

Effects of flight crew role assignment on aviation accidents and incidents: empirical evidence for a systemic safety issue

Capt. Tom Becker, MSc, TRI
Department of Psychology
City, University of London

Prof. Peter Ayton
Centre for Decision Research
University of Leeds



Currently allowed despite scientific concerns: PIC as PF → COMMAND & CONTROL

LEADER

PIC as PF



FOLLOWER

SIC as PM

RESEARCH DATA

- Database used: Jet Airliner Crash Data Evaluation Centre (JACDEC).

JACDEC claims that the database includes ***“all known accidents, hull losses, serious incidents and incidents in civil aviation... back to 1969”*** comprising (April 2021): 17,795 worldwide events: 4,885 hull loss accidents; 7,220 serious incidents and 5,690 incidents.

- We studied events between 2000-2020 involving **Medium & Large Commercial Aircraft only**.

We excluded

- ground events not associated with take-off or landing operations.
- events exclusively attributed to technical malfunctions.
- all events in which more than a single aircraft was involved
- all events involving military aircraft and aircraft requiring navigator/radio operator
- all events involving small aircraft (MTOW < 15t), e.g. due to single pilot operation.

- Final **sample of 2,293 events** comprising 370 Incidents, 1,459 Serious Incidents and 464 hull losses together accounting for 9,256 fatalities.



Four Assessed Variables

1) Role Assignment is a binary variable reflecting whether the PIC or SIC was the PF

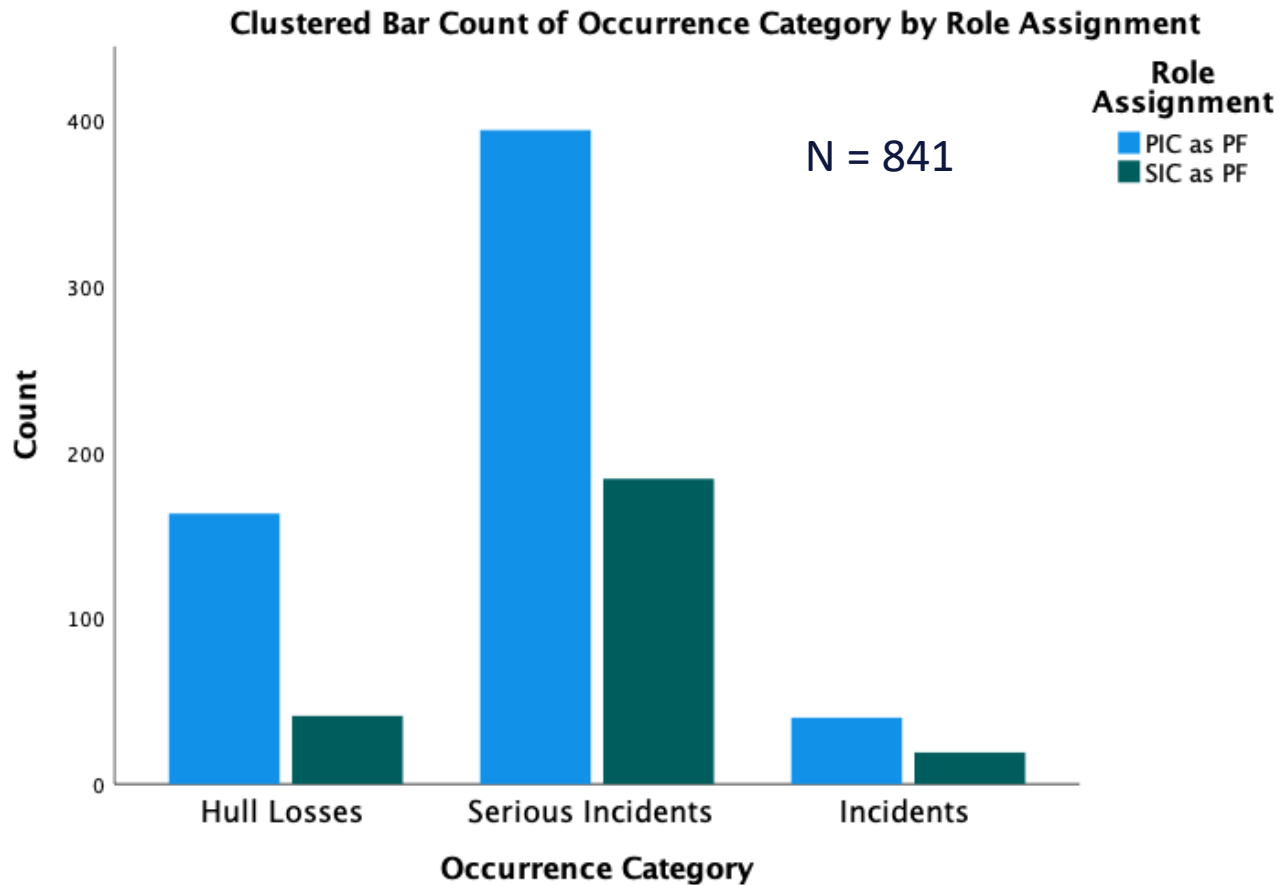
2) Mode of Operation is a binary variable reflecting whether the aircraft was in *Normal Operation* or *Non-Normal Operation* as defined by the aircraft's technical and flight status.

