PREVENTION

TEAM WORK
Visual Flight Rules (VFR)

AIR-TO-AIR COLLISIONS PREVENTION
(detailed presentation)
Limitations of See-and-Avoid Principle

2018 January 23rd - Philippsburg (Ger):
EC135 and Piper PA28 collided – 4 fatalities

2019 January 19th - over Ruitor glacier (It):
AS350 and D140 collided – 7 fatalities

2019 August 25th - Mallorca (Sp):
Ultralight vs helicopter – 7 fatalities

In 2015 Charley Shimanski has reported us the collision of two U.S HMS helicopters.
2018 February 2nd Le Luc French Army Tactical Flying Academy

FR 2 separated - instruction missions in dedicated operation area

FR Highly trained pilots (no student pilot)

☞ Two Gazelle helicopters collided in flight – 5 fatalities
FRENCH STATE AIRCRAFTS INVESTIGATION BOARD HAS HIGHLIGHTED THE LIMITATIONS OF

« SEE AND AVOID » PRINCIPLE ©
« Limitations of See-and-Avoid Principle* » ©

Austalian Transport Safety Board (1991)

*UNALERTED
« See and avoid » principle...

- Has been **THE** solution for years for low level flights separation.
- Is very often the only available deconfliction mean for us.
- Survey:
  We will all have experience of unexpected mid-air close position...
  ... Some of these situations may have never been detected

...let’s learn more about it in order to improve our safety
« See and avoid » principle...in 3 steps

- STEP 1: looking outside
- STEP 2: identifying a collision threat
- STEP 3: proceeding to an evasive action
3 steps that...

- takes time

See 0.1'' → Recognise 1'' → Identify collision track 5'' → decide action 4'' → Act 0.4'' → aircraft lag time 2''

12.5 S''

HUMAN FACTOR IS A KEY ISSUE
Limitations of See-and-Avoid Principle

STEP 1: looking outside – Human eye

vision field variations
**STEP 1: looking outside – Human eye**

Variation of visual acuity across retina

- **Temporal**
- **Nasal**

Blind spot (optic nerve)
**Limitations of See-and-Avoid Principle**

**STEP 1: looking outside – Human eye**

Variation of visual acuity across retina

Accommodation time:
- 1 sec for « young » persons
- a few more for all others
STEP 1: looking outside – Human eye

Variation of visual acuity across retina

Optic nerve head:
- Not a problem on binocular vision
- One eye partially obstructed (windows post,...) = blind spot
  - 20 cent coin at 40 cm
  - 18 m at 200 m = side of a light aircraft
Limitations of See-and-Avoid Principle

**STEP 1: looking outside – Human eye**

Human vision = 2 distincts systems:

- **Foveal** (retina’s center)
  - Colors
  - Slow movements

- **Peripheral**
  - Rapid movements
  - Night vision

* At twilight acuity is fairly egal across retina... and bad!
STEP 1: looking outside – Human eye

Vision = 2 distincts vision systems:

- Foveal identification
- Peripheral detection

As long as a moving object is not locked and tracked
Simultaneous actions are impossible.
STEP 1: looking outside – Airmen

- Private pilots on VFR: 50% of time inside cockpit (Sulzer/Skelton 1976)

- Natural « selective » scanning:
  - Areas of sky near the edges of windscreens are scanned less than the sky in the centre.
STEP 1: looking outside – Airmen

- **Workload:**
  - Visual field narrowing
  - Eye movements reduced up to 60%

- Hypoxia and adverse thermal conditions:
  - Visual field narrowing
**STEP 1: looking outside – Airmen**

- Individual search effectiveness relies on scanning technics:
  - Move eyes to scan the sky in retina’s high acuity area.
    
    \[\text{Scanning} = \text{detect} / \text{identify} / \text{detect} / \text{identify}...\]
  
  - Move head to avoid obstructions

- All individual factors are furthermore affected by:
  
  Fatigue - Hypoxia - Vibrations - Glare - ...
STEP 1: looking outside – team work

- Work organisation in the helicopter, some key points:
  - communication « I am inside / I am outside... »
  - assigning « crossed » scanning sectors
  - use of personal electronic devices PED = mental trap!
  - workload management

- Diffusion of responsibility
  « No need to say that I am looking at the ipad, other CM are certainly looking outside »
**STEP 1: looking outside – The cockpit**

○ Bug splatters on windscreen and window posts can generate:

- **Focal trap**: Eyes stay on the natural focus point = 50 cm.
  - Difficulty to see distant objects.

