

FLIGHT DATA MONITORING

Energy Management Study

SMS Department





GOL – Largest low-cost airline in LatAm



-  Standardized fleet of 120 Boeing 737-700 and 800 NG aircraft
-  64 destinations of which 11 international, in the South America and Caribbean
-  39 million passengers transported per year
-  Leading position at Brazil's main airports with high on-time performance
-  860 flights per day
-  +15,000 employees
-  Extensive cargo operations serving more than 3,100 cities in Brazil and 15 abroad

Comprehensive Global Network

 serving ~319 destinations in over 58 countries

 serving ~316 destinations in over 115 countries



Data analysis

FDM Possibilities

- | FDM can monitor many parameters of the aircrafts
- | It allows the global comprehension of all moments of a flight
- | Build up safety and quality indicators
- | Identify the
- | Identify the



Energy Management study: reasons

Segurança Baixo custo Time de Águias Inteligência Servir

FDX Outcome

Analyzing the benchmarking with IATA of 2014 we realized that GOL's main issue was High Speed on Approaches...



... however, every FDM program is mute and deaf.

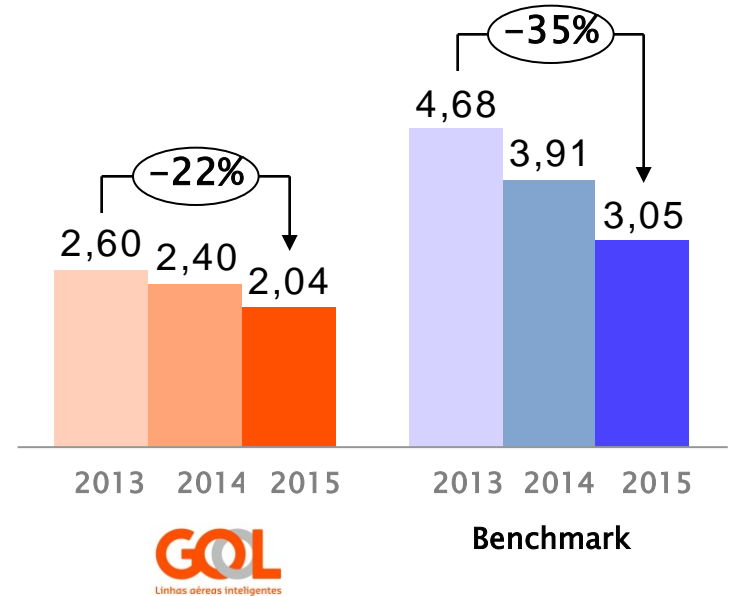
Source of Information



| We analyzed the outcome of:

- | Statistics
- | Events algorithm review
- | Pilots interview
- | Industry Benchmark
- | Flight emulations

Unstable approach related events/1000 cycles



FDX Outcome

- | FDM events adjusted accordingly to severity
- | ATC
 - | The outcome of LOSA pointed that the ATC has a direct influence on a flight approach
 - | Received ASR confirms that information
- | Pilots techniques
 - | Pilots have difficulties to recognize that the flight will be unstabilized at 1000ft.
 - | Incorrect use of aircraft deceleration tools

AQD



LOSA



FDM







FDX







Data findings

Stabilized Approach

-  Reduces workload
-  Improves situational awareness
-  Increases Safety
-  Saves money

