National Aeronautics and Space Administration

# Risk Informed Philosophy: Using What We Fear To Lose To Guide Us To Success

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**NASA Glenn Research Center**
**Cleveland, Oh**

# Agenda

- A little background
- Processes, Improvement, & Programs
- The Philosophy of Programs
- Risk, NOT a four-letter word
- Using Risk to guide project requirements

*Image Credit: European Space Agency (ESA)*

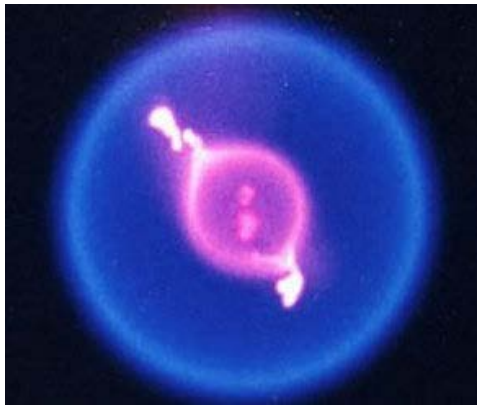
# Background

- **Spent much of my career around safety, process, and assurance requirements**
  - QMS Development (ISO, QS, AS)
  - Process Improvement (Lean, Six Sigma, Theory of Constraints, TRIZ, Global 8D, etc)
- **Served as the Chief Safety & Mission Assurance Officer (CSO) August 2012 – September 2015**
  - *Responsible for identifying S&MA requirements for each project*
  - Established common set of S&MA processes for projects (S&MA Plan)
  - Responsible for oversight of prime contractor
  - Responsible for the development of S&MA products for in-house projects
  - Head of the GRC ISS Projects Quality Assurance Organization
- **Exploration Systems Development Division S&MA, July 2015-Present**
  - Establishing safety review process for secondary payloads that will be launched aboard the Space Launch System (SLS) and the Orion Multi-Purpose Crew Vehicle (MPCV)
    - Help identify the hazards to the vehicles that these secondary research payloads pose
    - Levy the right requirements or good practices to mitigate or control

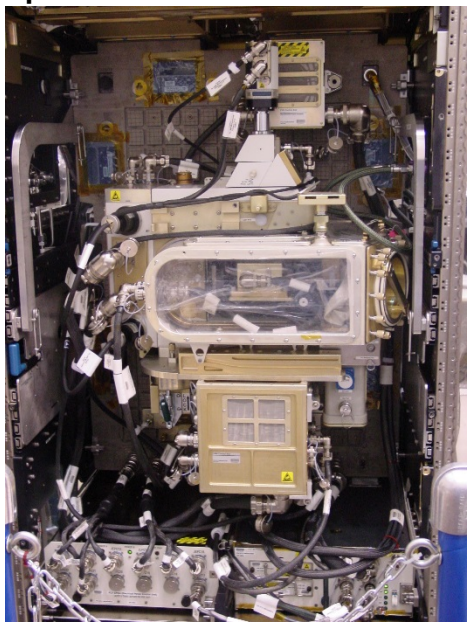
# GRC's ISS Physical Sciences and Human Research

- **NASA Glenn's ISS & Human Health Office leads the development of a wide range of research payloads bound for the International Space Station**
  - Areas of Research
    - Human Research, such as exercise countermeasures
    - Combustion Science
    - Fluid Physics and Advanced Fluids (Colloids)
  - Mix of in-house projects and hardware development via prime contract
  - Typically NASA Risk Classification C & D hardware
  - Performed aboard the ISS

*Astronaut Ron Garan configuring the Combustion Integrated Rack (CIR) for FLEX experiment*

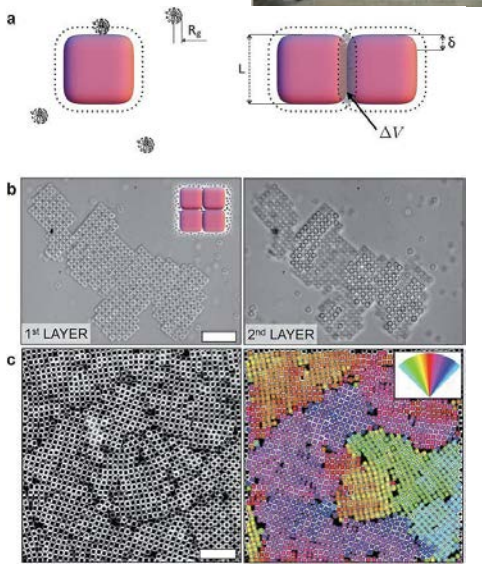


*Fuel droplet combustion during the Flame Extinguishing (FLEX) Experiment*



*The Light Microscopy Module (LMM) installed in the Fluids Integrated Rack (FIR)*

