

# FRACAS: DON'T CUT – INVEST!

A perspective on FRACAS vicious cycle.

Systems Engineering Leadership Program (SELP) Integrated Project

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# Agenda

- ▣ Topic inception
- ▣ Objectives / Approaches
- ▣ Definition
- ▣ Customer requirements
- ▣ Project Findings
- ▣ Case Studies
- ▣ Recommendation / Conclusion
- ▣ Questions / Answers



## Functional manager

- Functional department loads zero or minimum staffing support for the program

### PMO

- Not willing to fund or reluctant to fund FRACAS activities in new proposals
- External customer not willing to fund, so why do it (meaning no requirements)

### FRACAS

- No funding or minimum funding to perform FRACAS

### PM

- Corrective action suggested (if any were able to) cost too much
- Reliability growth too slow
- Not seeing FRACAS return on investment (ROI)

## VICIOUS CYCLE

### Program products

- Failure increasing
- Repair cost increasing
- Reliability decreasing

### FRACAS

- Playing catch up in collecting data
- Digging past data
- Asking testing engineers to remember and provide past records
- Not able to provide sufficient trending analysis

### Customer

- Customer Satisfaction decreasing in products

• UNHAPPY!

### Issues

- Program not set up for FRACAS
- No failure data readily available
- Functional department not staffed for program

- Demand reliability growth



# FRACAS Vicious Cycle

## Contributors

- ▣ Customer:
  - Not receiving reliable product – reluctant to fund the program's FRACAS bid
- ▣ Program:
  - Not receiving cost/benefit – reluctant to invest in FRACAS
  - Trying to keep the proposal a “low cost” deal
- ▣ FRACAS:
  - Not receiving sufficient funding to perform proper FRACAS



# Project Objectives

- ▣ To define the role of FRACAS within the total systems engineering process
- ▣ To reveal the key contributors to an ineffective FRACAS
- ▣ To provide the important factors to a successful implementation of FRACAS.



# Project approaches

- ▣ To understand what FRACAS is and what it means to the customer
- ▣ To identify the reasons behind management's reservation on fully funding FRACAS
- ▣ To evaluate the challenges faced by the FRACAS engineers in performing FRACAS activities.