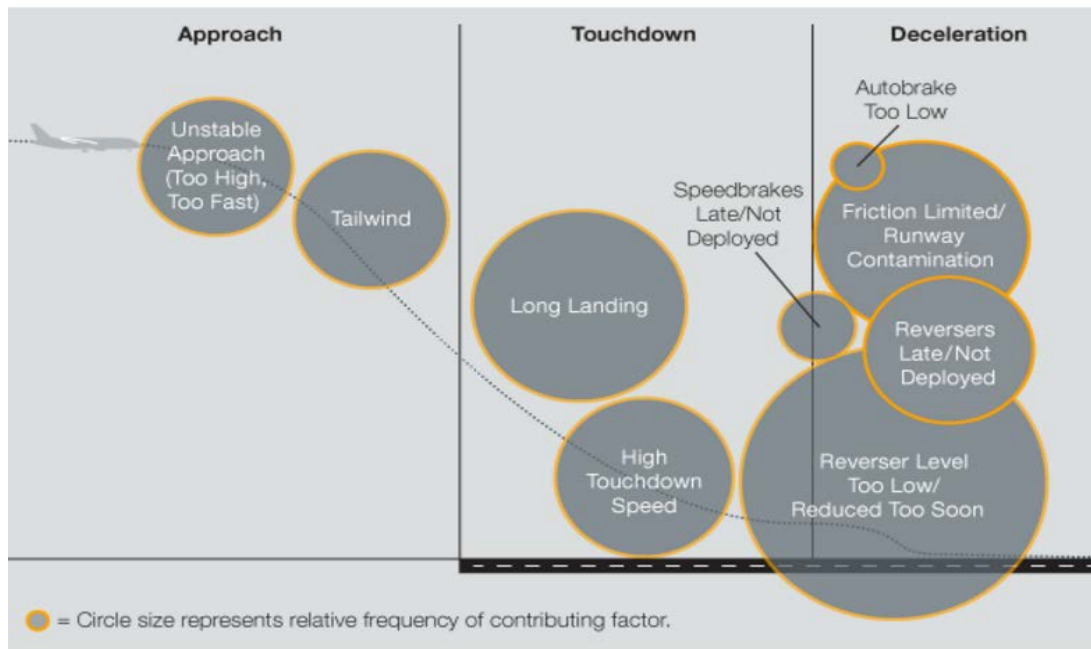
Unstable Approach

-  Most are a result of bad energy management
-  Most pilots proceed to landing
-  ATC interference is a common precursor
-  Pilot's don't recognize it until 1,000 feet

 **The idea came up**
...develop a method to help the pilots determine the point at which an unstable approach may become irreversibly.

Runway Overruns Precursors

In order to avoid a bigger problem it was important to work on the first problem pointed by Boeing



Academic Partnerships

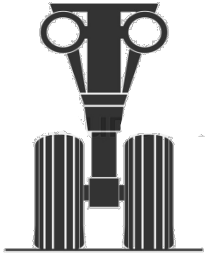


Embry-Riddle Aeronautical University

- | Most traditional aviation university in the world
- | The cooperation aims to achieve a scientific confirmation of our findings
- | ERAU will also develop a CBT based on our data
- | This CBT could be shared with other airlines



Rules of thumb for energy dissipation



LANDING GEAR

Most effective aid to decelerate the aircraft

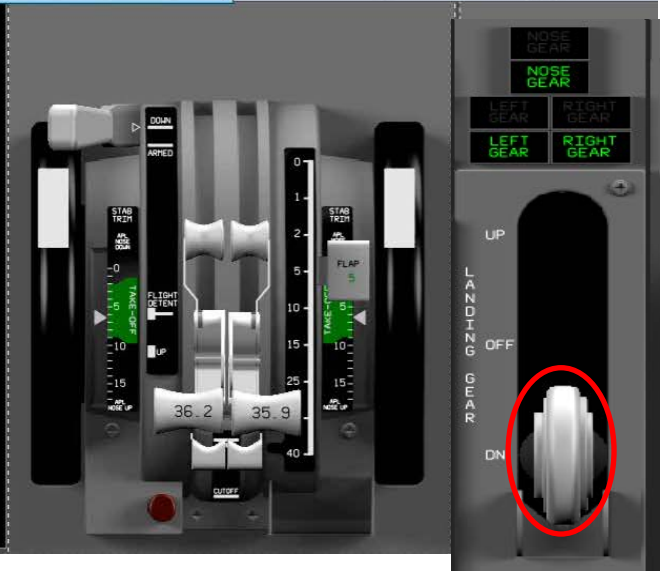
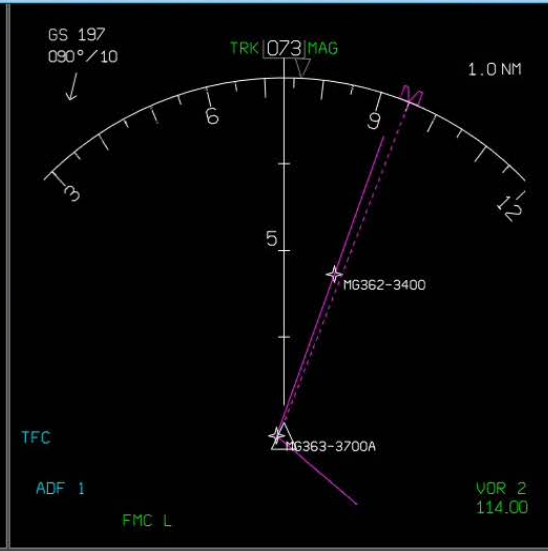
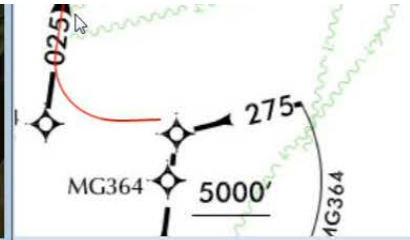
- | Identify the best moment to extend the gear is key for the success of the approach
- | On a flight path of 3° typical aircraft decelerates 10kt/nm with gear down
- | For each dot above the ideal flight path, gear extension should be anticipated in 1 nm
- | For every 20Kt of tailwind, 1 nm should be added

How we did it?