*The GRC developed improved harness in use on the ISS.*




*Studying self assembly of colloidal cubes during the Advanced Colloids Experiment (Mixing), ACE-M3 in the LMM.*

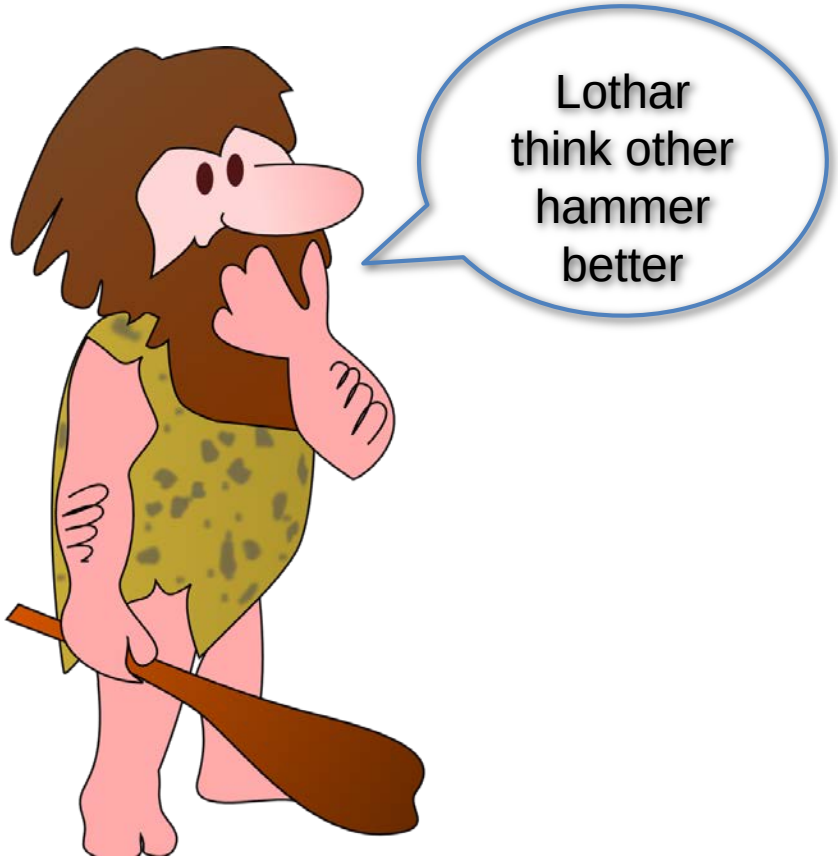
All images and descriptions available at: www.nasa.gov/mission_pages/station/research/experiments_category

# The Birth of Processes

**As soon as someone figured out a way to do something the same way, every time, processes were born….**

# The Birth of Process Improvement

**And, as soon as one person created a process, someone else came along who thought they knew how they could do it better….**

