Using STAMP to Address Causes and Preventive Measures of Mid-Air Collisions in Visual Flight

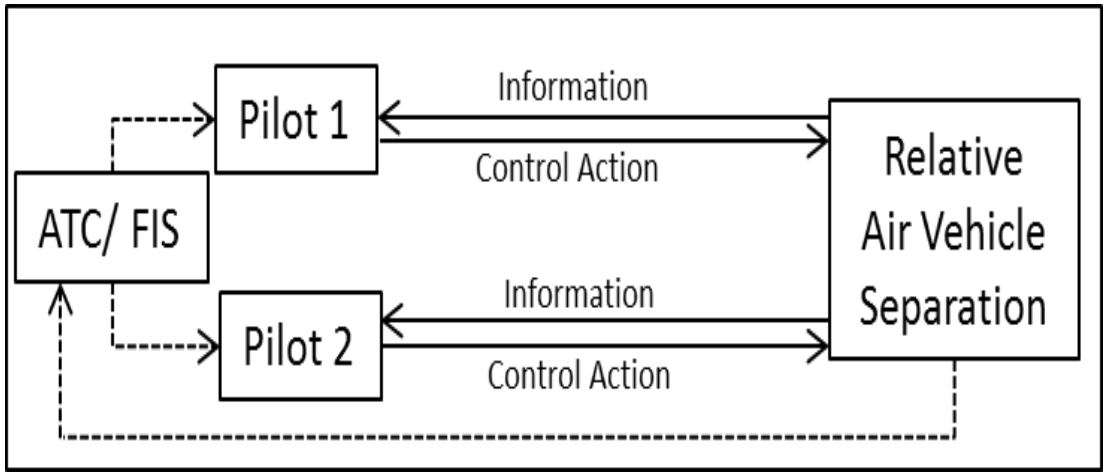
Ioana Koglbauer[1] and Nancy Leveson[2]
[1]Graz University of Technology, Austria, [2]Massachusetts Institute of Technology, MA, USA

Safety Risks in Visual Flight

- Loss of separation is one of the **key safety risk areas** in aviation (EASA, 2015)
- Mid-air collisions are among the **top ten leading causes of fatal accidents** in the General Aviation (FAA, 2015)

„See & Avoid“ in Visual Flight

The process of air vehicle separation



Accident: mid-air collision
Hazard: loss of separation
Safety assumption: the pilots will “see and avoid” each other in time

Pilots’ responsibilities for vehicle separation in visual flight:

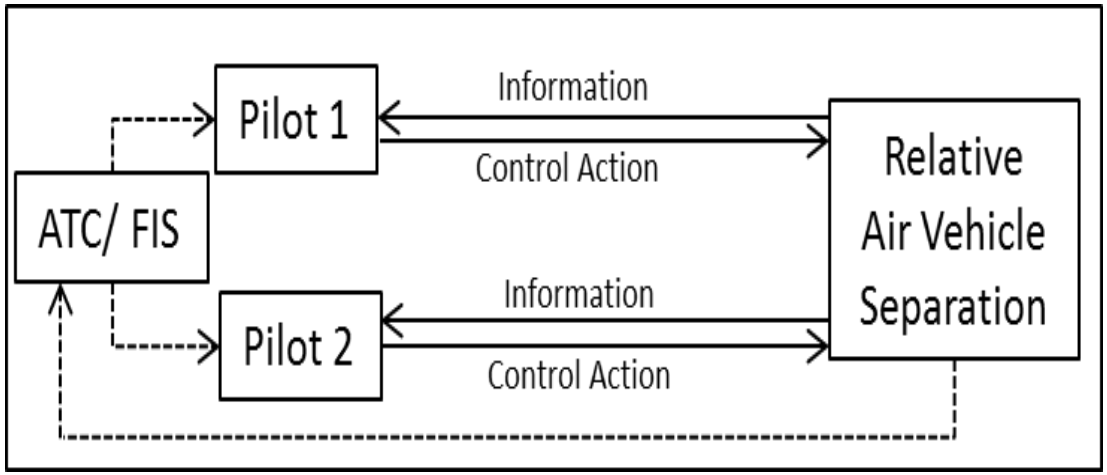
- maneuver the air vehicle according to the rules
- search for traffic information and
- provide position information