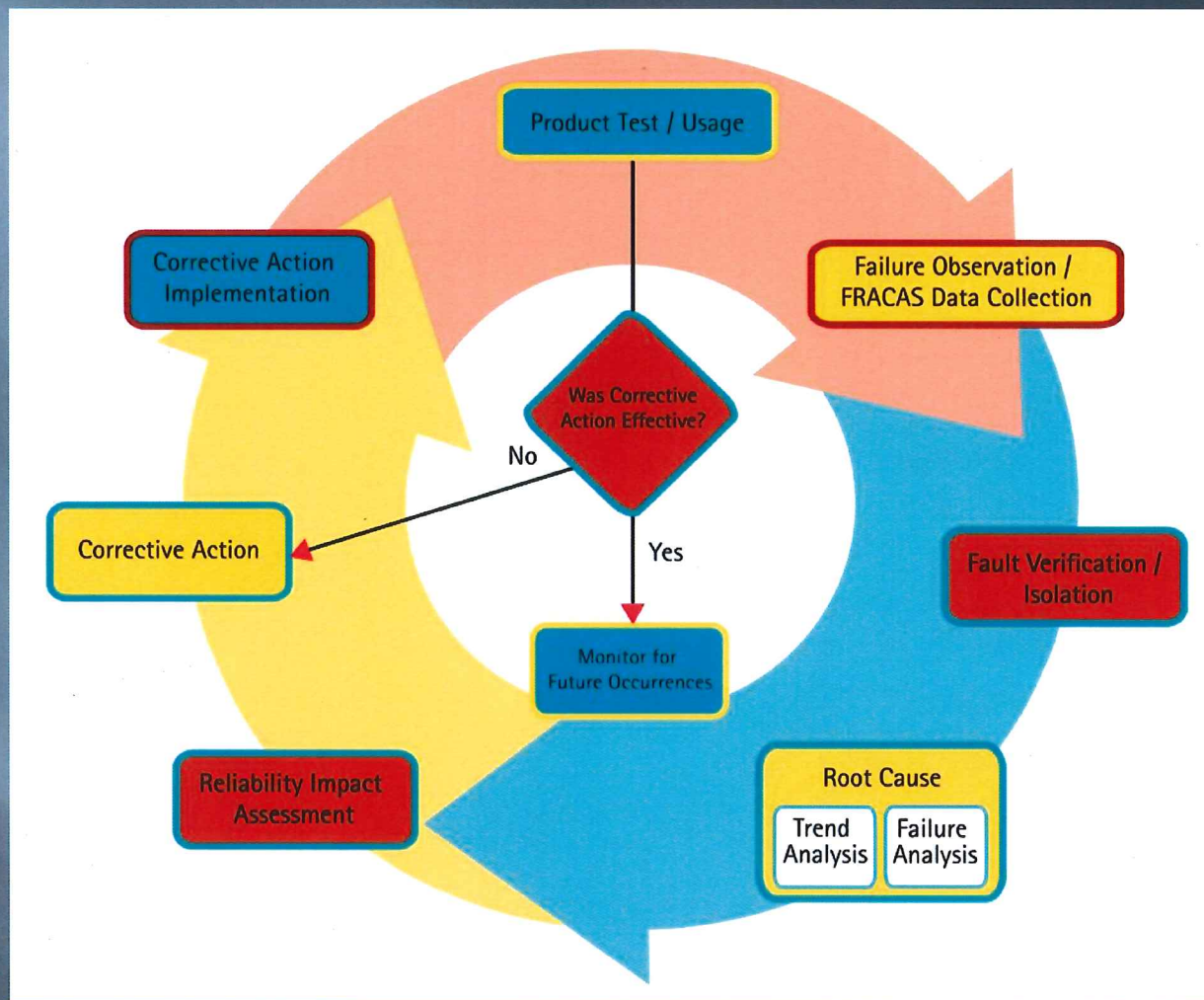


# What is FRACAS?

- ▣ A system which:
  - Provides management visibility and control for continuous improvement of quality, reliability and maintainability
  - Provides improvement of hardware and associated software with timely and disciplined utilization of failure and maintenance data
    - ▣ to generate and implement effective corrective actions
    - ▣ to prevent failure recurrence
    - ▣ to simplify or reduce the maintenance tasks.



# FRACAS = Closed Loop System



- ❑ Every failure is an opportunity to improve the reliability of our product.
- ❑ FRACAS is this closed loop engineering process allow us to measure, identify, and implement the improvements.



# FRACAS Basic Benefit

- ▣ The most basic benefit:
  - Timely detection and correction of
    - ▣ design errors
    - ▣ part problems
    - ▣ workmanship defects
    - ▣ process errors



# Customer Requirements

- ▣ FRACAS requirements were described within the military standards as early as 1969:
- ▣ Military Standard 785A
- ▣ Military Standard 785B (1980)
- ▣ Military Standard 2155 (1985)
- ▣ Recently emphasized by the Secretary of Defense through a Directive-Type Memorandum (DTM) 11-003 – Reliability Analysis, Planning, Tracking, and Reporting – on March 21, 2011.



# Directive-Type Memorandum (DTM) 11-003

- ▣ A recent released DTM further emphasized the reliability and maintainability (R&M) program as an integral part of the systems engineering process.
- ▣ “The program will consist of engineering activities including: R&M allocations...reliability growth testing at the system and subsystem level; and a failure reporting and corrective action system maintained through design, development, production, and sustainment.”



# PBL Concept by DoDD 5000

- ▣ In an effort to improve operational readiness and product reliability in support of the war fighters and their needs.
- ▣ The Performance Based Logistic (PBL) concept was introduced in the year 2000 by the government, mandated by DoD Directive (DoDD) 5000.
- ▣ Currently many programs are contracted under PBL support strategy.



# Systems Engineering Philosophy

- ▣ A design philosophy shift from classical engineering
  - - where the design focus is mainly on product performance
  
- ▣ To system life-cycle engineering
  - - where it greatly embraced the systematic approach to create a product design that simultaneously considers all elements of the product cycle



