Thinking about Thinking

Training Aircrew to Make Decisions in Complex Situations

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Difficult Decisions

Recently, a flight of fighters in Syria saw evidence that a proregime aircraft struck friendly forces. A rigid command and control structure, coupled with strict rules of engagement that prevented aircrew from deciding to engage without higher-headquarters approval, led to extensive delays in targeting the threat to friendly forces. The aircrew, in this case, acted as most Air Force aircrew likely would—they felt they did not have the authority to make a decision and needed a high-level headquarters to provide guidance.

Several years before, a different fighter squadron deployed to Afghanistan to provide close air support. One day, a pilot participated in a strike controlled by a special task force. As the pilot's flight lead rolled in to attack after hours of preparation, the pilot noticed a collateral damage potential. Unsure of the ramifications of aborting the strike, the pilot quietly radioed "abort" a single time. The flight lead and attack controller missed the quiescent call in the heat of the moment. The flight lead fired, killing the target but also incurring unnecessary collateral damage.

In both stories, highly-trained and well-qualified aircrew faced ambiguous situations—situations in which the fog of war prevented the aircrew from clearly observing the variables or perceiving a single desired outcome. In the first case, the aircrew did not perceive that they were authorized to make a decision and instead were stuck in an interorganizational dilemma as component-level headquarters debated action. For this discussion, *aircrew* includes those officers at the air component headquarters coordinating with the aircrew in flight. These people were all products of the Air Force training model, although they came from several different communities within the Air Force. Of note, when the situation became more clear-cut, the headquarters rapidly approved action.

In the second case, the aircrew's decision was correct but poorly executed due to a lack of confidence. These aircrews went through the typical predeployment training regimen that squadrons usually conduct should time allow. Further, they were the products of perhaps the most robust and high-fidelity aircrew training programs in the world. So why did they perceive they either could not make a decision or not aggressively act when a decision was made? The common thread between these vignettes is a breakdown of normal Air Force decision-making processes in a complex, ambiguous environment.

This situation begs a simple question: why could well-trained Air Force aircrew not make or apply effective decision-making in these situations? The answer is also relatively simple. They did not perceive they could act, or they did not know how to act. This predicament, unfortunately, leads to a more challenging question: why did they not know after years of training? This article attempts to address this question by examining the theory behind Air Force tactical aircrew training.

The author posits that the Air Force excels at teaching aircrews to perform in unambiguous, large-scale tactical environments. However, the Air Force should place more emphasis on proactively developing aircrew judgment and improving the recognition of strategic context as a fundamental attribute of situational awareness. This argument rests on the logic that at its core, sound tactical decision-making rests on the ability to effectively orient. If training only develops judgment and familiarity within clear-cut environments, aircrews will continuously have difficulty making decisions in more complex environments. This difficulty will reinforce the notion that detailed guidance is required for any situation that falls outside clearly defined parameters (leading to repeats of the first vignette) or more simply or poorly made or executed decisions (resulting in undesirable tactical outcomes like in the second vignette). The Air Force needs to *think about how it teaches aircrews to think*.

The Theory of Air Force Training

Currently, Air Force training for tactical aircrews generally follows a decentralized building-block approach. This model relies mostly on squadron-level instructors teaching younger aircrews to solve tactical problems and upgrading those pilots to higher levels of responsibility. As aircrews grow more experienced, the problems they are expected to solve become commensurately more challenging. This methodology produces superbly trained aircrews in the world for solving *identifiable* tactical problems. This approach is insufficient for success in modern conflicts.

The Air Force Training Model

Most people have heard the phrase "crawl, walk, run," at some point in their lives. This phrase aptly summarizes the Air Force theory of training. Initial formal training programs produce basic aircrews and form the first part of the crawl phase.

The crawl phase is all about learning to fly or otherwise operating an aircraft as a junior part of a flight or combat team. The aircrew are taught to perform tactical tasks when directed and trained to be "thinking wingmen"; this means the ability to anticipate a flight lead's or aircraft commander's directions. Wingmen develop this skill through experience. This development forms the latter part of the crawl phase and blends into the first portion of the walk phase.

Walking entails becoming proficient at operating one's aircraft and transitioning from being a wingman to leading a small team—becoming a flight lead or aircraft commander. Squadron commanders design syllabi, framed by limits set in *Air Force Manual* 11-2MDS, to progress aircrew through the various upgrades. Squadron-level instructors conduct this training, guided by commanders and weapons officers. In the author's experience, over time, instructors often develop "pet problems"—somewhat complicated tactical problems they typically present to students.

