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INTRODUCTION
HISTORY
Thanks to the experience accumulated by the company principals since the early stages of the nanosatellites’ industry, Tyvak recognized early on the unsettling approach toward mission assurance within the industry and worked to do things “the Tyvak way” while addressing the needs of our customers. As all processes, achieving mission assurance is not a set destination, but an ever changing process that evolves and perfects as the company grows and adapts.

- **January 2016**
  - “The epiphany”

- **October 2016**
  - Paper at NATO event

- **Mid-2017**
  - We need help!
  - Engaged UCLA B. John Garrick Institute for the Risk Sciences

- **2018**
  - Expansion of the team and creation of business units to bolster our customer-centric approach

- **2019**
  - The implementation – personnel equipment

- **2020**
  - Making difficult decisions – we maintain and perfect where additional support was needed and restructured accordingly
WHY DO WE CARE ABOUT MISSION ASSURANCE?
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OUR COMMITMENT: To deliver our customers’ mission success story
WHAT IT MEANS: We strive to provide the best possible outcome for our customers’ missions

TYVAK’S GUIDING MANTRAS

Our success is measured by how well our missions perform – nothing else

Fortune favors the well prepared – be prepared

Testing isn’t about validating one’s own work product. It’s about identifying issues in a controlled environment. Space is difficult enough as it is.

Engineering and science rely on analysis and intersubjective testability – not one’s opinions

We are all systems engineers in the end… each with expertise in a unique area
WHY DO WE CARE ABOUT MISSION ASSURANCE?

- Today’s mission assurance paradigms focus on compliance – not critical thinking or engineering judgment

- Compliance is NOT assurance
  - Using the language of compliance is (much) easier than analyzing performance
  - Excessive compliance causes poor performance
WHY DO WE CARE ABOUT MISSION ASSURANCE?

Typical Bathtub Curve

- **Region I:** 'Wear in' failures
- **Region II:** Constant hazard rate failures
- **Region III:** 'Wear out' failures

Derived SmallSats Reliability Curve

- Modified Weibull distribution
- Derived from a database of available data analyzed by UCLA in 2018

SmallSats Bathtub Curve

- **Region I:** 'Wear in' or quality failures
- **Region II:** Constant hazard rate
- **Region III:** 'Wear'
**WHY DO WE CARE ABOUT MISSION ASSURANCE?**

Evolve the company from **reactive** to **proactive** and **strategic**

**ORGANIZATIONAL VALUE**

- **2018**
  - regressive
  - making budgets now
  - failures or breakdown

- **2019/20**
  - planned
  - avoiding failures
  - availability
  - optimization

- **2020/21**
  - strategic

**KEY MOTIVATORS**

Ledet Model of Organizational Operational Domains
WHAT DO WE FOCUS ON?
WHAT DO WE FOCUS ON?

- **Manufacturing Issues**
  - Introduce failure causes that will likely induce failure early in the mission
  - These are failure mechanisms that ‘are not supposed to be there,’ meaning they introduce substantially shortened characteristic lifetimes

vs.

- **Fundamental design flaws**
  - Often cause by a weak understanding of basic engineering and physics principle
WHAT DO WE FOCUS ON?

- **Functional Testing**
  - Functional tests are only as useful as the ability for the outputs to influence design
  - We need to make sure there is scope for satellite design to change

- **Fault Tolerance (or resilience)**
  - Includes hardware and software based logic
  - Approached at architecture, system level or component level

- **Commercial-off-the-shelf (COTS) parts**
  - Assurance or way to assess whether the supplier has provided high quality components

- **Design Life**
  - We set it at 5+ years for boards and 3+ years goal for system
  - Data analysis shows that just by setting a greater goal, infant mortality decreases
WHAT DO WE FOCUS ON?

FROM: Qualification and Certification

TO: Critical Thinking and an ‘Assurance Culture’

E.g. : graceful degradation and adaptive mission strategies

How do we measure / quantify?
HOW DO WE ADDRESS IT?
HOW DO WE ADDRESS IT?

Provide valuable information

Small satellites are sub-systems of a larger system that includes the constellation of satellites within which they deploy and all supporting elements such as ground stations, data management systems, data processing solutions, and ultimately, tools to extract information.

Why is it important?

2x 80% reliability sat @ $500k each are better than 1x 95% reliability sat @ $1M

How is this possible?

Reliability for parallel systems: \(1-(1-R_1)(1-R_2) = 96\%\)

Best value

Integrate our customers’ business plan and risk profile into the design.

Align the “reliability” of systems and constellations of satellites with our value proposition to create “availability” based on mission needs.
HOW DO WE ADDRESS IT?

1. Address infant mortality
   ▪ ensure vehicles **functionally work** with all components interacting appropriately so they can easily overcome faults and anomalies

2. Address “wear-in” failures
   ▪ improve the **quality of manufacturing** processes for internal teams and third-party suppliers

3. Incorporation of an **evolutionary production process**
   ▪ satellite design and manufacturing strategies considered to be two sides of the same coin – in a way that is iteratively used and improved from satellite to satellite
HOW DO WE ADDRESS IT?

- Gold Suite stores Tyvak’s corporate knowledge that fuels the evolutionary production approach.

- Future Tyvak customers won’t be asking for a new satellite – they’ll be asking for a ‘Tyvak’ satellite adapted for their specific needs.

- Each new customer benefits from the satellites we’ve designed for previous customers.
HOW DO WE ADDRESS IT?

Maintain Tyvak's Standard of Standards document

Manage Corporate Knowledge

Challenge to Identify Defects

Quality Management Systems (QMS) control, compliance and oversight

external standards and assurance

design information management (DIM)

process

human resources (HR) and training

contestability

implementation

Manage Continuous Improvement process

Optimize business processes

Attract, retain and develop personnel
**How do we address it?**

*Rules are for the guidance of wise men and the obedience of fools.*

- Evolutionary Production
  - Evolving corporate satellite design knowledge

- Tailored Standards
- Focus on vehicle heritage
- Review-centric development
- Blind compliance

- Create a culture of assurance
  - (change role of reviews)

- Embrace and foster the return of critical thinking
THE PRINCIPLES
THE PRINCIPLES

1. WE ARE A TEAM OF ENGINEERING ATHLETES – NOT LABORERS
2. WE DON’T BLINDLY FOLLOW PROCESSES
3. WE FIND REASONS TO KEEP GOING BEFORE WE FIND A REASON TO STOP. THE ONLY THING WORSE THAN THE WRONG DECISION IS NO DECISION
4. WE LEVERAGE SUPPLIERS, BUT PREFER PARTNERS
5. THE MORE YOU SPECIFY ‘HOW,’ THE LESS YOU GET FROM WHAT WE DO
6. TYVAK EMPLOYEES ARE BIG THINKERS – AND WE REWARD THEM FOR THINKING BIG
7. WE TEST TO LEARN – NOT TO PASS
8. INFORMATION HAS VALUE – FORGETTING TO LEARN A LESSON COSTS MONEY