STAR | CANADA

A TECHWELL EVENT

W15

People & Teams
Wednesday, October 17th, 2018 3:00 PM

Testing at 43,000 Feet: Reporting Risk That Matters

Presented by:

Alexandre Bauduin
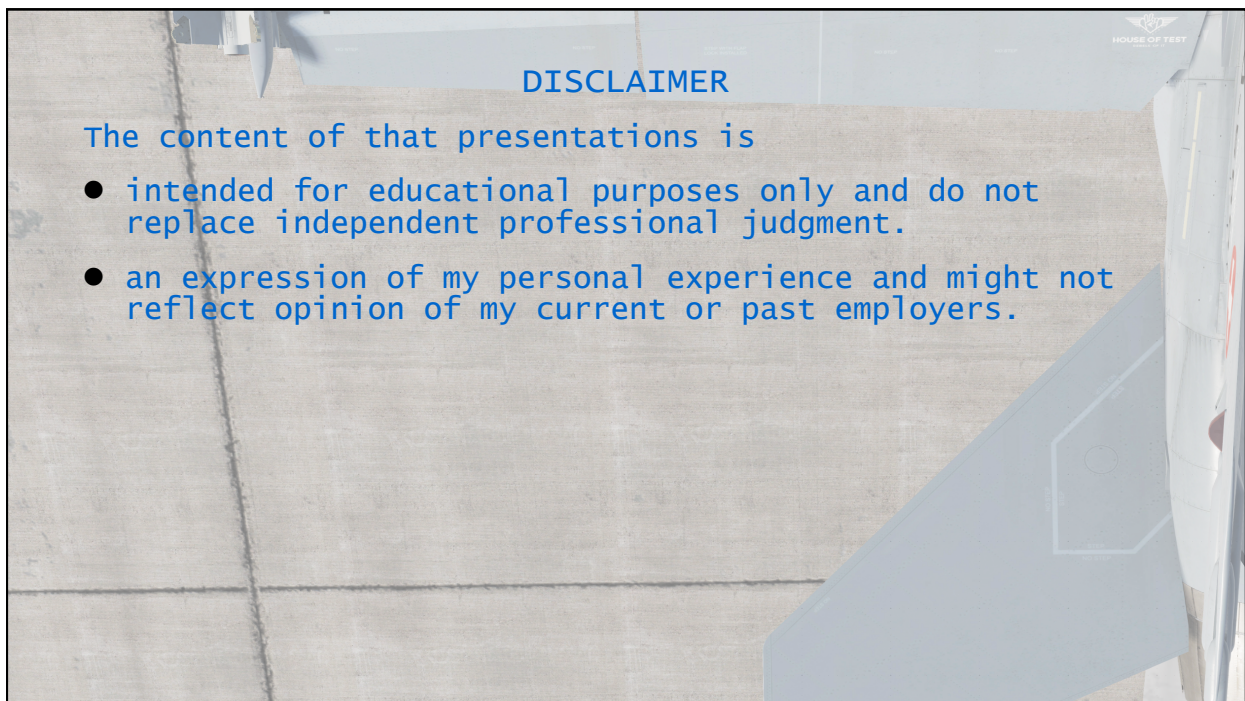
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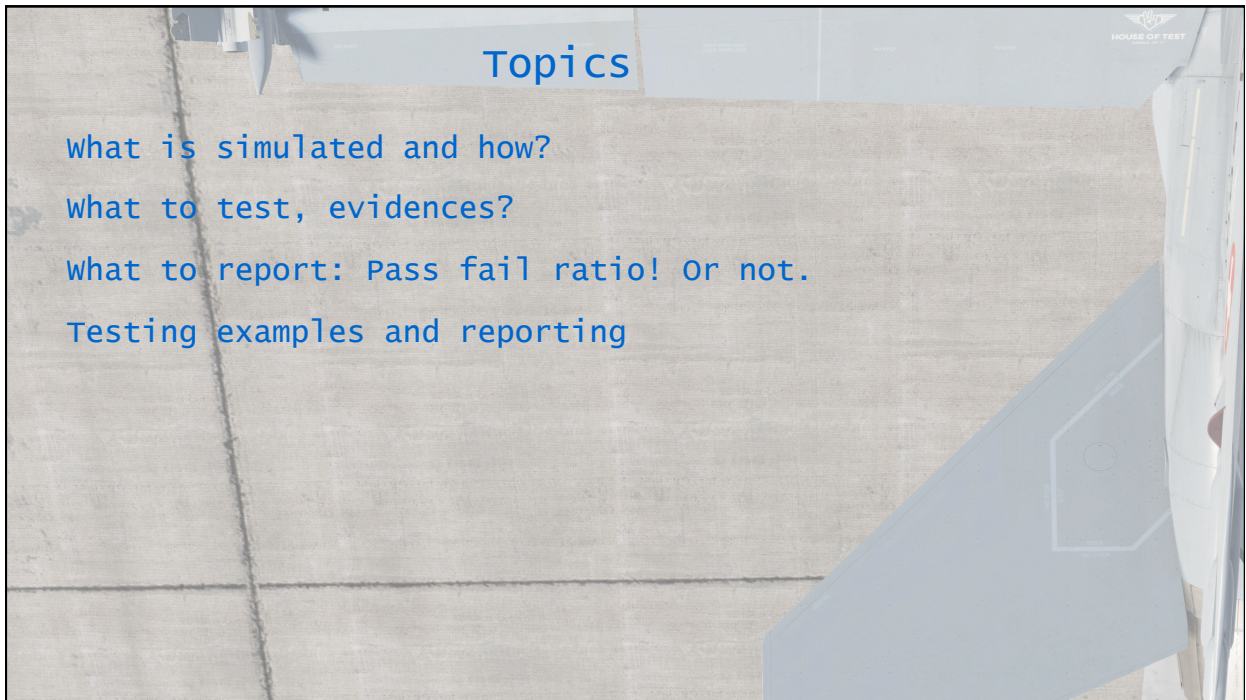
TECHWELL™