As an example, an A-10 instructor might consistently present an upgrading flight lead with a convoy being attacked by enemy troops within 100 meters or a close air support strike without a qualified joint terminal attack controller. A common problem in the F-15E community is to have an SA-15 battery "pop up" during the mission. Bomber instructors often present problems such as last-minute target changes or weapons malfunctions.

Most aircrews spend the bulk of their flying careers performing continuation training—meaning aircrew training themselves. The flight leader designs a mission to accomplish specific objectives, usually focused on practicing a specific skill or set of skills. Air Combat Command's (ACC) Ready Aircrew Program provides guidance as to what aircrew must practice on an annual basis. Ideally, aircrews hone their combat capabilities during these flights.

Putting the crawl and walk phases together shows the ideas behind the bulk of aircrew training. During early training, aircrews learn to solve simple, technical problems such as delivering weapons, operating sensors, and so forth. As they perform continuation training, they improve these skills. Once they demonstrate an appropriate level of proficiency, commanders enroll aircrew in squadron-level programs to upgrade them to higher positions.[1] The problems then become more difficult—they are tactical as opposed to technical problems. In general, those aircrews learn to analyze tactical problems and solve them as quickly as possible. Once they have mastered this, aircrews are ready to move into the "run" phase.

A tactical Airman "runner" can plan and lead a package to accomplish a mission. These aircrew members are instructors and mission commanders. As mission commanders, they are expected to be able to compile a series of individual tactical problems into a broader, overarching tactical problem that the mission package must solve. As instructors, these same Airmen must understand how to design training scenarios to teach those skills and the more basic skills acquired during the crawl and walk phases to younger aircrew.

Most activity in Air Force training, therefore, focuses on instilling technical skill and tactical acumen. The Air Force model relies on its Airmen learning the art and science of identifying and solving tactical problems to provide combatant commanders with the right people to execute air warfare. The entirety of this discussion on the current training model leads to this point: tactical problems are the root of Air Force aircrew development.

What is a Tactical Problem?

There is no agreed-upon definition of a tactical problem, but instructors around the Air Force discuss them at length. Air Force doctrine asserts that tactics are "concerned with the unique employment of force" and the "specifics of how engagements are conducted."[2] *Air Force Tactics, Techniques, and Procedures* (*AFTTP*) 3-3.IPE defines *tactical problems* as "meeting the commander's intent within the threat environment."[3] Tactical problems begin with a phrase well-known to most operations Airmen: backward planning.

Tactical problems begin with an effect correlated to a point or set of points, in time and space. At its most simple level, this could be an air-tasking order-directed strike on a fixed target—like a bridge—with a tasked time-on-target for weapons impact. Depending on the scenario, there might be friendly ground forces or collateral damage concerns that complicate the situation. Often, there may be several ways of achieving the desired effect, although, the weapons one takes off with limit those choices. Which kinetic or nonkinetic munition the planner selects is based on several factors that revolve around risk.

While strategic risk can be much more complex, operational and tactical risk can generally be divided into two categories: risk to mission and risk to force. Within these categories, most Air Force tactical communities tend to emphasize certain issues during training to generate risk. Instructors simulate risk to mission through technical failures (like onboard system failures), communications failures (flawed information passed), or late changes (target changes). Instructors present risk to force via enemy threats, usually surface-to-air threats based on replication availability. Tactical problems, therefore, are situations in which aircrew must mitigate risks to deliver an effect at a prescribed point in time and space.

Solving Tactical Problems

Solving these problems entails combining resources with specific tactics. Tactics are specific formations, maneuvers, contracts, and any other techniques or procedures used to employ the resources. Resources are tangible assets allocated to a given mission, such as aircraft, weapons, nonkinetic/nonlethal capabilities, and so forth. Aircrews decide how best to distribute the available resources and what tactics to use to create the overall mandated effect while mitigating risk to the mission and the force.

Often, aircrews make these decisions on the ground during mission planning. The Air Force model emphasizes planning as the best time to resolve the myriad issues, making tactical problem-solving difficult. The purpose of mission planning, according to *AFTTP* 3-3.IPE, is to solve tactical problems.[4] Aircrews learn to determine artful combinations of resources and tactics to create tactical solutions. When progressing to higher levels, the problems become more complicated and expectations for solutions grow, leading to the preparation of multiple solutions in case the situation in flight invalidates the primary solution. The purpose of mission planning is to make decisions "at one g" to speed decision-making in flight. This model developed over decades based on hard lessons learned in the last 70 years. The model's strengths and weaknesses are rooted, wittingly or not, in accounting for how people think.