Unsafe control actions (CA) identified with STPA

Control Action (CA)	CA causes hazard	Lack of CA causes hazard	CA too early/ too late/ wrong sequence causes hazard	CA too long or too short causes hazard
Pilots' Avoidance Maneuver	Moves in wrong direction (violates rules)	Does not maneuver when required by rules	Doesn't maneuver in time to avoid hazard when required by rules	Moves so far that causes loss of separation to another air vehicle Stops too early
Pilots' Scan of Airspace	Distraction Does not scan for additional air vehicles	Does not maintain awareness of air vehicles in vicinity	Scans too infrequently	Does not scan the entire surrounding area
Pilots' Provision of Position Information	Provides incorrect position information	Does not provide required position information	Provides required information too late	
ATC/ FIS Provision of Traffic Information	Provides incorrect traffic information	Does not provide traffic information	Provides traffic information too late	

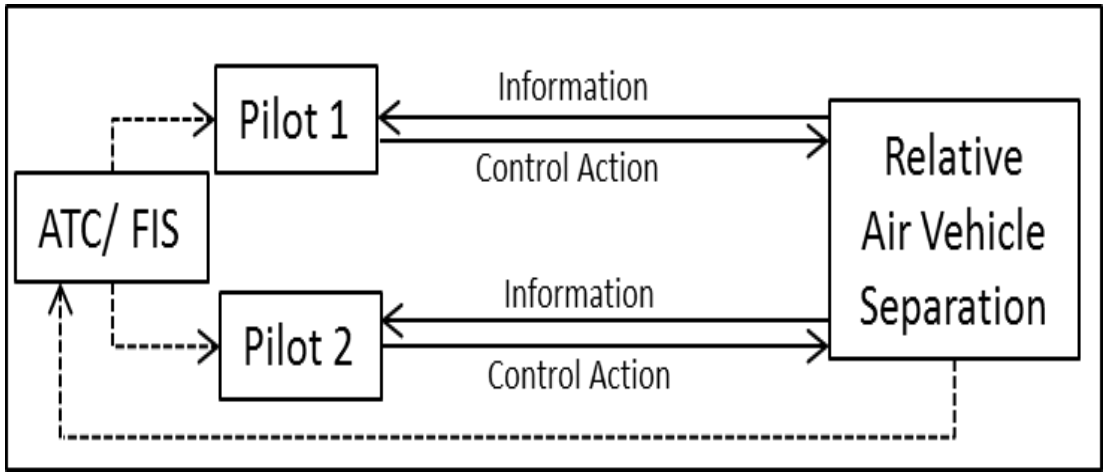
Multiple controller hazards

(Adapted from Ishimatsu, Leveson et al., 2011)