Thr Dist: 9.57 Nm

190 KT - 4 NM GEAR DOWN

Target: 150Kt at FAF



How we did it?

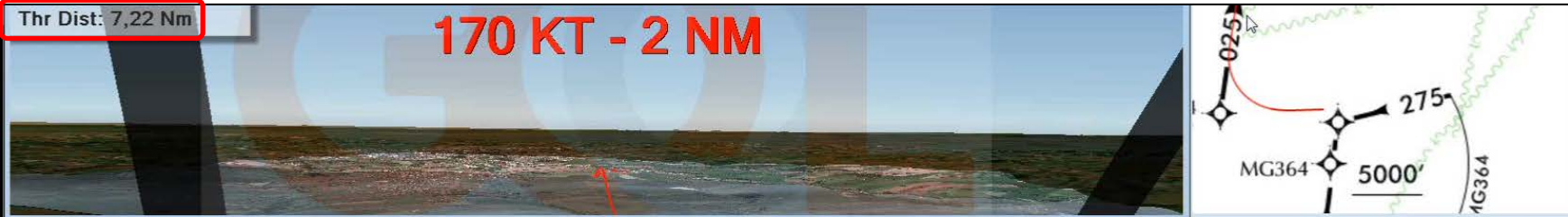
Thr Dist: 8,00 Nm

180 KT - 3 NM

The image is a composite of four cockpit-related views:

- Top Left:** A perspective view of a runway from the cockpit. A red box highlights "Thr Dist: 8,00 Nm". A red arrow points to a target on the runway. The text "180 KT - 3 NM" is overlaid in large red font.
- Top Right:** A flight path diagram showing a green track. A red line indicates a maneuver. Key points are labeled: "025", "275", "MG364", and "5000'".
- Bottom Left:** A vertical speed indicator (VSI) with a scale from 120 to 220. A red box highlights the value "179". Other instruments include a heading scale (095H), a magnetic heading scale (MAG), and a digital display showing "0:33".
- Bottom Center:** A heading scale from 6 to 12. It shows a heading of "096" (TRK) and "096" (MAG). Other data includes "GS 177 079°/14", "SBMG RW10", "MG362-3400", "PR363-3700A", "VDR 2 114.00", "ADF 1", and "FMC L".
- Bottom Right:** A view of the flap and landing gear controls. The flap selector is set to "5". The landing gear selector is circled in red and set to "UP".

How we did it?



FMC SPD | LNAV | VNAV PTH

2200 4600

220 200 180 170 160 140 120

CMD

0.8

4120 4000 3800 650

1017 HPA

0:49

095H MAG

This panel displays various flight instruments. At the top, it shows "FMC SPD", "LNAV", and "VNAV PTH" modes. The speed indicator on the left shows a scale from 120 to 220, with a red box around the 170 mark. The altitude indicator on the right shows a scale from 650 to 4600, with a green box around the 4120 mark. A central "CMD" display shows a vertical scale with a pink line. Below the speed indicator is a heading scale from 6 to 12, with "095H" and "MAG" displayed. A digital clock shows "0:49".

GS 167 076°/15

TRK | 095 | MAG

2.0 NM

SBMG RW10

MG362-3400

TFC

ADF 1

FMC L

VOR 2 114.00

This panel shows heading and distance information. At the top left, it displays "GS 167 076°/15". The heading indicator in the center shows a scale from 6 to 12, with "TRK | 095 | MAG" and "2.0 NM" displayed. Below the heading indicator, it shows "SBMG RW10" and "MG362-3400". At the bottom left, it displays "TFC" and "ADF 1". At the bottom right, it displays "FMC L" and "VOR 2 114.00".

