Lessons Learned as a Systems Engineer

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Outline

❑ **Lessons (maybe) Learned**

- Georgetown Bank ATM Stand-in Processing

- NIMA National Imagery Library

- MILES

- Mobile Command Center

- ISR Aerostat

- Unmanned Air Vehicle

- Fun with Schedules

- Backup: Proposal Writing Tips

❑ [Only *mostly* as SE. Also SWE, Program Manger, Proposal Lead, etc.]

MILES – Multiple Integrated Laser Engagement System   ISR – Intelligence, Surveillance, Reconnaissance   NIMA – National Imagery & Mapping Agency
SE – Systems Engineer   SWE – Software Engineer   ATM – Automated Teller Machine

Georgetown Bank ATM Stand-in Processing

ATM – Automated Teller Machine

"Oh, the spec is wrong"

- ❑ I ran my ATM transaction validation software through the Tri-State's automatic certification test suite

- ❑ Came back as FAILED

- ❑ I called and asked Why?

- ❑ You failed the *Transaction Authorization Reversal Override Denial* process

- ❑ But my result matches what the specification says it should be

- ❑ Oh, the spec's wrong

- ❑ Um, ooookayyyy…

FYI: The tri-state region consisted of Pennsylvania, New Jersey, Delaware, and Maryland! Guess they can't add any better than they can write specs.

Even if the Customer is always right, her artifacts might not be

National Imagery Library (NIL)

"No Single Points of Failure" is a Spec Failure

☐ *The NIL shall have no single points of failure.*

☐ So you are willing to meet this cascade of consequences:

- Double the number of robot readers?
- Double the number of robot rails?
- Double the number of tape storage units?
- Double the number of tapes?
- Install separate power supplies?
- Connect to separate power stations?
- Install in two different buildings, separated by how many miles?
- And so on….

☐ They backed down before I got past bullet #3, changed to an A_o requirement
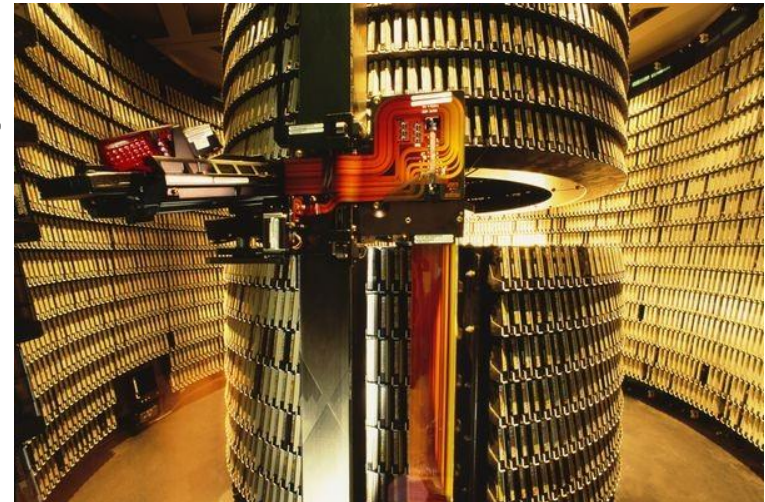
The customer didn't necessarily mean to say what he said

Cynicism

It just ain't what it used to be

BTW, "ain't" was originally coined to mean "am not" since "amn't" is hard to say and "aren't I" is incorrect. It's a shame it fell out of use due to misuse.

On transition from Vacation + Sick Leave to PTO

Fictitious Company, Inc. HR Rep:

- 90% of our employees legitimately need 8 days of sick leave per year.

- So we will use the 60th percentile number and add 4 days to your vacation to get a PTO number.

Query: So, you think engineers can't do simple math and realize you are punishing 30% of us who need those 8 days?

HR Rep: <crickets>

YOU GOT ME!

