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RETHINKING COMMAND AND CONTROL OF INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE

by

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DISCLAIMER

The views expressed in this paper are those of the author and do not reflect the official policy or position of the US government or the Department of Defense.

ABSTRACT

The modern battlefield is more complex than ever: layers of camouflage mask deadly threats, secure communication networks obscure enemy intentions, and mobile systems complicate targeting processes. Paradoxically, analysts must sift a growing deluge of data to derive “decision-quality” assessments. Traditional practices must be reworked to keep pace.

Time-dominant is one example of Airmen leveraging cloud-based tools to speed correlation of vast quantities of multi-discipline information, including social media, with real-time collection. In short, they optimize intelligence platforms by analysis closer to the point of collection. This enables proactive sensor posturing and dynamic collection plan updates.

Just as rapid intelligence analysis is a critical enabler of command and control (C2), so too is flexible C2 a critical enabler of responsive collection. Doctrinal processes divide intelligence tasks into discrete line items disassociated from actual intelligence questions, slowing both analysis and decision-making. Employing a problem-centric tasking model forces direct collaboration and shared understanding which, in turn, speeds analysis, clarifies communications, and accelerates decision-making.

Addressing modern threats, then, requires a problem-centric approach to intelligence tasking and analysis. Optimizing collection is reliant on eliminating prescriptive ISR tasks, integrating big data analytics, and reworking the overall tasking cycle to enable responsive ISR.

INTRODUCTION

Command and control (C2) and intelligence, surveillance, and reconnaissance (ISR) practices have remained largely unchanged since the 1991 Gulf War. Then, destroying Iraq's Scud missiles was a top priority for the US-led coalition, but the launcher's mobility posed significant challenges for ISR platforms responsible for informing C2. The collection plans employed were based on detectable signatures gleaned from Soviet exercise doctrine and when the Iraqis modified their prelaunch procedures and reduced communications, neither ISR nor C2 could adapt. As a result, not a single mobile Scud was killed by airpower during the war.[i] Recent conflicts in Libya, Syria, Sudan, and Ukraine have shown that modern battlefields have only become more dynamic. Today, advanced equipment—often crewed by unattributed personnel—maneuvers around ill-defined frontlines at a blistering pace. The challenge is compounded by new surface-to-air threat systems, such as Russia's mobile S-400 that can limit freedom of movement for airborne platforms out to 250 nautical miles and can disappear before being detected.[ii] To remain effective in this environment, C2 and ISR must evolve.

Evolution must start with current methodologies that are rooted in a deductive approach. The Air Tasking Order (ATO) cycle attempts to simplify complex problems into discrete line items that, if properly executed, achieve the commander's intent. It is a process-centric exercise that is reliant on end users predicting extremely specific details about the battlefield days ahead of time. For ISR, the issue is exacerbated when intelligence problems are disaggregated into inflexible, discipline-specific tasks, e.g. imagery and signals. This may have worked well against fixed facilities easily monitored by routine collection, but modern warfare is not so simple and surviving in it requires a marked departure from the current way of doing business. Effective C2 relies on flexible ISR, just as effective ISR relies on flexible C2.

How can the United States Air Force (USAF) modernize the symbiotic relationship of C2 and ISR to address twenty-first century challenges? First, the USAF must fundamentally shift from deductive to inductive processes. Second, ISR must embrace new technologies and streamline intelligence fusion. And finally, C2 entities must distribute authorities to increasingly lower levels.

DEDUCTIVE AND INDUCTIVE APPROACHES TO ISR

At its core, ISR is an exercise in reasoning, of which there are two basic types: deductive and inductive. With deductive reasoning, one attempts to prove a conclusion using sound arguments.[1] General theories are developed and then evidence is sought to prove them. Put another way, deductive reasoning is a big-to-small approach, like that shown in Figure 1. This set up forces analysts to look for activity that proves or disproves previously assessed enemy actions. Just as changes in Iraqi Scud tactics did not match expectations, the waves of anonymous soldiers seizing airports and government buildings in Crimea during February 2014 did not prove preconceived notions about how a Russian invasion would appear. As a result, decision-makers could not react quickly enough to counter the hostilities. The deductive approach is flawed because it presupposes the enemy's course of action and limits analytic flexibility.