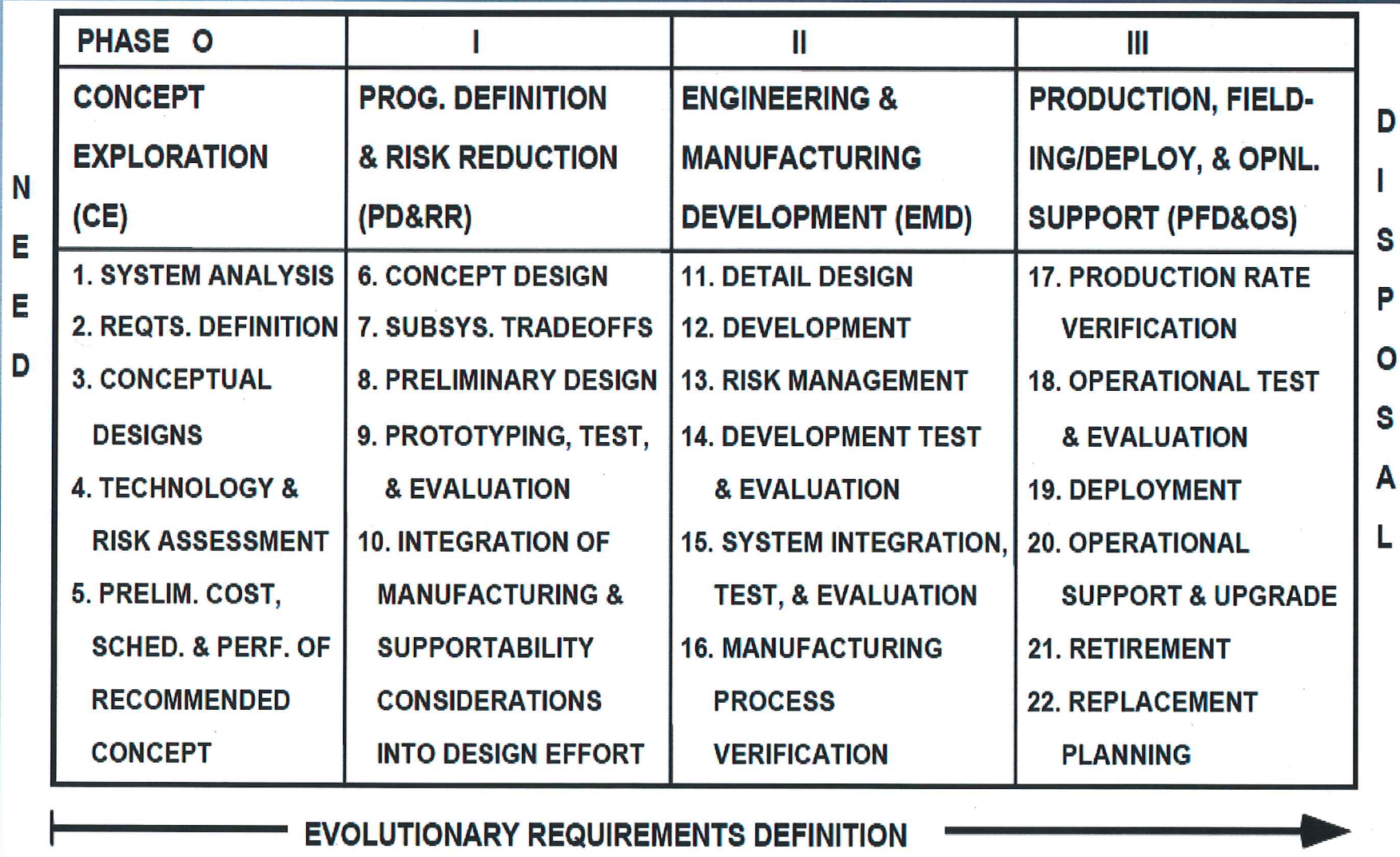
# Typical List of Engineering Function (Not Limited to)

- ▣ Manufacturing
- ▣ Quality Assurance
- ▣ Operations
- ▣ Customer
- ▣ Reliability
- ▣ Field Services Representative
- ▣ Program Manager
- ▣ Systems Engineering
- ▣ Hardware Engineering

- These stakeholders are the mix of the members on the failure review board (FRB).
- The success of resolving a failure effectively
  - Supportive program manager
  - Sufficient funding, labor, and tools
  - Active participating functions where the high interactive information flow is most critical



# THE SYSTEMS ENGINEERING PROCESS ACROSS PROJECT LIFE CYCLE





# FRACAS Performance Opportunities

## Contract Stages

SDD/EMD	PROD/LRIP/FRP	POST PRODUCTION
<p>Opportunity to Influence design = <b>Maximum</b></p> <p><b>By identifying early on:</b></p> <ul style="list-style-type: none"> <li>- Design related issues                             <ul style="list-style-type: none"> <li>- Lessons Learned                                     <ul style="list-style-type: none"> <li>- Parts obsolescence</li> </ul> </li> <li>- Inherent design traits</li> <li>- HW/SW design errors</li> </ul> </li> <li>- Production related issues                             <ul style="list-style-type: none"> <li>- Known STE problems</li> <li>- Sufficient test points</li> </ul> </li> <li>- Supplier related issues                             <ul style="list-style-type: none"> <li>- Workmanships</li> </ul> </li> </ul> <p><b>FRACAS Performance</b> = T1 test through Sell-off = 100% failure root cause</p>	<p>Opportunity to influence design = <b>Still have chance to correct</b></p> <ul style="list-style-type: none"> <li>- Design related issues                             <ul style="list-style-type: none"> <li>- May or maybe not be correctable</li> </ul> </li> </ul> <p><b>Maximum efforts to identify:</b></p> <ul style="list-style-type: none"> <li>- Production related issues                             <ul style="list-style-type: none"> <li>- Build Process related</li> <li>- Did not build to design</li> <li>- Bad planning</li> </ul> </li> <li>- Supplier related issues                             <ul style="list-style-type: none"> <li>- Non</li> <li>- Parts obsolescence alert</li> </ul> </li> </ul> <p><b>FRACAS Performance</b> = T1 test through Sell-off = Trend level failure root cause</p>	<p>Opportunity to influence design = <b>Costly</b></p> <ul style="list-style-type: none"> <li>-Design related issues                             <ul style="list-style-type: none"> <li>- Opportunity through functional related(provide new functionality)</li> </ul> </li> </ul> <p><b>Maximum efforts to identify:</b></p> <ul style="list-style-type: none"> <li>- Field product usage</li> <li>- Depot repair related issues                             <ul style="list-style-type: none"> <li>-Workmanships</li> <li>- Insufficient quality check points</li> </ul> </li> <li>-Supplier related issues                             <ul style="list-style-type: none"> <li>- Workmanships</li> <li>- Parts obsolescence alert</li> </ul> </li> </ul> <p><b>FRACAS Performance</b> = Field failure verify thru ATP = Trend level failure root cause</p>