- **Normal operation** (technically airworthy aircraft and no emergency present)
- **Non-normal operation** (aircraft was not technically airworthy or there was an aircraft related technical failure and/or onboard emergency (e.g. inflight smoke or fire))

3) Teamwork Behavior is a binary variable indicating whether or not “poor CRM” or “poor teamwork”, including missing or ineffective intervention, was a contributory or causal factor in the event.

4) Preventability is a binary variable denoting whether or not there was a realistic opportunity for preventing the event by pilot behavior.

Frequency of Events by Role Assignment – Period 2000-2020



All Events

- PIC as PF: 597 (71.0%); SIC as PF: 244 (29.0%)

Hull Losses:

- PIC as PF: 163 (79.9%); SIC as PF: 63 (20.1%)

Fatalities (Hull Losses):

- PIC as PF: 4078 (76.7%); SIC as PF: 1239 (23.3%)

Mode of Operation

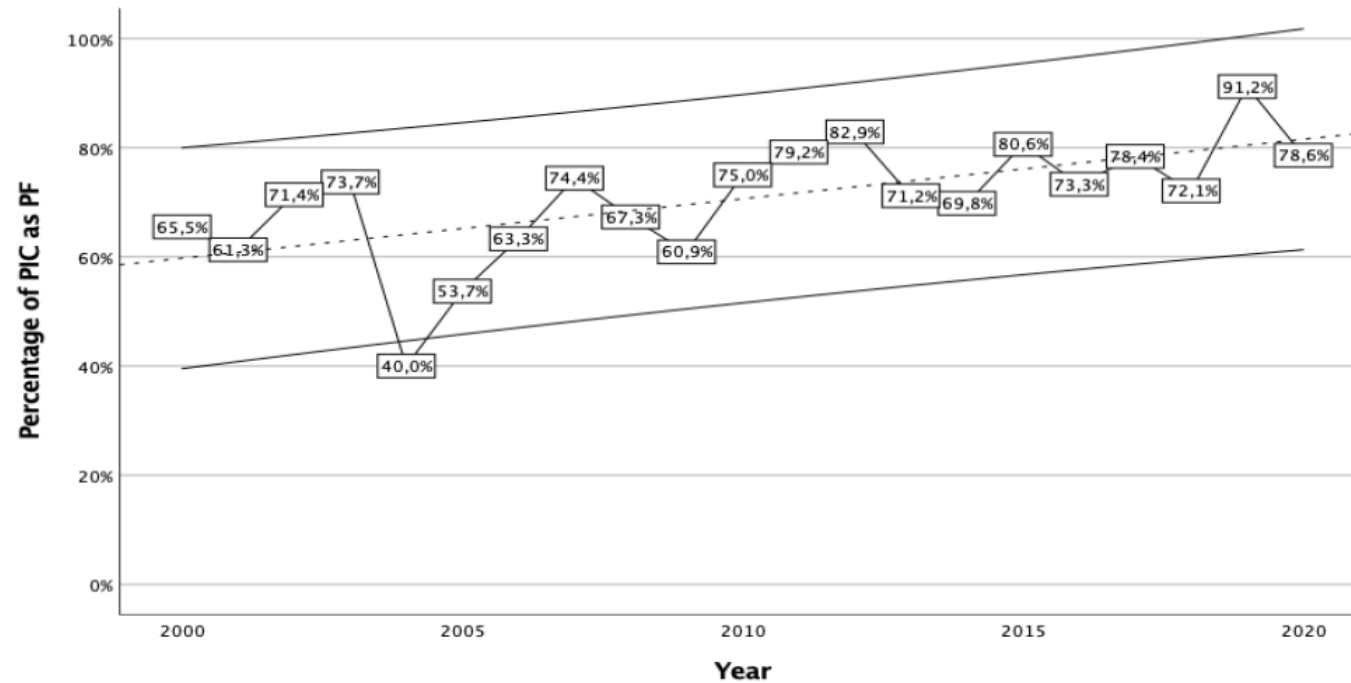
- Normal: PIC as PF: 76.3%
- Non-normal: PIC as PF: 69.6%

