



**DIRECTION GÉNÉRALE DE LA SÉCURITÉ CIVILE
ET DE LA GESTION DES CRISES**

PREVENTION

TEAM WORK

Visual Flight Rules (VFR)

AIR-TO-AIR COLLISIONS PREVENTION ***(detailed presentation)***

Limitations of See-and-Avoid Principle

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

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

2019 august 25 th - 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

Limitations of See-and-Avoid Principle

**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**

Limitations of See-and-Avoid Principle



« *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

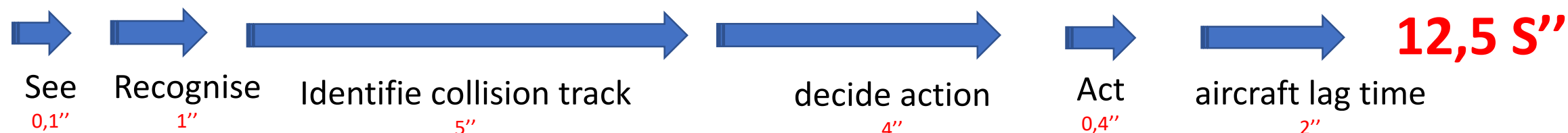
« *See and avoid* » principle...in 3 steps

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

Limitations of See-and-Avoid Principle

3 steps that...

