

# ***Basic Principles of Risk Assessments Standardisation***

*Workshop on Operators' SMS Oversight*

12th February 2019

*Andrew Rose*

*Llanbury Consulting Ltd*

# Risk

***‘Back to the beginning’ to  
‘Look forward from there’***

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*What is the question when it comes to Risk?*

***HOW BIG DOES  
MY RISK LOOK?***

Or

**How much do I actually  
know?**

*In SMS oversight terms*

## **Knowledge**

**Do they know what they need to know?**

**Do they understand what they don't know?**

## **(Re-)action**

**Do they act on what they know?**

**Do they have a plan to find out what they  
don't know?**

# Myths (or 'watch outs!')

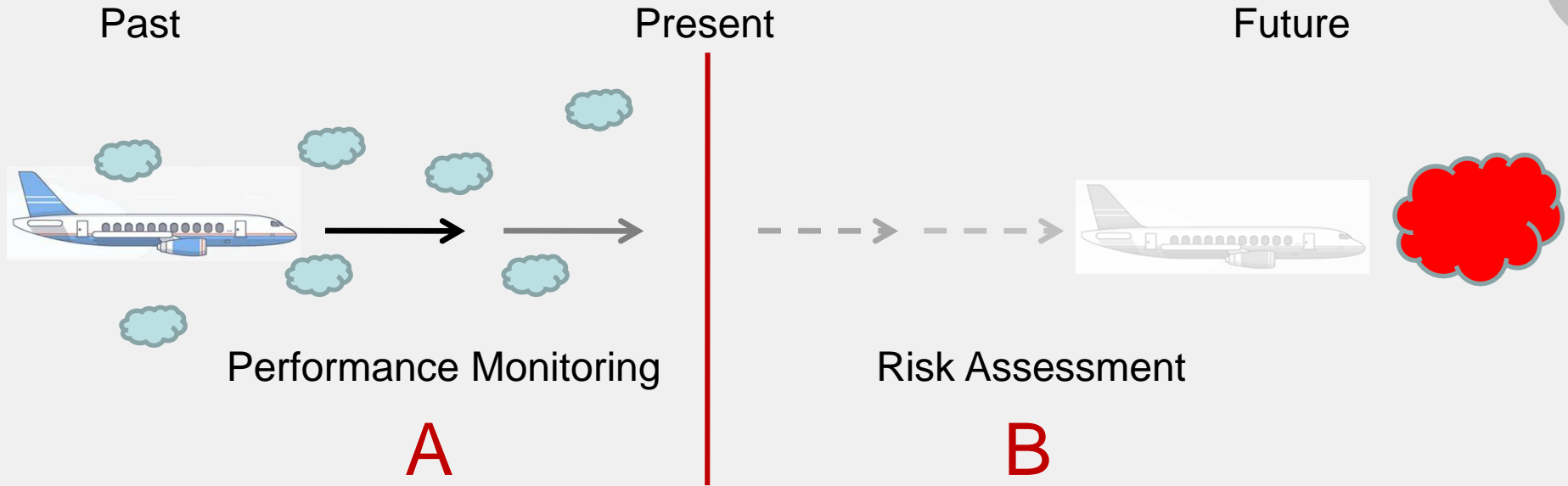
*“Safety reporting and incident analysis is ‘reactive’ safety”*

*“History is for Historians, we are looking to the future”*

*“We are a ‘proactive’ safety organisation, so we don’t focus on performance monitoring.”*

*“Incidents are just ‘lagging’ indicators so we just concentrate on our ‘leading’ indicators”*