Change of Control (n = 110 (13.1% of 841 events))

- 55 announced (52 by PIC (94.5%))
- 55 dual input (33 same direction, 22 opposite)

Increasing trend in annual proportion of events with PIC as PF (2000-2020)

Figure 1: Percentages of the PIC as PF per year



Note: The dotted line depicts the regression fit line. The two solid lines depict the 95% confidence interval around that line.

Increasing trend of proportions of PIC as PF

- Despite CRM Training
- Despite Label change from PNF to PM
- Despite Industry Initiatives on Monitoring

Role Assignment Effect Occurs in All Geographic Regions

Frequency of Events by Role Assignment and Geographic Region

Region	Role Assignment		
	PIC as PF	SIC as PF	TOTAL
	Events	Events	Events
Africa	41 (75.9%)	13 (24.1%)	54 (100%)
Asia and Middle East	204 (76.1%)	64 (23.9%)	268 (100%)
Europe	214 (66.9%)	106 (33.1%)	320 (100%)
North America	103 (65.6%)	54 (34.4%)	157 (100%)
South America and Caribbean	35 (83.3%)	7 (16.7%)	42 (100%)
Total	597 (71.0%)	244 (29.0%)	841 (100%)

Further Findings

Sexton, et al (2004): Group Interaction in High-Risk-Environments (GIHRE) – Project Recommendation 4 (p. 19):

“During high workload, the leading team member should manage the situation while others manage the technical task.”

- Most events (730 [87.5%]) revealed issues with flight crews’ teamwork behavior
- Most events with teamwork issue (491 [71.7%]) happen with the PIC as PF
- Most events (797 [87.9%]) were judged pilot preventable
- Most fatalities (5,501 [96.3%]) are due to preventable events
- Most preventable hull losses (149 [83.2%]) happen with the PIC as PF

What can be done to support ICAO’s goal of vision zero by 2030?

A Possible Solution: PIC as PM → COMMAND & MONITORING



SIC as PF
(PICuS)



PIC as PM

Research opportunities:

- 1) SIC acting as functional leader (PICuS) as the standard leadership model in normal operation?
- 2) How to evolve SIC-training to enable PIC-rating in 1500-3000hrs of jet/turboprop experience?
- 3) Guarding of controls by PM in critical flight phases & critical review of “Captains-only”-operation?

Becker & Ayton (2023)

“Effects of flight crew role assignment on
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