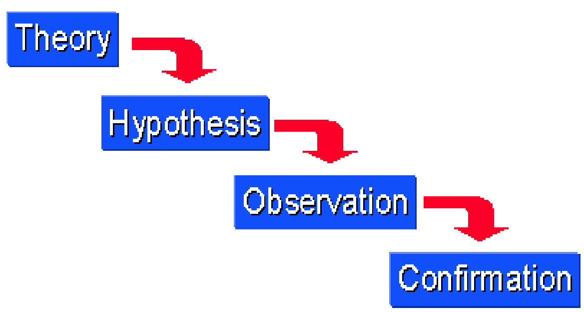

Figure 1: Deductive reasoning[iii]

[1] In *Critical Thinking*, Moore and Parker note that a deductive argument is valid if it is impossible for the premise to be true and the conclusion to be false. Sound arguments are those where the premise is, in fact, true.

Modern ISR planning doctrine exemplifies deduction. The air operations planning process[2] itself is designed to break complex theories about enemy activity into ever more discrete tasks used to demonstrate assessed courses of action. Using the Crimea example above, ISR operated under Cold War era premises that "if Russia is invading a country, they will use tanks" and "if Russia uses tanks, they will move from their garrison." These premises led to the conclusion that "if Russia is invading a country, tanks will move from their garrison." The premise is valid, but not necessarily sound. The overarching intelligence problem in this case would be determining whether or not Russia was invading, but ISR tasking would result in monitoring tank garrisons. The issue is worsened by requirements for end users to disassemble intelligence problems into source-specific tasks to facilitate ATO production, i.e. collection decks. The impact is three-fold: first, end users must develop very specific indicators to monitor well ahead of collection events; second, collection platforms and their associated analysts may not understand the full intelligence problem they are working to solve; and third, the onus for reassembly of resulting collection is pushed to end users, slowing decision-making.

The decision-making process can be sped by applying inductive reasoning, which enables analysts to derive assessments based on a holistic look at activity on the battlefield. With inductive reasoning, the model described above is turned on its head. Specific premises are used to support, not necessarily prove, general conclusions. This small-to-big method, characterized in Figure 2, derives patterns from small observations to develop theories based on the strength of supporting evidence. Put simply, activity drives assessments. In Crimea, analysts may have developed a theory based on small indicators. Premises including, "Russian military activity

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[2] Per Air Force Doctrine Annex 3-0, the ATO cycle consists of objective and guidance, target development, weapons allocation, ATO production, ATO execution, and assessment.

along a country's border is increasing," "unidentified armed men are arriving outside government facilities," and "Russian-made equipment, though not necessarily tanks, is being reported inside another country" drive the conclusion that "Russia is probably preparing an invasion." The conclusion is not unequivocally true, in this example, Russian-made equipment may be prevalent throughout the region and they may be simply preparing an exercise. However, analysts were freed to make an assessment based on a holistic look at activity rather than narrowly focusing on one indicator, such as tank deployments.

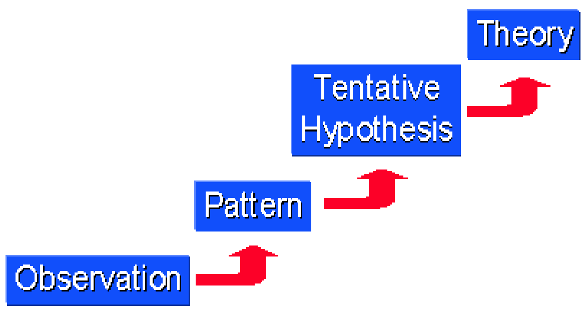

Figure 2: Inductive reasoning[iv]

While deduction may overly bound intelligence problems, induction may open them to a fault. It is important to note that the inductive approach is reliant on a broad definition of the intelligence problem, but it differs from deduction in that the answers or means to get to them are not prescriptive. The difficulties with induction are efficiently sifting through the sheer volume of potential indicators, especially given the multitude of ISR sensors available today, to form a coherent theory of activity on the battlefield and enabling C2 to action said theory. One solution to the former is effective intelligence fusion; a solution to the latter is adaptive C2 mechanisms.

Responding to the rapidly changing nature of the modern battlefield requires balancing deductive and inductive approaches to ISR. Deduction is best suited to establishing baseline assessments and defining key intelligence questions, while induction is most applicable to identifying anomalous activity and answering said questions. The inductive approach is now more practical than ever thanks to new technologies and innovative tactics harnessing the power of big data.