# Binary thinking - Performance to Prediction



*So which for Safety Management?*

**A or B?**

**A without B? - 'Navel Gazing'**

**B without A? - 'Crystal Ball Gazing'**

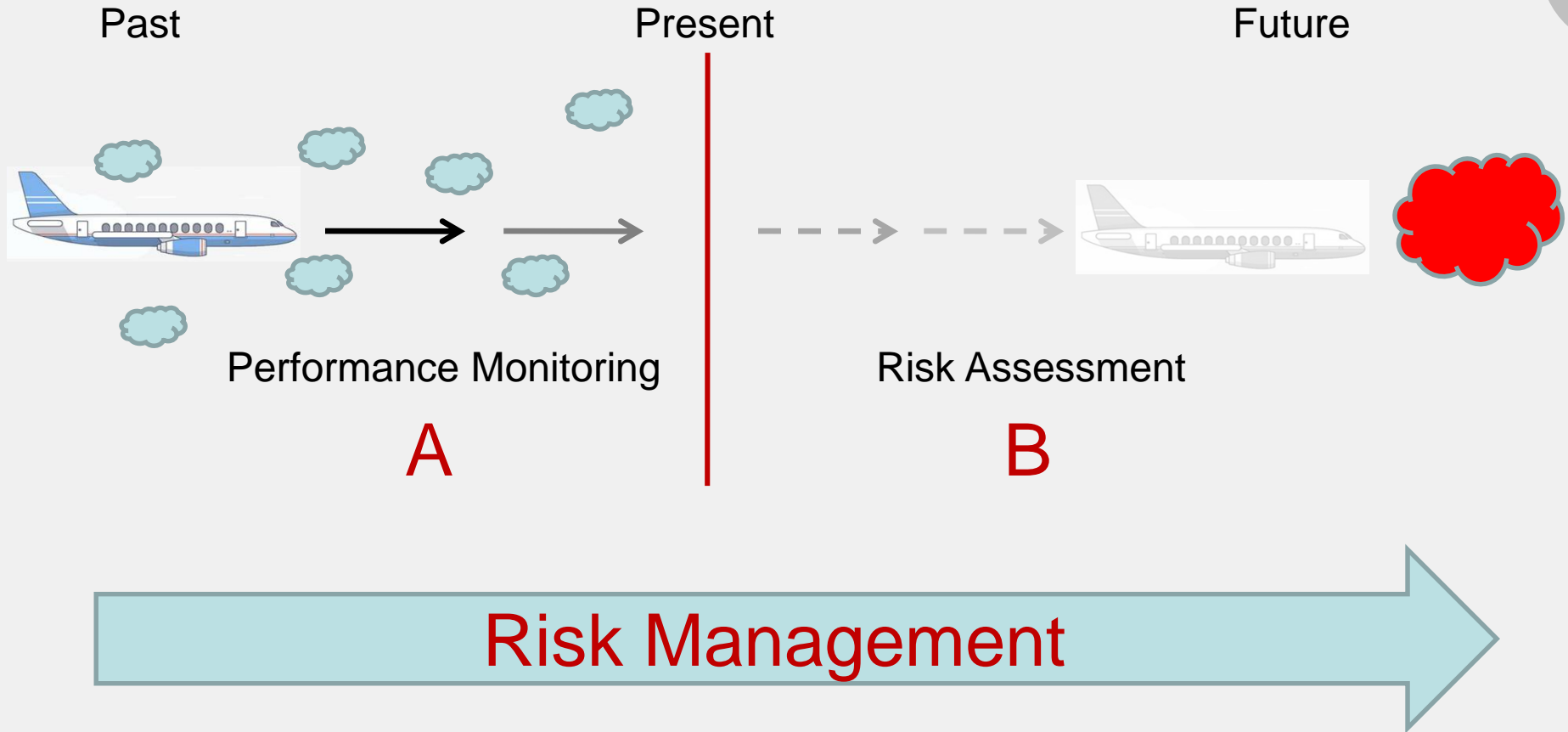
**A and B?**

**Do Performance Monitoring  
(and) Do Risk Assessments**

