Why do people make mistakes?

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A deadly omission (among other things)

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  - Flaps not set for takeoff
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• NASA ASRS: since 2000, pilots have reported their failure to properly set the flaps for takeoff over 70 times!
Hanging by a thread...

- ASRS #658970, night of May 2005, DCA
- DCA, VMC
- Crew of B737-800 reporting:
  - “.. As we started the taxi, I called for the taxi checklist, but became confused about the route and queried the first officer to help me clear up the discrepancy. We discussed the route and continued the taxi... We were cleared for takeoff from runway 1, but the flight attendant call chime wasn't working. I had called for the Before Takeoff checklist, but this was interrupted by the communications glitch. .. On takeoff, rotation and liftoff were sluggish. At 100-150 ft as I continued to rotate, we got the stick shaker. The first officer noticed the no flap condition and placed the flaps to 5. (No takeoff warning horn. Discovered popped circuit breaker back at the gate)...”
Inadvertent (deadly) Procedural Omissions


Typical examples include

• Detroit (1987): DC-9 crashed shortly after take-off
  – NTSB: Flaps/slats not set to take-off position

• Dallas (1988): B-727 crashed shortly after take-off
  – NTSB: Flaps/slats not set to take-off position

• LaGuardia (1994): MD-82 ran off runway end after high-speed rejected take-off
  – NTSB: pitot heat not turned on - anomalous airspeed indications

• Houston (1996): DC-9 landed gear-up
  – NTSB: Hydraulic pump not set to high position

• Little Rock (1999): MD-80 crashed into approach lights at departure end of runway
  – NTSB: ground spoilers not armed before landing (combination with other errors)
Were these accidents unique?

• No, they are just the tip of the iceberg

ASRS reports tell us about:

• Rejected take-off – forgot flaps
• Runway incursion – forgot to monitor
• Broken tow-bar – forgot to clear pushback crew
• Taxiing into a ditch – forgot to brief
• Engine flame-out – forgot to stop fuel transfer
• Departing with inadequate fuel – forgot to check on preflight
• Leaving APU running during takeoff – forgot checklist item
• Took off without PDC – forgot to request
• Deviated from speed or altitude restriction – forgot to enter on MCP
• Flying wrong departure route – forgot to follow new instructions

=> Compromises to safety
=> Unnecessary costs and delays
Are pilots alone?
Is Aviation alone?

No.

We see the same problems in all high-risk industries.
THE MULTITASKING MYTH

Handling Complexity in Real-World Operations

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Data Sources

Personal flying experience
Many different jumpseat observations

• Airline Training
• Analysis of FOMs, SOPs, & Checklists
• Analysis of accident and incident reports

• Extensive interaction with participating carriers and others.
Data Sources

Structured Jumpseat Observations and crew interviews

- Two major US carriers
- Routine, revenue flights, B737
- 1-2 hour legs; 3-day trips
- All phases of flight
- All over the country (domestic ops)
BEFORE START

FLIGHT DECK PREPARATION .................. COMPLETED
LIGHT TEST .................................. CHECKED
OXYGEN & INTERPHONE ..................... CHECKED
YAW DAMPER .................................. ON
INSTRUMENT TRANSFER SWITCHES ........ NORMAL
FUEL .............................................. ____ KGS & PUMPS ON
GALLEY POWER ................................. ON
EMERGENCY EXIT LIGHTS .................. ARMED
PASSENGER SIGNS ............................ SET
WINDOW HEAT .................................. ON
HYDRAULICS ................................... NORMAL
AIR COND & PRESS ......................... ____ PACK(S), BLEEDS ON, SET
AUTOPILOTS .................................. DISENGAGED
INSTRUMENTS .................................. X-CHECKED
ANTISKID ....................................... ON
AUTO BRAKE ................................... RTO
SPEED BRAKE .................................. DOWN DETENT
PARKING BRAKE ............................... SET
STABILIZER Trim CUTOUT SWITCHES ...... NORMAL
WHEEL WELL FIRE WARNING ................. CHECKED
RADIOS, RADAR & TRANSPONDER ........ SET
RUDDER &AILERON Trim .................... FREE & ZERO
PAPERS .......................................... ABOARD
FMC/CDU ....................................... SET
N1 & IAS BUGS ................................. SET
CAPTAIN
“Flaps 5, taxi clearance”

MONITOR
Ground

MONITOR
Ground, Company

TAXI CLEARANCE

By the book

FIRST OFFICER
Set flaps, verify in position
Obtain clearance

"Flaps 5, taxi clearance"

MONITOR
MONITOR
Taxi to the runway
CAPTAIN
FIRST OFFICER

MONITOR
Ground

MONITOR
Ground, Company

TAXI CLEARANCE

By the book

CAPTAIN
FIRST OFFICER
Set flaps, verify in position
Obtain clearance
Begin checklist
Checklist complete

Flaps 5, taxi clearance
Start taxiing
Ask for checklist
Line up with runway
Ask for checklist
Pilot calls when ready

CAPTAIN
“Flaps 5, taxi clearance”

FIRST OFFICER
Set flaps, verify in position
Obtain clearance
Begin checklist
Checklist complete
Activities are:

- **Linear**: task B always follows task A, in a fixed sequence
- **Controllable**: tasks initiated by each pilot, independently, at their choice
- **Predictable**: information available when needed, communications possible when necessary
IDEAL is different from REAL.
OK, so What?

