The Space Shuttle Challenger disaster

Incident Date: January 28th 1986

Background information

The launch of the Space Shuttle Challenger was eagerly anticipated because it was the first time a citizen would be travelling in to space (school teacher Christa McAuliffe). The space shuttle was due to launch in Florida but had been delayed for over a week because of a bout of bad weather.

On the day of the launch specialists sent up weather balloons which indicated that the weather conditions were fine for the launch. However, the launch pad was covered in ice with icicles over 1m long. No space shuttle had ever been launched in temperatures as low as they were on this day. Therefore the launch was delayed for a further two hours to allow the ice to melt. Just 30 minutes before the launch a passenger plane flew over the launch site and encountered a harsh jet stream. The system checks indicated that all systems were functioning correctly so a unanimous decision was made to launch.

The launch and subsequent explosion

The space shuttle launched without any data on the ground suggesting a problem. The shuttle hit a cross wind but the shaking quickly stopped. The shuttle powered the engines to full in order to escape the earth's gravitational force. However, 73 seconds into the launch the shuttle exploded, leaving control and the families of the astronauts on the ground stunned. Contact with the shuttle had ceased but the data on the ground had not indicated that anything was wrong. There were seven astronauts on board (including Christa McAuliffe) and despite desperate attempts to locate the crew cabin there were no survivors.

It was found that the rocket booster had malfunctioned. Rocket boosters are comprised of four sections that join at field joints. Rubber O rings expand to prevent rocket fuel leakages at the field joints. The investigations concluded that it was an O ring failure that caused the explosion. However, a simple O ring failure would have meant that the shuttle would have exploded on the launch pad.

Roger Boisjoly and Morton Thiokol

Roger Boisjoly was an engineer at Morton Thiokol (the company that built the rocket boosters for NASA). Boisjoly correctly predicted that the cold weather would affect the performance of the O rings. This prediction was based on evidence from the previous launch of the space shuttle Discovery. A year before Challenger, Discovery was launched in cold conditions. There was no explosion in the Discovery launch, but the booster recovered showed scorching of the O rings to the extent that they were only millimetres from being completely burned through. Boisjoly suspected that the cold weather made the O rings rigid and stopped them sealing the rocket fuel in the booster.

13 hours before the launch Boisjoly tried to stop it in a teleconference between Morton Thiokol senior managers and NASA. Boisjoly recommended that the shuttle should not be launched in the cold weather conditions and was supported by the senior managers at Morton Thiokol in this recommendation. NASA considered the evidence from the Discovery launch to be inconclusive. The senior managers at Morton Thiokol then put the conversation

on hold to reconsider. Boisjoly was adamant that Challenger should not be launched and was shouting at the Morton Thiokol managers to look at the evidence from the Discovery launch and the images of the O rings. However, this evidence was overlooked and all four senior managers agreed to the launch. NASA immediately accepted this decision. Boisjoly watched the launch feeling relieved that the shuttle had not exploded on the launch pad, but this relief was short-lived.

Why did the shuttle explode 73 seconds after launch?

1. The rocket boosters were ignited on launch.
2. There was an O ring failure (they became rigid due to the cold conditions) rocket fuel spilt out of the booster at the field joint but was then blocked by something (this is likely to be slag which is a by-product of the aluminium in the booster). This sealing of the field joint prevented the explosion occurring on the launch pad.
3. 58 seconds into the launch the shuttle was rocked by a violent jet stream (likely to be the jet stream experience by the passenger air craft 30 minutes prior to launch) which dislodged the slag causing fuel to leak from the booster.
4. The fuel leakage caused a flame to appear on the right rocket booster.
5. This flame caused hydrogen to leak from the external tank and the bottom of the tank gave way.
6. The nose of the booster (which was now free from the external tank) crashed in to the external tank causing the explosion.

If the slag had remained in position and not been dislodged for a further 62 seconds the boosters would have detached and disaster avoided.

Events following the launch

Following the Challenger disaster relatives of the astronauts that lost their lives received compensation. The NASA shuttle programme was shut down for three years so that the shuttles could be redesigned and safety systems incorporated. Morton Thiokol developed new boosters.

