A New Paradigm for Quality Metrics

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AGENDA

Overview of the Kennedy Space Center (KSC) Independent Assessment

Overview of Dimensionless Quality Metrics

- Metrics Assessment Overview
- What is a Metric?
- Concept of Variation and “Quality”
- Using Variation to Measure Performance
- Application of Dimensionless Quality Metrics
- Interpretation

Summary

KSC INDEPENDENT ASSESSMENT
WHO ARE WE? WHAT DO WE DO?

KSC Independent Assessment (IA)

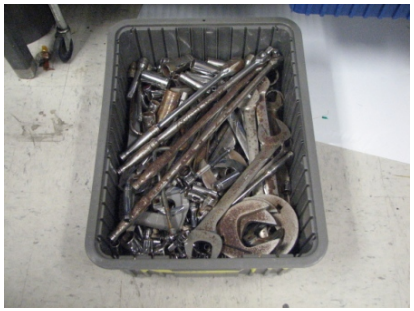
- Capability funded by the Office of Safety and Mission Assurance (SMA) for the NASA Human Spaceflight Centers.
- Allows Human Spaceflight Centers to independently review and assess technical and mission risks associated with Program and Projects.
- Provides objective, non-advocate analysis and solutions.

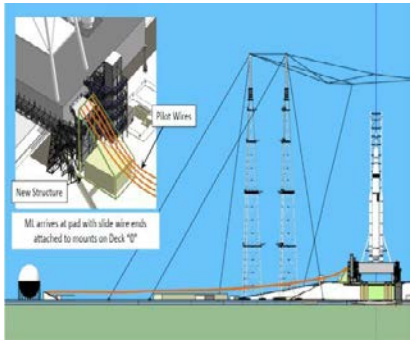
Assessments requests come from a variety of sources:

- KSC Center Director
- KSC SMA Director
- Program/Project Managers/Chief SMA Officers
- KSC Directors

Wide variety of subjects, such as:

- Systemic processes (e.g. Mission Assurance)
- Institutional (e.g. Personnel Safety)
- Technical (e.g. LC 39B Emergency Egress Assessment)





OVERVIEW NEW QUALITY METRICS

Focus on what should be measured; not what can be measured.

METRICS ASSESSMENT OVERVIEW

In December 2014, the KSC IA Team was tasked to develop a holistic set of measures to assess the health of the SMA Program at KSC.

S&MA metrics have been traditionally represented as either leading and lagging indicators:

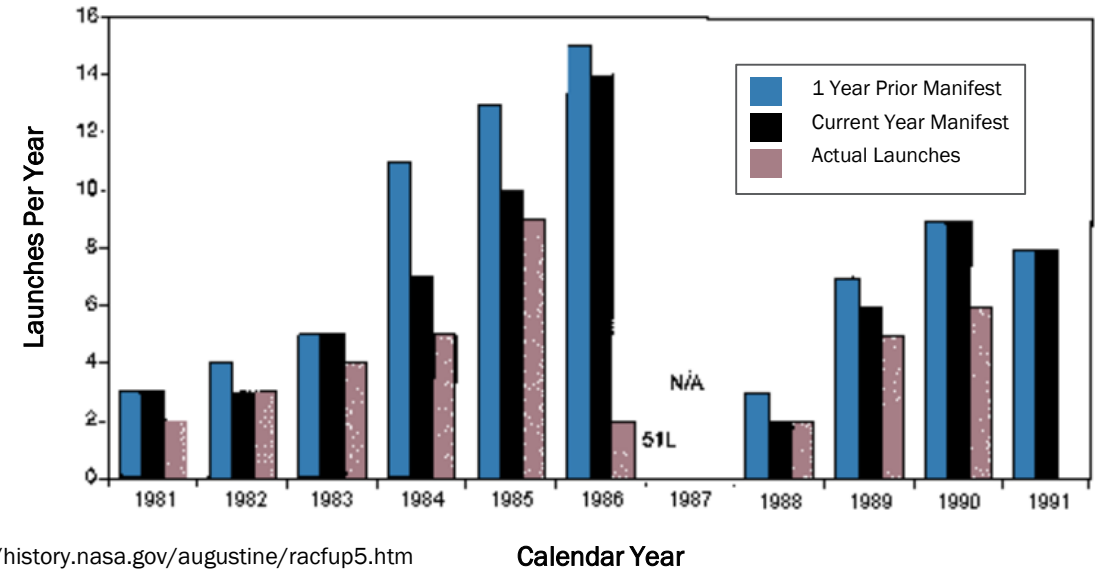
- Leading Indicator - Measureable factors that change before (ahead of) the underlying cycle starts to follow a particular direction or trend.
    - For example – Process Compliance
- Lagging Indicator - A count of activities or functions following an event.
    - For example – OSHA Lost Time Injury Rates
- These indicators are typically shown in a single graphs over multiple pages or in multiple windows in a dashboard format.

