LESSONS LEARNED FROM CONSTRUCTING SCIENCE AND TECHNOLOGY METRICS

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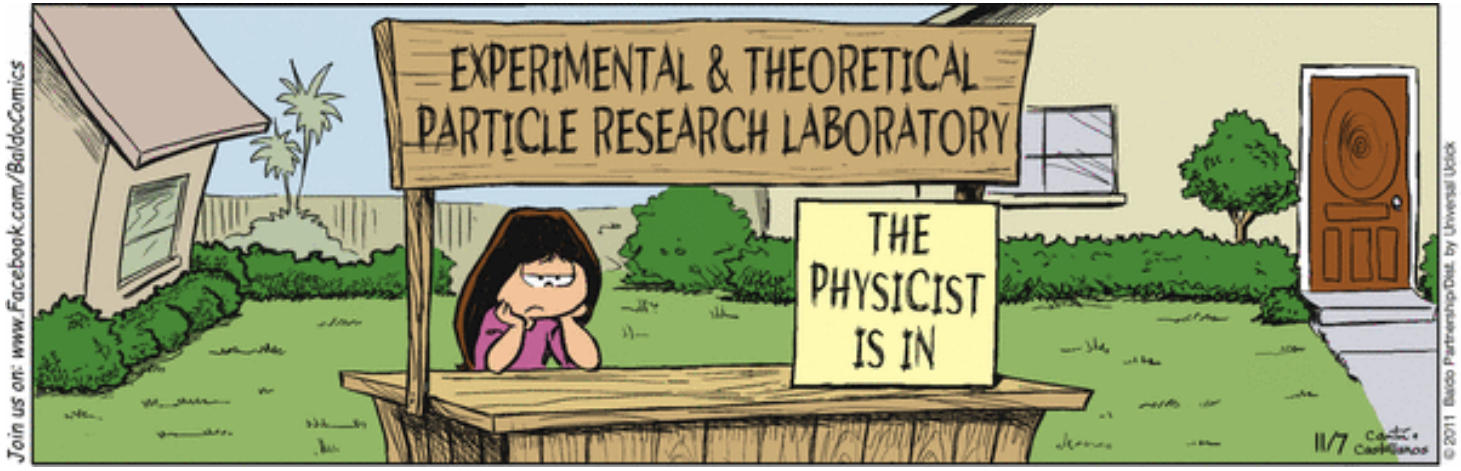
LFO

WHY AM I TALKING?

- 'I've felt your pain' - Two episodes of constructing metrics' for large US government science and technology organizations
- Organization #1- NRL a very old, very successful, broadly based national lab; the 'corporate lab' for DoD
  - The DOR said 'We're required to have a measurement system. I don't want it to be another numbers game …'
  - Formalize a sensor system that, apparently, is already being used and do no harm
- Organization #2 – The science component of a technology-intensive, DoD mission organization; Modeled on 'part DARPA - part NSF- part venture capitalist'
  - Very large extra-mural budget: 1-3yr R&D contracts to university and industry researchers with intensive oversight
  - Performance measurement system was established at the same time as the component to respond to management and OMB requirements
  - It's not working – we can't measure anything and we don't seem to be being effective