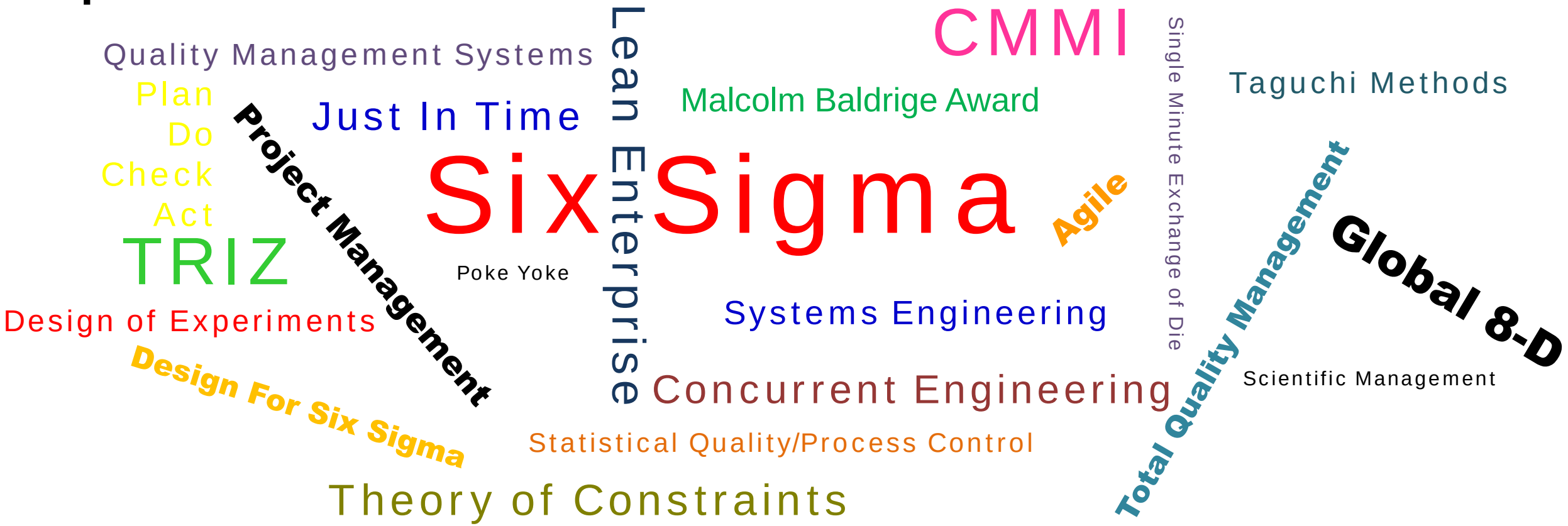



# A New Cottage Industry is Born

**Which was then followed by the birth of the process improvement consultant…..**

# Process Improvement Leads to “Programs”

**A program, in the context of process improvement, is really just a the collection of the concepts, processes, & metrics to be used to improve**



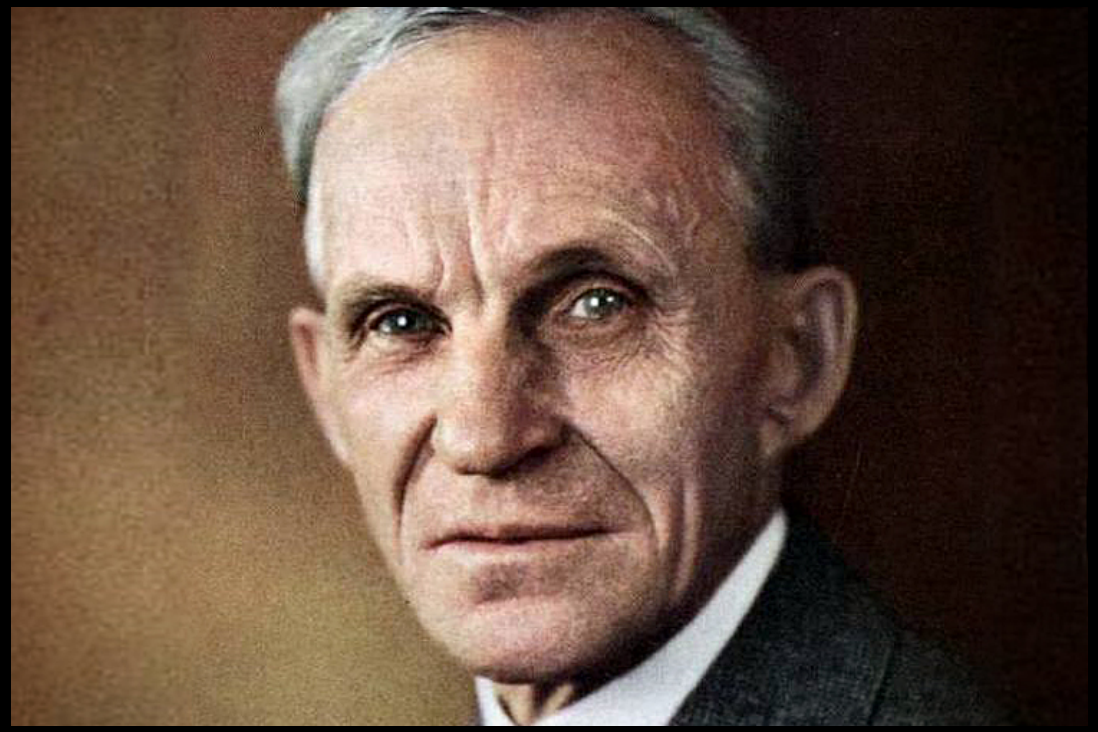
# Programs & Motivation

TEAMWORK

BECAUSE I SAID SO!

