Quality Cup

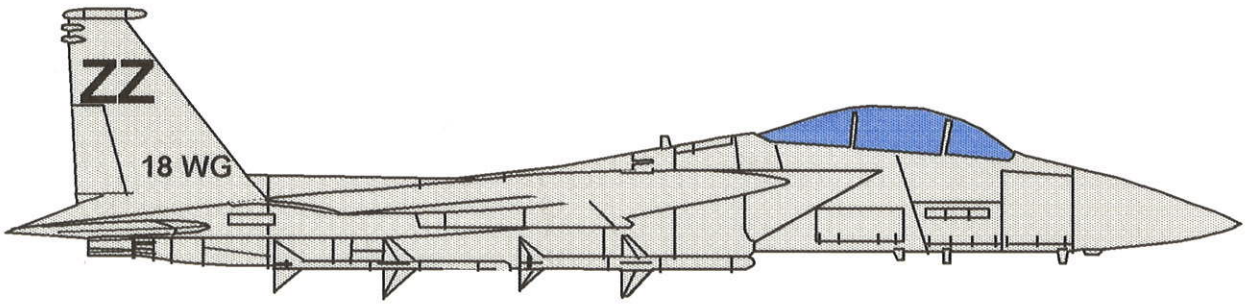
Rochester Institute of Technology/USA Today

1995 Nomination

AIM-9 MISSILE PROCESS ACTION TEAM

Intermediate-Level Repair Enhancement Program

Kadena Air Base, Japan



Air Force People, Building the World's Most Respected Air and Space Force... Global Power and Reach for America

(Air Force Vision)

1995 QUALITY CUP NOMINATION

Before completing this nomination form, please read the accompanying instructions carefully.

1. Name of the team or individual you are nominating: **(Air Intercept Missile) AIM-9 Missile Process Action Team.**

2. Name of organization submitting the nomination: **18th Wing, Kadena Air Base Japan.**

3. Nomination Category: Check the category in which the nomination is submitted. The category is determined by the principal activity of the organization which employs the nominees.

_____ a. **Manufacturing Industry** --- All for-profit manufacturing firms with over 500 employees. Subsidiary service firms, wholly owned by manufacturing and offering services to external customers, should be submitted in the service category.

_____ b. **Service Industry** --- All for-profit services with over 500 employees. Subsidiary manufacturing firms, wholly owned by service firms and offering manufactured products to external customers, should be submitted in the manufacturing category.

XXX c. **Government** --- All units of federal, state and local government. It does not include profit making firms devoted to providing government services or improvement for which this individual or team is being nominated. Please be sure to include a description of the magnitude of the problem or opportunity.

_____ d. **Not-for-Profit** --- This category is open to any 501 (c) (3) organization.

_____ e. **Small Organization** --- This category includes for-profit manufacturing and service firms with fewer than 500 employees. In counting the number of employees, include employees of any parent company and all divisions and subsidiaries.

The sponsors reserve the right to reclassify the nomination if doing so will place it in competition with a significant group of similar nominations. Please note:

* **All health care organizations should be included in the not-for-profit category.**

*** All primary and secondary educational institutions should be included in the governmental category.**

*** All post-secondary educational institutions should be included in the not-for-profit category.**

*** To help us confirm the category that you have chosen, would you please briefly describe the products/services offered by your organization and the types of customers/clients who use them.**

Answer: The United States Air Force's 18th Wing is located at Kadena Air Base, Okinawa, Japan. Using 90 combat aircraft, the Wing's primary product is "airpower." This story is about improving the reliability of an aircraft system, worth over $110 million, involving over 350 technicians, over $6 million of diagnostics equipment and facilities, while operating from Japanese soil. Our 18th Wing customers include the following:

* Commander Pacific Air Forces for the defense of American interests in the Pacific.

* 5th and 7th Air Force Commanders in defense of Japan and Korea

* Other Services and Allies...in defense of the Pacific

4. List the names(s) and job title(s) of the individual or of the individuals making up the team. If you are nominating a team, list the name of the team leader first. A team may include members who are not employees of the nominating organization, but are employees of a supplier or customer. The is no limit to the number of team members you may nominate. Use an additional sheet of paper if it is needed to list all the team members.

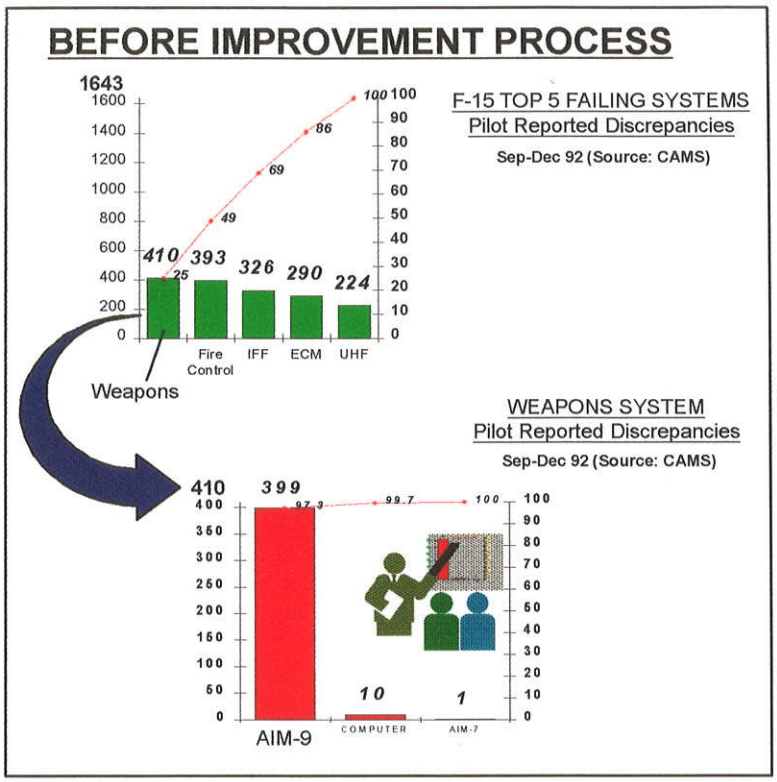
Name	Job Title
Tommie L. Limbrick, SMSgt, USAF Team Leader	Weapons Manager 18th Wing
John J. Kmiec, Jr., SMSgt, USAF Team Leader	Armament Systems Flight Chief 18th Maintenance Squadron
Monroe J. Ratchford, Lt Col, USAF Key Result Area Champion, Intermediate-Level Repair Enhancement Program	Commander 18th Maintenance Squadron
Kelly Fletcher, Capt, USAF Team Member	F-15 Aircraft Commander, Wing Weapons and Tactics 44th Fighter Squadron
Patrick Ellis, Capt, USAF Team Member	F-15 Aircraft Commander 20th Fighter Squadron
Charles T. Hart, SSgt, USAF Team Member	Load Standardization Crew Member 18th Operations Group
Joe McElwee, SSgt, USAF Team Member	Load Standardization Crew Member 18th Operations Group
William M. Stroup, SSgt, USAF Team Member	Precision Guided Munitions Maintenance Crew Chief 18th Munitions Squadron
Gary R. Sneller II, SSgt, USAF Team Member	Precision Guided Munitions Maintenance Crew Chief 18th Munitions Squadron
Michael Chapman, SSgt, USAF Team Member	Armament Systems Team Chief 18th Maintenance Squadron
Ragan T. Shirai, SrA, USAF Team Member	Armament Systems Team Member 18th Maintenance Squadron

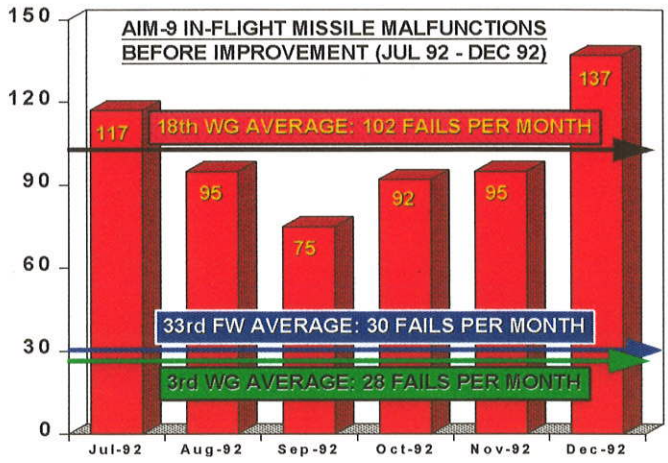
Name	Job Title
James P. Faucette, SrA, USAF Team Member	Armament Systems Team Member 18th Maintenance Squadron
Timothy Helms, SSgt, USAF Team Member	Weapons Load Crew Chief 12th Fighter Squadron
Patrick E. Mallard, SSgt, USAF Team Member	Weapons Load Crew Chief 44th Fighter Squadron
Thomas J. Sullivant, SrA, USAF Team Member	Weapons Load Crew Member 67th Fighter Squadron
Andrew McMillan, GS-11, USAF Technical Advisor	Air Force Engineering and Technical Service 18th Logistics Group
Leon Voorhies, GS-11, USAF Technical Advisor	Air Force Engineering and Technical Service 18th Logistics Group
Mitchell Villanueva, TSgt, USAF Facilitator	Quality Advisor 18th Maintenance Squadron

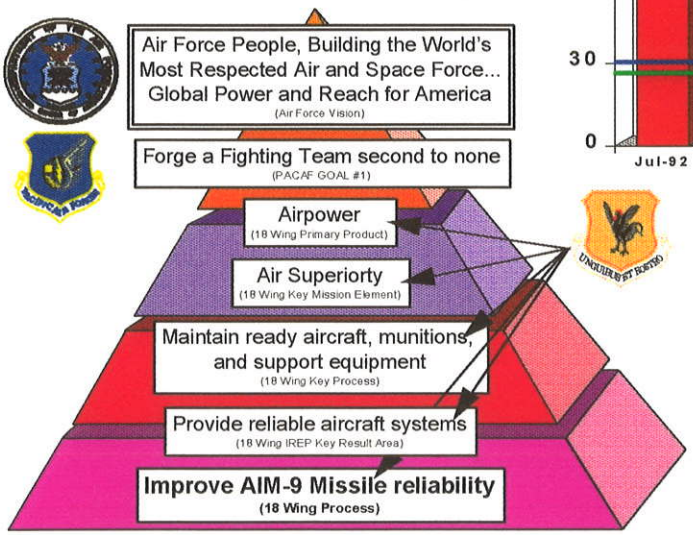
Before answering questions 5, 6, 7 and 8, please read the instructions carefully, noting that entries that exceed the word limits in responding to these questions will be judged, but that they will be penalized for excessive length. Also note, that additional exhibits, amounting to as many as six 8 1/2 x 11 pages can be used to supply statistical evidence in tabular or graphic format.

5. Brief Description: In **no more than one hundred words**, summarize the quality improvement for which this individual or team is being nominated. Please be sure to include a description of the magnitude of the problem or opportunity.

Answer: The Air Force vision is to build "the world's most respected Air and space Force...global power and reach for America." The 18th Wing uses 64 F-15 aircraft, pilots and maintainers to provide air superiority for this vision. Our pilots use AIM-9 missiles to shoot down potential enemy aircraft in the Pacific. However, during training missions, our pilots reported a monthly average of 102 AIM-9 missile system discrepancies. Even more distressing, of 23 aircraft systems, the AIM-9 system failed most. Our pilots couldn't practice their skills nor could we ensure combat performance. We had to improve missile systems reliability.


BEFORE IMPROVEMENT PROCESS
1643
1600
1400
1200
1000
800
600
400
200
0
100
90
80
70
60
50
40
30
20
10
0
410
393
326
290
224
25
49
69
86
100
Fire Control
IFF
ECM
UHF
Weapons
F-15 TOP 5 FAILING SYSTEMS
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)
WEAPONS SYSTEM
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)
410
399
97.3
99.7
100
400
350
300
250
200
150
100
50
0
10
1
COMPUTER
AIM-7
AIM-9


AIM-9 IN-FLIGHT MISSILE MALFUNCTIONS
BEFORE IMPROVEMENT (JUL 92 - DEC 92)
150
120
90
60
30
0
117
95
75
92
95
137
18th WG AVERAGE: 102 FAILS PER MONTH
33rd FW AVERAGE: 30 FAILS PER MONTH
3rd WG AVERAGE: 28 FAILS PER MONTH
Jul-92
Aug-92
Sep-92
Oct-92
Nov-92
Dec-92


Air Force People, Building the World's Most Respected Air and Space Force... Global Power and Reach for America
(Air Force Vision)
Forge a Fighting Team second to none
(PACAF GOAL #1)
Airpower
(18 Wing Primary Product)
Air Superiorty
(18 Wing Key Mission Element)
Maintain ready aircraft, munitions, and support equipment
(18 Wing Key Process)
Provide reliable aircraft systems
(18 Wing IREP Key Result Area)
Improve AIM-9 Missile reliability
(18 Wing Process)

6. Process: In **no more than three hundred words**, describe the process that led to the nominee's accomplishment. How was the problem or opportunity identified? What was (were) the root cause(s)? How was the solution developed and selected? How and by whom was the solution implemented? (Three hundred points.)