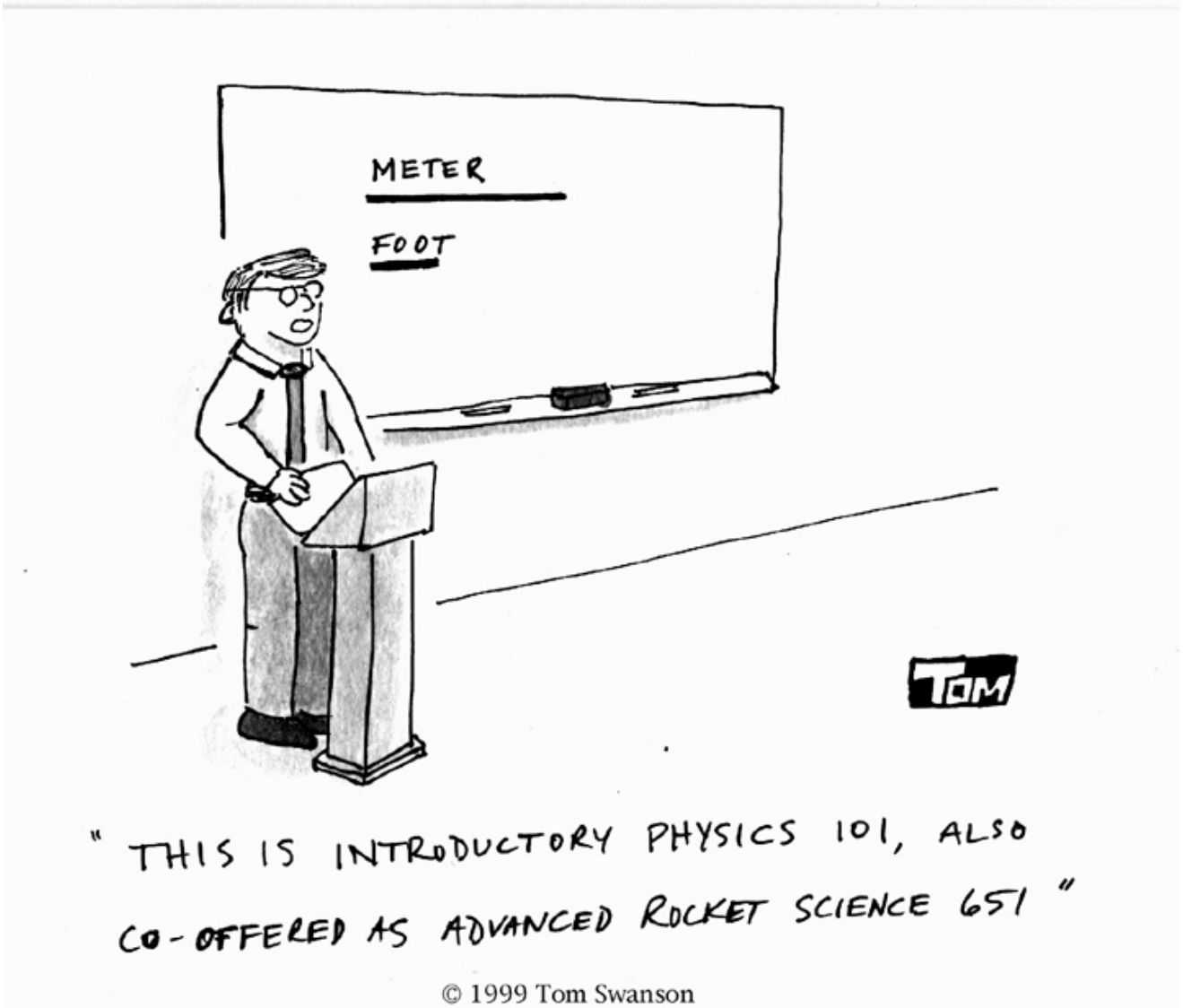
THE BIG LESSONS

- From NRL: Self-examination is a characteristic of excellent organizations - they don't have to be told to measure their own performance, they already do it.
- From the other: Ineffective or absent performance measurement is a symptom of an activity that is aimless or out of control.



Stop whining – everyone knows that this is hard. Comparing measurements to expectations is at the heart of science.

