TEST EFFECTIVENESS AND NMP

PURPOSE
• Provide status report on Test Effectiveness activities
• Provide status on answering “Kane’s question”

OUTLINE
• Test Effectiveness Program
• Kane’s “Simple” Question
• What are we doing?
• Synergistic Testing (e.g. VTMT vs Th/Vac + WCA)
• Back to the Question
• Results
• Future Work
# CURRENT TEST EFFECTIVENESS
PROGRAM ELEMENTS

<table>
<thead>
<tr>
<th>TE PROGRAM TASK</th>
<th>HELPS NMP?</th>
<th>METRICS?</th>
<th>FBC METHOD?</th>
</tr>
</thead>
<tbody>
<tr>
<td>* ETEA</td>
<td>YES</td>
<td>YES</td>
<td>?</td>
</tr>
<tr>
<td>Information Exchange and Dissemination</td>
<td>YES</td>
<td>YES</td>
<td>?</td>
</tr>
<tr>
<td>* EOL Simulation</td>
<td>?</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>PofE based Test</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>SLAM Force Data</td>
<td>?</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Th Cyc/Dwl Workshop</td>
<td>YES</td>
<td>YES</td>
<td>?</td>
</tr>
<tr>
<td>Synergistic Testing</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>* Cold Electronics</td>
<td>?</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>* Metrics Development and Implementation</td>
<td>YES</td>
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</tbody>
</table>

Received funding in December 1995, * not started yet due to HQ/JPL hold
KANE’S SIMPLE QUESTION

“DO I WIN IF I TAKE ALL MY ASSEMBLY MONEY AND SPEND IT AT SYSTEM?” . KANE CASANI

TO ANSWER:

• NEED METRICS ON RELATIVE EFFECTIVENESS OF PACT’s FIXES AND COSTS.
• “IF YOU CAN’T MEASURE IT, YOU CAN’T MANAGE IT” - DAN GOLDBIN

WE (DESIGNERS, TESTERS, ANALYZERS, INSPECTORS, ETC.) DO NOT HAVE GOOD METRIC INFRASTRUCTURE IN PLACE, BUT WE’RE IMPROVING.

• WHY?
  • IT’S HARD.
  • WHO WANTS TO PAY FOR INFRASTRUCTURE?
    (A BETTER FILLED OUT P/FR HELPS THE NEXT PROJECT....“WHO CARES?”)

KANE CAN HELP BY ASKING EVERYONE FOR METRICS AND DATA “PROVING” THE VALUE OF ADDING OR ELIMINATING ACTIVITIES
WHAT ARE WE DOING?

• DATA GATHERING
  ● COMMOY THREADS WORKSHOP (COMING)
  ● TEST EFFECTIVENESS WORKING GROUP (STARTED)
  ● FLIGHT PERFORMANCE WORKING GROUP (COMING)
  ● SLAM FORCE DATA
  ● NCMS ESS2000 (INDUSTRIAL SCREENING EFFECTIVENESS)
  ● THERMAL CYCLE/DEWELL WORKSHOP
  ● SSED (DoD "PER PLUS" DATA BASE) SSED=SPACE SYSTEMS ENGINEERING DATABASE
  ● INDUSTRY BEST PRACTICE SURVEYS

• TOOL DEVELOPMENT
  TACT KNOWLEDGE BASE
  10 KNOWLEDGE BASE
  PROBLEM LOG DEVELOPMENT (P/FR FRONT END)

• METHODOLOGY DEVELOPMENT
  PofF BASED TESTING (UTILIZE A "ROOT CAUSE" VIEWPOINT TO DEVELOP AND IMPLEMENT SPECIFIC TESTS)
  EOL SIMULATION (VOLTAGE, TEMPERATURE AND FREQUENCY CAN SIMULATE AGING AND RADIATION)
  DOP (UTILIZES THE MATRIX-BASED ACEQ ENGINE TO WEIGHT RELATIVE EFFECTIVENESS OF PACTS ON FAILURE VODES WHICH ARE OF THE MOST CONCERN)
  COLD ELECTRONICS (WHAT KEEPS US FROM OPERATING OUR ELECTRONICS COLD)
  SYNERGISTIC TESTING (MORE LATER)

• IMPLEMENTATION
  "NMP TECHNOLOGY VALIDATION STATUS" - WORKING WITH BARBARA WILSON
  ACEQ ON NMP (STARTED)
  ACEQ ON MDL (COMING)
  FLIGHT DEVELOPMENT REENGINEERING (STARTED)
BACK TO THE QUESTION

"DO I WIN IF I TAKE MY ASSEMBLY MONEY AND SPEND IT AT SYSTEM?"

