

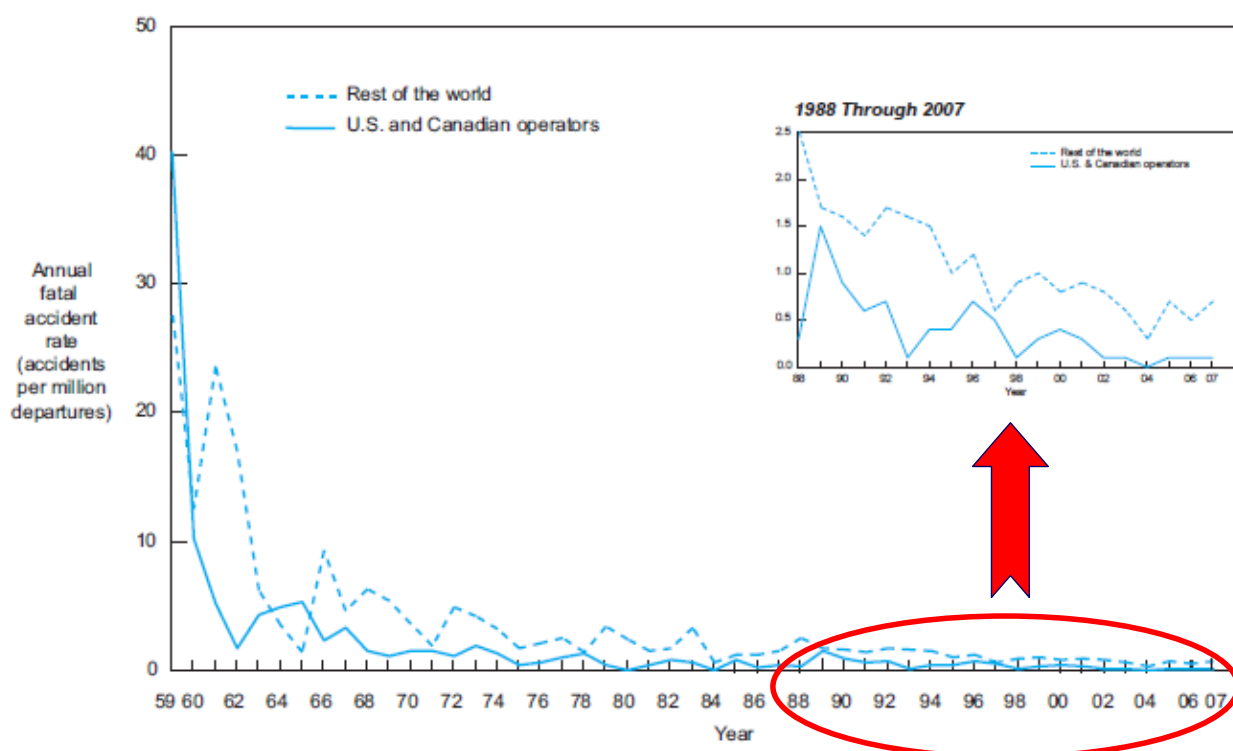
Human-Machine Collaboration for Safety and Comfort

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U.S. and Canadian Operators Accident Rates by Year Fatal Accidents – Worldwide Commercial Jet Fleet – 1959 Through 2007

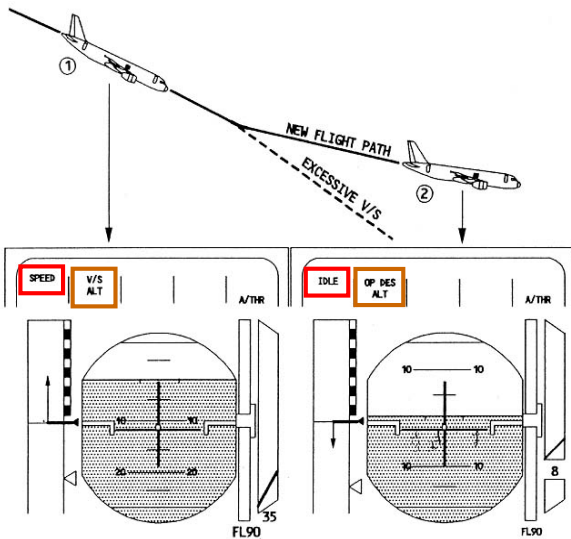


(Boeing, 2008)

