Maintenance and Availability Data Warehouse





Briefing to Air Force

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Outline

- Background
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  - Results summary
- Methodology
  - Top down and bottom up approach
  - Data trees
  - Data conversion process, search algorithm and machine learning
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  - Data sources
- Maintenance and availability data warehouse
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  - Current situation/limitations
  - Are we winning or losing the maintenance battle?
  - Predictive modeling

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Background - Origin of Data Warehouse

Started in FY2005 as a result of Congressional interest in reducing impact of corrosion on DoD weapons systems, infrastructure and facilities.

Congress mandated a DoD Corrosion Executive be appointed

A working team, the Corrosion Prevention and Control Integrated Product Team (CPCIPT) was formed. The corrosion impact study methodology was created to assist the CPCIPT.

The study methodology involves obtaining all maintenance records, all costs and all non-availability results. As a result, the data is very useful for all maintenance task, cost and availability analysis, for both corrosion and non-corrosion.

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Corrosion Results – Air Force Studies to Date

Fiscal Year of Data	Study Segment	Maintenance cost	Corrosion cost	Corrosion percent	Non-available hours (NAH)	Corrosion NAH	Corrosion NAH per asset
FY06	Air Force Aviation	$18,270	$3,760	20.6%			
FY07	Air Force Aviation	$18,859	$4,090	21.7%			
FY08	Air Force Aviation	$19,278	$4,407	22.9%	16,017,497	2,767,425	459.8
FY09	Air Force Aviation	$21,316	$5,018	23.5%	17,026,284	2,970,945	499.2
FY10	Air Force Aviation	$22,201	$5,534	24.9%	13,977,466	2,705,733	464.3
FY11	Air Force Aviation	$22,471	$5,522	24.6%	14,114,171	2,318,416	406.1
FY12	Air Force Aviation	$22,454	$5,719	25.5%	18,878,270	2,646,912	461.1
FY13	Air Force Aviation	$22,323	$5,559	24.9%	15,873,790	2,405,571	422.0
FY14	Air Force Aviation	$22,211	$5,684	25.6%	14,936,138	3,106,532	545.5
FY15	Air Force Aviation	$23,800	$5,325	22.4%	15,415,064	2,462,290	437.8
FY07	Air Force Infrastructure and Facilities	$3,877	$339	8.8%			
FY08	Air Force Infrastructure and Facilities	$4,241	$651	15.3%			
FY09	Air Force Infrastructure and Facilities	$6,077	$711	11.7%			
FY10	Air Force Infrastructure and Facilities	$4,761	$644	13.5%			
FY11	Air Force Infrastructure and Facilities	$4,524	$617	13.6%			
FY05	Air Force Other Miscellaneous Equipment	$3,381	$546	16.1%			
FY06	Air Force Other Miscellaneous Equipment	$3,219	$541	16.8%			
FY07	Air Force Other Miscellaneous Equipment	$3,295	$553	16.8%			
FY08	Air Force Other Miscellaneous Equipment	$3,665	$633	17.3%			
FY09	Air Force Other Miscellaneous Equipment	$3,444	$603	17.5%			
FY10	Air Force Other Miscellaneous Equipment	$2,921	$548	18.8%			
FY11	Air Force Other Miscellaneous Equipment	$3,108	$572	18.4%			
FY12	Air Force Other Miscellaneous Equipment	$3,108	$570	18.3%			
FY13	Air Force Other Miscellaneous Equipment	$2,101	$409	19.5%			
FY14	Air Force Other Miscellaneous Equipment	$2,480	$465	18.8%			
FY15	Air Force Other Miscellaneous Equipment	$1,266	$213	16.8%			
FY07 Totals	Air Force All segments	$26,031	$4,982	19.1%			
FY08 Totals	Air Force All segments	$27,183	$5,691	20.9%	16,017,497	2,767,425	459.8
FY09 Totals	Air Force All segments	$30,837	$6,332	20.5%	17,026,284	2,970,945	499.2
FY10 Totals	Air Force All segments	$29,883	$6,726	22.5%	13,977,466	2,705,733	464.3
FY11 Totals	Air Force All segments	$30,103	$6,711	22.3%	14,114,171	2,318,416	406.1
FY12 Totals	Air Force All segments (uses FY11 Infrastructure)	$30,086	$6,907	23.0%	18,878,270	2,646,912	461.1
FY13 Totals	Air Force All segments (uses FY11 Infrastructure)	$28,947	$6,584	22.7%	15,873,790	2,405,571	422.0
FY14 Totals	Air Force All segments (uses FY11 Infrastructure)	$29,215	$6,765	23.2%	14,936,138	3,106,532	545.5
FY15 Totals	Air Force All segments (uses FY11 Infrastructure)	$29,590	$6,155	20.8%	15,415,064	2,462,290	437.8

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Data Conversion Process

(Corrosion Algorithm)