Alexandre Bauduin

Alexandre Bauduin is a 51 year old world traveler. He worked in consulting firms gaining experience in several fields (medical, manufacturing, aerospace, pay TV, data warehouse-to name a few) in different countries (Switzerland, France, Spain, Canada, etc.) His career started in the space industry where he discovered his passion for aerospace, working on both military and civilian projects. He was sometimes steered away from aerospace but his passion pushed him to become an airline pilot, as a way to really understand how those instruments he programmed and integrated were operating in a cockpit. One of his last challenges was to organize flight simulator testing into a lean manufacturing environment. He works with milling machines, draftsmanship, accounting and finance, software development, electronic design and industrial robots, and it is always fun for him to use an oscilloscope, an ARINC bus analyzer, and step into assembly language or stall a Boeing 777!

Testing at 43 000 Feet:
Reporting Risk That Matters

StarCanada 2018. Toronto
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HOUSE OF TEST
REBELS OF IT

HOUSE OF TEST

DISCLAIMER

The content of that presentations is

- intended for educational purposes only and do not replace independent professional judgment.

- an expression of my personal experience and might not reflect opinion of my current or past employers.

Short intro

Topics

What is simulated and how?

What to test, evidences?

What to report: Pass fail ratio! Or not.

Testing examples and reporting

What is simulated

Might be easy to note what is not simulated!

- Ocean tide
- Cloud temperature
- Sound of ULD loading
- Physical air pressure
- Earth curvature...

All not relevant for training ignored.

How is it simulated ?

