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The Systems Engineering Incompetency Framework

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Authors

Andrew Pickard joined Rolls-Royce in 1977 after completing a Ph.D. at Cambridge University in Fatigue and Fracture of Metals and Alloys. He is a Rolls-Royce Associate Fellow in System Engineering, a Fellow of the Institute of Materials, Minerals and Mining, a Chartered Engineer and a member of SAE International and of INCOSE. He is Chair of the SAE Aerospace Council, represents Rolls-Royce on the INCOSE Corporate Advisory Board and is Chief of Staff for INCOSE.

Richard Beasley joined Rolls-Royce in 1986 with a Physics Degree from Bristol University, and an MSc in Gas Turbine Engineering from Cranfield University. After working on Integration Aerodynamics, Safety, Reliability and Life Cycle Engineering, he became the Global Chief of Systems Engineering and in 2011 was made a Rolls-Royce Associate Fellow in Systems Engineering. He was part of the BKCASE SEBoK author team, and is the Immediate Past-President of the UK INCOSE Chapter. He is a Chartered Engineer, Fellow of the Royal Aeronautical Society, INCOSE ESEP, and a Visiting Fellow to the Systems Centre at Bristol University.

Andrew Nolan joined Rolls-Royce in 1989 as a software developer. He was the Chief of Software Improvements for over 10 years before becoming the Chief of Project Estimation in 2013. Andy is full time in the development and deployment of estimation capability across Rolls-Royce.

Contents

Introduction

- The Systems Engineering Competency Framework
  - Yes, we support this!
  - One of the authors (Richard Beasley) is a contributing member of the Competency Working Group
  - The framework considers Systems Engineering Competencies from the point of view of absence of each competency through to expertise in that competency
- The Systems Engineering Incompetency Framework
  - What happens if a competency is not only absent, but other characteristics are present that actively work against that competency when executing a Project?
  - Is there a way that these characteristics can be detected early and actions taken to mitigate their potential impact?
- We will cover some of the incompetency examples described in the paper together with a few new examples

Essential Incompetencies

- Component Thinking
- Death Spirals
- Encouraging Corporate Memory Loss (Creating Unknown Knowns)
- Knowing Everything about Nothing
- *Fuzzy Thinking*
- Dissimulation about Modeling

Key:

- Blue = Covered in the paper and in this presentation
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Component Thinking

Incompetence

No systems thinking: Making changes to a component that could have been predicted to fail by looking at the system impact

Over-Constraint: Imposing cost/ schedule/scope constraints that prevent optimization at the system level

Note: Affects new designs and modifications. Trade studies are compromised by lack of consideration of the whole system

Competence

All trade studies and changes are assessed and optimized based on their systems impact.

"All changes occur in a system and therefore affect the whole system "
Blair et al, 2011

Beasley, R., Nolan, A. and Pickard, A. "When Yes is the wrong answer" INCOSE International Symposium 2014, paper 22

Death Spirals and Stagnation

Incompetence

Projects cashing in the benefits without considering the costs. Productivity spirals down. More improvements launched to address productivity issues and the business spirals into chaos