Step	Description	Original Percent Corrosion	Comments
1	Fault Cause Code (MAL)		
	170 - Corroded Mild/Moderate	100	
	211 - Corroded Internal Surfaces	100	
	212 - Corroded External Surfaces	100	
	667 - Corroded Severe	100	
	800 - No Defect - Component removed/reinstalled to facilitate other maintenance	10	only if Action taken code is "S"
	865 - Deteriorated	100	
2	Action Taken CD		
	Z - Corrosion Treatment	100	
3	WUC		
	02000 - Aircraft cleaning	100	For all aircraft except KC-135 models
	02110 - Cleaning and treating of equipment to prevent corrosion	100	For all aircraft except KC-135 models
	04119 - Corrosion control inspection	100	
	04141 - Corrosion control inspections	100	
	04145 - Transformer rectifier (T/R) unit capacitor check for electrolyte leakage/corrosion	100	
	04185 - Squib continuity and corrosion check	100	
	04221 - Corrosion inspection phase I (KC-135 and B-52)	100	
	04222 - Corrosion inspection phase II (KC-135 and B-52)	100	
	12BDV - Relief Crew Compartment Fixed Floor Panel Assembly Corrosion Finish	100	For all aircraft except KC-135 models
4	Text - corrosion key words	as per guidance	
	All steps are performed iteratively - records flagged from one step are set aside.		

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Data Conversion Process

(Corrosion algorithm applied)

HIGHER ASSY EQUIP DESIGNATOR	JOB CONTROL NUMBER	WUC	HOW MAL	ACTION TAKEN	WHEN DSCVRD	WORK CTR	LABOR MAN HRS	LABOR CAT	DISCREPANCY NARRATIVE	CORRECTIVE ACTION NARRATIVE
T038A	50250318	11561	170	G	F	A3130	13.5	6	UPPER BOATTAIL SKIN HAS NUMEROUS CORROSION HOLES	WORK IN PROGRESS.
F015A	52576926	75BM0	170	Z	M	Z5120	1	3	LAU-128 S/N 4964, 18 MO INSP REQD	PAINTING C/W
C017A	60190286	04119	255	A	F	QE110	8	3	INSPECTION	B/C/AND REPAIRED
C017A	60190286	11CA0	255	9	F	QE110	1	3	LANDING LIGHT W/N RETRACT	NRTS-9
C130E	60238752	13712	230	V	F	QE220	2	1	NLG WHEEL REQUIRES EDDY CURRENT INSPETCION	CLEANED, INSPECTED WHEEL AND TURNED INTO SUPPLY
C130E	60031566	13720	020	1	F	QE220	2	1	NOSE WHEEL SHIMMY	REMOVED WHEEL AND TURNED IN SKIN
C130E	60098808	13722	020	1	F	QE220	2	1	OUT OF ROUND OR OUT OF BALANCE	REMOVED WHEEL AND TURNED IN SKIN
KC135R	62132626	13CA0	865	Z	4	1E720	8	3	#8 BRAKE REMOVE AND REPLACE	PAINTED AS REQ

HIGHER ASSY EQUIP DESIGNATOR	NSN	ITEM	JOB CONTROL NUMBER	QTY	PRICE	DATE ORDER	FSC	Labor Corrosion Cost	Material Corrosion Cost
T038A	013451276	PANEL	50250318	1	43	11/2/08	1560	$675	$43

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Data Conversion Process

(NMC Algorithm Applied)

Type model series	Work unit code	Fault cause code	Action taken code	Work center	Discrepancy narrative	Cause NMC?	Number of NAH	Corrosion related work?	Corrosion percent	Corrosion NMC days
C-130H	11561	170	G	A3130	UPPER BOATTAIL SKIN HAS NUMEROUS CORROSION HOLES	No		Yes	100	
F-16C	04132	158	Z	Z5120	LAU-128 S/N 4964, 18 MO INSP REQD	Yes	2	Yes	100	2
T-38C	44CA0	255	A	QE110	LT WING LANDING LANDING LIGHT W/N RETRACT	Yes	3	No		
A-10C	75BMO	255	9	QE110	PHASE INSPECTION	Yes	5	Yes	40	2
F-15E	13712	230	V	QE220	REPLACE LEFT WHEEL HUB BEARING	No		No		
T-6A	13720	020	1	QE220	NOSE WHEEL SHIMMY	No		No		
F-15E	13722	020	1	QE220	OUT OF ROUND OR OUT OF BALANCE	No		No		
F-16C	13CA0	865	Z	1E720	#8 BRAKE REMOVE AND REPLACE	Yes	4	Yes	100	4

Total corrosion non-available hours → 8

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Machine Learning

(Object and Actions Text Search)

Object	***Action***	***FAULTDETAILDESC***
Battery	Inspect	**BATTERY** BPO/PRE **INSP**
Seat	Remove	**REMOVE** FWD **SEAT** FOR FOM OR PE
Brakes	Install	LEFT MAIN **BRAKE** ASSY **WORN**
Oil Filter	Install	ENGINE #1 OIL TEMPERATURE HIGH. REMOVED , INPSPECTED, AND **REINSTALLED FILTER**
Wheels and Tires	Replace	LT MAIN **TIRE WORN**
Rudder and Trim Tab	Remove	**REMOVE** FINISH AND TREATMENT FROM RIGHT LOWER **RUDDER BUMP SEAL** (553052) TO FOM
Attitude Indicator	Check	COPILOT **EADI** FLICKERED THEN WENT BLAMK. **CHECKED** CIRCUIT BREAKER - REMAINED INOP. LND TIME: 1420
Door	Paint	R/H UPPER **DOOR** HINGE NEEDS **PAINT**
Wheels and Tires	Replace	RT **TIRE WORN**
Distribution Box	Replace	POWER **DISTRIBUTION BOX** ON THE LEFT DC PANEL ACCESS #3 HAS A **BROKEN** 50 AMP C/B
Pylon	Remove	STA 6 **PYLON REMOVED** FOM
Landing Gear	Repair	**LANDING GEAR**..... LEFT MAIN GEAR FORWARD DOOR **DOES NOT CLOSE**
Seat	Adjust	C-MODEL **SEAT** REQUIRES **RAISE AND TILIT**
Battery	Remove	**BATTERIES REMOVED** FOR 28 DAY RECONDITIONING IAW 1Q-9(M)1-2-01JG-00-1 PG 2-1
Fuel Cell	Repair	AFT **FUEL CELL LKNG**
Landing Gear	Remove	(X) #3 **MLG** KNEEL CHAIN COVER **REM** TO F.O.M LUBE
Main Rotor	Lubricate	**MAIN ROTOR LUBE** DUE