# Programs & Motivation

QUALITY IS YOUR #1 JOB



BECAUSE YOU CAN BE REPLACED

# Anatomy of a Program

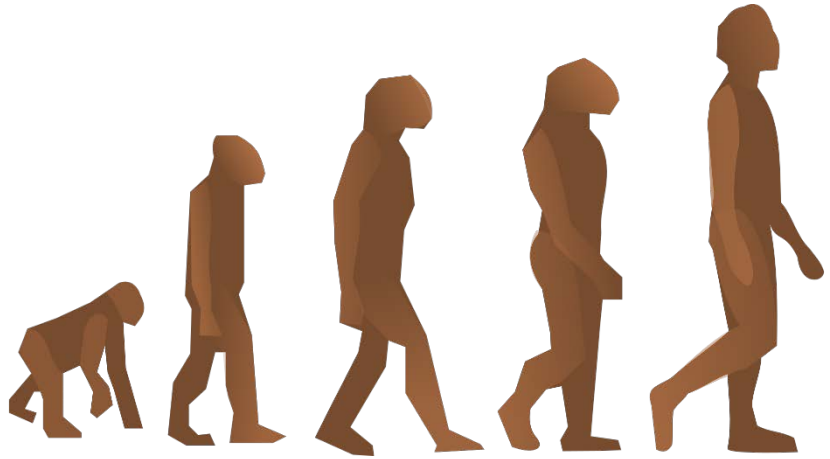
**Organizations can follow the identical sequence and get drastically different results**

**This is often attributed to:**

- Varying levels of commitment (did senior management really buy in?)
- The levels of resources applied (hours, full time vs. part time)
- The amount of pre-work or follow-up work

**Programs are often treated as something to be integrated once, with the occasional tune up**

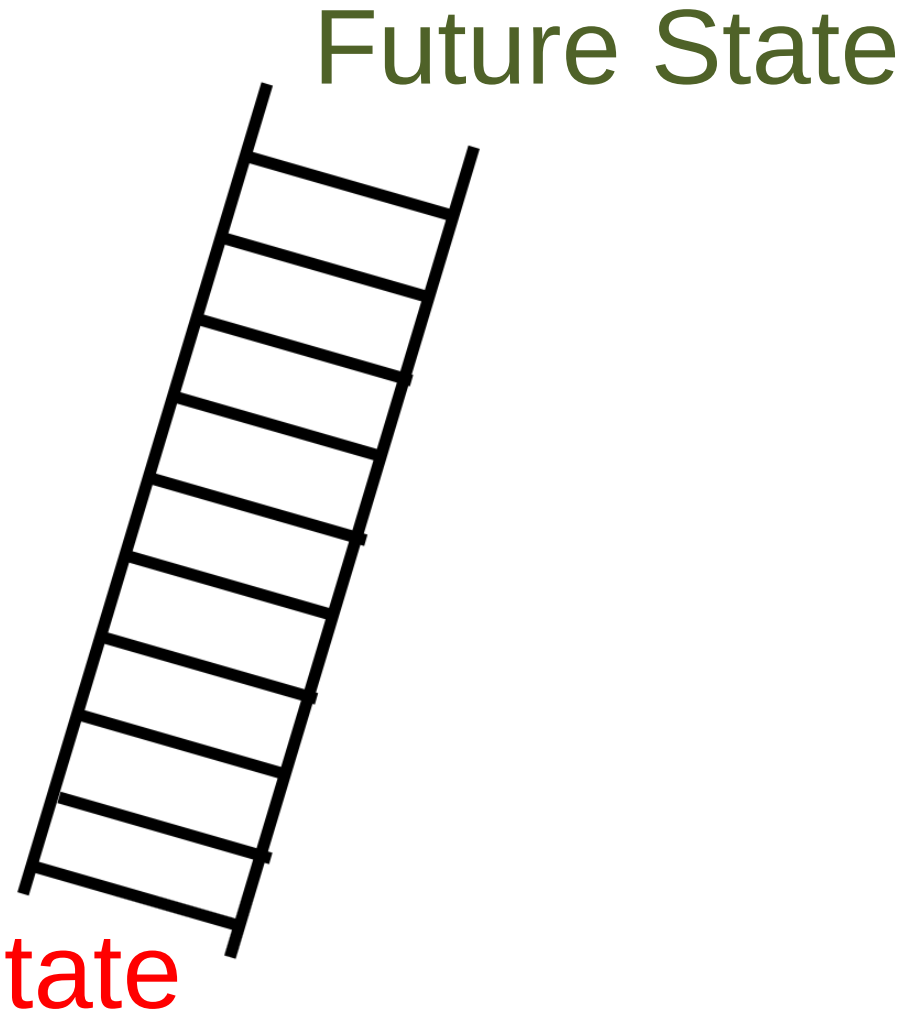
**The truth is that programs are organic, multi-faceted, and ever-changing endeavors**



