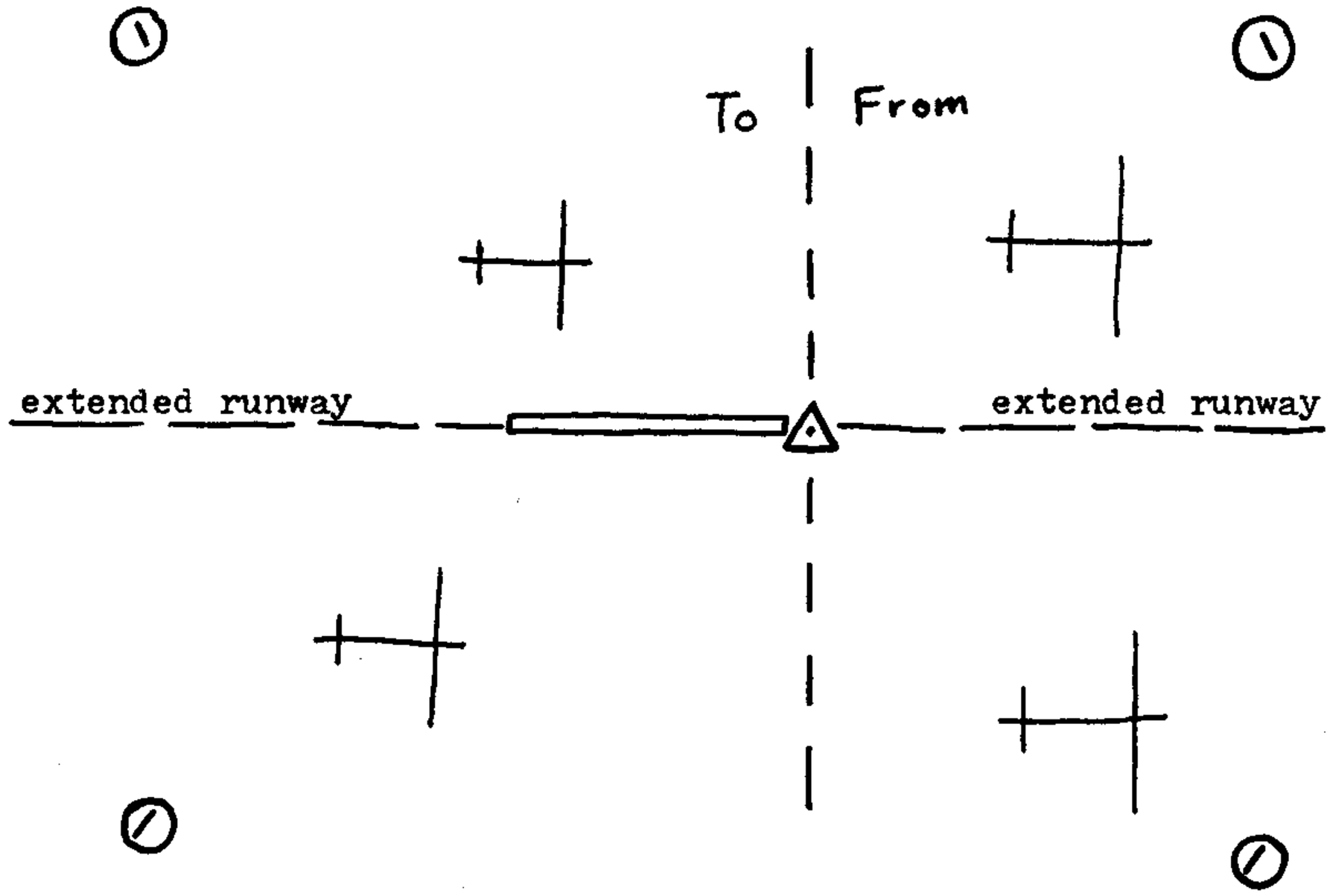
ILS Approach: viewed from side (not to scale)
(DH = decision height. Do not go below in clouds.)

ILS Approach: viewed from above (not to scale)
(Letters in parentheces refer to explanation in OPTIONS section.)