THE 10 MINUTE COURSE



PREREQUISITES

Fundamentals

- Performance *measurement* is different from *improvement*
  - Different metrics for different parts of the lifecycle
  - Steady state is often the hardest state to define
- The intent is to link *outcomes* with *outputs* (causality)
  - No strategy = no plan = no metrics: you can never succeed if you don't have some definable outcome expressed in concrete terms
  - Look for logical intermediaries – logically linked to outcomes
  - Output (or commodity) observables – causally linked to intermediaries
- Metrics can and will shape your project (the measurement problem)
  - Metrics imply priorities
  - The most assured way to change something is to start measuring it
- Never shun 'elevator talk' metrics (Occam's razor)
  - Good metrics are explainable
  - Firsts, superlatives, easy to explain measures (and those appearances in movies) count
  - The lack of 'happy snaps' says something

METRICS 101

Accept that your measurements will be output proxies for the optimum metrics, then

- Measure things that Indicate status, health or direction of the system
- Measure things that trigger responses or that you can change
- Engineer the measurement system - metrics are the sensor node in your control system
  - Finding a measurement interval and resolution that matches the response to control inputs will take some thought and/or experimentation
  - Filter out noise but don't correct for external influences
  - 'change is a constant' – look for dynamic metrics
- Never forget that metrics are retrospective - you can't change the past but you can often reconstruct it
  - Look for rates of change, correlated responses …
  - You really want leading indicators (in theory and in the data)
- When in doubt, cover a broad range of organizational characteristics
  - Outward – oriented to 'stakeholders'
  - Inward – oriented to personnel or day-to-day activities
  - Efficiency – to 'compare apples to oranges'
- Analyze the results

ADVANCED COURSE

Avoid over-thinking the task or … dashboards are good, traffic-lights are even better

- Heterogeneous metrics are OK
  - Be intuitive – report sensible metrics and don't be tyrannized by reporting requirements
  - Utility and understandability trumps formalism
- Establish realistic scales
  - Max and min based on fundamental considerations
  - Define achievable goals, acceptable and unacceptable levels
  - Find or establish 'green zone' and 'red line' benchmarks
  - When in doubt, measure with respect to historical baselines
- Bibliometrics are the accepted fallback approach but …
  - Understand that it's a highly researched and developed measure
  - Be prepared for the inevitable criticisms and 'if you live by the sword …'
- Traffic-light (or 'Christmas Tree') charts do not insult anyone's intelligence
  - Map complex information onto a uniform, understandable scale
  - Stoplights are not advisory
  - Report results - analysis is an internal task