DOOR ARMED

STAB TRIM

FLIGHT DETENT

UP

36.2 36.0

FLAP 15

LE FLAPS TRANSIT LE FLAPS EXT

LANDING GEAR

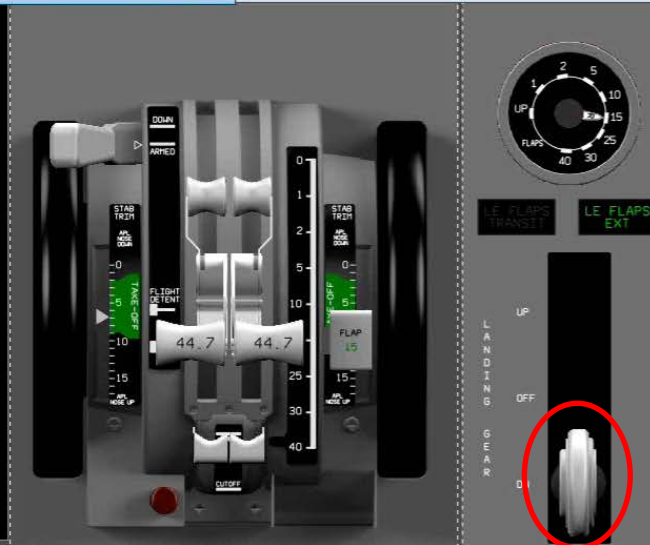
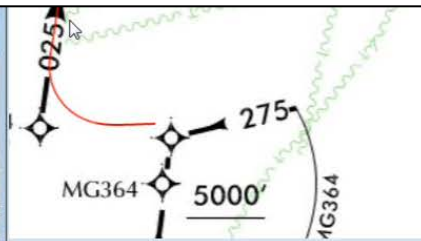
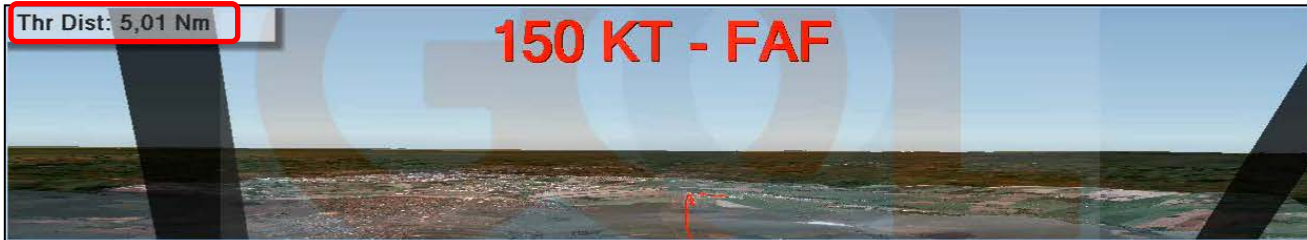
UP OFF DOWN

This panel shows the control levers for the aircraft. It includes a "DOOR ARMED" indicator, "STAB TRIM" controls, a "FLIGHT DETENT" lever, and a "UP" button. The flap lever is set to "15" and is highlighted with a red circle. Below the flap lever, it displays "36.2 36.0" and "FLAP 15". To the right, there are "LE FLAPS TRANSIT" and "LE FLAPS EXT" indicators, and a "LANDING GEAR" selector with "UP", "OFF", and "DOWN" positions. The gear selector is also highlighted with a red circle.

How we did it?