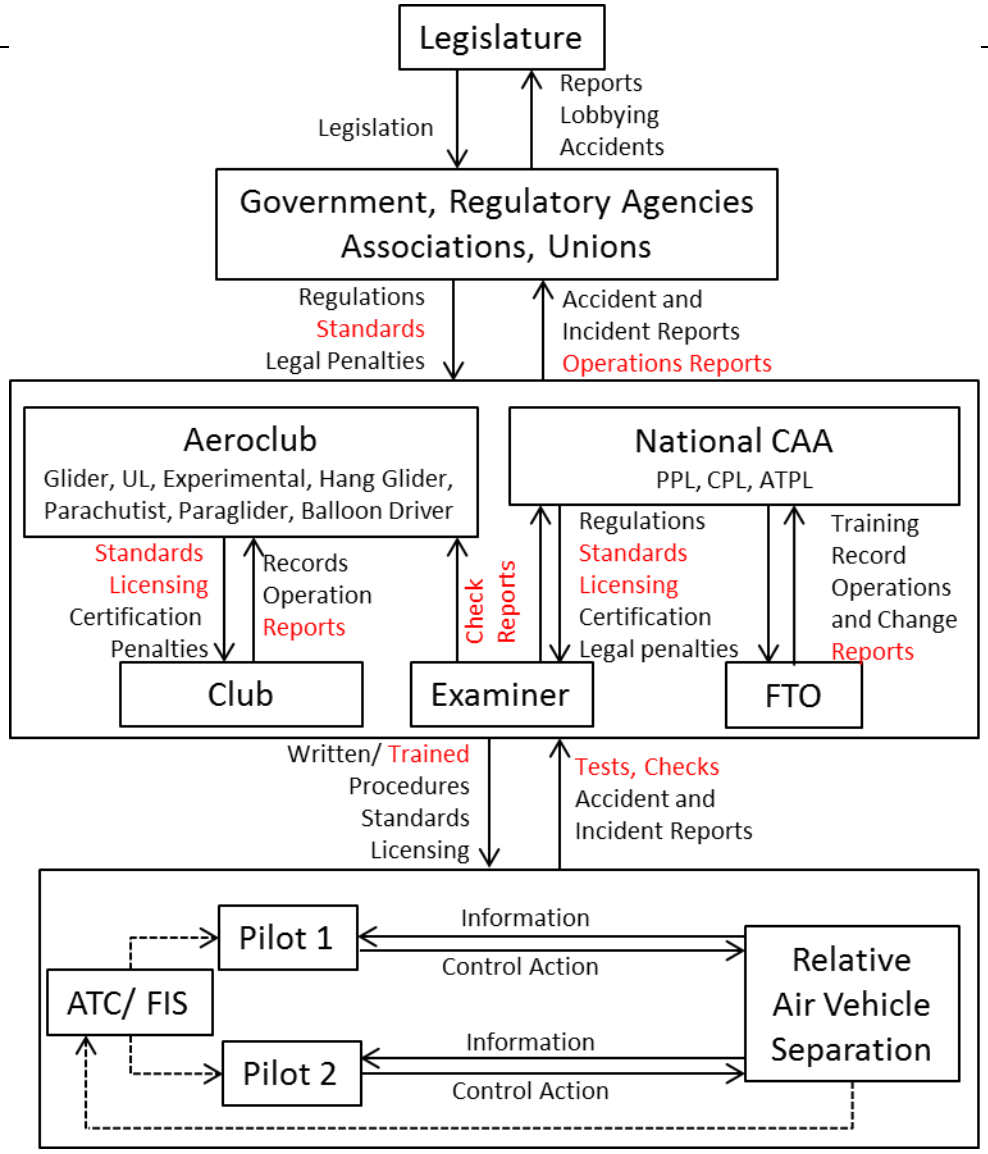
- Only one pilot provides a required avoidance action
- None of the pilots provides a required avoidance action
- The pilots provide both safe and unsafe avoidance actions
- Both pilots provide only unsafe avoidance actions

Pilots' process model and feedback



- Knowledge of the national and international **regulations** (ICAO, 2005)
- Knowledge of **relative kinematics**
- **Feedback** to update the process model:
  - Separation or incident/ accident
  - No systematic practical training

The hierarchical control structure



Preventive Measures

Improving pilots' capability:

- To detect and process traffic information (Koglbauer, 2015)
- To correctly perform required collision avoidance actions (Koglbauer, 2015)
- To provide the required position information

Actions at the higher control hierarchy:

- Provide **standards and requirements for practical** training on collision avoidance to the FTOs and clubs
- Collect reports on candidates' collision avoidance performance as a part of the **initial and recurrent examination** and licensing process
- Facilitate the introduction of **simple and affordable equipment** (e.g. traffic advisory systems, generic flight simulators) to the training facilities and to the pilots

Conclusion

- **STAMP** is a powerful model which enables the assessment of the collision avoidance process from different perspectives of the aviation system

- **Control flaws at different levels of the control hierarchy** can be identified and addressed by specific mitigation strategies

- The national and **international standards and procedures for pilots training, testing and licensing can be improved** to include not only theoretical knowledge, but also practical performance and evaluation of collision avoidance actions in simulated and real flight.


Thank you for your attention !

References

EASA European Aviation safety Agency (2015). Annual Safety Review 2014.

FAA Federal Aviation Administration (2015). Fact sheet - General Aviation Safety. [Downloaded on July 1, 2015 at http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=19134].

ICAO International Civil Aviation Organization (2005). Annex 2 to the Convention on International Civil Aviation. Rules of the air (10th ed.)

Ishimatsu, T., Leveson, N., Fleming, C., Katahira, M., Miyamoto, Y. & Nakao, H. (2011). Multiple controller contributions to hazards. Conference of the International Association for the Advancement of Space Safety , Versailles, France.

Koglbauer, I. (2015). Simulator training improves the estimation of collision parameters and the performance of student pilots. In V., Chisu, and I. Albulescu (Eds.) Procedia - Social and Behavioral Sciences (209), 261-267.

Leveson, N. (2011). Enginerring a safer world. Cambridge, MIT Press.