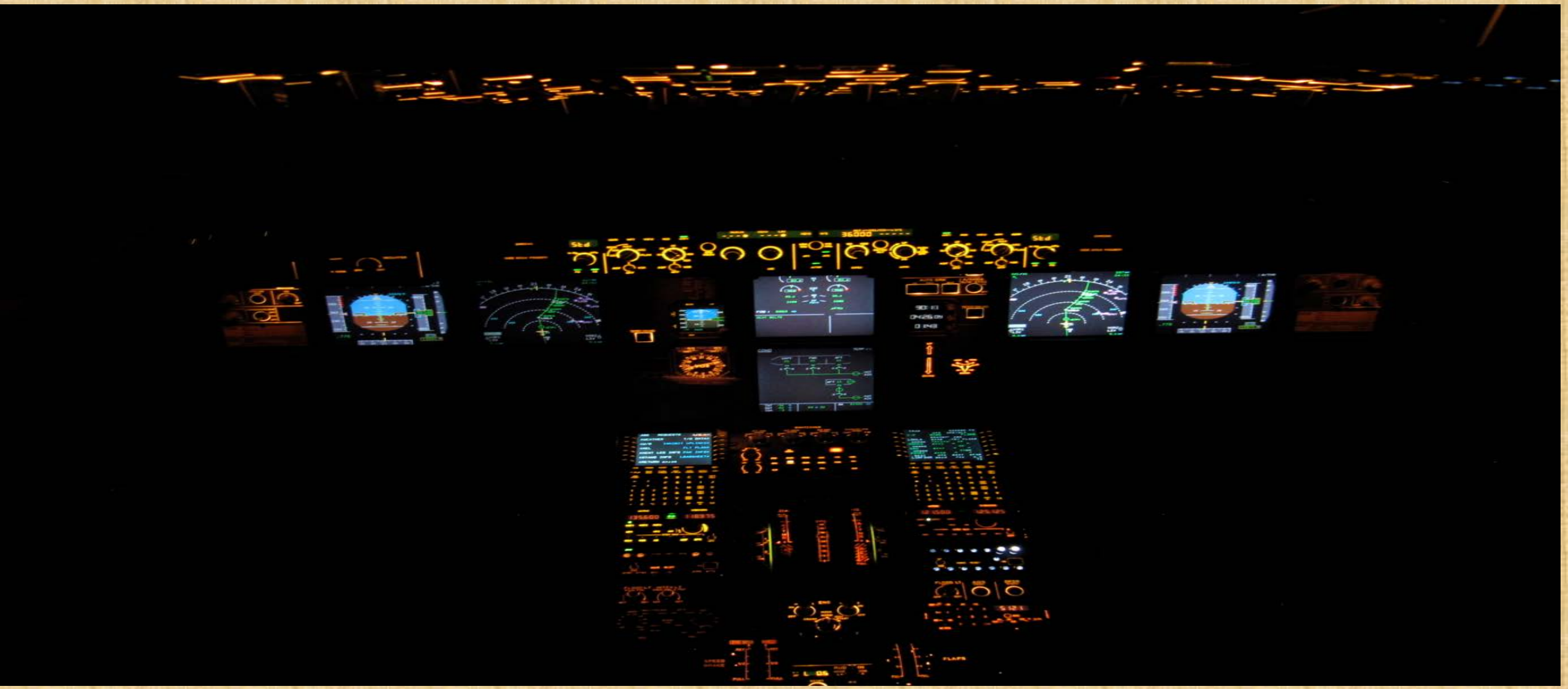
AUTOMATION: A THREAT OR A RESOURCE?



The starting point: loss of control inflight

- 1st june 2009

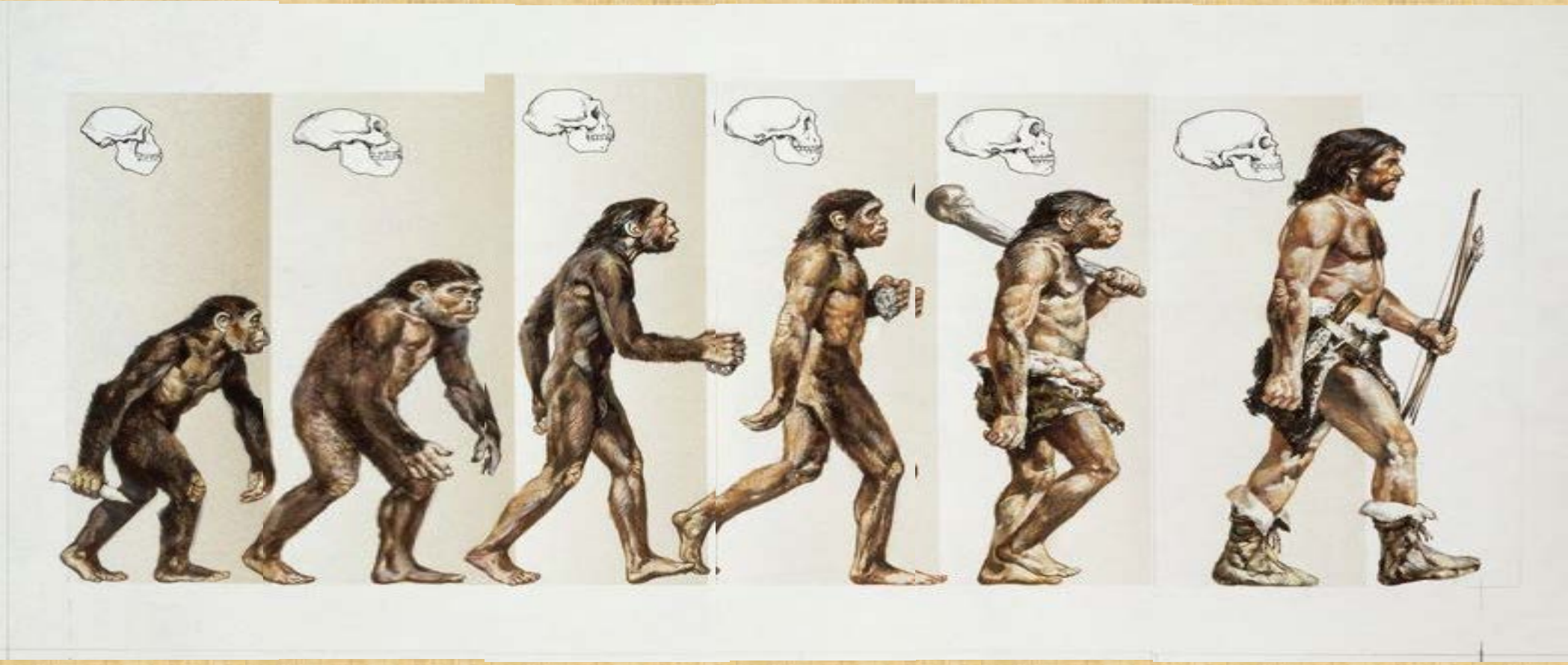
- 10th march 2019

Operators as imagined

The real operators..

