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Assessing Pit-Stop Maintenance for Army Aviation

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Background

- Pit-Stop: When a racing vehicle stops in the pits during a race for refueling, new tires, repairs, mechanical adjustments, a driver change, or any combination of the above.

- Pit-Stop is a term that is often not quite understood in terms of its impact if implemented properly.

- At its core, Pit-Stop Maintenance is Hyper-Readiness.
  - If we are maintaining, we are not ready.

Pit Stop: What is it?

Army/NASCAR Comparison

Maintenance Level Comparisons	
Army Aviation	**Racing**
Phase	Race Shop
Intermediate (AVIM)	Race Track Garage
Unit (AVUM)	Race Day

Maintenance Ratio Comparison

Maintenance Ratio (MMH/Operating Hour)			
	AVUM/Pit-Stop	**AVIM/Garage**	**Phase/Shop**
Pit-Stop Maintenance	0.09	20.83	59.17
AH-64D	12.34	2.17	2.88

In Pit Stop Maintenance, the workload shifts to the back shops. In current practice, the typical Army Aviation maintenance workload is shifted to the flight line and away from Phase.

Metric Comparison

	Operational Availability	# Assets in Use/Total Assets	Mission Reliability
Army Aviation	82-91%	18/24 = 0.75	80-85%
NASCAR	99-100%	1/2 = 0.5	95-99%

Mission Reliability

- NASCAR reliability has resulted in evolution and revolution of design over time.
  - This is a simple machine compared to a helicopter and the missions are scheduled and terrrain is known.
- Apache aircraft exhibit a consistent mission reliability over the past 8 years
  - This is good given the complexity of the aircraft and the various terrains

Asset Availability

- On average, an Army battalion will have available 18 of 24 A/C at any given time in a deployed theatre
  - This allows for 6 A/C to be undergoing Scheduled, Unscheduled, or Phases.
  - 18 A/C will be on the flightline ready to go
  - For the Army to go to a full Pit-Stop methodology, the number of aircraft at the battalion level would have to be increased from 24 to 36, but this is extremely cost prohibitive.
- In NASCAR, a back-up car is waiting in the trailer
  - This car is set up for the track and is usually the same car that was raced the previous week.

Improved reliability and operational floats would allow Army Aviation to improved Operational Availability.

Army Aviation & Pit-Stop

- Fundamental structure of Army Aviation will have to change.
  - Increase in maintainers
    - Back shop/Phase level personnel would increase by 20 times.
    - Intermediate crew would increase by 10 times.
  - Specialization: Servicing, Phases, DART Teams, etc.
  - System Redesign Focused on Minimal AVUM (RCM)
  - Increased # of Assets
- Design of Aircraft for Modular Replacement is Mandatory
- Prognostics/Diagnostics of Aircraft is mandatory
  - High cost of imbedding Conditioned Based Maintenance, the Black Boxes, & Transmission needed into Legacy Systems

Army Aviation can not be solely focused on repair time in its maintenance practices.
It can benefit greatly from the selective application of pit stop concepts.

Pit-Stop Trade-offs

Pit Stop Benefits may be at the ***expense*** of:

- Increased Cost
  - More Pre-built Assemblies/Floats
  - More Maintainers at the Phase/Backshop level
  - Training is more specialized
  - More parts at deployed positions
- Logistical Tail
  - More parts in the system to track
  - More aircraft available as backup to maintain asset availability ratio/float aircraft
- Increased Intermediate Maintenance
  - Move of work from the flight line to back shops and phase

U.S. Army Car

Army Pit Stop Initiatives

- The Fundamental Technology Initiatives of this effort:
  - Part and Tool Availability
  - Rapid Damage Repair/Mitigation
  - Prognostics/Rapid Diagnostics/CBM
  - High Reliability
  - Technologies Leveraged from Professional Racing

Part & Tool Availability

- Crash Carts
  - Complete Assemblies Built-up
    - Rear end, nose clips, suspension, brakes.
  - Tools segregated by labeled toolboxes & drawers
    - Labeled by area of car
  - Generators, Welders, Grinders, Cutting Torches, etc.

Roush-Fenway Racing Crash Cart

Labeled Suspension Repair Toolbox with Pre-Build Calipers

Rapid Damage Repair/Mitigation

- Pre-built/assembled Repair Assemblies

Fuel Filler-Neck with Bracket to Attach to Damaged Body Work in Case of Damage

Complete Float Rear Suspension Assembly from Grand American Road Racing

Damage Assessments from past races (particular to specific race track) are used to determine what parts need to be brought to the track and any modifications necessary for quick repair.

Rapid Damage Repair/Mitigation

- Crew chiefs/engineers
  - deeply involved in planning of race strategy
  - take into consideration driver age, driver skill, rest required, and the needs of the race team (someone who conserves gas, easier on car, etc.).

- This is very similar to the battlefield, in which the commander must take into account the crew strength, fatigue, equipment usage, and other factors in order to implement a battle plan.

Part & Tool Availability

- Crash Carts
  - Tools & Spare Parts are segregated by labeled areas, toolboxes, and drawers
    - Labeled by area of car
    - Generators, Welders, Grinders, Cutting Torches, etc.
    - 5S – Setting in Order – A Place for Everything to enable easy access to needed items.
  - Teams prepare carts each week for the particular terrain, expected damage, and conditions.

Roush-Fenway Racing Crash Cart

Labeled Suspension Repair Toolbox with Pre-Build Calipers

Planning and preparation for the mission to include commonly failed parts for a particular terrain is crucial to asset availability.

