Zero error culture – an attainable goal?

Cross-functional contribution to BIM Community 2017 in Aarhus

Stephan Lange| Quality Manager
Aircraft component Services | 04th Oct 2017

Lufthansa Technik

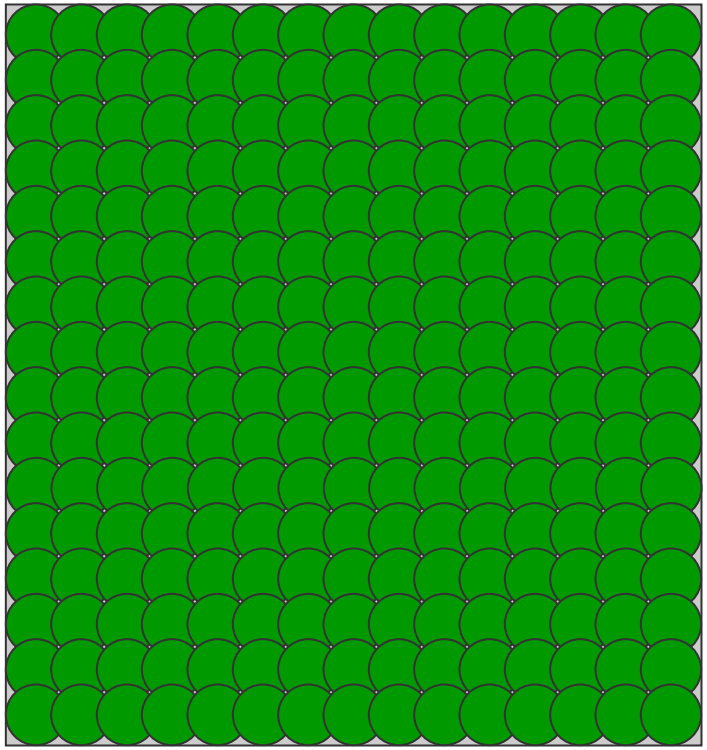
“MAN - A creature that was created at the end of the week when God was very tired.” **Mark Twain**

“No! No! That’s Self-Destruct!
Set Distance is the one on the left.”

Agenda

- **Capacity Modell**
- **General Flight Safety Aspects**
- **Human Error Theory Aspects**
- **Lufthansa Techik Error Management**

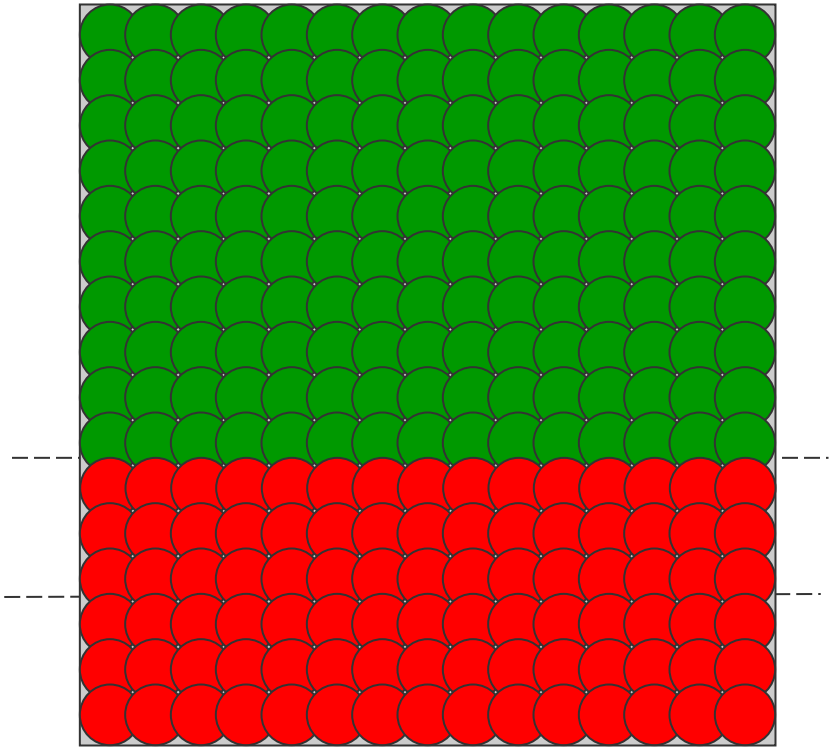
Capacity Modell



modified after Richter 2007

- Individual resources as „Performance Capacity“ to cope succesfully with situation
- Amount of „green bubbles available may vary:
  - day by day
  - from individual to individual

Capacity Modell

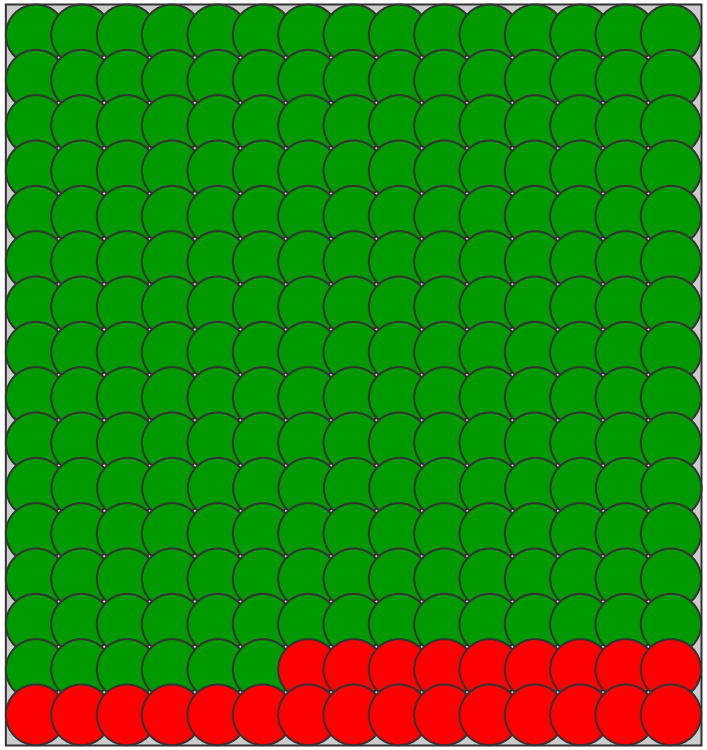


modified after Richter 2007

- Individual Resources
- Psychological & physiological factors do have limiting effect on resources available.

1. Question is, how much resources have we got at a specific time/ place/ situation to avoid making errors?
2. Revelation about current disposition does safe lifes and does save costs.

Capacity Modell

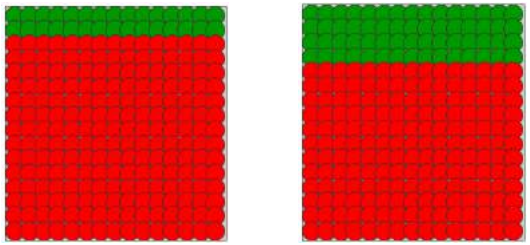


modified after Richter 2007

- My personal capacity model today
- Limited by nervousness and sleep deficit by 4 weeks old daughter
- Extension by personal motivation to support BIM Community 2017 approach to reflect and challenge „zero error culture“

Capacity Modell

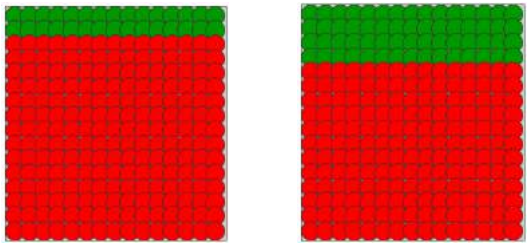
BER Airport staircase



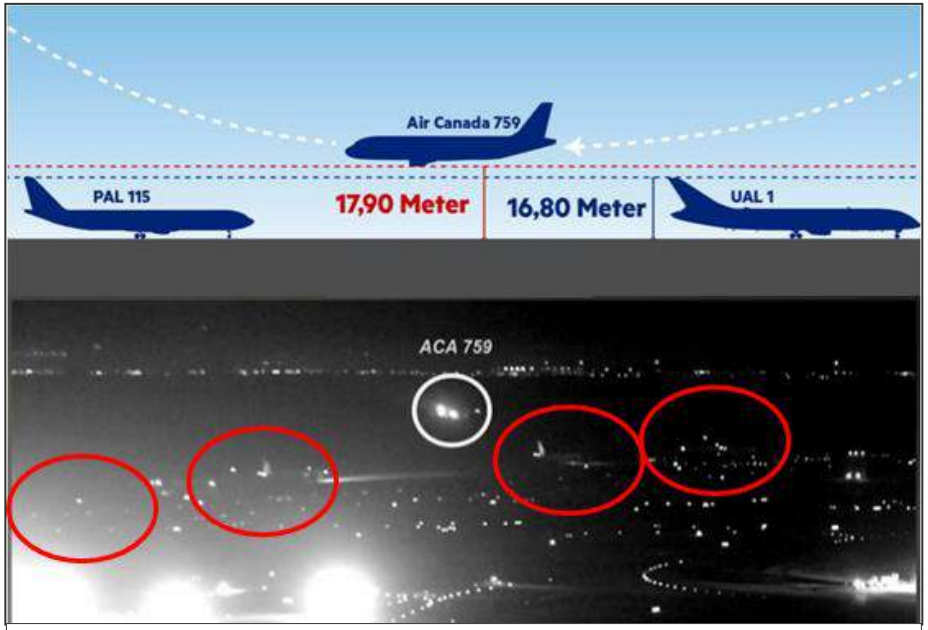
Manager Architect

“Staircase” as one of many deficiencies of BER Airport supposed to start operation in 2011. Still closed.

Air Canada 759 “near miss” 7th July 2017



Captain 1st Officer



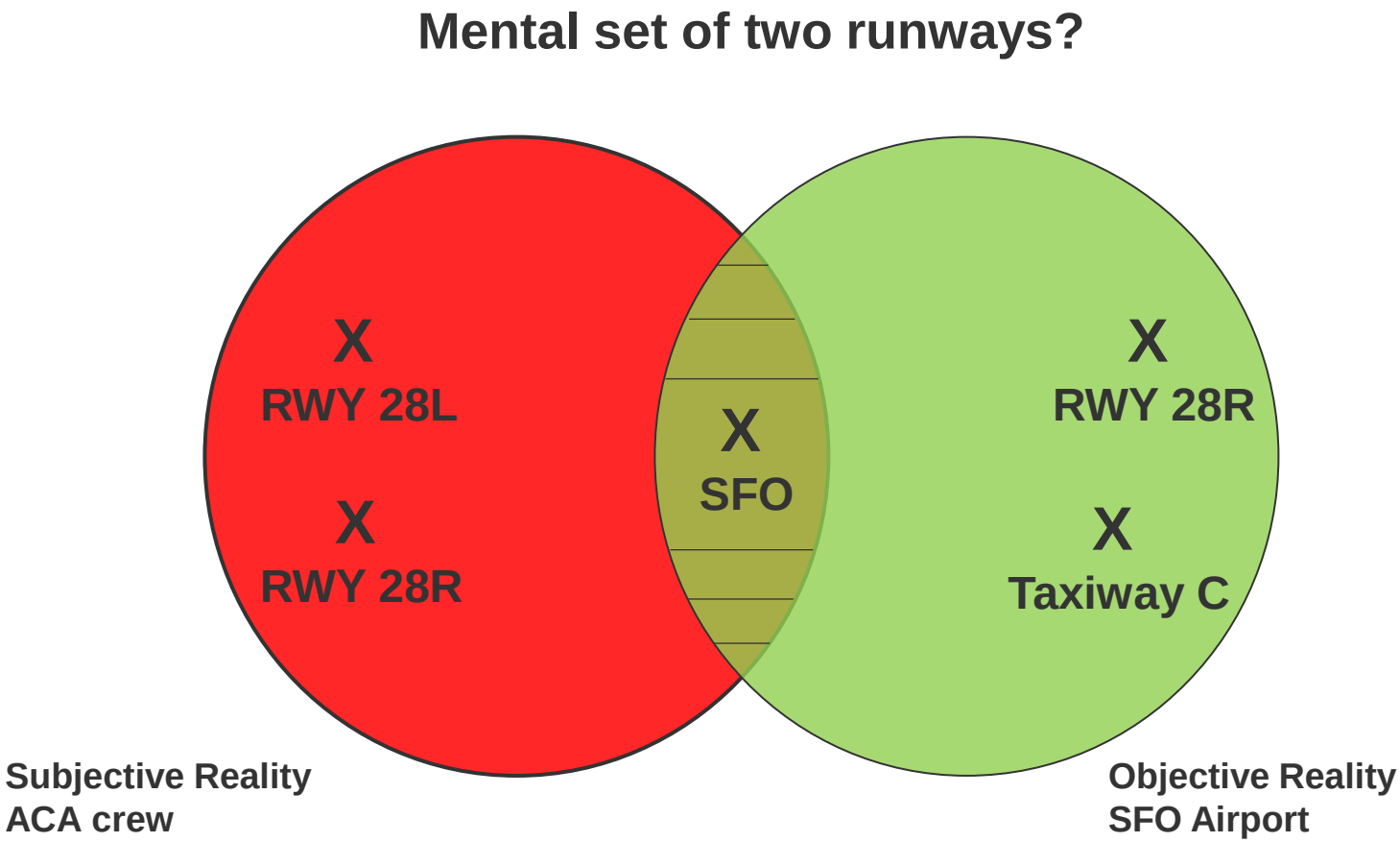
ACA 759 cleared to land on RWY 28R of San Francisco Airport but almost landed and crashed into 4 Aircrafts waiting on Taxiway.

