What we need to look at are those systems referred to as transformational; that are going to give us an even greater capability in the future. But you cannot get the transformation if you try to do everything … you are going to have to make some choices.

—David Keith (Dave) McCurdy

contemporary issues

Effects-Based Performance: Bridging the Gap Between Fighter Operations and Maintenance
Effect of Enterprise Resource Planning on Organizational Productivity

Contemporary Issues in this edition presents two articles: "Effects-Based Performance: Bridging the Gap Between Fighter Operations and Maintenance" and "Effect of Enterprise Resource Planning on Organizational Productivity."

In "Effects-Based Performance: Bridging the Gap Between Fighter Operations and Maintenance" Major Shamsher S. Mann, USAF, examines how effects-based operations (EBO) techniques might provide a more correct measure of both operations and maintenance performance. EBO advocates actions based on the desired effects over arbitrary metrics.

Traditionally, both operations and maintenance have focused on a myriad of statistics as a sole means to assess performance. While necessary, these metrics have become the final product in performance assessment and have taken on a life of their own. Drawing on the lessons from effects based operations, Mann believes there is significant room for improvement in how operations and maintenance in fighter squadrons assess themselves.

Major Julie S. Newlin, in "Effect of Enterprise Resource Planning on Organizational Productivity" provides an overview and discusses the effects of implementing enterprise resource planning (ERP) systems within an organization. ERPs are comprehensive packaged software solutions which aim for total integration of all business processes and functions.

According to Newlin, if time is spent on choosing the correct tool and ensuring the data is good, many benefits stand to be realized. However, there are stages to an implementation, and productivity may decline before it begins to improve. Discounting one study's negative findings (Shin) on the impact on productivity, findings are positive. Studies found that productivity improves after an initial decline, at worst returning to pre-implementation levels. Measurable implementation milestones should be set so that organizations can track their progress and quantifiably state productivity levels. Finally, managers need to be careful in defining success and manage each stage of the implementation to ensure overall, long-term improved productivity.

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Effects-Based Performance: Bridging the Gap Between Fighter Operations and Maintenance

Shamsher S. Mann, Major, USAF

Introduction

The US Air Force has been a dominant force in warfare for almost a century. Over the course of that century, strategic thinkers have continuously reevaluated existing methods of airpower employment to discover new and innovative ways to optimize its use in combat. One recent school of thought, known as effects-based operations (EBO), advocates actions based on the desired effects over arbitrary metrics. However, this revolutionary thinking has focused on warfare and not on the various supporting elements that contribute to that effort. Of these elements, perhaps none have such a direct impact on execution as the maintenance and repair of combat aircraft and the tactical training of the pilots that fly these aircraft. Airpower merely becomes jets to display or fly at air shows without these essential elements.

Traditionally, both operations and maintenance have focused on a myriad of statistics as a sole means to assess performance. While necessary, these metrics have become the final product in performance assessment and have taken on a life of their own. Drawing on lessons from effects-based operations, there is significant room for improvement in how operations and maintenance in fighter squadrons assess themselves. The two organizations share a supported and supporting role, with the final product being a combat ready aircrew employing a high-quality aircraft. While both organizations need specific metrics to gauge internal performance, there currently exists no vehicle to assess the performance of the operations and maintenance *team* in the Air Force. To successfully provide that vehicle, consideration needs be given to altering the context within which the metrics exist and establishing a new combined effectiveness criteria. In the spirit of EBO, this tool should measure the unit's *effectiveness* rather than capability. The difference is subtle, but doing so may enable implementation within the fighter squadron of the same innovative concepts that have enhanced warfare in recent history.

Why Effects Based?

EBO is banging its way into the lexicon. The Air Force is wholly committed to the concept and is attempting to lead the other Services.[1] EBO is a concept that, by definition, relates to operations in war with seemingly no relationship to logistics. However, the effects-based concept can be applied to areas outside the scope of strategy and tactics in warfare. An area that lends itself to discussion using an effects-based framework is the interface between the flying operations and maintenance of Air Force fighter aircraft.

One of the most fragile yet essential relationships in Air Force fighter aviation is the relationship between the maintenance organization and the operational flying unit. This relationship is defined by the *effects* sought by both organizations within a fighter unit. Operations flow

smoothly when the two sides of the organization share similar goals. Conversely, goals that are not mutually supportive can result in turmoil and friction. While both operations and maintenance use measures of effectiveness, the two organizations' measures are often mutually exclusive and are tracked within the respective operations or maintenance stovepipes.

Warfighting has evolved from using metrics such as tonnage dropped or body counts as measures of merit to "operations conceived and planned in a systems framework that considers the full range of direct, indirect, and cascading effects."[2] Currently, tactical aircraft maintenance is heavily focused on tracking metrics as measures of effectiveness rather than framing the process in terms of the final effect desired.[3] Like the evolution in warfare from metrics to effects, the time has come to reevaluate the relationship between fighter maintenance and operations performance to de-emphasize metrics and shift the focus to the desired effects as the overriding measure of merit.