Mismatches between humans and smart machines

- Intelligent machines can:
 - sense and analyze situations,
 - decide what must be done, and
 - implement control actions

→ *loss of situation awareness,
over-trust in automation,
automation surprises*



(FAA, 1995)

Situation awareness (SA)

Level 1 SA:

- perceiving critical factors in the environment

Level 2 SA:

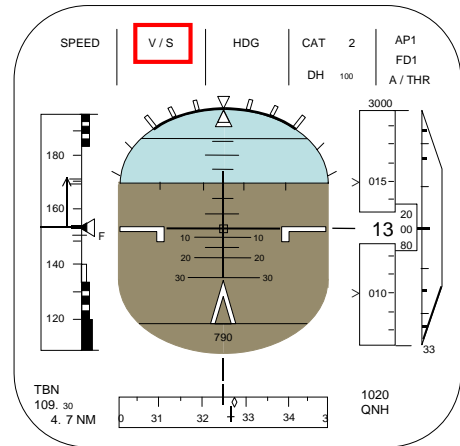
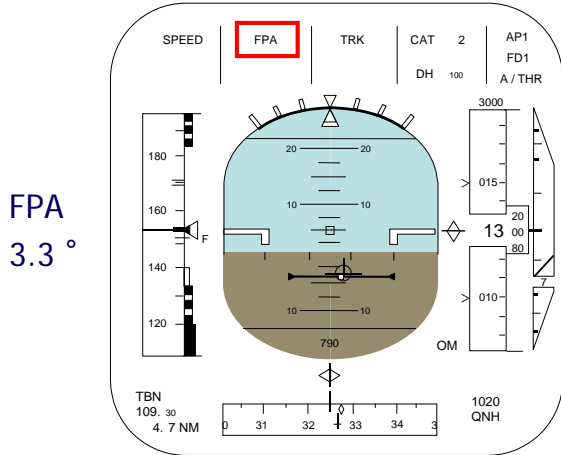
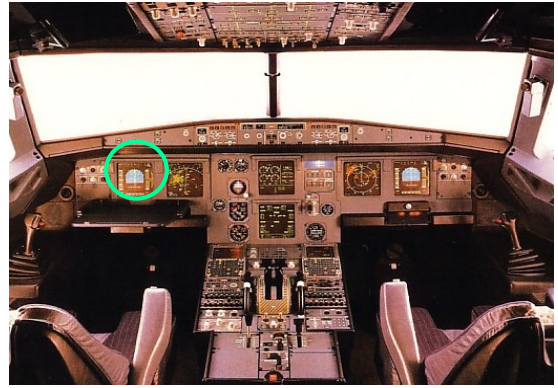
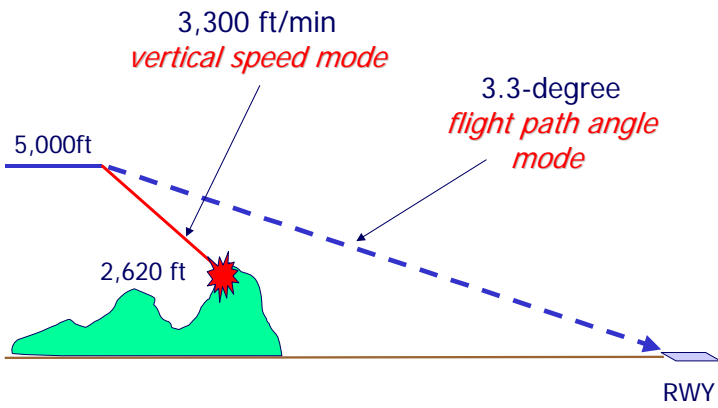
- understanding what those critical factors mean, particularly when integrated together in relation to the person's goal

Level 3 SA:

- understanding of what will happen with the system in the near future

(Endsley, 1995)