ACA 759 – mental set issue?

- Runway 28L (left) was closed and marked accordingly.
- ACA 759 was cleared to land on RWY 28R (right) but somehow mistakenly thought that the Taxiway C is RWY 28R.
- Taxiway “C” occupied with **4 Aircrafts**

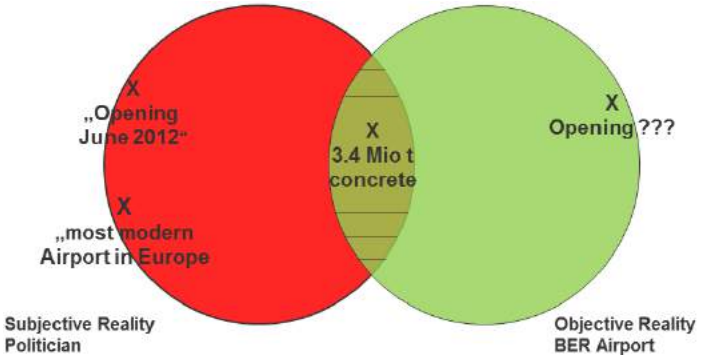
No investigation report yet. Could have been biggest air disaster ever.
Likely cause: low situational awareness due to mental set of 2 RWY and target fixation.

ACA 759 – low situational awareness due to mental set?



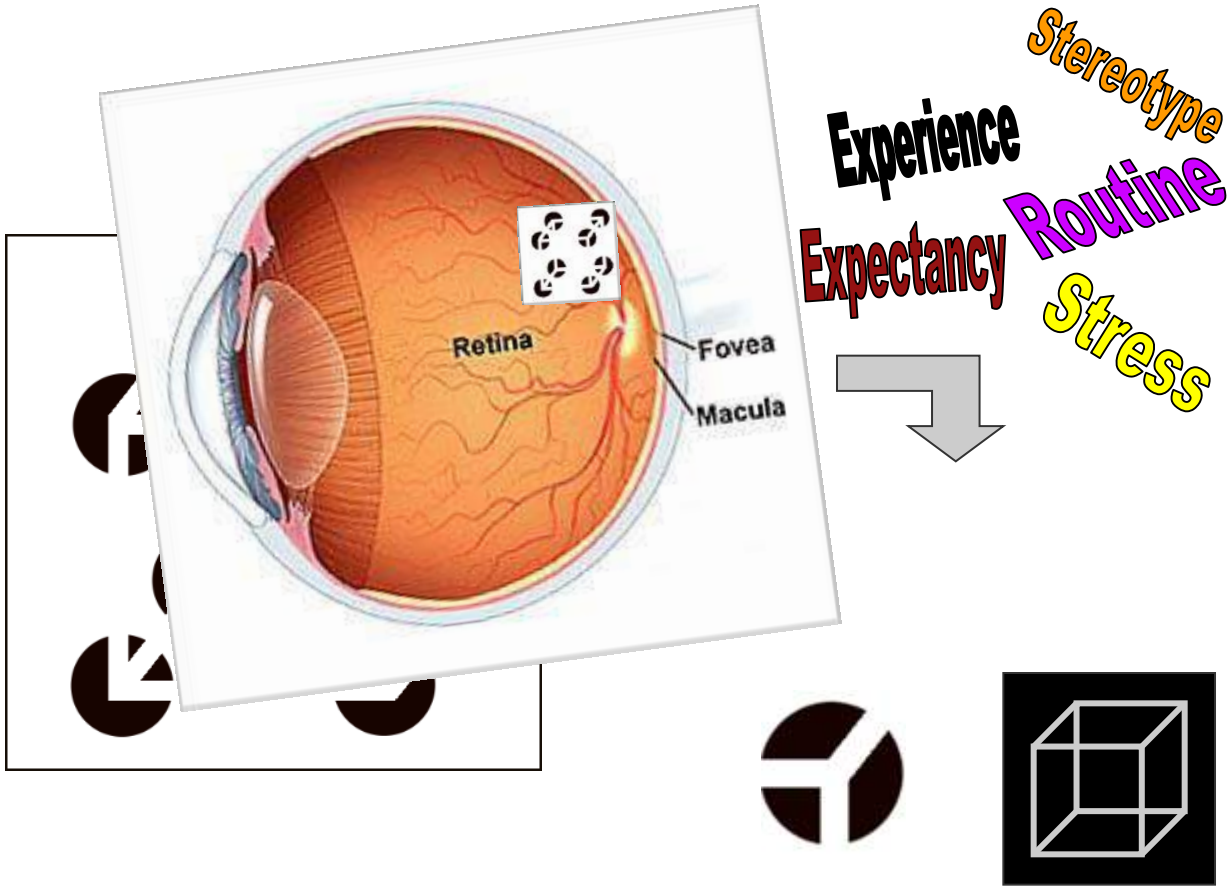
- **Situational Awareness** measures the degree of coincidence between subjective and objective reality.
- **Mental set** is a readiness for a particular thought process to the exclusion of others resulting in **fixation and/ or selective perception** to perceive the things we want to have them.

Berlin Airport – low situational awareness selective perception of most modern airport in Europe?



ACA 759 – low situational awareness due to mental set?

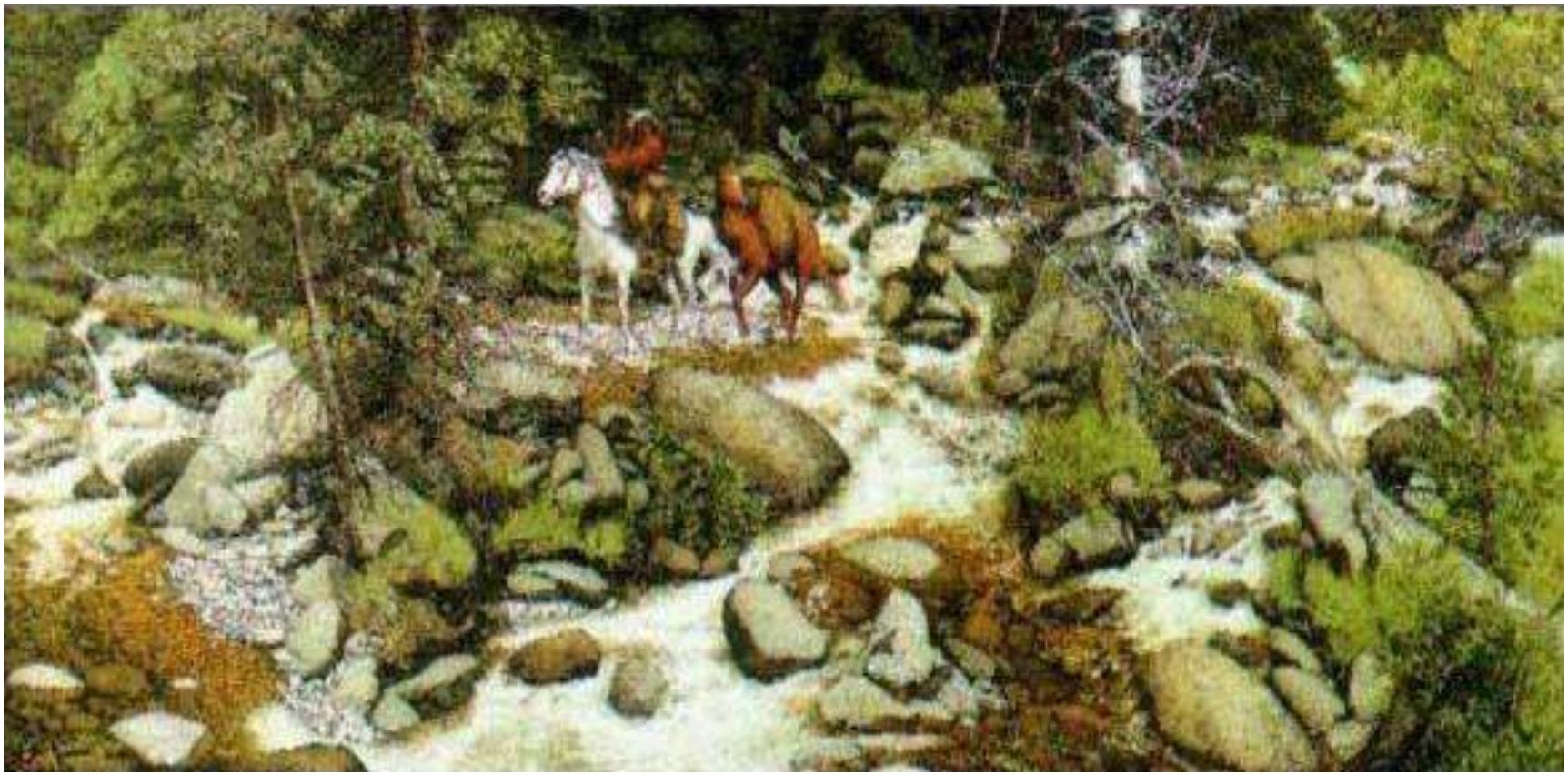
Seeing ≠ Perceiving



ACA 759 – low situational awareness due to mental set?