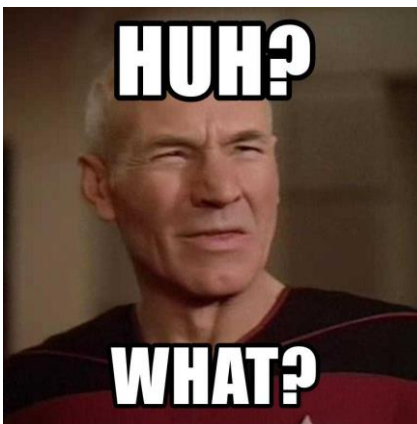## HR is Not Your Friend – Legally they Represent Management

Redefining Average Work Week

- ❑ The average hours worked at Fictitious Company, Inc. was 45/week
  - ▪ **with or without EWW**
  - ▪ i.e., company was getting a good amount of free time from employees
- ❑ So Management decided to declare 45 as the average work week
  - ▪ therefore, **no EWW** for 40-45 hours

45 is the new 40

I'm smarter than you're.
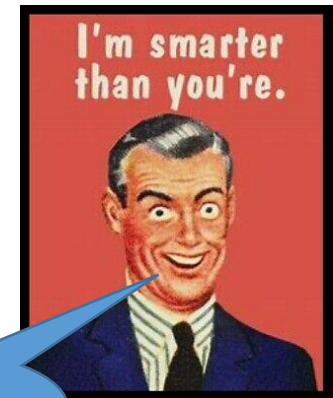
- ❑ They were surprised when average fell to 41 hours
  - ▪ and realize that that average extra hour was due to those working 50+ hours with EWW
  - ▪ i.e., **NOBODY worked more than 40 hours** any longer unless given EWW
- ❑ Really, Management? You were surprised?

Remember the Law of Unintended Consequences

EWW – Extended Work Week

MILES

(Multiple Integrated Laser Engagement System)

i.e. Military Laser Tag

Missing Serial Comma

❑ RFP stated that the *MILES system must distinguish between a soldier standing, sitting or prone.*

❑ Our MEMS accelerometers could distinguish two stances

- But that means we could distinguish between "Standing" and "sitting or prone", as the RFP stated since it lacked the serial (Oxford) comma

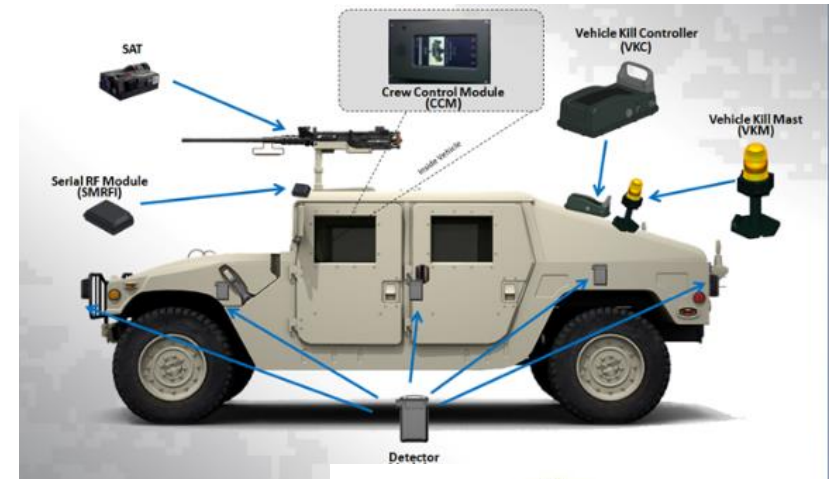- **So we claimed compliance**

Standing

Sitting or prone

Grammar matters! RFPs should be written carefully

MEMS - Micro Electro-Mechanical Systems   RFP – Request For Proposal   MILES – Multiple Integrated Laser Engagement System

Operational Availability Absurdity

- *MILES system shall have an A_o = 100% at start of exercise*, or fail requirement
  - Seemed reasonable at first blush
  - But it took 5 hours to kit all the soldiers and vehicles
  - And each had to deploy up to 10+ miles to reach their Start of Exercise position

- If a tank ran over our radio during that time, then we failed the requirement!
  - So they changed it to 98%
  - OK, technically doable…
  - …but it's going to cost in terms of spares

RFPs must be *read* carefully

A_o – Operational Availability   RFP – Request For Proposal   MILES – Multiple Integrated Laser Engagement System

Document Precedence

- Spec: "*The MILES equipment shall operate under all normal conditions.*"
  - No worries, yes?
- My Contracts lead pointed me to this wording in the RFP Glossary:
  - "Normal conditions are defined as *anything* a soldier does with the equipment."
- Even rolling over it with a tank? Yes, anything.
- OK, but that's just the glossary so who cares?
- Well, read this order of precedence of documents from the RFP T&Cs:
  - 1) These Contract Terms and Conditions
  - 2**) The Glossary**
  - 3) The SOW
  - 4) The Spec
- But, no worries, no court in the world would back that...we hope

