Lesson 2: Energy Management | Fly This Lesson Now

by Rod Machado

Imagine sitting on the back of a mean rodeo bull as the gates open and the audience cheers. You're holding on for dear life, ruing the day you gave up being a vegetarian. The stakes are high because the big steak you're riding is in rare form and in a mighty bad mood. After what seems like hours of trying to steer the steer, you're ejected from the beast and your life saved by rodeo clowns.

What does this have to with flying a jet? Without a good understanding of energy management, you'll probably feel something similar to riding a wild bull when trying to get a jet down and stopped on a runway. The only thing missing from this scenario will be the rodeo clowns. Like riding a steer, controlling a jet means understanding how to manage its energy.

Descents

We have covered the fundamental points involved in getting you airborne and leveled off at cruise altitude. Now you're wondering how you can descend and be in the right place at the right speed and altitude for landing. When it comes time to begin the descent, you must complete several important tasks in order to end up at the right place and at the right time. Prior to actually beginning the descent, air crews must complete the following:

- Plan when to start the descent.
- Get the ATIS and other information relating to the approach and landing.
- Calculate (or estimate) the landing weight of the aircraft.
- Determine the flap setting and Vref speeds for landing.
- Determine the appropriate landing runway and approach desired.
- Brief the crew on the specifics of the approach.
- Complete the Descent checklist.

Descent Planning

Descent planning is not a trivial matter. It requires some expertise—but we will show you the basics required to get the most enjoyment from your Flight Simulator experience. So here's the lowdown on getting down.

Aircraft equipped with turbine engines achieve their best performance at high altitudes where the air is thin and fuel consumption is low. Jets like to climb high quickly, and remain there for as long as possible. Although it may be better for the airplane's performance, a steep high-speed descent is not the most enjoyable experience for passengers. So, alas, we must find a way to descend from altitude at a more comfortable rate. After all, during the descent the last thing you want your passengers to do is throw their hands over their heads like they would on a wild rollercoaster ride, right?

Air crews flying large jets at high altitudes like to descend using the 3:1 principal. That is, for every 3 nautical miles (nm) traveled forward, they descend 1,000 feet. This rate produces the same 3-degree glide slope you typically use on final approach. There are two key components to descent planning: 1) When to start descent, and 2) Which rate of descent to use.

When Do I Start My Descent?

To figure out when you should start down from your cruising altitude, you need to know the point and the altitude where you'd like to be along your route. For simple VFR flight, you might want to be at traffic pattern altitude (1,500 AGL) as you enter the pattern. Commercial airliners often must follow an IFR Standard Terminal Arrival Route procedure (or STAR—which, by the way, isn't only used at night) that dictates the altitude and speed at which you need to be at points along the specified route. For example, a STAR might request that you descend to cross the 30 DME fix from the ABC VOR at 10,000 feet and maintain 250 knots (I guess we could call this a *falling star*, but we won't).

To figure out your starting point, or "Top of Descent," while following the 3:1 rule, subtract your target altitude from your current altitude and multiply this answer by three. This will give you the number of miles from your target that you need to start your descent. Consider the following examples:

If we are flying at 8,500 feet and want to be at 1,500 feet at the airport, calculate your descent point as follows:

8.5	Our starting altitude, in thousands of feet
-1.5	Subtract our target altitude, in thousands of feet

7.0	Our altitude to lose, in thousands of feet
x 3	The magic 3:1 multiplier

21	Nautical miles from the airport

Here's another simple way to calculate this in your head. Once you know the altitude you want to lose in the descent, multiply it by three to determine the miles from the fix you should be. We'll use this during the lesson to monitor our progress during the descent, which will then tell us if we need to make adjustments along the way.

According to our STAR instructions example above, if we were cruising at 28,000 feet and needed to be at 10,000 feet 30 miles from the VOR, our calculations would be as follows:

28	Our starting altitude, in thousands of feet
-10	Our target altitude, in thousands of feet

18	Altitude to lose, in thousands of feet
x 3	The magic 3:1 multiplier

54	Nautical miles from our destination point

Here comes the fun part of this example (and no rodeo clowns are involved). We need to begin our descent 54 nm from our target destination point—the 30 DME fix from the ABC VOR. This means we need to add in the additional 30 nm to this 54 nm figure and start our descent 84 nm (54 nm + 30 DME) from the ABC VOR.

You can have a lot of fun calculating descent points and then flying them to check your assumptions. The next important element of the equation is the actual rate of descent you use during the descent profile.