The OODA Loop and Heuristics

It is misleading to suggest that there is a single, articulated theory that underlies the described Air Force model. As argued previously, the bulk of aircrew development occurs within the operations groups and squadrons. This circumstance means that aircrew training and education are inherently decentralized. Each community develops its perspectives on what issues are important, and groups and squadrons further refine those perspectives. Nevertheless, common threads are observable across the tactical flying communities.

In military aviation, the ability to make accurate assessments and good decisions promptly is paramount. In one of the only codification examples of decision-making in Air Force guidance, most flying standardization and evaluation criteria include a category labeled as "Airmanship" or "Situational Awareness." This category is listed as "critical," and typically the first criterion listed is that the mission is executed in a "timely, efficient manner." The second criterion is along the lines of flying with "a sense of understanding and comprehension" of the situation, even as it changes in flight.[5]

Making sound decisions quickly based on an accurate understanding of the situation relates to John Boyd's famed Observe-Orient-Decide-Act (OODA) Loop. Boyd developed the OODA Loop initially as a model for understanding decision-making during dogfights. The pilot who could adapt to change faster would win the fight.[6] While Boyd adapted the OODA Loop dramatically throughout his lifetime to embrace strategic-operational problems, its original aerial tactical application remains a key part of many Air Force pilots' thinking. Instructors tend to focus on teaching their students to recognize situations and react as rapidly as possible. To do this, they present tactical problems to students with the goal of developing useful heuristics (mental models for solving problems). Two examples of basic heuristics taught to aviators from the beginning are "aviate-navigate-communicate" and "maintain aircraft control, analyze the situation and take the proper action, and land as soon as conditions permit." These simple phrases, drilled into their minds, provide a basic model for aircrew to understand prioritization and how to deal with emergencies, respectively.

In *Thinking, Fast and Slow*, Daniel Kahneman described the two systems that govern much of human thinking. System 1 functions automatically and quickly, while System 2 uses effortful thought to solve challenging problems.[7] When one intuitively knows the answer to two plus two, that is System 1 in action. However, years of experience as a child led to learning basic arithmetic skills, meaning that a developed mental model can be quickly applied when presented with a simple addition problem—a heuristic model. When thinking intensely about a chess move, that is an indication of using System 2 thinking. Unless already a chess master, a person does not have a model available to make rapid decisions, meaning they must consider the options before deciding and acting. Air Force training works under the presumption that a person can learn to *intuitively* know the right tactical "move" with the appropriate experiences, in the same way of intuitively knowing that two plus two is four.

This presumption is valid but only if the context is similar. Using the chess example, heuristics certainly help people play the game better. Psychologists and scientists conducted numerous studies of chess players in the past century. The general conclusion is that experienced players perceive chess positions as "chunks" or certain groupings of pieces. Having already learned the best move(s) for a given chunk, a player can quickly decide on an action. Masters may possess up to 100,000 chunks, while average players remember far fewer.[8] This example illustrates the idea behind Air Force training. Aircrews learn to recognize tactical problems and apply known solutions to solve them. This model only works, though, if both sides are playing chess and with the same ruleset. Aircrew judgment honed to function only with a narrow contextual frame will not benefit one's decision-making if the situation is outside that frame.

Kahneman's concept describes the cognitive process which occurs while working through the OODA Loop (see fig. 1). First, observe a situation. Observing, in the context of aircrew in a tactical environment, encompasses what Airmen refer to as situational awareness. This OODA Loop phase is defined as an aircrew's "continuous perception of self and aircraft concerning the dynamic environment of flight, threats, and mission, and the ability to forecast, then execute, tasks based on that perception."[9] The second portion of the definition shifts into orientation and decision.