The radio better still work

Note to Bill Shakespeare: We'd better not kill ALL of the lawyers

T&Cs – Terms and Conditions   RFP – Request For Proposal   SOW – Statement Of Work   MILES – Multiple Integrated Laser Engagement System

Mobile Command Center (MCC)

- In response to the Columbia disaster and availability of new Homeland Security grants

- $1.15M contract, Delivery 9 months ARO

ARO – After Receipt of Order (contract award)

RFP Specification Woes

❑ The MCC "Spec" was nothing but a list of equipment

❑ Much of it extraneous or infeasible
  ▪ Bio sensor from a French company
    ○ $250K apiece, and one wouldn't suffice
    ○ Not available for a year
    ○ Only the French could buy them in that time frame
    ○ It detects only one agent, and it's not Anthrax, Small Pox, or COVID (☺)
  ▪ Chemical sensors – feasible but eventually dropped due to cost
  ▪ Radiation-hardened (lead-lined) – too expensive and too heavy to tow!

❑ And some necessary equipment was missing, such as servers and cables

❑ We ended up swapping out the unnecessary equipment for the missing necessary equipment, and…

Sometimes you just have to tell the customer that he is wrong

MCC – Mobile Command Center   RFP – Request For Proposal

Proposal Woes

❑ ...I wrote into the Cover Letter instructions on how the customer should evaluate the bids

1. Delete the unnecessary equipment	**3. Normalize competitors'** bids to include the missing equipment
2. Include the necessary missing equipment	

❑ Sole Source?
  ▪ All the other competitors no-bid
    o including the one that created the equipment list!
  ▪ But customer conned one into bidding anyway
    o so they wouldn't have to do sole-source justification
  ▪ But with no intention of awarding to them
  ▪ But how, since that bidder was cheaper?
  ▪ **The cover letter did the trick**: We bid $1.7M on the $1.15M contract and won based on cost!
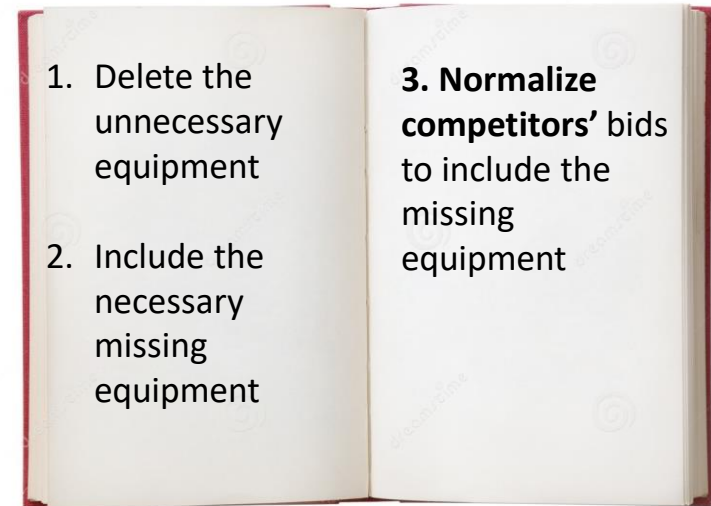
Sometimes you have to help your customer see how to make it right

Negotiation Woes

- ❑ Customer: "I was told by my management not to accept anything more than a 5% overhead rate"
    - My Contracts manager: "There's no need to continue talking since our overhead is nowhere near that low." [Nobody's is]
    - I started to panic, but then asked… "When you say 'overhead' do you mean normal overhead, or maybe G&A, which is basically 'corporate overhead'?"
    - PoH Rep: "Yeah… that's what I meant." (whether he really did or not)
    - Contracts: "Oh, OK, well yes, we're under that. Let's continue."

- ❑ In the end, we spent $100k+ on the proposal for the $1.15M job
    - But we got follow-ons that made it worthwhile

What'd you do to my ROI, Bryson???