Selective Perception

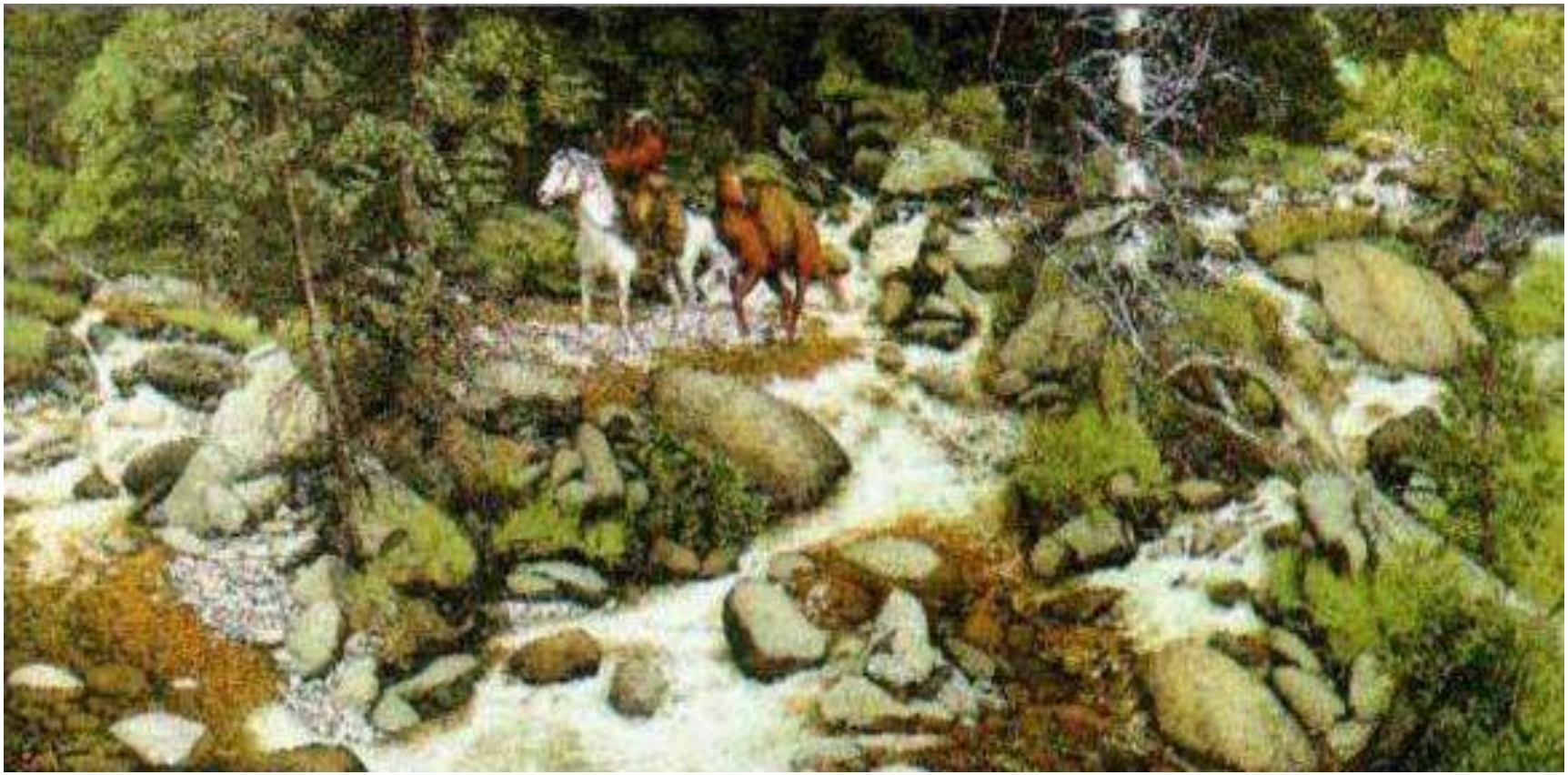
On which horse does the cowboy sit on?



ACA 759 – low situational awareness due to mental set?

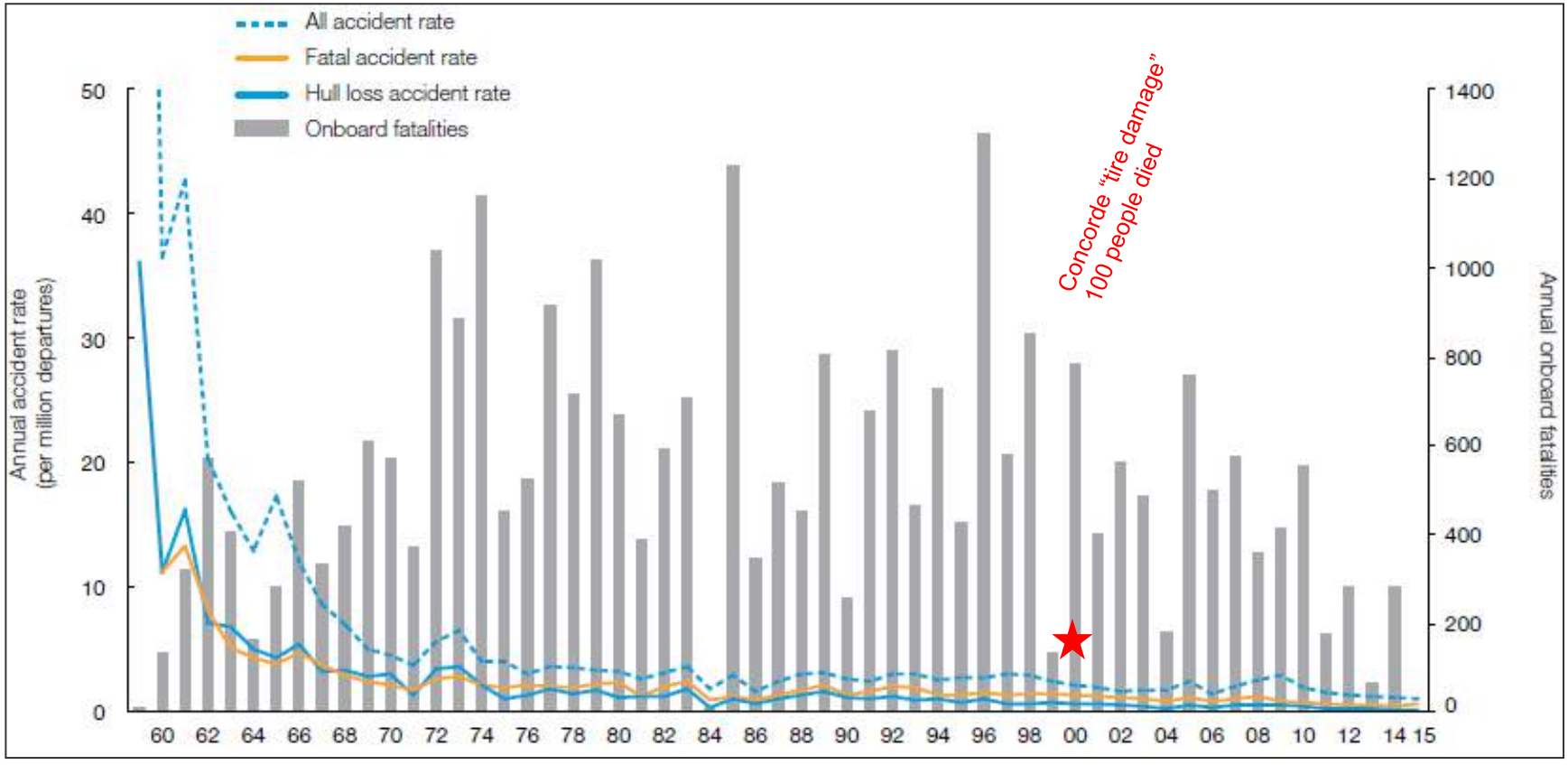
Selective Perception

How many faces are on the picture?



General Flight Safety Aspects

Worldwide accident rates and onboard fatalities by year 1959 through 2015*

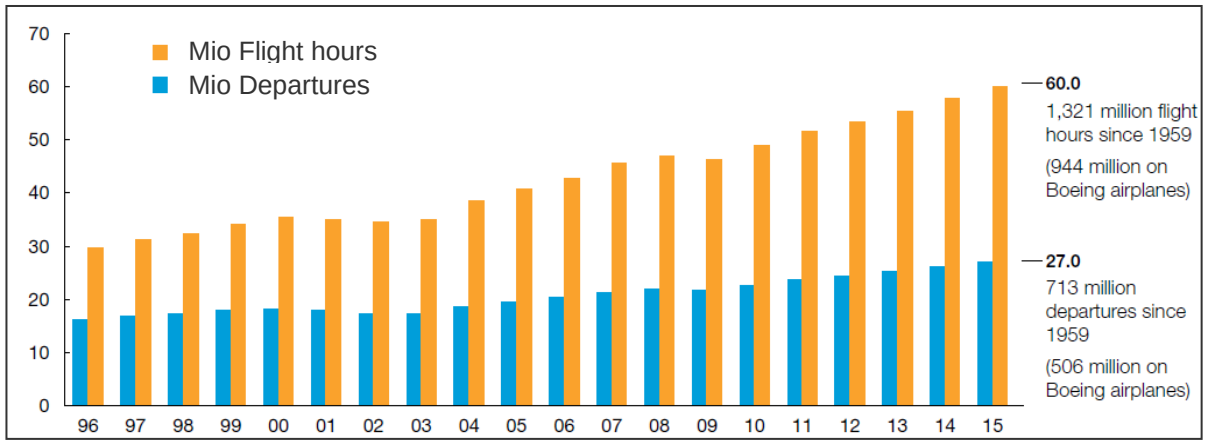


BOEING statistical summary via www.aviation-safety.net

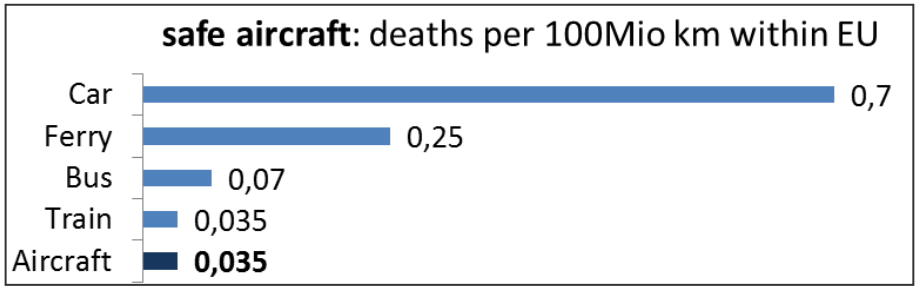
- Significant decrease of flight accidents past 60 years caused by
  - technical improvements and increase of reliability & cockpit automation (1960s)
  - first Human factor studies late 70s which became mandatory part of pilot qualification syllabus as „Crew Resource Management Training focusing on non technical skills (90s)
  - 3.7 Billion passengers in 2017 expecting to grow to 7 Billion in 2037 (IATA)

General Flight Safety Aspects

Worldwide departures, flight hours 1996 – 2015 and some safety figures



BOEING statistical summary via www.aviation-safety.net



ETSC

JACDEC

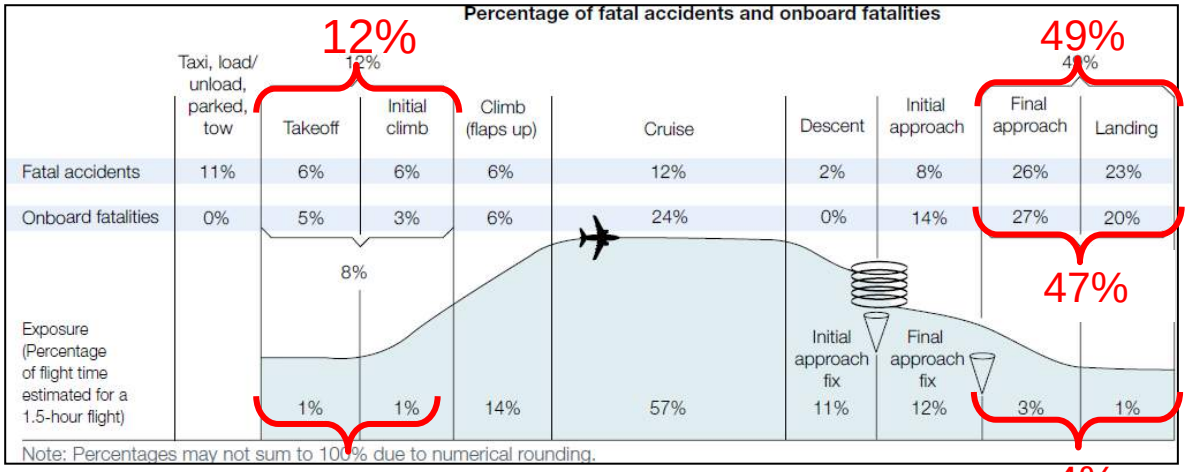
RANK	AIRLINE	CODECS
1	Cathay Pacific Airways	CX, CPA
2	Air New Zealand	NZ, ANZ
3	Hainan Airlines	HU, CHH
4	Qatar Airways	QR, QTR
5	K L M	KL, KLM
6	EVA Air	BR, EVA
7	Emirates	EK, UAE
8	Etihad Airways	EY, ETD
9	QANTAS	QF, QFA
10	Japan Airlines	JL, JAL
11	All Nippon Airways	NH, ANA
12	Lufthansa	LH, DLH
13	TAP Portugal	TP, TA
14	Virgin Atlantic Airways	
15	Delta Air Lines	
16	Air Canada	