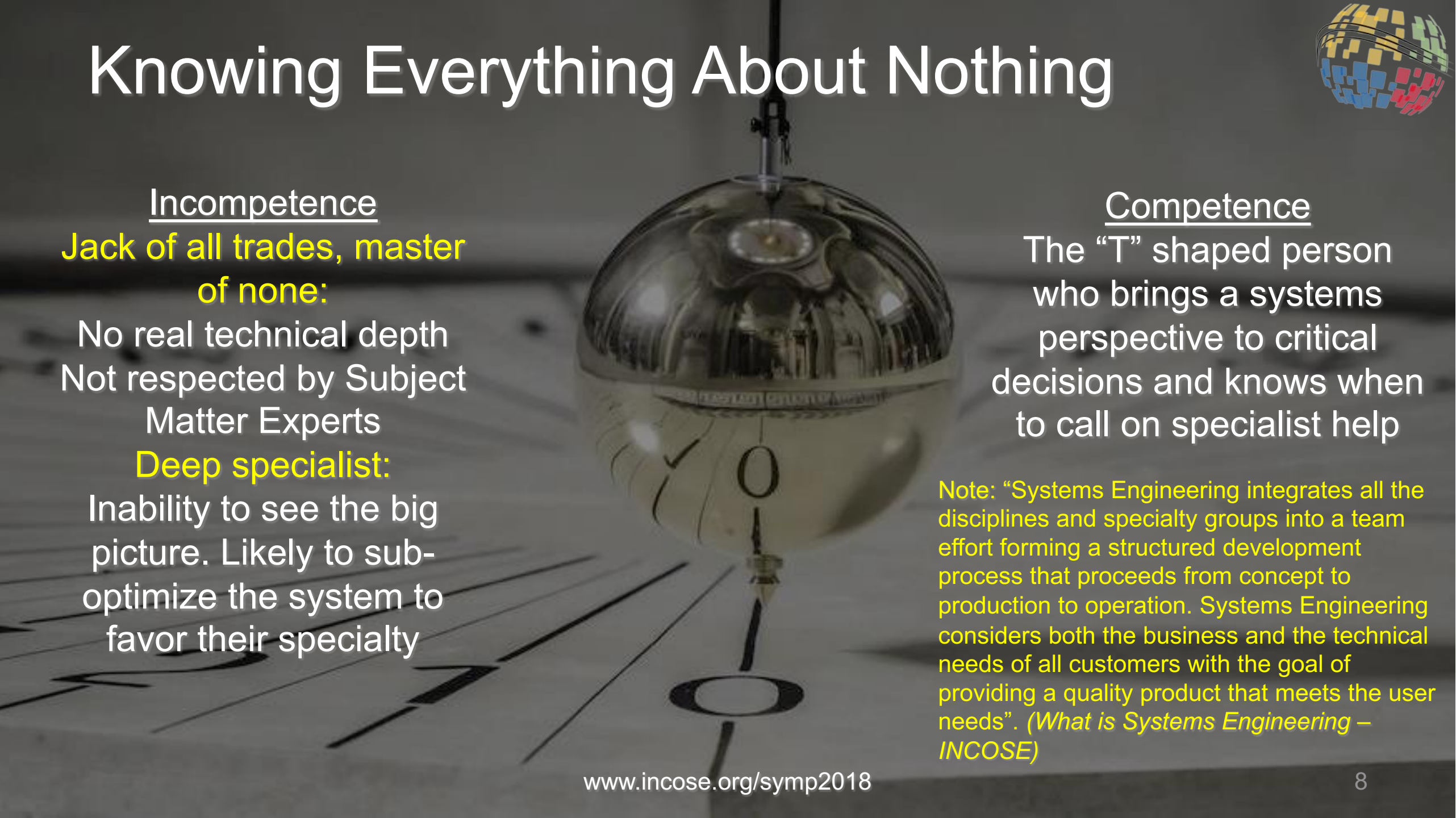
Competence

Benefits management and robust benefits estimating. Change management - be patient to let improvements settle in.

Note: according to research only 13% of improvements yield benefits. Costs are under estimated and benefits over estimated.

Nolan, A. and Pickard, A., "The 7 +/- 2 uses for an estimation tool", INCOSE International Symposium 2012, paper 20

Knowing Everything About Nothing



Incompetence

Jack of all trades, master of none:

No real technical depth

Not respected by Subject Matter Experts

Deep specialist:

Inability to see the big picture. Likely to sub-optimize the system to favor their specialty

Competence

The “T” shaped person who brings a systems perspective to critical decisions and knows when to call on specialist help

Note: “Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs”. *(What is Systems Engineering – INCOSE)*

Professional Incompetencies

- *Confuse and Insult (aka Consult)*
- *Being Economical with the Truth*
- Copying the Competition
- *Carrying a Big Stick and Shouting about it*
- Creating Dysfunctional Teams
- Creating Ivory Towers
- Graves Level 3 Management
- *Mushroom Management*

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Functional & Dysfunctional Teams

Incompetence

Assuming people can be trained to do any job.
"All people are equal" and therefore anyone can be assigned to any role

Competence

Assign roles and tasks in accordance with a person's competence

Note: according to research at Rolls-Royce, we saw a 10 fold difference in the competency for people with similar experience. Competency is linked to personality, not experience

Nolan, A., Pickard, A., Russell, J. and Schindel, W. "When two is good company, but more is not a crowd", INCOSE International Symposium 2015, paper 64

Creating Ivory Towers

Incompetence:

Minimalists: Less is more!
Reduce everything down until there is nothing left
"Mathematical Elegance"

Maximalists: More is more!
Over complicate everything.
"Information Overload"

Competence

Understand and focus on value based reasoning. Stop when the value is less then the cost
"Clear Communication"

Graves Level 3 & 4 Management

Incompetence

Level 3: Highly ego driven, often anti process. They can do it better. Driven by what makes them look good.