# Win-Win-Win Situation

- Happy customer gets a reliable product due to an effective FRACAS program
- FRACAS is fully funded and supported by the program office
- Program Office's FRACAS bid is approved by the happy customer.

What caused this win-win-win cycle to have shifted into this vicious cycle?



# Survey Questions to Program Manager

1. Did you ever manage a program with FRACAS already incorporated?
2. Did the program bid for FRACAS during the proposal phase?
3. What are the top 10 issues regarding FRACAS for your program?
4. Is FRACAS discipline relatively new to you?
5. What are the top 5 outputs you want to get out of FRACAS?



# Program Management Perspective on FRACAS

The evaluation found that most of the program managers do understand the fundamental principles of FRACAS and the values of what it could bring to the program. However, the delivery of FRACAS values is nowhere near adequate for program expectations.

Item #	Program Code	Program Size Code	Program Phase	FRACAS BID Initially?	FRACAS Continued?	FRACAS Added?
1	A	Large	PBL	Y	Y	N/A
5	E	Large	Proposal	Y	N/A*	N/A
6	F	Large	Proposal	Y	N/A*	N/A
8	H	Large	O&S	Y	Minimal**	N/A
14	N	Large	FRP/O&S	Y	N	Y
15	O	Large	O&S	N	N	Y
16	P	Large	FRP/O&S	N	N	N
19	S	Large	O&S	Y	Y	N/A
3	C	Medium	PBL	N	N	Y
7	G	Medium	Proposal	Y	N/A*	N/A
9	I	Medium	O&S	Y	Minimal**	N/A
2	B	Small	PBL	Minimal**	Minimal**	Y
4	D	Small	Development	Y	Y	N/A
10	J	Small	O&S	Y	Minimal**	N/A
11	K	Small	Production	Y	N	N
12	L	Small	O&S	N	N	Y
13	M	Small	Production	Y	Y	N/A
17	Q	Small	FRP/O&S	N	N	N
18	R	Small	Development	Y	Y	N/A

\* Program is in the proposal phase, therefore has not yet reached implementation stage.

\*\* Funding provided to perform failure tracking only, no closed-loop FRACAS.

PBL – Performance Based Logistic

O&S – Operation and Support

FRP – Full Rate Production

		FRACAS BID Initially?			
Program Size	FRACAS Continued?	Minimal	N	Y	Grand Total
Large	Minimal			1	1
	N		2	1	3
	N/A			2	2
	Y			2	2
Large Total			2	6	8
Medium	Minimal			1	1
	N		1		1
	N/A			1	1
Medium Total			1	2	3
Small	Minimal	1		1	2
	N		2	1	3
	Y			3	3
Small Total		1	2	5	8
Grand Total		1	5	13	19



# Program Management Perspective on FRACAS Cont.

## COMPILATION OF FRACAS ISSUES

- ▣ Team is weak in applying systems engineering methodology in solving issues
- ▣ Not efficient in producing valuable information such as usable metrics
- ▣ Perceived as data reporters
- ▣ Not flexible in meeting expectations of the business and the program changes
- ▣ High personnel turn-over rate
- ▣ Team is not finding ways to improve the implementation of FRACAS
- ▣ FRACAS is costly in manpower

## COMPILATION OF FRACAS EXPECTATIONS

- ▣ Metrics that fully support program requirements such as failure report closure rates
- ▣ FRACAS improvements that can assist program in cutting cost
- ▣ Establish baseline Reliability
- ▣ Ensure Solution to high profile critical failures
- ▣ Technical inputs to corrective actions
- ▣ Reliability Growth



# Survey Questions to FRACAS Engineers

1. What are the most common comments you get from the Program managers?
2. Did you ever work on a program with FRACAS already incorporated?
3. How many FRACAS engineers are on the program? Is it enough?
4. Do you have the right tools to perform FRACAS?
5. Is FRACAS discipline relatively new to you?
6. Do you feel like there's enough understanding on what FRACAS is from the program management?
7. Do you feel the expectation from program management is at the right level?
8. Have you ever worked on FRACAS requirements during program development phases?
9. Do you know or feel the requirements for FRACAS have been communicated adequately?
10. Did you have the data you needed to perform FRACAS?
11. Was sufficient training provided to perform your job properly?