For objects – use NIIN, text, then codes

For actions – use text, then codes

Using Natural Language Processing (NLP) machine learning to apply to the maintenance records

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Aviation Work Breakdown Structure (AWBS)

The AWBS is a five character code

The first character identifies the end item type

Code	End-item type
F	Fixed wing aircraft
R	Rotary aircraft
M	Missiles
E	Engines
X	Common use across aircraft types

The second identifies the maintenance action

Code	Maintenance activity	Examples
A	Assemble	Combine parts into subassembly
B	Calibrate	Bring into tolerance, adjust
C	Clean	Wash, decontaminate, blast, bath
D	Disassemble	Separate subassembly into parts
E	Dispose	Cannibalize, destroy
F	Fix	Remove, repair, reinstall
I	Inspect/Test	Troubleshoot, warranty, non-destruction inspection (NDI)
L	Installation	Install equipment, load, reload
M	Modify	Reconfigure, remove but do not repair or replace
O	Administrative	Order parts, prepare reports
P	Preserve	Lubricate, package, wrap
R	Replace	Remove and put back a new or refurbished operational part
T	Treat	Prime, paint, coat
U	Unknown	Unknown activity

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Aviation Work Breakdown Structure (AWBS)

The AWBS is a five character code

The 3rd and 4th characters identify the system

Code	Maintenance system
01	Engines
02	Airframe
03	Landing gear
04	Power distribution and electrical
05	Rotor and propeller system
06	Drive system
07	Hydraulics/pneudraulics
09	Miscellaneous aircraft
10	Fuel system
11	Flight control
12	Measuring and testing instruments
13	Environmental control
14	Ground support equipment
19	Avionics
20	Consumables and toolbox hardware
21	Bearings
22	Valves and pumps
31	Fire control system and target acquisition
34	Night vision assembly
35	Armament

The fifth character identifies the subsystem
(This example shows the subsystems for
System 31 – Fire control and target acquisition)

Sub-system	Subsystem description	FSC code[a]	FSC code description
1	Fire control designating and indicating equipment	1210	Fire control directors
		1217	Fire control equipment
		1260	Fire control designating and indicating equipment
		1265	Fire control transmitting and receiving equipment, except airborne
		1285	Fire control radar equipment, except airborne
2	Aircraft gunnery fire control components	1270	Aircraft gunnery fire control components
3	Optical sighting and ranging equipment	1240	Optical sighting and ranging equipment
4	Fire control computing sights and devices	1220	Fire control computing sights and devices
5	Miscellaneous fire control equipment	1290	Miscellaneous fire control equipment
6	Photographic and video equipment	5836	Video recording and reproducing equipment
		6710	Cameras, motion picture
		6720	Cameras, still picture
		6740	Photographic developing and finishing equipment
		6750	Photographic supplies
		6760	Photographic equipment and accessories
7	Underwater sound equipment	5845	Underwater sound equipment
8	Aircraft bombing fire control components	1280	Aircraft bombing fire control components
9	Other	1550	Drones

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Aviation Work Breakdown Structure (AWBS)

To illustrate, the AWBS code "FR312" means the following:

- F = Fixed wing
- R = replace
- 31 = fire control system and target acquisition
- 2 = aircraft gunnery fire control components, which consists of sub systems or parts with FSC code 1270.

Other comments:

1) The AWBS (Aviation), GWBS (Ground vehicle) and SWBS (Ships) codes are assigned after the fact by LMI analysts – maintenance technicians have no additional work.

2) The WBS codes are embedded into each maintenance record.

3) Codes are assigned by identifying the object worked on first and then mapping to the WBS structure. Objects are determined through parts requisitions (mapped to WBS structure by FSC), use of text descriptions of work, and then service codes as a last resort.

4) The typical structure is a total of 7 end item types (1st character of code), 14 maintenance actions (2nd character of code), 19 end item systems (3rd and 4th character of code) and up to 10 subsystems (5th character of code)

5) The WBS structure eliminates the verb/object conflict which is resident in each service WBS code structure. Example - Air Force work unit code "03" scheduled inspection or "04" special inspection, Navy ships "631" paint, etc.

