DA FORM 2410 USABILITY FOR RELIABILITY ANALYSIS

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PURPOSE

An investigation of the usability for DA Form 2410 data in reliability analysis, and how a FRACAS type system (such as RIMFIRE) is required in addition to DA Form 2410 *for Reliability Analysis* in Army Aviation products.

PROBLEM DESCRIPTION

- US Army Aviation uses DA Form 2410 for reporting maintenance, repair, removal and replacement data on helicopter components.
- The DA Form 2410 facilitates a pre-established list of Fail Codes which do not provide the level of data necessary for Reliability Analysis.
- Additional data is required for Reliability Analysis

ANALYIS DESCRIPTION

 This study uses validated failure/removal data from the RIMFIRE (Reliability Improvement through Failure Identification and Reporting) program to show the where DA Form 2410 data is lacking for use in Reliability Analysis.

Methodology

- 1. Download full completed RIMFIRE record dataset with the following data fields:
 - Sequence Number
 - Fail Code
 - Removal Reason
 - Review Board Reason for Return
 - Asset Aircraft Model
 - System Name
 - System Part Number
- 2. Combine 2410 Fail Code and RIMFIRE Review Board Return Reason columns into "helper column"
 - Using this column, establish the full array of combinations that occur in the dataset.
 - Grade accuracy of each combination using Category Decision Tree (Slide 5)
 - This will be the "Master Category List"
- 3. Create a pivot table with the dataset
 - Table: 2410 Fail Code -> Removal Reason -> Review Board Return Reasons -> # of Instances
 - Filters: Aircraft Model, Component Name, Component Part Number
- 4. Sum the occurrences of each category score to determine the probability of each.
 - Perform summation on full data set, individual component, helicopter platform, or any other combination of interest.

Components Selected for Analysis

- UH-60 Intermediate Gear Box
- AH-64 Nose Gear Box
- CH-47 Transmissions
- T-700 Engines
- UH-60 Main Mod

Scoring Categories

Exact:

The 2410 Fail Code accurately represents the removal event described by the RIMFIRE Review Board Return Reason, and describes the location of the failure or situation that required the removal.

Low Fidelity:

The 2410 Fail Code accurately represents the removal event described by the RIMFIRE Review Board Return Reason, but does not describe the location of the failure or situation that required the removal.

Ambiguous:

The 2410 Fail Code represents the removal event described by the RIMFIRE Review Board Return Reason, but not accurately enough for a reliability assessment.

Wrong:

The 2410 Fail Code does not represent the removal event described by the RIMFIRE Review Board Return Reason.

Category Decision Tree



Example of an "Exact" record score

UH-60M, Tail Rotor Gearbox Field Removal: 13-April-2015 TSN: 1726 hrs

- 2410 Fail Code: 803 Removed for Time Change/Retirement Change
- RIMFIRE Board Return Reason: Removed for Time Change – Scheduled Maintenance
- Fail Tag states Removed for TC/RC

- Logbook entry states: 3/20/2015 – REPLACEMENT DUE ON TAIL ROTOR GEARBOX ASSY GEARSHAFT, BEVEL DUE AT: 1800.0 HOURS

 RIMFIRE inspector found light scuffing on gear teeth, pitting on housing, corrosion on servo bore, wear inside shaft, grooves on seal sleeve.

- Inducted Item Informa	tion - Sequence Number: UZ-A	X17MAB706AXJ31-021		- Recordings -	
Nomenclature :	Gearbox, Tail Rotor	Fail Code :	803	TSN (hrs) :	1726
Serial Number :	A006-04003	Field Removal Reason	Removed for time change/retirement change	TSLI (hrs) : TSO (hrs) :	1726
Part Number :	70358-06600-048	Field Removal Date :	13-APR-2015	TSLDV (hrs):	-
NHA :	Transmission, Power	Overhaul Shop :	CCAD		
NHA SN :		Shop Induction Date :	27-FEB-2017		
Monitored Aircraft :	Yes	TDA :	PSA-Overhaul		
Aircraft Model :	UH-60M	Inspector :	GARZA, OSCAR OGARZA(A)		
Aircraft SN :	09-20199	Owning UIC :	W0U9T1		
Customer/User :	ARMY	Recapped :	Unknown		
Location Last Operated :	Unknown	Rimfire Tag :	No		
- Board Determinations					
Board Reason for Return	: REMOVED FOR TIME CHAN	IGE - SCHEDULED MAINTENAN	CE No Evidence of Failur	e (NEOF) : No	
Field Repairable :	Not Applicable		NEOF Subfield :		
Inspector Summary					
1. Pinion P/N 70358-06619 2. Output housing P/N 7035 3. Center housing P/N 7035 4. Reset over P/N 70356	101 S/N F319-01135 light scuffin 8-06609-043 S/N B313-00184 pit 8-06607-042 S/N F277-01208 co	g on gear teeth. Sing on housing. rosion on servo bore.			