The focus of this presentation is on specifically highlights the applicability of the IA Team's work to quality measures.

WHAT IS A METRIC?

A metric is a comparison of two quantities. One quantity describes what the system is "Expected" to do (perfect state). The other quantity describes what the system "Actually" did (current state):

Figure 9
Shuttle Launch Operations Planning and Realization



Source: http://history.nasa.gov/augustine/racfup5.htm

CONCEPT OF "VARIATION" AND QUALITY

Variation is a common concept throughout Quality and the history of Quality Control. Some notable quotes by W. Edwards Deming, (1900-1993):

- "Uncontrolled variation is the enemy of Quality."
- "Understanding variation is the key to success in Quality and Business."
- "If I could reduce my message to management to just a few words, I'd say it all has to do with reducing variation."

The concept of "Quality" reflects a recurring theme regarding documenting or recording variation:

- Variation from policies and procedures to actual practices.
- Variation from drawings to actual hardware configuration.
- Variation from specifications to actual application.
- Variation from requirements to actual results.
- Variation from process to actual work performance.

The concept of "Variation" can be used to compare the Expected and Actual States:

- Variation = Difference between the Expected versus Actual State

USING VARIATION TO MEASURE PERFORMANCE

Expressing variation as a ratio (the deviation between the Expected and Actual) allows different measures to be plotted on the same graph for trending and comparison to provide a holistic view across a particular theme or discipline.

- Since multiple sets of data could be used in calculating the ratio, the ratio should be an absolute value to keep from hiding under performance and over performance through averaging.