Level 4: Let the process do the thinking. One size fits all.

Competence

Level 5 Flexible, open minded, diplomatic, driven for success.

Prisons are filled with Graves Level 3 people

Nolan, A., Russell, J., Pickard, A. and Beasley, R. "One size fits all?", INCOSE International Symposium 2015, paper 63

Technical Incompetencies

- Jumping to Solution
- *Pasta Production (Spaghetti Architectures)*
- Ignoring Stakeholders
- *Disintegration*
- Ignoring Interfaces
- Performing Inappropriate Tests
- *Ignoring User Feedback*
- *Transition to Project Cancellation*
- *Ignoring the Aftermarket*

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Ignoring Interfaces

Incompetence

Making invalid assumptions:
Assuming the interface hasn't changed

Forgetting Lessons Learned:
Making the same interface errors over and over

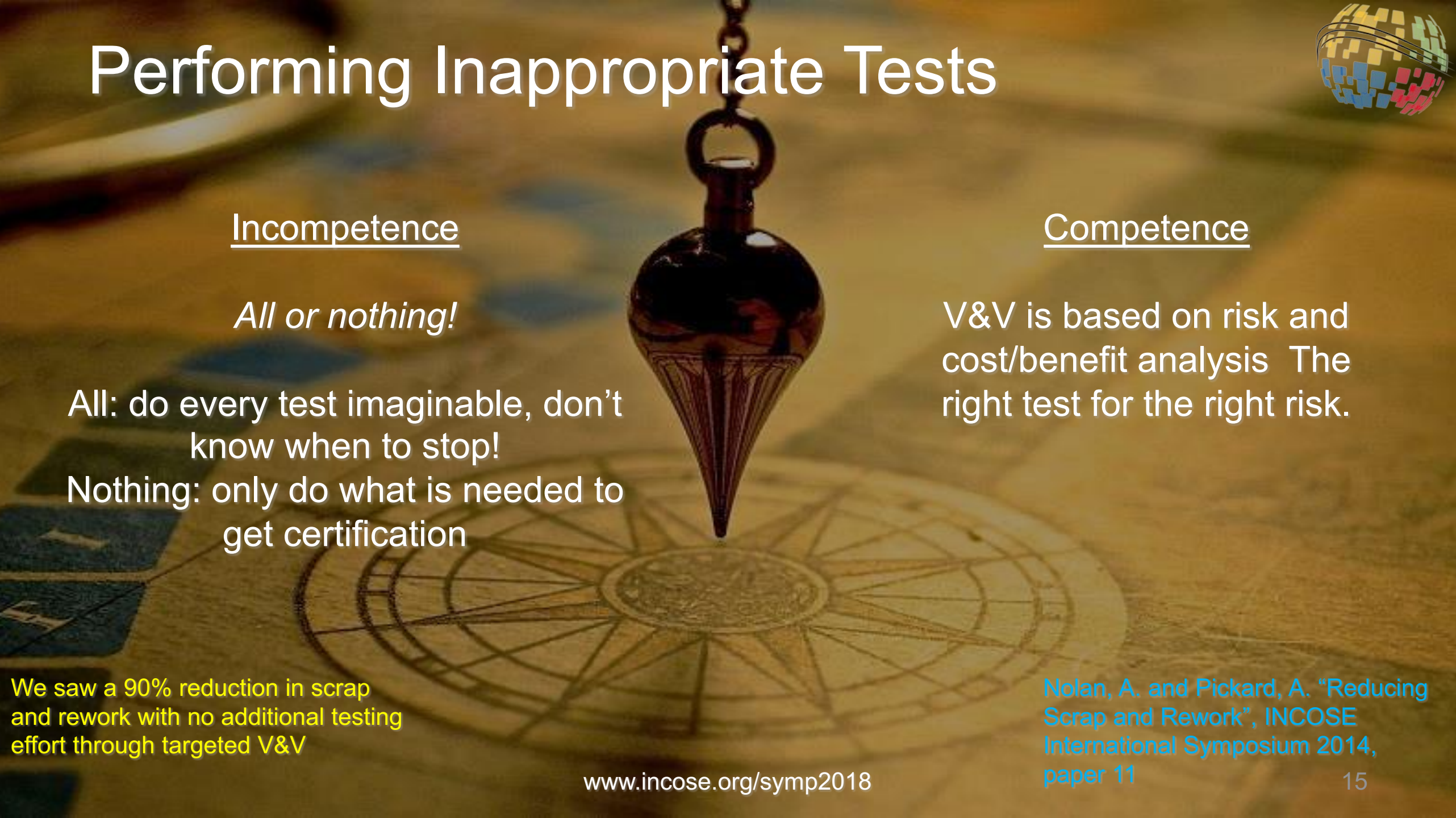
Competence

Review past experience.
Look for similarities and differences in interfaces.
Follow standard practice for interface identification and management

Note: "The greatest leverage in system architecting is at the interfaces; the greatest dangers are also at the interfaces" *Raymond, 1988*

Beasley, R., Nolan, A. and Pickard, A. "When Yes is the wrong answer" INCOSE International Symposium 2014, paper 22

Performing Inappropriate Tests