Evolution of the Effects-Based Concept

While the current trend toward embracing the effects-based concept is relatively new, the theory behind effects-based thinking is not new at all. "After all, good commanders have always kept their mind on objectives and related effects."[4] So why the excitement about the concept and how did it come about? "To a large extent, the EBO movement and the passion of its advocates stem from wartime experiences of young Air Force officers who were appalled by the frequently mindless and ineffective use of airpower in Vietnam."[5] These officers witnessed the all encompassing fascination with metrics and, in the case of Vietnam, a failure to link the metrics with the military effects desired. *"Appraisal of the Bombing of North Vietnam* reported that despite 55,000 sorties and the dropping of 33,000 tons of bombs, damage has neither stopped nor curtailed movement of military supplies and created no evidence of serious problems due to shortages of equipment."[6]

Leadership at the time thought that sortie counts and tonnage dropped might give them insight into the success of the air campaign while completely ignoring the actual effect they intended to achieve. For example, "it looks much better for the commander and the Service concerned to show 200 sorties on paper, even when 40 or 50 would do the same job."[7] The Vietnam generation resolved to do it better when their time came to lead and the culmination of their efforts resulted in the successful air campaign during Operation Desert Storm.[8] By Desert Storm, commanders were no longer bound by sorties flown or munitions expended. They based their warfighting efforts on targets hit and effects achieved through their destruction with minimal numbers of sorties and munitions.[9]

Article Acronyms

AEF – Aerospace Expeditionary Force
AFI – Air Force Instruction
AR – Abort Rate
BFM – Basic Fighter Maneuvers
C3BR – Code-3 Break Rate
CMR – Combat Mission Ready
DD – Delayed Discrepancy
DO – Director of Operations
EBO – Effects-Based Operations
FSE – Flying Scheduling Effectiveness
FMC – Fully Mission Capable
FTU – Fighter Training Units
IE – In-Flight Emergency
IP – Instructor Pilot
IQT – Initial Qualification Training
MC – Mission Capable
ME – Mission Effectiveness
MQT – Mission Qualification Training
MSE – Maintenance Scheduling Effectiveness
NMC – Nonmission Capable
PMC – Partially Mission Capable
RAP – Ready Aircrew Program
RR – Repeat/Recur
SMO/OIC – Senior Maintenance Officer/Officer in Charge
TAR – Total Abort Rate
TOT – Time on Target

Parallels of EBO with Fighter Maintenance and Operations

Broken down to fundamentals, the existence of tactical air forces is for the sole purpose of destroying an enemy. Fighter aircraft do not exist to generate sorties. Tactical airframes are a means to an end. That end is to destroy targets, airborne or on the ground, that meet the strategic and tactical objectives in a given military operation. With that in mind, the goal of the sorties flown is to successfully engage and destroy targets within that operations plan. There is no artificial requirement for number of missions or aircraft generated as a measure of merit. The sole measure of merit is mission accomplishment. However, measures of merit and statistics currently used by the operations and logistics communities, while absolutely necessary to assess the internal performance of the respective organizations, can be construed to overemphasize statistics and sometimes take on a life and priority of their own.

"Aircraft maintenance metrics are important. Don't let anyone tell you differently!"[10] While this statement is not entirely invalid, it highlights the emphasis that can be placed on metrics over the desired effects of fighter maintenance in training and combat. While the above quote can be taken out of context to imply that metrics are the end in themselves, reading further in the *Maintenance Metrics U.S. Air Force* illustrates that the authors understand that effect outweighs the metrics. Metrics "must be used correctly to be effective. Chasing metrics for metrics' sake is a bad thing and really proves nothing."[11] The task of a maintenance organization "is to provide *good iron* to operators when needed."[12] However, like all well intentioned guidance from leadership, direction can be misconstrued and emphasis can be placed on items of less emphasis.

Understanding Air Force Maintenance Metrics

Any organization, whether business, military, or other, must establish performance measures to gauge effectiveness of that organization. The Air Force maintenance community is no different, and it has established metrics used by leadership to assess performance of the organization. Air Force Instruction

(AFI) 21-101 highlights the importance of metrics and their use in the Air Force.

> The overarching objective of Air Force maintenance is to maintain aircraft and equipment in a safe, serviceable, and ready condition to meet mission needs. Maintenance management metrics serve this overarching objective and shall be established or maintained by Headquarters Air Force, major commands, wings and squadrons to evaluate and improve equipment condition, personnel skills, and long-term fleet health. Metrics shall be used at all levels of command to drive improved performance and adhere to well-established guidelines.[13]

A thorough explanation of all the metrics used by Air Force maintenance organizations can be found in the *Maintenance Metrics U.S. Air Force* handbook published by the Air Force Logistics Management Agency. This handbook serves as an encyclopedia of metrics used within the Air Force maintenance community.

The vast array of metrics can be broken down into two major categories: *Leading* and *lagging* indicators. As the names imply, leading indicators provide *predictive* data while lagging indicators provide *historical* data to the maintainers.[14] The combination of the two types of data is intended to provide a good snapshot of the performance and condition of a maintenance organization and possibly point to actions to maintain good performance or remedy poor performance. Within these two broad categories, many individual metrics exist, and these are broken down further into flying-related, maintenance-related, supply-related, shop-related, and Air Mobility Command-only related categories. This paper focuses on the flying related and maintenance related categories as the others are beyond the scope of this discussion.

