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# Space Launch Reliability History

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- A little bit of history





- Robert H. Goddard
  - Inspired Wernher Von Braun
- The V-2 rocket (1942)
- R-7 (1957)
- The Space Race
  - 1957
  - Sputnik 1 and Explorer 1
  - Apollo 11



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# Past





- Learning
  - Mostly accidents such as: fires, new technology, vacuum of space, space suits, rocket failures
- Russia and USA



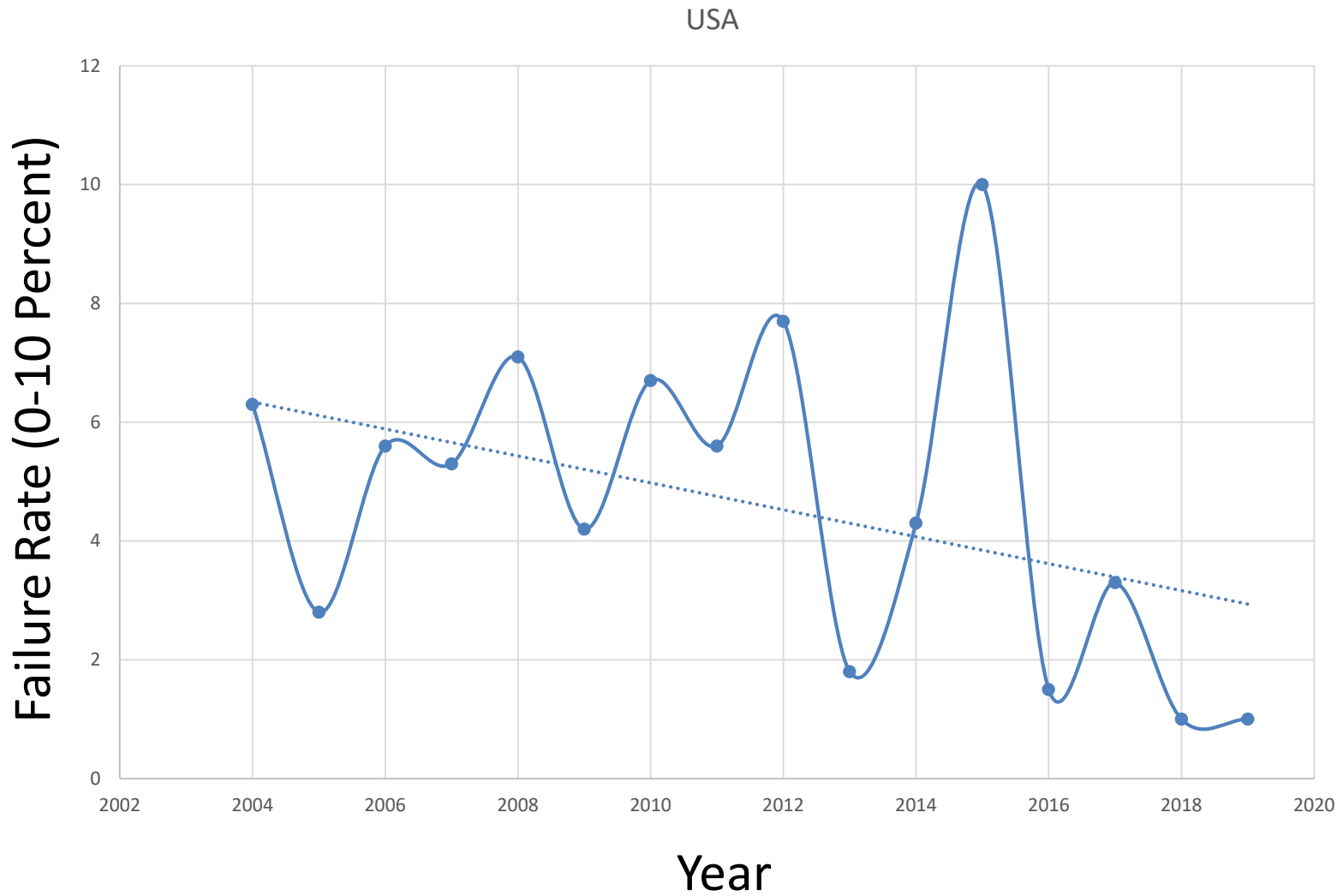
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# Present