200 deg x 40 deg FOV
Cockpit replica
Cockpit panels
Motion 6DOF platform
Controls with force feedback
(450 lbs on 777)
"In house" or OEM parts

How is it simulated ?
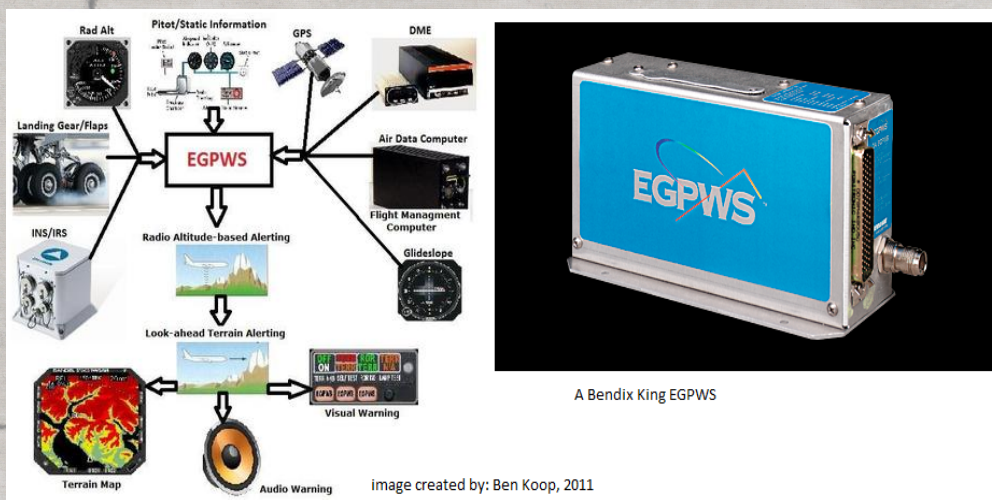
Module for each "system" (Fuel, electrics, LG..)

```
Constant TimeUp = 20;
Init();
Timing =0;
while (true){
    Wait_For_Go();
    //Landing gear selector
    if (i32_LdgSel== UP)  && (Timing  < TimeUp) {
    Retract_a_bit_LandingGear();
    Timing++
    }
    rest of the code…
}
```

Nasa

How is it simulated ?

Ground Proximity Warning System: OEM for aircraft

A Bendix King EGPWS

image created by: Ben Koop, 2011

How to test ?

Regulation
  ICAO: Main regulator
  Each country has some more specific (ex. FAA Part 60)

Specify what, how, who, when around the simulator

It is a law. Do not mess with it! Traceability, rigorous.

Electronic Code of Federal Regulations

e-CFR data is current as of **August 23, 2018**

Title 14 → Chapter I → Subchapter D → Part 60

Browse Previous | Browse Next

Title 14: Aeronautics and Space

PART 60—FLIGHT SIMULATION TRAINING DEVICE INITIAL AND CONTINUING QUALIFICATION AND USE

ICAO
UNITING AVIATION

Biggest fear?

Major risk around « Negative training »

Teaching something incorrect to pilots

Pilot build « truth » based on what seen in training.

Biggest fear?

To70 (Dutch consulting company) estimated that the fatal accident rate for large commercial passenger flights is 0.06 per million flights, or one fatal accident for every 16 million flights.

How to test ?

Build the simulator and then send V&V

Authorities requirements = follow the list

TESTS	TOLERANCE	FLIGHT CONDITIONS	FSTD LEVEL										COMMENTS
			FFS				FTD		FNPT			BITD	
			A	B	C	D	Init	Rec	I	II	MCC		
(5) Autopilot landing (if applicable).	± 1·5 m (5 ft) flare height. ± 0·5 s or ± 10%T$_f$. ± 0·7 m/s (140 ft/min) R/D at touchdown. ± 3 m (10 ft) lateral deviation during rollout.	Landing		✓	✓	✓							If autopilot provides rollout guidance, record lateral deviation from touchdown to a 50% decrease in main landing gear touchdown speed. Time of autopilot flare mode engage and main gear touchdown should be noted. This test is not a substitute for the ground effects test requirement. T$_f$ = Duration of flare.

Used for performance of the airplane, flight control forces, sound quality

How to test ?