Madrid – 2nd October 2019

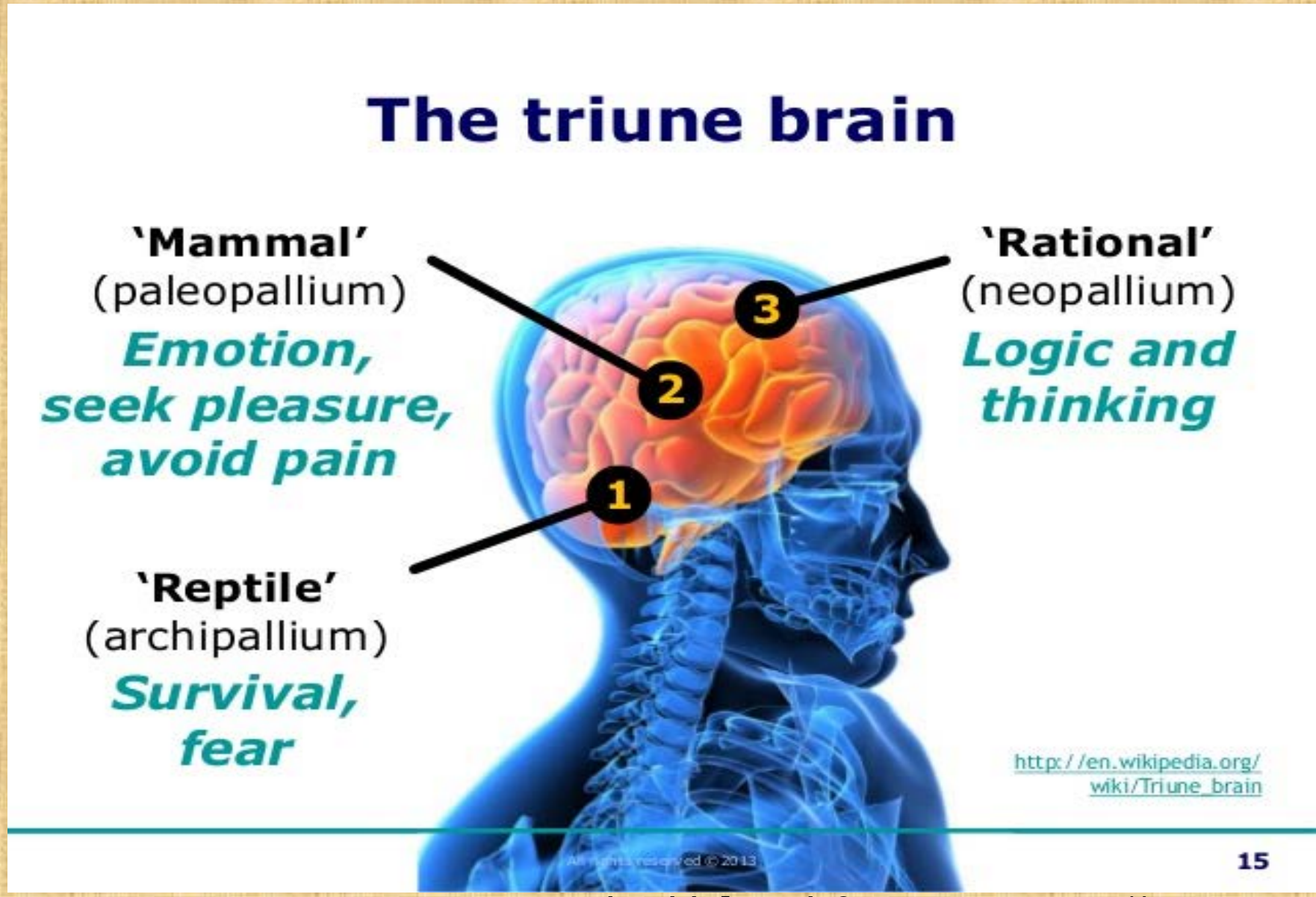
It takes time…



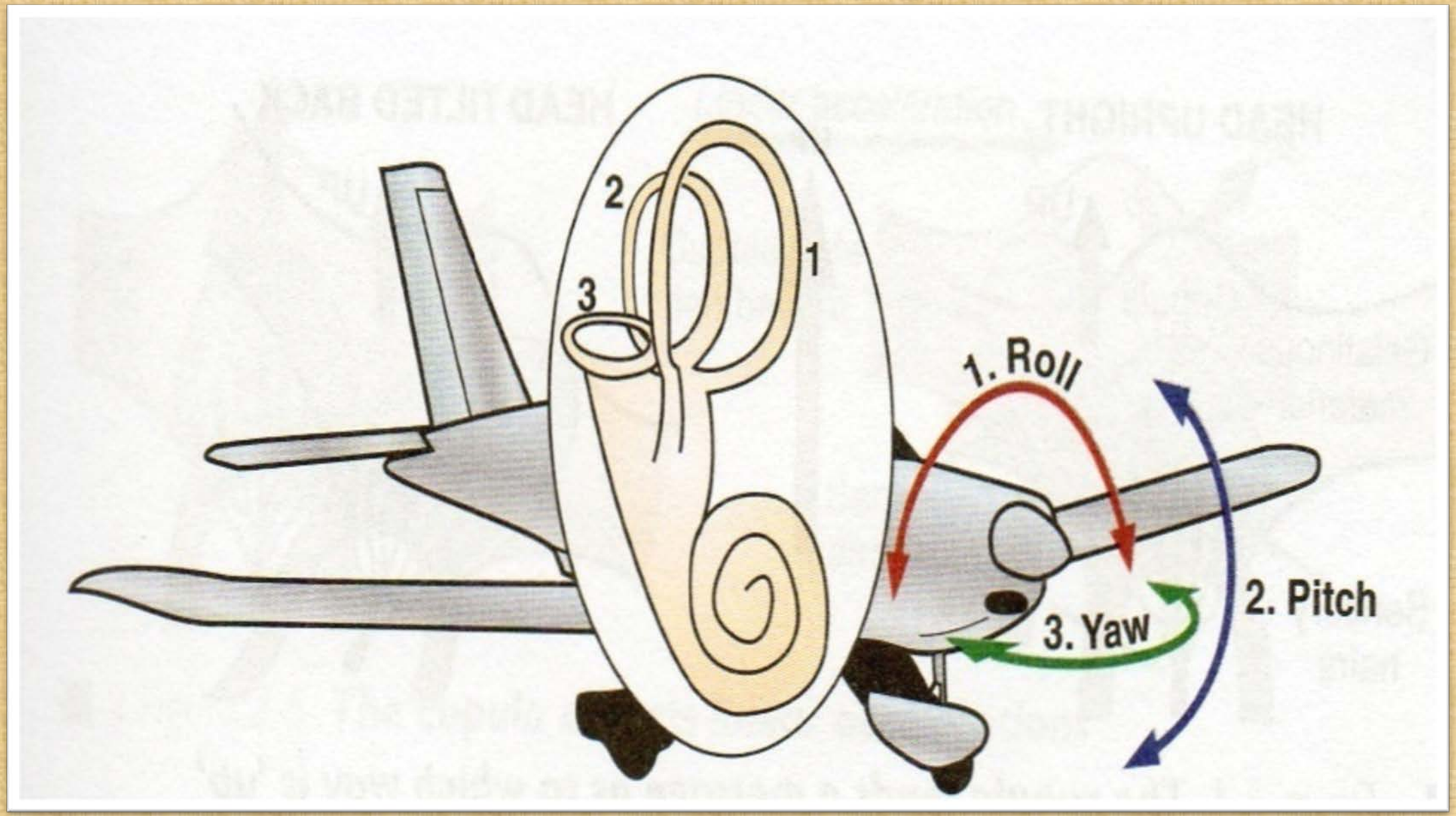
5.000.000 2.500.000 1.500.000 100.000 50.000 30.000 100