# FRACAS Engineers Point of View

- ▣ Program managers do not see the connection between FRACAS output and improvement to the bottom line
- ▣ FRACAS interpreted as a process that would delay schedule (i.e. counterproductive)
- ▣ Program managers worry about FRACAS cost in relation to its output
- ▣ Failure Review Board (FRB) uses too much engineering resources
- ▣ FRACAS need to provide reports that will help program managers make decisions
- ▣ FRACAS database not universal among programs
- ▣ FRACAS database not accessible (or website based) to other groups and functions
- ▣ FRACAS database not user friendly
- ▣ FRACAS database does not efficiently generate metrics
- ▣ Other organization bids "FRACAS Lite" results in insufficient funding
- ▣ FRACAS perceived to be redundant to other functions such as Corrective Action Board
- ▣ Need to review problems in a broad sense to find common issues
- ▣ FRACAS engineers do data mining only
- ▣ Reliability function is responsible for FRACAS, but has no authority to implement
- ▣ Program managers do not know the purpose and values of FRACAS
- ▣ Program managers do not know reliability engineer's roles and responsibilities
- ▣ Program managers do not have realistic FRACAS expectations
- ▣ Ambiguous/poorly defined requirements

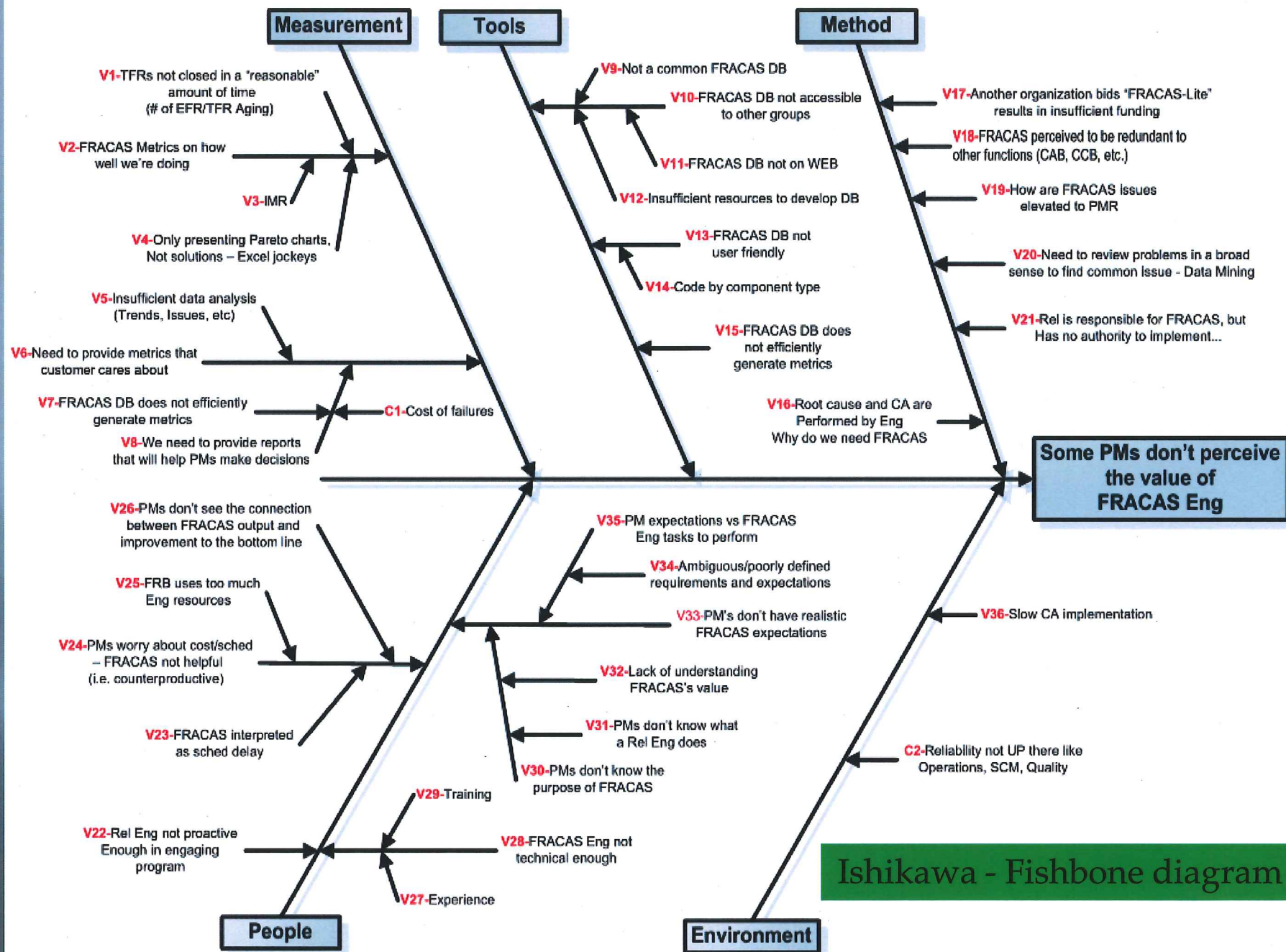


# Summary of Findings

- ▣ FRACAS engineers do not always agree with the program manager's expectations on FRACAS value delivery