HOMEWORK

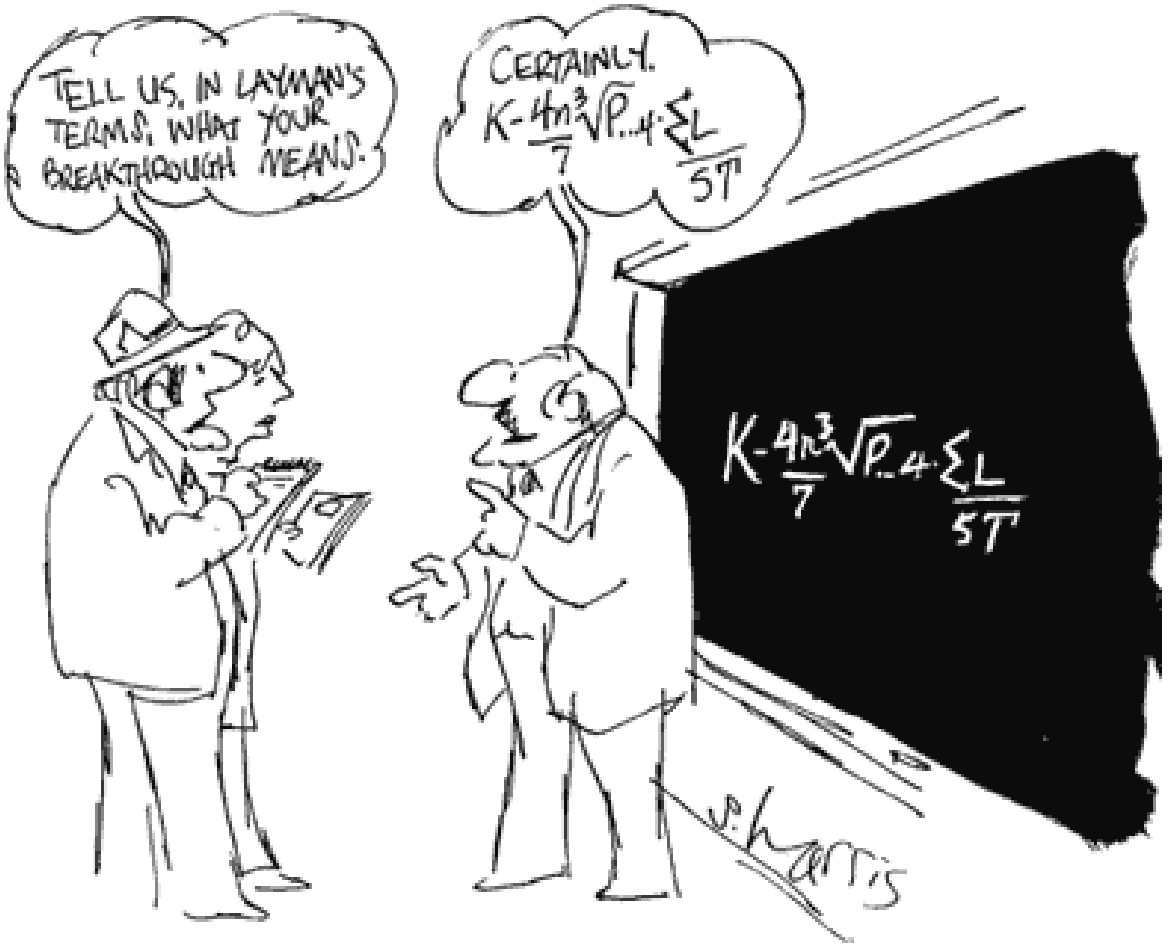
Things that I can't help you with

- What are you? Why does your facility exist?
  - Science infrastructure is an enabler - the grants program is for curiosity driven science
  - Are you a core competency, user facility, big experiment …?
  - Broader impacts, users, long term implications for science …
- Performance measurement is unfamiliar turf for science and scientists – irrespective of 'what you are'
  - Facilities are opportunities, investment, risks and a partnership between NSF, the facility and the community
  - There is a value proposition based on expectations

Parthian Shots

- Be aware of unintended consequences and collateral damage (and bonuses)
  - No number is ever forgotten
  - You are or will become what you measure
- Construct and use the measurement system to add value
  - Quality and flexibility is better than quantity
  - Measure the measurement system
- Do no harm

BECOME AN EXPERT



SOME READING

The classics

Geisler, E. “The Metrics of Technology Evaluation: Where We stand and Where We Should Go from Here” Stuart Working Paper 99-03 (1999)

www.cgee.org.br/atividades/redirKori/2861

Hauser, J.R., Katz , G.M. “Metrics: You Are What You Measure” European Mgt. J., 16 (5), 517- 528 (1998)

www.web.mit.edu/~hauser/www/Papers/Hauser-Katz%20Measure%2004-98.pdf

Kahn, C., McGourty, S. “Performance Management at R&D Organizations: Practices and Metrics from Case Examples” MITRE TR090181 (2009)

www.mitre.org/work/tech_papers/tech_papers_09/09_2188/09_2188.pdf

A useful guide (IT focused by generally valuable)

Plunkett, P.T. “Performance Based Management: Eight Steps to Develop and Use IT Performance Measures Effectively” GSA (1997)

www.itpolicy.gsa.gov/mkm/pathways/pathways.htm

How to think like a system engineer

Roedler, G., Jones, C. “INCOSE Technical Measurements Guide” INCOSE TP-2003-020-03 (2003)

www.incose.org/ProductsPubs/pdf/TechMeasurementGuide_2005-1227.pdf