**Effective Risk Management is**

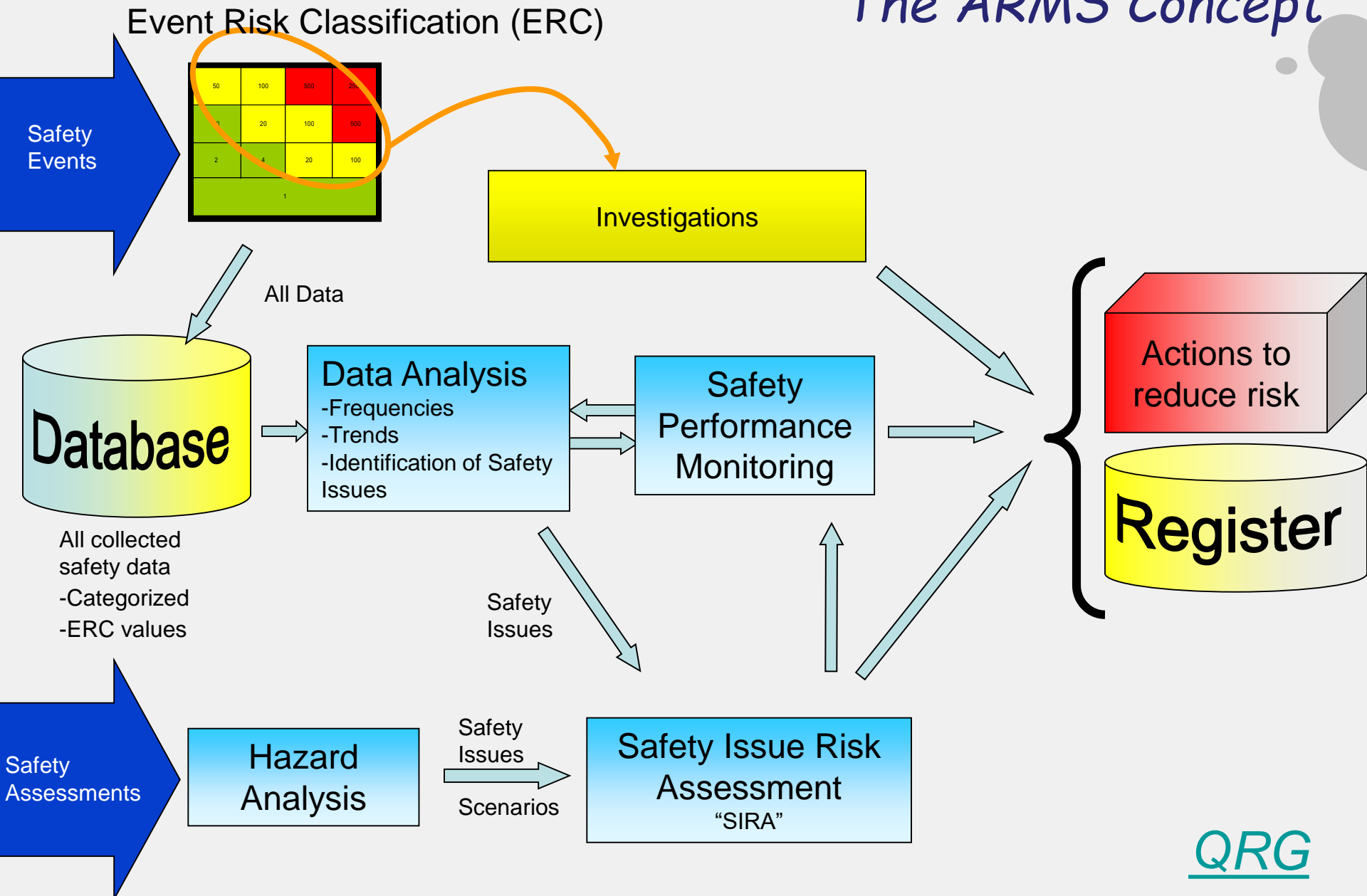
**A x B**

# Binary thinking - Performance to Prediction





# The ARMS Concept



QRG

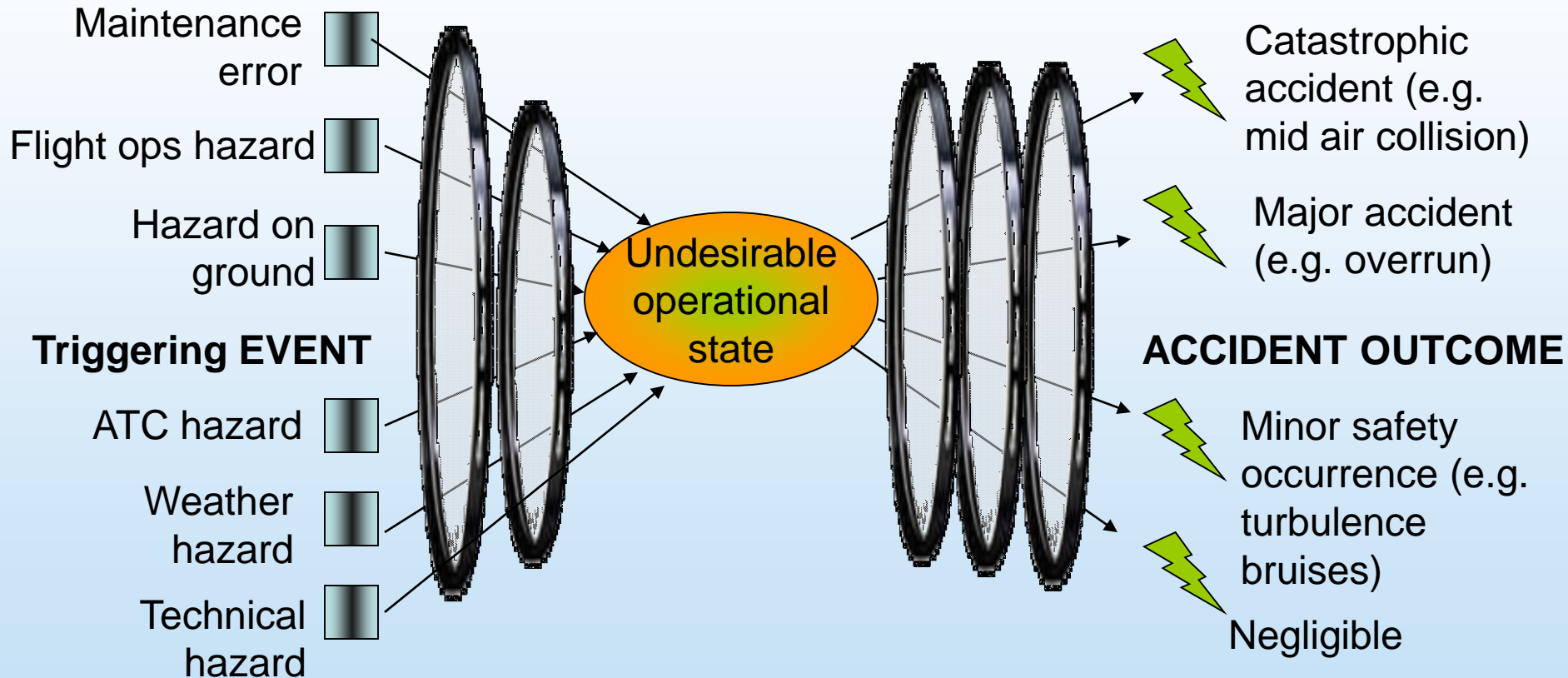
# Safety Issue Risk Assessment

(MINIMISE  
LOSSES)