1) Initial position: about to join landing pattern. Heading 045, altitude 1000 ft.
2) Turn "down wind". Heading 090, altitude 1000 ft.
3) On down wind leg, slow down to approach speed. Lower flaps if desired. Heading 090, alt 1000 ft.
4) Start descent at or before this point, turn to "base" leg. Heading 360, altitude: descending.
5) Continue descent, turn from base to "final". Heading 270, altitude: descending.
6) Continue descent, get lined up with runway. Control descent to touchdown shortly after passing threshold.
7) "Flare" to touchdown softly enough: pull back on stick and monitor power to control rate of descent. If a landing cannot be made of it because you lose control or miss the runway, apply full power with the A key to climb back to pattern altitude and to circle to the left to make another attempt. (See dotted line.)

Figure 3: Landing



Bearing and heading are both 090

Figure 4: Navigation

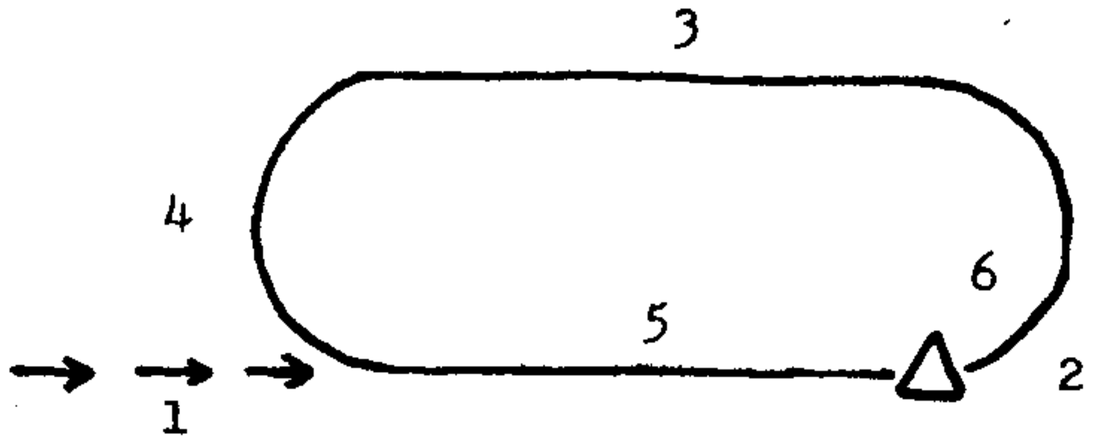


Figure 5: Holding pattern

1) Track inbound to VOR.
2) When passing VOR, turn 180° left.
3) Hold your heading (270) for 2 minutes.
4) Turn 180° left and intercept VOR 090 bearing inbound.
5) Correct if necessary and track to VOR.
6) Continue around as necessary.

For added difficulty, try holding with wind or turbulence.
Try leaving the holding pattern to fly a procedure turn.
(See Figure 7)
Try descending exactly 1000 feet while holding.