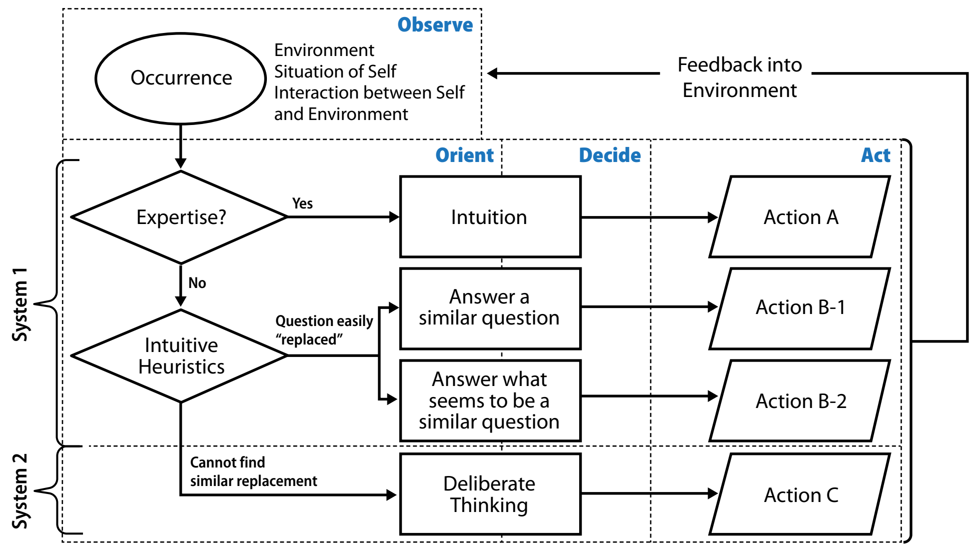

Figure 1. Kahneman's basic System 1/System 2 model overlaid with Boyd's OODA Loop

Boyd referred to orientation as "the big O," and it formed the center of his final iteration of the OODA Loop. He described *orientation* as an "amalgamation of genetic heritage, cultural traditions, previous experience, education, new information, and the analysis and synthesis that follows."[10] During tactical execution, orientation is the process of assessing the competing variables in an environment through a lens provided by years of Air Force training. Variables include physical properties like relative positions of objects, situational context like the intent of the current mission and rules of engagement, and cognitive context.

Cognitive context is the variable-set most applicable to this article. An Airman's mind is the place where aircrews interpret the observed physical and situational variables and assign meaning. This process allows the person to produce a set of possible decisions. The Air Force training model helps and hinders this process.

Earlier, this article explained System 1 thinking as an automatic, intuitive process. Kahneman argues that when people observe an occurrence, their minds seek a quick answer. People determine if the situation is precisely like one seen many times (and therefore already have a valid solution to the problem). If so, they apply the solution previously applied to the same problem. Humans rely upon an almost continuous stream of heuristics to navigate everyday life. Yet, despite their importance, they can, in some cases, have significant limitations and consequences. This tendency is particularly true for aircrew flying in a high-stakes, time-compressed environment.

Consider the difference between two pilots performing basic fighting maneuvers. If the flight lead has several thousand hours and thus has performed this skill potentially hundreds of times, this pilot will make any number of intuitive decisions during the engagements with minimal mental effort. Another pilot, fresh out of mission qualification training, may be unable to make those same decisions or take several seconds to enact a decision the experienced pilot performs in less than a second. This situation is intuition, or the lack thereof, at work. However, even highly experienced aircrew encounter less familiar situations.

If one cannot apply a known solution, the mind tends to transpose what it deems a similar situation to apply a solution perceived as valid. The mind finds a presumably acceptable existing model and unconsciously applies it to the current situation. This process can have serious consequences in solving novel problems.

Returning to basic fighter maneuvers, consider what often happens the first time a pilot fights another type of aircraft. Usually, even despite a briefing to the contrary, the pilot maneuvers in a way proper for fighting a similar aircraft but potentially inappropriate for a dissimilar aircraft with different weapons or flight characteristics. This tendency is an example of replacement. The pilot recognizes the situation: a dogfight against a dissimilar adversary. The pilot's mind, attempting to remain in System 1 thinking, orients on the situation by recalling heuristics useful for fighting a similar aircraft rather than go through the difficult process of determining new models for fighting the new aircraft. The mind presents a solution that appears valid but does not correspond to the true situation. Regardless, only if these two attempts to find an intuitive solution fail—or if one deliberately chooses—does the mind switch to System 2 thinking.

When one cannot intuit options, the mind resorts to deliberate thinking. This mode of thinking, while slower and more effortful, is best suited to resolving unfamiliar or complex problems. It is so effortful that using System 2 thinking can make one "effectively blind, even to stimuli that normally attract attention."[11] A characteristic of upgrading aircrew, especially in more difficult programs like instructor upgrades or the Weapons Instructor Course, is for students to stop communicating when the scenario becomes especially challenging. Most instructors can convey stories of students who either stopped acknowledging communications, stopped talking, or both. Likely, the student was in System 2 thinking. The student's mind was so focused on deliberately thinking through the problems that the student was unable to do other tasks, even critical ones, like communicating.