● takes time



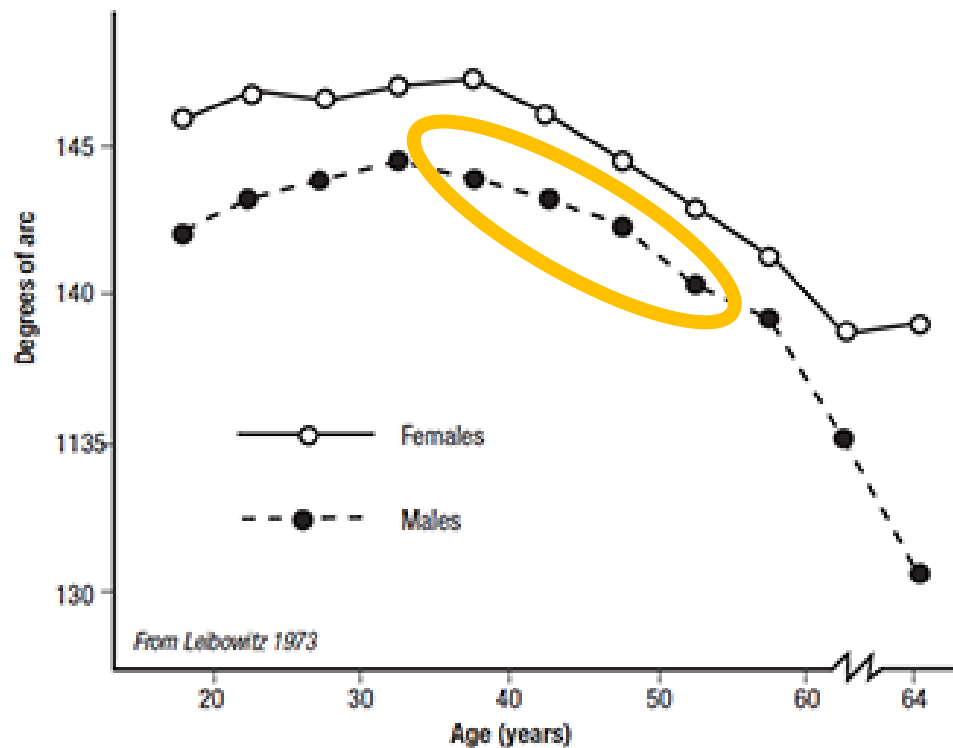
HUMAN FACTOR IS A KEY ISSUE

Limitations of See-and-Avoid Principle

STEP 1: looking outside – *Human eye*

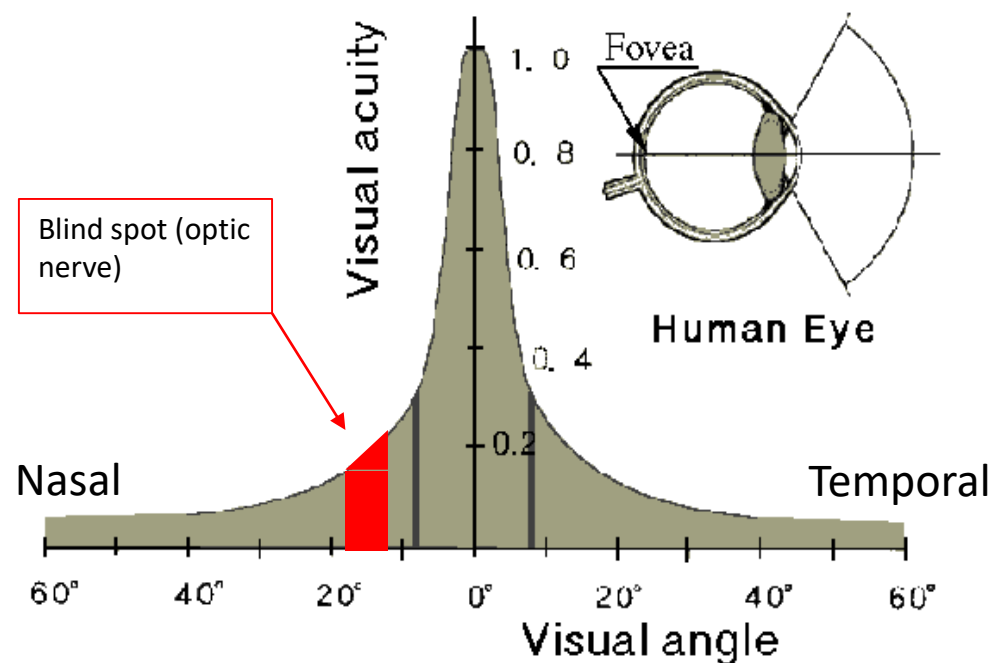
vision field variations

FIGURE 4:
Right eye visual field for males and females



STEP 1: looking outside – *Human eye*

Variation of visual acuity across retina



Limitations of See-and-Avoid Principle

STEP 1: looking outside – Human eye



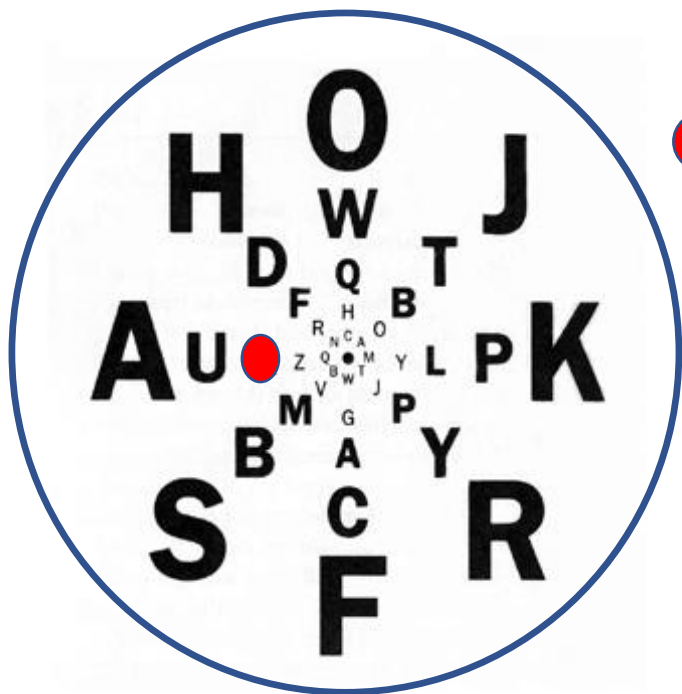
Variation of visual acuity across retina

Accomodation 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

STEP 1: looking outside – *Human eye*

Human vision = 2 distinct 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 distinct 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.

Scanning = detect / identify / detect / 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.

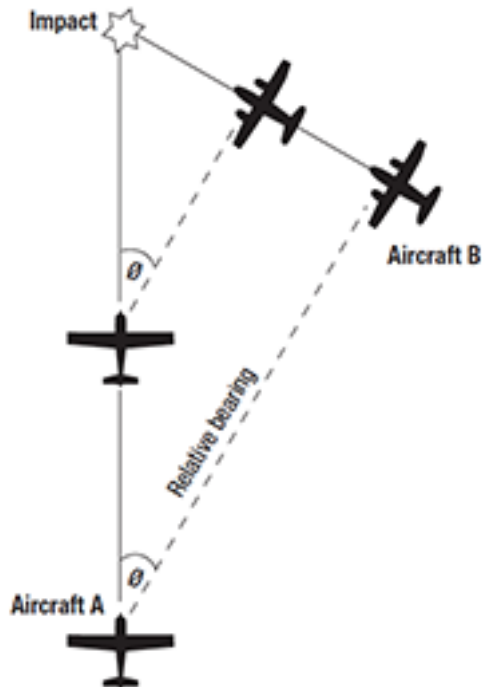
👉 human is better at detecting movement !

Limitations of See-and-Avoid Principle

STEP 2: Identifying a collision threat – *Collision course - similar speed*



FIGURE 11:
Lack of relative motion on collision course



STEP 2: Identifying a collision threat - **Target characteristics**

- ✎ Aircraft lightings / fluo paint only efficient for low flight*
- ✎ Aircraft's color 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 contours interact with the form of the aircraft, producing a less distinct image.

Limitations of See-and-Avoid Principle

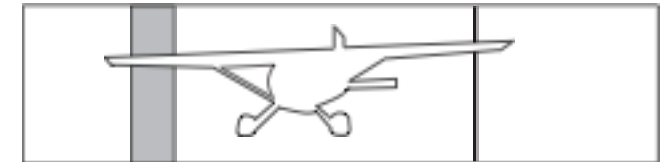
STEP 2: Identifying a collision threat - *Target characteristics*

Clear sky



High wing acft

With background



Retina image 1,8 Km



STEP 3: Evasive action

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

- ◎ When succesful to prevent a colision, 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 uncontrolled 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

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

ATSB report's recommendations - **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 recommendations

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...

CONCLUSION

☞ « 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.***



MINISTÈRE
DE
L'INTÉRIEUR

THANK'S FOR YOUR ATTENTION

FLY SAFE !



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