

AVIATION

Impressions of a Pilot

Flight is freedom in its purest form,
To dance with the clouds which follow a storm;

To roll and glide, to wheel and spin,
To feel the joy that swells within;

To leave the earth with its troubles and fly,
And know the warmth of a clear spring sky;

Then back to earth at the end of a day,
Released from the tensions which melted away.

Should my end come while I am in flight,
Whether brightest day or darkest night;

Spare me your pity and shrug off the pain,
Secure in the knowledge that I'd do it again;

For each of us is created to die,
And within me I know,
I was born to fly.

The series of notes is intended to inform, revise or present pilots with some knowledge of flight of which they may never have known.

You may be “gung-ho” cold, steely – eyed, weapons systems managers who kill the bad people and breaks things. You can be very charming and personable. The average pilot despite sometimes having a swaggering exterior is very much capable of such feelings as love, affection, intimacy and caring. These feelings generally do not involve anyone else.

You may not be as well informed as you may think to react logically in an emergency.

You may have been flying a **727** on a night of **1st December, 1974** where the pitot tubes freeze passing **16000 feet** and the airspeed increases on the dial. In an attempt to lower it, you pull back and back until the stick shakes. The relative airflow brings a high attitude stall and as you fall out of the sky you wished you had remembered on that night to do your pre take off checks with care and switch on the pitot heaters.

You wished you had remembered your first stalling lesson. The instructor had been “wasting his sweetness on desert air”? Lastly why did you not look at the artificial horizon before the aircraft entered a spiral spin It is too late now to recall those early flying lessons.

You might have been the trainee flight officer occupying the captain’s seat as he rested in the after cabin on that Airbus flight from Brazil to Paris when you were to climb through a storm.

The airspeed increased which is not what should be happening. You pull up until your side stick shakes. The First Flight Officer wakes up to the situation and he pushes his side control forward to unstall the wings. You are now pulling and he is pushing and the autopilot goes “**wazimu**” and does not know what is happening. The Airbus does not know very well what to do either and follows the natural laws and falls out of the sky. The Captain is now wide awake and rushes into the cockpit and calls you filthy names but it is too late. Names will no longer hurt you.

You might also have been the pilot of the Jumbo Jet taking off in the early morning from Jomo Kenyatta International Airport outbound to Johannesburg. You decide to take off downwind with the early morning sun to your back. You fail to notice the leading edge slats did not extend to the takeoff setting.

You raced down the runway using up a lot of tarmac with little airspeed to show for it. It is decision time – throw out the anchors and demolish their fence. You decide to pull up as you are just beyond V1 and away you go with the control column shaking itself out of the floor boards. Now you are airborne – just –you remember the nice man back in Frankfurt who always insisted you retard throttles after takeoff because the noise upsets the neighbour’s eardrums. You retard the throttles because that is what the company wants. Now the tail is dragging the ground and very soon the passengers will be losing their money, jewelry and watches. I am about to lose my new state of the art Kern theodolite too because I have a construction site right beside you. They only left the tripod to stand alone like a survey beacon.

Thirty five years ago there was a group of newly licensed PPL's who were desperate to accumulate flying hours for their CPL's. They flew for free, aircraft owned by private businessman. They formed a group of competing daredevils who explored the realm never envisaged by the aircraft designers for short take off and maximum rates of climb. Such stories were told at the Aero Club bar, a favourite was lifting off into a steep climb Cessna 180's at 40 mph with 2 on board and full tanks, an act not for the low hour novice. These stories have sad endings. one of which was the charred skeleton on a sugar estate airstrip alongside the wreckage of a Cessna light aircraft owned by a trusting businessman.

Since I learned to fly there have been 559 pilots and passengers injured through aircraft accidents in Kenya and another 49 who suffered fatalities. Sadly most of these were due to pilot error or lack of attention to detail.

So Now lets "**STAY ALIVE**" with some plain facts for Pilots.