Measures of merit and statistics currently used by the operations and logistics communities, while absolutely necessary to assess the internal performance of the respective organizations, can be construed to overemphasize statistics and sometimes take on a life and priority of their own.

Flying-Related Metrics

There are several metrics that fall within the flying-related category. These metrics are designed to provide insight into the effectiveness of the maintenance organization in relation to the flying operation itself. The flying-related metrics salient to this discussion are flying scheduling effectiveness (FSE), total abort rate (TAR), and code-3 break rate (C3BR).

Flying Scheduling Effectiveness

This metric is a leading indicator that is intended to measure "how well the unit schedules and executes the weekly flying schedule."[15] In simple terms, this rate is intended to show whether a unit is planning flying and maintenance activities in relation to actual execution of those activities.

> A high FSE rate indicates the unit has planned well and executed the schedule. A low FSE rate may indicate needless turbulence; however, not all turbulence is bad. When intentionally introduced to avoid additional turbulence later, it is smart management. Otherwise, it is nothing but added pain for the unit. It is all too easy to get drawn into operations requirements versus maintenance capabilities when looking at causes of turbulence. The mission is priority number one all the time, but firm scheduling discipline is a must for effective operations.[16]

This rate is calculated based on the number of deviations that occur in the execution of the flying schedule. A high number of deviations results in a low FSE rate while a low number of deviations results in a high FSE.[17] The deviations themselves are caused by such things as later or earlier takeoffs than scheduled and ground aborts (an aircraft scheduled to fly breaks before takeoff such that it cannot fly the mission). These deviations can be caused by any number of factors such as poor weather, air traffic delays, pilots running late, maintenance taking longer to prepare an aircraft, and so forth.

Total Abort Rate

This is a leading indicator that reflects aircraft reliability as well as the quality of maintenance performed on those aircraft.[18] This metric has an inverse relationship with FSE in that a high abort rate (AR) leads to a lower FSE, while a low AR can contribute to a higher FSE.[19] If an aircraft malfunction causes it to miss a scheduled sortie, that sortie is considered a ground abort. However, if the malfunction occurs after takeoff it is considered an air abort if the malfunction precluded the accomplishment of the mission. As stated in the maintenance handbook, "an air abort is really an operations call. Not all airborne malfunctions, however, result in an air abort. If an alternate mission is flown, then it is not an air abort."[20]

Code-3 Break Rate

The final flying-related metric discussed is the code-3 break rate. To understand this metric, the definition of the aircraft codes must first be explained. Upon landing after a mission in a fighter aircraft, the pilot is required to declare the landing status code. The most commonly used codes are code 1, code 2, and code 3. An aircraft that lands with a code 1 status is considered "fully mission capable with no additional discrepancies."[21] An aircraft landing with a code 2 status "has minor discrepancies but is capable of further mission assignment within normal turn times."[22] A code 3 aircraft "has major discrepancies in mission essential equipment that may require extensive repair or replacement prior to further mission assignment. The discrepancy may not affect

safety-of-flight and the aircraft may be nonmission capable (NMC) flyable."[23]

With the above landing codes explained, the code-3 break rate can be defined. This rate is "the percentage of sorties that land in a code 3 status."[24] This leading indicator is also an "indicator of aircraft system reliability and, sometimes, a measure of the quality of the aircraft maintenance performed"[25] on the aircraft assigned to that unit. A high code 3 rate can indicate a trend in a particular system's performance as well as a trend in lower quality maintenance performed on that system. A low code-3 rate can indicate a high level of quality in the maintenance performed on the aircraft and its various subsystems.

Maintenance-Related Metrics

Much like flying-related metrics, maintenance-related metrics are crucial to provide insight into the ability of the maintenance organization to support the flying mission. These metrics are not directly derived from the flying activities of the organization. Rather, these metrics track the internal operations of the maintenance unit, but are one step removed from the actual flight operations. However, they are critical to understanding support to those flying operations. These metrics include the fully mission capable (FMC) rate, partially mission capable (PMC) rate, mission capable (MC) rate, repeat/recur (RR) rate, 8-hour fix rate, maintenance scheduling effectiveness (MSE) rate, and delayed discrepancy (DD) rate.

Fully Mission Capable Rate

This rate shows whether aircraft are capable of executing all missions, and aircraft must have no limitations based on known system problems in order to execute those missions. In short, "the aircraft is capable of doing all assigned missions."[26] This rate is factored into the MC rate discussed later.

Partially Mission Capable Rate

This status is a degraded status from the FMC status and indicates that the aircraft is neither FMC nor NMC. An aircraft in PMC status "can accomplish one, but not all assigned missions."[27] While not FMC, the aircraft has some capability to execute some missions. This partial condition can be caused by maintenance or supply shortfalls. If caused by maintenance, it indicates that maintenance has not yet fixed the problem causing the degraded status. If caused by supply, it indicates that maintenance is awaiting parts from the supply chain to fix the problem causing the degraded status.