PREVENT

AVOID

RECOVER



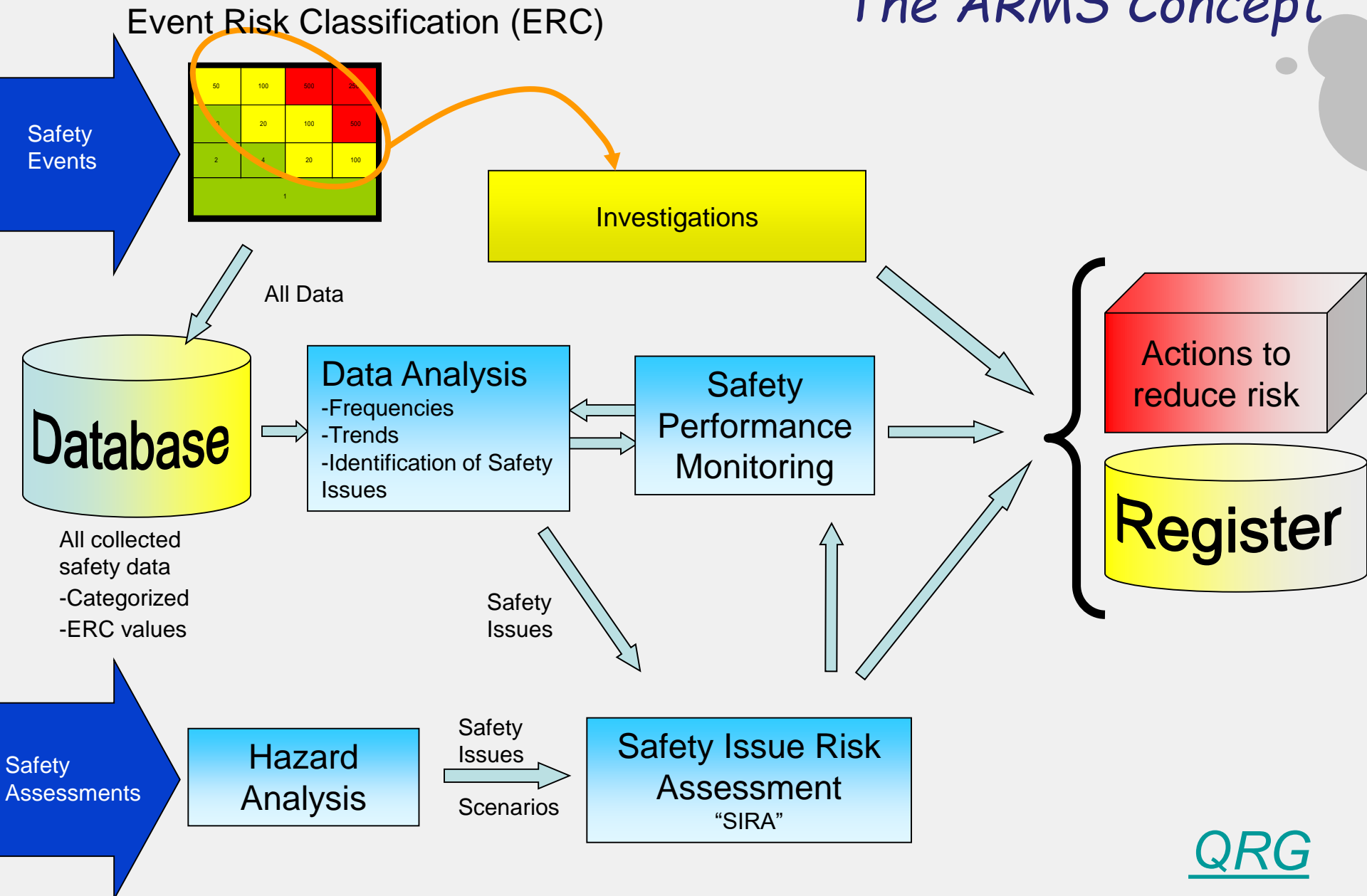
1. FREQUENCY  
OF Triggering EVENT

2. EFFECTIVENESS  
OF AVOIDANCE  
BARRIERS

3. EFFECTIVENESS  
OF RECOVERY  
BARRIERS

4. ACCIDENT  
SEVERITY

# The ARMS Concept



QRG

*Looking back to look forward*

**European Risk  
Classification  
Scheme**

**ERCS**

***'RISK' -  
IN BOTH  
DIRECTIONS***

Potential Accident Outcome	ref score	reference	points											
Extreme catastrophic accident with significant potential fatalities (100+)	1000	X	1000000	X/9	X/8	X/7	X/6	X/5	X/4	X/3	X/2	X/1		X/0
				1.00E-03	0.01	0.10	1.00	10	100	1,000	10,000	100,000		1,000,000
Significant accident with significant potential for fatalities and injuries (19-100)	100	S	500000	S/9	S/8	S/7	S/6	S/5	S/4	S/3	S/2	S/1		S/0
				5E-04	5E-03	0.05	0.50	5	50	500	5,000	50,000		500,000
Major accident with potential for some fatalities/life changing injuries (2-19) or major aircraft destroyed	10	M	100000	M/9	M/8	M/7	M/6	M/5	M/4	M/3	M/2	M/1		M/0
				1E-04	1E-03	0.01	0.10	1.00	10	100	1,000	10,000		100,000
Single Individual fatality/life changing injury or substantial damage accident	1	I	10000	I/9	I/8	I/7	I/6	I/5	I/4	I/3	I/2	I/1		I/0
				1E-05	1E-04	1E-03	1E-02	1E-01	1E+00	10	100	1,000		10,000
Minor and Serious Injury (not life changing) accidents and Minor Damage	0.01	E	1000	E/9	E/8	E/7	E/6	E/5	E/4	E/3	E/2	E/1		E/0
				1E-06	1E-05	1E-04	1E-03	1E-02	1E-01	1	10	100		1,000
	0	A	0	A/0										
				16-17	14-15	12-13	10-11	8-9	6-7	4-5	2-3	1		0
			1 in _ times	1.E-09	1.E-08	1.E-07	1.E-06	1.E-05	1.E-04	1.E-03	1.E-02	1.E-01		1.E+00
				remaining barriers predicted to fail 1 in 1,000M times	remaining barriers predicted to fail 1 in 100M times	remaining barriers predicted to fail 1 in 10M times	remaining barriers predicted to fail 1 in 1M times	remaining barriers predicted to fail 1 in 100,000 times	remaining barriers predicted to fail 1 in 10,000 times	remaining barriers predicted to fail 1 in 1,000 times	remaining barriers predicted to fail 1 in 100 times	remaining barriers predicted to fail 1 in 10 times		Realised accidents

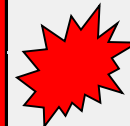
# The ARMS ERC Risk Space

*What is the probability of this remaining barriers between this event and the accident scenario?*