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Authoritative Data Sources Available to LMI
(Air Force)

Data use	Method of collection	Data Source
TD	Other work	Depot Maintenance Cost, called the "1307" report
TD	Self-serve	Distribution of DoD Depot Maintenance Workloads (also known as the 50-50 Report)
TD	Self-serve	Defense Manpower Data Center (DMDC) information
TD	Self-serve	Air Force Data Book, Operations and Maintenance, Air Force FY 2015 Budget Submission
TD	Self-serve	Air Force Reserve Data Book, Operations and Maintenance, Air Force FY 2015 Budget Submission
TD	Self-serve	FY2015 President's Budget (for 2013 per capita rates).
TD	Self-serve	Air Force National Guard Data Book, Operations and Maintenance, Air Force FY 2015 Budget Submission
TD	Air Force provide	Contractual funding data provided by AF headquarters
EQ	Air Force provide	Installations and Mission Support-Enterprise View (LIMS-EV)
Avail	Self-serve	Installations and Mission Support-Enterprise View (LIMS-EV)
BU	Air Force provide	Reliability and Maintainability Information System (REMIS)
BU	Air Force provide	Parts expenditures from REMIS
BU	Self-serve	Centralized Access for Data Exchange (CAFDEx)
BU	Other work	Depot Maintenance Cost System (DMCS)
BU	Air Force provide	Depot Maintenance Material Support System (DMMSS)
BU	Air Force provide	Job Order Production Management System (JOPMS)
BU	Air Force provide	Program Depot Maintenance Schedule System (PDMSS)
BU	Air Force provide	Defense Maintenance and Accounting and Production System (DMAPS)

TD	Top-down budgetary and spending information
EQ	Equipment lists
BU	Bottom-up maintenance records
Avail	Availability data
All data sources	Support needed from Air Force to obtain data

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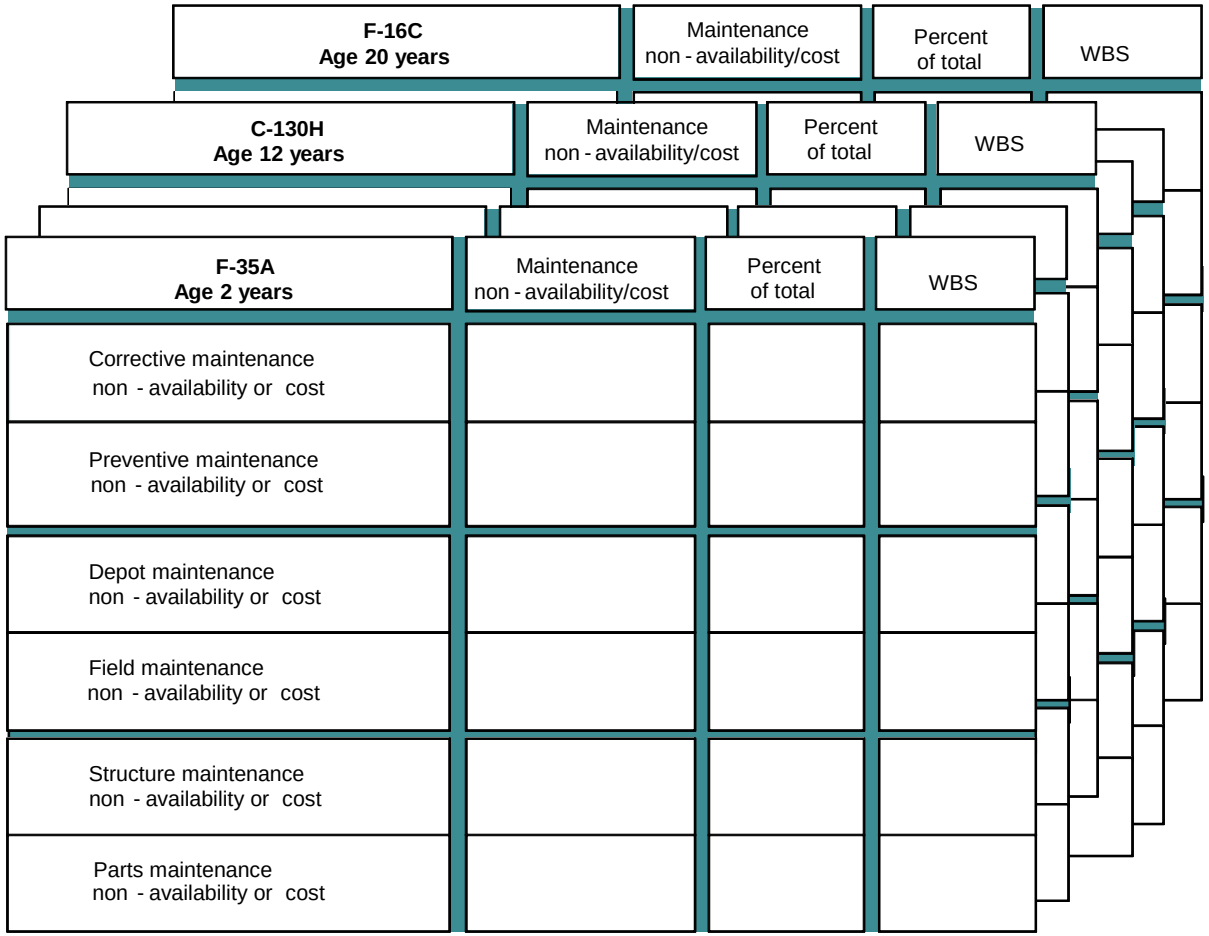
Maintenance and Availability Data Warehouse

Data can be arranged in any combination of data fields as depicted by the data structure diagram