Don't Panic! (ala the cover of Hitchhiker's Guide to the Galaxy)

G&A – General & Administrative   ROI – Return On Investment   OK –not an acronym; "okay" is wrong

ISR Aerostat

ISR – Intelligence, Surveillance, Reconnaissance

MTI Performance

❑ The aerostat MTI sensor shall detect 100% of watercraft

- of length 25 feet or larger
- within 300 NM of shore
- over the entire Eastern seaboard
  - o Note: the density of fishing vessels along the Gulf Stream is routinely greater than when in port

❑ With no more than three false alarms per day

Reality really can be stranger than fiction

MTI – Moving Target Indicator   NM – Nautical Mile…as opposed to "nm" which is *nanometer* – not quite the same thing

Operational Availability

- **A_o *shall be 100%, 24/7/365***

- ☐ I told them I could bid that immediately: **Infinite $**
  - ▪ Because no matter how many RQ-4 Global Hawk or MQ-Avenger backups you have for each aerostat, there's a finite chance you will lose them all at some point
  - ▪ So we'd need to bid an infinite number of backup ISR platforms

- ☐ "Fine, make it 99%."
  - ▪ OK, not [quite] infinite
  - ▪ But you're the USCG, so it might as well be

> **Cost to build: $$$$$**
>
> **USCG Budget: $**

- ☐ When the light at the end of the tunnel is getting bigger and brighter, you are standing on a train track. JUMP!

Sometimes you just have to run away – I left and joined GH

USCG – United States Coast Guard   ISR – Intelligence, Surveillance, Reconnaissance   GH – Global Hawk

Unmanned Air Vehicle (UAV)

Gapfiller Situational Awareness

- In Jan 2007, a "1-2 year gapfiller" SA message set was defined due to budget constraints
- In 2022 Gapfiller lives!
  - And costs much more
- It's everything wrong you learned about data design
  - Forced periodicity of non-periodic data
  - Bundling of unrelated data
  - Big kludge for ad hoc collects
  - No indicator of Short vs Full messages
- As big a PITA as I can be, not big enough this time

Full Message
Sent once/min
Tail #
AV Position Section
Comms Status Section
Full Nav Plan • every single time! • 1000s of waypoints, every single time!
Collection Plan • for time NOW forward • Catches changes, but lots of repetition every single time
Collection Status • for any/all tasks completed since last Full or Short message

Short Message
Sent once/sec • *Unless it's time for a Full Message instead*
Tail #
AV Position Section
Comms Status Section
Current Fly-to Waypoint
Collection Status • For those Tasks completed since the last Full Message was sent • Oh, but wait, what about Tasks added since the last Full Message? • So, better add Collection Plan info for those added since then!
Collection Plan info for ad hoc tasks added since last Full Message

Old Lesson Unheeded: There is no such thing as a temporary fix

PITA – you know

SA – Situational Awareness

Stabilizing Fins & RWR

- ❑ UAV added under-wing stabilizing fins after some flight tests

- ❑ The fins blocked most of the Field of Regard for the Radar Warning Receiver

- ❑ Customer said, OK, fine: remove the RWR

- ❑ Contractor told them what it would cost to remove the RWR
  - ▪ Add ballast to make up for weight of RWR to keep UAV's CG right
  - ▪ Update all the diagrams as per Air Worthiness regs
  - ▪ Etc.

- ❑ Customer balked, said unplug it but keep it in

- ❑ So, we still had to **buy** the expensive RWRs and install them but not power them on

Remember the Law of Unintended Consequences

CG – Center of Gravity   RWR – Radar Warning Receiver   UAV – Unmanned [or Unoccupied] Air Vehicle   OK –not an acronym; "okay" is wrong

Uh, Sir

Scene:

- I am in a UAV shelter observing a mission
- AF Major is piloting the UAV (i.e., reading a newspaper)
- Airman 1st Class is busy tasking the UAV

Airman says to pilot:

"Turn to heading 145…"

    [notices me standing behind him]

"…uh, Sir."

Two lessons:

1. Rank doesn't always tell you who is in control.
2. Need to maintain your situational awareness.

Maintain Situational Awareness!

"It's Not My Problem"

Bkgnd: The Sensor Management SW (SMS) was not interfacing correctly with the Flight Management SW (FMS)

- **Richard** to SMS SWE: We need to get you and the FMS SWEs together to work out the problems.

- **SMS SWE**: That's not my job. I meet my SRS.

- **Richard**: But the whole system needs to work or we all lose our jobs. Your SRS might need to be updated.

