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

TE PROGRAM TASK	HELPS NMP?	METRICS?	FBC METHOD?
* ETEA	YES	YES	?
Information Exchange and Dissemination	YES	YES	?
* EOL Simulation	?	YES	YES
PoFF based Test	YES	YES	YES
SLAM Force Data	?	YES	YES
Th Cyc/Dwl Workshop	YES	YES	?
Synergistic Testing	YES	YES	YES
* Cold Electronics	?	YES	YES
* Metrics Development and Implementation	YES	YES	

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 PACTs FIXES AND COSTS.
- "IF YOU CAN'T MEASURE IT, YOU CAN'T MANAGE IT" - DAN GOLDIN

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/DWELL WORKSHOP
  - SSED (DoD "P/FR PLUS" DATA BASE) SSED=SPACE SYSTEMS ENGINEERING DATABASE
  - INDUSTRY BEST PRACTICE SURVEYS
- TOOL DEVELOPMENT
  - PACT KNOWLEDGE BASE
  - FM 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)
  - DDP (UTILIZES THE MATRIX-BASED ACEQ ENGINE TO WEIGHT RELATIVE EFFECTIVENESS OF PACTS ON FAILURE MODES 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 FMs
FINDS ASSY ONLY FMs
FINDS LEVEL INDEP FMs
FALSE POSITIVES COST MONEY

SYS TEST

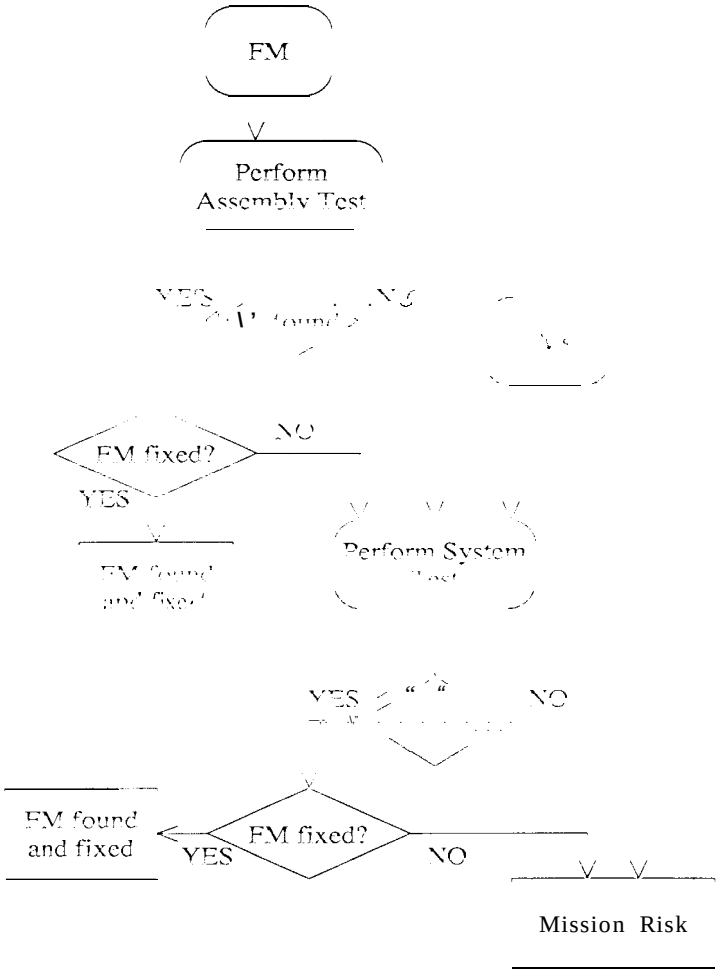
ONLY TEST TO FIND FILL UP INTEGRATED FMs
FINDS LEVEL INDEP/DEP FMs
FINDS LOWER LEVEL NON-FIXES

SIMPLIFYING ASSUMPTIONS

NO ASSY ONLY FMs
FMs ARE HARDWARE TYPE INDEPENDENT
ALL ASSY TESTS COST THE SAME
ALL FIXES COST THE SAME (ASSY DIFFERENT THAN SYSTEM)
ALL FMs 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)



EXAMPLE OF ALGORITHM

UTILIZED MATHCAD

$Cost_sys_test := 30000$

$Cost_assy_test := 250000$

$Cost_pf_assy := 10000$

$\beta := 3$

$Cost_pf_sys := Cost_pf_assy \cdot \beta$

$FM := 80$

$FMs := 20$

$Ea := 0.2 \quad E := 0.1 \quad Es := 0.$

$Prob_nf_assy := 0.5$

$Prob_nf_sys := 0.2$

$Cost_pf_sys := Cost_pf_assy \cdot \beta$

$Total_avail := Cost_sys_test + Cost_assy_test + Cost_pf_assy + Ea \cdot FM + Cost_pf_sys + Es \cdot FMs + E \cdot FM + Prob_nf_sys$

$Risk_sa := FMs \cdot (Es + Prob_nf_sys \cdot (1 - Es)) + FM \cdot (Ea + Prob_nf_assy \cdot (1 - Ea)) \cdot (E + Prob_nf_sys \cdot (1 - E)) \qquad Risk_sa = 6.8$