EXPANDING DATA SETS

Broadening data sources increases sample sizes and overcomes some existing sensor limitations by supplementing collect. As an illustrative example, intelligence analysts are constantly looking for detectable signatures, but mobile, camouflage, or silent systems do not present clear indicators, especially against static collection decks. Using the venerable U-2S Dragonlady spy plane, which is capable of simultaneous geospatial and signals intelligence, analysts are limited to a finite number of aircraft and sensor capabilities. Adversary signatures that do not present themselves clearly within the confines of the U-2 sortie times or sensor limitations may go unnoticed. Yet there is a deluge of information awaiting use that can optimize the airborne collection: big data. Big data is not reasonably processed or analyzed using traditional methods, but if harnessed, unlocks a picture of activity never-before accessible that contextualizes airborne collection, ultimately increasing assessment speed and accuracy.

Big data itself is often characterized by what are known as the three Vs: volume, velocity, and variety.[v] Intelligence professionals may also add a fourth “V” of veracity.[vi] Volume describes the total amount of information available to users, such as the exponential rise in the USAF’s MQ-1B Predator fleet to a staggering 164 since its initial operational capability in 2005.[vii] Velocity explains the speed with which data flows to users. In terms of intelligence, this means that analysts may have increasing access to reams of raw or pre-processed data as it is collected rather than having to wait for other agencies to produce finished products. Variety encompasses the diversity of big data including sources and formats. And finally, veracity defines the “quality and provenance of received data,”[viii] colloquially, the size of the data’s grey area. Taken together, these qualities define data sets that will increase sample sizes enabling analysts to better identify and mitigate challenges with traditional sensors. Open source data exemplifies the big data revolution.

As perhaps the most exciting big data-driven medium, open source clearly has a high degree of volume, velocity, and variety, and variable veracity. Historically, open source reporting has been limited primarily to newspaper reporting or broadcast news. These platforms contain a wealth of information, but are difficult to process. Simple key word searches of news articles or transcripts yield basic information about overall content and atmospherics, but care must be taken to identify false reporting, e.g. propaganda from state-owned media. Newspapers or broadcast news also rarely give specific enough locations or times to guide collection efforts. However, technological advances have changed the way that people interact with their world. People focus increasingly more attention online than on newspapers or news networks. As their online presence grows, a person's trail of digit breadcrumbs expands.

Social media is the most prevalent example of digital presence expansion. Interestingly, since users publish their data publically, social media provides free intelligence without the need for covert collection techniques—a fact long since recognized in the commercial world, where customer demographics are routinely collected and used to target advertising. A few general examples: using simple, online tools analysts can examine traffic to and from websites with excruciating levels of detail, including IP addresses, browser types, referring sites, and pages viewed. Analysts may also assess the larger social media landscape by searching for mentions of events, people, or areas in posts. Known users, or even target demographics, could be closely followed for indicators of activity. Presumably, even a small portion of posts would contain geo-tags, or specific locations, indicating where individual users were located. Consolidation of geo-tags from multiple users would give insight into demographics, especially when combined with other data, such as population levels, crime, median income, etc. to provide analytic context. Again, none of this information requires special techniques to gather; users freely offer it.

While a treasure trove in itself, social media content is even more powerful when combined with other sources. Da'esh, the former al Qaida faction responsible for thousands of attacks in Iraq and Syria, has a massive online presence. Their public affairs arm is responsible for countless Tweets, YouTube videos, and infographics detailing operations.[ix] Even posts from out of garrison tank operators, to refer to the earlier Russia examples, may indicate deployments—part of the reason US operations security is so strongly emphasized. These posts can quickly confirm or deny low confidence assessments based on other, more traditional sources. If an adversary successfully counters "normal" intelligence sensors using deception techniques, why not use their own data to mitigate the impacts? Even still, social media is not a panacea for intelligence gaps. Online posts are easily spoofed and often exaggerated, which degrades their usefulness when used alone. The key is increasing intelligence data sample sizes. The next section discusses methods analysts are developing to cope with big data analytics.