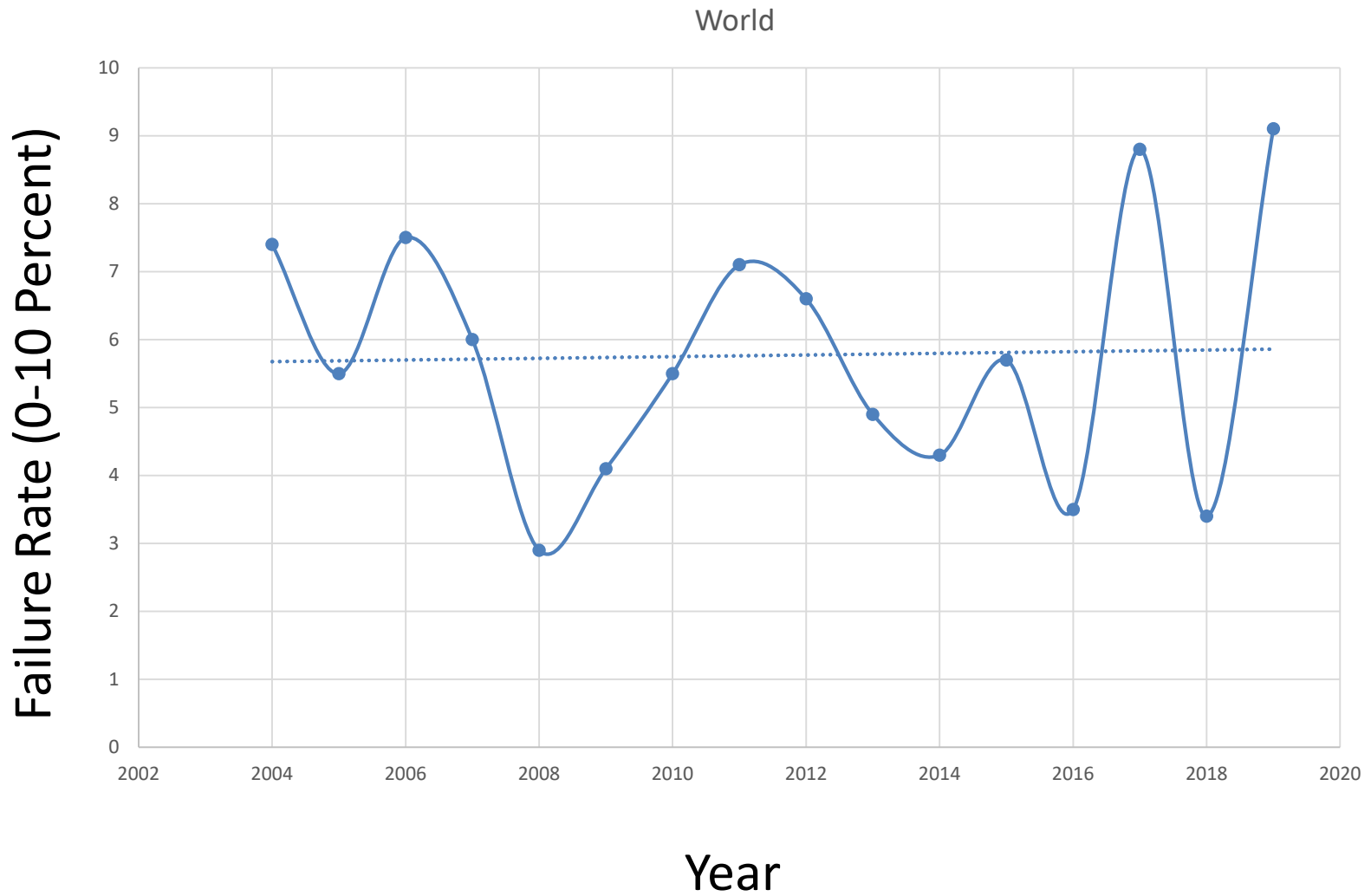




- Space flight is becoming increasingly popular
  - The first 8 months of 2019 had more launches than 2004 had in a year
- Worldwide safety has remained constant
  - Iran and China
  - USA at <1% failure rate since 2017
- 2018 was the busiest in history and 2019 is set up to take the lead









- As time progresses, things become more controlled
  - Consistent downward trend for most countries
- Facing different troubles in spaceflight
  - Separation and attitude



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# Future





- Downward trend in failures for countries that institute safety and reliability tactics
- 2019 and 2018 both have zero failures thus far and the US is averaging about 1 in 102 failure rate using the 1/3 rule



- Interplanetary travel
  - New and unknown hazards
- New unknown unknowns



- Next challenge in Reliability and Maintainability
  - New environmental hazards
    - Extended periods of time in space
  - Predictability
    - The corona of the sun
    - Parker waves
    - Parker Solar Probe



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# Conclusion



- Reliability over the past 6 decades
  - Launch rate is increasing
    - Commercialization and space exploration
  - Reliability has remained relatively constant
    - Recent data indicates possible improvement in reliability
- Reliability in the new era of spaceflight
  - Key to safe spaceflight as we return to unknowns





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# QUESTIONS?





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**Thank You!**

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