$Total_avail = Cost_sys_test + Cost_pf_sys + FM \cdot \left(1 - \frac{E}{\delta}\right) + FMs \cdot \left(1 - \frac{Es}{\delta}\right) \qquad Total_avail$

Soln1 $\quad \frac{-1}{(2 \cdot Cost_sys_test)} \cdot \left(Total_avail - Cost_pf_assy \cdot FM - Cost_pf_sys \cdot FMs + \sqrt{Total_avail^2 - 2 \cdot Total_avail \cdot Cost_pf_sys \cdot FM - 2}\right.$

Soln2 $\quad \frac{-1}{(2 \cdot Cost_sys_test)} \cdot \left(Total_avail - Cost_pf_sys \cdot FM - Cost_pf_sys \cdot FMs - \sqrt{Total_avail^2 - 2 \cdot Total_avail \cdot Cost_pf_sys \cdot FM - 2}\right.$

Note that the solution is only "physical" for values >=0

$\delta := 0.364 \qquad \begin{pmatrix} Soln1 \\ Soln2 \end{pmatrix} = \begin{pmatrix} -27.497 \\ 0.364 \end{pmatrix} \qquad Risk_sa = 6.8$

$Risk_s := \frac{FMs}{\delta} \cdot (Es + Prob_nf_sys \cdot (\delta - Es)) + \frac{FM}{\delta} \cdot (E - Prob_nf_sys \cdot (\delta - E)) \qquad Risk_s = 27.473$

RESULTS

QUESTION:

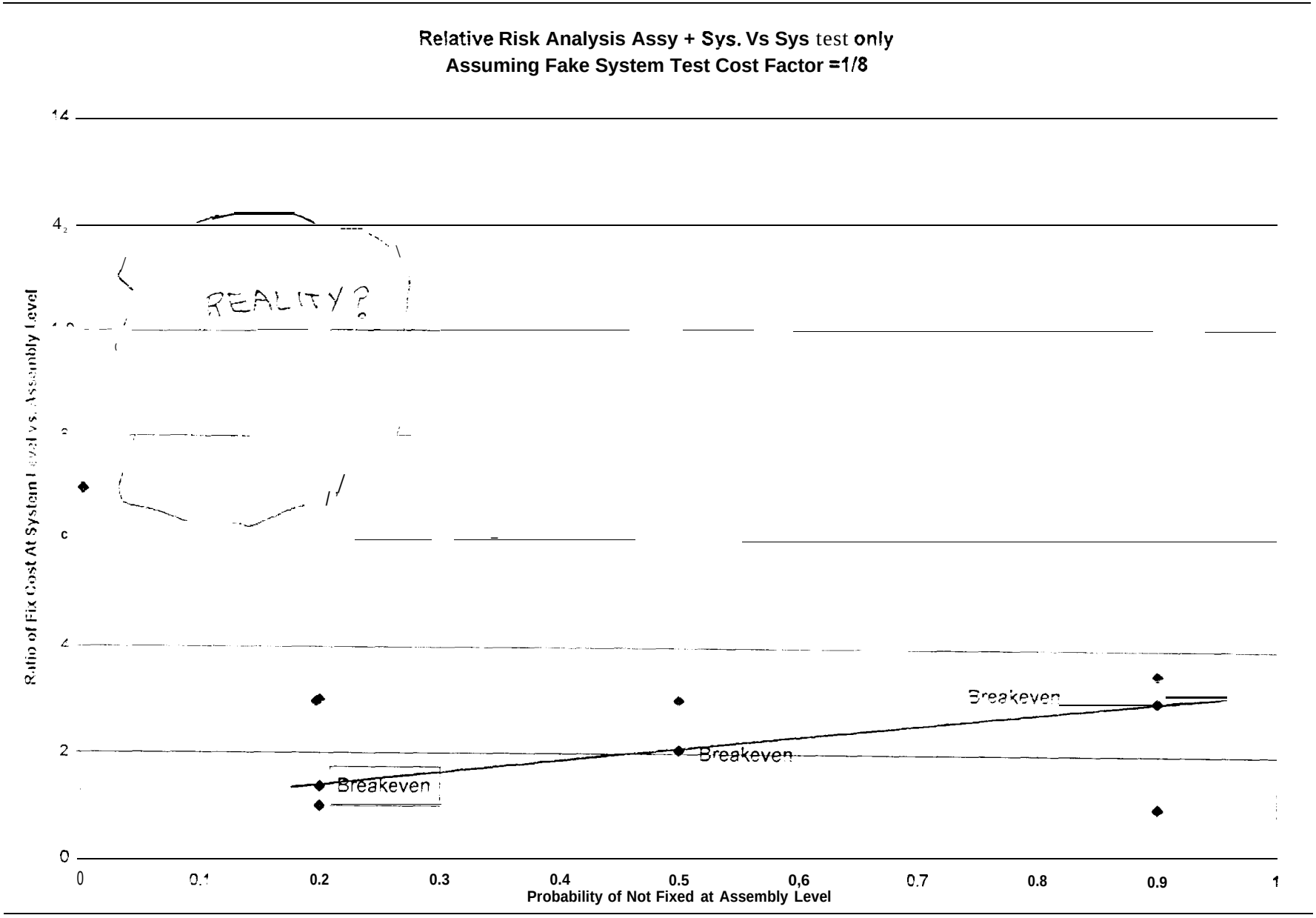
SHOULD **I DO SYSTEM ONLY TEST OR SYSTEM PLUS ASSEMBLY?**