This discrepancy is the mechanism that cycles this unwanted loop



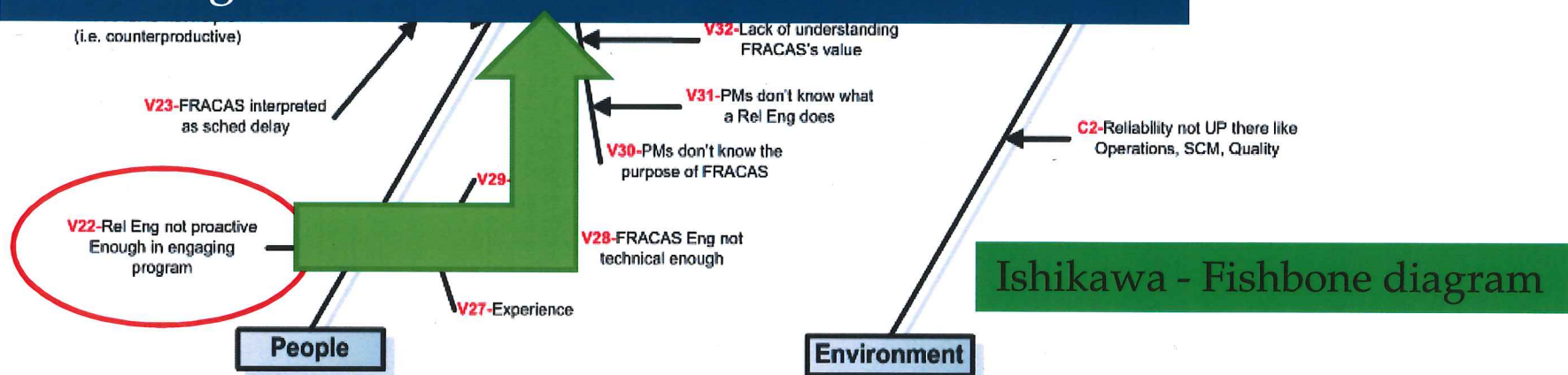




- Each of the fish-bone ribs was tagged with an identifier (Vx) and evaluated by a FRACAS expert committee.

- The voting outcome revealed identifier V22 – “Reliability FRACAS Engineering not proactive enough in engaging programs” to have the most opportunity for an improvement to break the FRACAS vicious cycle.

- The 5-Why methodology was conducted to evaluate the voting outcome of V22.