Missile Loaders install AIM-9 Missile on F-15 Aircraft

Armament Systems Technicians inspect AIM-9 Missile Launcher (Missile to Aircraft Interface)

Missile Repair Technicians maintain AIM-9 Missile Components

Answer: Not only was our missile system the least reliable, but the missile systems on other Wings' F-15 performed 70% better. In September 1992, our Wing Commander complained, "I flew today, and again my AIM-9 didn't work!" For weeks, each organization in the process: missile loaders, missile repair technicians, armament systems technicians and pilots, pointed fingers and claimed it wasn't their fault...nothing improved.

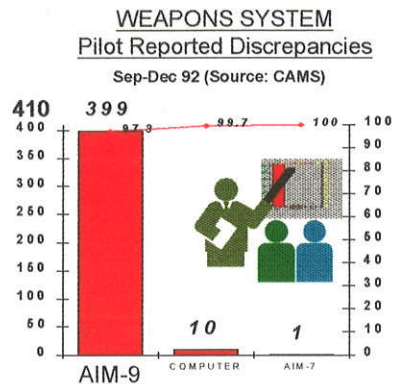
Pilots reported the missile "not cooling" as the most frequent malfunction. We performed root cause analysis, collected data and validated actionable root causes. We tested and incrementally implemented solutions for each of these causes.

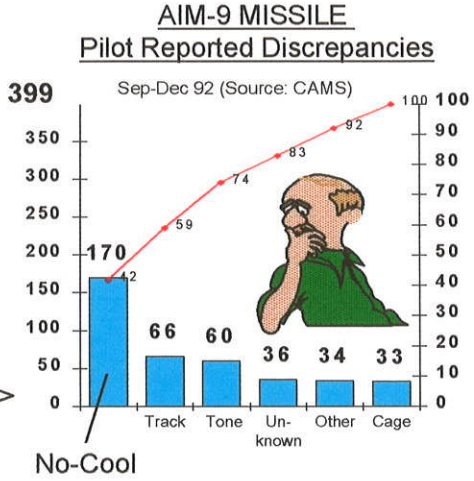
- Because the missile repair technician's diagnostic equipment typically couldn't detect all faults, missile loaders wouldn't turn missiles in for repair until the third fail. Repeat malfunctions resulted. Solution...loaders turn missiles in on the first fail and got better feedback from the missile repair technicians.

- Our data showed the missile not receiving cooling gas (argon) to be the highest failure cause. Investigations revealed the shorter missile loader technicians couldn't properly install the cooling gas (argon) bottles into the missile straight because the aircraft was so tall. Installing the bottles at an angel damaged missile components and caused missiles to malfunction in flight. Solution...missile loaders started using a ladder to install the bottle straight into the missile.

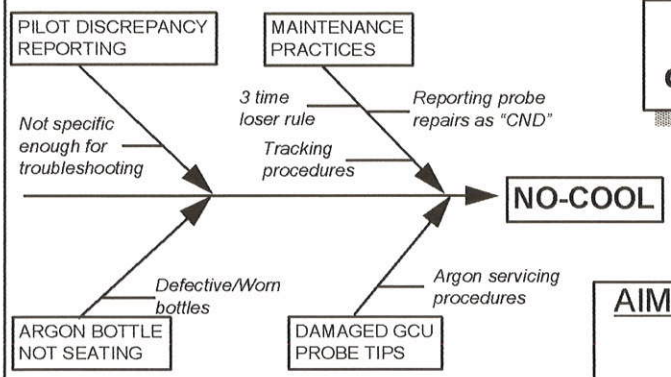
- Missile loaders failed to detect defective argon bottles. Solution...loaders validated argon bottle functions during missile loading and removed from service the defective ones.

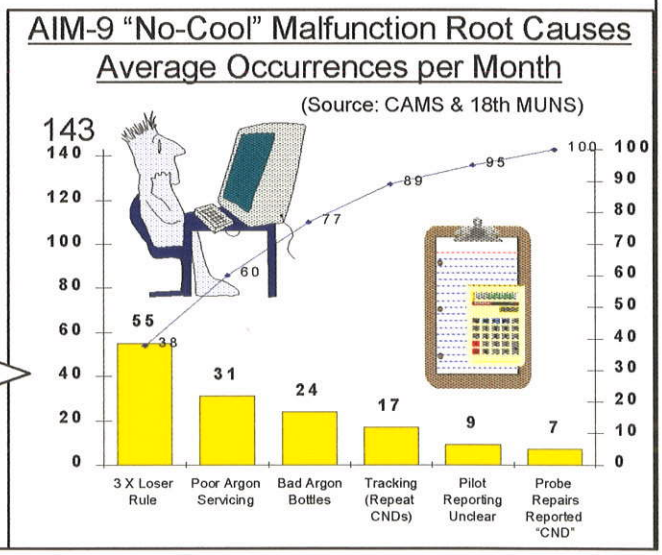
Nested Pareto Analysis of AIM-9 Missile Malfunctions





Root Cause Analysis of AIM-9 Missile Malfunctions





- Technicians didn't get feedback about the causes for failures or the corrective actions, so failures continued. Solution...missile loaders, missile repair technicians and armament system technicians tracked faults and provided feedback to all other technicians in the process.

- Pilots failed to provide specific feedback to allow technicians to properly diagnose, so malfunctions continued. Solution...train pilots on specific fault reporting techniques.

7. Result: In **no more than four hundred words**, describe the change brought about by implementing the solution. Identify, if possible, the internal or external customers affected by the change. Describe how the customers benefited from the change. (Four hundred points.)

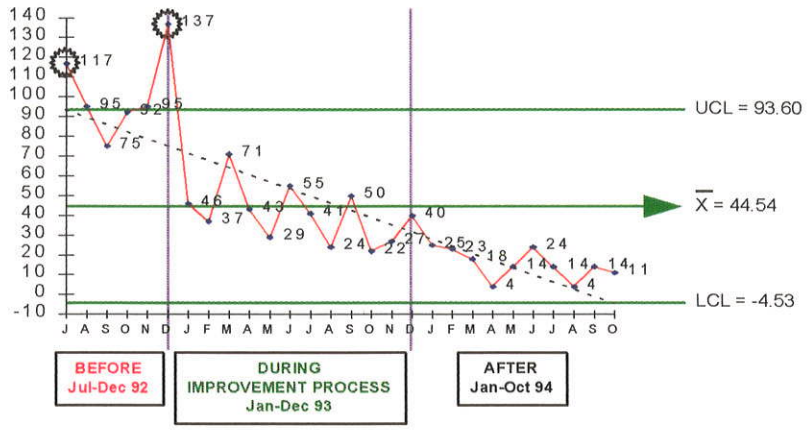
Answer: After testing our solutions on a few jets, we applied these fixes at every repair opportunity. Internally, our pilot customers started encountering fewer missile discrepancies in the air -- from 102 per month to just 34 in a year. The number of discrepancies caused by the missile not receiving cooling gas (argon) decreased 70% and had a corresponding 56% reduction on other missile malfunctions like tracking and target indications. With more reliable missile systems, our pilots trained more effectively because they use the missiles during peace time training just as they would employ the missiles in war. This intrinsically increased the confidence of our pilots. Our maintenance technician customer workload decreased 67% ($17,000 annually in labor cost), while repair cost reduced 99%. Perhaps more importantly Wing teamwork across functional lines became a way of life. The "finger pointing" stopped and now we consult each other for the few failures we get. When we get a missile system failure, everyone in the process wants to know what caused the fault and we work together to resolve it.

- Our team integrated process improvements into the daily operations of missile loaders, missile repair technicians, armament system technicians and pilots. We gave briefings on the new procedures and provided training to wing leadership, pilots and maintainers. We published all process improvements into the missile loader academics' lesson plan and argon bottle servicing checklist. We also published a maintenance operating instruction applicable to all maintainers (including flow charts and metrics), and rewrote local pilot operating procedures. Our standardized procedures ensured continuity despite an annual 33 percent turnover in technicians. Standardized procedures and continued system tracking ensured our process is still improving today. We have had as few as 4 missile discrepancies in a month. We currently have the most reliable F-15 missile system in the Air Force at less than 15 fails per month...an 85 percent improvement!

AIM-9 In-flight Missile Malfunctions
X,mR Control Charts
Jul 92 - Oct 94 (Source: CAMS)

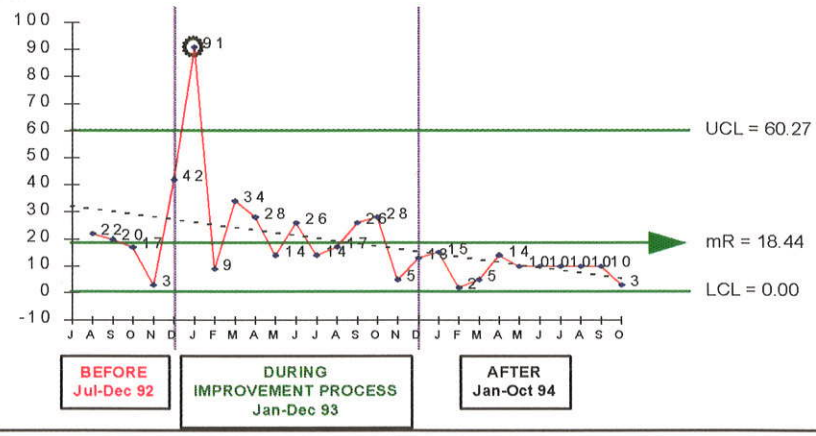
X (Run) Chart: Number of AIM-9 Pilot Reported Discrepancies (PRDs) recorded each month.

Less Is Better!



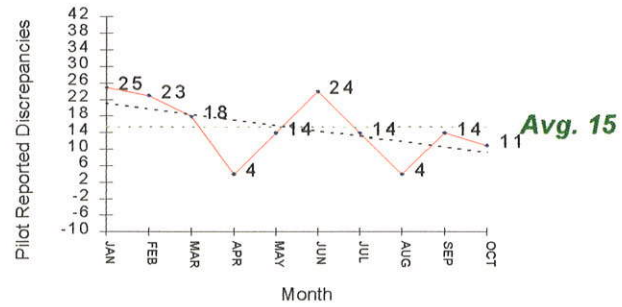
mR Chart: The Moving Range of X. The difference between the number of PRDs reported in a specified month and the one preceding it. When read in conjunction with the X (Run) Chart, it shows a clear reduction in the overall number of discrepancies and process variation over time resulting from improved, standardized procedures.

Less Is Better!

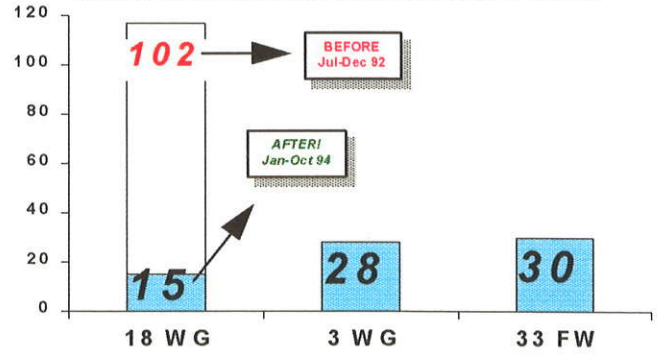


AFTER IMPROVEMENT
AIM-9 In-flight Missile Malfunctions
X (Run) Chart
Jan 94 - Oct 94 (Source: CAMS)

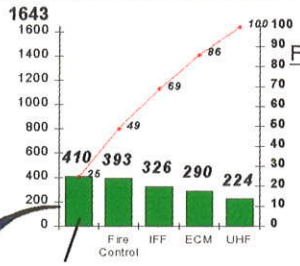
Less Is Better!