Mission Capable Rate

This rate is one of the indicators most used by maintenance organizations to assess fleet health and thus receives the most attention. "The MC rate is perhaps the best known yardstick for measuring a unit's performance. This rate is very much a composite metric. That is, it is a broad indicator of many processes and metrics."[28] This rate is derived from combining the FMC and PMC rates of an organization's aircraft.[29] As stated in the metrics handbook, "Exceeding this mark is not necessarily indicative of poor maintenance. However, a unit with poor production problems may consistently exceed 8-/12-hour fixes in a wide variety of systems."[30]

Repeat/Recur Rate

This metric tracks system problems that become repetitive over time. "R/R is perhaps the most important and accurate measure of the quality of maintenance performed in a unit."[31] The metrics handbook further explains the difference between a repeat problem and a recurring problem. "A repeat discrepancy is one occurring on the same system or subsystem on the first sortie or sortie attempt after originally reported. A recurring discrepancy occurs on the second through fourth sortie or attempted sortie after the original occurrence."[32] For assessment purposes, a low number of repeat/recurs can indicate that high-quality maintenance is being performed to fix aircraft system discrepancies when they arise while a high number of repeat/recurs can indicate that maintenance actions to fix a particular problem are falling short of permanently fixing the discrepancy.

8-Hour Fix Rate

This metric is often called the 8-/12-hour fix rate. However, the 12-hour rate is used primarily in relation to tanker and transport aircraft while the 8-hour rate is primarily used for tactical airframes. This is a leading indicator that "shows how well the repair process is being managed."[33] This rate is a cumulative figure consisting of the number of code 3 breaks that are fixed within 8 hours after landing from a mission. Repairs that exceed the 8-hour mark count against this rate and bring it down while a high percentage of repairs made within this allotted time results in a high 8-hour fix rate.

Maintenance Scheduling Effectiveness Rate

The MSE rate mirrors the previously discussed FSE rate with the emphasis being on maintenance actions and not actual sortie production. "MSE is a measure of maintenance's ability to plan and complete inspections and periodic maintenance."[34] If the unit is constantly deviating from the planned schedule, the MSE rate is low. A high MSE rate indicates that the unit is scheduling maintenance actions in advance and the schedule is well thought out to preclude having to deviate severely in order to conduct maintenance actions while simultaneously supporting flying operations. The metrics handbook further explains the relevance and importance of this metric.

> When maintenance misses a scheduled action because an aircraft is broken off station, that's a reasonable occurrence. When maintenance misses a scheduled action because the aircraft is pulled to support the flying program, beware. A unit should schedule maintenance first and then support the flying schedule with the remaining aircraft available. Too often, units do it the other way around—schedule maintenance with airframes left over after schedulers fill the flying schedule.[35]

Delayed Discrepancy Rate

The DD rate simply tracks discrepancies that are delayed in being fixed as the name implies. Many minor system malfunctions are not critical to mission accomplishment or safety of flight.

The *fixing* (repair) of these discrepancies can be delayed until the aircraft is not needed on the flying schedule because of the minor nature of the problems. "Sometimes maintenance actions must be deferred to a more opportune time."[36] DDs can be caused by either maintenance time limitations or supply parts availability. An example of such a discrepancy is cockpit lighting. If the unit is only flying day sorties, the cockpit lighting is not critical and the repair can be delayed until a more opportune time. Obviously, if the unit is night flying, this is likely not a candidate for DD status and must be repaired prior to the next flight.

Understanding Air Force Fighter Operations Metrics

Like the maintenance organization, the operations organization has its own metrics that are tracked to assess mission capability. The operational metrics are necessarily different than those within the maintenance organization, but they serve just as important a function in indicating the performance and readiness of an organization. One of the key programs used by operational fighter squadrons is the Ready Aircrew Program (RAP). "RAP identifies the minimum numbers of sorties that must be flown by each category of pilot during a set time period."[37]

Ready Aircrew Program

RAP drives fighter aircrew training requirements and is a system devised by the Air Force to assess the readiness of fighter units to accomplish assigned combat taskings. The genesis of RAP was the collective set of observations during and following conflicts related to aircrew performance.

> Air Force combat pilots enter periods of conflict at a reduced state of readiness and gradually increase capabilities until peaking near the end of the conflict. After combat ceases, the readiness of the pilots rapidly decreases back to a peacetime level. This decreased readiness level leads to combat losses at the beginning of the next conflict. Those that survive early combat gain critical experience that enhances the chances of later survival.[38]

This tendency to gain experience during a conflict was seen as undesirable, and a program to increase combat capability before a conflict was desired. "To decrease combat losses and improve mission effectiveness, the Air Force created a program designed to keep the pilots' readiness state at a combat level even during peacetime."[39] That program was RAP, and it was initiated by the Air Force in 1997.[40]

Air Force Instruction (AFI) 11-2F-16v1 states that RAP "is designed to focus training on capabilities needed to accomplish a unit's core tasked missions."[41] This program is tied to a unit's aerospace expeditionary force (AEF) commitment and is designed to prepare pilots for their AEF tasked missions. "An effective RAP training mission requires accomplishing a tactical or building block profile. Each mission requires successfully completing a significant portion of the relevant events as determined by the squadron commander."[42] Therefore, the bulk of flying training conducted in a fighter squadron is designed to fulfill the requirements laid out by the annual RAP tasking message. This message breaks down the individual mission types and mission elements flown by a particular unit and the number of those missions and elements that must be flown by each pilot in the squadron.