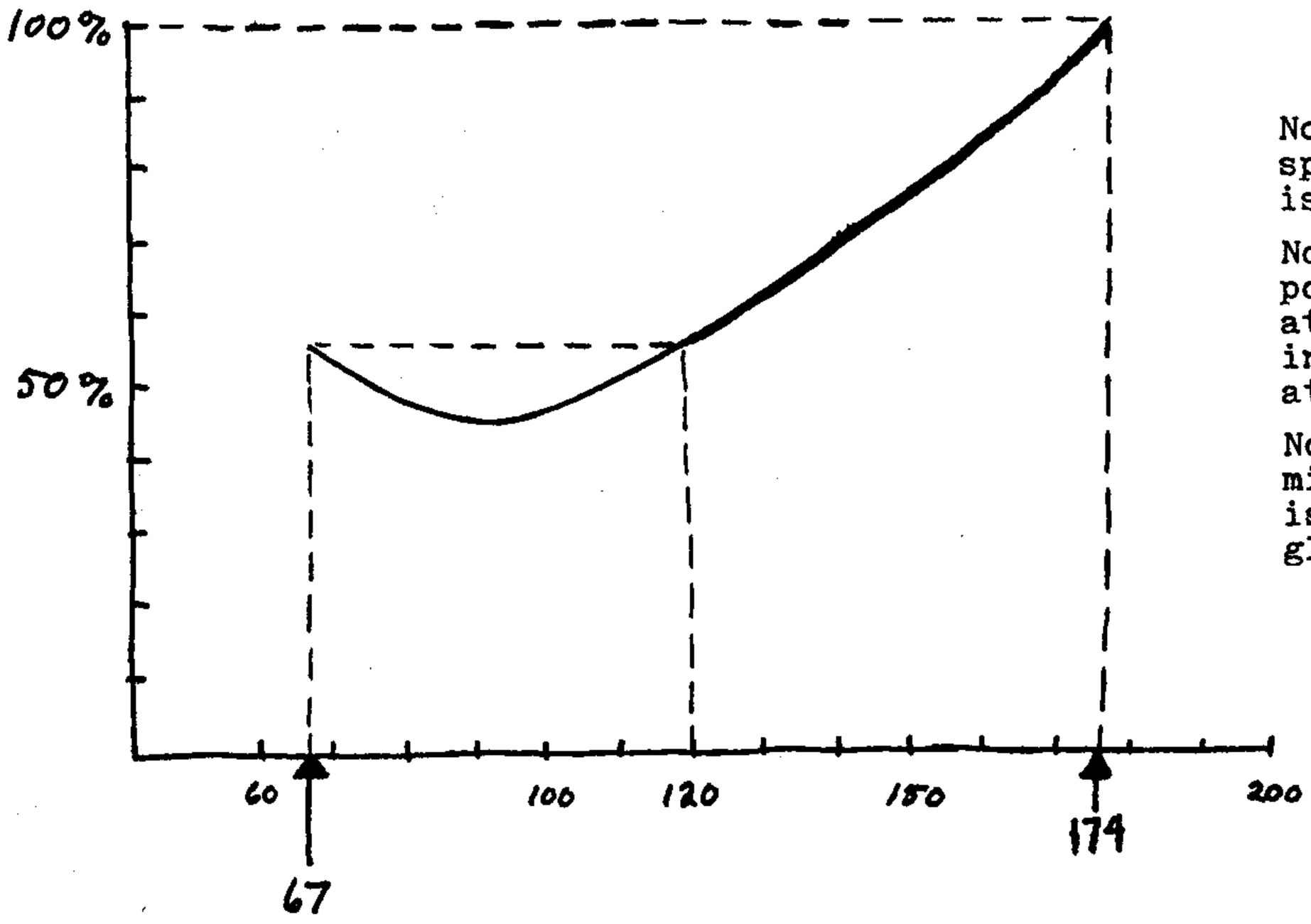


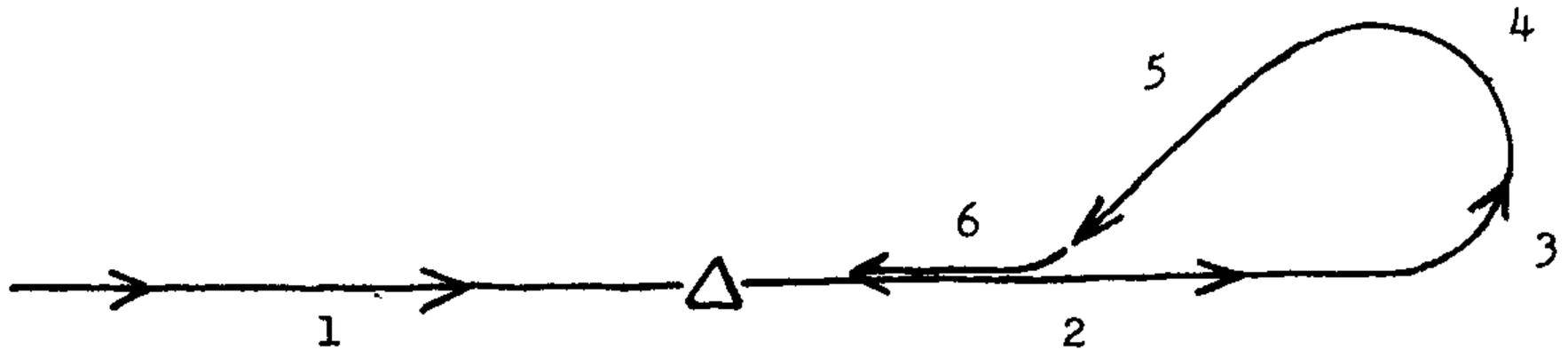
Figure 6: Power vs speed

Note that max speed (174mph) is at 100% pwr.

Note that same power is needed at 67mph (stalling speed) as at 120mph.

Note that minimum pwr is near best glide speed (92).

Figure 7: Procedure turn



1) Track inbound to the VOR
2) After crossing VOR, track outbound for 2 minutes.
3) Turn left 45^{o}. (Fly straight 1 minute if desired.)
4) Turn left 180^{o}.
5) Fly straight until intercepting inbound bearing.
   (Use I key to change from 090 to 270 first.)
6) Track inbound to VOR.