- Flight hours and departures doubled past 20 years to 60Mio hrs and 27Mio departures p.a.
- Generally Aircrafts are very safe by 0.035 deaths per 100Mio km
- „If you fly once a day you will have to wait 14000 years to encounter fatal accident“ JACDEC

*exclusions defined by BOEING

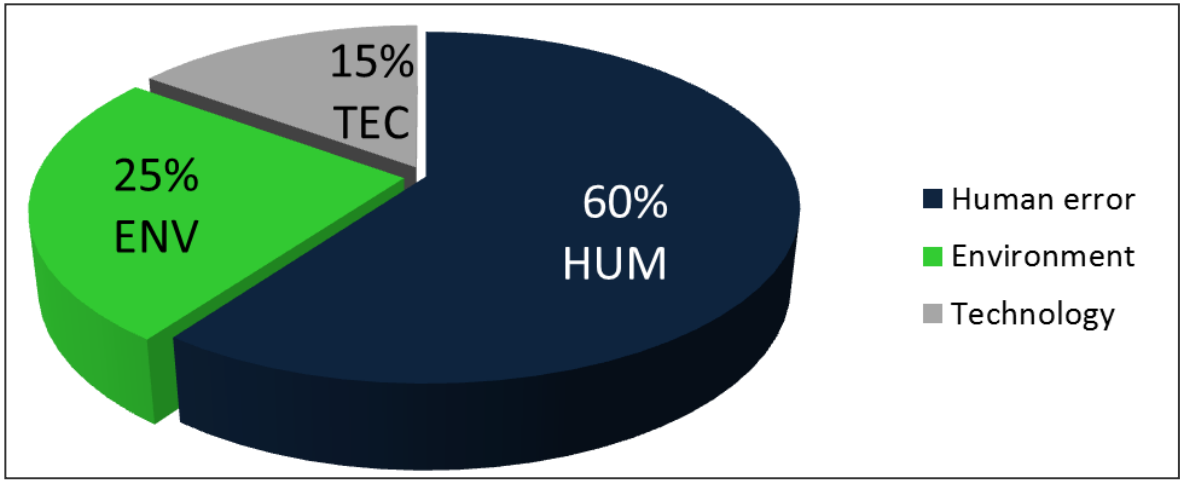
General Flight Safety aspects

Accidents by Phase of flight and Causes of aircraft accidents



	Taxi, load/ unload, parked, tow	Takeoff	Initial climb	Climb (flaps up)	Cruise	Descent	Initial approach	Final approach	Landing
Fatal accidents	11%	6%	6%	6%	12%	2%	8%	26%	23%
Onboard fatalities	0%	5%	3%	6%	24%	0%	14%	27%	20%
Exposure (Percentage of flight time estimated for a 1.5-hour flight)		1%	1%	14%	57%	Initial approach fix 11%	Final approach fix 12%	3%	1%

Note: Percentages may not sum to 100% due to numerical rounding.



- ~ 50% of fatal accidents during final approach/landing although this phase takes 4% time only
- ~ 50% to 75% of all accidents caused by human error

General Flight Safety aspects

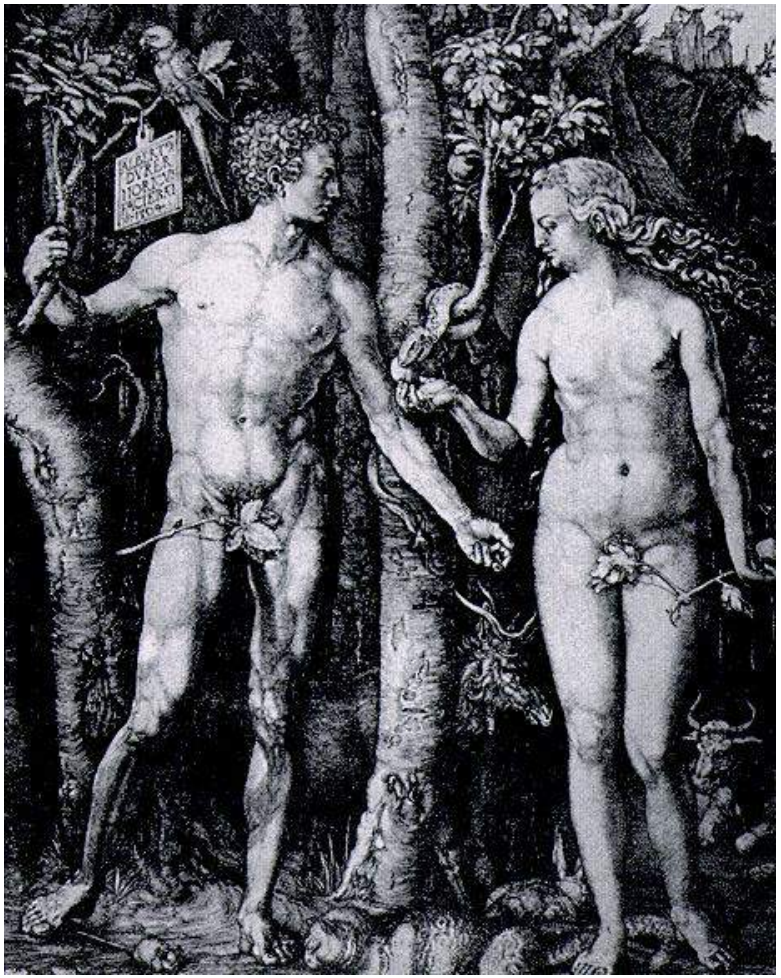
WHY Crew Resource Management

CRM Modules/ Syllabus	
Error Management	✓
Company Safety Culture	
Stress Management	
Decision making & Risk Assessment	
Communication & Cooperation	
Leadership	
Situational Awareness	✓
Case studies	✓

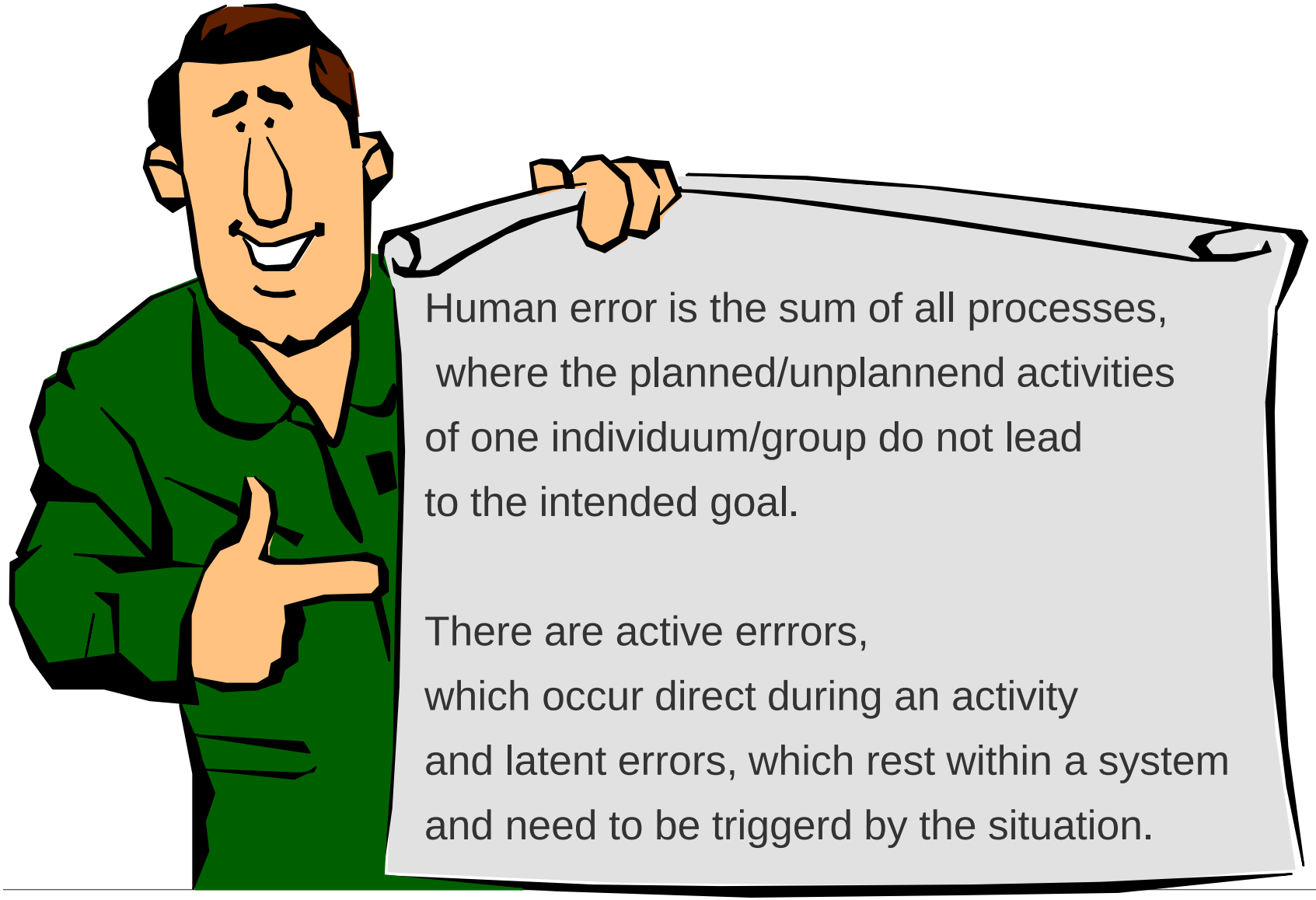
Crew Resource Management (CRM) is the **effective** use of **all available** resources to achieve **safe** and **efficient** operation and ha,

Human error

…to start from the beginning, what does makes this scene so interresting?



Human error



Human error is the sum of all processes,
where the planned/unplannend activities
of one individuum/group do not lead
to the intended goal.

There are active errrors,
which occur direct during an activity
and latent errors, which rest within a system
and need to be triggerd by the situation.