Flange P/N 70357-06116-041 S/N N/A grooves on seal sleeve.
 Retention plate P/N 70358-06612-042 S/N K259-10204 grooves on seal sleeve

Example of a "Low Fidelity" record score

UH-60A, Intermediate Gearbox Field Removal: 8-Dec-2014 TSN: 4993 hrs

- 2410 Fail Code: 170 Corroded
- RIMFIRE Board Return Reason: Corrosion
- Fail Tag states Corroded beyond limits
- 2410 Remarks state RESET ACFT 8123619 UH60A 5709.5 ACFT HRS
- No specific Logbook entry found.
- RIMFIRE inspector found corrosion on the center housing mounting foot.

- Inducted Item Inform	mation - Sequence Number: UZAX	15MSB209AXJ31-074	
Nomenclature :	Gearbox, Intermediate	Fail Code :	170
Serial Number :	A005-00792	Field Removal Reason	: Corroded
Part Number :	70357-06300-042	Field Removal Date :	08-DEC-2014
NHA :	Transmission, Power	Overhaul Shop :	CCAD
NHA SN :		Shop Induction Date :	17-APR-2015
Monitored Aircraft :	Y	TDA :	PSA-Overhaul
Aircraft Model :	UH-60A	Inspector :	GARZA, OSCAR OGARZA(A)
Aircraft SN :	81-23619	Owning UIC :	W0H95T
Customer/User :	ARMY	Recapped? :	γ
Location Last Operate	ed : Unknown	Rimfire Tag :	Ν
Board Determination	ns		
Board Reason for Ret	urn : CORROSION		
Field Repairable :	No		
V Inspector Summa	ry		
1.Center housing P/N 7 2.Flange P/N 7035706	70357-06305-042 S/N C315-00156 116-041 S/N 02105 grooves on sea	corrosion on mounting foot. I sleeve.	



Example of an "Ambiguous" record score

UH-60A, Intermediate Gearbox Field Removal: 25-Oct-2012 TSN: 4866 hrs

- 2410 Fail Code: 705 Beyond specified tolerance
- RIMFIRE Board Return Reason: Corrosion
- Fail Tag states Corroded beyond limits
- No 2410 remarks.
- No specific Logbook entry found.
- RIMFIRE inspector found heavy pitting on the center housing mounting feet. Other corrosion and typical wear found.

 Inducted Item Informa 	tion - Sequence Number: UZ AX	15MSB209AXJ31-033	
Nomenclature :	Gearbox, Intermediate	Fail Code :	705
Serial Number :	A005-00512	Field Removal Reason :	Beyond specified tolerance
Part Number :	70357-06300-042	Field Removal Date :	25-OCT-2012
NHA :	Transmission, Power	Overhaul Shop :	CCAD
NHA SN :	NOTAPPLICABLE	Shop Induction Date :	23-DEC-2014
Monitored Aircraft :	Y	TDA :	PSA-Overhaul
Aircraft Model :	UH-60A	Inspector :	ESTRADA, LARRY LESTRADA(A
Aircraft SN :	82-23729	Owning UIC :	WY3XA0
Customer/User :	ARMY	Recapped? :	Y
Location Last Operated	CONUS	Rimfire Tag :	N
Board Determinations			
Board Reason for Return	n : CORROSION		
Field Repairable :	No		

) HEAVY PITTING ON THE CENTER HOUSING MOUNTING FEET. P/N 70357-06305-042 S/N A315-00214 2) HEAVY WEAR GROOVES ON THE OUTPUT FLANGE ASSEMBLY. P/N 70357-06116-041 S.N C0210 3) HEAVY CORROSION IN THE OUTPUT BEVEL GEAR SPLINES. P/N 70357-06315-101 S/N C318-00355 3) HEAVY CORROSION (RUST) ON THE INPUT FLANGE SPLINES. P/N 70357-06116-041 S/N C0211