Inspection is an example of one type of maintenance “recipe”.
A recipe can be created to answer virtually any type of maintenance question

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Maintenance and Availability Data Warehouse

(Sample record with 10 of the 40 labor data fields showing)

ENDITEMUNIQUEID	AVAILCD	Maint NMC	Maint Operation	Maint Object	LMIWBS	UNITCD	Maintenance Cost	MAINTDLH	ESI
163989	Z	0.11	Adjust	Launcher	FM353	N39787	$3,751.84	8	1
160107	Z	0.14	Strip	Door	RC020	M09383	$6,285.91	18	7
166365	Z	0.07	Replace	Hydraulic hose	RR062	NF9823	$414.25	1.2	12
166291	Z	0.11	Clean	Locking pin	RC034	N09822	$681.00	2	3
166388	Z	0.13	Check	Track	RI351	M53923	$3,300.35	3	5
164075	Z	0.09	Replace	Hydraulic hose	RR062	N09299	$62.60	0.2	12
164075	Z	0.15	Replace	Hydraulic hose	RR062	N09299	$62.60	0.2	18
164075	Z	0.14	Replace	Hydraulic hose	RR062	N09299	$214.32	0.8	3
160825		0	Weld	Airframe	RF020	M09202	$543.59	2	5
156438		0	Repair	Gearbox	RF053	M09793	$3,164.43	5.8	6
154853		0	Repair	Gearbox	RF053	M52790	$3,215.00	6	8
165910		0	Install	Computer	FL116	M09439	$158.80	1	2
165931		0	Repair	Drive Unit	FF062	N09678	$1,016.37	1	4
166407		0	Install	Alarm	FL194	N09355	$257.80	1.2	11
166532		0	Install	Alarm	FL194	N4544A	$257.80	0.2	10
166533		0	Configure	Controller	FM095	N55138	$407.79	0.1	9
166532		0	Configure	Alarm	FM194	N55138	$74.34	0.1	9

Approximately 600 million maintenance records for weapon systems for all services

All weapon systems studies now being executed on a yearly basis

All yearly maintenance costs accounted for relative to these systems

Standardized data structure across DoD

Availability results for ground and aviation systems since FY2008. No availability results for Navy ships (not measured by the Service)

The NMC totals equal the reported totals for each Service by weapon system.

Contains both labor (task) and materials (parts) detail. Parts are linked to labor through the job control number.

Results can be determined to the action and object level of detail

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Maintenance and Availability Data Warehouse

(Added value over DoD standard systems)

- Completeness – missing data added to each maintenance record as needed (i.e. – model, item price, etc)
- Correction – incorrect relationships are rectified (i.e. – serial number to model, dates, MAJCOMS, etc.)
- Costs – all costs included for all weapon systems (commercially performed, military labor, supplemental funds)
- Structure – all naming conventions standardized (i.e. - BUNO, tail number, serial number are “end item unique”)
- Centralization – all data in one place (costs at all levels of maintenance, availability results)
- Significant value added data embedded within each maintenance record
  - Non-availability results embedded within the maintenance records.
  - Standardized work breakdown structure (commodity, action, system, subsystem) for each weapon system type.
  - Maintenance object and action solved for within each record
  - Environmental severity index included in each maintenance record with a UIC.
  - Preventive and corrective, parts and structure classifications embedded within each record.

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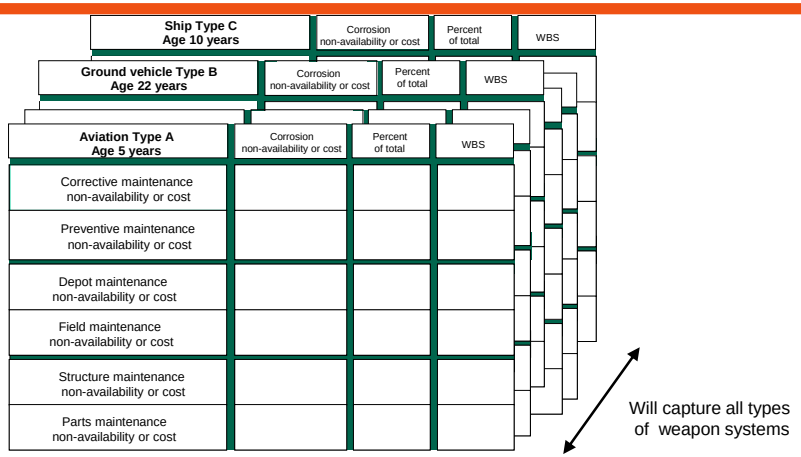
MADW - Limitations



1) Commercially performed maintenance bottom-up records not readily available (except for Navy ships)

2) 20% of DoD maintenance costs are not accounted for to the system and subsystem level of detail. This includes ammunition, small arms, crew served weapons, clothing, Army watercraft, etc. Essentially, these are the non-end item pieces of equipment.

3) Environmental severity index based on location of home base of equipment. This may not always be the physical location of the equipment.

4) Current data approval process is somewhat cumbersome for non-corrosion related purposes.

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How Do We Tell if We Are Winning or Losing in Maintenance?

Q: Why do we spend money on maintenance?

A: To buy availability

Q: Is there a target availability?

A: Yes. If it doesn't exist for every readiness reportable system currently, it should.