Data injection from real flight into simulation

All automated
150-200 cases
Need some tuning (mechanical parts)
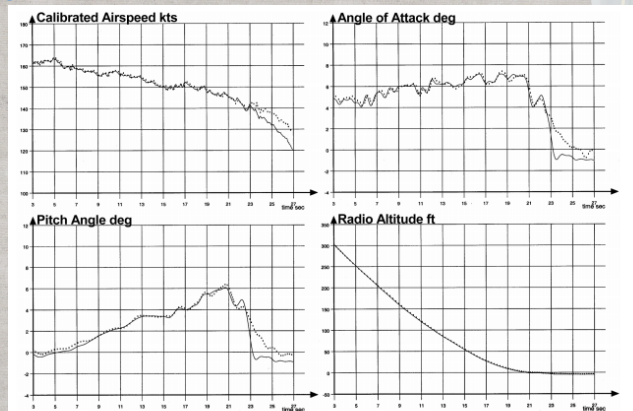Yield 2500 pages of tests results

Required to explain any deviation

Figure 2e4-1
Example of Simulator Test Results for Engine Inoperative Landing

2E-15

How to test ?

System: Perform manual checks

	Pass	Fail
Note: Skip tests as required for LLD		
Reposition to take off.		
Check		
Gear indication DOWN green	_	_
Landing gear doors closed	_	_
Try to raise landing gear		
Check lock solenoid prevent landing gear selector mvt	_	_
Check gear indication: no change	_	_
Perform normal take off do not retract gear.		
Increase speed to 250 Kts.		
Check		
Landing gear vibration increased with speed	_	_
Landing gear sound increased with speed	_	_
Move landing gear selector UP		
Check		
DOWN green is replaced by hatched white indication	_	_
Gear doors sound audible	_	_
Gear up bump motion present	_	_
After 17 seconds UP green appears	_	_
Hatched white indication disappears	_	_
Open alternate gear selector cap		
Hold down switch for 7 seconds		
Check		
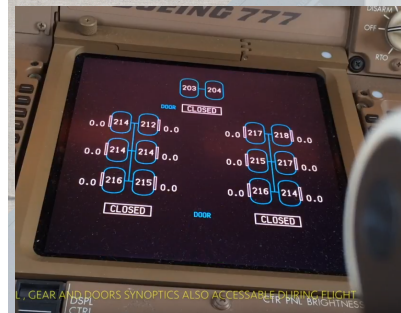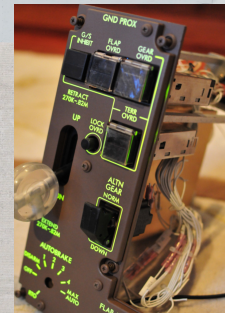
17-20 thousand ticks

One month of checking

Pass fail per system

1000 issues

-What is the status?
-All pumps running!

Challenge the question

What to report ?

Ensure that every story is covered by a test case?

Given weapon system armed
When pilot presses release button
Then bomb is released

Exit criteria met. And?

What to report ?

Test are 100 % passing so all good.

Exploded after take off:
Overflow, exception not trapped
Induced by:
5 times more acceleration vs Ariane 4

More on Wiki

Context : Data and test content designed in point in time

what to report ?

Testing boundaries in aviation is important:

```
Float outsideAirTemperature (float staticTemperature…)
{
    Some magic calculations;
    Return result;
}
```
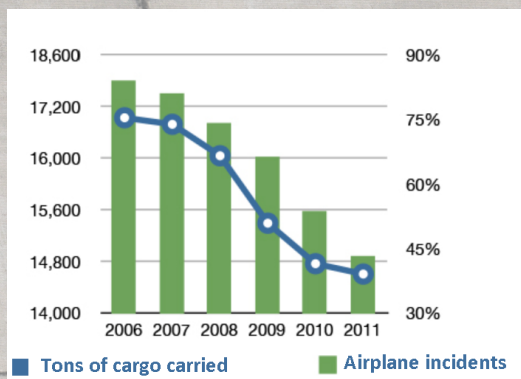
OAT in aviation : -73c / 55c
-100 / + 100 to be safe.

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what to report ?