Incompetence

All or nothing!

All: do every test imaginable, don't know when to stop!

Nothing: only do what is needed to get certification

Competence

V&V is based on risk and cost/benefit analysis The right test for the right risk.

We saw a 90% reduction in scrap and rework with no additional testing effort through targeted V&V

Nolan, A. and Pickard, A. "Reducing Scrap and Rework", INCOSE International Symposium 2014, paper 11

SE Management Incompetencies

- Rigor-Mortis Planning
- *Letting it Happen*
- Jumping to Conclusions (when one jumped back at me)
- *Sequential Engineering – Over the Wall*
- It's my Project, and I'll Cry if I Want To
- Squeezing Blood from Stones
- *Hiding Information*
- *Propagating Confusion*
- Risk Admiration

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Jumping to Conclusions – when one jumped back at me

Incompetence

Mistakes of Omission*: No Decision Management Process

No access to Key Decision Makers, Stakeholders or SMEs

Decision Frame not defined …

Mistakes of Commission*: No credible Objectives or Measures

Performing an Advocacy Study …

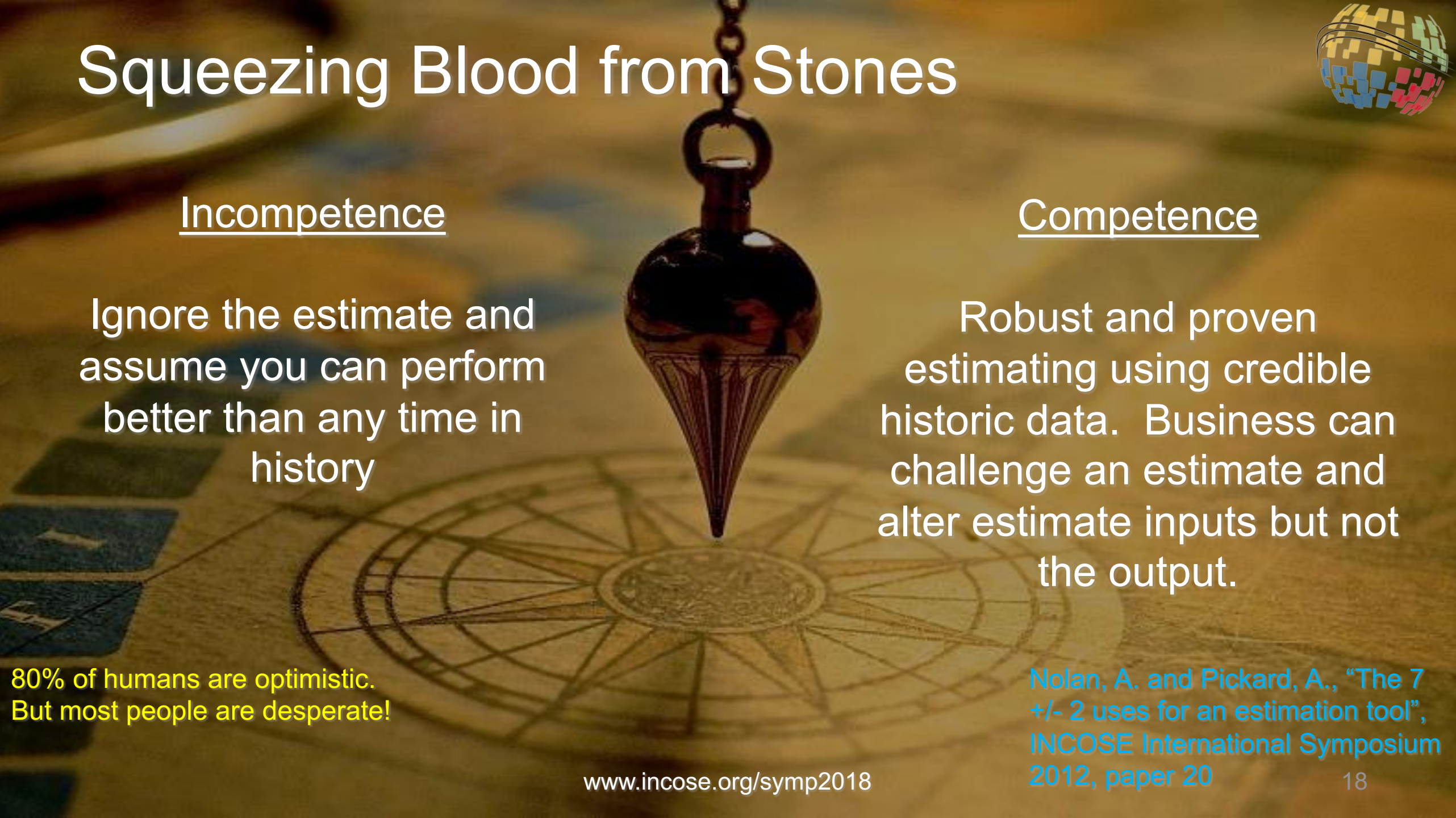
Note: Al Stewart. Album: "Zero She Flies", Song: My Enemies Have Sweet Voices", Lyric "I was jumping to conclusions, and one of them jumped back"