Still the same magic box…

- Perceptual
- Emotional
- Cognitive



Vestibular apparatus

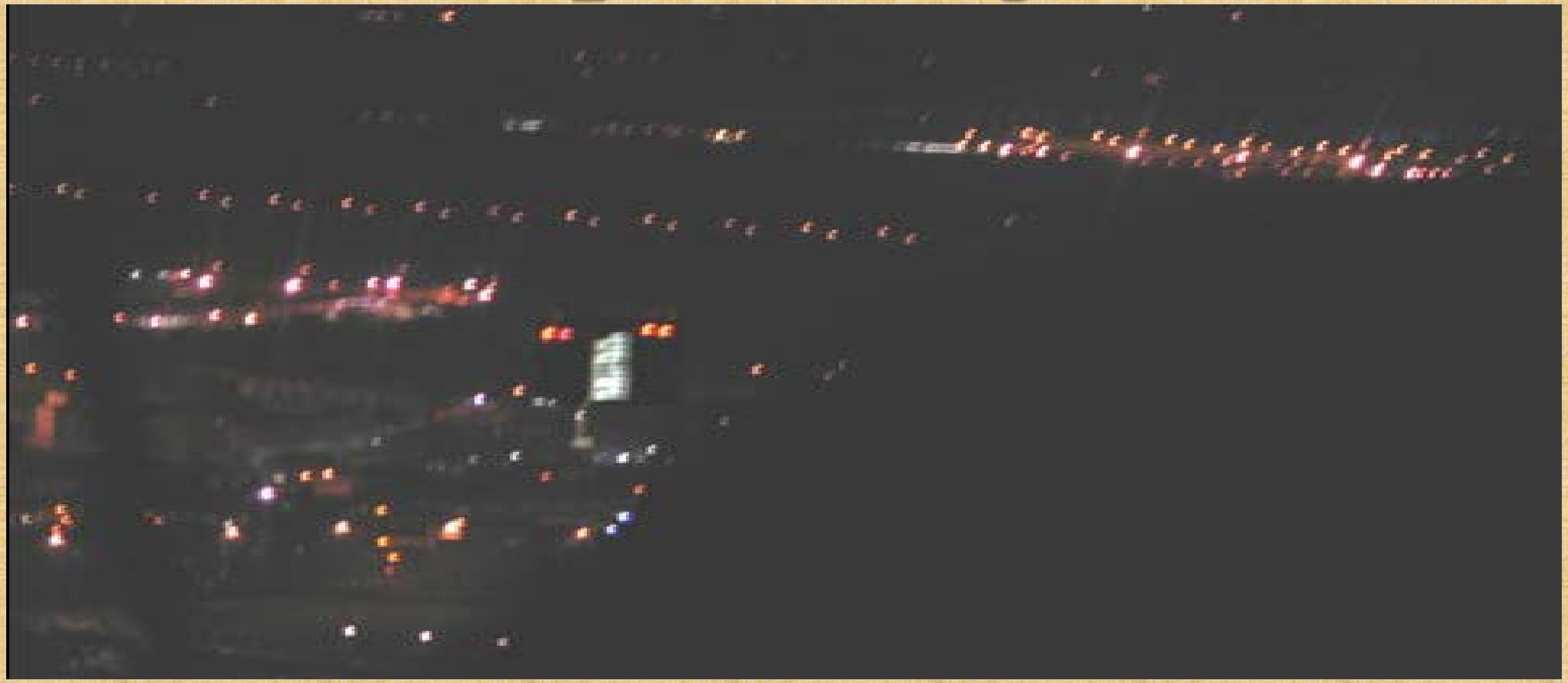


Indexes of depth’s perception

White out

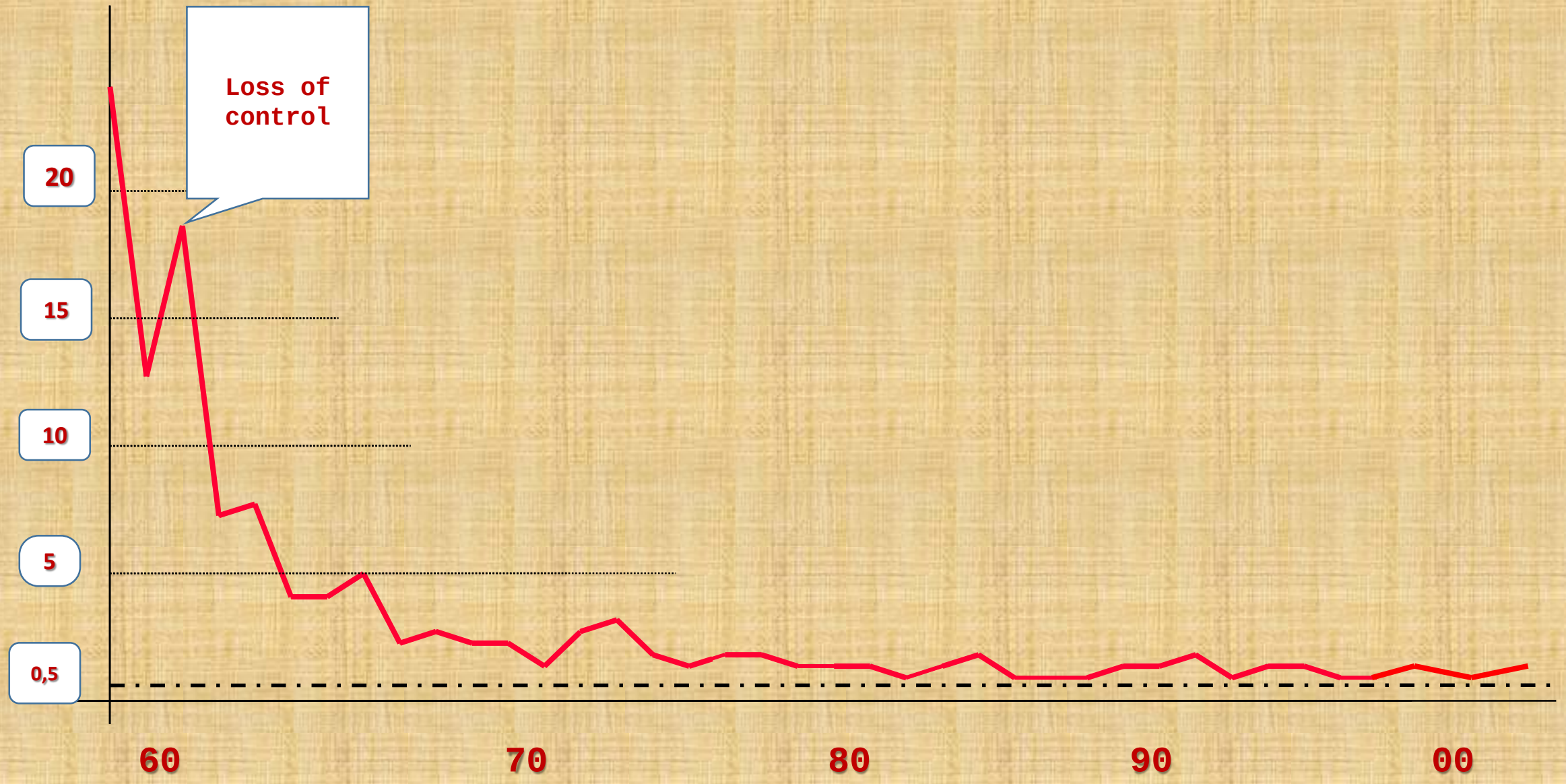
Foggy weather: RVR 100 mt.