Human error

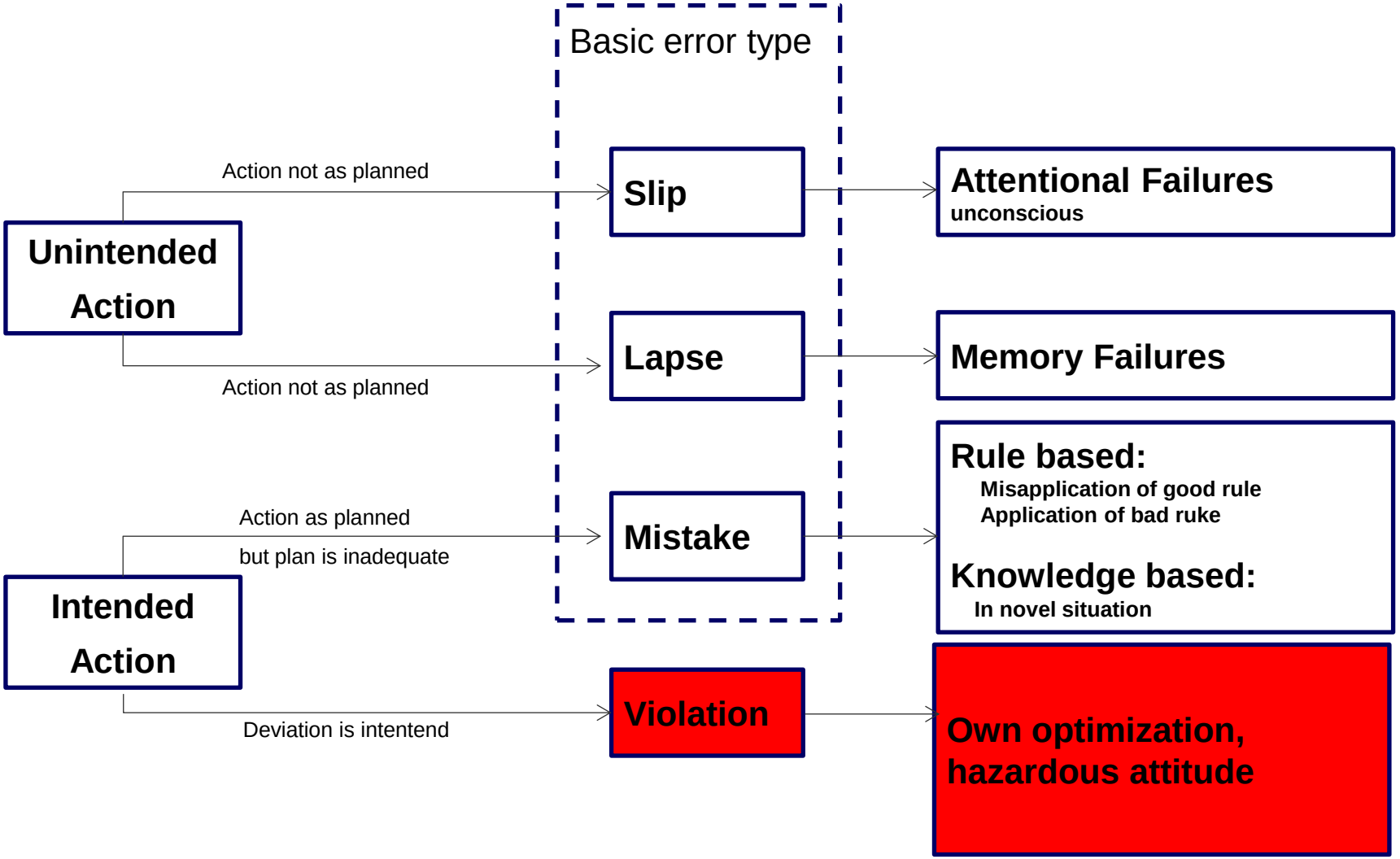
Active error vs. latent condition

Active Failure	• unsafe acts, done be sharp enders/ operators • always connected with negative consequencies • create weaknesses in protective layers
Latent condition	• longer lasting than active failures • they are present within a system prior to an advers event and have not been recognised as long an icident/accident occurs • often unwittingly seeded by designers, engineers, managers

All attempts to discover and neutralize latent errors are more succesful, than fighting active errors.

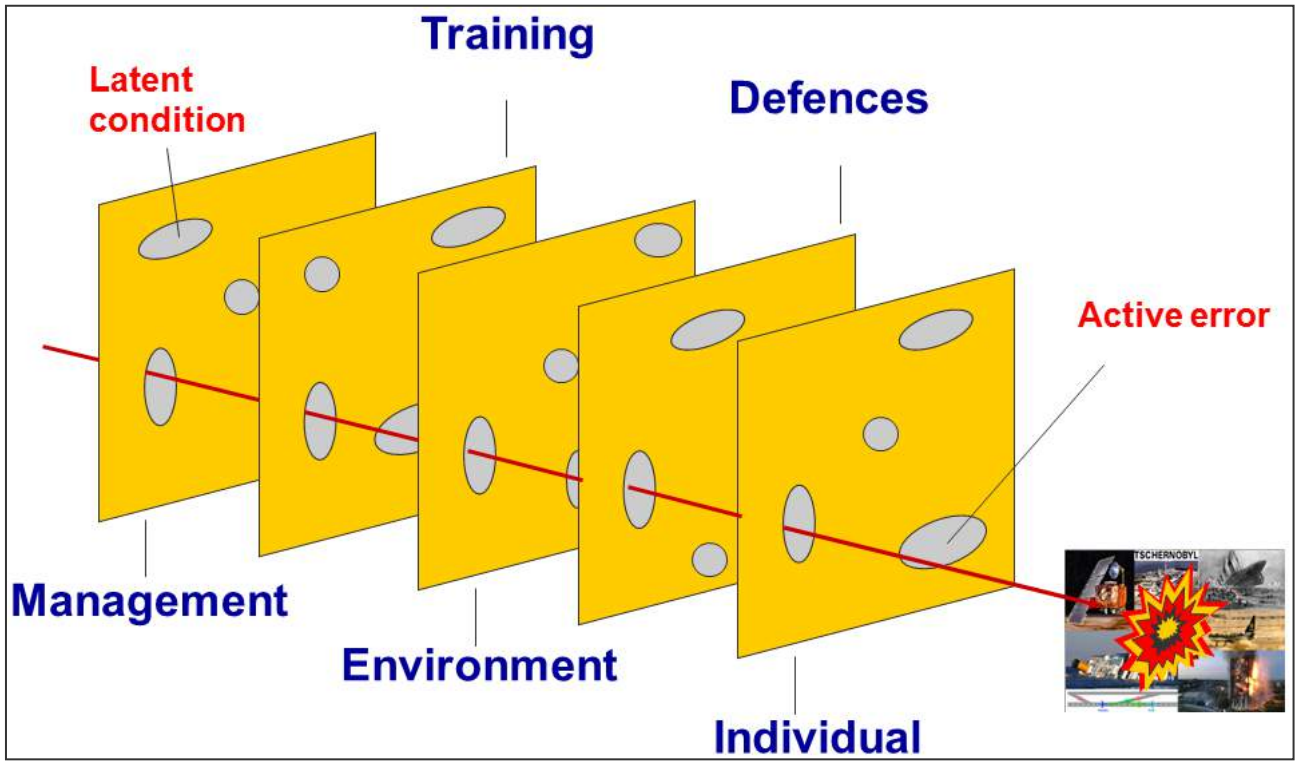
Human error

Basic error types



Human error

Swiss Chees Modell

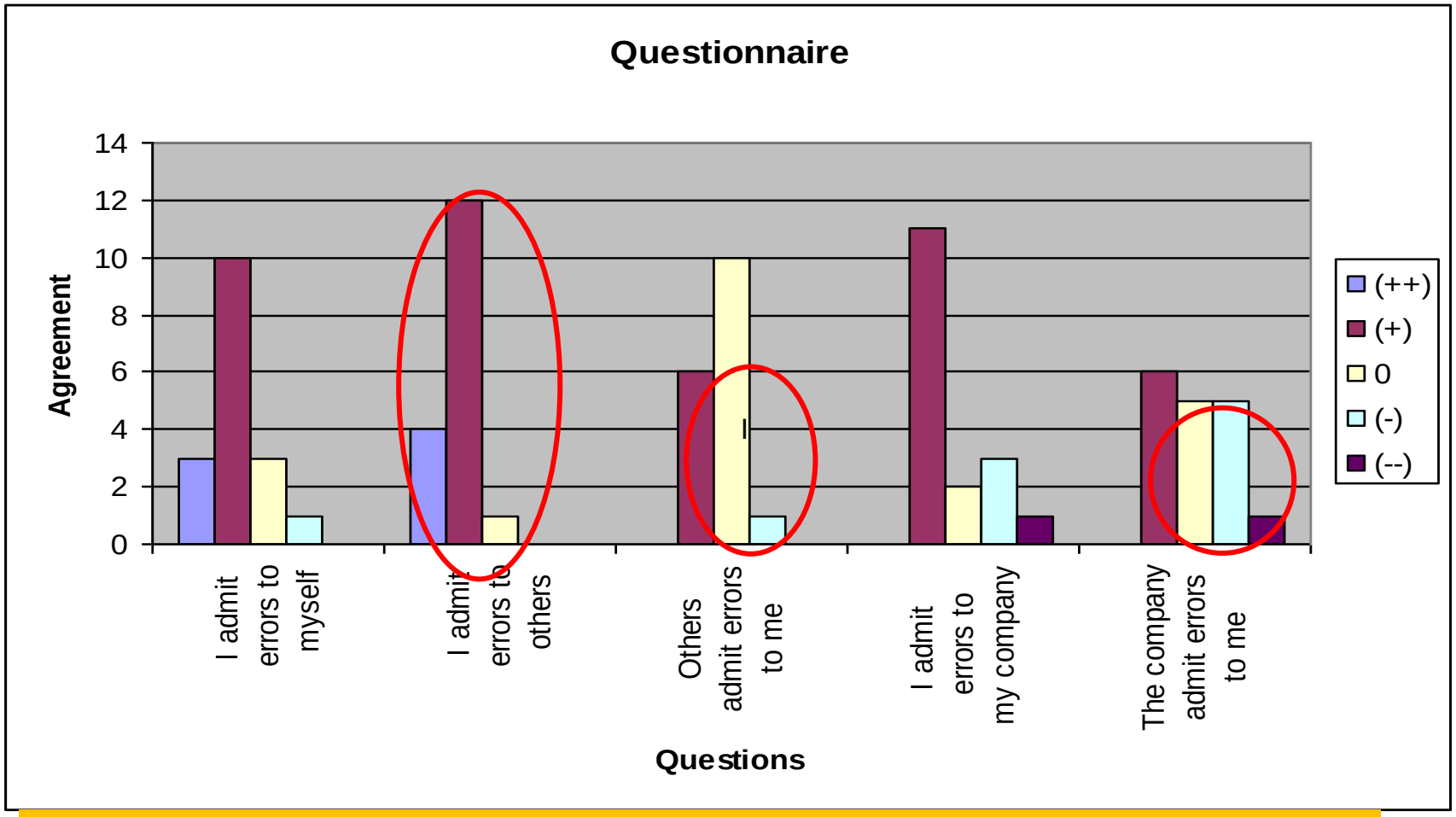


modified after Reason

- Systemic approach by J. Reason
- Safety barriers/ strategies to be establlished by organizations to avoid direct trajectory of erros
- Active erros and latent condition create weaknesses and holes

Human error

Quick check for error culture



- For quick check ask your team/ organization of how thy feel when it comes to mistakes. Interesting results to talk about…

Concorde accident at Charles de Gaulle Airport Paris 7/2000

background information

Cause

According to french investigation report (BAE) catastrophe was caused by 43cm stainless metal strip which laid on Runway. Contrary to the original part which was made of aluminium this metal strip was made of titanium. If tyre had rolled over the original part, the tyre would have been damaged.

Chain reaction

Debris with transverse cut 32cm

The metal strip which had fallen from another aircraft damaged one tyre when Concorde rolled over it. Debris (4,5kg) was thrown against the wing structure leading to a rupture of a tank. A major fire, fuelled by the leak, broke out almost immediately under the left wing and finally caused the aircraft to crash in a hotel. 113 people died

Question of guilt

The titanium metal strip fell of from a another aircraft DC-10 (US operator) which had taken off 5min earlier. Investigation revealed that the maintenance staff deviated from maintenance instructions. Instead of using an aluminium part they used a titanium metal strip. Neither metal strip nor riveting work performed to assembly the strip was in accordance to maintenance manual of the OEM.