INTELLIGENCE FUSION

Practical use of big data sources in intelligence is really a problem of contextualization—a critical function of fusion against a modern adversary. In its most basic form, fusion is the process of combining multiple sources of data to provide a complete picture of activity on the battlefield. By looking at a broader base of activity, analysts are able to identify signatures that may not otherwise meet reporting thresholds. The importance of new data sources and fusion techniques is especially obvious in the example of Russia's takeover of Crimea where Soviet-era principles of maskirovka, or integrated deception, were employed to hide Russia's true intentions. Russia's methods masked signatures traditionally associated with an invasion and, as such, there was not sufficient tactical warning to enable a proactive NATO response. Once the invasion started, the so-called "little green men" who led the seizures of government facilities could not be undeniably tied to any country, slowing international responses. In this case, intelligence analysts incorrectly assumed that simple layering of traditional sources at upper echelons would see through Russia's deception—the results speak for themselves. Clearly, attribution is a more complex problem requiring new fusion methods to rapidly integrate the big data discussed above.

Fusion must emphasize context and characterization over individual collects to identify centers of activity or patterns of behavior indicative of adversary action. If an analyst is empowered to look at the aggregate of collection, then exploitation of every image or signal is no longer necessary; analysts need only exploit those likely to contain useful data. In the social media context, this would be characterizing a network rather than focusing on individual posts to highlights outliers and trends. In this way, clusters of data—centers of activity—and connections between them can be derived easily. The attribution of little green men may actually be possible if analysts are looking at local reporting, military unit postures compared to historic norms, or concentrations of communications. Many intelligence organizations are capable of performing some or all of these functions, making collaboration and deconfliction crucial.

The more data included in a collection scheme, the more important collaborative analytics becomes. To help identify who is doing what, Major Amanda Figueroa defined two broad categories of functions performed by intelligence organizations: content-driven analysis and time-dominant fusion. Specifically,

> Analysts [performing content-driven analysis] nearer to policy-makers provide an understanding of the overall environment in which forces are operating…They communicate what is known about adversary doctrine, training, culture, armament, seasonal weather effects, and a myriad of other considerations and the effects those considerations have on the battlespace at a macro level. Additionally, analysts close to policy makers play a key role in identifying the commander's priority intelligence requirements (PIRs), questions whose answers will lead to decision points.
>
> Analysts [conducting time-dominant fusion] in close proximity to sensors take the articulated commander's intent for ISR and the contextual analyses provided from the policy level and apply them to mission operations, adjusting as required to the realities of any given day. It is because these analysts have a contextual baseline from which to begin that they are able to rapidly identify events which signal the adversary is operating in a different manner than expected…quickly flag the activity, cross-cue to other sensors for multi-INT collection, and provide a rapid, fused assessment of the activity.[x]

Agencies like the National Air and Space Intelligence Center (NASIC) fall into the former category, while the Distributed Common Ground System (DCGS) falls into the latter. Content-driven analysis, which forms baseline assessments, and time-dominant fusion, which identifies deviations from it, are inextricably linked. A further characteristic tying analytic agencies is the requirement for appropriately capable tools.

Tools capable of contextualizing data for analysts have three common elements: 1.) Large volumes and varieties of data are collected from multiple sources, tagged, and stored in an information cloud; 2.) Applications are developed allowing analysts to manipulate, visualize, and synthesize data; and, 3.) Analysts' operations are captured and continuously added to the cloud[xi] to enable collaboration. Today, analysts have access to cloud-based tools, such as Joint Enterprise and Modeling Analytics (JEMA), which allow them to model and automate iterative processes required for processing, sorting, and displaying large volumes of data from a multitude of sources. When combined with powerful geospatial tools, e.g. Google Earth, analysts can easily view data spatially or temporally. Importantly, these new technologies give analysts access to information that would have otherwise gone unreported against which they can apply fusion tradecraft to derive high fidelity, inductively generated, activity-based assessments.

If Airmen can harness the power of big data, how will they use it to rapidly inform decision makers? First, social media will be used as an additive fusion layer to be incorporated into foundational intelligence preparation of the operational environment. This content-driven analytic function is a critical component of putting limited ISR assets in the right place at the right time. Second, it will be used by time-dominant fusion entities to rapidly correlate or modify collection and increase the fidelity of assessments. And third, it will be used to identify deviations from known patterns of life that may indicate adversary actions before traditional sensors can be repositioned. C2, however, must be adapted to take these inputs and respond quickly enough to catch the enemy in the act.