Runway in sight….



Sure?

Accidents' trend

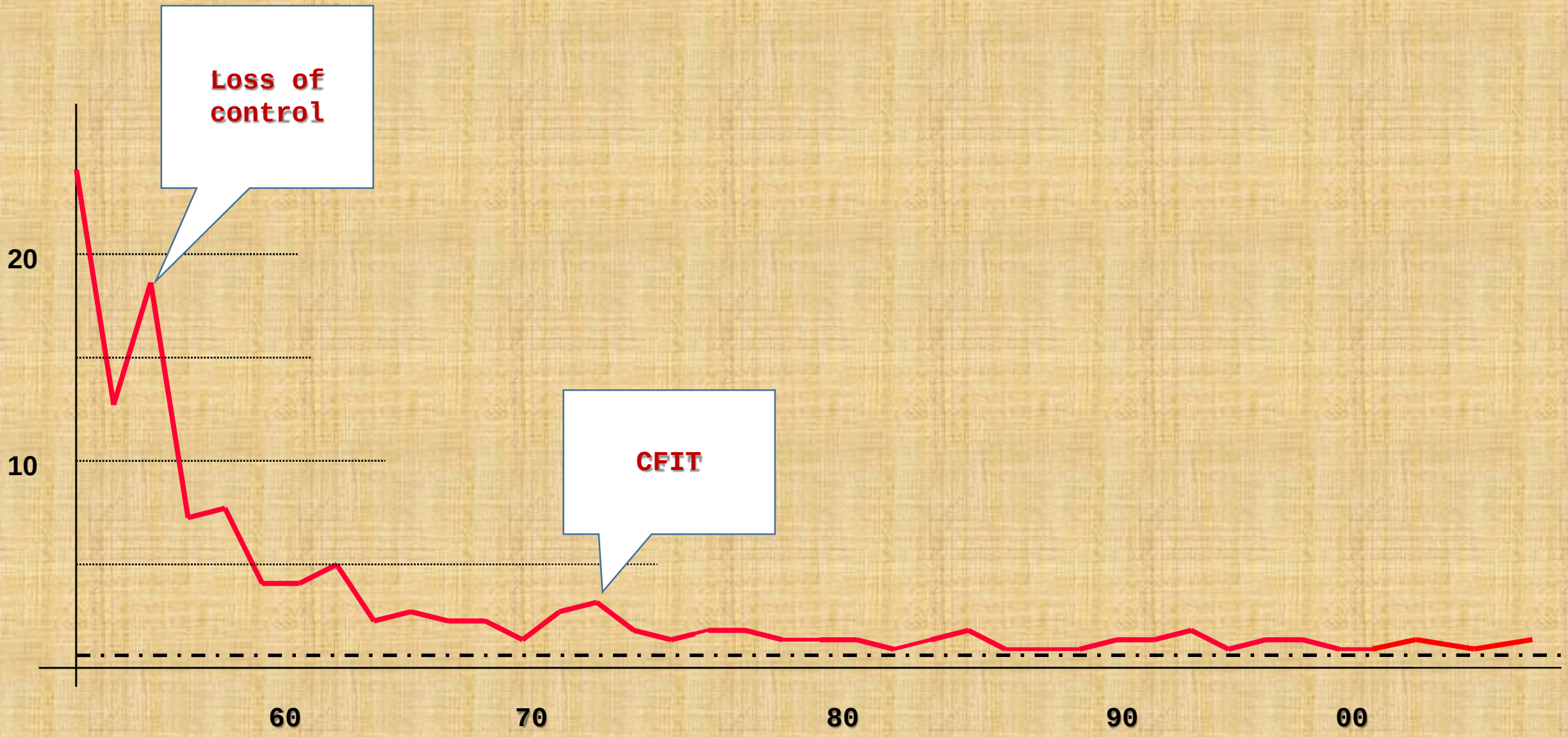


Root causes:
Human performances and limitations

- Flying skills deteriorated by;
- Fatigue
- Sleepiness
- Distractions
- Poor design
- High mental workload
- Jet lag
- Visual illusions

Human problem……
Technological solution

- Autopilot
- Flight director
- Auto-throttle
- Radar
- ILS
- Inertial platform
- ……



Human problem: poor teamwork

- Lost or impaired situational awareness
- Uneffective Leadership
- Top-down approach of captain vs. poor assertiveness by the copilot
- Complacency
- Lack of critique

Tenerife 1977

Human problem… psychological solution

Pilots started to be selected..