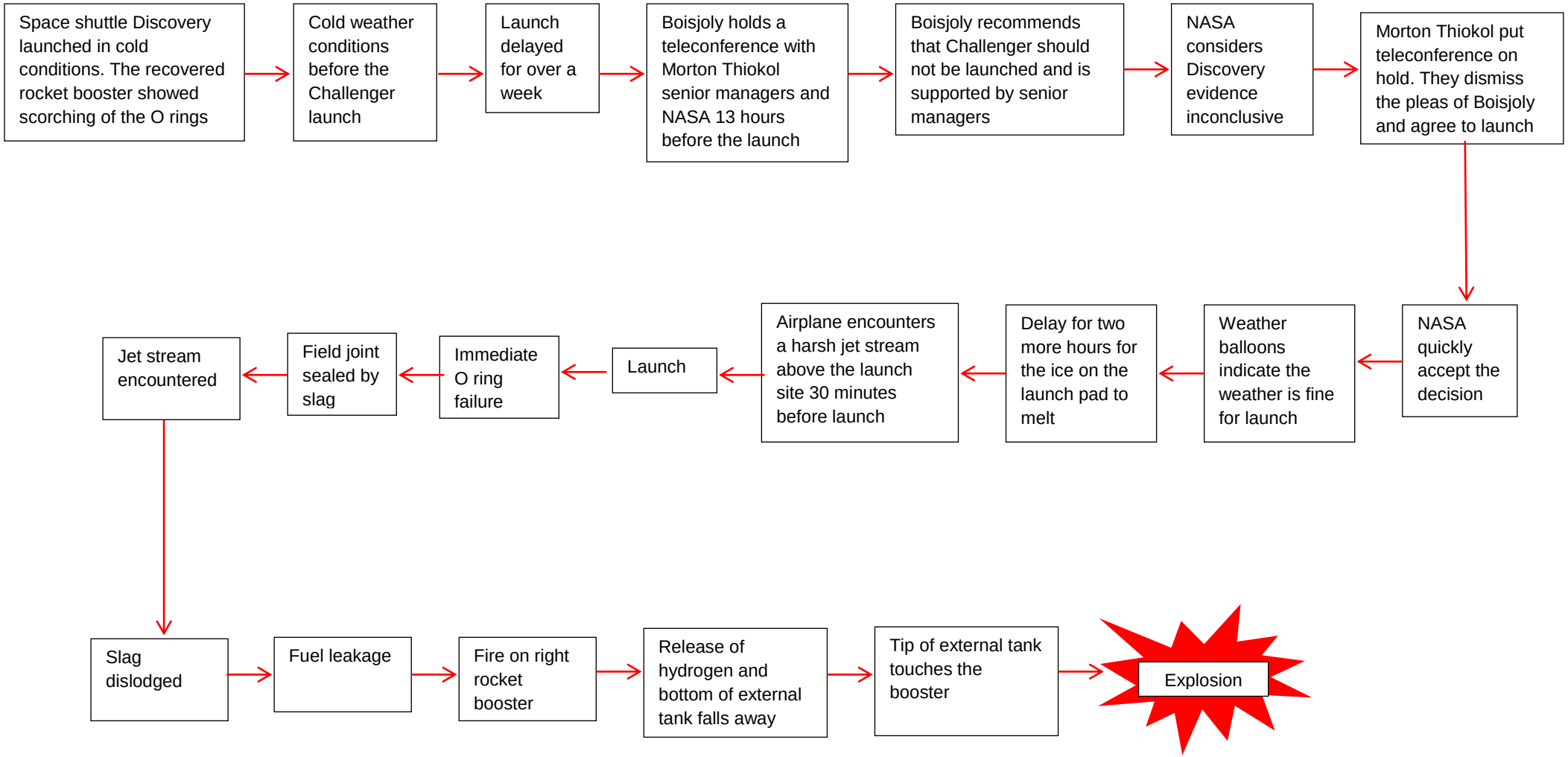
In 2003 NASA launched Columbia which burned apart on its return journey to earth claiming the lives of seven more astronauts. The accident investigation report identified that NASA had not learnt its lesson from the Challenger disaster. No private citizen has been on board a space shuttle since the Challenger disaster.

Roger Boisjoly left Morton Thiokol and after the disaster suffered a mental breakdown.

Data sources

Information in this document has been sourced from the National Geographic ‘seconds from disaster’ television series, but further information is available from the Nicholas and Smith Ltd ‘Disaster management’ DVD series.

What happened?



What NTS contributed to the Space Shuttle Challenger disaster?