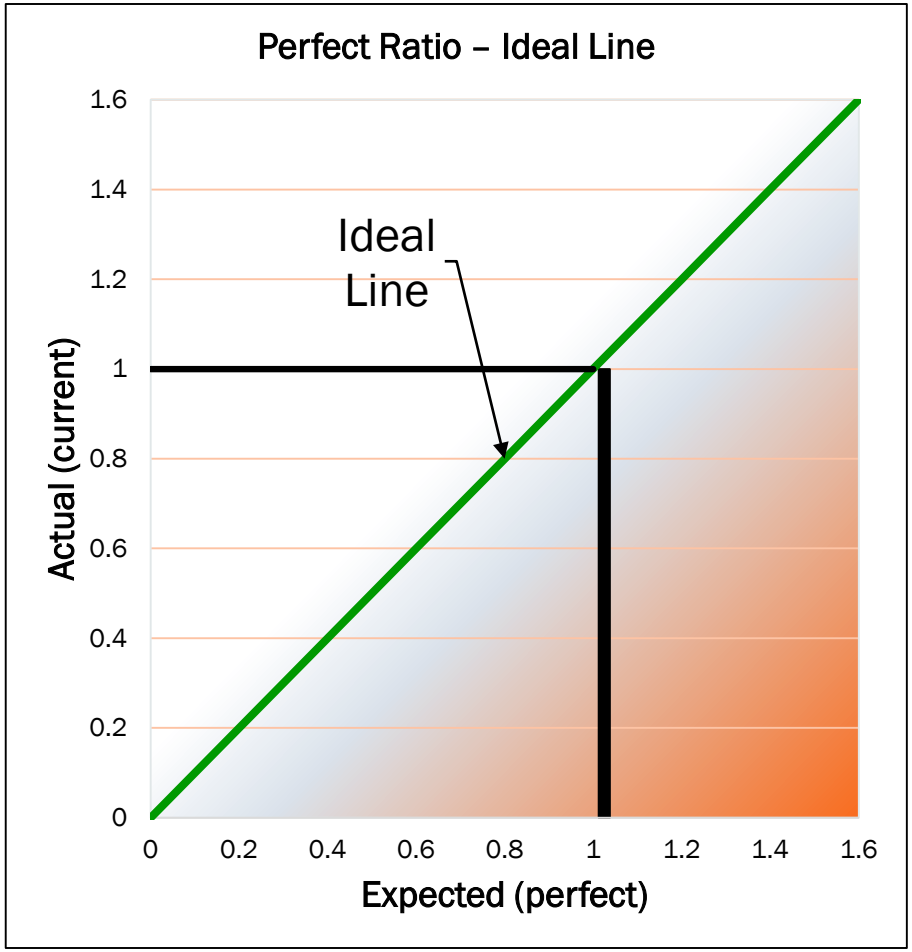
Since all measurements are a ratio of variation and dimensionless, this variation-based metrics approach can be used a new analytical tool which is complimentary to existing/value-added metrics tools

- Leading and lagging indicators can be used with this non-traditional approach.
- Combining different but related data on a single graph to provide a holistic view of the health and status of a particular facet of a quality program which could not be done with traditional methods.

THE IDEAL LINE – NO VARIATION

If Variation represents the difference between the Expected and the Actual, then the lack of Variation would have the following characteristics:

- There would be a 1:1 correlation between the Expected and the Actual results.
- A single green line on an X-Y Axis chart would be shown as a 45 degree angle representing equal values between the "Axes."
- The X and Y values would be the same at any point on the line.



ILLUSTRATING VARIATION

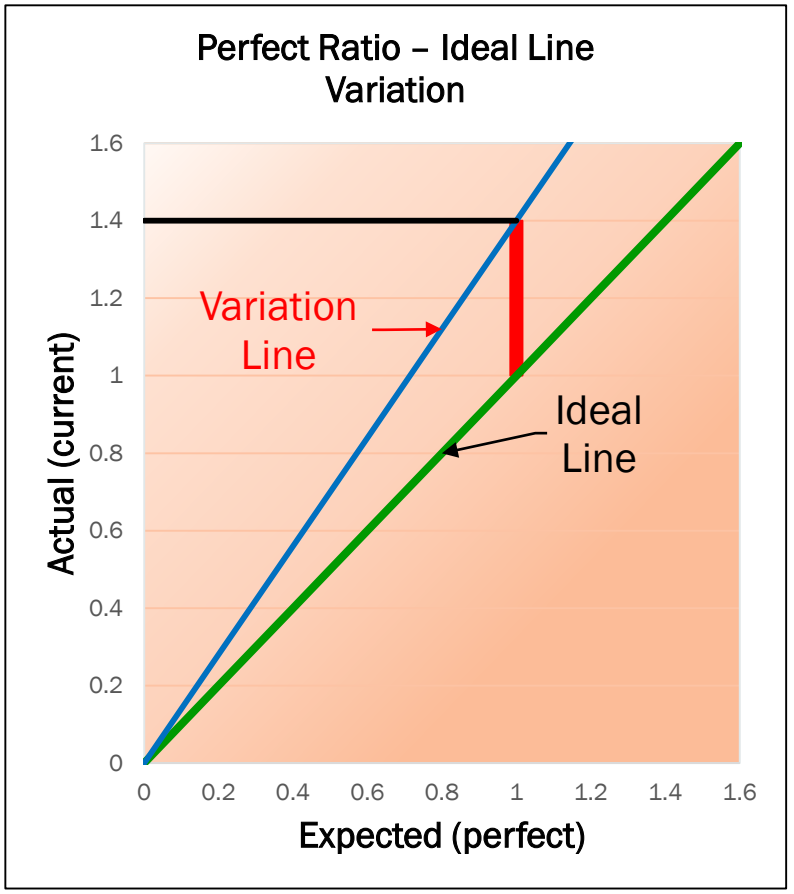
The blue lines represent the Variation from the actual to the expected values.
Since Variation represents any difference from the actual to the expected, then it would have the following characteristics:

- The correlation would be equal to the Ratio of the difference between the Actual value and the Expected value relative to the Expected value or:

$$Variation\ Ratio = \left|\frac{Actual\ Value - Expected\ Value}{Expected\ Value}\right|$$

Hence, the Variation Ratio (red vertical bar) for this metric is dimensionless and could be plotted for trending with:

- Historical data
- Other dimensionless ratios such as:
  - Only other Quality ratios
  - Only other Safety ratios
  - Or a mixture of Safety and Quality ratios



APPLICATION OF DIMENSIONLESS QUALITY METRICS

"…when you can measure what you are speaking about and express it in numbers you know something about it.."

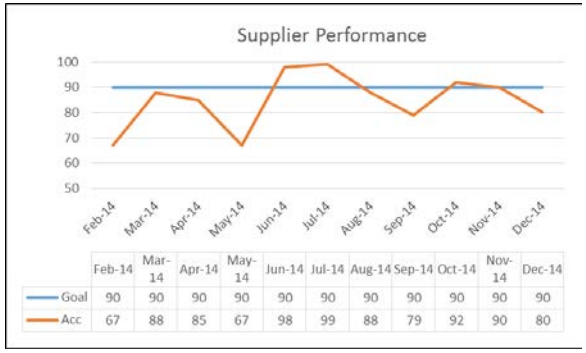
William Thomas, 1st Baron Kelvin, 1824-1907

TRADITIONAL – QUALITY PROGRAM PERFORMANCE METRICS

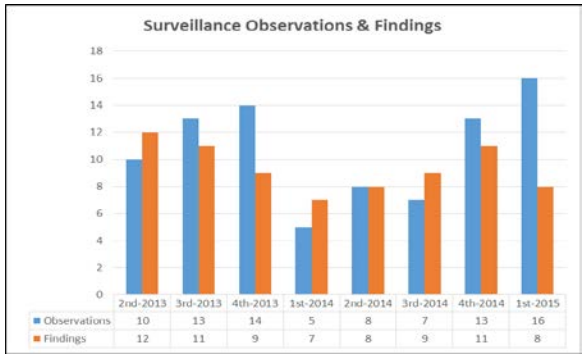
Attributes of an quality program can be chosen and looked at as a aggregate. Examples include:

- Quality of Delivered Products
  - Supplier Performance
  - Customer Satisfaction
- Products Process Nonconformity:
  - Audits
  - Surveillance
  - Inspections
- Products Acceptance and/or Rejection:
  - Rework
  - Repair

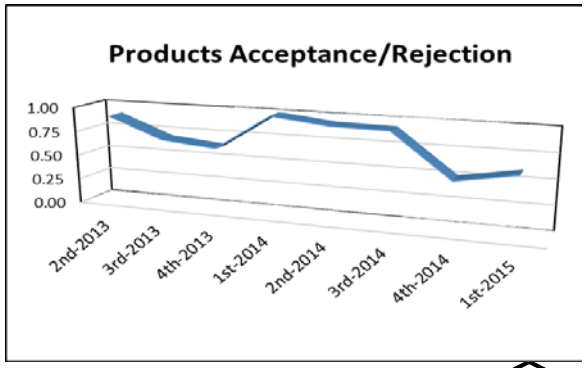
The criteria for Products Acceptance/Rejection will be used to illustrate how variation and dimensionless can be applied as variation-based quality metric.