What Rate of Descent Will Get Me There?

Using the right rate of descent in feet per minute (fpm) will be the key to arriving at your target destination at the proper altitude. In order to maintain our 3:1 descent profile, we can calculate the required rate of descent by multiplying our estimated ground speed for descent by six.

To determine your ground speed

Look in the upper right corner of the HSI. 147 KTS
-or-
Bring up the GPS by clicking the Display/Hide GPS icon

But how will you know what your ground speed will be in the descent before you descend? Our profile initial descent speed from altitude will be approximately 0.74 Mach (or about 400 knots ground speed). So, you can use 400 knots as your initial ground speed during descent and calculate the required rate of descent by multiplying 400 (knots) by 6 to get 2,400 fpm.

So, in our example above, at 84 nm from the ABC VOR, begin a 2,400 fpm descent.

In cruise, you have been traveling at around 400 knots with N1 set at around 71 percent. For descent, initially reduce your N1 to 60 percent to 62 percent to keep from over speeding the aircraft.

A very quick way to estimate your descent rate is to consider the following:

Above 25,000 feet	300 knots at 2,500 fpm
Below 15,000 feet	250 knots at 1,700 fpm
	200 knots at 1,400 fpm

How Fast is Too Fast?

A subtle piece of the equation is speed control. There are two places you will need to modify your profile to keep within parameters: during descent as you descend into thicker denser air, and at the level off point where you may need to start slowing down to meet any assigned speed restriction (for example, slowing to 250 knots).

Now, it's very important to remember the FAA regulation that limits airspeed to no more than 250 knots when you are below 10,000 feet. In the lesson, we'll stay below this airspeed, but it'll be important to remember on your checkride.

As you descend into thicker air, your airspeed unit of measure will change from a percent of the speed of sound (Mach) back to knots. To prevent a close shave by flying too fast when it's not appropriate to do so, you can determine this threshold by noticing the "barber pole"—the red and white striped pole, or needle, displayed on the upper left side of the airspeed indicator. This needle marks the "never exceed speed" for the aircraft. During descent, the barber pole increases toward the needle of the airspeed indicator and left unattended, will eventually cross paths. Should this happen, you will have an over-speed condition on your hands as marked by the "click-clacking" audible warning, which also sounds like the copilot's chattering teeth because he's quite nervous by now. To avoid this, reduce N1 to 45 percent and maintain 310 to 320 knots during the remainder of your descent.

As you descend from cruise altitude, you will be storing up all kinds of kinetic energy as you go swooping down at more than 300 knots. All this works against you as you reach your target point and need to slow down. The solution is easy. During your descent planning, allow for an additional 5 nm to level off and slow to your target speed at idle. In our example above, this would mean beginning your descent at 89 nm from the ABC VOR, arriving at 10,000 feet 35 miles from the VOR. Once leveled at 10,000 feet, reduce power to flight idle and coast the 5 nm bleeding off speed until you reach 250 knots. At this point, increase throttles to N1 of 52 to 55 percent and maintain 250 knots.

And now a word of warning from your sponsor--me. If you have been using the autopilot with autothrottles enabled, you may not slow down in time to meet your crossing restriction. In the second example above, the autothrottles will get you slowed to 250 knots, but not by the 30 DME fix. Typically, the autothrottles can take as much as 7 minutes to slow down. You can cover a large distance in this amount of time. Without access to the Flight Management System (FMS), the best way to handle this is to disengage autothrottles as you level at the 5-nm lead point and set power to flight idle manually. Optionally, you can use a 10-nm lead point to account for the extra time and distance required for autothrottles to slow down.

Remember to Reset Your Altimeter

Remember that as you descend below FL 180 (18,000 feet) you need to reset your altimeter from 29.92 inches to the local pressure setting, which you get from listening to ATIS.

Of course, as a last resort, you can always deploy the spoilers (or speed brakes) by pressing the **SLASH (/)** key. With careful planning, such as the above steps, you should be in fine position for your approach and landing profiles.

Now you are an energy manager because the 3:1 rule on descent planning is true for any plane you fly, such as the Cessna Skyhawk and Beechcraft Baron 58, and at lower altitudes and airspeeds. Perhaps I should now call you the *all-being, master of space, time, and dimension* because so few people ever master energy, much less master it in a Boeing 737. OK, I won't call you that yet. All I'll say is give this lesson a try and practice the principles you've learned here. More power to you!

Ok, see you in the cockpit. Click the **Fly This Lesson** link to practice what you've just learned.

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