*If this event had escalated into an accident, what would have been the most credible accident outcome?*

EFFECTIVE LIMITED MINIMAL NOT EFFECTIVE

2	20	200	2000
1	10	100	1000
0.1	1	10	100
0.01			



Catastrophic accident with multiple fatalities >8



1-8 fatalities, multiple serious injuries, major damage/loss to the aircraft



Minor injuries, minor damage to aircraft

No potential damage or injury could occur



System Actors	Aircraft, Equipment and Infrastructure	Tactical Planning	Regs, Procedures, Processes	Situational Awareness & Action	Warning System Operation & Action	Recovery Action	Protections	Unknown	Credible Accident Outcome		
ATC, Flt Ops, (Maint)	X/9	X/8	X/7	X/6	X/5	X/4	X/3	X/2	X/1	Between Controlled Traffic	Collision
ATC, Flt Ops, (Maint)										With uncontrolled traffic	
ATC, Flt Ops, (Maint)										Obstacle	
ATC, Flt Ops, (Maint)										Terrain	
ATC, Flt Ops, (Maint)										Two aircraft on the runway	
ATC, Flt Ops, Airport Ops, (Maint)	S/9	S/8	S/7	S/6	S/5	S/4	S/3	S/2	S/1	Aircraft and vehicle on the runway	Loss of Control
ATC, Flt Ops, Airport Ops, (Maint)										In Movement Area	
ATC, Flt Ops, Airport Ops, (Maint)										Runway overrun on landing	
ATC, Flt Ops, Airport Ops, (Maint)										Runway overrun on take off	
ATC, Flt Ops, Airport Ops, (Maint)										Runway veer off	
ATC, Flt Ops, Airport Ops, (Maint)	M/9	M/8	M/7	M/6	M/5	M/4	M/3	M/2	M/1	Taxiway/apron excursion	Loss of Control
Gnd Hdlg, Flt Ops, (Maint)										Aircraft upset due flight preparation	
Flt Ops, (Maint)										Aircraft upset due flight crew operation	
Maint, Flt Ops										Aircraft upset due technical factors	
ATC, Flt Ops, (Maint)										Aircraft upset due environmental factors	
Gnd Hdlg, Flt Ops, (Maint)	I/9	I/8	I/7	I/6	I/5	I/4	I/3	I/2	I/1	Smoke/ Fire/ Explosions (Load/ Pax)	Unserviceable A/C environment
Maint, Flt Ops										Smoke/ Fire/ Explosions (Technical)	
Maint, Flt Ops										Pressurisation and Conditioning	
Gnd Hdlg										Ground Handling	
Maint										Maintenance	
Cabin Ops, Flt Ops	E/9	E/8	E/7	E/6	E/5	E/4	E/3	E/2	E/1	Cabin	Injuries or Damage
Cabin Ops, Flt Ops, ATC, (Maint)										Turbulence	
	1E-06	1E-05	1E-04	1E-03	1E-02	1E-01	1	10	100		