Example of a "Wrong" record score

AH-64D, T700-GE-701D

Field Removal: 26-Sept-2011 TSN: 5587 hrs

- 2410 Fail Code: 799 Serviceable, no defect
- RIMFIRE Board Return Reason: Internal Failure
- No fail tag.
- DA Form 2410 indicates engine was returned in a serviceable condition, 3 LIGHT DIRT ACCUMULATION ON STAGE 2 FORWARD GG COOLING PLATE with no defect.
- Aircraft logbook says "2011 09 23 ENG #2 CHIPS INTERMITTENT IN FLIGHT/ 2011 09 28 REPLACED".
- MCDS shows that the Fail Code used on the DA Form 2410 Copy 1 dated 26 SEP 2011 was actually 804 which is "Removed for scheduled maintenance" while the DA Form 2410 attached in the PDFs shows the Fail code was 799 which is "Serviceable, no defect".
- RIMFIRE Engineering Assessment: This Engine was returned due to metal on magnetic plug caused by a damaged Axis A DuplexBall Bearing with cage wear that was in the process of failing. A PQDR was submitted on the Axis A Bearing (See attached PDFs). Examination of the bearing revealed that the bearing was unserviceable and "THE MANUAL ROTATION OF THE AXIS-A BEARING, BALL DUPLEX, (P/N 4040T20P03, S/N NHAD3819), PRODUCED NOISE AND WAS ROUGH TO THE TOUCH. ONCE THE BEARING WAS REMOVED FROM THE GEARBOX, AN ASSESSMENT OF THE BEARING REVEALED MODERATE COKING, NUMEROUS SCOURED BEARING BALLS AND EVIDENCE OF HEAVY BEARING CAGE WEAR".

Inspection and Engineering Assessment (Engineering Review Status:Completed

- Inducted Item Infor	mation - Sequence Number: 70	2009-E3591-14	
Nomenclature :	T700-GE-701D	Fail Code :	799
Serial Number :	GEE306447C	Field Removal Reason	Serviceable, no defect
Part Number :	5130T00G01	Field Removal Date :	26-SEP-2011
NHA:	N/A	Overhaul Shop :	CCAD
NHA SN :	N/A	Shop Induction Date :	16-OCT-2013
Monitored Aircraft :	Y	TDA :	PSA-Overhaul
Aircraft Model :	AH-64D	Inspector :	SUDELL, DENISE DSUDELL(A)
Aircraft SN :	99-05151	Owning UIC :	WHZZA0
Customer/User :	ARMY	Recapped? :	Y
Location Last Operate	ed : CONUS	Rimfire Tag :	N

Board Determinations

Board Reason for Return : INTERNAL FAILURE Field Repairable No

✓ Inspector Summary

GEARBOX

WORN BEARING CAGE ON AXIS A DUPLEX BALL BEARING HEAVY COKING ON DUPLEX BALL BEARING ENGINE 1. HEAVY DIRT ACCUMULATION ON STAGE 1 FORWARD GG COOLING PLATE 4. LIGHT EROSION ON 1ST STAGE COMPRESSOR BLADES 5. 2 EACH CLIPPED BLADES ON COMPRESSOR ROTOR 1ST 6. FAIL TAG MISSING





UH-60 Intermediate Gear Box Overall Results



AH-64 Nose Gear Box Overall Results



CH-47 Transmissions Overall Results



T-701D Engines Overall Results



UH-60 Main Mod Overall Results





***Top 10 Fail Codes account for 57.80% of the dataset

Top 10 2410 Fail Codes Rollup



Top 10 2410 Fail Codes



Top 10 2410 Fail Codes (cont'd)



Top 10 2410 Fail Codes (cont'd)



UH-60 Intermediate Gear Box Top 10 Fail Code Accuracy



AH-64 Nose Gear Box Top 10 Fail Code Accuracy



CH-47 Transmissions Top 10 Fail Code Accuracy



T-701D Top 10 Fail Code Accuracy



UH-60 Main Mod Top 10 Fail Code Accuracy



Conclusions

- The DA Form 2410 Fail Codes that are most accurate are the ones describing:
 - Time Change / Retirement Change Removals
 - Precautionary Removals (lightning strikes, FOD, aircraft mishaps, etc.)
 - Removals for Scheduled Maintenance events (Recap/Reset)
- DA Form 2410 lacks required data and accuracy for use in Reliability Analysis
- These types of DA Form 2410 Fail Codes describe events and situations that required removals, but do not give Program Managers insight to how and why parts are failing due to deficiencies that could be corrected or improved.

Conclusions continued...

- Data required for *Reliability Analysis and Improvement* include (but are not limited to):
 - Condition of component that indicated necessity of removal
 - Location of fault (at the subcomponent level)
 - Severity of fault
 - Measurements of wear/damage
 - Performance degradation over time
- This data can be obtained through verified FRACAS data, such as data from the RIMFIRE program, and is required for *reliability analysis and improvement of a system*.

Credits:

CGI Federal

QuantiTech, Inc.

RIMFIRE Program