Q: Can we measure achieved availability compared to target?

A: Yes. This is a measure of effectiveness

Q: Can we measure how well we are buying availability?

A: Yes. This is a measure of efficiency

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How Do We Tell if We Are Winning or Losing in Maintenance?

A) Achieved availability at target availability?

Example – F-16C. Target: 70.0 %
Achieved: 69.8%
Result: Slightly under target

B) How well are we buying availability?

EITM	Potential Days	Total Non-available days	Total available days	Maintenance cost	Maintenance cost/day of availability
A-10	112,420	30,073	82,348	$658,381,450	$7,995
B-2	7,300	3,955	3,345	$255,243,617	$76,315
B-52	28,105	10,583	17,522	$947,101,527	$54,051
C-5	31,390	7,033	24,357	$860,123,852	$35,314
C-17	81,030	22,736	58,294	$1,738,914,276	$29,830
CV-22	16,425	7,925	8,500	$117,210,264	$13,789
C-130	204,400	63,105	141,295	$2,382,595,608	$16,863
F-15	172,645	62,933	109,712	$2,331,462,906	$21,251
F-16	371,935	112,552	259,383	$1,896,100,077	$7,310
F-35	27,740	5,810	21,930	$33,577,141	$1,531
C-135	158,045	51,279	106,766	$3,733,436,617	$34,968
T-38	185,055	71,229	113,826	$657,684,324	$5,778
MQ-9	68,985	12,469	56,516	$132,237,521	$2,340

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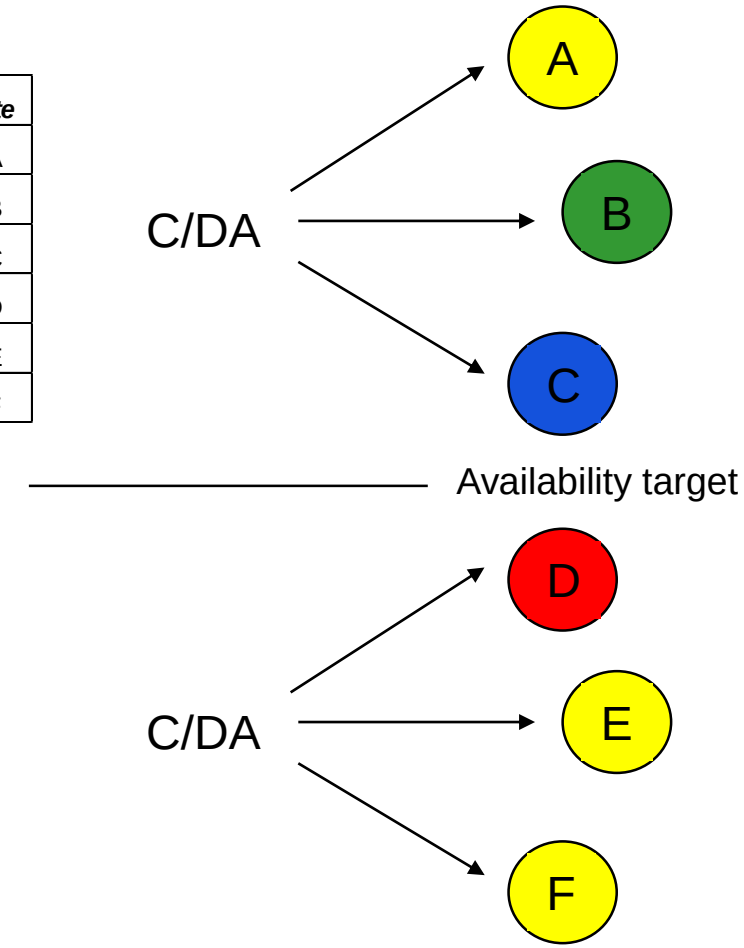
How Do We Tell if We Are Winning or Losing in Maintenance?

Goal: “Achieve target availability at the lowest cost”

Availability Results	*Cost/day of availability*	*Conclusion*	*Action*	*Note*
At or above target	Upward trend	Potential problem	Reduce costs	A
At or above target	Stable	Winning	Stay focused	B
At or above target	Downward trend	Crushing it	Celebrate	C
Below target	Upward trend	Big problem	Buy cost efficient availability	D
Below target	Stable	Potential problem	Buy cost efficient availability	E
Below target	Downward trend	Potential problem	Spend more to buy availability	F



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Win-Win for Corrosion

Goal: “Achieve target availability at the lowest cost”

Can identify systems where corrosion is a major contributor to C/DA

		Corrosion			
EITM	**Maintenance cost/day of availability**	**Corrosion Non-available days**	**Corrosion Cost**	**Corrosion Cost/day of avail**	**Percent of cost/day of availability due to corrosion**
C-135	$34,968	9,279	$1,111,542,917	$10,411	29.8%
C-130	$16,863	14,798	$663,449,373	$4,695	27.8%
B-52	$54,051	2,263	$249,571,561	$14,243	26.4%
B-2	$76,315	714	$65,598,089	$19,613	25.7%
A-10	$7,995	4,139	$138,375,990	$1,680	21.0%
C-5	$35,314	1,026	$176,526,197	$7,248	20.5%
F-35	$1,531	851	$6,764,098	$308	20.1%
F-16	$7,310	17,562	$381,591,578	$1,471	20.1%
C-17	$29,830	3,953	$340,447,235	$5,840	19.6%
T-38	$5,778	9,890	$120,616,228	$1,060	18.3%
F-15	$21,251	10,306	$411,416,577	$3,750	17.6%
CV-22	$13,789	1,131	$16,127,675	$1,897	13.8%
MQ-9	$2,340	2,418	$15,870,807	$281	12.0%