Initial Qualification Training, Mission Qualification Training, and Checkrides

As stated previously, RAP makes up only a portion of a squadron's flying training, and it applies only to aircrews that are already fully qualified in the unit's combat tasked missions. Newly arrived aircrews must go through various upgrade programs outlined in the AFIs to gain their mission qualification. The initial qualification training (IQT) occurs at the fighter training units (FTU) located at various training bases. Upon arriving at a new base, inexperienced aircrew must complete mission qualification training (MQT) before being certified as combat mission ready (CMR). These training sorties do not count toward the RAP.

In addition to tracking RAP, fighter squadrons also individually track the qualifications of all aircrew assigned through various evaluation events at specified intervals. For example, AFI 11-2F-16v2 requires F-16 pilots to complete instrument qualification check flights and mission qualification check flights every 18 months in order to maintain currency. The results of these check rides are recorded and distilled to provide leadership the metrics to assess aircrew performance within their respective organizations.

It is quite evident that there is no shortage of tools to assess performance within respective organizations. Flying organizations, through use of the RAP, are clearly able to assess whether aircrews have flown the required number of the various mission types and elements required. Maintenance organizations possess even more detailed data on the performance of the maintenance organization.

Metrics versus Effects

After exploring many of the metrics used by the operations and maintenance communities in the Air Force, it is quite evident that there is no shortage of tools to assess performance within respective organizations. Flying organizations, through use of the RAP, are clearly able to assess whether aircrews have flown the required number of the various mission types and elements required. Maintenance organizations possess even more detailed data on the performance of the maintenance organization. Both organizations track numbers of hours and sorties flown. A heavily weighted indicator of fighter squadron performance is successful execution of the RAP. A major indicator used by maintenance as stated in the maintenance handbook is MC rate. Both indicators are useful, but both indicators fall short when viewed through the effects-based lens.

Using an effects-based framework, both operations and maintenance are arguably working toward the same goal. During peacetime, that goal is an organization that is highly trained and ready to execute combat taskings. During wartime, the goal is to successfully execute that combat tasking. However, there is a glaring disconnect between how the two sides of an effective combat fighter organization assesses that readiness.

RAP is an imperfect tool that assumes that required numbers of sorties flown equals desired combat capability. The Air Force assumes that if an aircrew member executes a certain number of missions and mission tasks, he or she is fully capable of executing the unit's mission tasking. While there is some validity to that reasoning, the missing ingredient is the effect sought. Simply because a pilot executes the required number of ground attack missions, it does not follow that he or she is capable of effectively engaging and destroying a ground target. There is no vehicle outside individual squadrons to assess an individual aircrew memember's capability to perform his or her mission effectively. There is no accurate method to assess at the Air Force level whether all aircrews that executed their required RAP sorties executed them effectively. At the unit level, programs exist to track individual aircrew weapons effectiveness, but these programs are often informal and inconsistent unit to unit.

Similarly, maintenance metrics also fall short of tracking desired effects. Maintenance metrics are heavily weighted on tracking sortie counts and maintenance status of those sorties, but there is no method of tracking whether maintenance performance adequately supported operational objectives other than providing *good iron* to operators and how quickly the *bad iron* is repaired.

The Operations and Maintenance Disconnect

As demonstrated previously, fighter operations and maintenance use completely separate sets of metrics to assess performance. This separation often leads to conflicting priorities between the two organizations. The resolution of this conflict often boils down to individual personalities of the leaders of the organizations. If an organization is considered successful, "the success was totally based on a trust and confidence between the senior maintenance officer/officer in charge (SMO/OIC) and director of operations (DO)."[43] However, in an endeavor as important as combat readiness and training, the deciding factor should not be personality. While the goals of the two organizations appear complementary, the current framework sometimes causes them to be contradictory.

Upgrade Sortie Ground Abort

As an example of this contradiction, a hypothetical situation is presented. Although similar situations occur regularly in fighter organizations, this example highlights the contrasting priorities between operations and maintenance. An F-15 squadron is conducting a flight lead upgrade mission to qualify a pilot to lead a four-ship of F-15s in a defensive counter air mission. To qualify a pilot to lead a flight, he must first fly an evaluation sortie with an instructor pilot (IP) as his wingman.

The flight consists of the upgrade student as the flight leader or number 1. The IP flies on his wing as number 2. Number 3 is a qualified flight lead and number 4 is a qualified wingman. The flight's objective is to defend a target area from a separate flight of simulated adversary aircraft attempting to attack it. The adversary flight may consist of four or more F-15s, also from the same fighter squadron.

A malfunction on the ground prior to takeoff illustrates two totally different views taken by operations and maintenance. In this scenario, number 2's aircraft has a malfunction that prevents it from taking off. For maintenance, that counts as a single ground abort which impacts their FSE rate. However, for operations the effects are more profound. If an IP is not with the student for the flight, number 1 cannot lead the other two aircraft for the mission as he is not yet qualified to do so. Therefore, this situation has two possible outcomes.