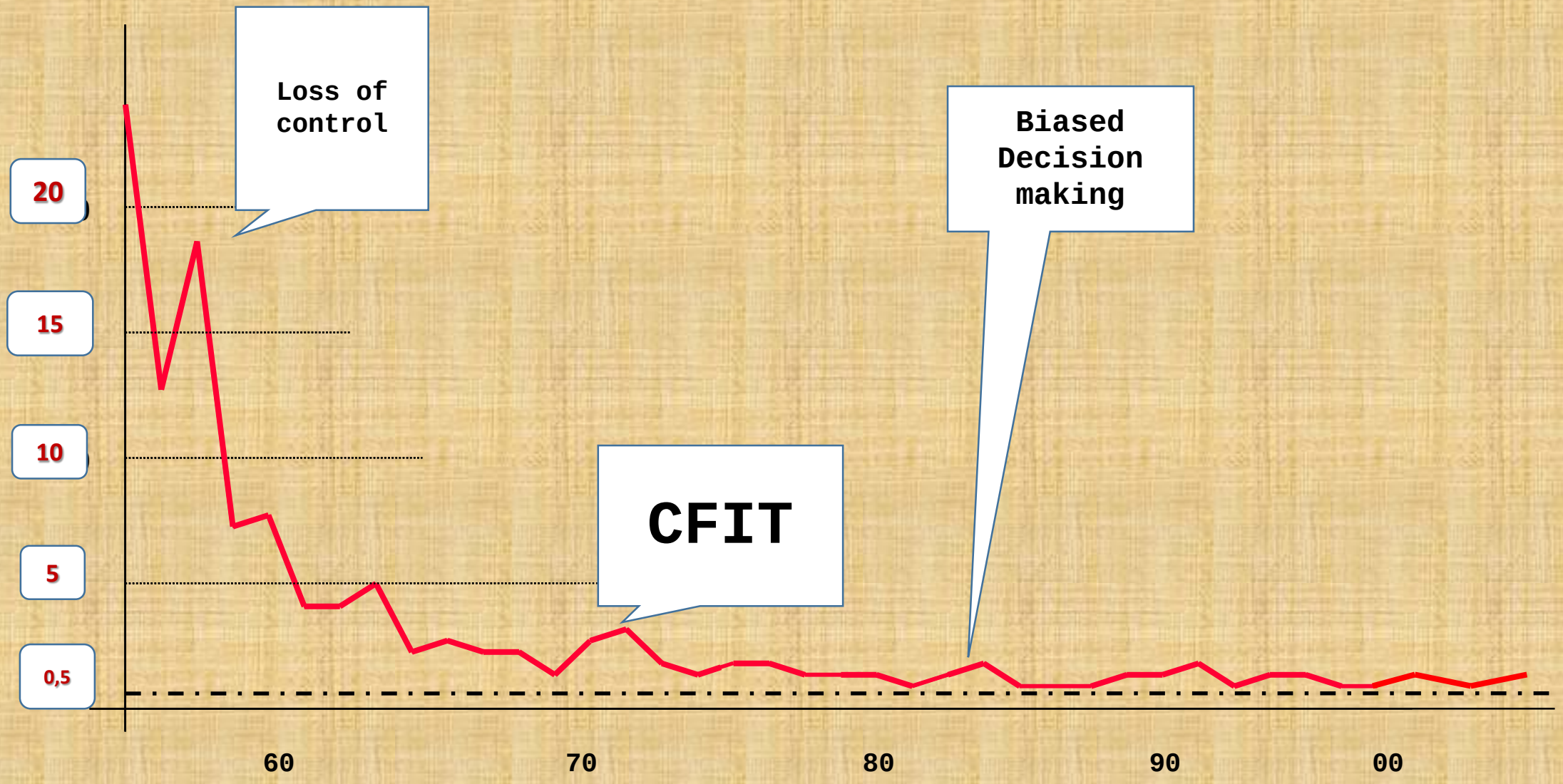
Trained to good teamwork

Cockpit Resource Management/ Crew Resource Management

Evaluated for their non technical skills

GPWS helped, too..

Accidents' trend



Human problem: organizational issues

- 1980: «Happiness is a cheap seat»
- Protection vs. production
- Cuts to maintenance, training, safety investment.
- NASA is managed according to the mantra: cheaper, faster, better…
- 1985: «Happiness is a safe seat»..

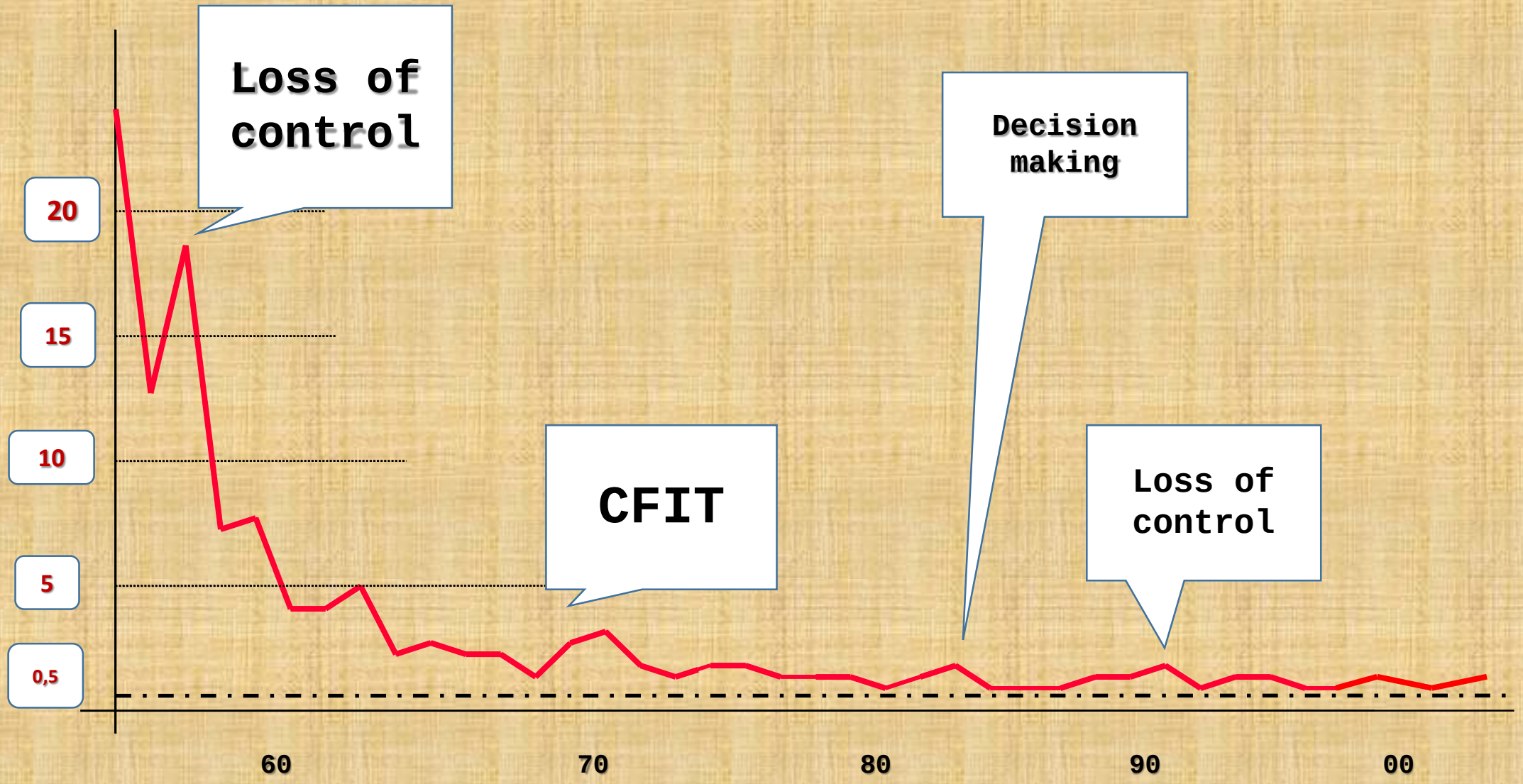
Paradigmatic accident: Dryden 1989

Human problem…
Solution: Normative

- Stricter rules and checks
- Flight time limitations
- Better checks by the regulator
- More frequent maintenance checks

In the meantime:
Cheaper, faster, better….