Metal strip on Rwy

Concorde accident at Charles de Gaulle Airport Paris 7/2000

background information

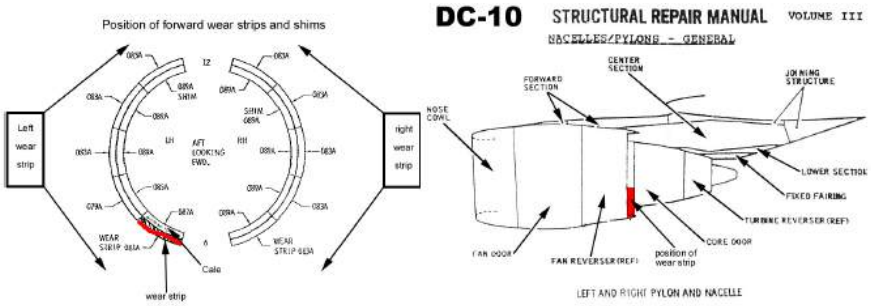


Figure 51: Diagram showing the position of the wear strips

Position of wearstrip at DC10 thrust reverser

BAE Investigation :

"*In aviation, maintenance is a critical element for safety and it is* ***indispensable to complete all the necessary checks****,* ***however urgent the operation may be….***

The ***loss of the wear strip*** *from the thrust reverser door on the Continental Airlines DC-10 originated* ***from lack of rigorous maintenance…***

*…****inadequate adherence to maintenance procedures*** *by the various workshops that carried out work on the reverser cowl. Thus the engine cowl support was* ***drilled with thirty-seven holes*** *whereas the installation of the strip requires* ***only twelve; equally, a titanium piece was used*** *…which is not normally used for this operation"*

Concorde accident at Charles de Gaulle Airport Paris 7/2000

background information

Individual: deviation from maintenance procedure

Management: missing safety culture

Training: qualification, skills

Management: weak tyres (75 known tyre burst)

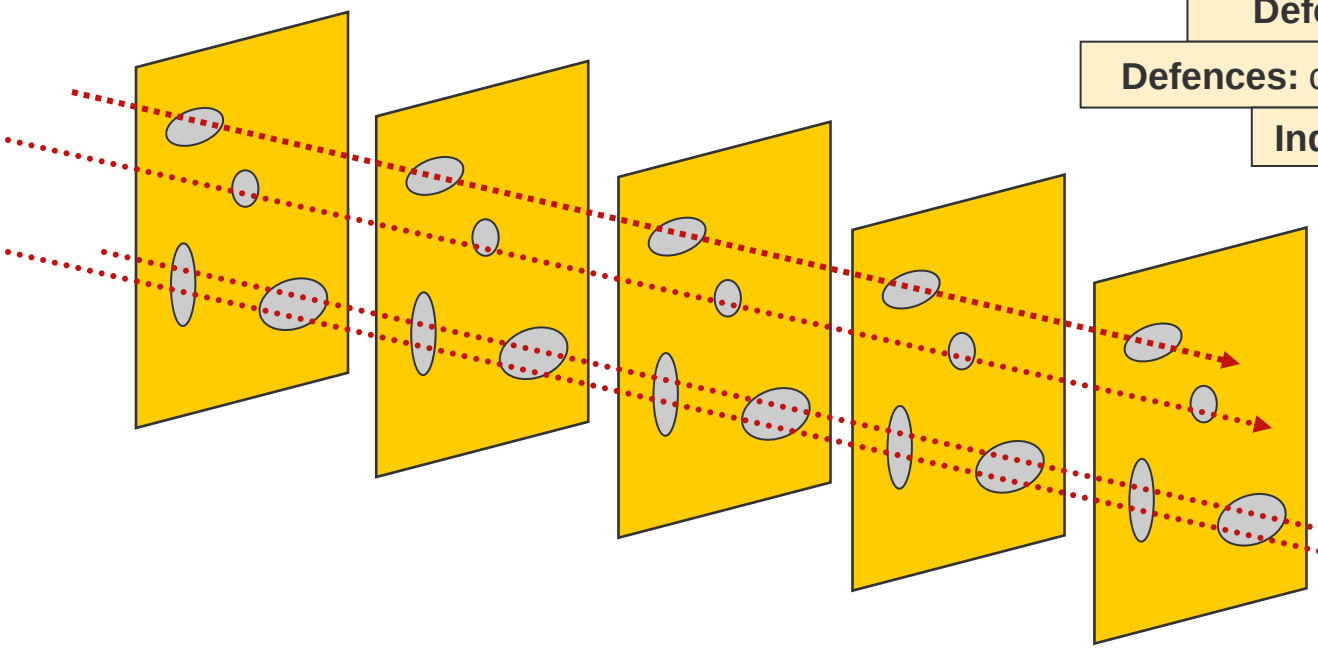
Defences: fuel, baggage overload

Defences: center of gravity out of balance

Individual: distance ring missing

Environment: tailwind

Defences: tank structure



- Deviation from maintenance procedure undoubtfully as major cause nevertheles manyfold contributing causes

modified after Reason

Lufthansa Technik Group – Facts & figures

Leading provider of MRO services in the world's airline business

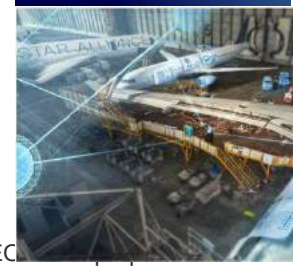
800+
customers
worldwide

~21.000
employees
worldwide*

>4.000
Contracted aircrafts

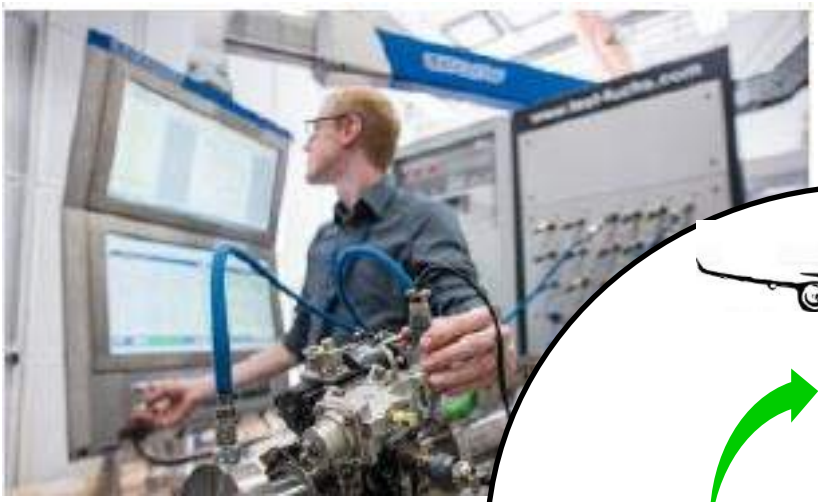
5.1
billion €
in revenue*

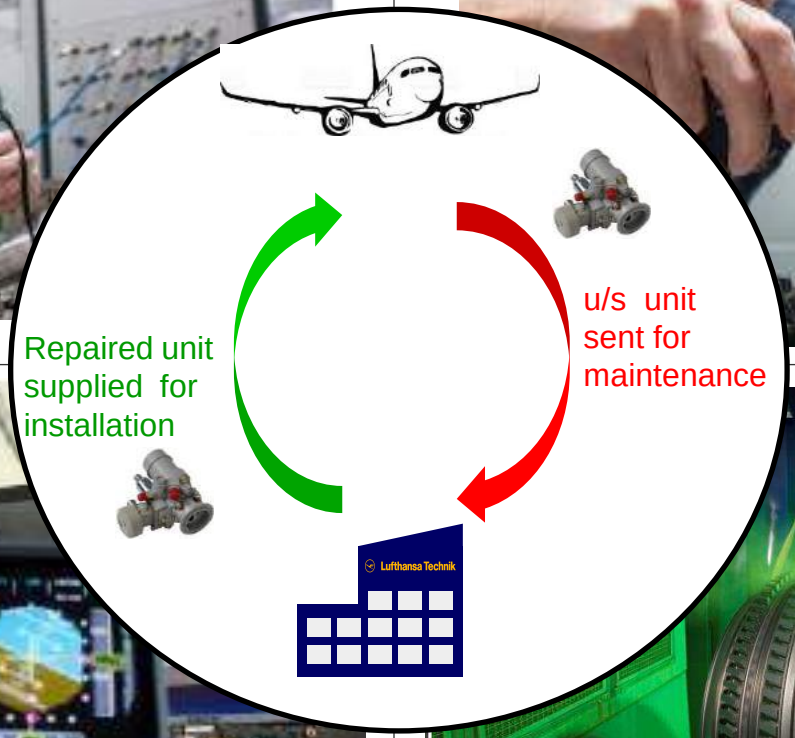
6 divisons
Global footprint

Aircraft Services (Maintenance, Overhaul)	Engine Services	Component Services	Landing Gear Services	VIP & Special Mission Services	Digital Fleet Solution
					

Lufthansa Technik – Component Services

Every Aircraft of the world operates with parts from LHT Component Services





Lufthansa Technik – Component Services

Every Aircraft of the world operates with parts from LHT Component Services

Promote learnings from errors to prevent recurrence!

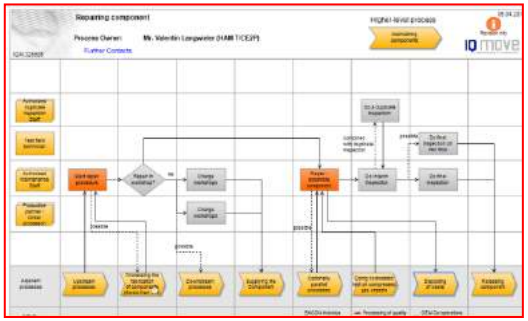
Work in accordance to maintenance manuals & Aviation Authority Requirements!

"Our products and services become …

Integral part of our customers safety nets."

T. Stüger, Member of Executive Board

q/star
q/star



Report errors via occurrence reporting tool to ensure investigation & sustain correction!

Follow defined process to ensure high standardization!

Lufthansa Technik – Component Services

incorrect position of ball in the valve assy

Customer PO	2278901
LHT reference	accelerated pool supply request 24989589
Part designation / description	VALVE ASSY-WASTE SYS
Part Number	2651-357-13
Serial Number	145416
Engine type - Customer	./.
Description of problem	**Customer requested Valve assy P/N 2651-357-13 S/N 145416. In order to avoid AOG unit was accelerated by customer service. OVHL of this unit was performed according CMM ATA 38.38.10 Revison date 31.08.2009 and included cleaning, dissassembly and repair of parts. During assembly ball was assembled according to drawing of CMM but finally incorrect.**
Qty of parts	**1**

- Customer complaint because of incorrect assembly. Component could not be installed on aircraft.

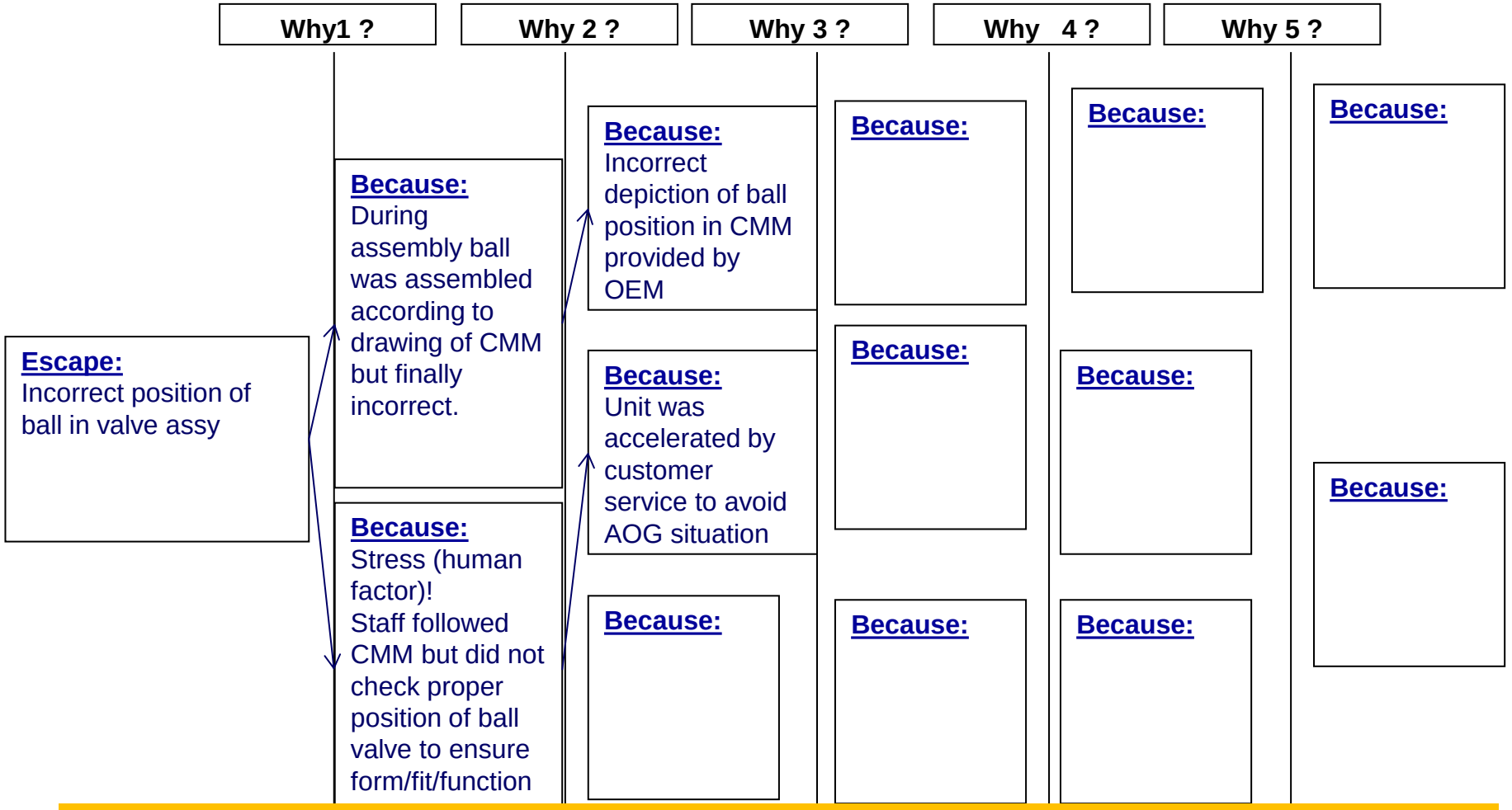
8D report_ VALVE ASSY-WASTE SYS PN 2651-357-13 SN 145416