- **SMS SWE**: But that's not my problem. My SW meets my SRS.

- **Richard**: OK, this conversation (and all others with you in the future) is over.

SMS SWE left the company soon thereafter

My spec says to build a red cube. I don't care that it must fit in a round hole. Not my problem.
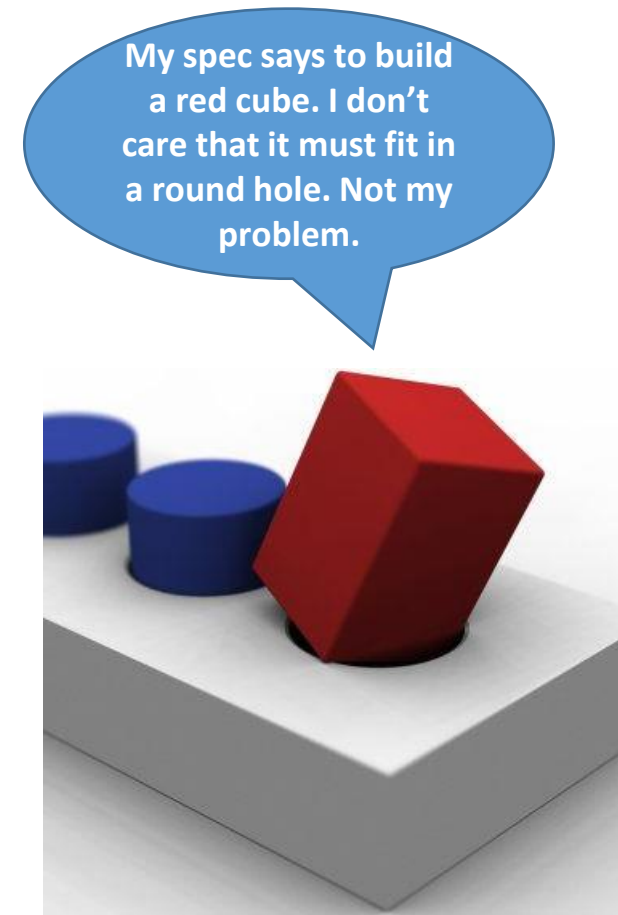
"Everyone should be a Systems Engineer" – but not everyone can

SW - Software   SWE – Software Engineer   SRS – Software Requirements Specification

World War Z Documentary

Scene: A break in an MTI training session to Airmen

❑ **Airman**: "I am so disappointed in the movie. They had a chance to tell it like it is, a real documentary, and they blew it."

❑ **Classroom**: Stunned into silence for 30 seconds

❑ **Instructor**: "Uh, OK, so getting back to MTI…"

They got the eyes wrong!

Real zombies don't climb quite that fast!

Consider that this airman is defending our country! How can that be?

MTI – Moving Target Indicator

Fun with Schedules

Lessons Learned as a Systems Engineer

# There is no such thing as a 2-week schedule slip

[a Jim Gottfried rubric]

❑ **Rationale** (if I may speak for Jim):

- ▪ If you claim that you don't know before two weeks out that you are behind schedule, then you are either lying or horrible at your job…or both
  - o And you are most unlikely to be finished in another two weeks
- ▪ If you do know further out than two weeks, then you have time to do something about it