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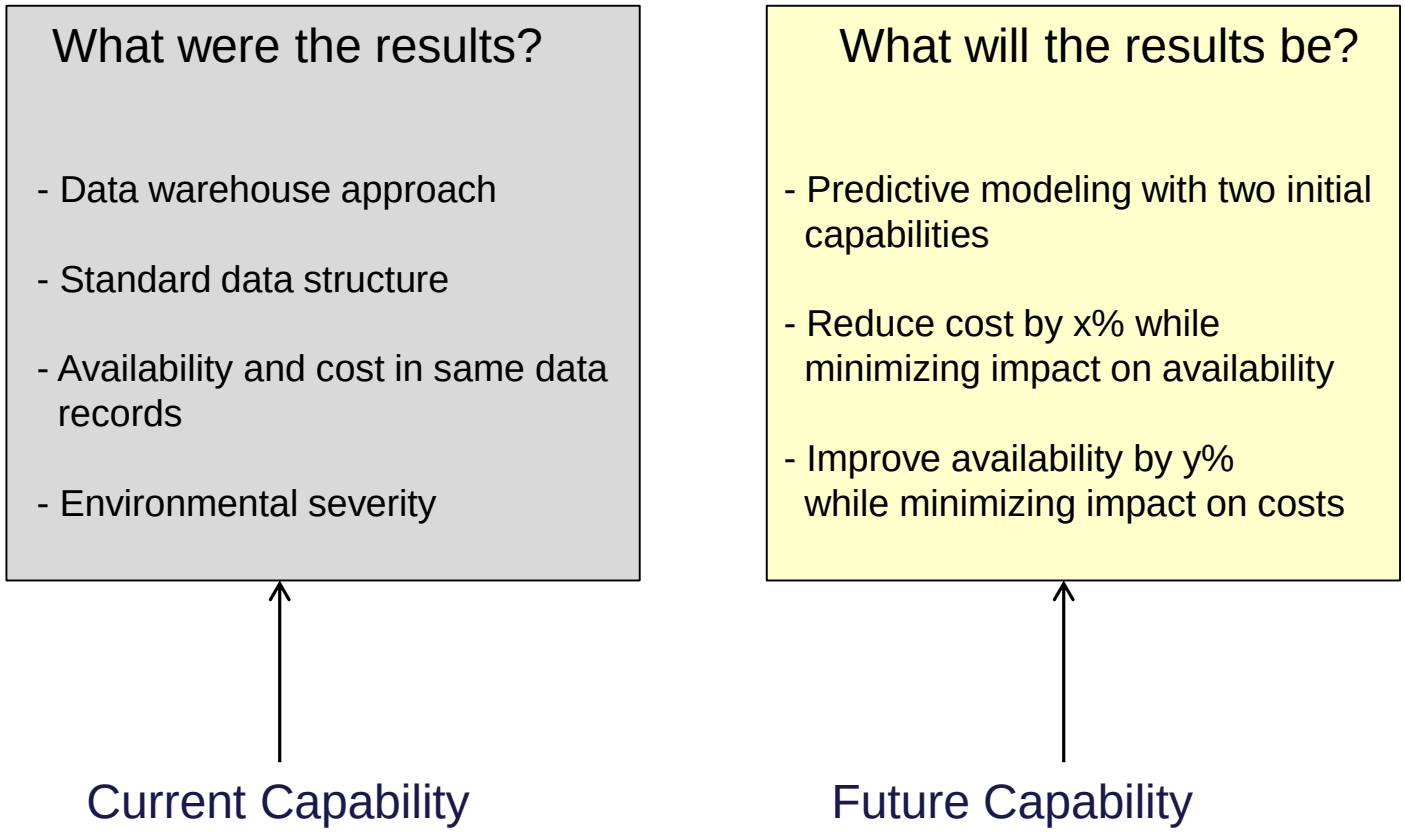
MADW Future Capability – Predictive Modeling