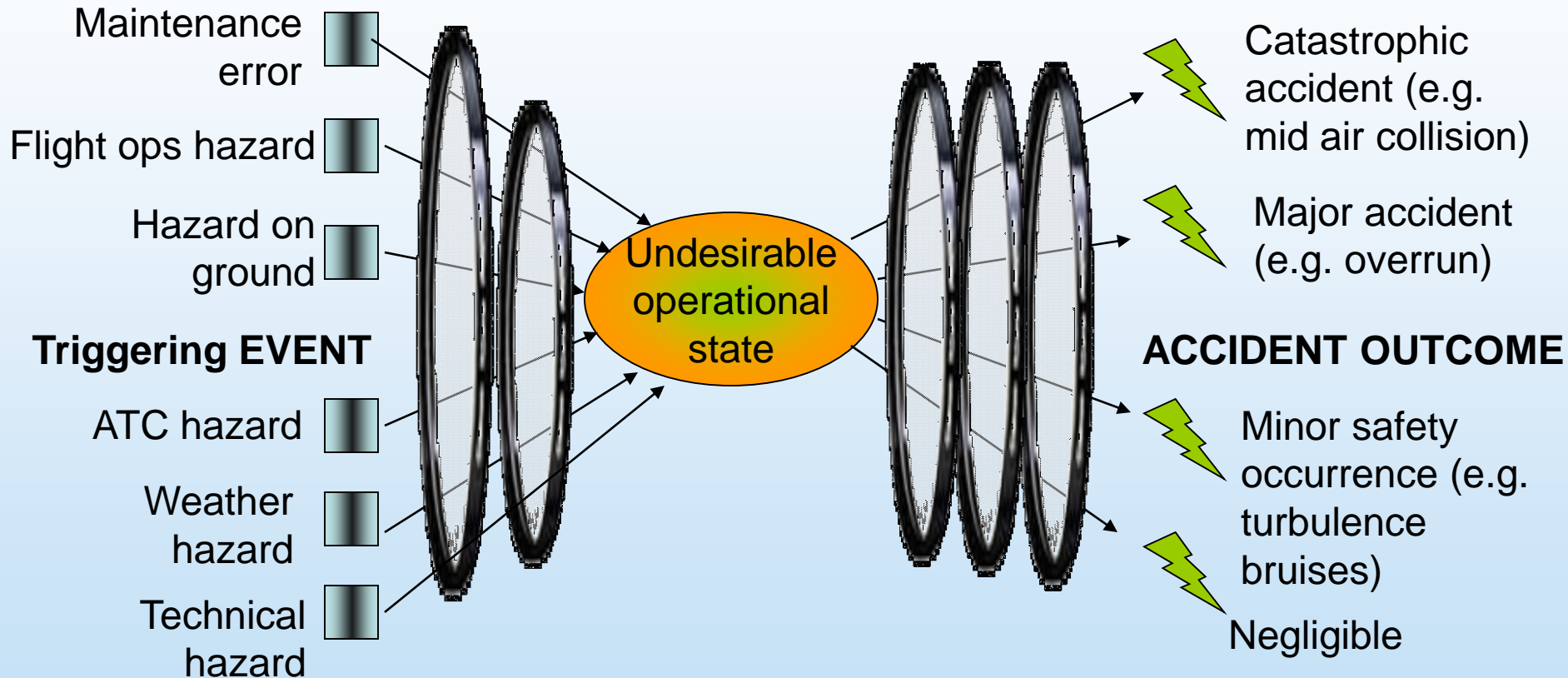
# Safety Issue Risk Assessment

(MINIMISE  
LOSSES)

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1. FREQUENCY  
OF Triggering EVENT

2. EFFECTIVENESS  
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BARRIERS

3. EFFECTIVENESS  
OF RECOVERY  
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4. ACCIDENT  
SEVERITY



# ERCS (Naked!)

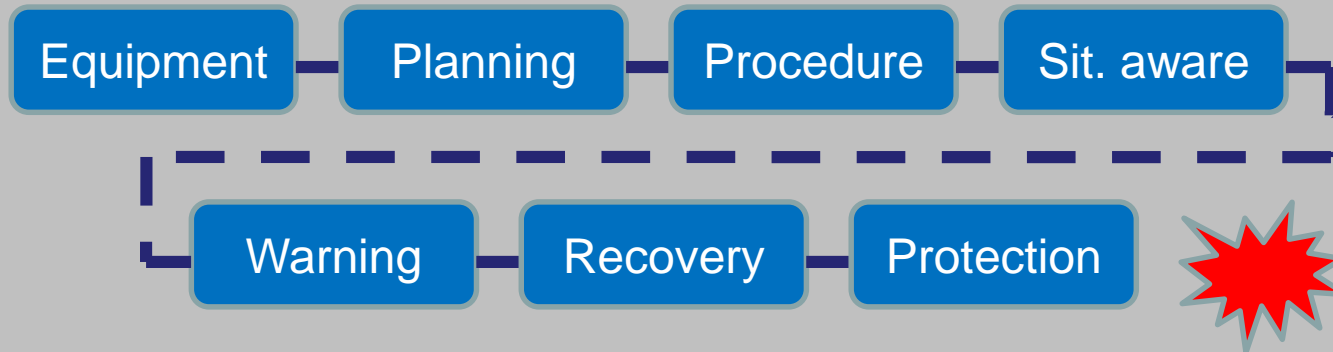
System Actors	Aircraft, Equipment and Infrastructure	Tactical Planning	Regs, Procedures, Processes	Situational Awareness & Action	Warning System Operation & Action	Recovery Action	Protections	Unknown	Credible Accident Outcome	
ATC, Flt Ops, (Maint)									Between Controlled Traffic	Collision
ATC, Flt Ops, (Maint)									With uncontrolled traffic	
ATC, Flt Ops, (Maint)									Obstacle	
ATC, Flt Ops, (Maint)									Terrain	
ATC, Flt Ops, (Maint)									Two aircraft on the runway	
ATC, Flt Ops, Airport Ops, (Maint)									Aircraft and vehicle on the runway	
ATC, Flt Ops, Airport Ops, (Maint)									In Movement Area	Loss of Control
ATC, Flt Ops, Airport Ops, (Maint)									Runway overrun on landing	
ATC, Flt Ops, Airport Ops, (Maint)									Runway overrun on take off	
ATC, Flt Ops, Airport Ops, (Maint)									Runway veer off	
ATC, Flt Ops, Airport Ops, (Maint)									Taxiway/apron excursion	
Gnd Hdgl, Flt Ops, (Maint)									Aircraft upset due flight preparation	
Flt Ops, (Maint)									Aircraft upset due flight crew operation	Unserviceable A/C environment
Maint, Flt Ops									Aircraft upset due technical factors	
ATC, Flt Ops, (Maint)									Aircraft upset due environmental factors	
Gnd Hdgl, Flt Ops, (Maint)									Smoke/ Fire/ Explosions (Load/ Pax)	
Maint, Flt Ops									Smoke/ Fire/ Explosions (Technical)	
Maint, Flt Ops									Pressurisation and Conditioning	
Gnd Hdgl									Ground Handling	Injuries or Damage
Maint									Maintenance	
Cabin Ops, Flt Ops									Cabin	
Cabin Ops, Flt Ops, ATC, (Maint)									Turbulence	