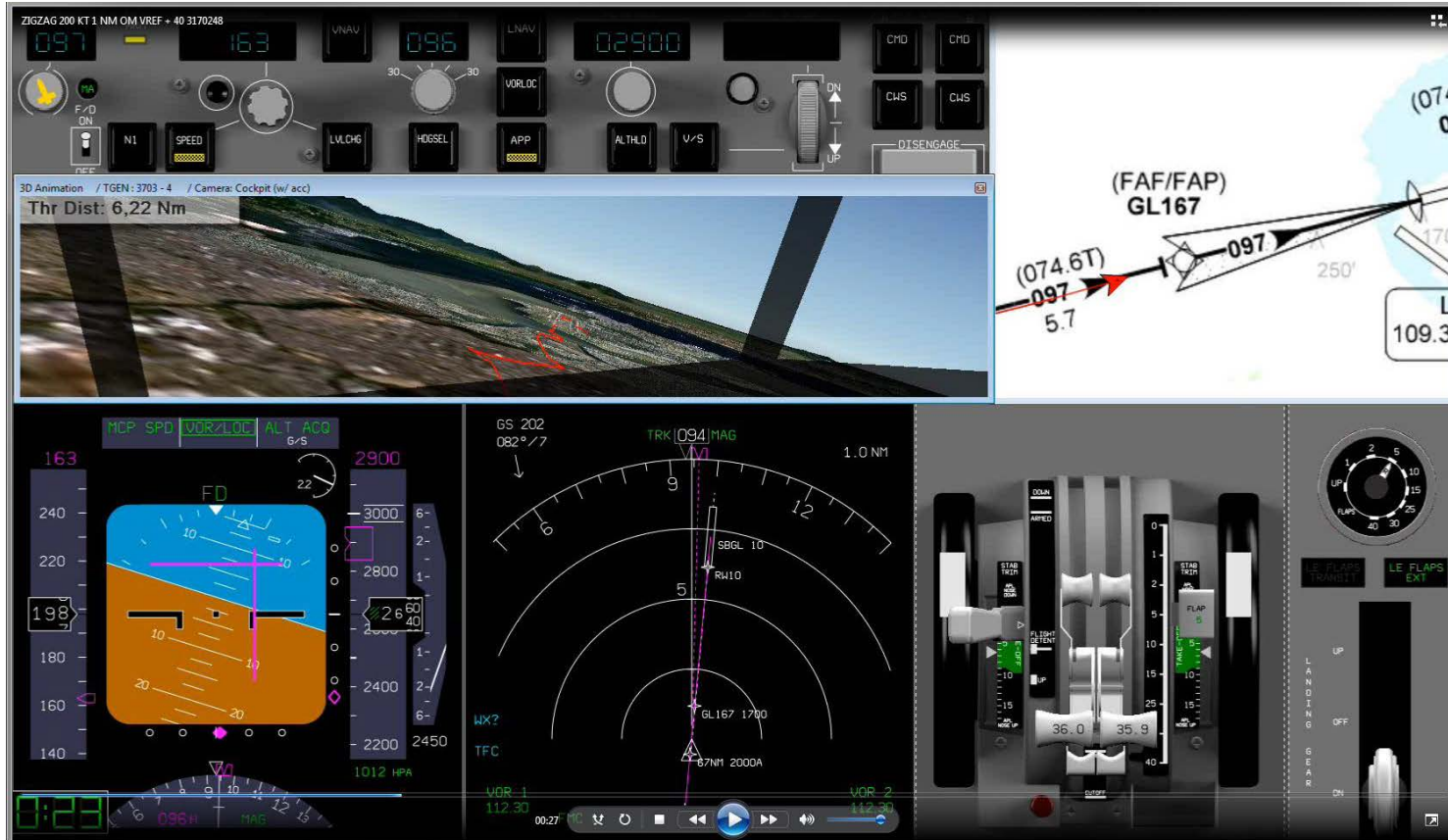
Thr Dist: 5,01 Nm

150 KT - FAF



Energy Management Exemple 1

Flight Emulation – Energy Dissipation



Flight Emulation – Energy Dissipation

Top Left: PFD Instruments
ZIGZAG 200 KT 1 NM OM VREF + 40 3170248
097 (Heading) | 163 (Speed) | 096 (VNAV) | 02900 (Altitude)
Buttons: CMD, CHG, CWS, DISENGAGE, VORLOC, APP, ALTHLD, V/S, LVLCHG, HDGSEL, F/D ON, N1, SPEED, MA, F/D ON, N1, SPEED, LVLCHG, HDGSEL, APP, ALTHLD, V/S, DISENGAGE

Top Right: Map View
(FAF/FAP) GL167
097 (Heading) | 5.7 (Distance)
170 (Altitude)
109.3 (Frequency)

Middle Left: 3D Animation
3D Animation / TGEN: 3709 - 0 / Camera: Cockpit (w/ acc)
Thr Dist: 5,91 Nm

Middle Right: Flap Lever
FLAP 5
36.0 (Lever Position)
Buttons: STAB TRIM, FLIGHT RESET, UP, DOWN, LE FLAPS TRANSIT, LE FLAPS EXT, LANDING GEAR

Bottom Left: Instrument Cluster
MCP SPD 163 | VORLOC | ALT 2900 | ACB 6/S
FD (Flight Director) display
200 (Speed) | 2900 (Altitude)
1012 HPA (Barometric Pressure)

Bottom Middle: Radar Display
65 203 | 072° / 7
TRK 091 | MAG
1.0 NM
SBGL 10 | RH10
GL167 1700
67NM 2000A
WX? | TFC
VOR 1 112.30 | VOR 2 112.30