The first outcome is a noneffective mission by operation standards. Since number 1 is not yet a qualified flight lead, he would be required to take off separate from the remainder of his flight and fly an alternate mission than the one planned. The other two fighters in the flight would either fly their own alternate mission or attempt to execute the planned mission with a significantly reduced force ratio. Regardless of which course of action is taken, all four missions are noneffective from an operations scheduling standpoint, since they were all scheduled with the purpose of supporting number 1's upgrade sortie which did not occur.

Maintenance views this situation differently. For maintenance, number 2's sortie is a ground abort, and therefore noneffective. However, if the other three aircraft take off and fly any type of mission, maintenance tracks this as three effective sorties, even though the desired end effect of the entire four-ship mission was not achieved.[44]

The second possible outcome is more complex. In this scenario, number 2 is the linchpin for successful completion of number 1's syllabus required training event. In this case, operations might elect to have one of the other pilots shut down his aircraft and allow the IP to take that aircraft if no spare aircraft are available. Executing this *pilot swap* inevitably causes delays and the three good aircraft (IP now in a good jet) would most likely take off more than 15 minutes after the scheduled takeoff time. Any takeoff greater than 15 minutes later than scheduled departure time is considered a takeoff time deviation by AFI.[45] The operations supervision displayed flexibility in an effort to complete an effective sortie, but the situation that follows highlights the perverse emphasis on metrics.

All the actions taken in this scenario by the operators and maintainers are tracked in any of the several metrics. The jet that did not take off is counted as a ground abort and detracts from maintenance's FSE Rate. The remaining late takeoffs are the source of an often seen battle between operations and maintenance. From the operations perspective, the late takeoffs should be charged against maintenance because their root cause was a mechanical malfunction on one aircraft. The ripple effect of shuffling pilots to ensure an effective sortie was the by-product of the single malfunctioning jet. Maintenance would view this differently. From the maintenance perspective, the three late takeoffs are an operations responsibility since operations chose to shuffle pilots. The other three aircraft were mechanically sound and would have been able to take off on time had operations not chosen to swap pilots.[46] Neither side is incorrect in their conclusion, but the situation illustrates the disconnect in

priorities often caused by the key metrics currently in place. None of the metrics track the desired effect of this entire exercise. The desired effect is to produce a qualified flight lead.

In-Flight Emergency

Another scenario that vividly illustrates the aforementioned disconnect between the operations and maintenance camps occurs when dealing with an aircraft that encounters an in-flight emergency (IFE). In this example, an F-16 takes off for a tactical training mission but experiences a critical systems malfunction (hydraulics in this case) at the beginning of the mission. The pilot then spends time orbiting over the field to burn down fuel to an acceptable landing weight before executing an emergency landing. The loss of his hydraulic system causes his brakes to be ineffective and he uses the cable arresting system to safely recover his aircraft.

For operations, this is obviously not an effective mission since few, if any, of the tactical tasks required during the sortie were executed. The pilot may be able to log a RAP counter sortie if any tasks were accomplished. Also, this may count as an air abort if operations declares it so. The maintenance implications are different. For maintenance, this sortie contributes to their IFE rate and would count as a code-3 mission. However, maintenance could count it as an effective sortie since the aircraft successfully took off and landed.[47] Furthermore, the "code 3 doesn't affect any maintenance stats unless it exceeds their 8-hour fix rate or sits for a while. That sortie, even though it was a *launch to high key, and slide into the cable*, would still count as effective in maintenance math."[48]

RAP versus Maintenance Effectiveness

A final example highlights the disconnect between the RAP tasking message and maintenance statistics. The draft 2008 F-16 Block 50 RAP tasking message states that inexperienced pilots must fly 12 basic fighter maneuvers (BFM) sorties to fulfill the requirements laid out by the message.[49] BFM is essentially a one-versus-one dogfight mission where both aircraft attempt to maneuver to a position of advantage in a visual dogfight, and then achieve valid weapons employment. Therefore, the mission is necessarily flown as a two-ship.

In a hypothetical situation—for purposes of discussion—two F-16s are scheduled for a BFM mission. However, one F-16 aborts on the ground for a mechanical malfunction. The remaining F-16 takes off, but is unable to execute the scheduled BFM mission because of the lack of an adversary aircraft. For maintenance, this is one noneffective sortie since the other aircraft was able to take off and fly an alternate mission. However, for operations, this counts as two noneffective missions because the RAP-tasked mission of BFM was unable to be flown. In terms of simple statistics, this scenario provides a 50 percent effectiveness rate for maintenance, while being 0 percent effective for operations in terms of RAP accomplishment. This is too great a disconnect when viewed as a means to effectively track the combined effectiveness of the two sides of the equation to assess combat capability.

Effects-Based Meets Metrics

The three situations discussed provide a few examples of commonly faced metrics dilemmas by fighter operators and maintenance. Furthermore, they highlight a potentially disconnected set of priorities for the two organizations. In an environment where segments of the military have begun to embrace the effects-based concept, perhaps the time has come to do the same with regards to logistics and operations. Doing so will require a change in mindset, a redefinition of the context within which metrics exist, and the introduction of a new simplified metric to track unit effectiveness.