# The model behind the scenes

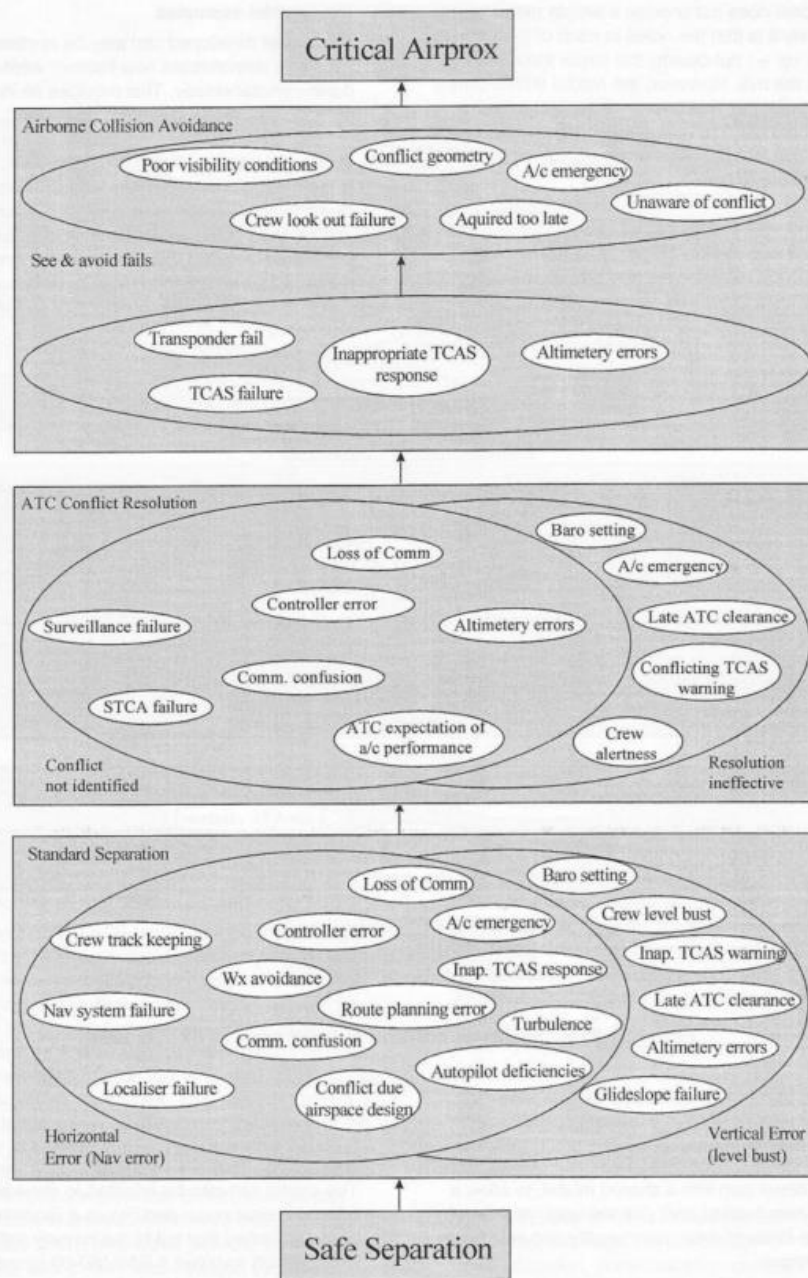
*Complex*



Complicated



# History



Full paper available at:











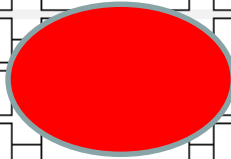
<http://www.risk-thebigpicture.biz/publications.html>