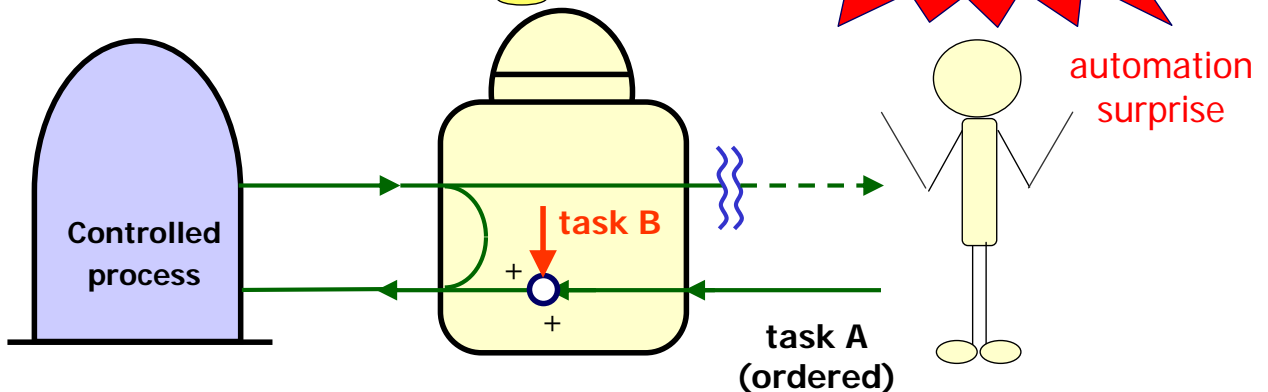
Loss of Level 1 SA



Loss of Level 2 SA

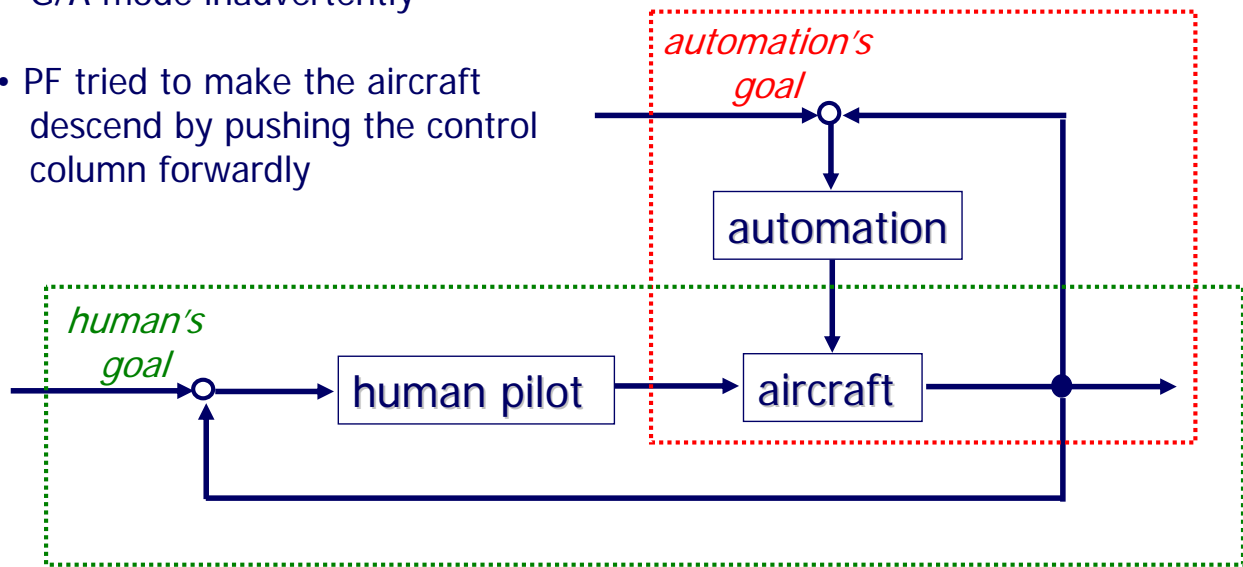
When task A is needed,
it would be better to do task B
at the same time.

What the
hell is going
on?