These "facts" were first compiled by the late Sir Henry Dalrymple, Dalrymple White, DSO and Bar, a long standing flight instructor, pilot and student of the natural laws of defeating those of gravity. I was prepared by him for the instructors rating. As I had a university background in physics and mathematics, he co-opted me to assist with various formulae and editing the copies rolling off his finger banging manual Olympic typewriter. The object was to teach the rules of safe flight by simplified mathematical physics.

We designated the work to the memory of Mr. Henri Pitot, the immortal inventor of the Pitot Tube. M Pitot had been born in Aramor, France in **1695** and he died in **1771** having served as Chief Engineer (canals and bridges), Languedoc. He was a keen observer of the movement of liquids in rivers and gulleys.

CHAPTER ONE - STAY ALIVE

This may be somewhat boring to the gung ho members but they do apply to our everyday lives.

Basic Mechanics

1.1. Mass, Acceleration and Force

In these notes **S.1. (*Systeme International*)** units are used with distance measured in metres, time in seconds and mass in kilograms. But weight, or more exactly force, is measured in Newtons. So it is essential to distinguish clearly between mass and weight and to discover what is meant by force.

Mass is 'the quantity of matter in a body' (a body being some particular object) and, if nothing is added or taken away, a body's mass will remain the same wherever it may be located. It's weight, however, will depend on the gravitational force to which it is subjected. Thus on Earth a body of one kilogram mass is said to weigh **9.81** Newtons because the Earth's gravitational force, called '**g**', exercises a pull acting to accelerate it, or trying to accelerate it, downwards at a rate of **9.81** metres per second (**9.81m/s²**). By definition,

$$\mathbf{1\ Newton = 1\ kilogram\ accelerated\ at\ a\ rate\ of\ 1\ m/s^2.}$$

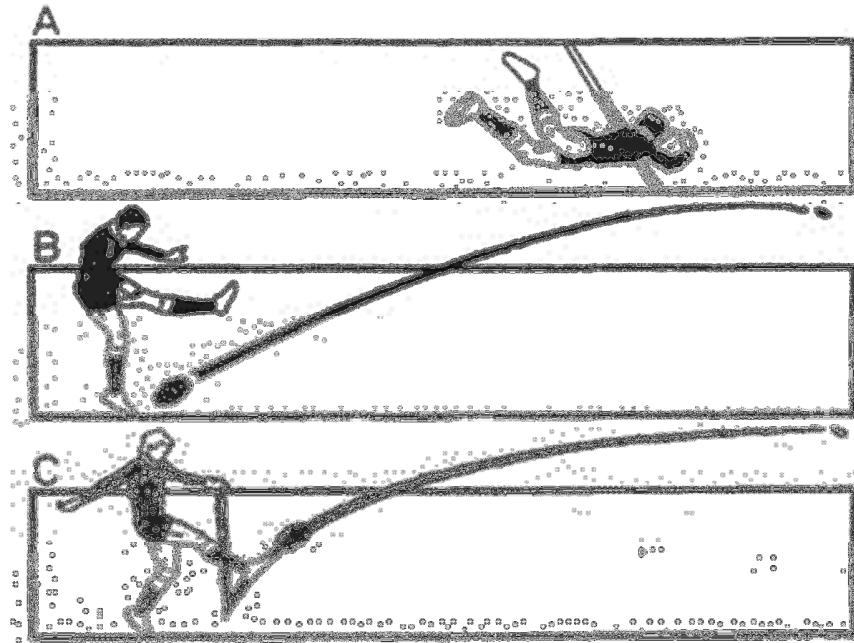
It will weigh **9.81** Newtons. But on Jupiter, a much larger planet than Earth, '**g**' is **25.9 m/s²**. Consequently a one kilogram mass will weigh **1 x 25.9 = 25.9** Newtons while on the relatively tiny moon it will weigh only **1.62 N** since lunar '**g**' is only **1.62 m/s²**.

Weight, is the result of a gravitational force acting on a mass and so raises the question of what exactly is meant by a force,

'Force is something that causes, or tries to cause, acceleration of a mass'.