AIM-9 IN-FLIGHT MISSILE MALFUNCTIONS
Average Malfunctions per Month (Before & After)
Compared to 3 WG & 33 FW Monthly Averages
(SOURCE: CAMS, 3WG & 33 FW)



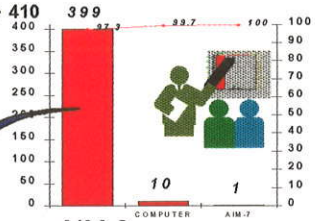
BEFORE IMPROVEMENT PROCESS



F-15 TOP 5 FAILING SYSTEMS
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)

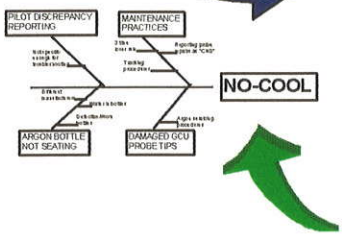
Weapons

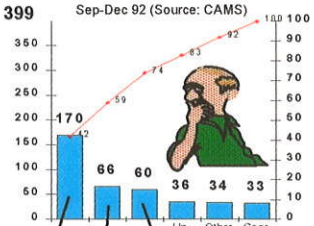
WEAPONS SYSTEM
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)



AIM-9

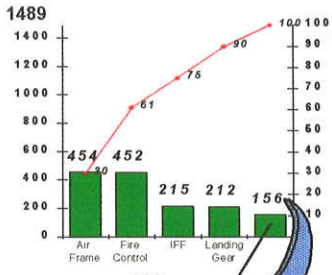
AIM-9 MISSILE
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)





Cool Track Tone

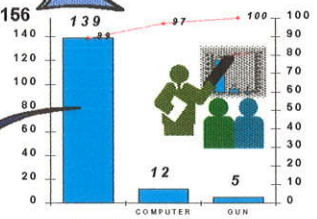
DURING IMPROVEMENT PROCESS



F-15 TOP 5 FAILING SYSTEMS
Pilot Reported Discrepancies
Sep-Dec 93 (Source: CAMS)

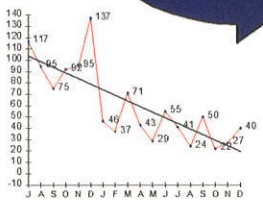
Weapons

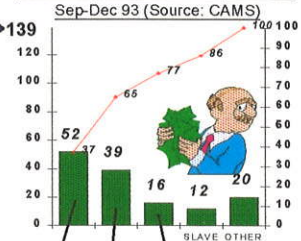
WEAPONS SYSTEM
Pilot Reported Discrepancies
Sep-Dec 93 (Source: CAMS)



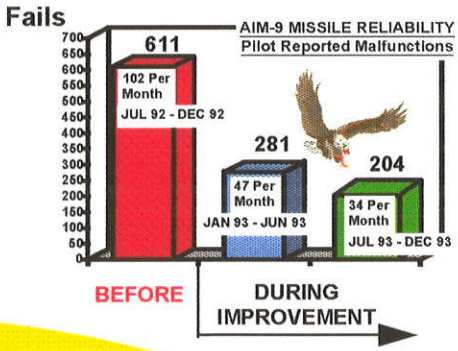
AIM-9

AIM-9 MISSILE
Pilot Reported Discrepancies
Sep-Dec 93 (Source: CAMS)



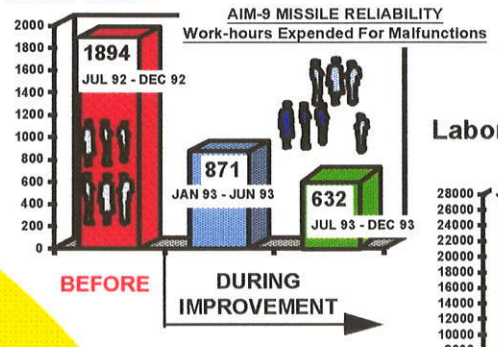


Cool Track Tone



67% fewer fails!

1262 fewer work-hours!



$17,000 saved!

Annual AIM-9 Argon Bottle Maintenance Costs
Replacement (before) vs. Repair (after)
(SOURCE: Missile Shop)

$120,223 Savings!

$120,250

$17

REPLACEMENT PROCEDURE (before): Turn in 130 bottles annualy to depot at a cost of $925 each

REPAIR PROCEDURE(after): Our team discovered that unserviceable bottles could be repaired by replacing a 13 cent pre-form packing at the base of the bottle. 130 repairs a year costs less than $17!

- Our primary external customer, Headquarters, Pacific Air Forces command, evaluated our product during an Operational Readiness Inspection, a simulated wartime effectiveness exercise. Our improved aircraft missile systems performed flawlessly...not one discrepancy! Our Pacific customers evaluated again our product, airpower, during the bi-annual world air-to-air weapons (missile) accuracy competition "William Tell." Again, our missile systems performed without a single discrepancy and earned the Wing awards as best F-15 and best active duty Air Force unit. Our Pacific customers know we will provide them the world's best air superiority.

8. Metric: In **no more than three hundred words**, describe the way in which you measured: (1) the change brought about by implementing the solution, (2) the benefits to customers. (Three hundred points)

Answer: (1) We tracked AIM-9 missile discrepancies and flightline corrective actions in a Wing computer maintenance action data base. Pilots made malfunction entries into the data base after each flight, and technicians updated the data base after completing each corrective action. We reviewed maintenance history data weekly, aggregating the information into cumulative Pareto charts for analysis. This way, we were able to analyze what was going wrong with the missiles, and what was being done to fix them. More importantly, we were able to get near real time effects of our action plan on the process so we could continue to improve. Also, we gained valuable lessons learned from customers and technicians by sharing our findings during monthly progress reports. Having all the process players meet and share lessons helped us validate the plan and increased buy-in. We also tracked work-hour savings and cost avoidance...annual projected savings are 3230 work-hours and over $163,000 based on only 15 fails per month since January 1994.

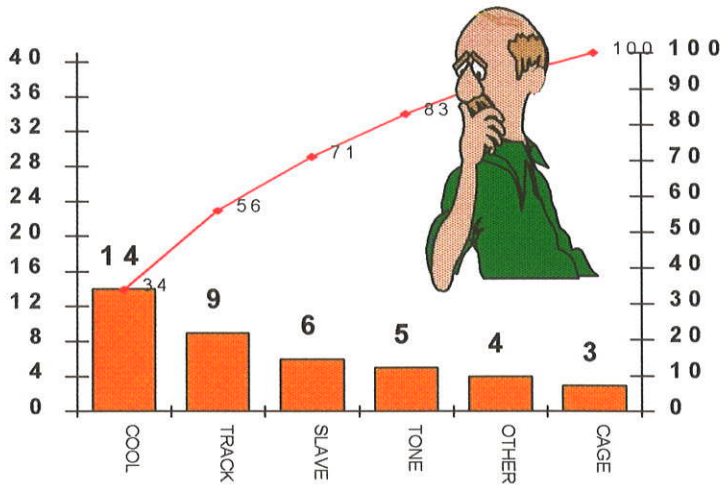
(2) Since our pilot's key customer requirement is to have reliable AIM-9 missiles, we saw steady progress in our data base towards that goal. As fewer missiles failed, pilot training became more effective, and the Wing gained increasing confidence in its ability to produce its primary product...***Airpower!*** In combat, there are no prizes for second place. To be successful in defending U.S. and allied interests in the Pacific, army soldiers on the battlefield depend on our pilots to sweep the skies of enemy aircraft. Before our team succeeded in improving AIM-9 missile reliability, we may have jeopardized that mission. Now, our allies and sister services are confident that our Wing will provide reliable AIM-9 missile systems for air superiority..."global power and reach for America" in action!

AIM-9 MISSILE
Pilot Reported Discrepancies

1 Jul - 31 Jul 93 (Source: CAMS)

COOL	TRACK	SLAVE
14	9	6

CAGE	TONE	OTHER
3	5	4

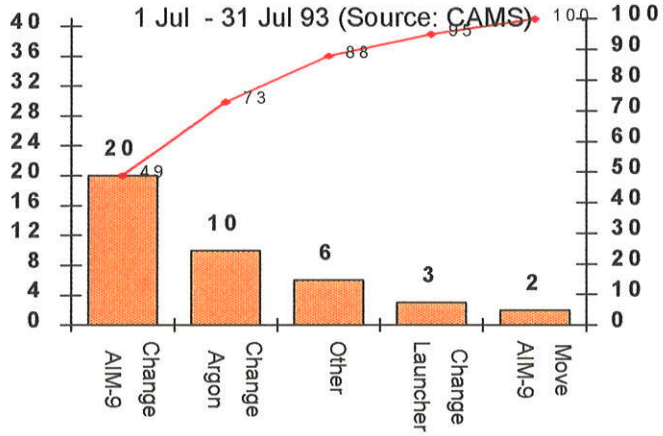


AIM-9 MISSILE
Weapons Flightline Corrective Actions

1 Jul - 31 Jul 93 (Source: CAMS)

Change AIM-9	Move AIM-9	Change Launcher
20	2	3

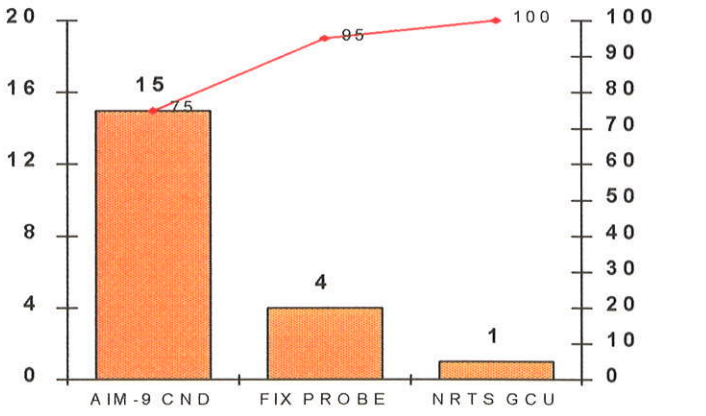
Change Argon	Other
10	6

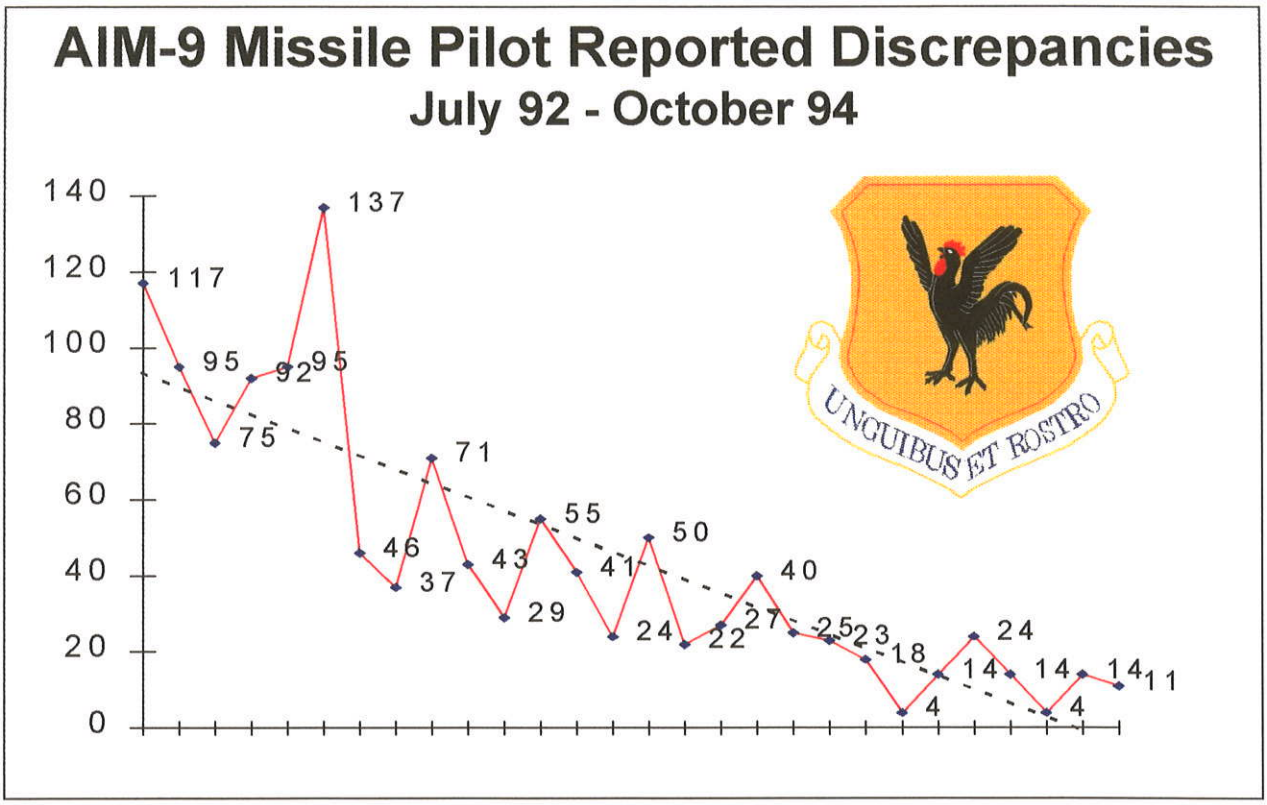


AIM-9 MISSILE
Missile Shop Corrective Actions

1 Jul - 31 Jul 93 (Source: CAMS & 18 MUNS)

Cannot Duplicate Malfunction (CND)	Fix Probe	GCU Not Repairable this Station (NRTS)
15	4	1





9. Person who can respond to questions about this nomination.

Name (typed or printed): John J. Kmiec, Jr., SMSgt, USAF
Title: Quality Improvement Flight Chief
18th Maintenance Squadron
Address: PSC 80 Box 14935
APO AP 96367-4935

Telephone number: (work) 011-81-611734-4429 (home) 011-81-611733-6119

FAX number: 011-81-611734-2273

10. Release: Nominations for the Quality Cup provide valuable illustrations of the measurement and achievement of continuous improvement, quality, and customer satisfaction. Please indicate whether you are willing to allow such use of your nomination.