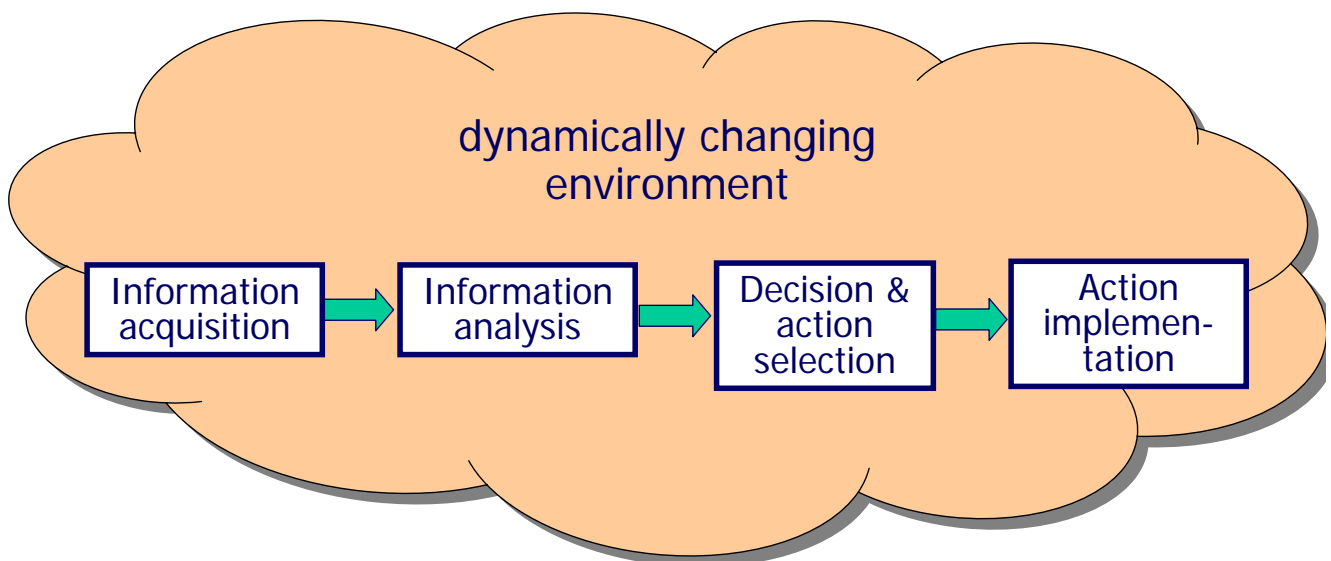
Loss of Level 3 SA

- Automation was put into the G/A mode inadvertently
- PF tried to make the aircraft descend by pushing the control column forwardly

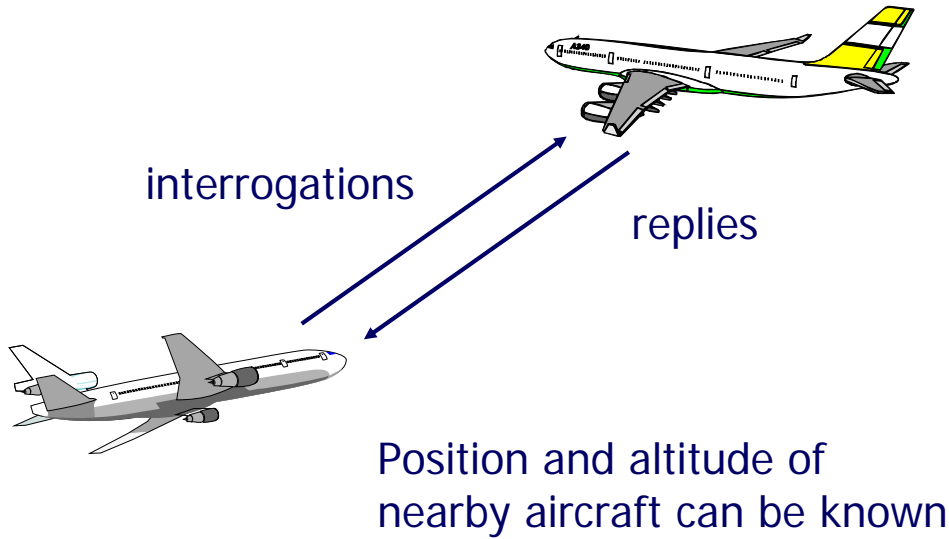
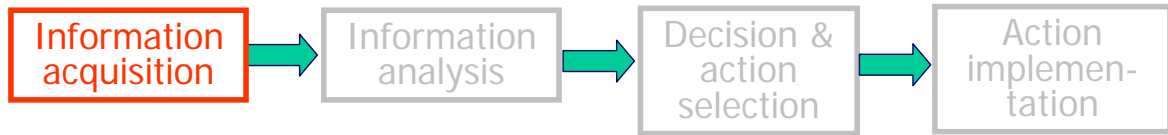


- Control inputs are disturbances when *human's goal* \neq *automation's goal*

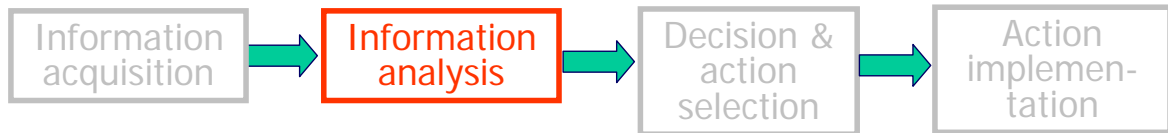
Which aspect can be supported by machines and how?