Accidents' trend



After the technological revolution

- Habsheim (26-6-1988) : A-320 Air France (demonstration)
- Bangalore (14-2-1990): A-320 (approach phase)
- Warsawa (14-3-1993) : Lufthansa A-320 (overrun)
- Toulouse (30-6-1994): Airbus A-330 (demonstration)
- Perpignan (27-11-2008): Air New Zealand (test flight)
- Amsterdam (25-2-2009): B-737 Turkish (Approach)
- Atlantic Ocean (1-6-2009): A-330 Air France Rio-Parigi
- Indonesia - Lion Air (2014): A-320 (cruise phase)
- Indonesia - Lion Air (2018): B-737 max (initial climb)
- Ethiopian Airlines (2019): B-737 max (initial climb)

Problem: human-machine interaction

- Complacency
- Poor manual skills
- Poor knowledge of systems
- Situation awareness
- Design Opaqueness
- Fundamental surprise vs. situational surprise

Root causes of loss of control

- Ergonomics (physical, cognitive, social)
- Automation (opacity, unruly technology, complexity)
- Poor Training: e-learning and self-training, demotivation, “use it or lose it”

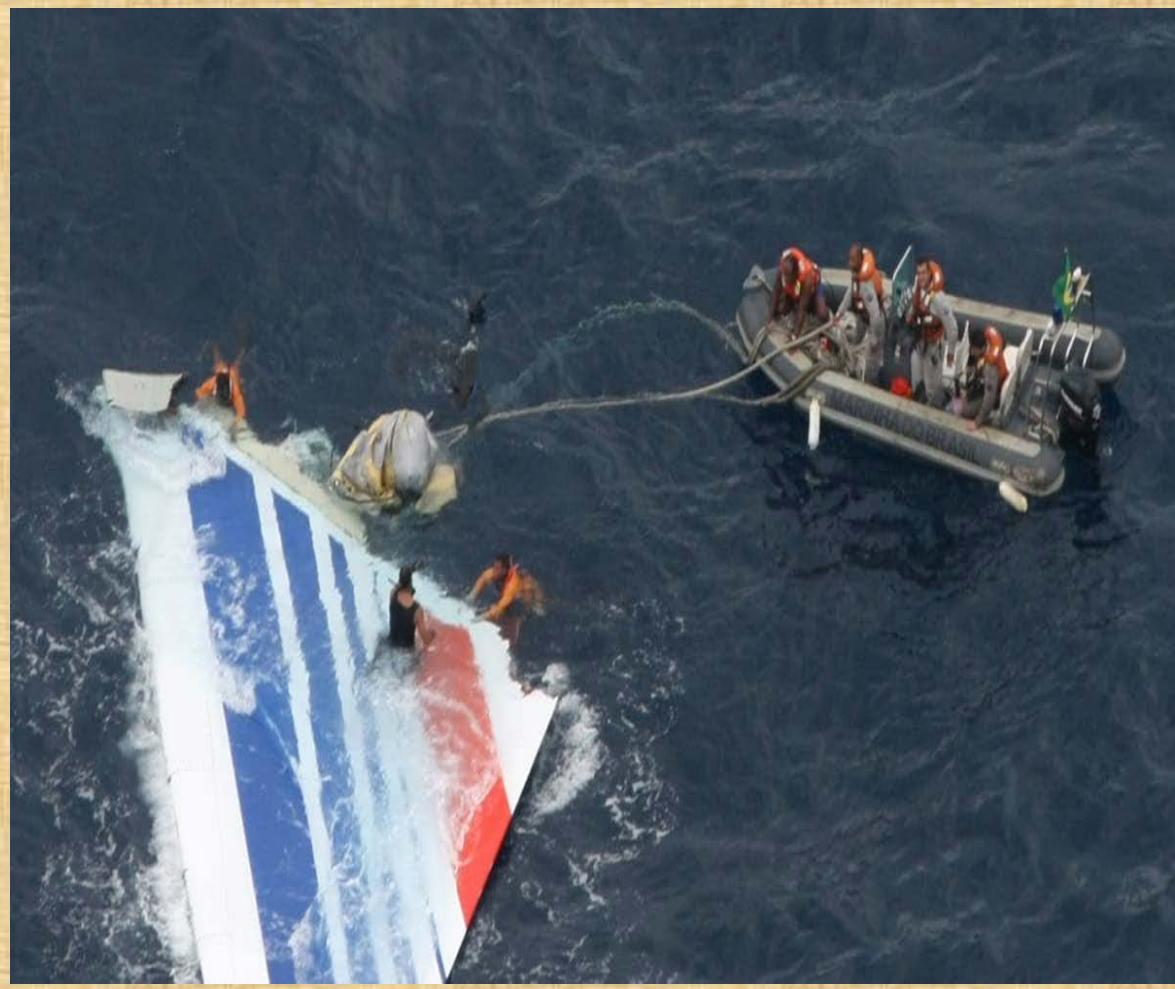
Human problem….

- And the Solution is…

Better Ergonomics and proper Automation

AF 447

- Poor design
- Crew coordination & integration
- Situation awareness
- Fatigue
- Automation surprise
- Out of the loop syndrome
- Training issues (back to basic)
- Ergonomics (flight control and side-stick)
- And much more…



What is ergonomics?

- The word "Ergonomics" comes from two Greek words "ergon," meaning work, and "nomos" meaning "law"
- Today, the word is used to describe the science of "designing the job to fit the worker, not forcing the worker to fit the job."
- Ergonomics covers all aspects of a job, from the physical stresses it places on joints, muscles, nerves, tendons, bones and the like, to environmental factors which can effect hearing, vision, and general comfort and health.

Chicago world's fair motto 1933

- Science finds
- Industry applies
- Man adapts

Modern times (1936)

Evolution of ergonomics

- Until ’50’s: man is a bolt-on element added to the system (adaptive approach)
- Physical movements, applied forces and anthropometric measures are studied
- From ‘50’s to ‘70’s: man is conceived as a system monitor (interactive approach) Studies on cognitive processes, attention, memory, etc.
- From ’80’s to today: man is part of an echo-system (ecological approach).
- Complexity and its associated phenomena are studied

Physical ergonomics

Physical ergonomics and usability

Social ergonomics - standardization:
C-47
(left: fuel) (ctr: throttle) (right: Propeller)

Social ergonomics - Standardization
C-82
(left: prop) (ctr: throttle) (right: fuel)

Social ergonomics - Standardization
B-25
(left: throttle) (ctr: prop) (Right: fuel)

Cognitive ergonomics - Enigma....