# Anatomy of a Program

**Programs are generally thought of as having two legs: some type of process, and some sort of toolkit**

**What steps to we take, and how do accomplish those steps**



# Program Processes & Toolkits

| Program | Process | Toolkit (Examples) |
|---|---|---|
| Six Sigma | Define, Measure, Analyze, Improve, Control | Multi-variate, MSA, DoE, Process Mapping |
| Lean Manufacturing/Enterprise | Define Value, ID Waste, Flow, Pull, Continuous Improvement | Value stream mapping, SMED, 5S, Poke Yoke |
| Project Management | PMI PMBOK, NASA Procedural Requirement 7120.5 | Project charters, schedules, reviews |
| Systems Engineering | Waterfall Development<br>“V” Development | Requirements management, functional architecture diagrams, physical architecture diagrams, N2 charts for interfaces, phase-gate design review |
| Quality Management Systems | Standards (AS9100, TS16949, ISO9001, etc) | Configuration management, risk management, process control |
| Theory of Constraints | Identify, protect, elevate, and eliminate bottlenecks | Process mapping, scheduling, quality at source, work balancing |

# The Missing Leg?

**Is anything with only two legs to stand on going to be stable?**

**Why ARE some organizations more successful than others with programs?**

**What is missing? PHILOSPOHY!**

**WHY is it we do WHAT we do!**

# Philosophy – The Missing Leg

**The Philosophy of  program is the *WHY* that explains the motivation**

**As such it provides the context behind it, and shapes the development and selection of the process to be followed, and the tools to be used**

**If addressed, it is usually considered once**

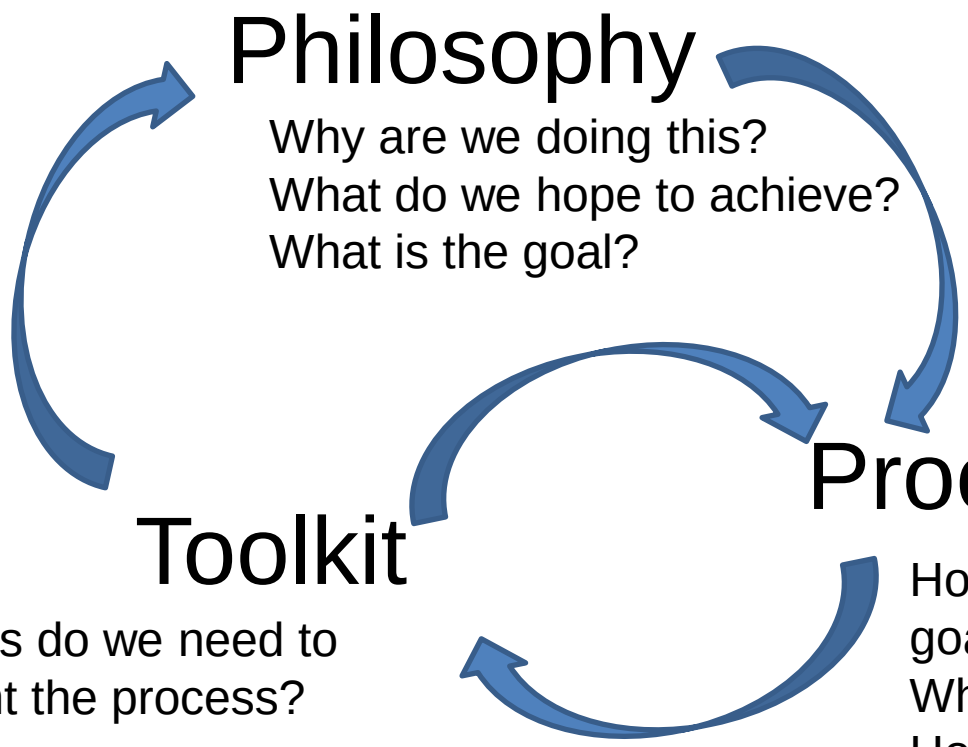
**The WHY is often clouded in sales speak or justification for using, and not a real exploration of what is to be implemented**