incorrect position of ball in the valve assy

D1: Team 1. *Team description*	1. ….	
D2: Problem 1. *Supplier to describe discrepancy*	1. see page 1	
D3: Risk control + immediate measure 1. *Assess risk! (low-medium-high)* 2. *State immediate action!* 3. *Define impacted population!* 4. *State containment action!* 5. *Did supplier contain escape?*	1. medium (unit could not be assembled to aircraft but caused AOG situation) 2. correct installation of ball in valve assy 3. 1ea 4. stock check 5. yes	
D4: Root cause analysis 1. *Do "5 Why"*	1. next page	
D5: Planned corrective actions 1. *Regarding creation* 2. *Regarding detection*	1. Product Engineer to inform OEM to ensure correct CMM with proper and clear explanation of ball position 2. Creation of supplemental page to be embedded in LHTs component maintenance document system "CMDS" and information to all mechanics of this workshop in shop performance dialog. Additionaly this case will be used as case study for next human factor training.	
D6: Implemented corrective actions 1. *Regarding creation* 2. *Regarding detection*	1. No answer yet from OEM Rockwell Collins 2. See D5 & additionally stock check was performed by LHT including 1ea BOX home base unit SN 141689 which turned out to be assembled correctly	1. Implementation date: still open but follow up 2. Implementation date: 26.08.2015
D7: Actions to prevent recurrence 1. *FMEA or other actions* 2. *Provide evidences*	1. ./. 2. See pictures attached slide 4-5. Demonstration during BOX Audit calendar week 39.	
D8: Congratulation 1. Name + supplier closure date	Stephan Lange, 17.09.15	

8D report_ VALVE ASSY-WASTE SYS PN 2651-357-13 SN 145416

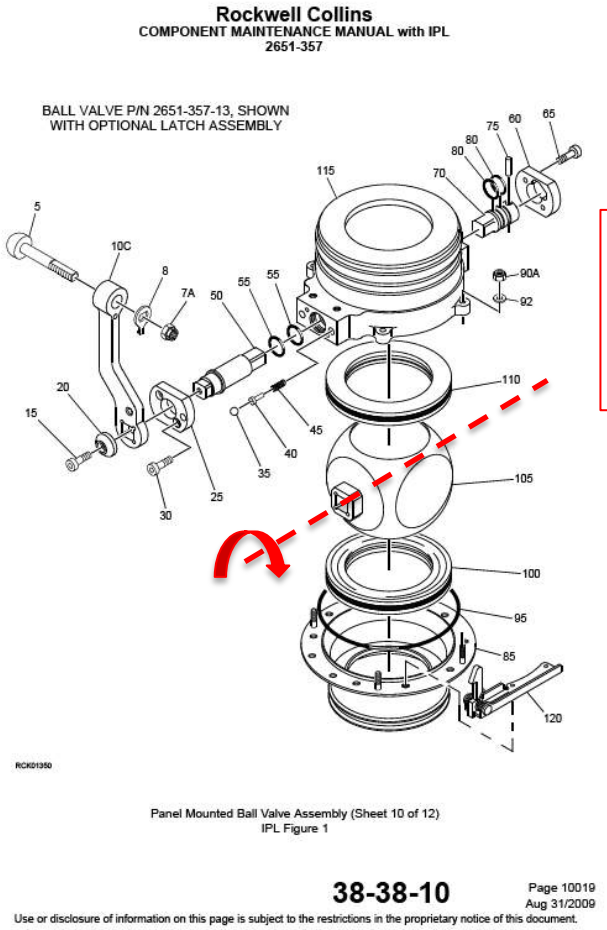
incorrect position of ball in the valve assy



- 5WHY analysis revealed incorrect manual description which was correctly followed but led to incorrect assembly

8D report Ball valve PN 2651-357-13 SN 145416

incorrect position of ball in the valve assy



Ball 105 with incorrect position as per CMM.
If you rotate the ball 90° as shown the **curved backside of the ball** will be on top side in closed position.

Correct position of ball will ensure flat side on top in closed position.

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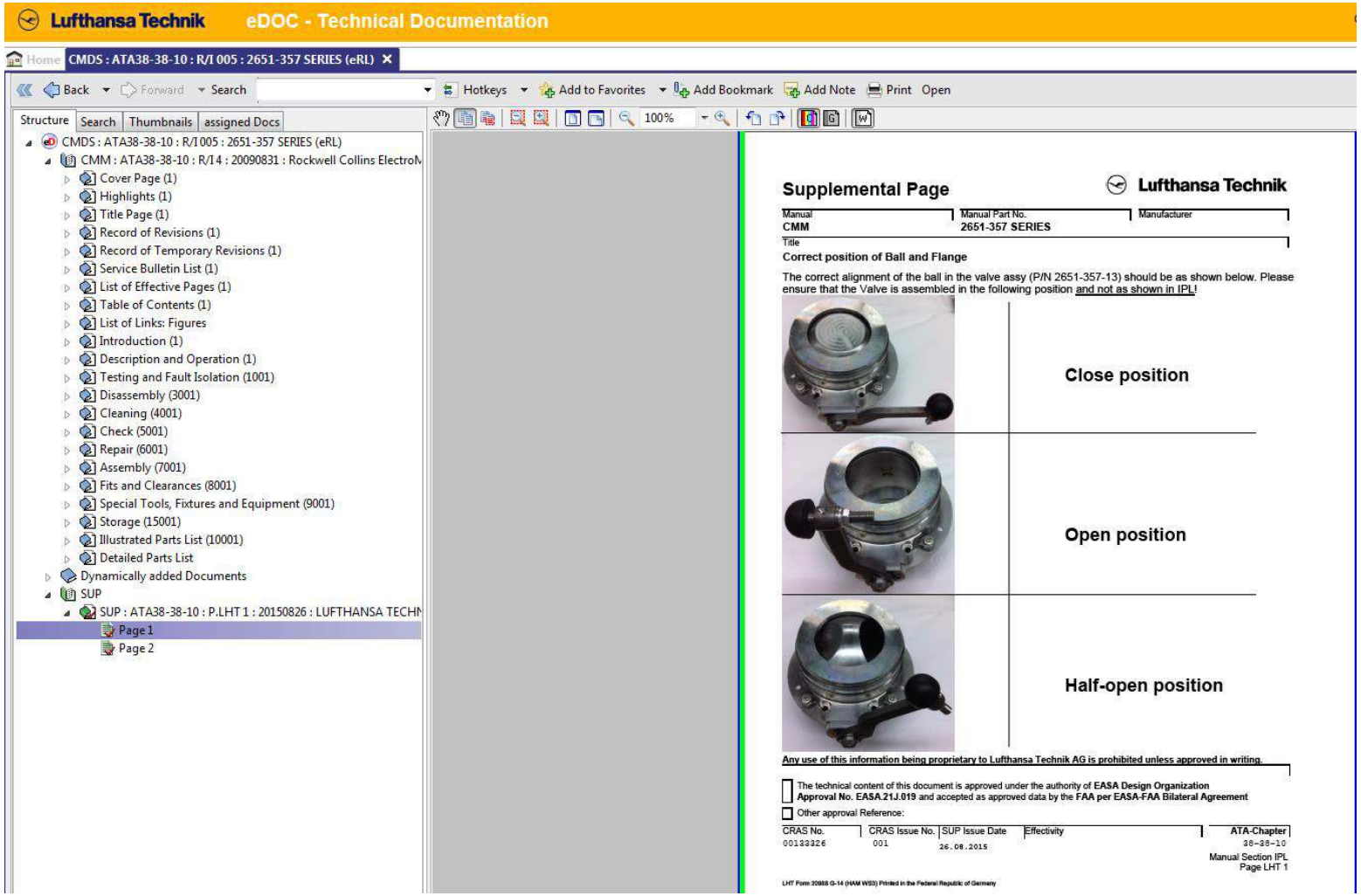
8D report_ VALVE ASSY-WASTE SYS PN 2651-357-13 SN 145416

incorrect position of ball in the valve assy



Screenshot of supplemental page 1 embedded in CMDS explaining correct ball position

Core Message

1. **„To err is human.“ To strive for a „zero error“ state, it is not an attainable goal! Errors are inevitably and reflect the strengths and weaknesses of human mental functioning.**

2. **Succesfull Error Management in organisations avoids „blaming“ and reduces the negative consequences of errors. It promotes learning & innovation and it positively correlates with firm performance.**

3. **Try to find out circumstances which caused errors and figure out WHY the behaviour might have been rational to the people involved!**