Air Force training aims to help aircrew remain in System 1 thinking—especially in flight—by building expertise or the ability to apply intuitive heuristics and thus orient, make decisions, and act quickly. Air Force training seeks to develop useful heuristics for an aircrew to make decisions earlier in the decision-making process, thereby speeding the OODA Loop cycle. Possessing a robust "toolkit" of models to resolve tactical problems with, aircrew should theoretically be able to make rapid decisions by operating mostly in System 1 with System 2 merely cross-checking the results of System 1. This conclusion brings the discussion back to the notion of tactical problems.

Previously, *tactical problems* were defined as comprising two key elements: effects and risks. Through years of training, aircrews learn to deliver effects at discrete locations and mitigate risks, including risks to the mission and force. Boyd's OODA Loop suggests that whoever can adjust to a continuously changing environment faster is more likely to succeed in a fight. Therefore, Air Force training strives to teach expertise for technical tasks and heuristic models for solving tactical problems so that aircrew can make quick decisions by remaining largely in fast System 1 thinking.

This system is quite effective at producing highly skilled aircrew for large-scale combat. When Air Force aircrew know exactly what the desired outcome is, they excel at determining solutions to problems. The Air Force training process produces aircrew with a mastery of dealing with clear tactical environments in which failure is only possible through poor execution.

What happens, though, when an aircrew does not know what the desired effect is? The very structure of the tactical problem breaks down because there *is no clearly defined desired effect*. The two stories in the introduction, as well as many others just like them, suggest that the current system does not prepare the aircrew well for the unclear situations that are becoming more commonplace in the various operating environments around the world.

Judgment

If tactical problem-solving revolves around combining situational awareness and judgment within a contextual frame to select a course of action, then failures in decision-making must stem from failures in one of those two broad categories. A brief examination of the ways instructors teach situational awareness and judgment suggests that any shortcomings with the current model stem from efforts to teach judgment.

Situational awareness is a key element in most aspects of the Air Force training model. Every aircraft standardization manual includes situational awareness as a critical criterion for evaluation, illustrating its perceived importance. This importance also plays out in training methodologies.

Debriefing techniques focus extensively on situational awareness. In the last two decades, the debrief focus point process took hold within the Combat Air Forces. After identifying the root cause of a problem, one should determine if the issue was an "input error" (the aircrew did not have correct situational awareness), "output error" (the pilot had situational awareness but did not execute as intended), or "decision error" (the pilot had situational awareness and executed as intended but made a bad decision).[12] While the specific terms vary in usage, this concept is embedded within ACC learning methodologies. Two of these errors are rooted in technical expertise and situational awareness. The third, decision errors, alludes to judgment.

Judgment, though, is a more elusive quality to both learn and teach. Sir Andrew Likierman, a former dean of the London Business School, asserts that *judgment* is "the ability to combine personal qualities with relevant knowledge and experience to form opinions and make decisions." The same author further argues that good judgment is essential to making decisions in ambiguous situations—the crux of this article.[13] Assuming that an Air Force flying training model is unable to meaningfully change someone's personal qualities (perhaps not a fair assumption, but necessary to limit the length of this discussion), this leaves the question of how the Air Force training model provides knowledge and experiences to inform decision-making.

Studies into critical thinking divide knowledge into three categories. *Declarative knowledge* is concepts, stories, principles, and so forth to make inferences. *Procedural knowledge* is knowing when to use declarative knowledge to act.[14] *Metacognition*, also called executive control, makes plans, sets goals, and observes the effects of one's actions.[15]

Analyzing this categorization of knowledge informs the type of knowledge one needs for good judgment is metacognition. Metacognition, typically described in an educational sense, focuses on the ability to assess one's thinking processes.[16] An aviation example of metacognition can be seen during emergency procedures. Part of the emergency heuristic described earlier and taught to all Air Force pilots is to "assess the situation." Metacognition is the part of the thought process that, after the aircrew has diagnosed the problem, pauses for a moment to verify that there are no other variables that might recommend a different course of action.

The Air Force model certainly provides both declarative and procedural knowledge. The training process supplies ample instruction in the technical aspects of performing aviation tasks. Additionally, the nature of aviation makes it difficult to perform tasks out of a suitable context. In an extreme example, one can see that performing a task normally associated with landing while cruising, like landing gear, would be "self-correcting." Since the training model provides these two forms of knowledge, instructors should ensure that they also deliberately teach metacognition. Figure 2 adds the forms of knowledge to the previous thinking model.