• Pilots (and others) become accustomed to concurrent task demands, interruptions, distractions and disruptions.

and the truth is ...

• Pilots (and others) routinely manage multiple, competing, concurrent task demands just fine...
Obtain clearance

Begin checklist

Checklist complete

Begin checklist

Checklist complete

TAKEOFF CLEARANCE

Request taxi clearance

Start taxiing

Ask for checklist

CAPTAIN

FO failed to monitor CA - busy checking and correcting calculations of load data - aircraft taxied past hold short line

FO failed to monitor CA - busy with flow; night taxi - taxied in wrong direction

FO failed to monitor CA - busy with fuel problem, runway changes, programming FMC - aborted takeoff

FO failed to monitor CA - busy with pre-takeoff preparations - aircraft crossed hold short line

Confuse own position on taxiway diagram - new terminal; studying NOTAMs; runway change - taxied into ditch

Taxi Errors

Start taxiing without clearance - crew discussing taxi instructions - struck pushback tug

Started taxiing without clearance - engine problem - rushed to accept takeoff clearance - aborted takeoff

Started taxiing without clearance - rushed by other aircraft waiting to pull into gate; radio congestion; marshaller's headset

Omitted call for flaps - rushed to clear ramp/gate area for arriving aircraft - aborted takeoff

Omitted flaps - checklist interrupted after item had been read but not verified - aborted takeoff

Failed to start engine #2 - distracted while discussing special operations for destination; omitted checklists - delay takeoff

Omitted checking into bleed air indicator light - busy with delayed engine start and checklists - crew rushed to perform delayed engine start - flew with potential equipment problem

Omitted flaps - checklist interrupted by Tower; crew hurried to accept takeoff clearance - aborted takeoff

Omitted flaps - checklist interrupted by thrust reverser light; crew busy troubleshooting - aborted takeoff

Misunderstood Tower instruction - new FO on IOE, CA coaching FO - taxied onto runway without clearance

Omit checklist - running late, checklist interrupted by Tower, unexpected clearance for takeoff - aborted takeoff

 started taxiing without clearance - problem with engine start - nearly hit ground handler

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Flaps incorrectly set - late paperwork and runway change; programming FMC; short taxi; rushed to accept takeoff

CA taxis without having fully understood instructions - busy looking at other aircraft on taxiway and ramp - warning issued by ground controller

Incorrect trim setting - checklist interrupted after item had been read but not verified - aborted takeoff

Neglected to set flaps - preoccupied with new departure clearance and packs-off operation - aborted takeoff

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BREAK in Predictability

BREAK in Linearity

EXPECTATION (If already taxiing, flaps have been set)

BREAK in Controllability

Need for CONCURRENT TASK MANAGEMENT (≠ than high workload)
The reality of cockpit operations

Constant presence of **Perturbations** that:

- **Interrupt ongoing activity**
- **Force tasks to be performed outside their normal (habitual) sequence**
- **Give rise to new, unanticipated tasks**

Implications:

- **Attention diverted, even if for split second**
- **Actions and tasks suspended**
- **Actions and tasks deferred**
- **Actions and tasks interleaved**
- **Deferred tasks must be remembered later**
- **...There is no PAUSE button!**
Vulnerable to Omissions when...

- **Interrupted** *(4 Prototypical Situations)*
  - e.g., interrupted while conducting a checklist – forget to return to line item at which interrupted

- **Must perform tasks outside normal** *(habitual)* **sequence**
  - e.g., defer setting flaps until reaching runway for takeoff because of slush on taxiway – forget to extend flaps before takeoff

- **Must perform new, unanticipated tasks** *(in lieu of habitual actions)*
  - e.g., fly different heading than normal upon departure – forget to comply with new instruction and fly usual heading instead

- **Must interleave multiple tasks**
  - e.g., re-program FMC during taxi – forget to monitor aircraft
Individuals forget to act because the cognitive demands of these situations interact with the ways in which the human brain processes information.
The hidden complexity of cockpit operations

• Complexity is not just a matter of workload
• Situations appear diverse but share underlying features that involve:
  
  **Multitasking**: multiple tasks, concurrently

• Pilots (all humans) **cannot multitask well** yet they typically do it:
  • without a second thought
  • without an appreciation of their true (in)ability
  • with an incomplete understanding of the **risks they are taking** when doing so
The Multitasking Myth

• We typically **overestimate** our ability to **multitask**

• In reality, our ability to multitask is a function of:
  – the degree to which tasks are practiced together
  – the degree to which each individual task requires conscious effort and attention
  – the cues available to prompt recall of intended actions

• Multitasking situations substantially **increase our vulnerability to errors**
  – Common error: forgetting/failing to perform a procedural step
  – Common error: inattention (being distracted)
THANK YOU for your attention

Additional Information:

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