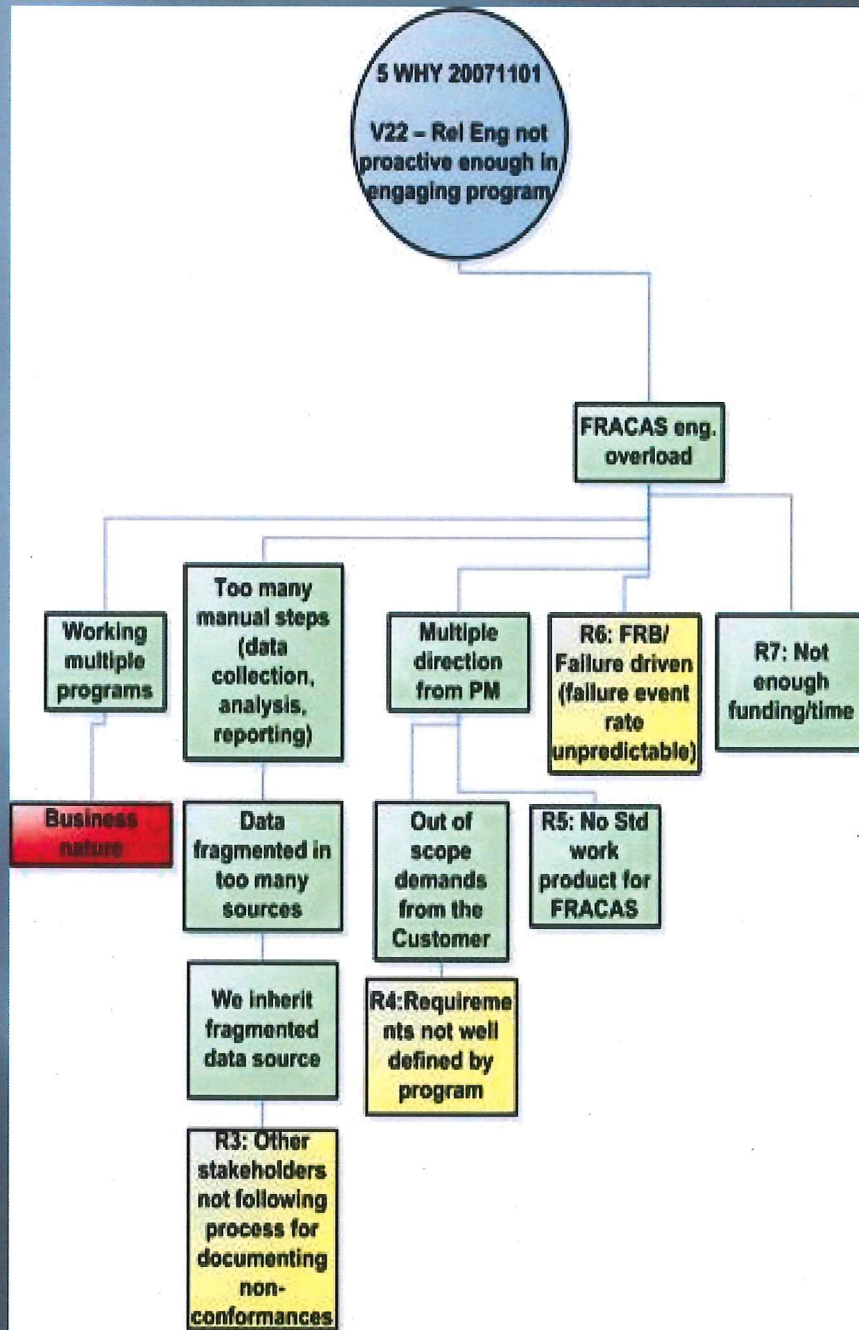




## 5-Why Approaches:

- ▣ Brainstorming on all root causes on V22
- ▣ When a root cause is identified, indicate it with letter “R” followed by a number
- ▣ Evaluate each solution on both Savings and Risks
- ▣ Determine and group the solutions by various combinations of savings and risks (i.e. High Saving/Low Risk to Low Saving/High Risk)
- ▣ Determine commonality among the group solutions





Using R4 as an example, there were five possible solutions to that root cause.

1. To participate in proposals and early design reviews.
2. Review statement of work and contract documentations to validate requirements.
3. To push back on requirements that are out of the scope.
4. Get clarification from the customer.
5. Flow requirement checklist to the program.



# Spiral Out of the FRACAS Vicious Cycle by exercising Solution 2

Note: : these have no real relation to any entities

ROI realization using the following as factors for simplicity on calculation:

- \$100 dollar per hour

- \$15,000 repair cost per failure from field through repair center to back out to field.

## Current scenario

- ❑ Program C bid FRACAS with minimal effort (10 hours per week) initially to track failures only
- ❑ There are no closed-loop FRACAS activities for this program.

	Year 1	Year 2	Year 3	Year 4
# of failures	17	14	32	23
Repair cost / failure	\$15,000	\$15,000	\$15,000	\$15,000
Total cost	\$255,000	\$210,000	\$480,000	\$345,000

Program C's investment on FRACAS can be calculated as the following:

- 10 hours per week for four years = \$208,000 = \$52,000 per year

Program C's total repair cost for four years equals \$1,290,000



# Spiral Out of the FRACAS Vicious Cycle by exercising Solution 2

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## Break-Even analysis for an ideal implementation of FRACAS process

- Program C's investment on FRACAS:
    - 40 hours per week for Year 1 = \$208,000
  - Program C's Year One cost at no failure prevented equals:
    - $\$255,000 + \$208,000 = \$463,000$
  - Investing in closed-loop FRACAS in Year 1
    - Proper implementation of corrective action of the failures lead to a domino effect in Years Two through Four.
- The initial investment is recouped by preventing 15 of the 69 failures in the following years.
    - 15 failures times \$15,000 = \$225,000 (greater than \$208,000)

Note: : these have no real relation to any entities ROI realization using the following as factors for simplicity on calculation:  
- \$100 dollar per hour  
- \$15,000 repair cost per failure from field through repair center to back out to field.



# Spiral Out of the FRACAS Vicious Cycle by exercising Solution 2

FRACAS Lead approached the program manager to take initiative on further understanding the program requirements. After investing a total of one week's worth of time and effort, the FRACAS Lead was able to convince the program manager to invest in 20 additional hours per week to perform a closed-loop FRACAS process. The additional funding results in a labor increase from 10 hours to 30 hours for a three-year minimum contract.

Note: : these have no real relation to any entities  
ROI realization using the following as factors for simplicity on calculation:  
- \$100 dollar per hour  
- \$15,000 repair cost per failure from field through repair center to back out to field.

## Break-Even analysis for the additional funding:

FRACAS team investment = one week time = 40 hours = \$4,000

- Secured future funding of additional 20 labor hours per week for 3 years

- 20 hours per week = \$2,000 per week = \$104,000 per year

- 

- Program C's new investment on the proposed scenario equals a total of \$160,000 for Year 5.