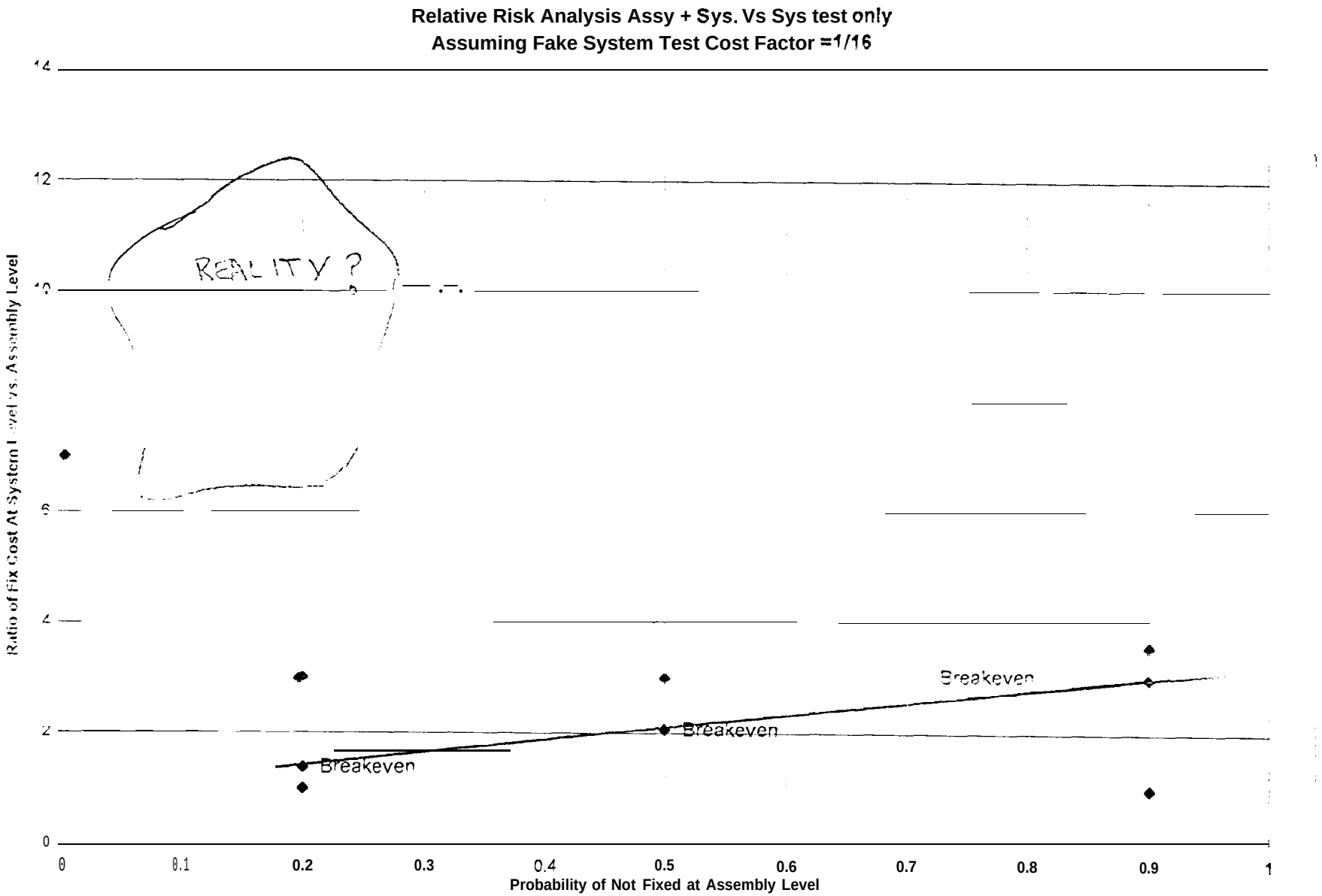
CONCLUSION:

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


Relative Risk Analysis Assy + Sys. Vs Sys test only
Assuming Fake System Test Cost Factor =1/8
14
4
2
0
Ratio of Fix Cost At System Level vs. Assembly Level
REALITY?
Breakeven
Breakeven
Breakeven
0
0.1
0.2
0.3
0.4
0.5
0,6
0.7
0.8
0.9
1
Probability of Not Fixed at Assembly Level


Relative Risk Analysis Assy + Sys. Vs Sys test only
Assuming Fake System Test Cost Factor =1/16
14
12
10
8
6
4
2
0
Ratio of Fix Cost At System Level vs. Assembly Level
REALITY ?
Breakeven
Breakeven
Breakeven
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Probability of Not Fixed at Assembly Level

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!