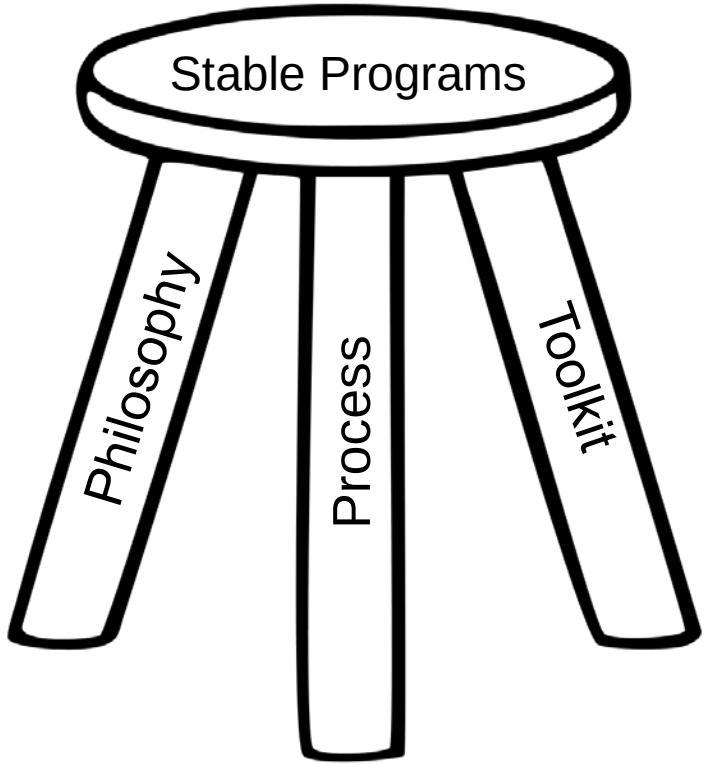
- "Company XYZ used Six Sigma, and improved quality – let's do what they did"
- "Lets follow Organization ABC that saved money with Lean"
- The additional exchange at the end of Goldratt's 'The Goal'

# Program Philosophies

| Program | Philosophy | Process | Toolkit (Examples) |
|---|---|---|---|
| Six Sigma | Improving product and process performance through the characterization and reduction of variation | Define, Measure, Analyze, Improve, Control | Multi-variate, MSA, DoE, Process Mapping |
| Lean | Improve efficiency though the identification, reduction, or elimination of waste | Define Value, ID Waste, Flow, Pull, Continuous Imprv. | Value stream mapping, SMED, 5S, Poke Yoke, |
| Project Management | Improve project performance to cost and schedule through defined processes | PMI PMBOK, NPR 7120.5 | Project charters, schedules |
| Systems Engineering | Improve design effectiveness by using structured processes to control design inputs, review, and verification | NASA Procedural Requirement 7123.1 | Requirements management, functional architecture diagrams, physical architecture diagrams, N2 charts for interfaces, phase-gate design review |
| Quality Management Systems | Improvement the consistency of products through the application of controlled processes | AS9100, ISO9000 | Configuration management, risk management, process control |
| Theory of Constraints | Identifying, protecting, or eliminating bottlenecks protects production capacity and ability to deliver to schedule | Identify, protect, elevate, and eliminate bottlenecks | Process mapping, scheduling, quality at source, work balancing |