Cognitive ergonomics – design

Airbus a-320 in Strasbourg

Human-machine interface

Human problem
Solution: improved Ergonomics

- Human factor experts are involved at the early stage of systems design;
- Designer must focus not only on usability but a wide range of issues are taken into consideration: physical, cognitive, social.
- Operator-friendly or user-friendly?

F-111: how do pilots think?

strangely!

New ergonomics

- Humans propose
- Science studies how
- Technology adapts (Norman)

What is Automation?

1. - PERCEIVING

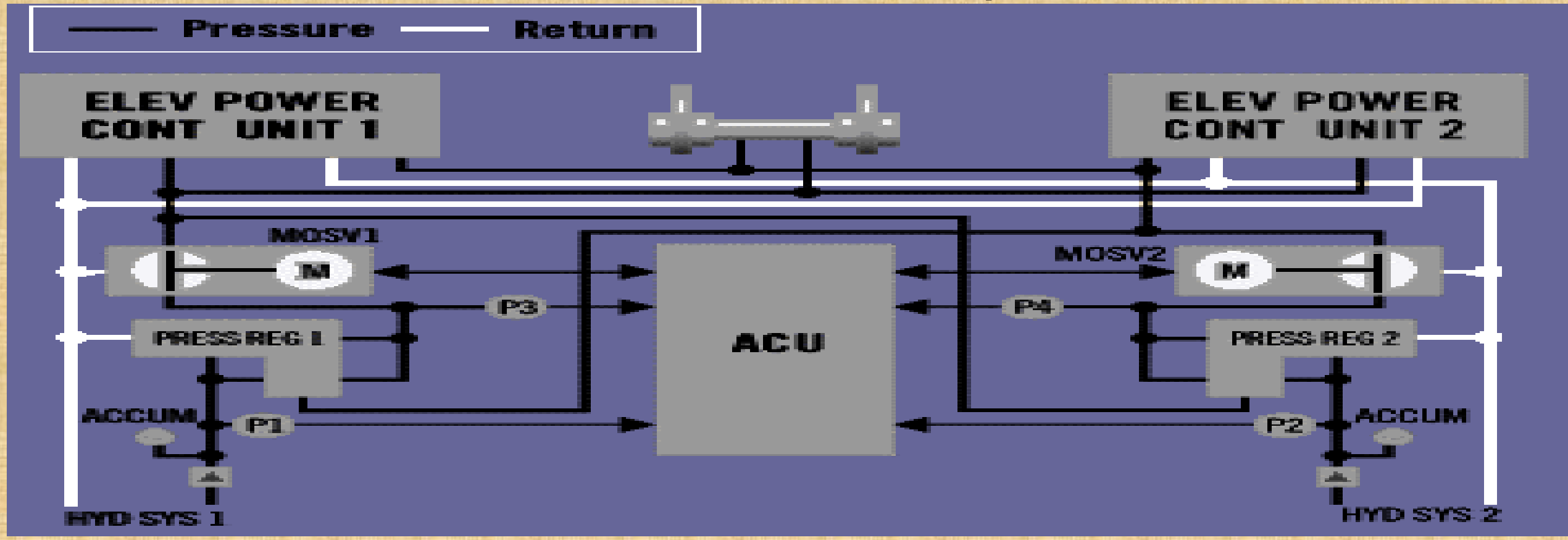
Integration and mechanization of the detectors of the environmental phenomena gathered by artificial sensors

2. – Processing

The process of analysis of data and the decision-making function addressed to co*mputers*

3. – Execution

Mechanical actions, made via motors or devices which apply forces over an environment;

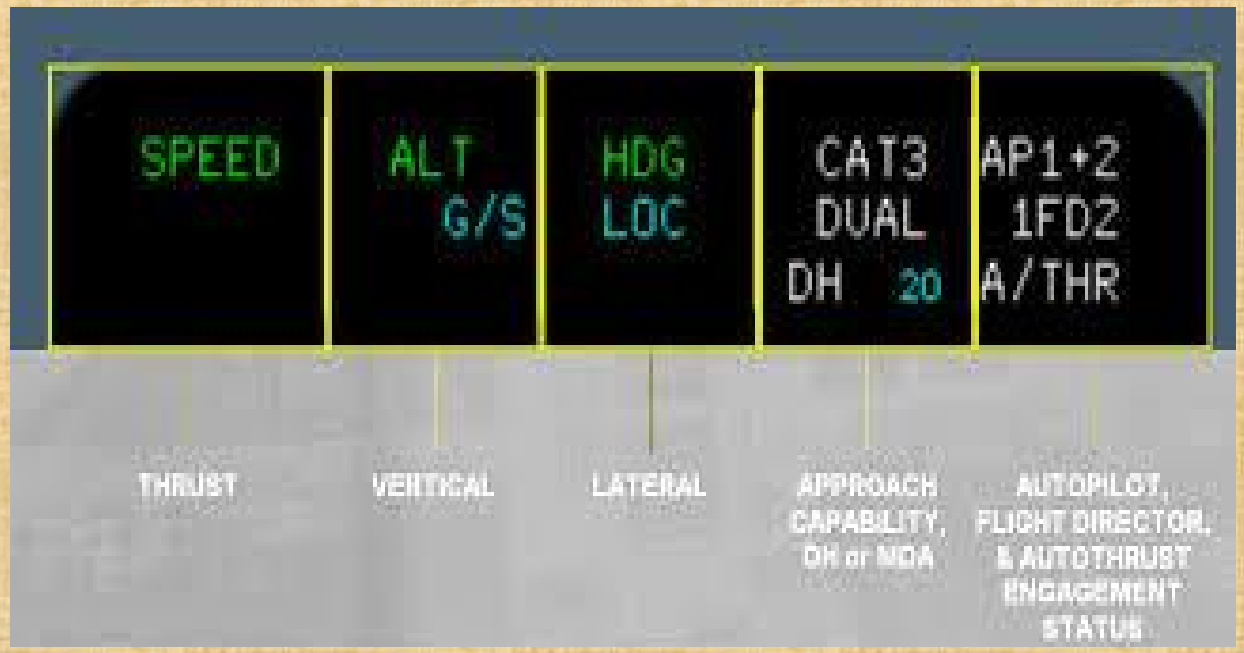


Distance between Pilot input and aircraft response

- Pilot – Cloche- aerofoils
- Pilot – Servo-mechanisms – aerofoils
- Pilot – autopilot –servo-mechanisms – aerofoils
- Pilot – Flight Management System – autopilot – fly-by-wire – servo-mechanisms – aerofoils
- Pilot – remote control – Flight Management System – autopilot – fly-by-wire – Servo-mechanism – aerofoils
- Pilot – remote control – satellite – Flight Management System – autopilot – Servomechanism – aerofoils

4. – Information

<u>Informative actions</u>, via communications of the status to the operator.