XXX a. Information in the nomination may be used for the purpose of teaching and research.

_____ b. Information in the nomination may be used for the purpose of teaching and research, but only after I have had an opportunity to review the use to which it will be put.

_____ c. Information in the nomination may **not** be used for the purpose of teaching and research.

11. Signature of the officer or executive whose span of authority includes the nominee.

Signature: _____ Date: _____

Name (typed or printed): Monroe J. Ratchford

Title: Commander, 18th Maintenance Squadron

Address: 18 MXS/CC
Unit 5183
APO AP 96368-5183

Telephone number: 011-81-611734-1644 FAX number: 011-81-611734-4265

Mail four copies (one, a signed original) along with the $150 nomination fee, payable to the RIT College of Business to:

Quality Cup
c/o Carol Ann Skalski
USA Today
1000 Wilson Blvd., 22nd floor
Arlington, VA 22229

Quality Cup

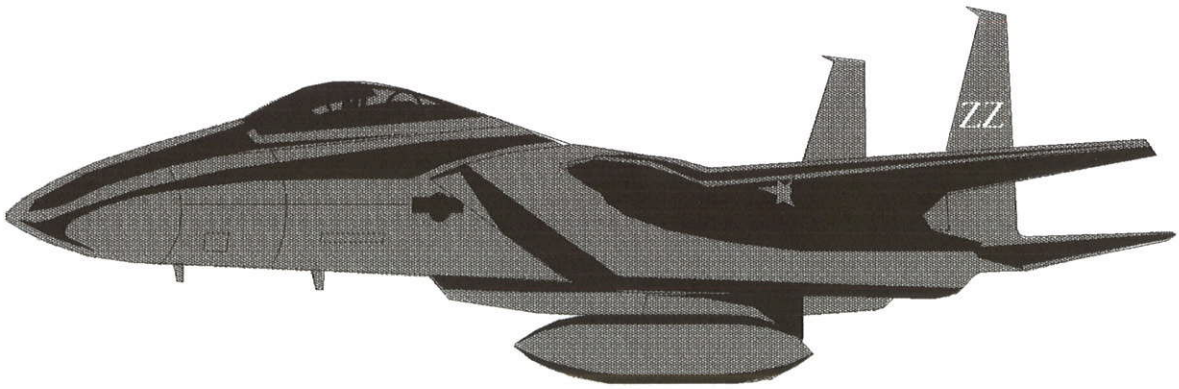
Rochester Institute of Technology/USA Today

1995 Team Presentation
Supplemental Information

AIM-9 MISSILE PROCESS ACTION TEAM

Intermediate-Level Repair Enhancement Program

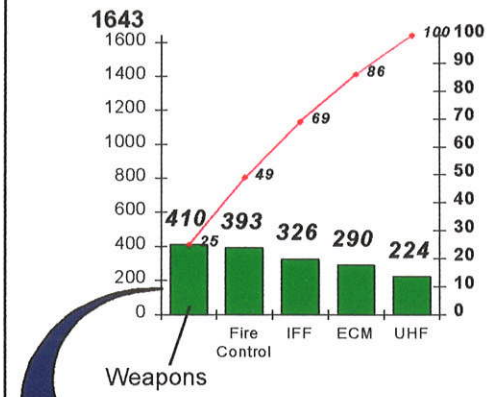
Kadena Air Base, Japan



Air Force People, Building the World's Most Respected Air and Space Force... Global Power and Reach for America

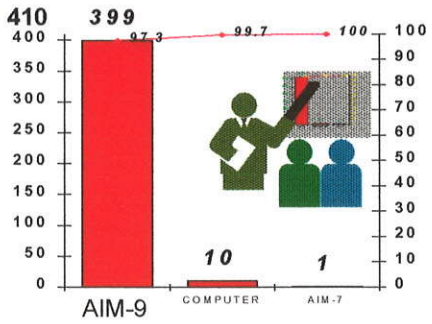
(Air Force Vision)

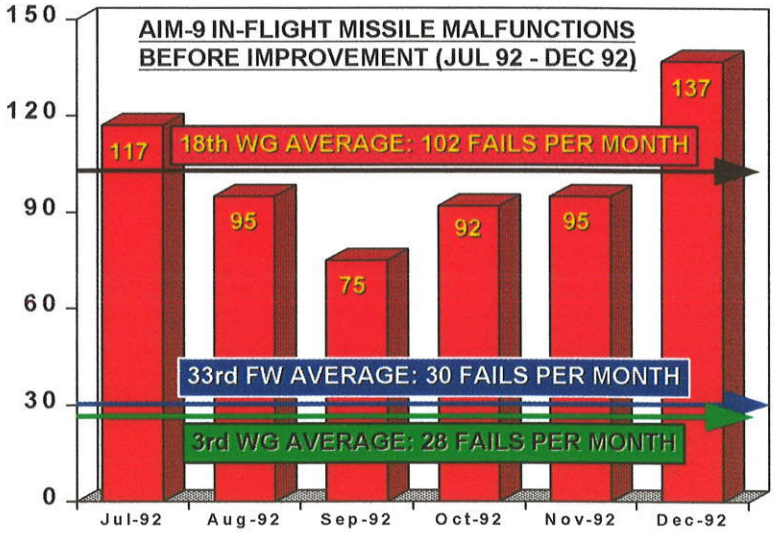
BEFORE IMPROVEMENT PROCESS

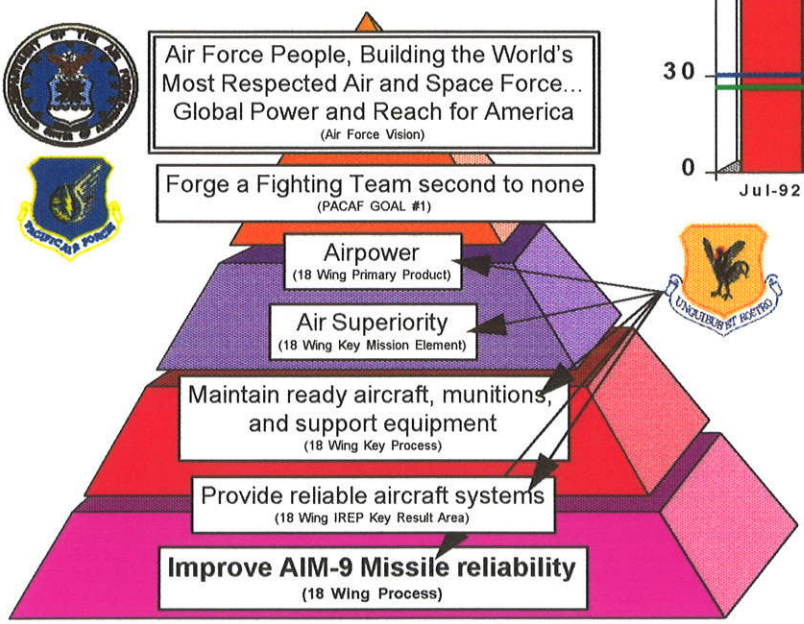


F-15 TOP 5 FAILING SYSTEMS
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)

WEAPONS SYSTEM
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)







AIM-9 Missile Process Action Team
Process Owner/Customer/Supplier/Stakeholder Identification

Process Owners	External Customers	Internal Customers	External Suppliers	Internal Suppliers	Stakeholders
Operations Group Commander $	PACOM *	F-15C/D Pilots (Primary)	OG-ALC Hill AFB, UT	18th Supply Sq.	F-15C/D Pilots (Primary)
Logistics Group Commander $	PACAF*	Fighter Squadron Weapons Flights	WR-ALC Robins AFB, GA	3 Fighter Squadron Weapons Flights	Commander 18th Wing
	5th & 7th Air Forces *	400th MMS Missile Shop	SA-ALC Kelly AFB, TX	400th MMS Missile Shop	Operations Group Commander
	Other Services & Allies...Locally & while deployed *	18th Maint. Sq. Armament Shop		18th Maint. Sq. Armament Shop	Logistics Group Commander
	Commander 18th Wing			F-15C/D Pilots	Wing Weapons Manager
				Wing Weapons Manager	Fighter Squadron Weapons Flights
					400th MMS Missile Shop
					18th Maint. Sq. Armament Shop

NOTES:
* **Identified by 18th Wing Quality Council during Strategic Planning Process.**
$ **Identified by 18th Wing Commander through the Intermediate-Level Repair Enhancement Program.**

AIM-9 Missile Process Action Team
Process Owner Requirements for Suppliers

Suppliers	Product/ Service	High Product Performance	Low RSD Costs	Base Repair Capability High	Critical Parts Available
OG-ALC Hill AFB, UT	AIM-9 Missile	☑	☑		☑
WR-ALC Robins AFB, GA	Missile Launchers, Adaptors & Pylons	☑	☑		☑
SA-ALC Kelly AFB, TX	Testers	☑	☑		☑
18th Supply Sq.	Parts		☑		☑
3 Fighter Sq. Weapons Flights	Reliable Aircraft Weapons Systems	☑		☑	
400th MMS Missile Shop	Reliable Missiles	☑		☑	
18th Maint Sq. Armament Shop	Reliable Launchers, Adaptors & Pylons	☑		☑	
F-15C/D Pilots	Air Superiority	☑			
Wing Weapons Manager	Reliable Aircraft Weapons Systems & Load Training	☑		☑	

AIM-9 Missile Process Action Team
Key Customer Requirements

External Customers	External Customers Requirements	Internal Customers	Internal Customers Requirements
Commander-in-Chief PACOM Commander PACAF Commanders 5th & 7th Air Forces Other Services & Allies...Locally & while deployed Commander 18th Wing	Weapons Systems that work; Reliable AIM-9 Missiles. ***Air Power*** as defined in classified Operational and Contingency Plans (measured by Operational Readiness Inspections, break/fix rates, mission capable rates, etc.).	**F-15C/D Pilots (Primary)** Fighter Squadron Weapons Flights 400th MMS Missile Shop 18th Maint. Sq. Armament Shop	Weapons Systems that work; Reliable AIM-9 Missiles. Reliable AIM-9 missiles and Armament Systems components. Accurate Pilot Reported Discrepancies. Reliable, accurate tester. Accurate discrepancy reporting. Reliable, available parts. Reliable, accurate tester. Accurate discrepancy reporting. Reliable, available parts.

NOTE:
Requirements identified by 18th Wing Quality Council during Strategic Planning Process, and during surveys and interviews with Customers (Customer/Supplier Alignment).

AIM-9 Process Action Team Charter
Intermediate-Level Repair Enhancement Program

- **Team Purpose.** Improve AIM-9 missile reliability for assigned F-15C/D aircrews...reduce in-flight Code 3 pilot reported malfunctions.
- **Team Services.**
  - Flow chart the process, determine causes, and develop , test and implement solutions.
  - Summarize obstacles to success and proposed solutions to overcome them.
  - Provide monthly progress reports to Key Result Area Champion, and quarterly progress reports to the IREP.
- **Scope of Authority**
  - Don't violate technical orders, regulations , directives, maintenance operating instructions, environmental or safety standards.
  - Do submit Quality Deficiency Reports, Air Force Suggestion Forms 1000, AFTO Form 22 Technical Order Change Requests, and Job Fair and Product Improvement Working Group inputs.
  - Do propose policy changes, recommendations and investment strategies beyond the authority of this team to the OG/CC and LG/CC for resolution at the IREP.
- **Time Frame.** Indefinite. Team will provide quarterly status reports to IREP, and continue to improve the process until the IREP Council determines it is no longer feasible or cost effective to continue.
- **Resources.**
  - Weapons Standardization Classroom.
  - Wing Analysis.
  - Air Force Engineering and Technical Service (AFETS).
  - Gold Flag.
- **Team Composition.** Team members, highly experienced in the AIM-9 Process, will be provided by the following organizations to attend weekly meetings and perform duties relevant to the team's success, as determined by the Team Leader;
  - 12th, 44th, and 67th Fighter Squadron Weapons Flights.
  - 400th Munitions Maintenance Squadron Missile Shop.
  - 18th Maintenance Squadron Armament Systems Shop.
  - 18th Operations Support Squadron Weapons & Tactics (F-15C/D Pilot).
  - 18th Operations Group Weapons Standardization Section.