Competence

Making sound decisions based on a well framed Trade Study

- * Parnell, G., Cilli, M. and Buede, D. "Tradeoff Study Cascading Mistakes of Omission and Commission", INCOSE International Symposium 2014, paper 77.
- Beasley, R. and Partridge, R. "The three T s of Systems Engineering – Trading, Tailoring and Thinking, INCOSE International Symposium 2011, p. 1356

Squeezing Blood from Stones



Incompetence

Ignore the estimate and assume you can perform better than any time in history

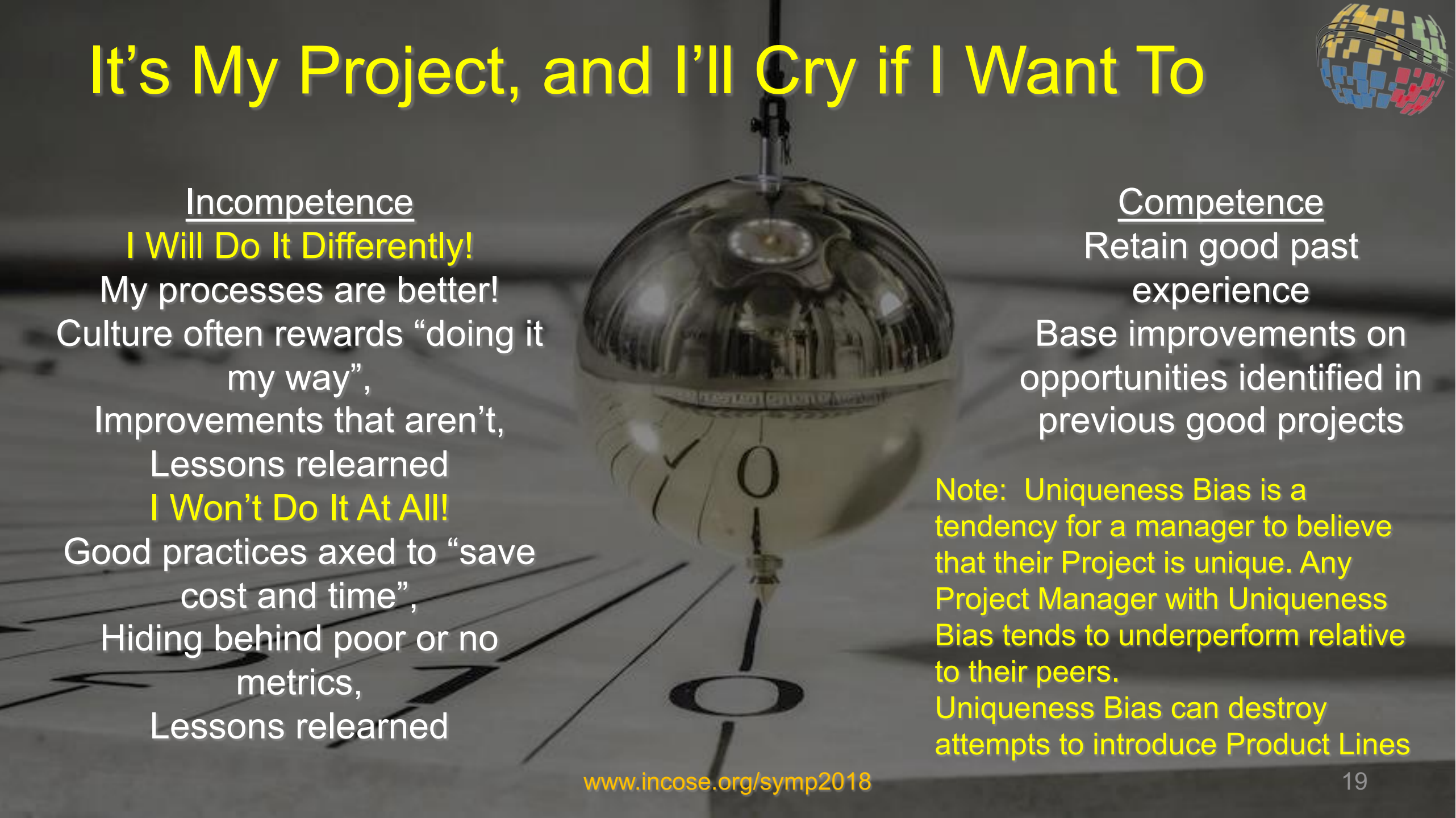
Competence

Robust and proven estimating using credible historic data. Business can challenge an estimate and alter estimate inputs but not the output.

80% of humans are optimistic.
But most people are desperate!

Nolan, A. and Pickard, A., "The 7 +/- 2 uses for an estimation tool", INCOSE International Symposium 2012, paper 20

It's My Project, and I'll Cry if I Want To



Incompetence

I Will Do It Differently!

My processes are better!

Culture often rewards "doing it my way",

Improvements that aren't,

Lessons relearned

I Won't Do It At All!

Good practices axed to "save cost and time",

Hiding behind poor or no metrics,

Lessons relearned

Competence

Retain good past experience

Base improvements on opportunities identified in previous good projects

Note: Uniqueness Bias is a tendency for a manager to believe that their Project is unique. Any Project Manager with Uniqueness Bias tends to underperform relative to their peers.

Uniqueness Bias can destroy attempts to introduce Product Lines

Risk Admiration

Incompetence

No Risk Management Activity:

Risk assessment is performed, but the risk log is "put on a shelf"

No risk "triggers"

Project does not use contingency for risk mitigation

Ignoring the Real Risks:

Certainties declared as risks

Trivial risks given a lot of attention

Real risks downplayed

Competence

Effective Project and Technical Risk Management and Mitigation