# The Ideal Circle of Program Life



# So, Where is RISK in All This

**Risk is defined as the loss of something of value**

**Formal risk management evaluates or quantifies these losses by considering a likelihood and a consequence of that loss**

**We work to mitigate these consequences or reduce the likelihood that they happen**

**When a risk is broad, and can impact an entire organization, we can use programs to do this mitigation**

# The Risk(s) Driving Program Philosophies

| Program | Philosophy | What Risk Does it Mitigate? |
|---|---|---|
| Six Sigma | Improving product and process performance through the characterization and reduction of variation | Too much variation in our products may lead to loss of business<br>Variation of product & process can lead to increased cost and lower margins |
| Lean | Improve efficiency though the identification, reduction, or elimination of waste | Excessive non-value added steps or operations will lead to increased cost and reduced profit<br>Excessive steps can lead to reduced flexibility |
| Project Management | Improve project performance to cost and schedule through defined processes | Project complexity can lead to breakdowns in cost, schedule and performance, yielding higher costs, higher cycle times, and missed opportunities |
| Systems Engineering | Improve design effectiveness by using structured processes to control design inputs, review, and verification | Design complexity can lead to breakdowns in performance, with missing requirements yielding excessive late cycle costs to remedy |
| Quality Management Systems | Improvement the consistency of products through the application of controlled processes | A lack of consistent processes can lead to inconsistent products, missed defects, lost customers |
| Theory of Constraints | Identifying, protecting, or eliminating bottlenecks protects production capacity and ability to deliver | If the process bottlenecks are unknown and unprotected, scheduled time can be lost – forever, leading to missed deliveries. |

# Risk as a powerful motivator……and educator

Even though risk has a negative connotation, we should embrace it

The reality is that risk exists, whether we acknowledge it, or not

To understand your project's or organization's risk simply means to understand how something of value might be lost (spacecraft, people, mission, customers, reputation, etc.)

Understanding these risks allows you to apply good practices or requirements that will mitigate them, such as selecting the right program

# The Ideal Circle of Program Life, Revisited

## Org/Proj Risks

What is it we might lose?
What do we need to mitigate

## Philosophy

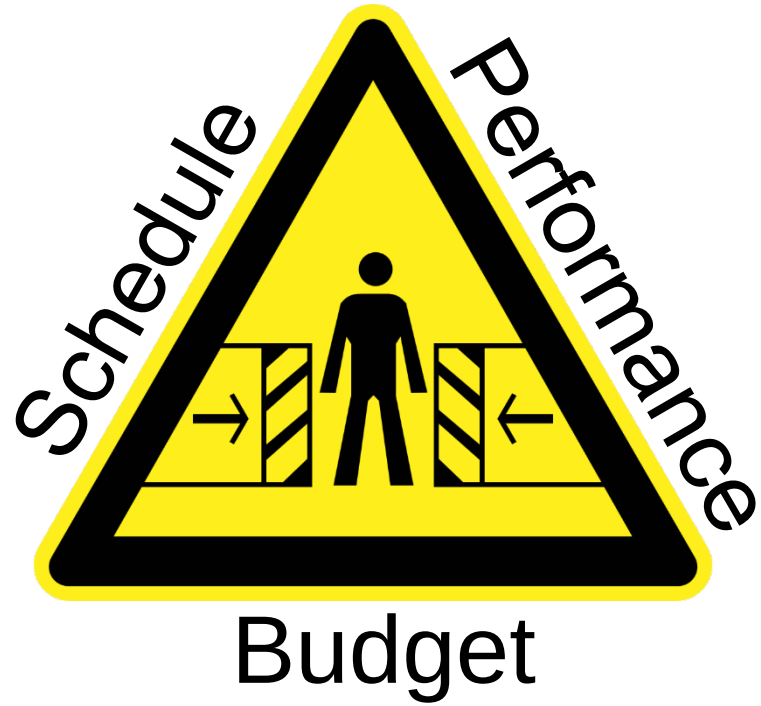
Why are we doing this?
What do we hope to achieve?
What is the goal?

## Process

How are we going to accomplish the program goals?
What steps will we take to get there?
How will we evaluate our progress?

## Toolkit

What tools do we need to implement the process?