	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
Goal	90	90	90	90	90	90	90	90	90	90	90
Acc	67	88	85	67	98	99	88	79	92	90	80



	2nd-2013	3rd-2013	4th-2013	1st-2014	2nd-2014	3rd-2014	4th-2014	1st-2015
Observations	10	13	14	5	8	7	13	16
Findings	12	11	9	7	8	9	11	8



EXAMPLE – QUALITY OF DELIVERED PRODUCTS

The formulas below for the Products Acceptance/Rejection metrics were selected as examples how this variation-based metrics approach can be used a new analytical tool.

- Formula for Repair Ratio (RR):

$$RR = \left| \frac{Actual\ Items\ Repair - Expected\ Repair}{Expceted\ Repair} \right|$$

Assume 10 items are expected to be repaired per quarter and measured was 14.

Therefore, the 4th Quarter RR = 0.40

- Formula for Rework Ratio (RWR):

$$RWR = \left| \frac{Actual\ Rework - Rework\ Goal}{Rework\ Goal} \right|$$

Assume there 22 items reworked and the goal was 20 items.

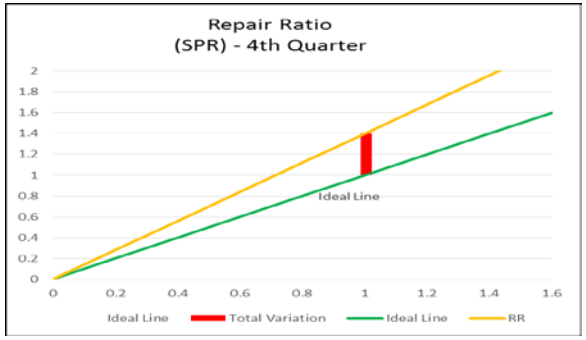
Thus, the 4th Quarter RWR = 0.10

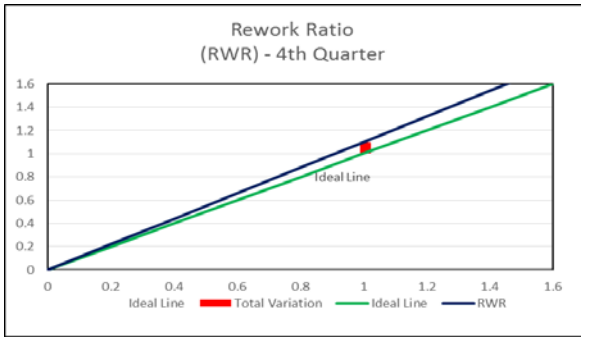
- Formula for Products Acceptance/Rejection Ratio (PARR):

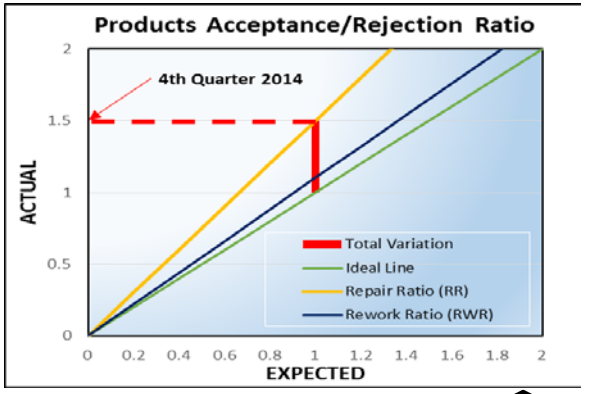
$$PARR = \mathbf{RR} + \mathbf{RWR}$$

The 4th Quarter PARR is 0.50 as an aggregate of the Repair Ratio and Rework Ratio.