ENABLING COMMAND AND CONTROL CONCEPTS

As illustrated above, ISR must be responsive in order to operate against a modern adversary. In reality, there are two concepts to address: ISR for C2 and C2 of ISR. ISR is the only USAF core capability that has a symbiotic relationship with another; better ISR results in better C2, just as better C2 results in better ISR.[xii] Current C2 processes, such as the ATO cycle, are simply not fast enough to respond to real time developments on the battlefield. In fact, entirely new processes, such as ad hoc collection and dynamic targeting,[3] have been implemented to make up for an ATO's shortcomings. Ad hoc collection, in particular, undercuts Air Force Doctrine Annex 3-60's assertion that "following the collection plan leads to detections."[xiii] Some argue that the reason ISR is unresponsive is because the process is imperfectly implemented. If execution were better, the ISR results would be too. In reality, the world changes too quickly for the ATO; the real problem lies in the industrial-age process itself.

Current C2 models are inherently limited because they emphasize methodical, systematic deconstruction of an enemy, which is dependent on the enemy not adapting adequately. The ATO cycle largely focuses on rigidity over flexibility or the process over the result. That is, successful strategy requires simple modeling of the enemy from which centers of gravity can be identified and then necked down into specific targets for action. Executing assets then impact the right centers of gravity to cause paralysis in the enemy. [xiv] In terms of ISR, supported units must take complex intelligence problems, develop narrow requirements, and generate source-specific tasking. The underlying assumption is that simply collecting the right points or frequencies

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[3] Ad hoc targets are those that are added to collection decks after the ATO has begun execution. The approval chain for ad hocs ranges from minutes to hours, as opposed to 72-96 hours.

enables near-perfect knowledge of the adversary. These processes may work in a static, strategic context, but they are ineffective in dynamic environments.

Warden's Rings, from which planning doctrine is based, do not account for shifting enemy landscapes characteristic of today's battlefields. Thanks, in part, to technological advances, targeting a center of gravity causes the entire system to react. Once the enemy system changes, the initial model is invalid. ISR employment faces the same challenge. One cannot expect that a highly specific collection deck developed over 72-hours will account for troop movements on the battlefield. Noting an insufficient collection deck and simply trying harder during the next evolution is the current, ineffective method. If a key to combating modern adversaries is moving to an inductive approach, then C2 must radically shift away from process-centric models.

Changing the prescriptive process is simpler than it seems at first glance, but it involves delegating additional authorities to lower levels. The availability of full-motion video on every computer has allowed strategic- and operation-level leaders to become deeply involved in tactical-level decision-making, effectively stifling innovative mission commanders with over centralization. Lieutenant General (retired) David Deptula points out that centralized control, decentralized execution[xv] must evolve to centralized command, distributed control, and decentralized execution as an "appropriate progression towards more agile, flexible C2 in an era of increasing threats and accelerating information velocity."[xvi] By empowering lower echelons, commanders can create a thinking organization where ISR operators are given effect-based tasking allowing them to plan based on purpose and intent. They will fuse information to posture sensors and will collect new indicators from which they can derive robust assessments.

One of the most common flexible tasking constructs is the Mission Type Order (MTO),[4] which is generally only employed for short-duration operations. A primary benefit of an MTO is that it does not force a supported unit to use the ATO cycle, at least not in the traditional sense, to accomplish their mission. They are not required to distill their intelligence problems into source- or platform-specific collection decks, allowing each asset to optimize their sensors based on a full understanding of their task. This mutually supports both content-driven analysis and time-dominant fusion processes. Put another way, end users establish all encompassing questions and empower ISR units to seek specific indicators to derive answers. Furthermore, MTOs tie supported units directly to supporting assets, ensuring information flows to the right person.

An MTO also, normally, establishes a distributed control authority. With the freedom to modify sensor employment at the tactical-level, an MTO slashes ISR reaction times by eliminating the need to constantly revalidate collection requirements with higher echelons. Non-traditional indicators, including social media trends, can be easily incorporated into collection planning. Normalizing MTO concepts, in short, inverts "the paradigm of large, centralized theater C2 nodes and develop[s] a system that issues specific direction to… multiple nodes responding in parallel"[xvii] to solve complex intelligence problems. It should be noted, however, that an MTO is not necessarily freestyle ISR; each is scoped with key intelligence questions approved by centralized command, but not prescriptive tasks. An MTO, though, opens the process to allow C2 operators, collection platform crews, and analysts to find innovative problem solving methods. A groundbreaking model in the DCGS is demonstrating one way integrated control, collection, exploitation, and analysis can optimize both ISR for C2 and C2 of ISR.

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[4] According to Joint Publication 1-02, a Mission Type Order is an order to a unit to perform a mission without specifying how it is to be accomplished.