The first challenge to solving the disconnect between operations and maintenance is a mindset change. Both organizations must embrace the effects-based concept. Leadership on both the operations and maintenance sides are under stress to perform, and the most visible measure of performance is the numerous metrics briefed at daily and weekly meetings with group and wing leadership. This stress can lead to a myopic view that loses sight of the joint goal and focuses on the metrics themselves.

Changes in Mindset

The first challenge to solving the disconnect between operations and maintenance is a mindset change. Both organizations must embrace the effects-based concept. The *Maintenance Metrics U.S. Air Force* handbook states that, "a unit should schedule maintenance first and then support the flying schedule with the remaining aircraft available."[50] This statement quite literally places the cart before the horse. The intent of the statement is to ensure fleet health and ensure that a flying unit's aircraft are not flown without regard to maintenance requirements. However,

literal interpretation of this statement can lead to an antagonistic relationship between two partners in a critical relationship.

Both sides of this equation must realize that they share a common goal. That common goal is to produce the best trained aircrew flying the most reliable aircraft. To this end, the tracking of the plethora of maintenance metrics often detracts from this goal rather than supporting it. Even though both the metrics handbook and AFI 21-101 warn against chasing metrics for metrics sake,[51] anecdotal evidence shows that sometimes to not be the case. Leadership on both the operations and maintenance sides are under stress to perform, and the most visible measure of performance is the numerous metrics briefed at daily and weekly meetings with group and wing leadership. This stress can lead to a myopic view that loses sight of the joint goal and focuses on the metrics themselves.

Redefining the Context

As stated in the metrics handbook, metrics are important. This article does not argue that current metrics should be done away with. However, the existing metrics should be reframed and placed in a different context. The existing metrics need to be used to track unit performance internally and not be used to display unit performance to higher leadership.

AFI 21-101 states that, "the MC rate is perhaps the best-known yardstick for measuring a unit's performance."[52] However this rate tells leadership little in relation to the overall effectiveness of the unit. This rate provides a snapshot of aircraft that are capable of executing some of the tasked missions. Referring to the previous explanation, this rate includes aircraft that are both fully and partially mission capable. Possessing capable jets on the ground tells very little about whether or not those aircraft effectively accomplished the mission. However, this statistic is often the measure of merit used to assess whether the organization and leadership within a maintenance unit are functioning effectively.

Similarly, all the various metrics previously discussed provide a good symptomatic snapshot of the maintenance units' preparation to support flying operations, but they do little to highlight the sought-after effects. The FSE shows how well or poorly the schedule was executed. The code-3 rate can show how many of the aircraft suffered major malfunctions. The RR and ground abort rate can indicate the quality of maintenance performed. The DD rate can show a requirement for more time to fix minor discrepancies. However, none of these statistics truly represent how well maintenance is supporting the end result desired.

As a result of the emphasis placed on these metrics, flying unit leadership finds themselves bombarded with countless statistics and metrics that provide very little insight as to whether the operators are able to effectively train for combat or not. The wing commander or maintenance group commander at a fighter base can do little to impact each individual statistic and they thus become barely actionable data. The leadership needs to be concerned with macro issues, such as whether the two partners in this relationship are working well to produce an effective end product. The metrics bombardment can often bring leadership attention to a more micro level than required.

To prevent this leadership spiral to the micro level of operations, the existing bounty of metrics needs to be a tool used within the individual maintenance units to assess performance. The micro-level statistics should be removed from the purview of base leadership and used as internal control and performance measures. The leadership exposure should be limited to mission effectiveness and nothing else. Then, if desired by leadership to investigate problem areas, the various metrics can be presented for troubleshooting purposes. The many metrics do not help leadership at the group or wing level unless action needs to be taken to fix major problem areas.

Mission Effectiveness Rate

This article highlights several examples where operators and maintenance assess effectiveness using different criteria. This does not make sense when the two sides are so intertwined and supposedly working towards the same goals. Mission effectiveness should mean the same thing to a maintainer as it does to an operator. There should be no difference as to how the two sides view an effective sortie. Operations cannot base effectiveness on whether certain tasks were accomplished during the mission, while maintenance views any sortie that takes off and safely lands as the measure of effectiveness.

To this end, perhaps a new measure of effectiveness is needed. That measure is mission effectiveness (ME) rate. The calculation of the ME rate needs to be extremely straightforward and focus on the effects-based concept. Merely flying a sortie is not an effective measure of success. Similarly, simply accomplishing a set of tasks dictated by the RAP tasking message cannot be the sole indicator of operational success. Both types of statistics are similar to the sortie counts and bomb tonnage used in Vietnam to gauge effectiveness and are, just as in Vietnam, not an accurate portrayal of whether a fighter organization is ready to execute a wartime tasking. As they exist currently, these metrics provide nothing more than a *square filler* mentality to fighter operations.

The ME rate should consist of inputs from both the maintenance and operations side of a fighter unit. Both units work toward a common goal, so receiving a common *report card* is not an unreasonable method of tracking performance. Under the current system, the maintenance is graded heavily on MC rates while operations focuses on RAP tasking accomplishment. This divided effort can foster detached objectives that may not complement each other. The combination of the two organizations within a unit should then be presented to leadership for their assessment of unit performance.