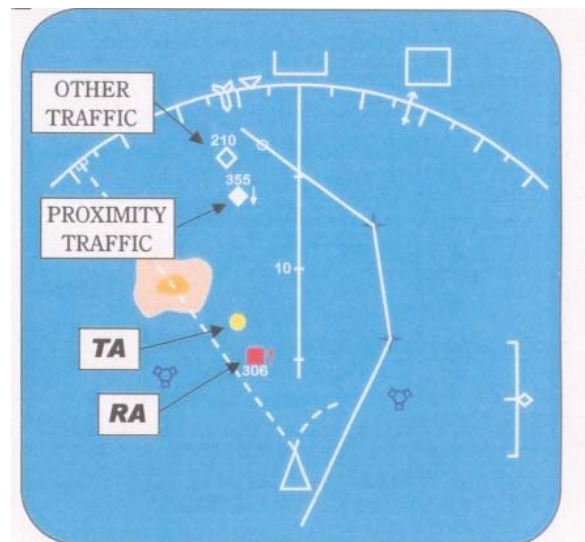
Traffic alert and Collision Avoidance System (TCAS)



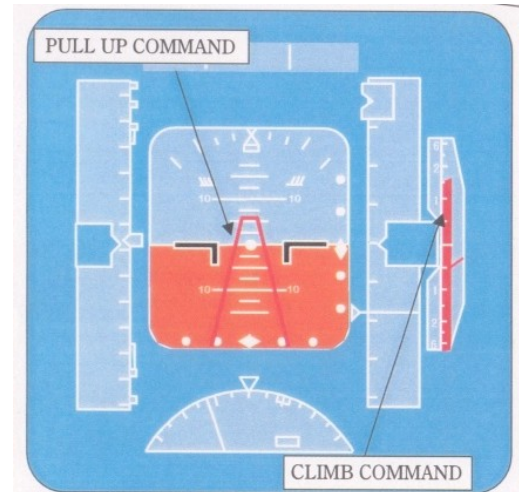
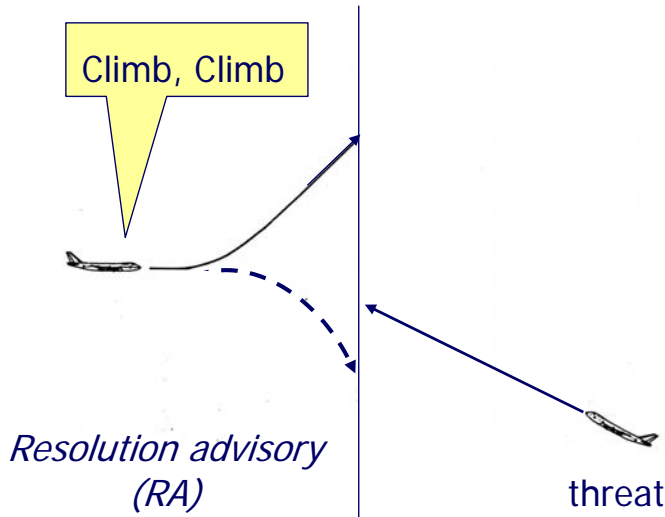
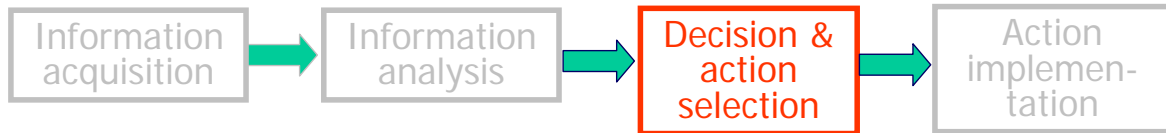
Traffic alert and Collision Avoidance System (TCAS)