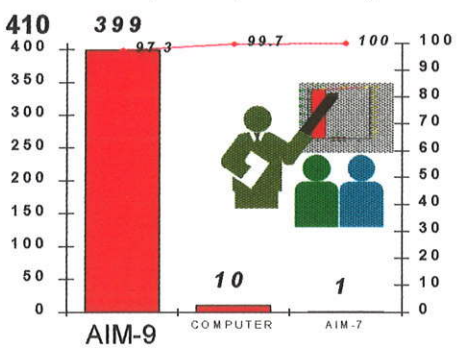
CLEARANCE T. LOWRY, Colonel, USAF
Commander, 18th Logistics Group

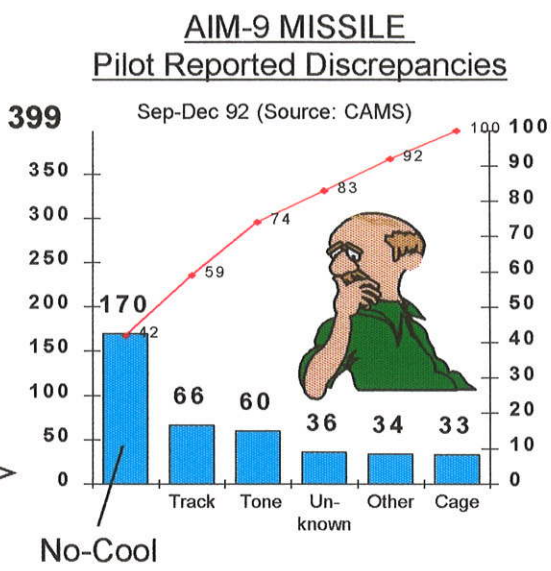
RANDALL K. BIGUM, Colonel, USAF
Commander, 18th Operations Group

MONROE J. RATCHFORD, Lt Col, USAF
Key Result Area Champion, AIM-9 PAT

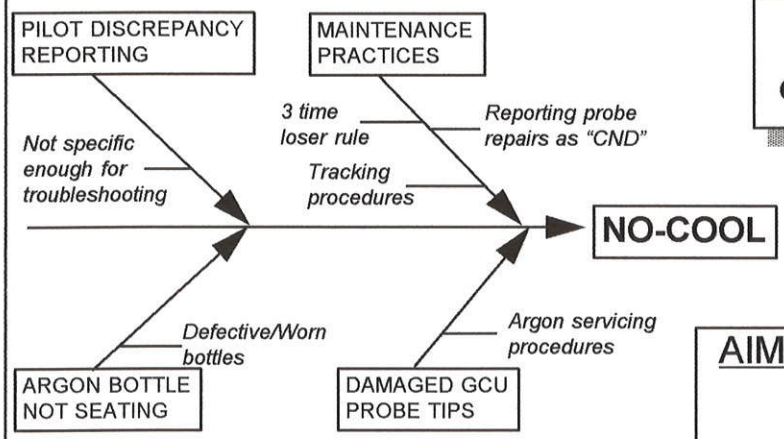
TOMMIE L. LIMBRICK, SMSgt, USAF
Team Leader, AIM-9 PAT

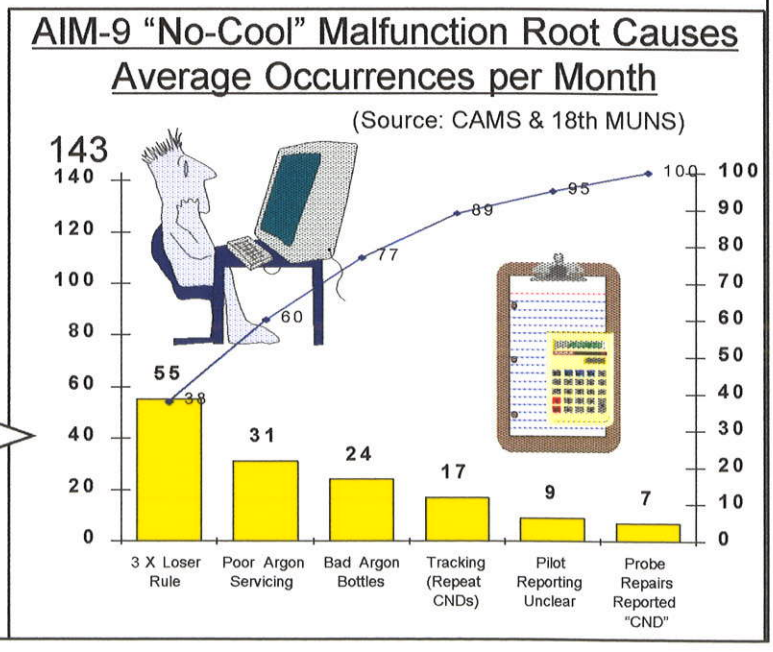
Nested Pareto Analysis of AIM-9 Missile Malfunctions





Root Cause Analysis of AIM-9 Missile Malfunctions





AIM-9 Missile Process Action Team Cost-Benefit Analysis

Corrective Action	Positive Affects (Benefits)		Negative Affects (Costs)	
	Tangible	Intangible	Tangible	Intangible
1. Turn in AIM-9s to Missile Shop after each malfunction *(3 time loser rule)*	• Accurate trend data available...better trouble-shooting & repair • Missiles get fixed 1st time • Fewer malfunctions • More missiles available • More effective sorties	• Increased morale (fewer malfunctions, less rework, less complaints) • Increased pilot confidence • Greater cooperation	• Less missiles available at first (short term) • Increased workload initially as bad missiles get identified & fixed (short term)	• Decreased morale at first due to increased workload and decreased missile availability (short term) • Resistance to change
2. Use ladder & "hiss" check to validate argon seal *(Argon servicing)*	• Fewer malfunctions, & less damage to GCUs • Bad missiles & argon eliminated *before* flight • More effective sorties	• Increased morale (fewer malfunctions, less rework, less complaints) • Increased pilot confidence	• Less missiles/argon available at first (short term) • Increased workload initially as bad missiles & argon get identified & fixed (short term)	• Decreased morale at first due to increased workload and decreased missile/argon availability (short term) • Resistance to change
3. Turn in bad argon bottles to Missile Shop *(Bad argon bottles)*	• Bottles fixed 1st time • More bottles available • Fewer malfunctions • More effective sorties	• Increased morale (fewer malfunctions, less rework, less complaints) • Increased pilot confidence	• Less bottles available at first • Increased workload initially as bad argon bottles get identified & fixed (short term)	• Decreased morale at first due to increased workload and decreased argon availability • Resistance to change
4. Record and track all GCU probe repairs in Missile Shop *(Probe repairs reported as "CND")*	• Accurate repair data available...better trouble-shooting & repair • Missiles get fixed • Fewer malfunctions • More missiles available • More effective sorties	• Increased morale (fewer malfunctions, less rework, less complaints) • Increased pilot confidence • Greater cooperation	• Less missiles available at first (short term) • Increased workload initially as bad missiles get identified & fixed (short term)	• Decreased morale at first due to increased workload and decreased missile availability (short term) • Resistance to change
5. Record and track all missile malfunctions from the jet to the shop *(Tracking procedures)*	• Accurate repair data available...better trouble-shooting & repair • Missiles get fixed • Fewer malfunctions • More missiles available • More effective sorties	• Increased morale (fewer malfunctions, less rework, less complaints) • Increased pilot confidence • Greater cooperation	• Less missiles available at first (short term) • Increased workload initially as bad missiles get identified & fixed (short term)	• Decreased morale at first due to increased workload and decreased missile availability (short term) • Resistance to change
6. Accurately record missile malfunction data during pilot debrief *(Pilot reporting unclear)*	• Accurate trend data available...better trouble-shooting & repair • Missiles get fixed • Fewer malfunctions • More missiles available • More effective sorties	• Increased morale (fewer malfunctions, less rework, less complaints) • Increased pilot confidence • Greater cooperation	• Less missiles available at first (short term) • Increased workload initially as bad missiles get identified & fixed (short term)	• Decreased morale at first due to increased workload and decreased missile availability (short term) • Resistance to change

AIM-9 MISSILE PROCESS ACTION TEAM

CORRECTIVE ACTIONS

Process improvement Activity (by root cause)	By Whom	When	How	Added Resources: People	Time	$	Equip	Facility
Root Cause: 3 time loser rule								
1. Turn in failed AIM-9's to 400 MMS on 1st fault.	Fighter Squadron Weapons Flights	After each missile malfunction. (after flight)	Troubleshoot to determine if fault is aircraft or missile. If missile, tag and turn into 400 MMS.	None	None	None	None	None
Root Cause: Argon servicing								
1. Use ladder to remove & install argon	Fighter Squadron Weapons Flights	Argon removal & installation.	IAW AFOSH Stds.	None	5 seconds	None	Ladder	None
2. Perform "Hiss Check" to validate argon seal	Fighter Squadron Weapons Flights	Argon installation.	Screw argon in all the way. Back off until gas pressure is released. Listen for hiss/feel for gas release. Tighten bottle back down.	None	20 seconds	None	None	None
Root Cause: Defective/worn argon bottles								
1. Turn in unserviceable argon bottles to 400th MMS	Fighter Squadron Weapons Flights	When discovered.	Attach AFTO Form 350 tag and turn into 400th MMS Line D driver.	None	None	$926 each to replace. Repair cost unknown.	None	None
Root Cause: Reporting repaired GCU probes as "CND"								
1. Record and track all probe repairs.	400th MMS Missile Shop	When repaired.	Annotate all corrective actions, including probe repairs, in malfunction log. Include; Missile tail number, date, malfunction and corrective action. Provide data to Team Leader end of each month for analysis.	None	10 seconds	None	None	None

Process improvement Activity (by root cause)	By Whom	When	How	Added Resources: People	Time	$	Equip	Facility
Root Cause: Missile tracking procedures.								
1. Record and track all missile malfunctions.	Fighter Squadron Weapons Flights, 400th MMS Missile Shop, and 18th Maint. Squadron Armament Systems Shop.	When discovered/ repaired.	Weapons Flights will annotate all corrective actions, including missile serial number in CAMS. 400th MMS will record all missile repairs in malfunction log (include; Missile tail number, date, malfunction and corrective action). Armament Systems will accurately record all corrective actions, and track launcher & adapter reliability in CAMS. All will provide data to Team Leader end of each month for analysis.	None	2 minutes	None	Log book.	None
Root Cause: Pilot discrepancy reporting.								
1. Accurately record missile malfunction data.	Pilots.	During aircrew debrief.	Be as descriptive as possible regarding the type of malfunction, including how long into the flight the malfunction manifested itself.	None	20 seconds	None	None	None

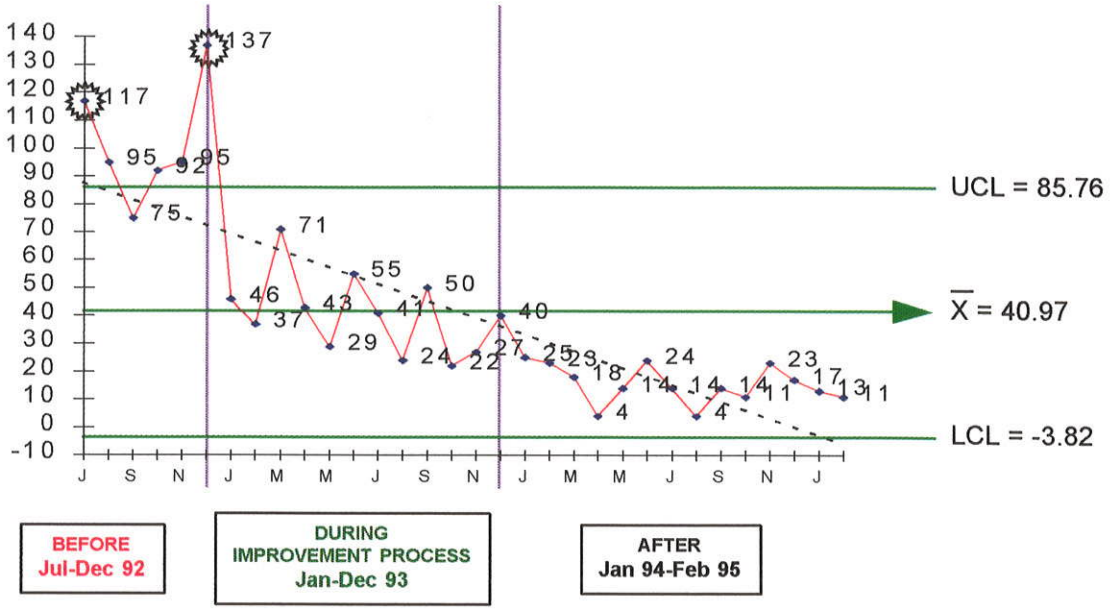
AIM-9 In-flight Missile Malfunctions

X,mR Control Charts

Jul 92 - Feb 95 (Source: CAMS)