Forces can be created in a multitude of ways other than by gravity, for example, electrically, magnetically, pneumatically, hydraulically, by the gas pressure derived from

burning fuel in an engine cylinder, or by sheer muscle power. But what they all have in common is that they cause, or tend to cause, acceleration of a mass. In crude, unscientific terms, this can be regarded as some form of pull or push.



The player provides the **Force**.

The rugby ball provides **Mass**.

The speed at which the player runs for a try or the movement of the ball after the impact of the kicker provides the **Acceleration**.

This gives us the equation,

Force = Mass multiplied by Acceleration

$$\mathbf{F = MA} \quad \text{Force} \quad \text{(i)}$$

So that, by elementary algebra,

$$\frac{\mathbf{F}}{\mathbf{M}} = \mathbf{A} \quad \text{Acceleration} \quad \text{(ii)}$$

Equation (i) shows that in gravitational fields, acceleration is a fixed quantity, the greater the mass the greater the force and in equation (ii) that, it is the force that is fixed, the greater the mass the less the acceleration. This explains why cars and

aeroplanes accelerate faster, other things being equal, when lightly loaded than when heavy. Worth remembering isn't it ?

On your peril do not confuse accelerations, m/s^2 , with velocities measured in metres per second and written m/s . But if an acceleration and the time for which it acts, measured in seconds, are known the resulting velocity is easily calculated since,

$$\text{Acceleration} \quad \times \quad \text{Time} \quad = \quad \text{Velocity.}$$

A body accelerating at, 3m/s^2 will achieve a velocity at the end of the first second of 3m/s . But by the end of the second it will be going 3 m/s faster and so its velocity will be $3+3 = 6\text{ m/s}$ and at the end of the third second it will be going 3 m/s faster still making its velocity $3+3 +3 = 9\text{ m/s}$, and so on.

1:2. Measuring Force.

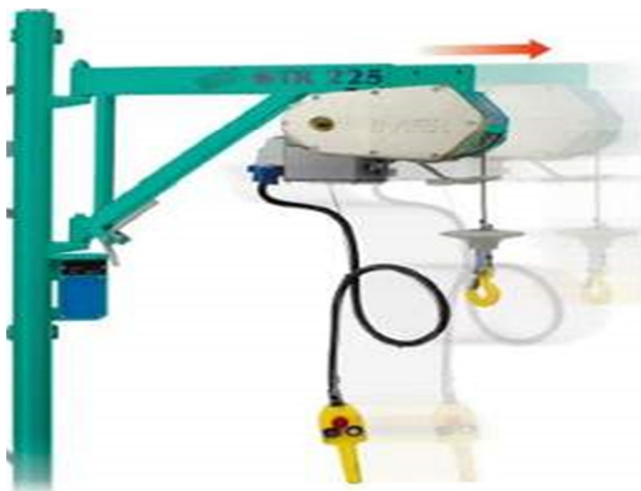
Forces can be measured with an ordinary spring balance where, due to the stretching of the spring under load, a pointer moves against a scale calibrated in Newtons. Therefore space explorers landing on a strange planet could, if equipped with such a balance, quickly find local 'g' simply by weighing a known mass since.

$$\text{Weight} = \text{Force (Newtons)} = \text{Acceleration (m/s}^2\text{)}$$

$$\text{Mass} \quad \quad \quad \text{Mass (Kilograms)}$$

So by calibrating a balance to read in Newtons we get a tool which measures force, whether created by 'g' or something else.

Figure 1:1



For example, fig 1;1 shows a weight hanging from a rope which passes over a pulley wheel and then runs horizontally to a secure anchorage on a wall. Should the weight be say, **500** Newtons then the tension in the rope will be 500N. So a spring balance spliced into it will read 500 N and created in other ways than by a suspended weight. For instance, by a person hauling on a rope, and so measureable by incorporating a balance, the important point being that, however brought about, all pulls are forces and consequently will be measured in Newtons.