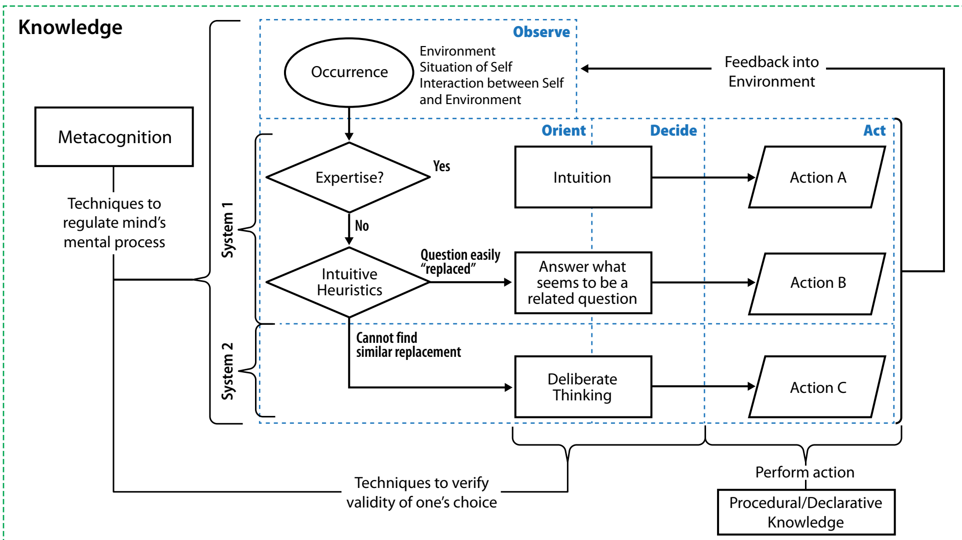

Figure 2. Kahneman's basic System 1/System 2 thinking model overlaid with Boyd's OODA Loop and forms of knowledge

One learns metacognition (and the other forms of knowledge) through the second aspect of judgment described by Sir Likierman: experience. The discrete events that comprise a typical training experience for an Airman teach that person technical expertise and a variety of heuristics to solve technical and tactical problems. Those experiences also coalesce into metacognitive processes that help an aircrew make choices about which expertise or model to apply to a given situation.

These observations lead to the conclusion that an aircrew's experiences and reflection on those experiences produce intuition, heuristics, and metacognitive processes. When a situation causes the aircrew to progress beyond the first stage of System 1 thinking (expertise), metacognitive processes guide the selection of heuristics or movement into deliberate thinking. Therefore, if experiences provided in training do not present ambiguous situations or operational context, it is significantly more difficult for an aircrew to develop the judgment to deal with complex situations. Worse, aircrew members might apply an irrelevant heuristic to the situation, make a poor decision, and not possess the metacognitive qualities necessary to validate their own decision. In short, the lack of ambiguity and context in training breeds the mental paralysis demonstrated at the beginning of this article.

Recommendations

Air Force training methods should more deliberately cultivate judgment to better prepare the aircrew for complex contemporary operational environments. This goal can be achieved by incorporating ambiguity and more complicated context into training environments. Instructors should present aircrew with situations in which there is no "right" or "winning" answer—situations that force the aircrew to make hard choices based on incomplete information. Given the decentralized methodology of Air Force training, these recommendations focus primarily on options for implementation at the squadron level.

Ambiguity

Ambiguity is the most important variable that should be introduced into training scenarios. By presenting aircrews with unfamiliar problems for which there is no clear answer, instructors will force them into System 2 thinking and provide opportunities for metacognitive development.

In most training tactical problems, the desired effect is clearly understood by the aircrew. The learning mostly occurs in using situational awareness and judgment to determine the best combination of resources and tactics to deliver that effect while mitigating risk. However, there is great value in sporadically presenting problems in which the answer is unknown. This tactic will force the aircrew to decide which resources they should use (or even if they should apply resources) and in what tactical manner given the situation.

One example, already becoming familiar given recent experiences in Syria, might be to include a third-party actor in an air interdiction scenario. A potential target could either belong to the intended enemy or the neutral third party, forcing the aircrew to decide whether to strike. Additionally, a third-party surface- or air-based platform might threaten trainees, forcing them to decide how to react.