IMPLEMENTING DISTRIBUTED CONTROL

By integrating control, collection, exploitation, and analysis, the USAF created an ideal ISR problem-solving model in the DCGS that can be used as an exemplar of distributed control in practice. Traditionally, the DCGS has been limited to collection and exploitation for only a handful of sensors. Establishment of DCGS Analysis and Reporting Teams (DART) in 2008 added Airmen responsible for linking collection across mission sets to increase analytic fidelity. As DART tradecraft developed, the ability to analyze raw collection proved invaluable to refining collection requirements and optimizing airborne sorties. In fact, in early 2015, at the behest of US Air Forces Central (AFCENT), the DCGS expanded its influence in airborne sorties by assuming distributed control of select unmanned ISR sensors to directly feed target discovery efforts. AFCENT's move singlehandedly flattened hierarchical C2 processes, allowing the DCGS to organize into nimble, multi-source teams capable of inductively locating enemy activity centers leading to a 300% increase in named areas of interest within the first month.

The reason the DCGS target discovery model is so effective is three-fold: first, it focuses on problems over platforms; second, it integrates multi-source analysis from the very beginning; and third, it dynamically re-postures sensors to respond to enemy activity. Not unlike current ISR planning processes, the DCGS-driven process starts with centralized command nodes assigning specific problem sets or priorities based on supported unit needs. As a practical example, AFCENT tasked the DCGS with nominating enemy targets in broadly defined geographic areas and assigned remotely piloted aircraft (RPA) to aid intelligence gathering. However, rather than further specifying the targeting problem into imagery or signals tasks, the new paradigm hands it over to the DCGS to determine the next steps. There, the DART coordinates directly with the supported task force for specific intelligence needs, e.g. product formats. They then pull big data collected over the entire region and overlay it spatially and temporally. This technique highlights clusters of activity, such as groupings of multi-source reports, which are used to develop initial areas of interest. Additionally, the DART collaborates with content-driven analytic agencies to determine expected activity baselines for analysts. Locations of interest are fed to mission planners, sensor operators, and crews to develop initial schemes of maneuver and begin mission execution. Importantly, as the DART uncovers new intelligence, it is fed to the crews; as the crews find new information, it is fed to the DART. Because the controllers, collectors, and analysts operate as integrated teams, they are able to immediately modify the scheme of maneuver to reposition sensors based on real time changes on the battlefield. Unlike existing C2 processes, which require new intelligence to filter through higher echelons before collection plans are modified, this new model directly links analysts and collectors enabling them to respond to enemy adaptations. In the AFCENT example, this means that if the team is investigating a facility and analysts run a JEMA model that identifies enemy communications in a nearby town, they can actually respond in time to find the enemies before they move. Under the old model, the asset would have been tasked to collect on the first facility with only a centralized control node authorized to shift assets to the new activity. Centralized controllers are responsible for the entire battlefield not individual problem sets, which limits their ability to fully understand nuanced tactical details or respond quickly enough to impact operations. Centralization, then, is applied most effectively to the prioritization of problem sets and assignment of resources, rather than specific tactical details therein.

CONCLUSION

The basic mission of any ISR operation is to provide the right information, to the right person, at the right time. However, current ISR processes create substantial roadblocks to the "three rights."[xviii] Specifically, the focus on static target decks prevents analysts from seeking out activity-based intelligence indicative of adversary action (the right information). Disaggregation of ISR tasks distances analysts from their customers and the intelligence problems they are trying to solve (the right person). And finally, rigid process-centric operations restrain otherwise responsive capabilities, potentially keeping critical intelligence "on the rail" (the right time).

Modernizing the Air Force's ability to address activity-based intelligence relies on opening analysts' aperture. An inductive approach to ISR tasking allows for creative problem solving. Analysts can leverage new capabilities and data sources to identify detectable signatures that might otherwise go unreported. By framing tasking in problem-centric terms, supported unit processes are simplified and ISR platforms are freed to optimize their capabilities. Problem-centric ISR tasking, exemplified by the MTO construct, leads to ownership of problem sets. Bookended by content-driven analysis, analysts performing time-dominant fusion are directly tied to their customers and can actually drive collection and subsequent decision-making. In short, the Air Force must do three things: 1.) Enable inductive analysis by eliminating prescriptive ISR tasks, wherever able; 2.) Develop big data analytic tools and empower Airmen with increased training in analytics and information technology; and, 3.) Revamp the ATO cycle using a problem-centric, responsive approach, such as an MTO, as the model.

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