The basic construct of the ME rate should account for the major competencies of the operations and maintenance structures. At an individual sortie level, the effectiveness of that sortie should be measured by one thing and one thing only. Was the tactical objective achieved? If the tactical objective was not achieved, then there should be an explanation as to why not. For example, assume that a flight of four A-10s (Hog Flight) launches on a surface attack tactics mission. The main objective set by the flight leader is to drop all bombs within a 10-minute time on target (TOT) window and for at least 75 percent of the bombs carried to achieve hits. The ME rate for that sortie would be 100 percent if all four jets dropped within the TOT window and all scored hits.

The ME rate would vary based on maintenance or operation inputs. If one aircraft ground aborts, but the remaining three hit the target as planned, the ME rate would be 75 percent for that flight. In combat, operational fighter aircraft do not fly as single

ship missions. The mission effectiveness is based on the results of the flight and not individual aircraft of pilots. Therefore, individual sortie ME rates should not be used in measuring training. Leadership would be briefed that Hog Flight achieved a 75 percent ME rate and the reason for the rate would be given as ground abort. Conversely, if all four aircraft took off, but only two executed effective attacks, the leadership would be briefed that Hog Flight achieved only a 50 percent ME rate. The reason presented for that rate would be pilot performance.

All the metrics previously discussed in this article are still relevant and should continue to be used to fine tune the performance of the organization. However, the final measure of success should be the overall ME rate. This provides leadership a macro-level tool to focus their attention. If a unit is achieving a consistently low ME rate due to maintenance issues, the commander should focus his or her attention on the processes used by the maintenance organization. Conversely, if a unit achieves a low ME rate due to pilot performance, the leadership may consider investigating the squadron's pilot proficiency and training programs. The bottom line is that the ME rate gives leadership a tool to assess overall performance and an indication of what aspect of an organization needs attention to fix any deficiencies.

flying squadrons. Numerous requirements exist to fly many types of missions and to conduct specified numbers of mission tasks during those sorties, but no true method exists to convey true combat effectiveness to wing leadership and above.

Similarly, the maintenance organization has developed a plethora of statistics and measures of merit to assess performance. As stated in the many governing documents, these statistics are designed to provide a *snapshot* of unit performance in relation to the ability to provide good iron on the ramp for use by operators. However, all these statistics fall short of truly assessing the effectiveness of the maintenance organization to support training and combat taskings. Just as RAP is an ineffective tool to gauge pilot effectiveness, the maintenance statistics do not provide an accurate measure of the support provided to operators. The statistics merely reflect the condition of the aircraft before and after the mission. The desired effect is not tracked by any existing means.

Just as the US military has departed from assessing success based on sortie counts and tonnage dropped, the time has come to enhance assessment of fighter operations and maintenance in terms of desired effects rather than mere statistics. Both communities strive for accomplishing complementary goals. The performance metrics need to measure desired effects and not internal items used to assess and modify performance. The mission effectiveness rate meets this requirement. To implement this concept, old paradigms for assessing performance must be eschewed in favor of a new mentality. That mentality is the focusing of all effort within a fighter organization to support a single goal. That goal is the effect sought. The time has come to modify the current measures of merit and construct a framework that seeks desired effects in a training environment to maximize combat capability in Air Force fighter squadrons.

Just as RAP is an ineffective tool to gauge pilot effectiveness, the maintenance statistics do not provide an accurate measure of the support provided to operators. The statistics merely reflect the condition of the aircraft before and after the mission. The desired effect is not tracked by any existing means. The goals need to measure desired effects and not internal metrics used to assess and modify performance. The mission effectiveness rate meets this requirement.

Summary and Conclusion

Both the flying and the maintenance of fighter aircraft in the Air Force have made great strides since the advent of tactical aviation. The lethality of pilots and aircraft has grown by leaps and bounds when compared to the young aviators flying fabric-covered biplanes during the infancy of flight. Similarly, the logistics community has gone a long way to codify sound practices for repairing and maintaining tactical aviation assets. Both communities have come a long way, but they have not achieved the final solution yet.

The operations community is too entrenched in accomplishing a set number of tasks to gauge effectiveness. Far too much emphasis is placed on the annual RAP requirements as a means to assess training performance. Pilots are required to fly an arbitrary number of certain types of missions to prove combat capability. There is no current method for communicating true performance during training missions outside the individual

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Logistics…embraces not merely the traditional functions of supply and transportation in the field, but also war finance, ship construction, munitions manufacture, and other aspects of war economy.

—Lieutenant Colonel George C. Thorpe, USMC

Logistics comprises the means and arrangements which work out the plans of strategy and tactics. Strategy decides where to act, logistics brings the troops to that point.

—General Antoine Henri Jomini

The hardest thing to change is organizations that have been successful and have to change anyway.

—Deputy Secretary of Defense John White

New conditions require, for solution—and new weapons require, for maximum application—new and imaginative methods. Wars are never won in the past.

—Gen Douglas MacArthur, USA

The creative leader is the one who will rewrite doctrine, employ new weapons systems, develop new tactics and who pushes the state of the art.

—Secretary of the Army John O. Marsh, Jr