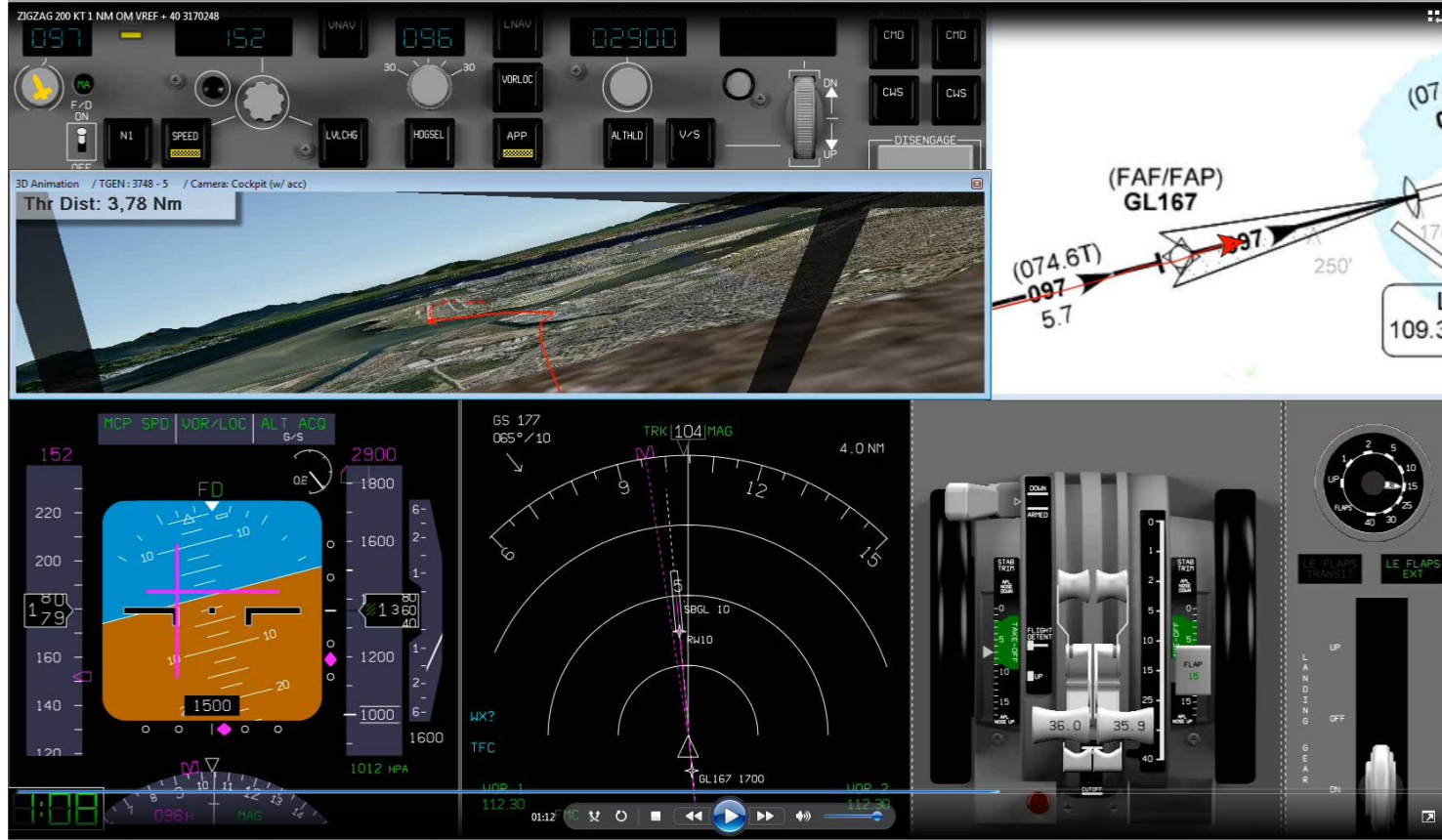
Bottom Right: Flap Lever
FLAP 5
36.0 (Lever Position)
Buttons: STAB TRIM, FLIGHT RESET, UP, DOWN, LE FLAPS TRANSIT, LE FLAPS EXT, LANDING GEAR

Flight Emulation – Energy Dissipation

The image displays a comprehensive flight simulator interface for a Boeing 737 MAX 8, divided into several key sections:

- Top Left: Instrument Panel** - Shows various cockpit controls including MCP (Mode Control Panel) with speed (163), VOR/LOC (096), and ALT (2900) readouts. It also features buttons for VNAV, LNAV, VORLOC, APP, ALTHLD, and V/S.
- Top Right: Traffic Display (TD)** - A vector display showing the aircraft's position relative to other traffic. The own aircraft is at the top, and a traffic alert (TA) is shown for a nearby aircraft (097) at 5.7 NM. The display includes heading, altitude, and distance information.
- Middle Left: 3D Animation** - A perspective view from the cockpit showing the runway ahead. The text "Thr Dist: 5.17 Nm" is displayed at the top of the view.
- Middle Right: Traffic Display (Continued)** - Shows a detailed view of the traffic alert for aircraft 097, including its heading (074.6T) and distance (5.7).
- Bottom Left: MCP and Vertical Scale** - A detailed view of the MCP showing speed (163), VOR/LOC (096), and ALT (2900) readouts. It also includes a vertical scale for altitude and a digital clock showing 0:42.
- Bottom Center: Traffic Display (Continued)** - Shows a detailed view of the traffic alert for aircraft 097, including its heading (070°/9), distance (1.0 NM), and altitude (1700).
- Bottom Right: Flap Control Panel** - Shows the flap control panel with various flap settings (UP, DOWN, EXT) and a digital readout for flap position.