The interpretation and advantages of the aggregate chart is outlined on the next page.







INTERPRETATION

The aggregate chart is a roll up of dimensionless metric ratios.

- Once the target ratio is identified, the associated data subset can be analyzed for trends, stratification of types or sources of issues, the ability to drill down to specific areas, etc.

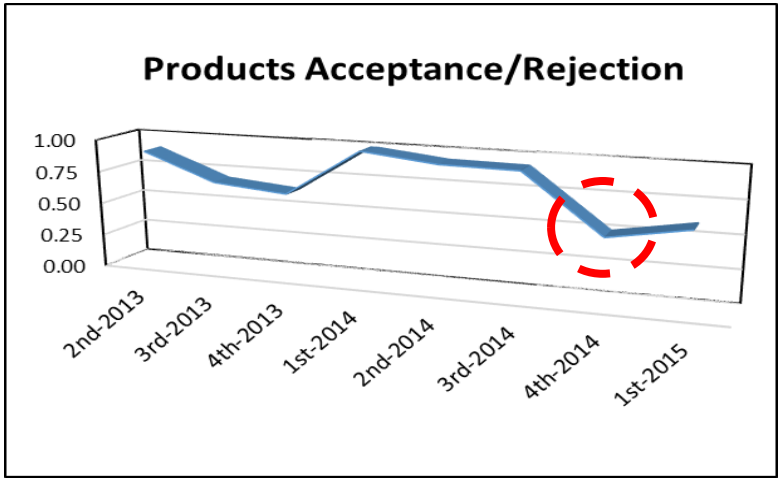
Are the ratios balanced?

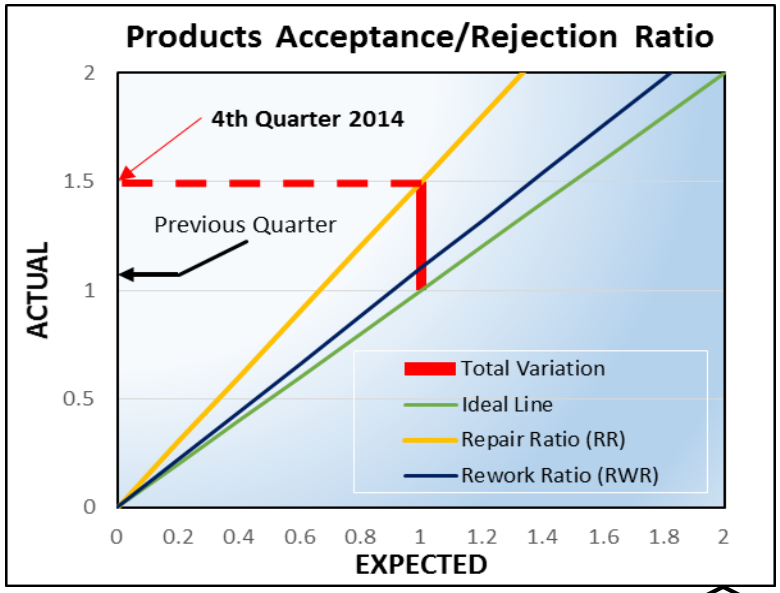
- Is the ratio (expressed as variation) from ideal acceptable?

Total variation and/or individual ratios can be:

- What is the trending (increase/decrease based on Laplace Test results)?

Does one or more ratios stay constant regardless of resources or effort?





SUMMARY

QUALITY METRICS

Good metrics start with good goals, and good goals as a set are like good management—holistic

SUMMARY

S&MA metrics have been traditionally represented as either leading and lagging indicators.

Traditional ways of viewing these metrics and trending the data is via graphs which reflect one attribute in each graph.

Using the concept of variation to develop “dimensionless” metrics allows for the combination of different but related data on a single graph to provide a holistic view of the health and status of a particular facet of a quality program.