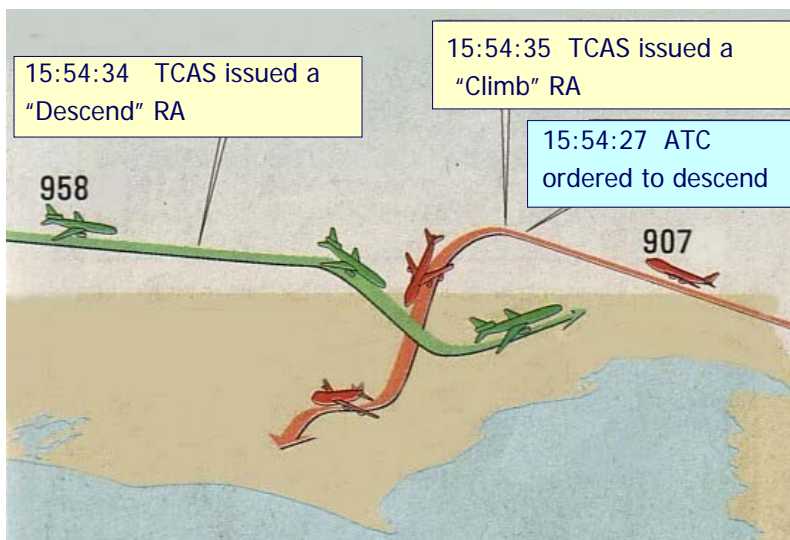
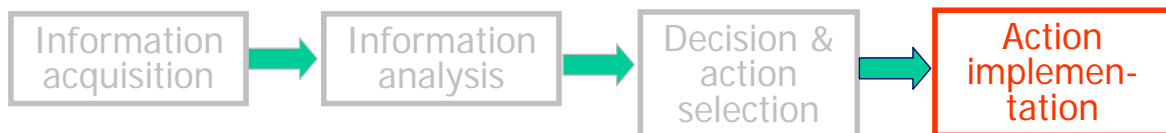
{ range test
altitude test } ⇒ threat ?



Traffic alert and Collision Avoidance System (TCAS)



Traffic alert and Collision Avoidance System (TCAS)



TCAS does not perform any collision avoidance maneuver.

Human pilot may disregard the RA.

Near mid-air collision over Yaizu, Japan (January 31, 2001)

Human-centered aviation automation

The human bears the ultimate responsibility for safety of aviation system.

Therefore:

- The human must be in command.
- To command effectively, the human must be involved.
- To be involved, the human must be informed.
- Functions must be automated only if there is a good reason for doing so.
- The human must be able to monitor the automated system.
- Automated systems must, therefore, be predictable.
- Automated systems must be able to monitor the human operator.
- Each element of the system must have knowledge of the others' intent.
- Automation must be designed to be simple to learn and operate.

(ICAO, 1998)

Human-centered aviation automation

The human bears the ultimate responsibility for safety of aviation system.

Therefore:


- The human must be in command.
 - At all times and on every occasion?
- To command effectively, the human must be involved.
- To be involved, the human must be informed.
- Functions must be automated only if there is a good reason for doing so.
- The human must be able to monitor the automated system.
- Automated systems must, therefore, be predictable.
- Automated systems must be able to monitor the human operator.
 - What the automated systems should do when they detected improper behaviors of the human operator?
- Each element of the system must have knowledge of the others' intent.
- Automation must be designed to be simple to learn and operate.

Control action in a given situation

		human's control action		
		Action needed in the situation	Action allowed in the situation	Action not appropriate in the situation
computer's judgment	"Action is detected"			B
	"Action is not detected"	A		

What the computer should or may do?

		human's control action		
		Action needed in the situation	Action allowed in the situation	Action not appropriate in the situation
computer's judgment	"Action is detected"			B
	"Action is not detected"	A		



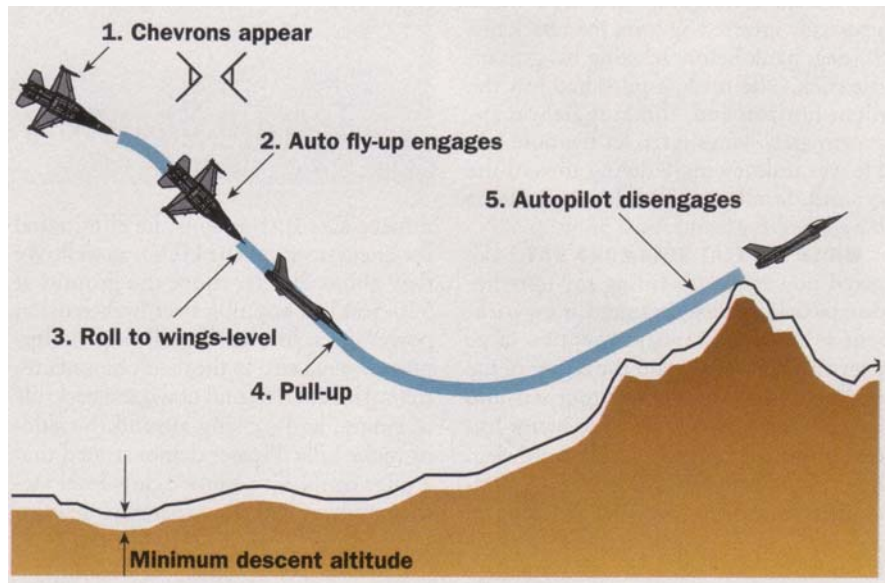
"The PF is too late in performing a control action needed in the situation."