- \$52,000 (original 10 hours) + \$4,000 (FRACAS Lead) + \$104,000 = \$160,000

- The new investment is recouped by preventing 11 failures in the following years.

- 11 failures times \$15,000 = \$165,000 (greater than \$160,000)



# CASE STUDY

## SMART-T (*Secure Mobile Anti-Jam Reliable Tactical Terminal*)

### RELIABILITY PROBLEMS: NO FRACAS ACTIVITIES

- Contract Value > 212M
- Customer: USA/CECOM
- 388 terminals plus spares
- Terminal MTBF requirement of 800 hrs could not be verified during Reliability Growth Test (RGT)

- **Observed MTBF < 500 hrs**
- **Unable to enter final phase of RGT due to high failure rate**
- **No structured FRACAS program in place**
- **Production put on hold!**



*"The SMART-T Program's failure to meet its reliability requirement (in 2000) delayed a production decision and precluded fielding terminals to the soldiers..."* David Jimenez, Milsatcom SMART-T Program Manager

### FRACAS IPT LAUNCHED IN AUGUST 2000

- Active customer partnership & participation (Army & Air Force)
- Collected all prior field, test, production and RGT failure data
- Identified/investigated all problems and implemented "root cause" corrective actions prior to restarting RGT
- **Enabled program to move forward, resulting in successful RGT (0 failures in 1,322 hours)**
- **\$100M in bookings in 2001 that would not have happened**

*"...The FRACA IPT between government and contractor enabled the program to move forward, resulting in the terminal passing RGT on July 12, 2001."* David Jimenez, Milsatcom SMART-T Program Manager



# *A Win-Win-Win Success Story*

- Program A's customer made an evaluation between the conventional contract and the PBL contract deciding which contract option would best serve their needs.

<b>Conventional Contract Option</b>	<b>PBL Contract Option</b>
Buy many spares	Buy minimum spares
Stand-up repair center	Utilize supplier repair center
Customer owns Configuration Control	Supplier owns Configuration Control
Customer responsible for all repairs	Supplier responsible for all repairs (not induced by the customer) throughout product life-time
	Supplier responsible for Parts Obsolescence throughout product lifetime

The decision was made by Program A's customer to go with the contract based on performance, therefore, a PBL contract was formed.

A crucial element within the contract was the mutual understanding between both parties that their agreement is a "Reliability Contract" and not a "Repair Contract".



# *A Win-Win-Win Success Story Cont.*

- ▣ Program A is a “Firm-Fixed Price PBL Contract that guarantees
    - Systems Mean Time Between Maintenance Actions (MTBMA) of 120 flight hours
    - Ao of 90% throughout the lifetime of the product.”
  - ▣ Established FRACAS where failure event and root cause analysis were performed for all failures.
    - FRACAS was implemented properly throughout the course of the program
- ▣ Ten years of success for Program A:
    - Achieving > 20 percent of MTBMA (120 hours)
    - Achieving > 10 percent of Ao (90%)



# A True Win-Win-Win Scenario

- The customer has the product with high reliability and is available over 99 percent of the time.
- This program has, and continued to provide to its customer, a complete end-to-end long term performance based support with its overall costs minimized.
- FRACAS continued to serve its intended purpose of securing product reliability by preventing failures from reoccurring with necessary labor and resources.



# Recommendation

- ▣ It is pertinent to ensure:
  - Unrealistic plans are avoided
  - Sufficient resources are provided
  - Efficient communication among stakeholders
  - Full accountability of results
- ▣ Educate personnel on FRACAS process
  - Increasing positive perceptions toward this subject
- ▣ View FRACAS as a “centralized function”
  - Value of reliability function increases as the surrounding functions understand the tremendous close relations of each other



# Conclusion

- ▣ FRACAS is heavily people and tools orientated and therefore, companies should ensure the following key elements are well established:
  - ▣ • Qualifying personnel with a curious mind
  - ▣ • Proper and sufficient training
  - ▣ • Adequate and efficient tools
  - ▣ • Stream-lined and managed information system among all entities
  - ▣ • Enough resources in terms of both funding and people
- ▣ Essential to invest in the FRACAS process as early as possible in its product life cycle phases.
- ▣ Critical to have in place, a well-functioning, proactive FRACAS
- ▣ Failure data and root cause investigations must be thorough
- ▣ FRACAS' vicious cycle spirals into a win-win-win cycle – where reliability is maximized and cost and schedule impacts are minimized.
- ▣ As a result, the FRACAS program develops a reputation and the integrity to warrant proper funding for the next program or phase.



# QUOTE to Ponder

*“If you haven’t got time  
to stop these failures from recurring,  
how are you going to find the time  
to keep fixing them?”*

Alexander Dunn: Director, Assetivity Pty Ltd



# Q & A



WIN-WIN-WIN HAPPY Cycle