Note: All turns standard rate.

Try going east far enough to select an ILS approach.

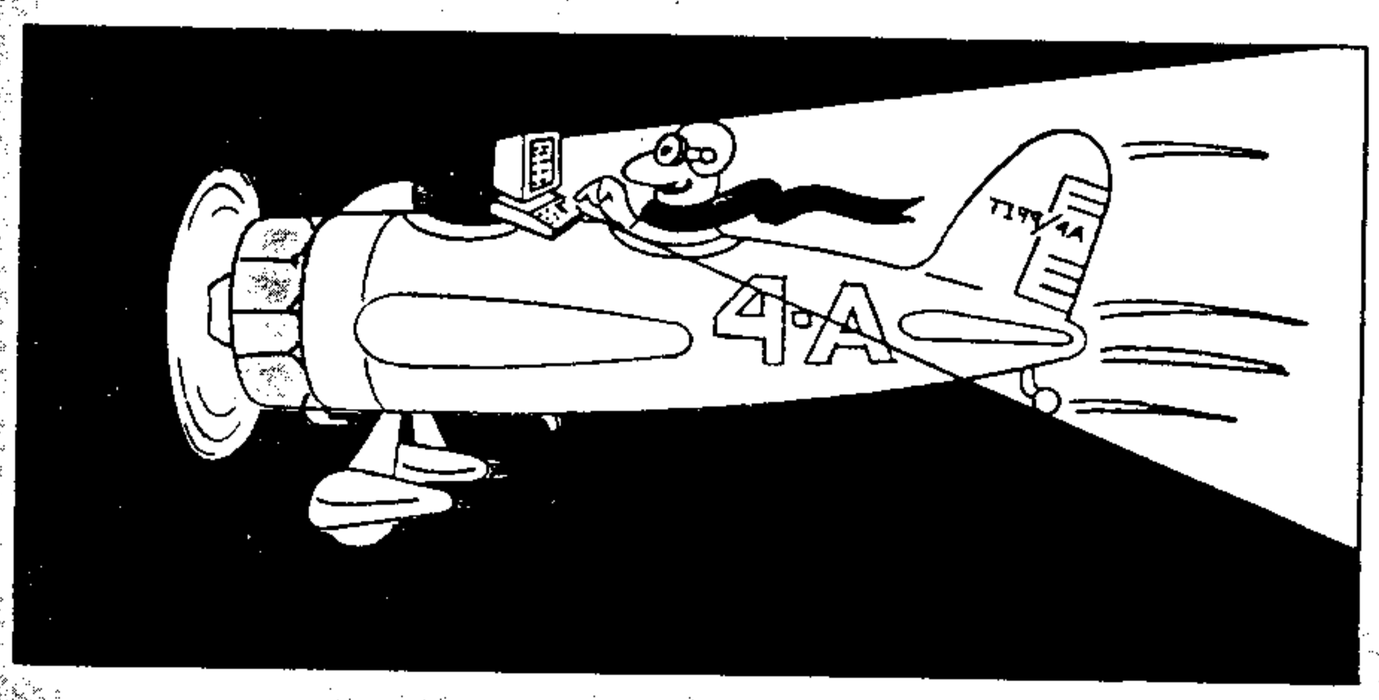
GLOSSARY (cont.)

ILS (cont.) - CONTROL section's description of the NAV radio and the OPTIONS section's description of the ILS approach.
ILS mode - NAV radio shows whether above or below glide slope and course needle is very sensitive. Indicated by light being on. (In real plane, indicated by frequency selected by pilot.)
Leveler - Automatic device that keeps wings level, even when in severe turbulence.
Maneuvering speed - maximum speed at which plane's wings will stall before pulling too many G's and failing. Do not exceed this speed in rough air.
Marker beacon - radio transmitter on ground and receiver in plane, used to determine distance from runway during ILS approach.
Missed approach - pilot determines that landing is not possible.
Missed approach procedure - path and altitudes to be flown to safely abort landing or approach attempt to avoid obstacles.
Percent power - how much power is being produced. Depends on throttle and altitude.
Pitch - whether nose is up or down.
Pitch effectiveness - digit selected by pilot to control effectiveness of stick when pushed or pulled.
Roll - Change in bank.
Stall - turbulence caused by too great an angle of attack causes wings to lose lift.
Trim - Control used by pilot to stabilize plane at whatever airspeed he desires.
VOR - Very high frequency Omnidirectional Radio range. Navigational radio used to navigate enroute. Read INSTRUMENTATION AND CONTROL section's description of NAV radio and NAVIGATION SECTION.
VOR mode - NAV radio needle less sensitive than in ILS mode. Glide slope needle inoperative. Light is off. Affected by inverting the bearing.