# Risk at the Project or Working Level

**Risk, or knowledge of it, can also be used to help identify the kinds of additional controls or requirements that should be levied on a project**

**What requirements might help mitigate your project risks?**

- Safety requirements > prevent or mitigate hazards
- Mission/Quality Assurance requirements> prevent failures in performing the mission
- System engineering requirements > prevent omissions in mission or interface requirements
- Project Management requirements > prevent failures in budget or schedule controls

**This mentality has been quite helpful in ensuring Glenn's ISS Research projects have the right amount of requirements, balancing cost, schedule, and performance**

# Risk Management Good Practices

**There are several resources for guidance on how to do Risk Management (NPR 8000.4, etc)**

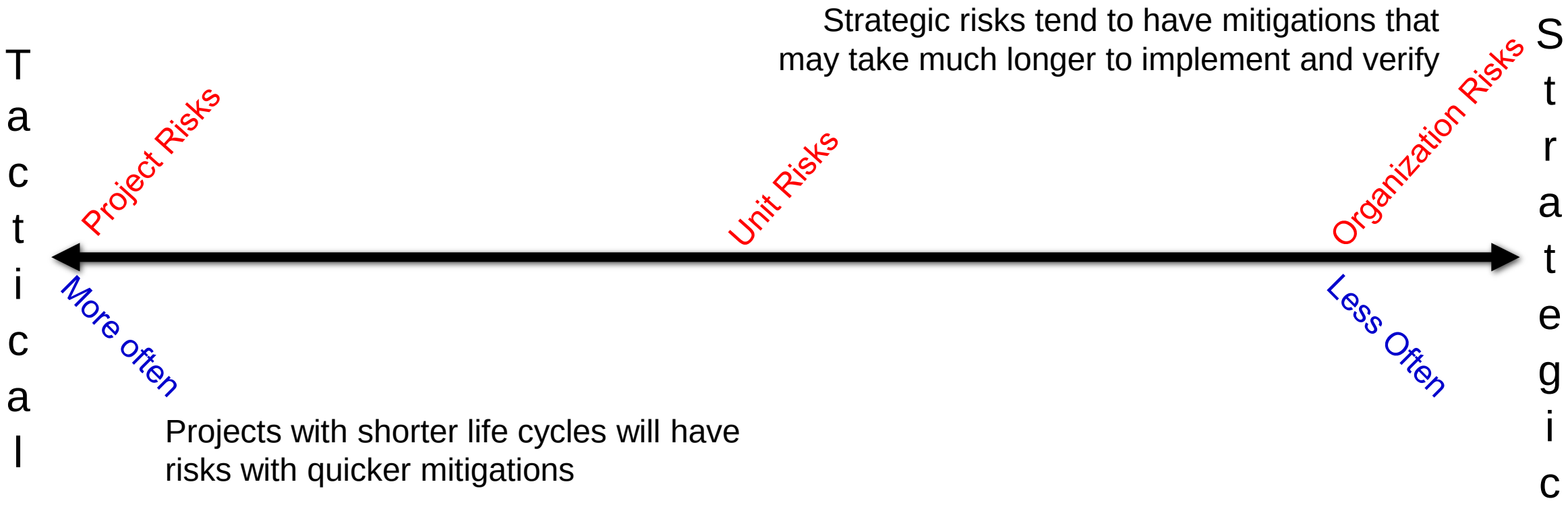
**Many organizations already use some manner of Risk Management at the project, or tactical level, and just need to starting using it for the higher level, strategic issues**

**At a high level, there are just a few key practices to keep in mind**

- **Fact-based**
- **Timely review**
- **Open and free discussion**
- **Common definitions for likelihood & consequence**
- **Accessible to those responsible for making decisions**

# Timeliness

## How often risks need to be reviewed is based upon the its level



# Conclusions

**Risk exists at all levels of the organization**

**Using some manner of risk management can empower organizations to make informed choices, not just at the tactical (project) level, but at the strategic or institutional level**

**Choosing programs or requirements based on the risks an organization or project has can be a more effective way to mitigate them**

**Risks, once known, can be power educator and motivator**

# Questions?


Glenn Research Center
Lewis Field
RESEARCH AND TECHNOLOGY
FOR THE BENEFIT OF ALL