Ariane 5 (1996 explosion)

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Introduction

- An American and Russian dominated industry
- Boosting the technical advancements
- U.S Space industry worth $60 billion in year 1999
- Handful of nations can afford such an industry
- European Effort: Formation of European Space Agency (ESA)
- ESA is the proud maker of the Ariane Rocket series
Ariane 5’s Purpose: delivering satellite to space

Improved version of Ariane 4

Control system of Ariane 5 composed of:

- An inertial reference system (SRI)
- An On-Board Computer (OBC)

SRI of Ariane 5 same as one in Ariane 4
Summary of Events

- Morning of June 4\textsuperscript{th} 1996
- Rocket exploded around 40 seconds after lift-off
- Inquiry board set to discuss the failure
- Failure due to SRI software exception
- Exception caused due to a data conversion
- SRI failed about 31 seconds after lift-off (Same SRI worked perfectly in Ariane 4)
Consequences

- ESA spent $8 billion developing this rocket
- They flaunted Ariane 5 as a new era in Satellite delivery technology
- ESA’s reputation was jeopardized
- Loss of market share and revenue
- ESA lost the European faith in the program
- Nobody was found liable for the damage
- European public left with no one to blame but faulty software
Causes of failure identified

• “Complete loss of guidance and altitude information (30 seconds after lift-off)” [2]
• “This loss of information was due to specification and design errors (in SRI software)” [2]
• Adequate analysis and testing could have detected the potential failure [2]
• Causes of failure were direct result of faulty design, review and testing
Stake-holders

- European space Agency (ESA)
- Centre National d’Etudes Spatiales (CNES)
- Governments funding the project
- 53 European shareholders
- European taxpayers
- Designers
Stake-holders

- Requirements engineers
- Test Engineers
- Project managers
- Reviewers
- The software engineering profession
Ethical Issues

Some ethical standards engineer should obey by:

- Engineers shall expose risks openly to supervisors.
- Engineers shall participate in a lifelong learning process regarding the practice of their profession.
- Engineers shall ensure that their products meet the highest professional standards possible.
Were engineers at fault?

? Were there engineering methods developed at the time that could have been used in order to prevent the disaster?

? The answer is yes, yes and for a long time

? Many areas of software development were lacking in the development of SRI software

- Design
- Documentation
- Testing
- Review
Individuals involved in developing the SRI did break the code of ethics by engaging in erroneous software engineering practice.

Is software really needed?

- Easier to maintain
- Generally cheaper
- Remote accessibility
- Software does not wear
Was ESA at fault?

? ESA could have pursued the guilty parties and consequently punish them (More ethical approach)

? This would have caused

- Loss of client
- Waning of public trust in the program
- Costly for ESA (but only in the short run)
Why is it less costly in the long run?

- The software error could be prevented if the faulty members were persecuted

Why is it more ethical?

- Not pursuing the guilty parties was a setback for the software industry as a whole
- Could have been a warning: You can be held liable for the software you create
Social ramification of disaster

? Negative social implications:

- No particular individual or group of individuals were identified as the cause of failure
- Software can not be error free!

? Software engineering would have to adapt to society’s need for error free products, like other engineering disciplines have done before it
Comparing with conventional engineering disciplines

- Like other disciplines, Software engineering has its disposal methods for proper creation of software.
- The designers of Ariane 5 did not use that knowledge.
- Engineers would have been held responsible if the error was made in electrical or mechanical sections.
- Engineers in other disciplines had the power to inform different organizations of faulty engineering practices at ESA.
Conclusion

- Engineers at ESA did break the following ethical engineering codes:
  - Did not expose risks associated with not fully testing and reviewing the software
  - Did not keep up with advancements in their field
  - Did not insure that the product was of the highest quality possible
- ESA broke the code of ethics by not holding anybody responsible
Conclusion

- The Ariane 5 disaster was a wake up call for the software engineering community
- Proper actions should be taken to ensure such a failure does not occur again
- True software engineers will carry the torch into an era where software will be error free
Referances

[1] NSPA publication No. 1102 as revised January 1987
[2] ARIANE 5 Flight 501 Failure, Reported by the Inquiry Board
   http://www.cas.mcmaster.ca/~baber/TechnicalReports/Ariane5/Ariane5.htm