STAGE		SUB-SKILL	WHO DISPLAYED THE NTS	NOTES
OBSERVE	1.1	Attention to detail	All	NASA/Morton Thiokol failed to pay attention and observe the evidence from the Discovery launch. Boisjoly paid attention to the O ring evidence details.
	1.2	Overall awareness	All	NASA/Morton Thiokol had an overalll awareness of what could happen but did not pay attention to the evidence. Boisjoly was aware of what could happen.
	1.3	Maintain concentration		
	2.1	Systematic & thorough approach		
	2.2	Checking		
	3.1	Listening	NASA/Morton Thiokol	Failed to listen to the warning from Boisjoly.
UNDERSTAND (KNOWLEDGE)	1.2	Overall awareness		
	1.4	Retain information		
	1.5	Anticipation of risk	All	Boisjoly anticipated the risk as did Morton Thiokol but NASA did not.
	4.1	Effective decisions	NASA/Morton Thiokol	NASA/Morton Thiokol understood the risks but overlooked them.
	4.2	Timely decisions	NASA/Morton Thiokol	Had the opportunity with understanding to make a timely decision (13 hours before launch).
	4.3	Diagnosing & solving problems	NASA/Morton Thiokol	Did not learn/solve the problems from the Discovery launch.
DECIDE	4.1	Effective decisions	NASA/Morton Thiokol	It was an ineffective decision to launch Challenger.
	4.2	Timely decisions	NASA/Morton Thiokol	Had time to decide to postpone the launch.
	4.3	Diagnosing and solving problems	NASA/Morton Thiokol	Decided to launch despite being aware of a possible O ring problem.
	2.3	Positive attitude to rules & procedures		

	3.4	Sharing information	Morton Thiokol/Boisjoly	Morton Thiokol and Boisjoly both shared the Discovery evidence with NASA at a time when the launch could have been postponed.
	5.1	Considering others' needs	Boisjoly	Held the teleconference to try to prevent a loss of life.
	5.2	Supporting others	Morton Thiokol	Failed to support Boisjoly.
ACT	4.1	Effective decisions	NASA/Morton Thiokol	Ineffective decision to launch Challenger.
	4.2	Timely decisions	NASA/Morton Thiokol	Could have acted in time to prevent the launch.
	4.3	Diagnosing & solving problems	NASA/Morton Thiokol	Nothing was done to prevent an O ring failure.
	2.1	Systematic & thorough approach		
	2.2	Checking		
	3	Communication (all)	All	3.1 - NASA/Morton Thiokol failed to listen to Boisjoly. 3.2 - Boisjoly was clear in the information he was giving. 3.3 - Boisjoly was assertive but was also aggressive. 3.4 - Boisjoly/Morton Thiokol did share the information about Discovery with NASA.
	5.2	Supporting others	Morton Thiokol	Did not support Boisjoly after NASA dismissed Discovery evidence.
	5.3	Treating others with respect	Boisjoly/NASA	Boisjoly was shouting at his managers to listen to him. It is not entirely surprising that he acted this way given the potential consequences but he did not treat his managers in a respectful way. NASA did not respect the views of Morton Thiokol/Boisjoly in their decision to launch.
	5.4	Dealing with conflict / aggressive behaviour	All	Boisjoly was shouting at his senior managers who dealt with this by ignoring him.

ALL STAGES	6	Workload management	All	6.1 – NASA/Morton Thiokol focussed their attention on launching the space shuttle because they were under time pressure (launch had already been delayed). 6.2 – NASA/Morton Thiokol prioritised the launch over the delay it would take to wait for warmer weather. 6.3 – Boisjoly was not calm under pressure (was in a very high pressured situation).
	7	Self-management		

Description of the Space Shuttle Challenger disaster

Roger Boisjoly

Situational awareness					Conscientiousness			Communication				Decision making & action			Cooperation and working with others				Workload management			Self-management			
1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	7.1	7.2	7.3	7.4

Morton Thiokol Senior managers

Situational awareness					Conscientiousness			Communication				Decision making & action			Cooperation and working with others				Workload management			Self-management			
1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	7.1	7.2	7.3	7.4

NASA

Situational awareness					Conscientiousness			Communication				Decision making & action			Cooperation and working with others				Workload management			Self-management			
1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	7.1	7.2	7.3	7.4