# What does their operation look like?

System Actors	Aircraft, Equipment and Infrastructure	Tactical Planning	Regs, Procedures, Processes	Situational Awareness & Action	Warning System Operation & Action	Recovery Action	Protections	Unknown	Credible Accident Outcome	
ATC, Flt Ops, (Maint)									Between Controlled Traffic	Collision
ATC, Flt Ops, (Maint)									With uncontrolled traffic	
ATC, Flt Ops, (Maint)									Obstacle	
ATC, Flt Ops, (Maint)									Terrain	
ATC, Flt Ops, (Maint)									Two aircraft on the runway	
ATC, Flt Ops, Airport Ops, (Maint)									Aircraft and vehicle on the runway	
ATC, Flt Ops, Airport Ops, (Maint)									In Movement Area	Loss of Control
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ATC, Flt Ops, Airport Ops, (Maint)									Runway overrun on take off	
ATC, Flt Ops, Airport Ops, (Maint)									Runway veer off	
ATC, Flt Ops, Airport Ops, (Maint)									Taxiway/apron excursion	
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ATC, Flt Ops, (Maint)									Aircraft upset due environmental factors	
Gnd Hdg, Flt Ops, (Maint)									Smoke/ Fire/ Explosions (Load/ Pax)	
Maint, Flt Ops									Smoke/ Fire/ Explosions (Technical)	
Maint, Flt Ops									Pressurisation and Conditioning	
Gnd Hdg									Ground Handling	Injuries or Damage
Maint									Maintenance	
Cabin Ops, Flt Ops									Cabin	
Cabin Ops, Flt Ops, ATC, (Maint)									Turbulence	

## Where are their holes?

# What does their operation look like?

System Actors	Aircraft, Equipment and Infrastructure	Tactical Planning	Regs, Procedures, Processes	Situational Awareness & Action	Warning System Operation & Action	Recovery Action	Protections	Unknown	Credible Accident Outcome	
ATC, Flt Ops, (Maint)									Between Controlled Traffic	Collision
ATC, Flt Ops, (Maint)									With uncontrolled traffic	
ATC, Flt Ops, (Maint)									Obstacle	
ATC, Flt Ops, (Maint)									Terrain	
ATC, Flt Ops, (Maint)									Two aircraft on the runway	
ATC, Flt Ops, Airport Ops, (Maint)									Aircraft and vehicle on the runway	Loss of Control
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ATC, Flt Ops, Airport Ops, (Maint)									Runway veer off	
ATC, Flt Ops, Airport Ops, (Maint)									Taxiway/apron excursion	Unsuitable A/C environment
Gnd Hdlg, Flt Ops, (Maint)									Aircraft upset due flight preparation	
Flt Ops, (Maint)									Aircraft upset due flight crew operation	
Maint, Flt Ops									Aircraft upset due technical factors	
ATC, Flt Ops, (Maint)									Aircraft upset due environmental factors	
Gnd Hdlg, Flt Ops, (Maint)									Smoke/ Fire/ Explosions (Load/ Pax)	Injuries or Damage
Maint, Flt Ops									Smoke/ Fire/ Explosions (Technical)	
Maint, Flt Ops									Pressurisation and Conditioning	
Gnd Hdlg									Ground Handling	
Maint									Maintenance	
Cabin Ops, Flt Ops									Cabin	Injuries or Damage
Cabin Ops, Flt Ops, ATC, (Maint)									Turbulence	

## How big are their holes?

# What does their operation look like?

System Actors	Aircraft, Equipment and Infrastructure	Tactical Planning	Regs, Procedures, Processes	Situational Awareness & Action	Warning System Operation & Action	Recovery Action	Protections	Unknown	Credible Accident Outcome	
ATC, Flt Ops, (Maint)									Between Controlled Traffic	Collision
ATC, Flt Ops, (Maint)									With uncontrolled traffic	
ATC, Flt Ops, (Maint)									Obstacle	
ATC, Flt Ops, (Maint)									Terrain	
ATC, Flt Ops, (Maint)									Two aircraft on the runway	
ATC, Flt Ops, Airport Ops, (Maint)									Aircraft and vehicle on the runway	Loss of Control
ATC, Flt Ops, Airport Ops, (Maint)									In Movement Area	
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Maint, Flt Ops									Smoke/ Fire/ Explosions (Technical)	
Maint, Flt Ops									Pressurisation and Conditioning	
Gnd Hdlg									Ground Handling	
Maint										
Cabin Ops, Flt Ops										
Cabin Ops, Flt Ops, ATC, (Maint)									Turbulence	

**Do they have common holes?**

# What does their operation look like?

System Actors	Aircraft, Equipment and Infrastructure	Tactical Planning	Regs, Procedures, Processes	Situational Awareness & Action	Warning System Operation & Action	Recovery Action	Protections	Unknown	Credible Accident Outcome	
ATC, Flt Ops, (Maint)									Between Controlled Traffic	Collision
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ATC, Flt Ops, (Maint)									Obstacle	
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Gnd Hdlg									Ground Handling	
Maint										
Cabin Ops, Flt Ops										
Cabin Ops, Flt Ops, ATC, (Maint)									Turbulence	

## What are they good at?

## Questions and Discussion

*Risk is a journey* - a journey from the past into the future

We know of it because of the past, but it only matters because of the future.

Thank you

For further information or discussion:

Andrew Rose – [andrew@llanbury.co.uk](mailto:andrew@llanbury.co.uk)

[www.risk-thebigpicture.biz](http://www.risk-thebigpicture.biz)