❑ On the other hand…

There is no such thing as a 2-week schedule slip

Two Weeks Ahead of Schedule?
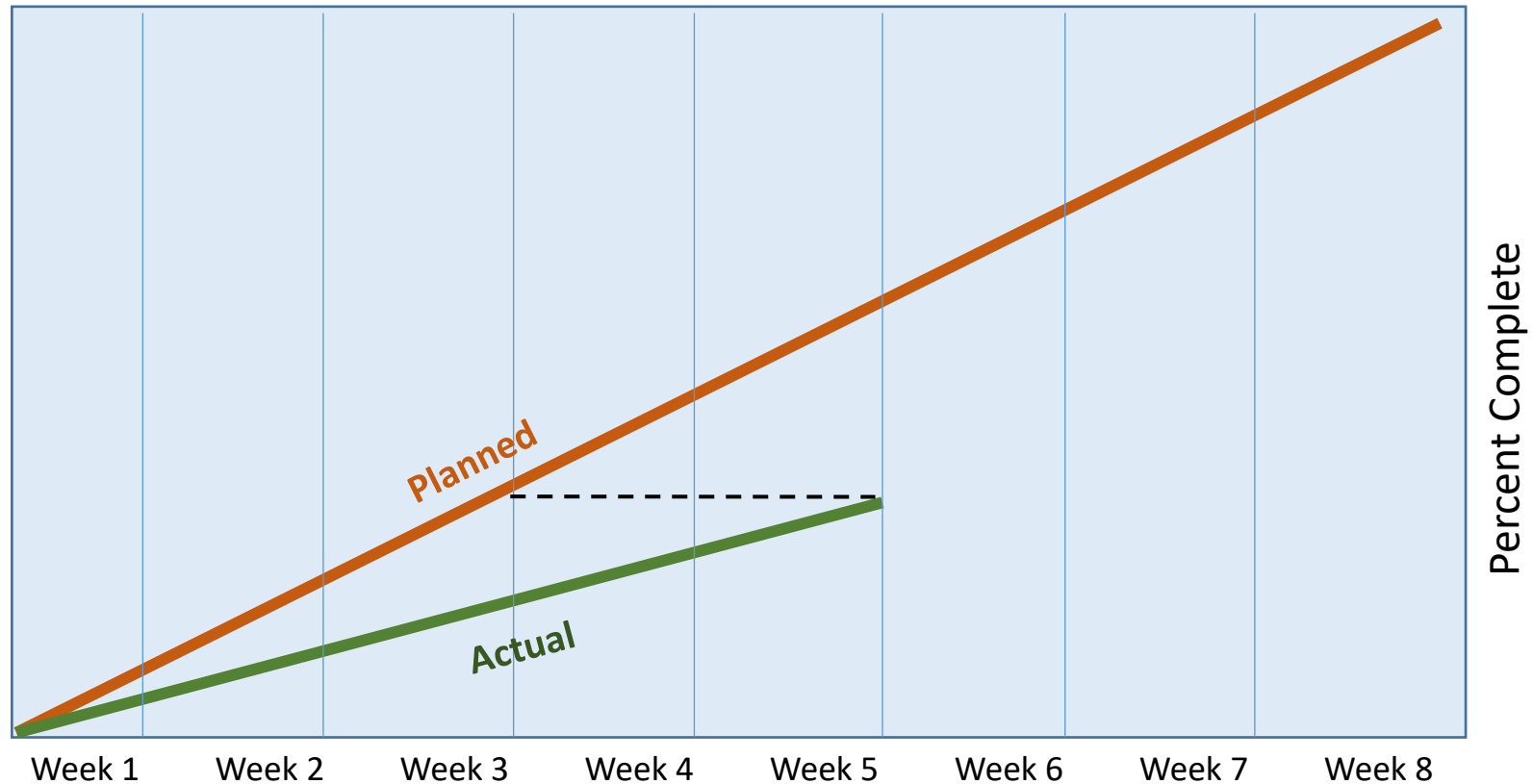
Richard: "This schedule clearly shows that I am two weeks ahead of schedule…
…because I didn't plan on being two weeks behind schedule for another two weeks"

Earned Value done right is your friend; but it's not a carrot and stick thing: DON'T GAME IT!

Safest Place Is on the Ball

❑ I learned early on to plan my vacations for whenever a big formal review was scheduled later in the year

- ▪ SRR
- ▪ PDR
- ▪ CDR

❑ Because that was the one date I *knew* the review would not be held

❑ Only time it almost backfired was when I planned a vacation for CDR

- ▪ CDR slipped of course, as expected
- ▪ But then PDR slipped almost to that date

> Guys, the safest place with this duffer swinging at the ball is to be ON the ball.

It's unfortunately safe to assume the schedule will slip…but how much?

SRR – System Requirements Review   PDR – Preliminary Design Review   CDR – Critical Design Review

Closing Thought

Lessons Learned as a Systems Engineer

$500 for a hammer?!?!
And other sensational headlines that sound horrific to the taxpayer.

- $2000 for a coffee pot on an airplane?

- I can get Mr. Coffee for $30

- I want my $2 [thousand] DOLLars [back]!

I'll take **"Don't Scald Me!"** for $2000, Alex.

But if you were sitting next to it when you hit turbulence…

Sometimes the $500 Hammer is Worth Every Penny

Questions?