Some challenges might even present moral dilemmas. For example, many Weapons School Integration phases include a noncombatant evacuation operation. The instructor of this mission could create a situation in which enemy forces break into the base perimeter during the loading process, or the assembly area begins to take artillery fire. Such a circumstance forces the mission commander to make an exceedingly difficult decision that has no clearly "correct" answer. Other opportunities exist to simultaneously force decision-making in ambiguous circumstances and enhance the concept of all-domain operations.

An instructor can generate a plan for a student that includes certain simulated effects created within or through other domains. At the appropriate time within the scenario, the instructor can either tell the student the desired effect was not achieved or provide no input whatsoever, forcing the aircrew to make a hard choice about further actions.

These options, among a myriad of other possibilities, intend to create situations in which there is no clear answer. The purpose is not to instruct the aircrew (whether in flight or the debrief) on what the *right* answer was; instead, the intent is to provide an opportunity to develop *judgment*. Ambiguity forces aircrew to apply System 2 deliberate thinking and use metacognitive skills to assess their thinking to ensure that their actions make sense in the given environment.

Operational Context

The above suggestions require that instructors put thought into the operational context of a given mission. Boyd emphasized context in a variety of forms as a key part of orienting. An Army research paper on tactical problem solving cited context as "the foundation for rational decision-making and purposeful activity."[17] Since most of the arguments in this article revolve around the process of orienting and deciding, the context within training is vital. Indeed, the *Integrated Planning and Employment* manual (*AFTTP* 3-3.IPE), asserts that "tactical experts need to be aware of the multi-domain context in which their missions are conducted and strive to understand how their tactical operations both rely on and bolster other domains."[18] Without context, situational awareness is incomplete since context-less awareness would only include the physical aspects of the situation and ignore countless other variables which should inform judgment.

This lack of awareness does not mean that each training scenario requires an intricate backstory or a highly developed plot. Instead, instructors should deliberately provide information before the mission that should color the upgrading aircrew's perspective. Then, the instructor should strive to present a situation in which the aircrew must make a decision, taking the information into account.

An example that applies to any counterland mission might be to lay out a situation in which the aircrew must disrupt or prevent enemy movement through a certain area to enable friendly action in another domain. Then, the instructor might present easy targets in different areas of the battlespace to see if the aircrew loses sight of the intended purpose. Another related example is to place a scenario within a more constrained operational environment. Consider the difference in decision-making that might result from presenting the same target, such as a convoy of light armored vehicles traveling through a town, in a large-scale combat context versus a more constrained context like that present over Kosovo in 1999. In a large-scale combat environment, it is likely appropriate to attack immediately. In a more limited environment, a better decision might be to wait until the convoy is in the open, although there is a risk associated with potentially losing track of the target. These sorts of decisions and risk-mitigation discussions are precisely the point of introducing tactical problems within different contexts.

When to Introduce These Concepts

In a recent discussion about this subject, an instructor asked this author at what training level such concepts could be realistically introduced. While there is no clear answer to this important question, it seems logical that these ideas do not apply to early training ("crawl" phase) when aircrews are still learning basic skills. Instructors should introduce minor contextual problems or small amounts of ambiguity to aircrews in the intermediate ("walk") phase of training. Aircrews in the advanced ("run") phase should receive more complex context and ambiguous situations to further develop judgment. This approach rests on the idea that there is a distinct separation between technical skill and tactical problem solving.

During early training, aircrews learn technical skills—how to operate systems, how to perform maneuvers, and the like. They do not need to learn why to use those skills. The expectation is that a flight leader or aircraft commander will inform them when it is time to employ a known skill. Ambiguity or complicated context would merely confuse the learning objectives.

However, the latter phases of training teach aircrews to solve tactical problems. Aircrews should learn from the beginning that selecting the appropriate resources and tactics for a given problem does not rest solely on the tactical situation. There are broader considerations that should inform their judgment. Further, the situation may not always be clear, and context should help inform their decision-making in those times.

The need to learn good judgment should be balanced, though, with the understanding that aircrews in an upgrade are usually performing a role for the first time. Most of the tactical problems that aircrews face should be clear and the context relatively easy to understand, allowing them to develop a baseline for judgment. As the aircrew progresses through the given upgrade, they should be presented with more complicated context and ambiguous situations commensurate with their experience and performance. Only by presenting these situations will aircrews develop better judgment tools.