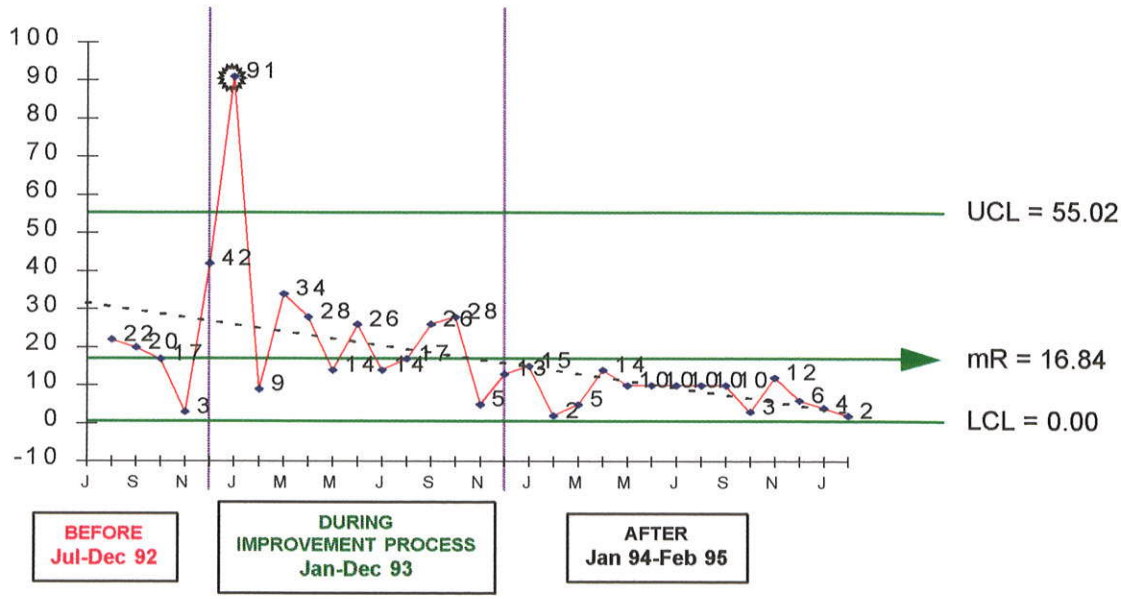
X (Run) Chart: Number of AIM-9 Pilot Reported Discrepancies (PRDs) recorded each month.

Less Is Better!

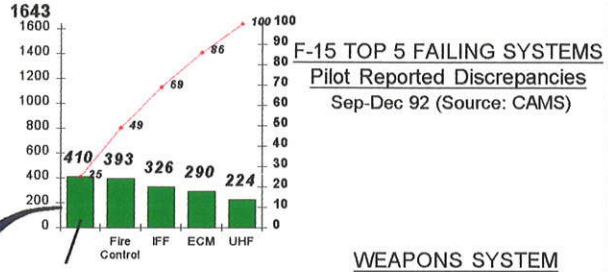


mR Chart: The Moving Range of X. The difference between the number of PRDs reported in a specified month and the one preceding it. When read in conjunction with the X (Run) Chart, it shows a clear reduction in the overall number of discrepancies and process variation over time resulting from improved, standardized procedures.

Less Is Better!

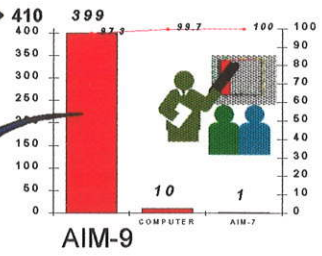


BEFORE IMPROVEMENT PROCESS



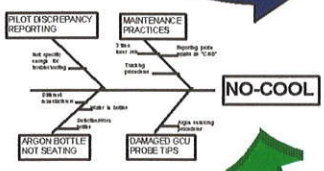
F-15 TOP 5 FAILING SYSTEMS
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)

Weapons

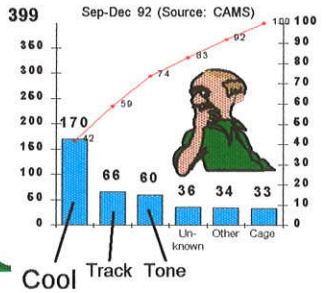


WEAPONS SYSTEM
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)

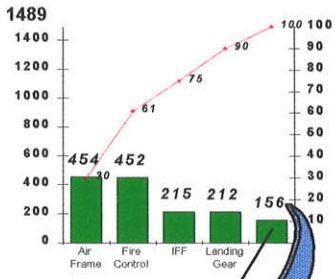
AIM-9



AIM-9 MISSILE
Pilot Reported Discrepancies
Sep-Dec 92 (Source: CAMS)

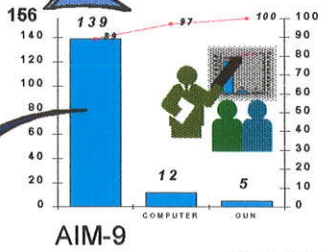


DURING IMPROVEMENT PROCESS



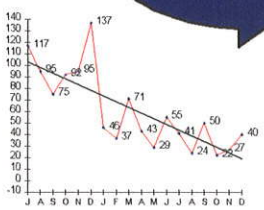
F-15 TOP 5 FAILING SYSTEMS
Pilot Reported Discrepancies
Sep-Dec 93 (Source: CAMS)

Weapons

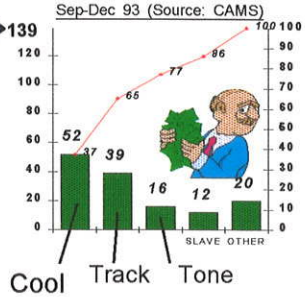


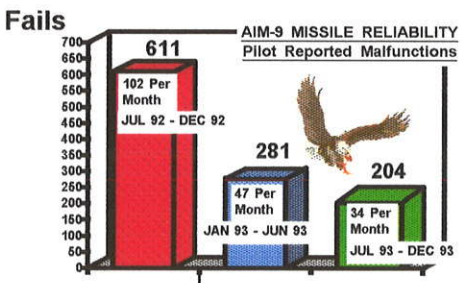
WEAPONS SYSTEM
Pilot Reported Discrepancies
Sep-Dec 93 (Source: CAMS)

AIM-9



AIM-9 MISSILE
Pilot Reported Discrepancies
Sep-Dec 93 (Source: CAMS)

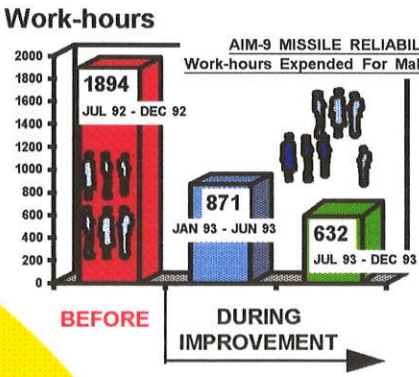




AIM-9 MISSILE RELIABILITY
Pilot Reported Malfunctions

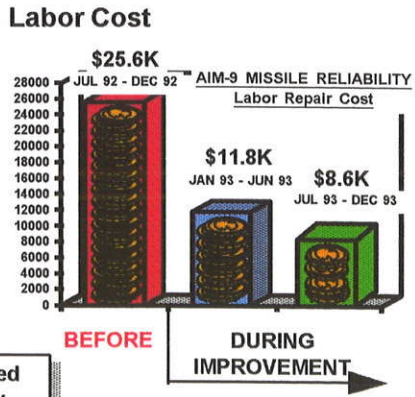
67% fewer fails!

1262 fewer work-hours!



AIM-9 MISSILE RELIABILITY
Work-hours Expended For Malfunctions

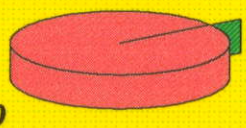
$17,000 saved!



AIM-9 MISSILE RELIABILITY
Labor Repair Cost

Annual AIM-9 Argon Bottle Maintenance Costs
Replacement (before) vs. Repair (after)
(SOURCE: Missile Shop)

$120,223 Savings!



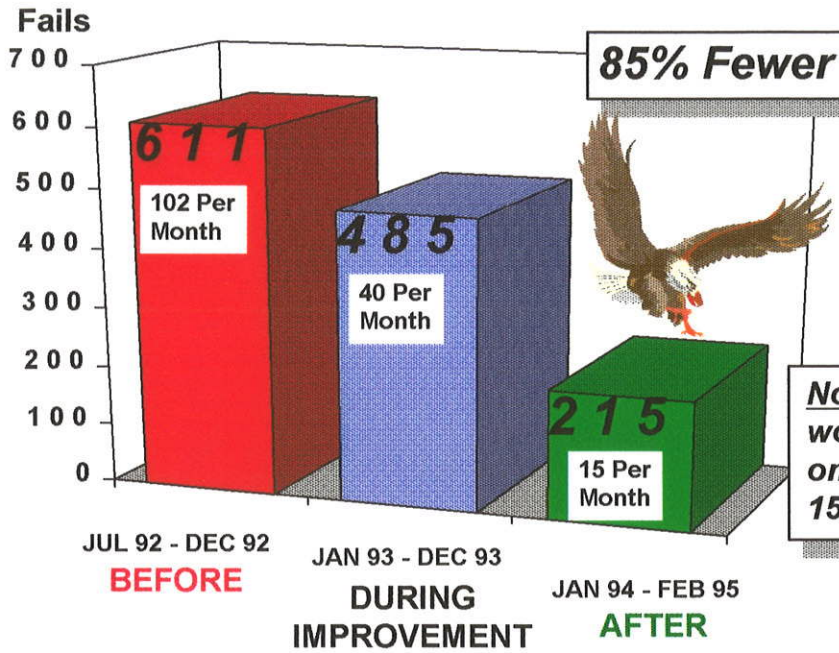
$120,250

$17

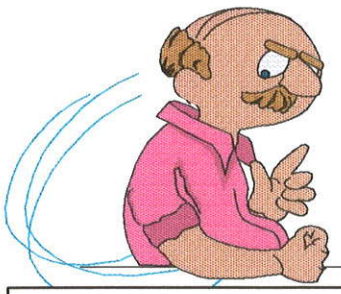
REPLACEMENT PROCEDURE (before):
Turn in 130 bottles annualy to depot at a cost of $925 each

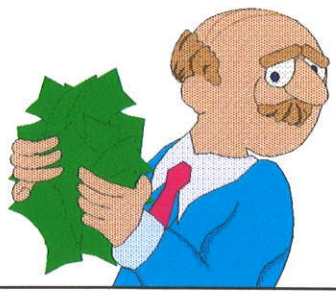
REPAIR PROCEDURE(after): Our team discovered that unserviceable bottles could be repaired by replacing a 13 cent pre-form packing at the base of the bottle. 130 repairs a year costs less than $17!

AIM-9 MISSILE RELIABILITY
Pilot Reported Malfunctions



Note: Annual savings of 3236 work-hours & $162,000 based on 18th Wing average of only 15 fails per month since Jan 94!