Note: Many projects claim they do good risk management but there is little evidence of much activity beyond project (cost and schedule) risk identification. Investigation of one project showed 50% of people claimed they identified Technical Risks but only around 10% actually did anything with the results! Taking on risk and doing nothing about it is no better than gambling.

Pickard, A., Nolan, A. and Beasley, R. "Certainty, Risk and Gambling in the Development of Complex Systems", INCOSE International Symposium, 2010, paper 461

Integrating Incompetencies

- Project Management
- *Financial Politics*
- *Just-To-Late Delivery*
- Doing it Over (Rather than Doing it Right)

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Doing it Over (Rather than Doing it Right)

Incompetence

Assuming certainty because its easier to manage. Blame someone else when things go wrong.

Competency

Risk and uncertainty analysis. Calculated uncertainty.

Pickard, A., Nolan, A. and Beasley, R. "Certainty, Risk and Gambling in the Development of Complex Systems", INCOSE International Symposium, 2010, paper 461

Systems Engineering Incompetency Levels

- *Unawareness*
- *Misdirected Incompetent*
- Unsupervised Incompetent
- *Wall Builder*
- Graves Level 3 Master Wall Builder

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Unsupervised Incompetent

Incompetence

Ignoring Other Opinions:

Being blind to the faults of your own work

Persisting with a solution when there is clear evidence it is not working

Not Learning from Experience:

Acting with certainty and confidence no matter how much evidence there is to the contrary

Competence

Being "Calibrated" to your own abilities and using this to learn

Note: A study of 50 projects inside Rolls-Royce (Nolan, 1999) showed that the top 5 highest performing projects were all led by humble engineers whilst the lowest 5 were all engineers convinced they were high performers. The very act of being convinced in your ability seems to mark the end of learning and the origin of incompetence.