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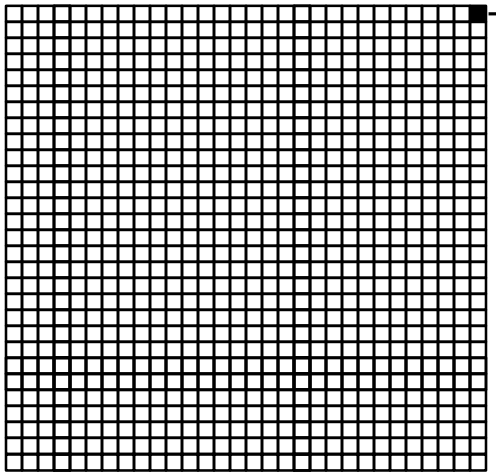
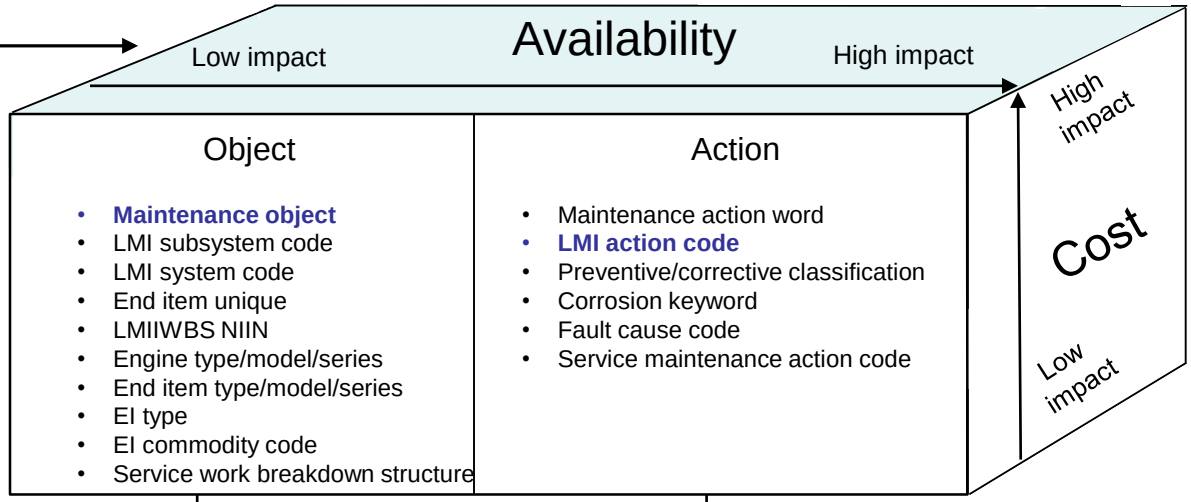
Predictive Capabilities – Use of Objects and Actions

Data Warehouse - 600 million records





		Availability	
		Low	High
Cost	Low	Low $, Low Avail	Low $, High Avail
	High	High $, Low Avail	High $, High Avail

Goal: Isolate those action/object combinations (AOCs) that impact cost and non-availability significantly to understand their relationship to each other.

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Predictive Capabilities – Use of Objects and Actions

Capability 1 - reduce maintenance costs

Capability 2 - improve availability results

Capability 1

		Availability	
		Low	High
Cost	Low	Low $, Low Avail	Low $, High Avail
	High	High $, Low Avail i.e. Replace tire	High $, High Avail i.e. Repair fuselage

Capability 2

		Availability	
		Low	High
Cost	Low	Low $, Low Avail	Low $, High Avail i.e. Replace vent duct
	High	High $, Low Avail i.e. Replace tire	High $, High Avail i.e. Repair fuselage

Once the target action/object combinations (AOCs) are isolated that will impact capabilities 1 and 2 significantly, the goal will be to identify the task attributes that are abnormal within these AOCs.

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Predictive Capabilities - Maintenance Task Attributes

Maintenance task attributes →

1) Frequency of execution
2) Duration of task
3) Labor content of task
4) Materials used
5) Waiting

Number	Task attribute	Example	Impact
1	Frequency of execution	Aircraft wash cycles	Cost and availability
2	Duration of task	Repair cycle time	Availability
3	Labor content of task	Labor rate	Cost
4	Materials used	Decision to repair or replace circuit cards	Cost and availability
5	Waiting	Obsolete part	Availability

For the targeted AOCs, can we measure the task attributes?
Can we measure abnormality in these attributes?
If so…….the model can predict what the results will be if the attributes were normal.

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Predictive Capabilities – Returning Abnormal to Normal

Maintenance attributes	Maintenance tasks								
	AOC = Replace tire			AOC = Repair fuselage			AOC = Replace vent duct		
	Current level	Normal level	Opportunity?	Current level	Normal level	Opportunity?	Current level	Normal level	Opportunity?
Frequency of execution	4 per vehicle	2 per vehicle	Yes	20 per aircraft	10 per aircraft	Yes	12 per ship	6 per ship	Yes
Duration of task	45 minutes	45 minutes	No	3.2 days	1.1 days	Yes	8 hours	9 hours	No
Labor content of task	$400	$450	No	$5,000	$10,000	No	$500	$500	No
Materials used	$800	$600	Yes	$2,500	$2,700	No	$1,250	$1,300	No
Waiting	1.5 days	0.5 days	Yes	0	0	No	12 days	3 days	Yes

Once the maintenance characteristics are measured for the target action/object combinations (AOCs), they are compared to normal performance for each characteristic. The normal performance can be derived in a variety of ways including the average of all weapon systems of that same type, or the historical performance for the same weapon system, or the performance of similar systems in the other services.

The model will then assess the new results of the system based on achieving the normal performance in the characteristic that is above normal.

For example, the opportunity presented in the replacing the tire AOC is to reduce the frequency from 4 to 2 times per year, to spend $200 less per occurrence and to reduce the waiting time by 1 day.

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Conclusion

- The MADW is a powerful tool with the flexibility to answer virtually any historical maintenance or corrosion question for weapon systems concerning cost or availability.
- This capability will be further enhanced with the development of the predictive modeling
- The goal of “Achieve target availability at the lowest cost” can serve as a unifying, common objective across operational, logistics and maintenance organizations
- The metric of “Cost per Day of Availability” can serve as the measurement of metric progress towards achieving target availability at the lowest cost. It is also a valid to gauge improvement for business case analysis

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