Rapid Damage Repair/Mitigation

- Pit-Crew Training
  - Must first be proficient in trade at garage first
  - Crews formed by Crew Chief on feel and demonstrated chemistry at practices & races
  - Physical Training is specialized according to task
    - Jack-man must be strong/agile.
      - Core Strength & Explosive Exercises
    - Tire changes must be quick and accurate.
      - Visual Acuity & Quickness Exercises
  - 2 Hours per Day are set aside for exercises
  - Actual pitting of cars is also performed during the week with a Pit Stall set up to accurately mimic the next race track pit.

Prognostics/Rapid Diagnostics

- Endurance racing, like Grand American sports car, is allowed more telemetry than NASCAR
  - Unlike the Army, they do not try to monitor all parts, only what helps complete the mission.
- Telemetry includes: accelerometers, strain gages, air/fuel ratio, tire wear, weather, shock travel, & pit windows
  - Data sent wirelessly (real time) to a command at the pit stall for the crew chief/engineers to determine race strategy/car or crew changes.
  - Over 48 channels of data are recorded.

Grand American Race Cockpit

NASCAR Limits Telemetry to Tests

Rapid Diagnostics/Prognostics

- NASCAR information technology professionals are the heart and soul of the operation.
  - During a race, pit row computers help the team make rapid operational decisions based on data such as tire wear, fuel loads, track conditions, weather and engine sensors.
- Army engineers and combat systems technicians use computer technology to monitor critical system performance for battlespace dominance.

High Reliability

- Root Cause Analysis
  - Both good & poor performances
- Easy, fast, & usable data collection
  - Component performance
  - Supplier part performance
  - Race car testing
    - Wind tunnel
    - Handling
    - Engine
  - Team performance
    - Pit-Stop Times
    - Daily schedules
    - Critical Job Responsibility
- Each car has a record of components, when tested, mileage sheets similar to a Logbook.

Garage Stall – Lowes Motor Speedway

Leveraged Technologies

- Aviation Wind-Shield Tear-offs
  - Qualified on UH-60, AH-64, & Others
  - Working on a Multi-Layer
- Istotropic Superfinish
  - Used by NASCAR on Gears
  - Qualification begun on CH-47 & AH-64 Drivetrain
- Kitting of High Removal Items
  - Consumables & Built-up Assemblies
  - UH-60 & AH-64
  - Better packaging
- Relook of Battle Damage Repair Kits
  - Quicker panel repairs
  - Innovative & Custom Tailored by Units

Superfinished Gears

Installation of
Windshield Tear-offs

Pit Stop Implementation

- Pit-Stop Maintenance could be an initiative on a project by project basis on Legacy Aircraft.
  - Kitting of commonly removed/replaced items
    - Kit would contain all consumable parts and prebuilt assemblies of items such as a Tail Rotor Gearbox, Main Module, etc.
    - Phase Kits should be reexamined
    - Better determine part mixture by demand/need
    - Labeled for individual area of aircraft
    - Labeled for type of work (Intermediate vs. AVUM)
  - Redesign of components to be more modular.
  - Crash carts with tools and prebuilt assemblies and repair panels
    - Improved reaction times to damaged or failed aircraft

Pit Stop Implementation

- For New Acquisitions: Consider pit-stop maintenance as a maintainability & design goal from ORD to Final Fielding.
- Dedicated maintainers with a career path that fosters expertise and not promotion out of the “pit-crew.”
- Concerted effort to remove tasks of legacy aircraft from on-aircraft to back shops.
  - Modular design & prebuilt subassemblies is an intermediate step.

Pit-Stop Implementation

- Specialized Crew & Maintenance Procedures
  - Complete Phase teams
    - Crewmen who specialize only on certain areas of the aircraft
    - Specialization increases speed and decreases repair time
  - Specialized servicing crews whose sole job is to service an aircraft to get it back in the air in a minimum amount of time.
  - Communications & wireless downloads of maintenance data or exceedances to ground crew to prepare for maintenance work.
- Improved & more specialized DART teams
  - Better reaction to damaged aircraft
  - Practices of typical repairs to improve time & crew communication
  - Assigned jobs during repairs

3rd ID in Iraq had specialized maintenance crews due to high Op-Tempo's
  - Aircraft were flying over 125 hours per month with 6 phases per month per Unit.
  - Crews were set up to service aircraft as the aircraft would land to return the aircraft for battle & escort missions.
  - Full-time phase teams which specialized on certain areas of the airframe.

Questions?

NASCAR Maintenance Workload

Pit-Stop Maintenance (1 Team)	Race Manhours
Race Rebuild (chassis & body)*	200
Engine Rebuild (Overhauled Every Race)	100
Paint/Wrap Body	20
Refilling Repair Carts	20
Training during week for Pitstops	80
Race Prep at Shop	15
Race Prep at Race / Garage Work***	125

Pitstop Time (Typical Race)**	0.525	
*Not including Engine/Drivetrain/Painting		
*For 15 pitstops at an average of 14 seconds with 9 men		
***For 10 men, 10 hours of time plus 2 hours adjusting for practice, plus 30 minutes during a race for a mishap.		

NASCAR Manhours

- The number of man hours spent in the shop for a" turn around" car not including Engine, Drivetrain and Paint is about 200hrs.
- 5 men 40hrs. that`s real close...Race prep is usually 5 men 3 hrs.
- this is just the car system…
- For manhours associated with maintenance team at the race before and during practice = 12 men, hours = 12, 140 manhours

Army Maintenance Workload

Army Unit Correlation (AH-64D)	Army Manhours (avg)
Phase (After Every 500 Flight Hours)	1250
Engine Rebuild (Overhauled)	150
Logistics of Kits/Parts Refilling	40
Weekly PT	30
Scheduled Inspections	7.5