Nolan, A., Vlad, O., Pickard, A. and Beasley, R. "Fortune Telling, Estimating and Systems Engineering". INCOSE International Symposium, 2017, paper 68

Graves Level 3 Master Wall Builder

Incompetence

Ignoring Other Opinions:

"You're Fired" approach to challenge

Over-inflated ego

Not Learning from Experience:

Huge confidence in uninformed decisions

Challenges the truth or applicability of past experience

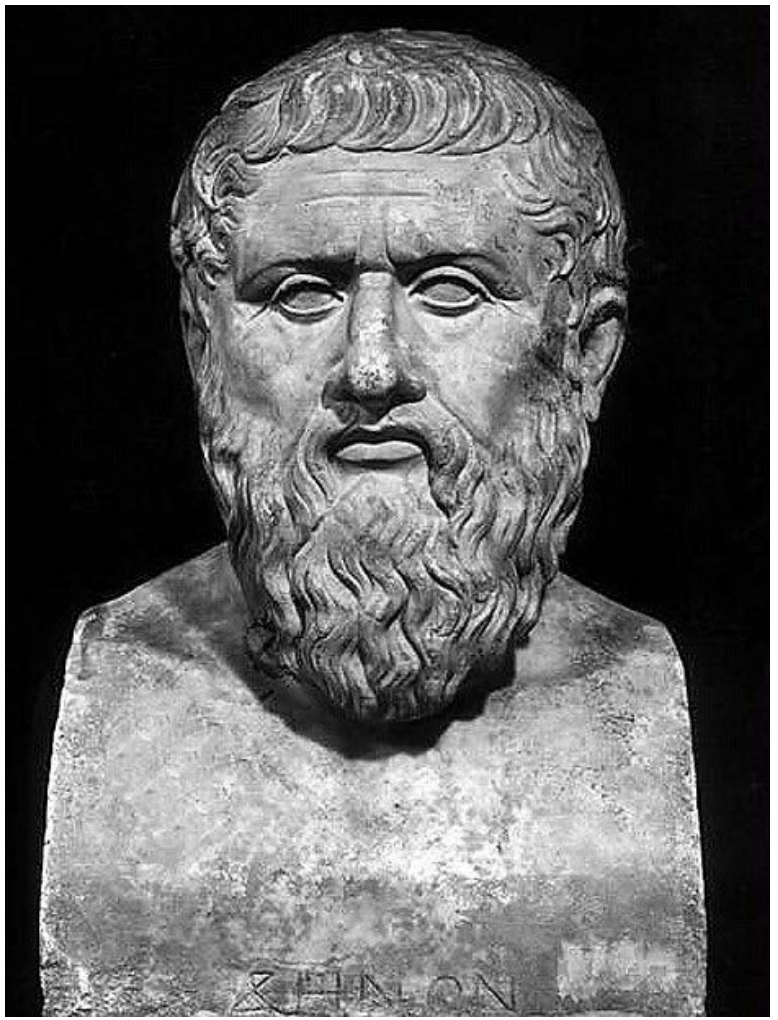
Competence

The humble Engineer who just "gets things done"

Note: Personal survival may limit the identification of examples!

Early Detection of Incompetencies

- Start Right: “The beginning is the most important part of the work” (Plato, c. 380 B.C.)
- Use the INCOSE SE Competency Framework to map SE Processes to Incompetencies
- Track Record
- Assign a competent Coach/Mentor
- Measure and Monitor



Conclusions

- Being aware of Systems Engineering Competencies
  - The first step to avoiding them
- Illustrative examples of some of the Incompetencies
- Advice on Early Detection
- One reviewer just didn’t get it!
  - In general terms, I simply couldn't see why the authors created this "Incompetency Framework". What are the benefits over the original work done by INCOSE Competency Working Group?
  - It seems the authors simply applied a Boolean NOT to the original work and gave examples trying to show that incompetency, when present, causes problems, which seems obvious to me.
- We leave it to you to judge if this reviewer was correct or not!

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