In fact, in aviation's early days, the static thrust from an aeroplane's propeller (**a force acting as a pull**) was something found by placing the plane in the flying altitude and lashing it's tail to a convenient tree with a length of rope having a spring balance and then opening up the engine, a crude but effective technique to measure pull.

Measuring a 'push' force is easy. You do that every time you step on a bathroom scales.

1:3. Now to Work.

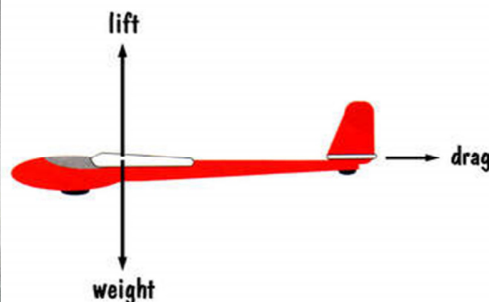
In the theory, 'Work' is said to be done when a force acts to move a body over a distance, e.g. a pull or push over distance, the equation being,

$$\text{Force (**Newton**s)} \times \text{Distance (**Metre**s)} = \text{Work Done (**Newton metres**).$$

Unless there is movement, i.e. a distance covered, no work is done however great the force applied. Work is measured in Newton metres though in S.I units a Newton meter is usually called, a Joule. Thus.

$$\mathbf{1 \text{ Newton} \times 1 \text{ meter} = 1 \text{ Newton metre} = 1 \text{ Joule}}$$

Figure 1:2



As an example of work done Figure 1:2 shows a tug aeroplane towing a glider. The glider's aerodynamic drag, a force which can be measured by splicing a spring balance into the tow rope, will act to decelerate the tug plane.

So to prevent this, and maintain a constant speed, the tug's propeller must counter with a precisely equal but opposite thrust force. For, instance, should the glider's aerodynamic drag be, say, **250 Newtons** then the work done in towing it over a distance of **50 metres** would be

$$250 \text{ N} \quad \times \quad 50 \text{ M} = \quad 12500 \text{ Joules}$$

And over a distance of 100 metres

$$250 \text{ N} \quad \times \quad 100 = \quad 25000 \text{ Joules}$$

Figure 1:3



The figure also shows a tractor pulling a trailer along a level road. Here there are two forces acting to cause deceleration, the trailer's aerodynamic drag plus the friction between its wheels and the road surface, the sum of these two combined can be shown if a balance was fitted to the tow bar

. Hence the situation is analogous to an aeroplane's take off run where both the plane's aerodynamic drag and its wheel friction act as retarding forces.

Determining the work done in raising a load vertically against gravity is simple, being merely the load's weight, in Newtons, multiplied by the vertical distance risen, in metres. For instance, raising a weight of, say **500N** through **30 metres** would result in work done of

$$500 \text{ N} \times 30 \text{ M} = 15000 \text{ Joules.}$$

1:4. Power

Power involves **time** because power is defined as 'the rate at which work is done', its equation being

$$\text{Power} = \frac{\text{Work done (Joules)}}{\text{Time Taken (seconds)}} = \text{Joules per second} = \text{Watts}$$

SI units, a Joule per second is called a Watt. Thus should it take **10 seconds** to raise the load in the section above the power required would be **15000/10 = 1500 watts** If it took only 3 seconds, $15000/3 = 5000$ Watts would be needed.

On the other hand, if a load is raised at a known velocity, V , then, if V is measured in metres per second,

$$\text{Load (Newtons)} \times V \text{ (m/s)} = \text{Power (required or applied).}$$

Thus raising a load of 500 Newtons at, say, 10m/s will require

$$500 \text{ (N)} \times 10 \text{ m/s} = 5000 \text{ Watts}$$

Therefore, we get an equation, which applies to work done horizontally as well as vertically,

$$\text{Power} = \text{Force (Newtons)} \times V \text{ m/s} = \text{Watts.}$$

Measuring power in Watts can lead to large numbers. So the convention, so far as aeroplanes are concerned, is to divide by one thousand and quote power in kilowatts (Kw).

(Now, If you have not understood this so far, you could consider a career change).