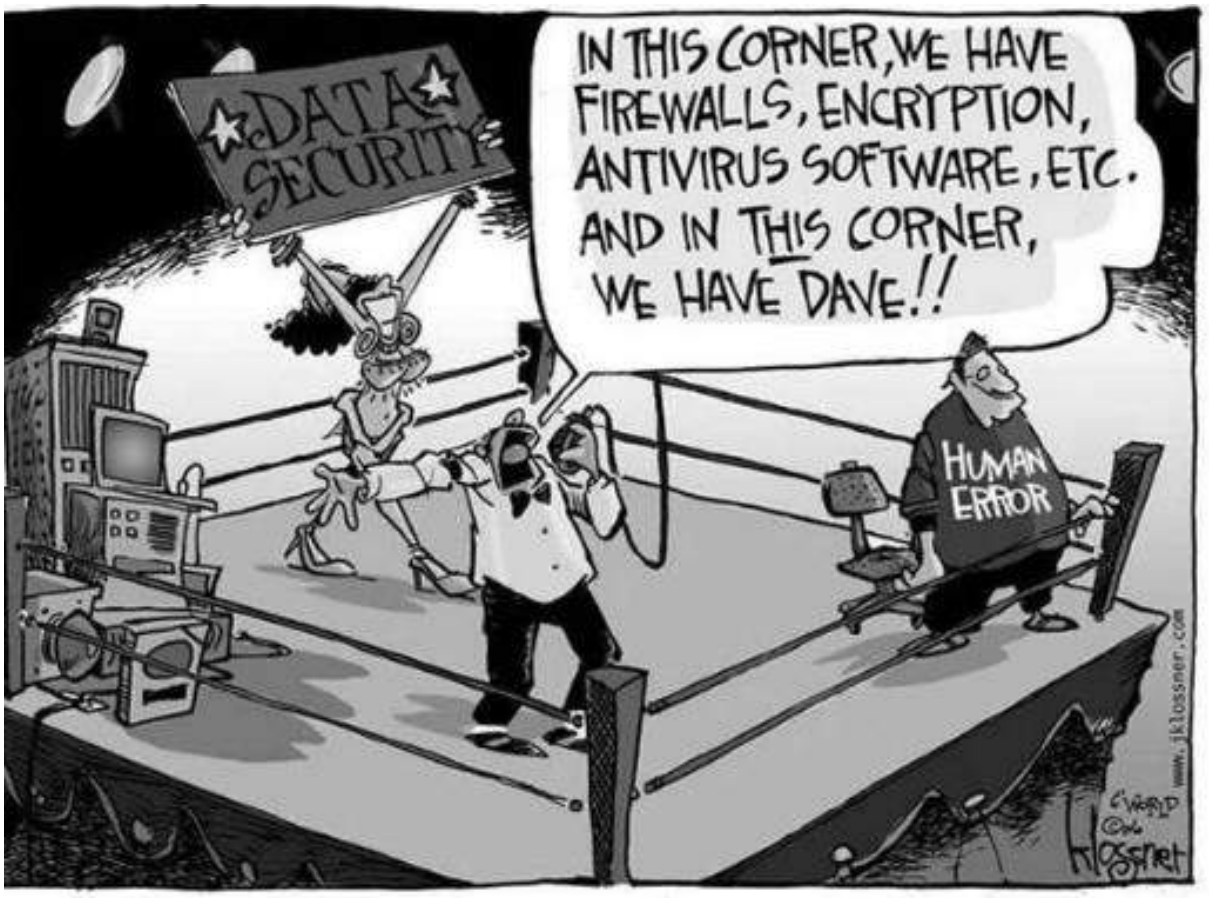
4. **People are prone to make mistakes in novel situation. Nevertheless errors mark the boundaries of an acceptable, innovative way forward.**

5. **Difference between active errors and latent condition. Level of consciuosness differenciates slips, lapses , mistakes and violations.**

6. **Designers, Architects, Engineers … are prone to seed latent failures/ conditions into a system which will rest there and which are present prior to an active failure.**

7. **Violations decline with age/ seniority, errors do not. Men at all ages violate more often than women whereas women are more lapse prone („uppsis“).**

End



… and Dave from Lufthansa has finished his lecture.

Thank you very much for your patience...

…and don`t forget that only a 0 does not have any corners and edges.

Lufthansa Technik

Maintaining components

Process Domain Owner: Mr. Udo Janssen (HAM T/CE2)

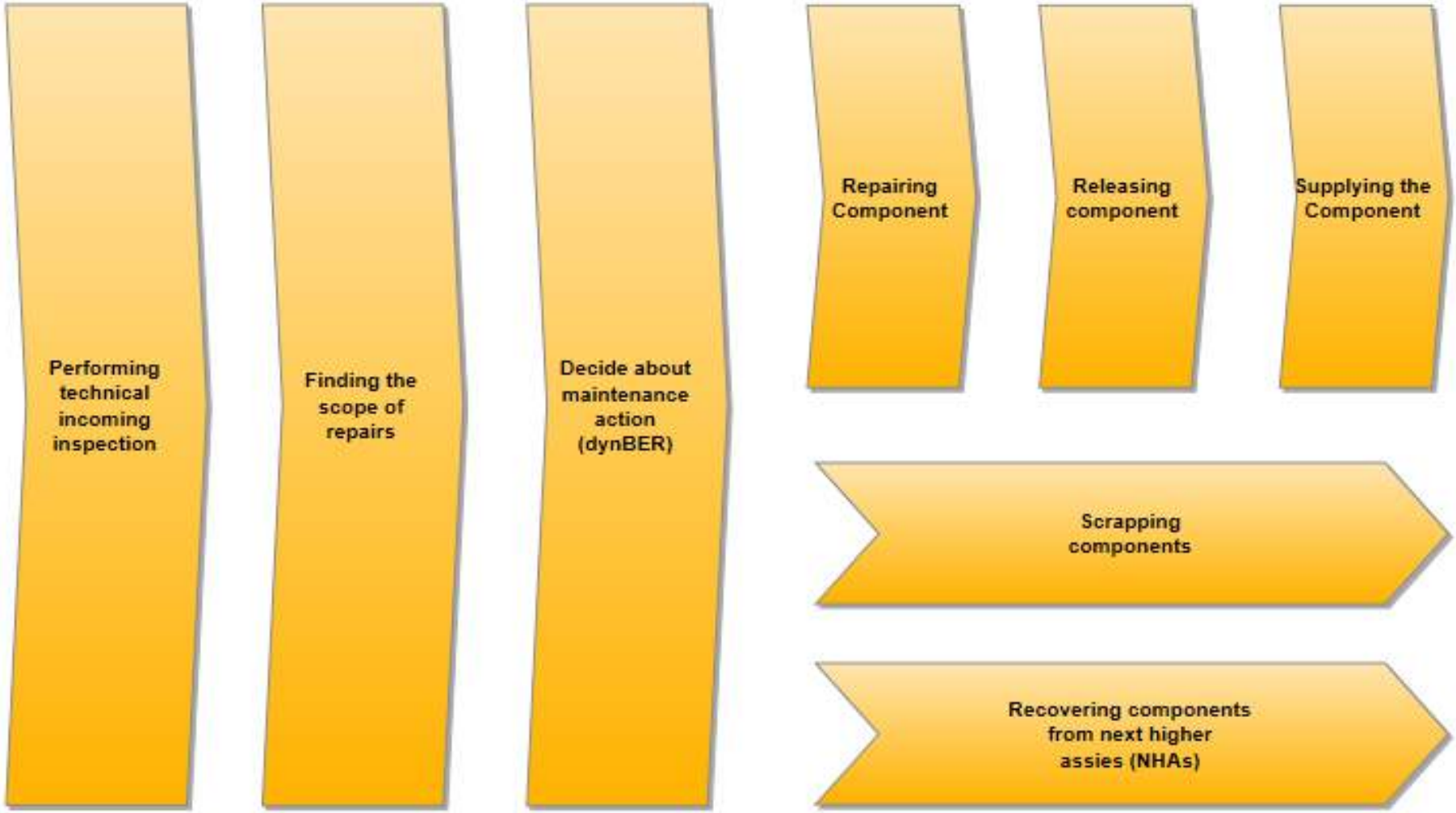
Emergency concept: Materials Supply Chain for Workshops

Higher-level process: Perform component maintenance

16.12.2015

Revision Info

IQM.298749



Releasing component

06.09.2017

Process Owner: Mr. Valentin Langwieler (HAM T/CE2P)

Further Contacts

IQM.305912

Higher-level process

Maintaining components

Revision info

IQ move

Additional Information for testing of card assies

Responsibility of the Certifying Staff

Authorized Maintenance Staff

Certifying staff

Authorized Duplicate Inspection Staff

Order manager

Do final check

Certify component

Do a duplicate inspection

with findings

In case of a control table adjustment for Yosho items

requirement for dual inspection

Do final check after certification

with findings

for special time limit requirements

Complete the order technically

Adjacent processes

- Repair / Technical incoming inspection
- Repairing Component
- Maintaining control table for "Flight important critical items" (Yosho items) of Japanese pool customers
- Apply for + implement change of operating times as required by the aviation authority
- Provision - internally / SLCs
- Repairing Component
- Provision - internally / SLCs
- Invoice / Guarantee

Activity-related documents

- Processing of quality inspections
- LLK User Manual
- Processing of quality inspections
- Archiving regulations
- Certificate of Conformance (LHT Form 32765)
- Completion Instructions EASA Form 1 (LHT-020)
- Doing the instructed work
- Processing of quality inspections
- Brief instruction GAR-Field workshop
- ICS Processing Reference for Workshops
- Processing help GAR-Field (Workshop)
- Short instructions

IQ move

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Ausfüllanleitung EASA Form 1 / Instructions for completing EASA Form 1

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3. Feldweise Ausfüllanleitung für Instandhaltung (Part-145) / Completion of each single Block for Maintenance (Part-145)

Feld/ Block	Eintragung (Part-145)	Entry (Part-145)
1	Vorgedruckt – keine Eintragung erforderlich.	Pre-printed – no entry required.
2	Vorgedruckt – keine Eintragung erforderlich.	Pre-printed – no entry required.
3	Vergeben Sie eine eindeutige, rückidentifizierbare Nummer (kann alphanumerisch sein) aus der EDV *ODER* generieren Sie eine Nummer der folgenden Form und tragen Sie diese ein: „Abkürzung der LHT Group Approval Firma / Werkstatt-Organisationszeichen, falls genutzt / Datum (*dd MMM yyyy*) / laufende Tagesnummer" z. B.: (1) LHT/WG225/03NOV2010/003 (bedeutet: drittes Zertifikat von LHT-WG225 am 3. November 2010) (2) LTB/03AUG2011/001 (bedeutet: erstes Zertifikat von LHT Budapest am 3. August 2011)	Enter a unique, traceable number (maybe alphanumerical) from the EDP system *OR* Generate and enter a number in the following format: "LHT-Group Approval Company Abbreviation/ Workshop-Abbreviation, if used / date (*dd MMM yyyy*) / consecutive number for current date" E.g.: (1) LHT/WG225/03NOV2010/003 (meaning: the third certificate issued by LHT workshop WG225 on 03 November 2010) (2) LTB/03AUG2011/001 (meaning: first certificate issued by LHT Budapest on 03 August 2011)
4	Vorgedruckt – gleicher Name und gleiche Adresse für alle LHT Group Approval Firmen unter der gleichen LBA-Genehmigung.	Pre-printed – same name and address for all LHT Group Approval companies under the same LBA approval.
5	Bei Kunden-Einzelaufträgen: Tragen Sie die Kundenbestellnummer ein, ansonsten die interne Auftragsnummer.	For one-off customer ord… number, other…
6	Bei der Freigabe von mehr als einer Teilenummer: Tragen Sie die Zeilennummerierung (1, 2, 3... oder 0… 02, 03... oder 0200, 0500, 0300... oder AB1 C… sonst freilassen.	

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Ausfüllanleitung EASA Form 1 / Instructions for completing EASA Form 1

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1. Abbildung der EASA Form 1 (LHT Form 30800) / Facsimile of EASA Form 1 (LHT Form 30800)

1. Approving Competent Authority / Country
LBA / Germany

2.
AUTHORISED RELEASE CERTIFICATE
EASA FORM 1

3. Form Tracking Number

4. Organisation Name and Address:
Lufthansa Technik
Lufthansa Technik AG
Weg beim Jäger 193
22335 Hamburg
Germany

5. Work Order/Contract/Invoice

6. Item	7. Description	8. Part No.	9. Qty.	10. Serial No.	11. Status / Work

12. Remarks
ATA TP MK-No. Pack Code Resp. Workshop Workshop Station

Return to Service in Accordance with 14 CFR part 43
The work identified in Block 11 and described herein has been accomplished in accordance with 14 CFR part 43 and in respect to that work the items are approved for return to service under
FAA Certificate No.
TCCA Approval No.:
Further details of work performed are attached either in a Workshop Report reference number see blocks 3 and 5 or in other applicable documents

13a. Certifies that the items identified above were manufactured in conformity to:
approved design data and are in a condition for safe operation
non-approved design data specified in block 12

14a. Part-145.A.50 Release to Service
Other Regulation specified in block 12
Certifies that unless otherwise specified in block 12, the work identified in block 12, was accomplished in accordance with Part … considered ready for release to service.

13b. Authorised Signature

13c. Approval / Authorisation Number
DE.21G.0047

14b. Aut…

13e. Date (dd mmm yyyy)