Tools and CLERC (C Level Executive Ready Charts)

Jira, Xunit, Static code
metrics,branch coverage,
Jenkins builds…

You are the expert: Numbers are right!?

Slide 1

what to report ?

If defective...


```
Note: Skip tests as required for LLD              Pass    Fail
Reposition to take off.
Check
    Gear indication DOWN green                     _       X
    Landing gear doors closed                      _       X
Try to raise landing gear
Check lock solenoid prevent landing gear selector mvt  _   X
Check gear indication: no change                   _       X
Perform normal take off do not retract gear.
Increase speed to 250 Kts.
Check
    Landing gear vibration increased with speed    _       X
    Landing gear sound increased with speed        _       X
Move landing gear selector UP
Check
    DOWN green is replaced by hatched white indication  _  X
    Gear doors sound  audible                      _       X
    Gear up bump motion present                    _       X
    After 17 seconds UP green appears              _       X
    Hatched white indication disappears            _       X

Open alternate gear selector cap
    Hold down switch for 7 seconds
    Check ......
```
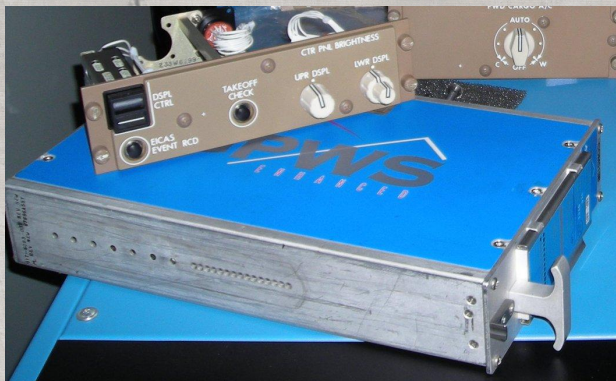
Could you help me get that fixed?

Slide 2

what to report ?

Ground Proximity Warning System: OEM for aircraft

Certified to be installed in real plane
Firmware certified by aviation

Equiped with « self test »

Third party: Knowing it helps estimating risks

what to report ?

Automatic « testing » framework to the rescue

2202 test « cases » automated
8 modules ENTIRELY automated

How many phone numbers you know now?

Expertise in automation <> expertise in product

What to report ?

Could you verify that 5000 cars per hour EAST WEST is OK?

Testing does not always requires code!

What to report ?

Keep test procedure "light", too many maintenance!!

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS	FFS			
	A	B	C	D
(11) Tyre failure dynamics			✓	✓
(a) Dependent on aeroplane type, a single tyre failure may not necessarily be noticed by the pilot and therefore there should not be any special motion effect. There may possibly be some sound and/or vibration associated with the actual tyre losing pressure. With a multiple tyre failure selected on the same side the pilot may notice some yawing which should require the use of the rudder to maintain control of the aeroplane				

```
                                    Pass      Fail
Reposition to take off
Increase speed to 80kts
Blow tire 11 on left main gear
Check
    Effects are representative       _         _
```

What to report ?

Mathematic model for "contaminants" deposit on RWY

```
Float Temperature (float dewpoint, RelHum)
    { ...
        Return x;
    }
```

What occurs around freezing point?

Informal chit chat are worth it!

What to report ?

We found 987 issues in the last version

Issue to fix = $$$

32% contractual terms unclear
17% fatal error (exception)

Oxford Comma Dispute Is Settled as Maine Drivers Get $5 Million …
https://www.nytimes.com/2018/02/09/.../oxford-comma-maine.htm... - Traduire cette page
9 févr. 2018 – And state lawmakers have dispensed with **commas** altogether in the … of Appeals **for** the First Circuit ruled that the **missing comma** created …

Being part of the problem or the solution

What to report ?

Login feature has been tested!

What is understood? What do YOU mean?

So I can sell to Spain, Switzerland? ç öëäeê

Conclusion

Dash board and numbers are very easy to build

Not everybody is expert in your domain

Dashboard or a face to face discussion?

Reporting or learning?

Questions and answers

Thank you, safe trip home!

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