BEFORE	AFTER
102 fails per month (source: CAMS)	15 fails per month (source: CAMS)
1224 fails per year (102 X 12)	180 fails per year (15 X 12)
3794 work-hours per year (3.1 repair hours per malfunction X 1224)	558 work-hours per year (3.1 X 180)
$51,295 per year labor ($13.52 X 3794) (source: 18th Wing Financial Management. Figure based on 1992 estimated labor cost of $13.52 per hour for one E-4 technician).	$9,620 per year labor ($17.24 X 558) (source: 18th Wing Financial Management. Figure based on 1995 cost of $17.24 per hour for an E-4).
$120,250 per year argon bottle replacement costs (source: 18 Munitions Squadron. 130 replacements per year X $925 per bottle).	$17 per year argon bottle repair cost (source: 18 Munitions Squadron. 130 X $0.13 pre-form packing).
$171,545 total annual cost ($51,295 + $120,250)	$9,637 total annual cost ($9,620 + $17)

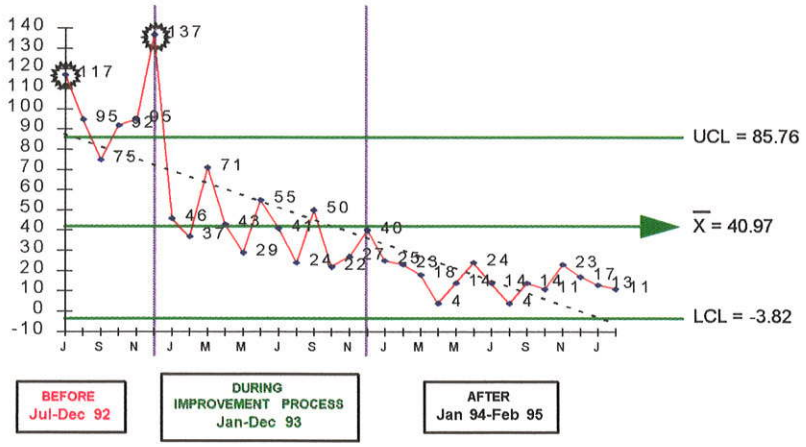
AIM-9 In-flight Missile Malfunctions

X,mR Control Charts

Jul 92 - Feb 95 (Source: CAMS)

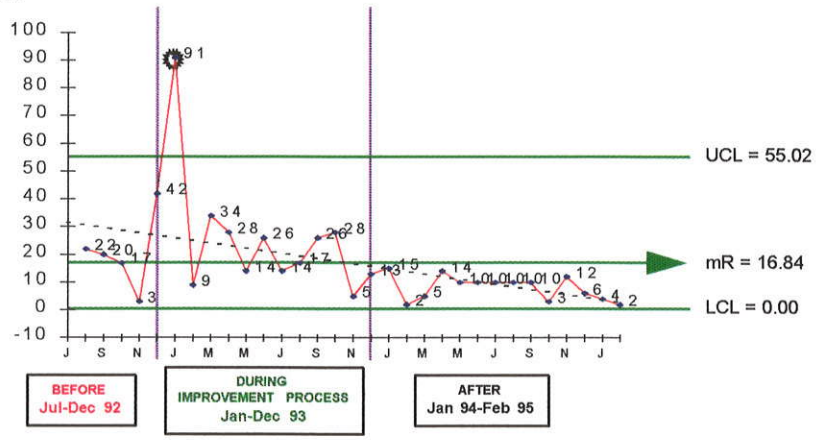
X (Run) Chart: Number of AIM-9 Pilot Reported Discrepancies (PRDs) recorded each month.

Less Is Better!



mR Chart: The Moving Range of X. The difference between the number of PRDs reported in a specified month and the one preceding it. When read in conjunction with the X (Run) Chart, it shows a clear reduction in the overall number of discrepancies and process variation over time resulting from improved, standardized procedures.

Less Is Better!



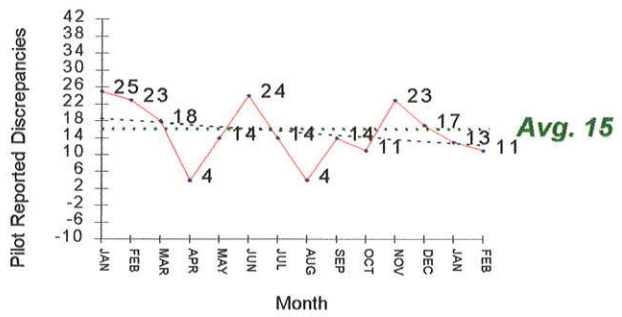
AFTER IMPROVEMENT

AIM-9 In-flight Missile Malfunctions

X (Run) Chart

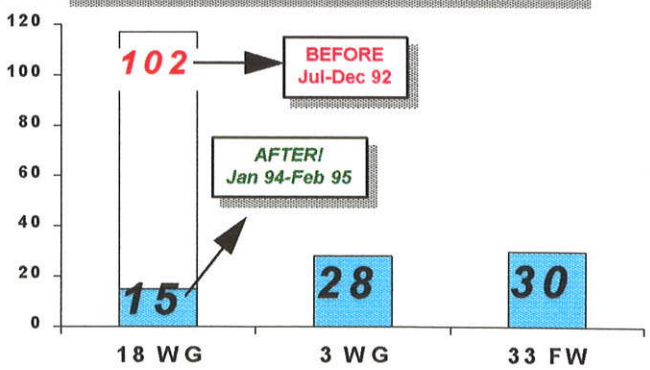
Jan 94 - Feb 95 (Source: CAMS)

Less Is Better!



AIM-9 IN-FLIGHT MISSILE MALFUNCTIONS

Average Malfunctions per Month (Before & After)
Compared to 3 WG & 33 FW Monthly Averages
(SOURCE: CAMS, 3WG & 33 FW)



File in JJF

CHIEF OF STAFF
UNITED STATES AIR FORCE
WASHINGTON

5 May 1995

Dear Tom General Hobbins

I want to extend my congratulations to you and to Lt Col Monroe Ratchford and his team for winning the government category of this year's USA TODAY and Rochester Institute of Technology's College of Business' Quality Cup Competition. The exceptional teamwork exhibited by the team reflects their professionalism, leadership, and dedication to the mission. They can take great pride in the significant accomplishments that contributed to winning this prestigious award.

Please congratulate each of the winners for me. They have set a higher standard of performance for our units and our commands, and I'm grateful for their dedicated efforts.

RONALD R. FOGLEMAN
General, USAF
Chief of Staff

Brig Gen William T. Hobbins, USAF
18 WG/CC
Unit 5141, Box 10
APO AP 96368-5141

SECRETARY OF THE AIR FORCE
WASHINGTON

MAY 30 1995

Brigadier General William T. Hobbins
18 WG/CC
Unit 5141 Box 10
APO AP 96368-5141

Dear General Hobbins:

I recently learned that the AIM-9 Missile Process Action Team, 18th Wing, Kadena Air Base, was awarded one of the Rochester Institute of Technology/USA Today Quality Cup awards. Competition for these awards is extremely keen and it is an honor just to be nominated, but this team walked away with the first prize in the Government category.

Please convey to the men and women of the 18th Wing my personal congratulations on this outstanding achievement! Out of more than 300 entries this year the Air Force won two of the five top awards - - a remarkable feat. None of the other services was so recognized and I am proud to have individuals of this caliber serving in the United States Air Force.

Sincerely,

Sheila E. Widnall

AIM-9 MISSILE PROCESS ACTION TEAM

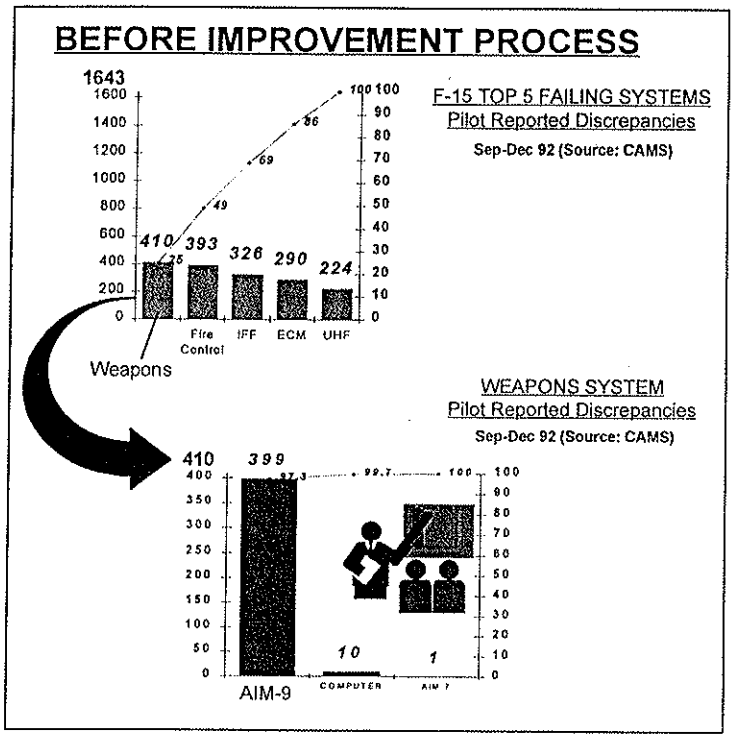
Intermediate-Level Repair Enhancement Program

Kadena Air Base, Japan

May 1995

IMPROVEMENT OPPORTUNITY: 18th Wing F-15C/D Fighter Aircraft stand ready to provide ***Air Superiority*** for the Pacific Forces. One weapon used to prosecute this mission is the AIM-9 Sidewinder heat seeking missile. To destroy the enemy in air-to-air combat, and ensure our Wing's ability to produce its primary product...***Airpower***, our pilots need reliable weapons. This is the story of how our team used Quality Principles to give our Pacific Air Forces "***A Fighting Team Second To None!***"

The AIM-9 process was chronic, averaging about 102 in-flight missile malfunctions per month. This made the weapons system among the top five failing systems in the Wing! If the Wing was to improve its Key Process of ***"Maintaining ready aircraft, munitions, and support equipment,"*** the most logical place for us to start was with the AIM-9 process.

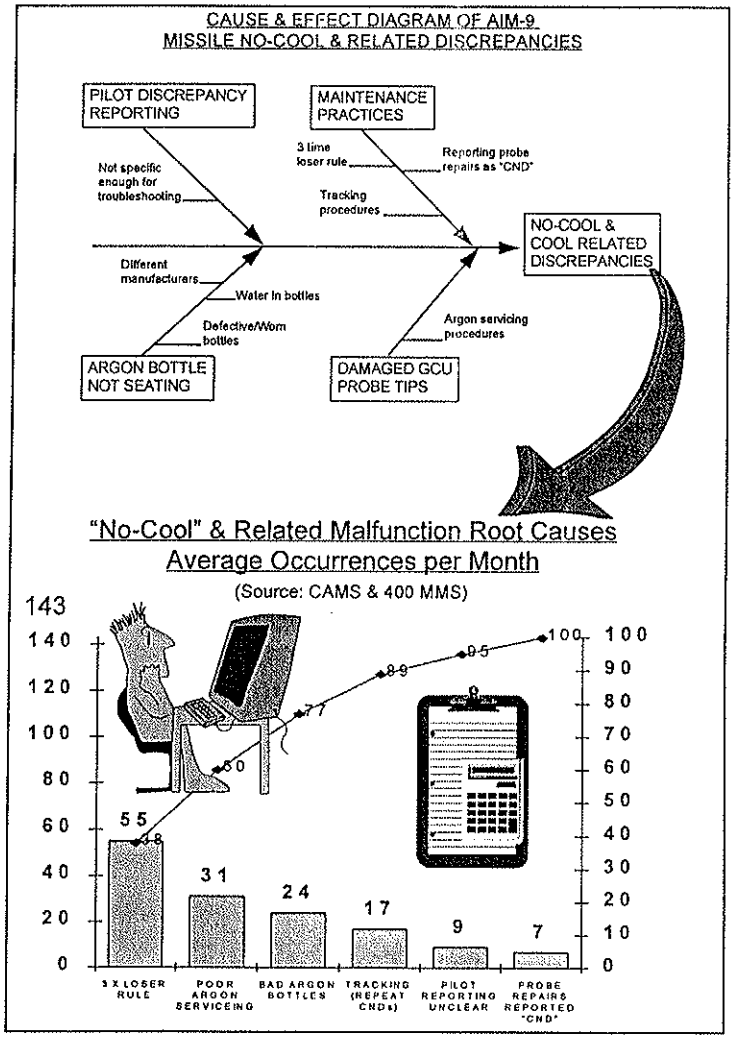


Our team was chartered under then newly reorganized Intermediate-Level Repair Enhancement Program (IREP). The IREP, under the authority of the Wing, Operations and Logistics Group Commanders, and PACAF Regulation 65-3, is responsible for affecting base level repair capability and reducing impediments to the repair cycle. IREP does this by assessing and prioritizing improvement opportunities with the Wing Quality Council, and chartering Process Action Teams (PATs) to improve them. Our AIM-9 PAT is one such team, consisting of maintainers and pilots from eight different organizations in the Wing.

We felt it was extremely important that our team focus on the needs of the primary user of the AIM-9 missile. For this reason, we identified our Pilots as our Primary Customer. And, in the final analysis, as far as our customers were concerned, it all came down to one thing. Our Pilots wanted weapons systems that worked...reliable AIM-9 missiles.