GLOSSARY

Altimeter - measures height above sea level.
Artificial horizon - shows attitude of plane.
Attitude - whether nose is up or down, whether plane is banked.
Bank - Whether plane is tilted left or right.
Bearing - direction to or from ground station.
Best angle of climb - used to get maximum height in minimum distance, to clear obstacle.
Best L/D - best ratio of lift to drag, speed used for best glide distance.
Best rate of climb - used to get maximum height in minimum time.
Ceiling, absolute - altitude at which rate of climb is 0 fpm.
Ceiling, service - altitude at which rate of climb is 100 fpm.
Course - direction of ground track of plane. May differ from heading due to wind.
Decision height - on an ILS approach, the height below which you must not go unless the runway is in sight.
Flaps - section of trailing edge of wing which may be put down to increase both lift and drag. Used to clear obstacles on take off or landing.
G force - ratio of force acting on an object to force of gravity. For an airplane, ratio of lift to weight. Maximum G force wings can tolerate is 3.8 G's.
Glide slope - flat radio beam extending outward and upward at 3.4° from horizontal from touch down point on the runway. Used by NAV radio to show pilot whether too high or too during ILS approach.
Heading - direction plane is pointed.
ILS - Instrument Landing System. For advanced pilots. Enables landing through cloud cover. Read INSTRUMENTATION AND

THE 4A INTO *FLIGHT:*



A Review of the Dow-4 Gazelle Flight Simulator

By David Welcker
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Learn to Fly! That is the challenge of *Gazelle* by John T. Dow. From the first roar of the Gazelle's engine, this real-time simulation will keep you on the edge of your cockpit seat. And it does so without a single laser blast or invading alien! What grabs your attention is your sudden take-off as the pilot of a single-engine plane—and the scenario is likely to include a frenzied operator, a dog-eared manual, and joysticks wet with perspiration.

Before taking control, you have to absorb thirty pages of text and several drawings, and you can expect to consult the manual for at least the first few flights. During flight, the screen displays a dashboard—ten dials and eleven indicator lights which the student pilot must understand and manipulate via the joystick and keyboard controls. Above the dash is an indicator in the night sky showing the distance and direction to the landing field. As this is the only non-instrument indicator, the simulation is even more difficult than daytime flying—you can't even look out the window to see how the plane is situated.

When you finally land the plane (under these circumstances it took me about fifteen tries) there is the further challenge of instrument landings with more sensitive controls, short-field landings, and rapid take-offs—as well as "challenges for the advanced pilot," suggested in the manual. After mastering them, the pilot can choose to tackle maneuvers under varying turbulence. As a result, the program keeps its appeal, even when mastered. And unlike some challenges for 99'ers, the "expert" sessions need not become marathon.

Speed of response to your controls is excellent and realistic. A "time out" option lets you freeze the action in order to deal with backseat drivers, calls of nature, and disgruntled spouses. If you make a mistake (by flying too fast, missing the runway, or losing control), you'll hear the crash followed by the whine of the ambulance. The cause of your misfortune is displayed with other flight data, including start options. Safe landings earn a musical pat on the back and the warm satisfying glow that comes only with mastery of this demanding task.

Some will complain that *Gazelle's* instruments are hard to read, in that pixels (dots) make up the indicator needles and calibrations. I have not found this hard to get used to, but if you have eyeglasses, be sure to wear them. In any case, the increased speed is worth the squinting. The program makes use of the full 16K, thus some of the usual title screen/text amenities are left out (and barely missed).

And best of all, you really can learn the principles of flying! The interaction of the controls and indicators is quite well integrated. The game is so realistic, that the level of understanding needed to play it probably excludes anyone too young to fly a real plane in the first place!

Whether to teach or to entertain, this simulation will meet all your expectations. And should you accept the challenge of *Gazelle*, please watch for me up there—my registration is Tango India Niner Niner Four Alpha.

Dow-4 Gazelle by John T. Dow is available in TI BASIC (joysticks required) for $30.00 on cassette through John T. Dow, 6360 Caton, Pittsburgh, PA 15217.

99'er