Continuation training is another opportunity to present ambiguity and context. This form of training is where aircrews spend most of their flying careers and, ipso facto, where they develop most of their perspectives on decision-making. This approach may not always be effective because it is challenging for flight leaders or aircraft commanders to give themselves a problem to which they do not have an answer. Further, there is some risk in this approach. Overzealous aircrews may give themselves or their wingmen problems that put them into unsafe situations. Additionally, each time someone resolves a problem, they create a new heuristic for themselves.

These considerations lead to three conclusions. First, ambiguity and context should be presented during upgrade training because instructors are the best people in a squadron capable of managing safety, and the upgrading aircrew will not know the answer ahead of time. Second, commanders should consider having instructors fly on continuation training missions with the express intent of presenting such situations to the other aircrew. Finally, the point is not for an aircrew to conclude in a debrief that "when faced with X, I should do Y." The goal is to look at a successfully resolved problem and ask, "how did I approach thinking about this novel problem that worked out so well?" Instructors should not repeatedly present the same problems to an aircrew. Such a practice reduces the likelihood of aircrew-building heuristics, instead encouraging increased emphasis on *thinking processes*.

Opportunity Cost

Such an approach should improve the overall quality of an aircrew's thinking. As a result, an aircrew would be more capable of effectively orienting during future missions. This, in turn, would make the aircrew more capable tactical problem solvers. Leaders should not, therefore, view adding ambiguity into training scenarios as an additional burden to already overtaxed squadron training schedules.

Ideally, the Air Force should fund additional flight hours to give commanders more sorties to provide this sort of training. However, fiscal realities, steadily increasing costs per flying hour for large portions of the CAF's fleet, and squadrons already flying their aircraft at or near maximum sustainable utilization rates make increasing sorties unlikely. Additional spending due to COVID-19 in excess of $4 trillion makes any increase in sorties virtually impossible in the near future since defense budgets will probably reduce.

If live flying resources will not increase, commanders should consider reducing or even dropping training time spent on familiarization-only recruiter assistance program events. The added time could then be used to add the training described in this article. The improved aircrew judgment that would result would presumably improve their ability to make better decisions in missions they are unfamiliar with, potentially offsetting the negative aspect of cutting familiarization training.

Another option is to leverage simulators. Simulator missions generally require minimal effort to produce and have the advantage of being able to present entities and situations not easily created in typical live training. However, simulators often suffer from technical issues that sometimes detract from the desired tactical focus (nonfunctional systems, improper displays, etc.). Additionally, commanders will need to devote instructors' time to simulator missions. In this author's experience, most simulator mission debriefs last for 10 minutes or less absent significant errors. To get the full desired effect, a simulator debrief should incorporate a full analysis of the student aircrew's decision-making and performance, using debrief focus points or learning points just like a live flight.

Time spent on ambiguous tactical problems invariably means that one or two more traditional tactical problems are not presented. However, aircrews will still spend most of their training time solving traditional tactical problems (those with clear-cut desired outcomes and sufficient information available to accurately orient to the situation with few unknown variables). Thus, they will still achieve a similar level of skill at general tactical problem solving. Introducing ambiguous problems should only improve an aircrew's overall problem-solving ability, not detract from the skillset development the current model instills in the aircrew.

Conclusion

The Air Force training model is a sound concept that has delivered exceptional results over decades. However, the operational environments aircrews may face in the next decade are unlikely to be characterized by relatively unrestricted, large-scale combat against peer adversaries.[19] While Air Force aircrews should prepare for that possibility, they must also be able to make decisions in more ambiguous and confusing environments like those found in Afghanistan, Syria, or the next potential combat zone.

Air Force commanders and instructors should emphasize developing nuanced judgment within the aircrew. Aircrews should enhance their situational awareness with deeper understandings of operational context. Introducing operational context and ambiguous situations into training regularly should improve and develop aircrews' judgment throughout their flying careers. They should then apply that judgment to complex situations and make reasonable decisions that advance the joint force, through tactical action, toward achieving operational and strategic objectives. ✪

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Notes

1. While squadron commanders choose who is placed into an upgrade, Air Force Instructions (AFI) and *Air Force Manual* (*AFMAN*) 11-2MDS Volume 1 set out minimum experience levels for many specialized upgrades. Usually, these levels are based on flying hours.
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4. AFTTP 3-3.IPE, 2-1.
5. Reference any AFI or AFMAN 11-2MDS Volume 2, *Evaluation Criteria*.
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19. Raphael S. Cohen et al., *The Future of Warfare in 2030: Project Overview and Conclusions*, RAND Report RR-2849/1-AF (Santa Monica, CA: RAND, 2020), 47, https://www.rand.org/.