Lessons Learned as a Systems Engineer

Backup Slides:

Proposal Writing Tips

Just some snippets;
Can do a brief on these if desired

Posters (or Post-Its) I put on the wall for all proposals I run

- ❑ **Make Every Word Tell**
  - ▪ Much of what follows does so from this

- ❑ Use Active Voice (passive voice will not be used)

- ❑ Use Present Tense: Tell a story

- ❑ Eliminate extraneous words: e.g. use "and" vs "as well as"

- ❑ Don't *tell* me your solution is proven. **Prove it.**

- ❑ No, your solution probably is not *unique* (one of a kind), nor does being unique necessarily make it good

- ❑ Use the serial comma to avoid ambiguity (*see slide 8*)

- ❑ Avoid business jargon such as *dynamics, synergy, move forward,…*

- ❑ Go which hunting: replace defining *which*es with *that*s

Style Matters: Read *Elements of Style* periodically

Avoid Common Word Misuse

- [ ] Use *use*, don't utilize *utilize*
- [ ] *Consensus* means unanimity, not majority
- [ ] Irregardless (if it were a word) would mean "regardful"; use *regardless*
- [ ] *Generic* means "unbranded", not "general"
- [ ] *Superfluous* vs *redundancy*
- [ ] *Fewer* vs *less*
- [ ] "Different from" vs "different than"
- [ ] "Try to", not "try and"
- [ ] Don't use "and/or"
  - "or" is inclusive in English
    - i.e., "or" means "and/or"
  - "Either…or" is *exclusive or* in English
- [ ] *Assure* vs *ensure* vs *insure*: QA s/b QE?

Word Usage Matters

QA – Quality Assurance QE – Quality Ensurance s/b – should be

Other Proposal Tips

- ❑ You and he gave the Proposal Tips briefing to her and me. (**correct**)

- ❑ It's an **exclamation point** (Oh my!), *not* an emphasis point
  - ▪ use your words or pictures for emphasis (or ***bold italics*** font I suppose ☺)

- ❑ TBDs, not TBD's – unless the TBD owns something

- ❑ Define all initialisms (including acronyms) and abbreviations

- ❑ White space enhances readability

- ❑ No blank lines; use Word styles to create white space

- ❑ Hyphenate adjectival phrases
  - ▪ you *check out* your groceries at the *check-out* line

- ❑ Be careful where you put *only* and *not*
  - ▪ "All that glitters is not gold" is **FALSE** – because gold glitters, and it's gold
  - ▪ "Not all that glitters is gold" is **TRUE**

- ❑ Judicious use of *that* can eliminate ambiguity

Grammar Matters

TBD – To Be Determined

Initialisms & Abbreviations

A_o	Operational Availability	PDR	Preliminary Design Review
ARO	After Receipt of Order	PITA	Pain In The [butt]
AF	Air Force	PM	Program Manager
ATM	Automated Teller Machine	PTO	Paid Time Off
AV	Air Vehicle	QA	Quality Assurance
CDR	Critical Design Review	QE	Quality Ensurance
CG	Center of Gravity	RFP	Request For Proposal
EWW	Extended Work Week	ROI	Return on Investment
FMS	Flight Management Software	RWR	Radar Warning Receiver
FYI	For Your Information	SA	Situational Awareness
G&A	General and Administrative	s/b	should be
GH	Global Hawk	SE	Systems Engineer
HR	Human Rescources	SOW	Statement Of Work
ISR	Intelligence, Surveillance, Reconnaissance	SMS	Sensor Management Software
INCOSE	INternational Council On Systems Engineering	SRR	System Requirements Review
MCC	Mobile Command Center	SRS	Software Requirements Specification
MEMS	Micro Electro-Mechanical Systems	SW	Software
MILES	Multiple Integrated Laser Engagement System	SWE	SoftWare Engineer
MTI	Moving Target Indicator	T&Cs	Terms and Conditions
NIL	National Imagery Library	TBD	To Be Determined
NIMA	National Imagery & Mapping Agency	UAV	Unmanned Air Vehicle
NM	Nautical Mile	USCG	United States Coast Guard

Note: An acronym is a *pronounceable* initialism. So SOW is an acronym whereas ATM is not.

End

Lessons Learned as a Systems Engineer