PROCESS EVALUATION: First, we brainstormed an Opportunity Statement based on our team's Charter. Then, our team developed flowcharts to identify the process as defined in our Opportunity Statement, *"An opportunity exists to improve AIM-9 Missile reliability* ***beginning with*** *a serviceable missile being turned out of the missile shop and* ***ending with*** *the missile performing successfully for, our ultimate customer, the pilot..."* We measured customer satisfaction in terms of pilot reported discrepancies in the Core Automated Maintenance System (CAMS) data base, feedback from our pilots, maintainers and our senior leaders. Based on a nested Pareto analysis of the pilot reported discrepancy (PRD) data we had collected from the CAMS data base, we identified missile "No-Cool" and related malfunctions as our greatest opportunity for improvement, representing 74 percent of all fails. *Explanation*: The missile will not function unless the guidance control unit is sufficiently cooled by the release of argon gas from its bottle. Cooling also affects missile tone and tracking necessary for target acquisition. Basically, everything hinges on the missile properly cooling.

ANALYSIS: After Pareto analysis of the existing pilot reported discrepancy data in CAMS, we brainstormed the causes of the "No-Cool" and related malfunctions. We then collected data to verify the actionable root causes identified during our *fishbone analysis* so we could isolate those having the greatest probable impact.



TAKE ACTION: We planned, tested and implemented solutions for all our actionable root causes. We also monitored our plan's effectiveness using data we collected on system performance, and made adjustments to the plan, when needed, to ensure continuous improvement;

1. **Root Cause:** *"3 time loser rule."* Practice of not turning in failed missiles for repair until the third fail. Nobody was tracking this, and the missiles weren't getting fixed. **Solution:** Turn in missiles on the first fail.

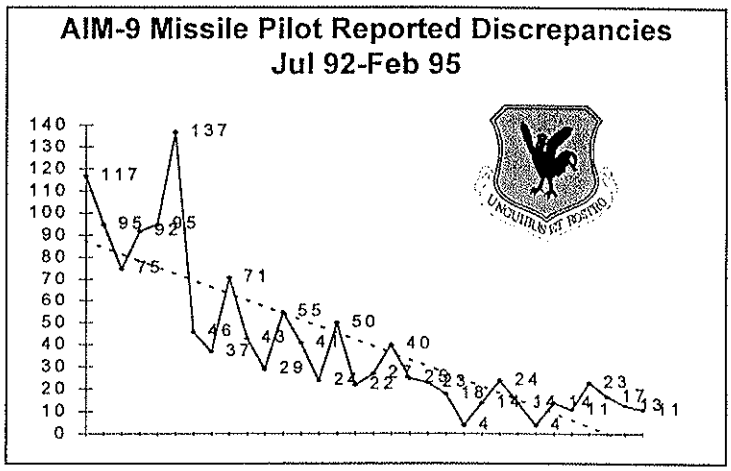
2. **Root Cause:** *Flightline argon servicing procedures.* Caused damage to the Guidance Control Unit (GCU) probe tip, prohibiting the transfer of cooling argon gas. Technicians couldn't reach the AIM-9 loaded on the aircraft without damaging the probe. **Solution**: Use a ladder to inspect the probe, and verify a positive seal by venting the argon bottle.

3. **Root Cause:** *Defective/Worn argon bottles.* Bottles incapable of properly seating and cooling the missile. **Solution**: Identify and turn in unserviceable bottles. We also discovered that by replacing a 13 cent pre-form packing at the base of the bottle we could prevent up to $120,000 in annual replacement costs for defective bottles!

4. **Root Cause:** *Tracking procedure.* We had no idea what the relationship was between flightline and missile shop corrective actions, resulting in an unknown number of discrepancies going unfixed. **Solution**: Track and record all missile problems from "jet to shop."

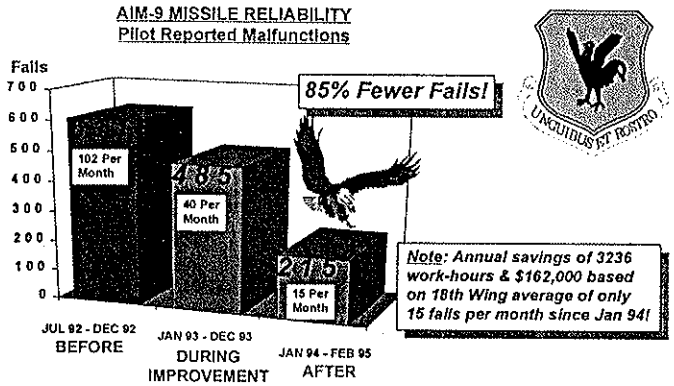
5. **Root Cause:** *Pilot write ups weren't specific enough to allow proper trouble shooting of the system.* Technicians didn't have enough information to fix malfunctions, often resulting in problems repeating. **Solution**: Increased emphasis and training for pilots on accurate discrepancy reporting.

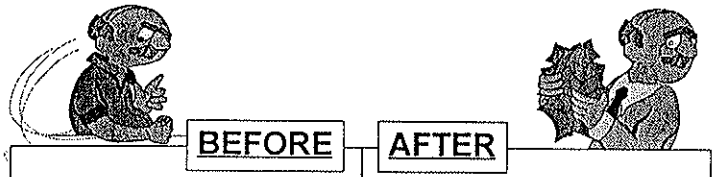
6. **Root Cause:** *Reporting GCU probe tip repairs as CND.* False cannot duplicate indications resulted in the "3 time loser rule" and masked what was really wrong...bad probes not allowing the transfer of cooling argon gas! **Solution**: Record and track all probe repairs.



RESULTS: By the time our team drew to a close in January 1994, AIM-9 Pilot Reported Discrepancies dropped from 102 to 34 per month. That's a 67

percent decrease! Our "No Cool" and related malfunctions also decreased sharply when compared to figures collected before our team was formed, showing a direct relationship with the overall decrease in system failures. That is; as we decreased the "No Cool" and related malfunctions, overall system performance improved significantly. In fact, we've realized an annual savings of 3236 work hours and over $162,000 based on our 18th Wing average of only 15 fails per month since January 1994!





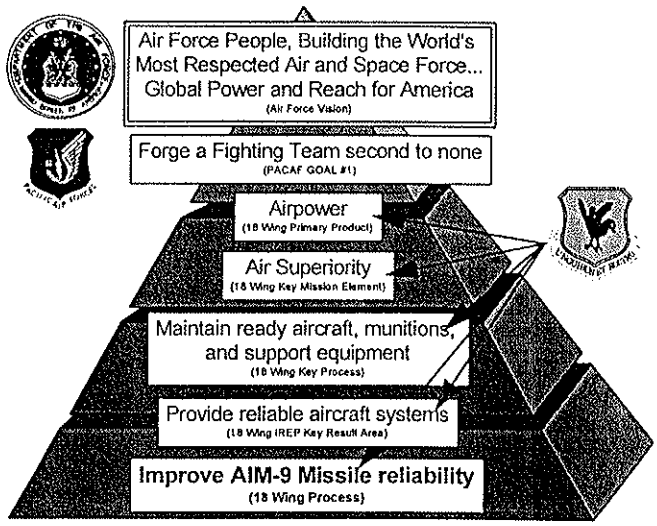
BEFORE	AFTER
102 fails per month (source: CAMS)	15 fails per month (source: CAMS)
1224 fails per year (102 X 12)	180 fails per year (15 X 12)
3794 work-hours per year (3.1 repair hours per malfunction X 1224)	558 work-hours per year (3.1 X 180)
$51,295 per year labor ($13.52 X 3794) (source: 18th Wing Financial Management. Figure based on 1992 estimated labor cost of $13.52 per hour for one E-4 technician).	$9,620 per year labor ($17.24 X 558) (source: 18th Wing Financial Management. Figure based on 1995 cost of $17.24 per hour for an E-4).
$120,250 per year argon bottle replacement costs (source: 18 Munitions Squadron. 130 replacements per year X $925 per bottle).	$17 per year argon bottle repair cost (source: 18 Munitions Squadron. 130 X $0.13 pre-form packing).
$171,545 total annual cost ($51,295 + $120,250)	$9,637 total annual cost ($9,620 + $17)

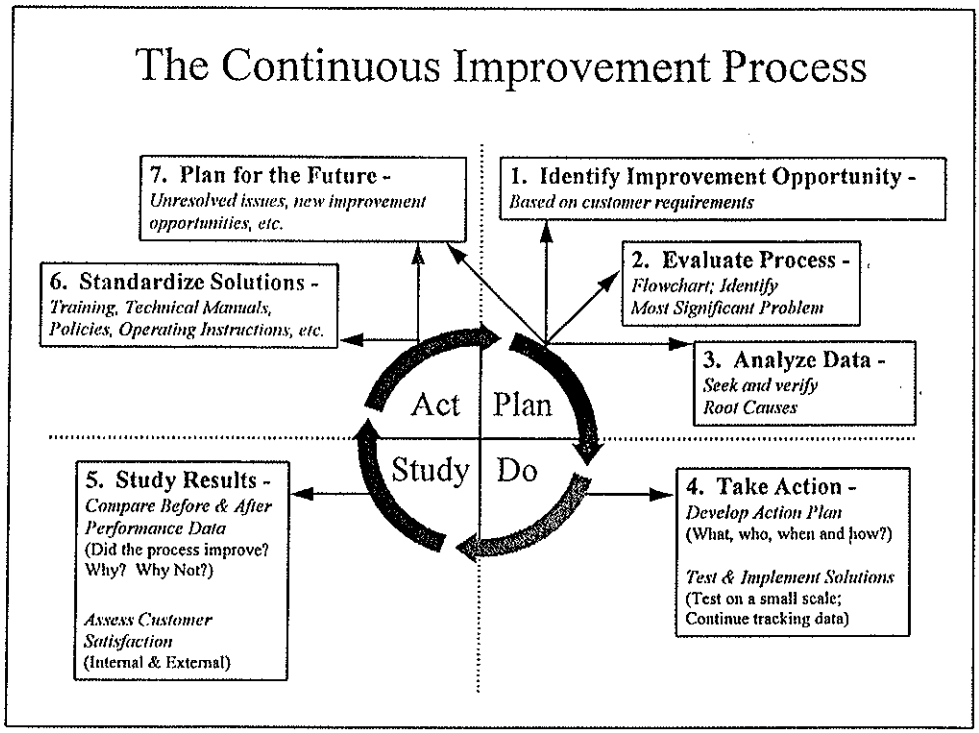
STANDARDIZE: We published all process improvements into the Wing Weapons Academics lesson plan, On-the-Job Training lesson plans, a local argon servicing checklist, AIM-9 maintenance operating instruction, and local aircrew operating procedures. Standardized procedures enhanced training capability for our pilots and maintainers, ensured continuity as personnel rotated assignments, and formed the basis for continual process improvement. In fact, process performance has continued to improve, even after our team came to closure, with an overall 85 percent decrease in missile malfunctions since we were first charted to improve system reliability.

We shared our story and lessons learned at the World-wide Weapons Product Improvement Working Group, and with the PACAF Weapons Manager and PACAF Gold Flag Conference. In this way, we reached F-15 and AIM-9 missile units from around the world. We also gave demonstrations to commanders at all levels; the Wing Quality Council; Wing QAF Awareness Classes; maintenance managers, technicians and supervisors from all levels; visiting VIPs from the Air Force Logistics Community and the 1994 Air Force Daedalian Tour. By showing how Quality Principles can directly effect mission capability, we paved the way for other significant improvements.

Finally, our team was a finalist for the 1994 Chief of Staff United States Air Force Team Quality Award. And, we won the highly coveted Rochester Institute of Technology/USA Today Quality Cup in 1995, as the best example of quality team application in the United States of America, government category.

PLAN FOR THE FUTURE: Our Missile Shop submitted a suggestion to the Depot to have the GCU probe tip re-engineered to make it a replaceable item. Currently, these are not replaceable and the entire GCU has to be shipped to the depot for repair...a cost of $25,000 a piece. We don't want our tax payers to pay this much! We also submitted trend data on our in-shop missile tester to the Depot for analysis, because it repeatedly passes missiles that fail on the aircraft. The results of these initiatives are currently pending Depot review and approval.





7 Lessons Learned:

1. The improvement model is a cycle. It's NOT linear.

2. It's important to baseline improvement opportunity in Step 1 using data (run chart, control chart, etc.). This will ensure you maintain focus and give you something to gauge your improvement efforts against in Step 5.

3. It's important to verify root causes in Step 3 using data. This will keep you from chasing the wrong things.

4. In step 4, test solutions on a small scale first to prevent your improvement effort from causing problems elsewhere in the system.

5. Try to implement solutions systematically (incrementally) to address each root cause one at a time. This way you'll be able to measure which one's actually improved the process.

6. Remember to keep good records of your improvement effort for sharing, replication, or in case you have to revisit an earlier step.

7. Celebrate your successes and reward team members. Remember...we get what we reward!