ASSY TEST
DONE EARLIER
(1:10:100 OR VARIATION THEREOF)
MORE EFFECTIVE ON LEVEL DEPENDENT FM's
FINDS ASSY ONLY FM's
FINDS LEVEL INDEP FM's
FAKE POSITIVES COST MONEY

SIMPLIFYING ASSUMPTIONS
NO ASSY ONLY FM's
FM's ARE HARDWARE TYPE INDEPENDENT
ALL ASSY TESTS COST THE SAME
ALL FIXES COST THE SAME (ASSY DIFFERENT THAN SYSTEM)
ALL FM's HAVE SOME PROBABILITY OF NON-FIX (ASSY DIFFERENT THAN SYSTEM)
ALL EXTRA MONEY USED FOR BETTER SYSTEM TEST
BETTER SYSTEM TEST: EFFECTIVENESS SCALES WITH MONEY AVAILABLE
FM SCREENING LEVEL DEPENDENCY IS CONSTANT (Eassy = X, Esys = Y; For all FM)
DEFERRED RISK MODEL

(SOME DATA FROM GALILEO FOR DESIGX P/FRs ONLY)

FM

V

Perform Assembly Test

NO

FM fixed?

YES

FM fixed?

NO

FM round and fixed

YES

FM fixed?

NO

Mission Risk

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EXAMPLE OF ALGORITHM

UTILIZED MATHCAD

```
Cost_sys_test := 300000
Cost_assembly := 250000
Cost_pf_repair := 10000
\beta := 3
Cost_pf_sys := Cost_pf_repair - 3
FM := 80
FMs := 20
Es := 0.2
\delta := 0.8
Risk_f := 0.5

Total_avail := Cost_pf_repair + Cost_assembly + Cost_pf_repair
Risk_s := \pi \cdot \delta \cdot FM \cdot Cost_pf_repair - 2
Total_avail := C \cdot \text{sys} \cdot \delta \cdot \text{FM} \cdot \text{Cost_pf_repair}
Risk_s := \pi \cdot FM \cdot Cost_pf_repair

(2 \cdot \text{Cost_sys_test}) \cdot \frac{\text{Total_avail}}{\delta \cdot \text{FM} \cdot \text{Cost_pf_repair}}
\text{Solution 1:} \quad \frac{\text{Total_avail}}{\delta \cdot \text{FM} \cdot \text{Cost_pf_repair}}
\text{Solution 2:} \quad \frac{\text{Total_avail}}{\delta \cdot \text{FM} \cdot \text{Cost_pf_repair}}

\text{Note that the solution is only 'physical' for values } \geq 0
\delta := 0.364
\delta := 0.364
Risk_s := \frac{FMs}{\delta} \cdot (Es - \text{Prob_pf_sys}(\delta \cdot Es)) + \frac{FM}{\delta} \cdot (E \cdot \text{Prob_pf_sys}(\delta \cdot E))
\text{Risk_s} = 6.8
\text{Risk_s} = 27.473
```

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RESULTS

QUESTION:
SHOULD I DO SYSTEM ONLY TEST OR SYSTEM PLUS ASSEMBLY?

CONCLUSION:
WITH CURRENT DATA, WE WOULD RECOMMEND AGAINST DOING SYSTEM ONLY TEST.

HOWEVER, THE MODEL SHOWS THAT THE "TALL POLE" PARAMETERS ARE:

• RATIO OF SYSTEM FIX COST TO ASSY FIX COST - SINGLE BIGGEST DRIVER
  IF WE CAN GET THE INTEGRATION/REPLACEMENT PROCESS TO BE SEAMLESS, THE ANSWER TO KANE'S QUESTION COULD BE YES!

• PROBABILITY OF INADEQUATE ASSEMBLY FIXES - MODERATE DRIVER

• COST OF ASSEMBLY FIXES - SMALL DRIVER

• OTHER FACTORS WEAKER DRIVERS

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Relative Risk Analysis Assy + Sys. Vs Sys test only
Assuming Fake System Test Cost Factor = 1/8
Relative Risk Analysis Assy + Sys. Vs Sys test only
Assuming Fake System Test Cost Factor = 1/16

![Chart Image](image-url)
FUTURE WORK

- TAKE PF/Rs AND GET FM DEPENDENCY (GET MORE DATA)
- FOCUS ON ESCAPES FROM DIFFERENT LEVELS OF ASSEMBLY
- GET BETTER ESTIMATES OF HIDDEN COSTS OF TESTS
- SORT FAILURE MODE/COSTS BY HARDWARE GENERAL TYPE (E.G. ANALOG, DIGITAL, RF, MECHANISMS, POWER)
- GET BETTER ESTIMATES OF COSTS OF FIXES
- INCORPORATE MORE DATA FROM INDUSTRY, NASA AND DoD
- IMPROVE MODEL AS DATA PERMITS
- REPORT BACK WITH STATUS OF NEXT SETS OF FINDINGS AND WORK JUST NOW UNDERWAY!