Which is more appropriate:

- setting off a warning?
- initiating a control action?

Automatic ground collision avoidance system (Auto-GCAS)

If the pilot does not respond to the “pull-up” warning,
the computer takes control back from the pilot and
executes an automatic collision avoidance maneuver.



(Scott, 1999)

What the computer should or may do?

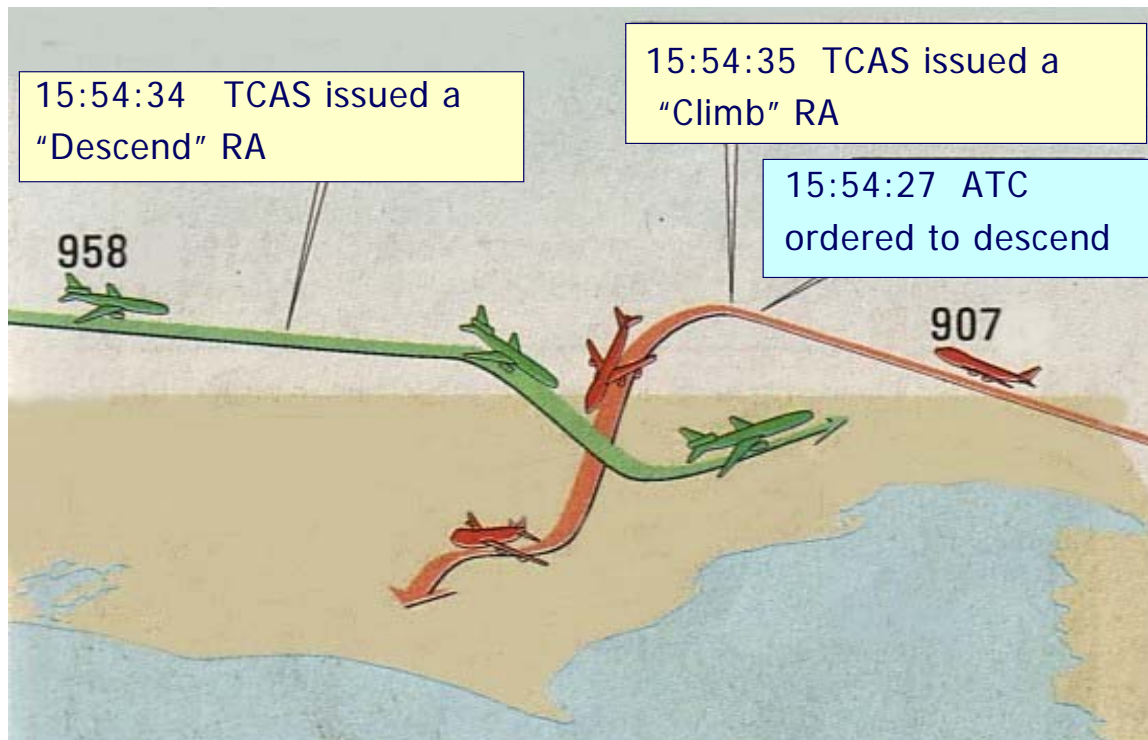
		human's control action		
		Action needed in the situation	Action allowed in the situation	Action not appropriate in the situation
computer's judgment	"Action is detected"			B
	"Action is not detected"	A		

"The PF misunderstands a given situation and his control action does not fit to the situation."

Which is more appropriate:

- setting off a warning?
- initiating a control action?

Although "Climb" was necessary in the situation...



Adapted from (Asahi, 31 January 2001)

Advanced TCAS

would automatically maneuver the aircraft away from a potential mid-air threat without input from the flight crew



(*Flight International*, 22 March 2006)