- **Monocular vision**:
  - Far less efficient than binocular vision (blind spot, movement detection)
**STEP 1: looking outside**

- Now that we are aware of all traps let’s go for a good scanning:
  - 3 eye fixation per second (10°)
  - ...15 minutes to scan 180° (Harris 1979)
STEP 2: Identifying a collision threat

Danger is converging aircraft...

...which is the most difficult to see due to lack of relative motion course.

human is better at detecting movement!
STEP 2: Identifying a collision threat – Collision course - similar speed
STEP 2: Identifying a collision threat - Target characteristics

- Aircraft lightings / fluo paint only efficient for low flight*
- Aircraft’s color is less important than contrast with background

Atmospheric effects: haze, fog scattered light in good visibility!
STEP 2: Identifying a collision threat - Target characteristics

Effects of complex backgrounds

Background countours interact with the form of the aircraft, producing a less distinct image.
STEP 2: Identifying a collision threat - Target characteristics

Clear sky

High wing acft

Retina image 1,8 Km

With background
**STEP 3: Evasive action**

- No TCAS (Traffic Collision Avoidance System)
  - no coordination of evasive actions...
  - growing danger of collision during evasive

- When successful to prevent a collision, evasive action...
  - could lead to injuries inside cabin!
See and avoid principle...

- Has many limitations:
  - Human visual system
  - Workload
  - Cockpit design

☞ A human will never perform a 100% traffic search
ATSB report was issued on April 1st, 1991!

Since 1991:

- Mission environment has not changed that much
- We still fly VFR in uncontroled areas
- Human has not changed
ATSB’s report was issued on April 1st 1991!

Since 1991:
- Still no 100% reliable technology available for us:
  - ADS-B: Automatic Dependent Surveillance - Broadcast
  - FLARM: Flight Alarm

  - 100% reliable if 100% of traffic equipped...
  - No coordinated evasive action instructions

- Air traffic has increased
- Drones popping up
Limitations of See-and-Avoid Principle

Since 1991 more traffic, pop up of drones... less eyes outside!

Drones...

- Focus to come very shortly
- Has no eyes (not yet!)
- Far more difficult to spot than manned aircraft
- Most challenging issue for helicopters crews and rulers
Limitations of air spaces where only *unalerted* see and avoid is the sole mean of separation

TCAS *(ADS-B / FLARM)*

White strobe rather than red
ATSB report’s recommendations - OPERATORS

☞ « Pilot CREW » should be aware of limitations of visual system
☞ « Pilot CREW » trained in traffic scan
☞ « Pilot CREW » should not rely entirely on vision to avoid collisions
About TSB’s recommandations

REC: «Crew aware of limitations of visual system»

We could, for exemple:

☞ Refere to ATSB report in initial training course
   - Helicopter crews
   - Rescuers
   - Doctors or paramedics
About TSB’s recommandations

REC: «Crew trained in traffic scan», we could, for exemple:

☞ Train to manage work load (PED, communication,...)

☞ Insert trafic and obstacle search item in mission briefing

« M.E.M.O » Mission

Equipments (rescue triangle, Lezard...)
My safety devices (transciver, ...)
Obstacles and AIR TO AIR COLLISIONS

NOTA: « MEMO » has significantly increased the number of traffic reported by rescuers.
About TSB’s recommandations

REC: «Crew should not rely entirely on vision to avoid collisions»

We could, for exemple:

- Use ADS-B And / or FLARM
- « Be searchable » : use of air to air frequency
- Coordinate air operations
About TSB’s report

Some more points to highlight:

☞ Fly with clean windscreen. not a rec...just an « old » pilot secret !

☞ Tie down all equipments in cabin.
CONCLUSION

We fly in areas where:

☞ « See and avoid » is very often the sole separation mean
☞ UNALERTED « See and avoid » is our reality
  - Gliders*
  - paragliders
  - drones
  - slakelines...
"See and avoid" is highly limited

Remains an important safety system

- 34 times more collisions if no "see and avoid" and no Air Traffic Service

Our teams must work every day during every mission to improve efficiency of "see and avoid" principle.
THANK’S FOR YOUR ATTENTION

FLY SAFE !