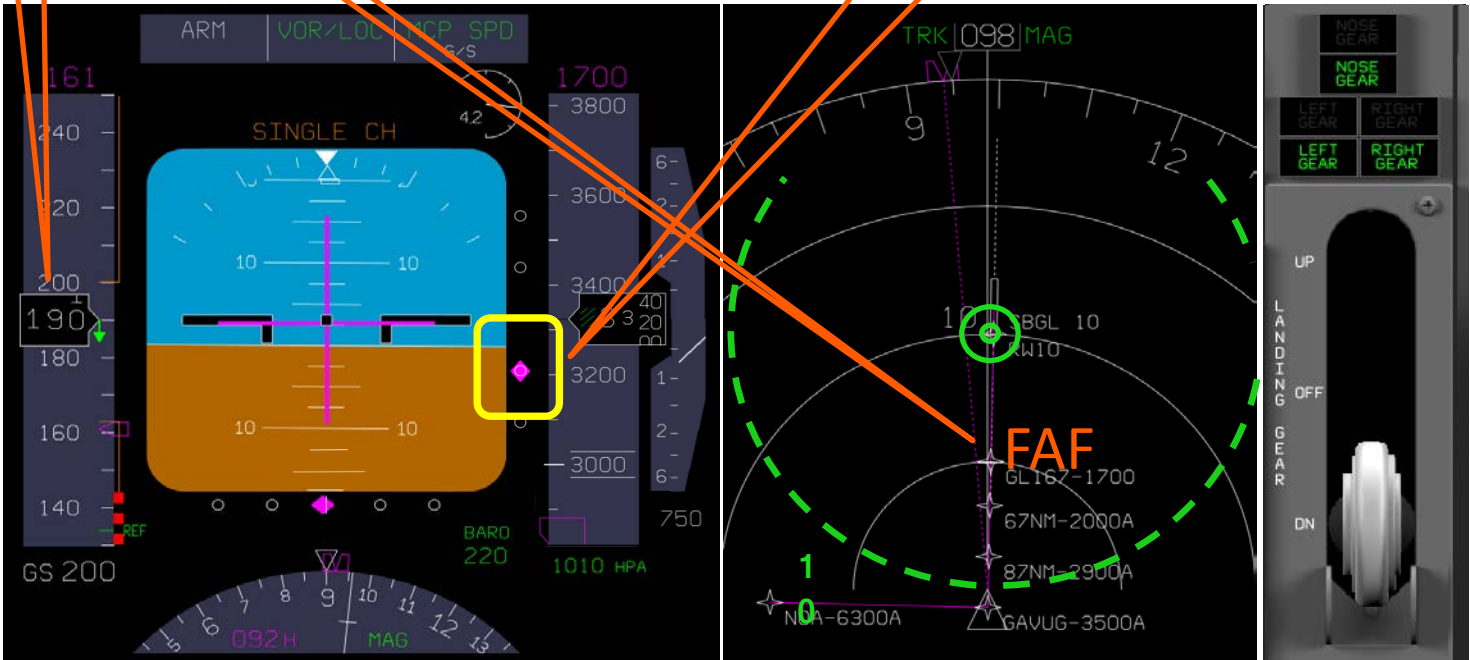
Flight Emulation – Energy Dissipation



Energy Management Exemple 2

Flight Emulation - Above Glide Path

$$190 - 150 = 40 \text{ kt} \Rightarrow 4 + 1 \text{ Dot} = 1 = 5 \text{ nm}$$



Flight Emulation – Above Glide Path



MCP SPD | VOR/LOC | G/S

139
200

SINGLE CH

6.9

7000

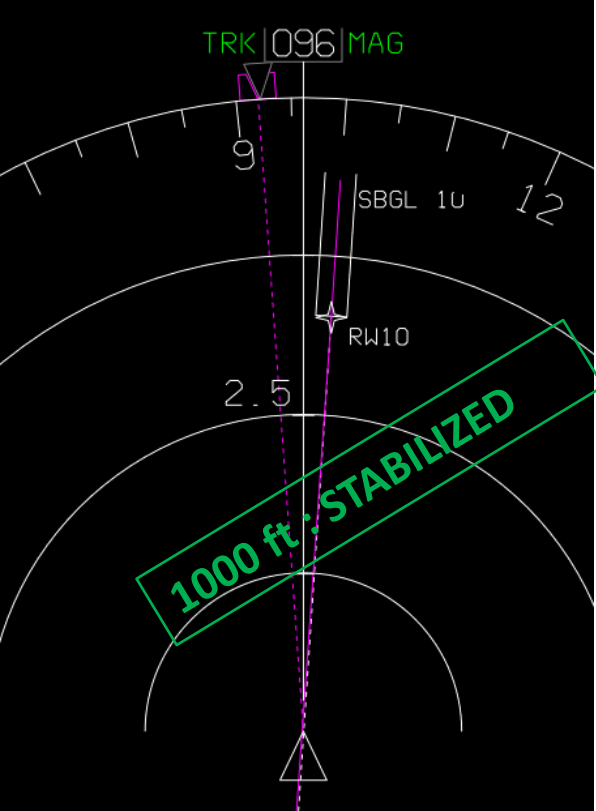


GS 150

600 800

BARO 220 1010 HPA

092H MAG



NOSE GEAR

NOSE GEAR

LEFT GEAR RIGHT GEAR

LEFT GEAR RIGHT GEAR

UP

LANDING OFF

GEAR

DN



Energy Management Exemple 3

Flight Emulation - High Tailwind

ARM | VOR/LOC | VNAV SPD
6/S

5000
6200

SINGLE CH

Thr Dist: 15,6 Nm

26

260
240
200
180
160

219

Tempo (min:seg)

0:00

149H MAG

1007 HPA

NOSE GEAR
LEFT GEAR
RIGHT GEAR

UP
LE FLAPS TRANSIT
LE FLAPS EXT

LANDING OFF

DN
RIGHT GEAR
LEFT GEAR

GS 272
298° / 28

TRK 145 | MAG

15
10

SBGL 15
RW15

CAX / 1700
IGL 78 / 200QA

EGBAT / 3300A
SDNY

RJ002 / 5000A

UTBOM / 6300A

DF 1

Flight Emulation – High Tailwind



Lessons learned

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Keep in mind

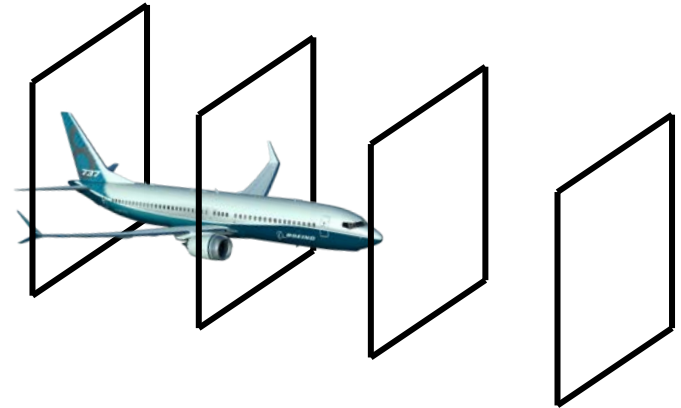
| Apply the three rules for energy management:

| Speed

| Glide

| Wind

| If you're still not stabilized... **GO AROUND!**



Cost avoidance

Cost avoidance



STABILIZED APPROACHES

saves money to the company

Direct costs:

Fuel

(go arounds reduction)



Up to
USD 400,000
per year

Brakes



Reverse



Tyres



Cost avoidance



STABILIZED APPROACHES

saves money to the company

Indirect costs:

Disruptions
(delays, cancellations)



Loss of image



Accident



Lessons learned

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Lessons learned



- | Flight patterns must be accomplished
- | Efficient energy management starts before **top of descent**
- | Identify the best moment to extend the gear is essential for the success of the any approach
- | There are different sources of information that you must look for
- | Share and exchange information with other operators
- | Comprehend the cultural facts of your company is absolutely important
- | Every safety rule must be accomplished
- | Don't hesitate to look for a good partner
- | Remember that you are preserving lives and saving money!

Thank you!



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