Information channels

- Aural warning (overspeed)
- Visual warning (stall)
- Tactile alert (stick-shaker)
- Interface messages

Which is the right level of automation?
MABA-MABA: Man Are Best At

- To perceive small and qualitative variations
- To perceive visual and aural configurations
- To deviate from procedures
- Multi-modal memory
- Induction
- To feel, to imagine, to plan

MABA-MABA
Machines Are Best At:

- To quick respond to signals
- To manage huge forces
- To monitor
- To get informations in the quickest way
- To cancel informations from memory
- Multi-tasking

Evolutionary hazard
Tolouse – 2007 ENGINE TEST Etihad

Technological revolution

- Glass cockpit
- Fly-by-wire
- Dark panel

Traditional Display: T-model

Why automation? Glass cockpit

- Color coding
- Simbology (maps, symbols, animations)
- Less information delay (vertical speed, turns, etc.)
- Lower maintenance costs
- Integrated systems
- Devices Swap
- Redundancy

Advantages of Fly-by-wire

- Lighter airplanes (steel cables vs. Optic fibres)
- More manoeuvrable
- Lower maintenance costs
- Fuel saving
- Interactivity
- Protections along the whole flight envelope

Shortcomings of the fly-by-wire

- No feedback on opposite crewmember side-stick
- Side-stick hardly visible, particularly at night
- Excessively responsive (I.g. gusty wind)
- No trimming during normal operations
- Different behaviour in normal, abnormal and emergency situations
- Some failures (side-stick interference) potentially catastrophic

Why automation? Dark panel

- Pros:
- No lights: Ok
- Lower Maintenance costs
- Saving on spare parts
- Fully automatic

- Cons:
- «Use it or lose it»
- Poor knowledge of systems
- Hardly visible or recognizible knobs.
- Pushbuttons sometimes faulty

Operational level: crew coordination

- Sometimes in emergency, redundancies disappear
- Rythm given by procedures – step by step
- Cross-check: split work in emergency
- Keyboard inputs vs. touch and feel
- Low or missing awareness of pilot’s input on side-stick
- Pilots communicate via an electronic crewmember,who has its own syntax
- The problem of the unreliable indications

Would you accept these money?

Wrong

False

Invalid vs. Unreliable

- **Perception**

- Flag in view
- Intermittent values (ON/OFF)
- Flashing lights
- Procedures

- **Perception**

- Erratic or fluctuating indications
- Instruments Mismatch
- Cross-check required
- Airmanship

Ethiopian flight 302 – 10th March 2019

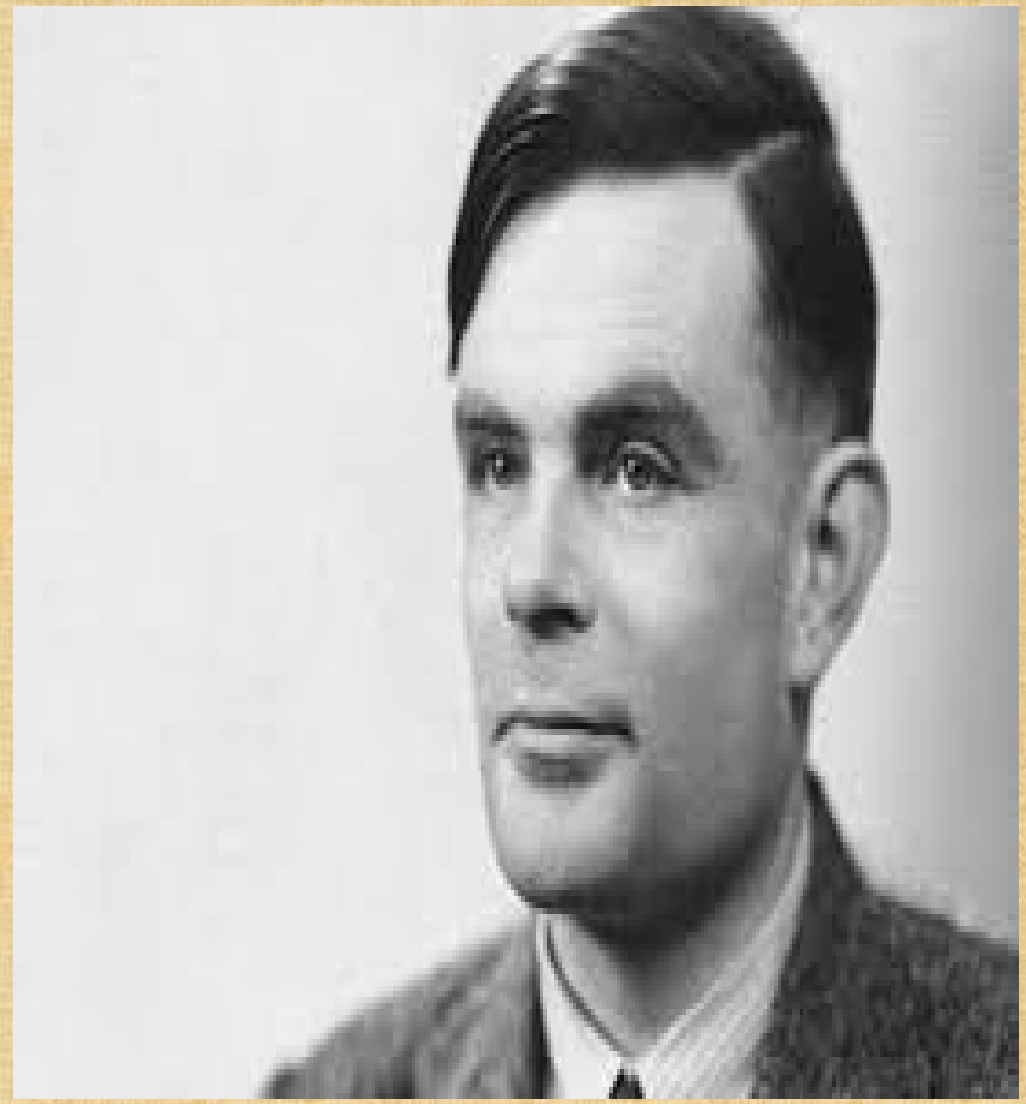
- Uncontrolled dive from 5000 ft.
- Angle of attack failure
- Did they know the system logic?
- Is a 50 minutes self-learning, for a system potentially lethal, enough to assure safety?
- Procedure not familiar
- System velocity and strenght unchallenged by the pilots
- MCAS: Certified with wrong parameters.
- Gain and lag: what they are?
- Copilot: 200 hrs

Open questions

- Certification process: do we have qualified personnel? Simulation or test flight? Self-certification?
- May a Safety-related items be considered an optional?
- Legal issues: who is accountable, responsible and liable for a technological failure?
- Scattered responsibilities along the production line. What is the product? Where is it produced? Which is the failure?
- Revolutionary approach vs. evolutionary approach: who fit best aviation?
- Emergent proprieties and complexity: they make the system behaviour unpredictable. How to cope with them?
- Does automation require more training or less training?
- Could a failure be reproduced on ground?
- Do electronic echo-systems permit a thorough retro-fit?

Artificial intelligence

- If you ask me to build a machine that is infallible, it won’t be intelligent;
- And if it must be intelligent it won’t be infallible



Thank you for your attention!

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