In this chapter, we will identify the factors that constrain the capacity of operational units to absorb newly trained pilots. We recognized in Chapter Three that newly trained pilots must first be assigned to an operational unit so that they can fly under the supervision of flight leads or aircraft commanders while they develop the operational knowledge and mission experience essential to subsequent assignments. This process of gaining operational knowledge and mission experience must be incorporated into what we mean by absorption. Although this aspect of absorption is not explicitly addressed in AFI 11-412, the explanatory text makes clear that it is an important concern. Because the capacity of operational units to absorb newly trained, inexperienced pilots is limited, a better understanding of absorption constraints and their implications is essential for policy decisionmakers. This need is not new, however, so it will be useful to consider the historical context that led to the existing aircrew management system.

HISTORICAL BACKGROUND: THE ORIGIN OF RDTM

Following the end of the war in Southeast Asia, the Air Force encountered severe aircrew manning problems. These difficulties were caused by the force structure reductions that followed the end of hostilities combined with the continued flow of new aircrews out of the sizable training pipelines that had been assembled to feed wartime combat needs. Such problems were clearly exacerbated by other factors, including changing aircrew demographics, peacetime
training constraints resulting from rapid peacetime budget reductions and the 1973 fuel crisis, conflicting residual combat attitudes, and policy decisions governing aircrew composition and combat tours. The situation’s severity led the Air Force to recognize that if the problem was to be corrected, a dramatic paradigm shift would be necessary to ensure that an adequate long-term aircrew management system could be developed and implemented. The new paradigm, called the rated distribution and training management (RDTM) system, was implemented in USAF Program Guidance PG-77-1 dated January 6, 1975. The system’s purpose is quoted directly from that document:

f. Rated Distribution and Training Management (RDTM). RDTM systematically determines the interrelationships existing between various individual weapon systems and other functional areas and then manages all functions associated with those weapon systems in such a manner that requirements of each weapon system are met. To accomplish the foregoing, both requirements and resources need to be identified and projected throughout the Five-Year Defense Program in order to determine the training required to bring the two into balance. . . .

(1) The FYDP training rate is used as a departure point to define short-term absorption (the ability of a weapon system to accept new pilots and maintain an acceptable experience level in the cockpit). Computations on absorption are a function of cockpit positions, experience definition, percent experience desired, the formal course washout rate, and the time (years/months) to reach experienced status. . . . Absorption models are on line for all weapon systems and are used to compute UPT/FAIP distribution.

The importance of turning new pilots into experienced ones in the absorption process is clear in the above context, and our list of ab-

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2Headquarters (HQ) USAF, USAF Program Guidance PG-77-1, Section C, paragraph 4-10, January 6, 1975, pp. 4–20.

3The emphasis on the absorption definition is ours. We should note that the FYDP has since been extended and renamed the Future Years Defense Program, but its purpose remains essentially unchanged.
Absorption constraints will not differ dramatically from that given in this quotation.

The steady-state absorption models for each MWS category cited in the quotation above was an approach toward aircrew management that represented a significant advance over previous efforts. However, additional challenges have emerged during the past decade as a result of an ambitious defense strategy that was inadequately supported by a reduced and underfunded force structure. 4 We will see that these challenges require that the RDTM concept be expanded to incorporate a systemic approach toward aircrew management that also captures the dynamic properties of the behavior both within and among MWS categories.

We will continue to discuss additional original RDTM innovations as they pertain to our development of the absorption constraints.

**ABSORPTION, PRODUCTION, AND ABSORPTION CAPACITY**

Most of the terms that we will use in the sections that follow are already familiar. We will develop them here, however, because of their importance and because precise terminology is essential to our modeling effort, which enables us to examine numerical excursions for a variety of parameter values. 5 Our point of departure is the AFI 11-412 definition of absorption.

**Absorption**

Recall the AFI 11-412 definition: “Absorption is the number of inexperienced crewmembers that can be assigned to a major weapon system per year.”

Although this definition seems clear, experience compels us to discuss it more fully. Two key issues need to be addressed in this context. The first is to accurately identify the source of these inexperienced pilots. Because pilots are assigned to an MWS, absorption ignores any UFT graduates who initially go to flying...

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4 See Larson et al., 2001.

5 Several of our models are documented in a forthcoming RAND publication.
assignments in non-MWS aircraft. This means that the absorption process will not deal with FAIPs, for example, until they have completed their UFT instructor assignments and have entered the appropriate FTU B-Course or IQT program to become qualified in their specific weapon system. Thus, the source of the inexperienced crewmembers to be absorbed (in accordance with the definition) will be the FTU B-Course (for fighters) or the initial IQT program (as appropriate for other MWSs).\(^6\)

The second issue is to establish when the absorption process terminates. There is a definite experience condition implied in AFI 11-412, and the same paragraph that states the absorption definition also establishes the approval authority for constraining absorption because of experience. Indeed, the italicized portion of the RDTM statement of purpose quoted above confirms that a primary objective in introducing the absorption concept is to provide a means of managing experience within a weapon system. This is readily accomplished by tracking the inexperienced pilots assigned. We will thus concur that the absorption process terminates once new pilots have become experienced in accordance with the rules that apply for the appropriate weapon system. We will develop precise definitions soon, but first we turn to production.

**Production**

Although we have established a very close relationship between absorption and B-Course production within an MWS, there is a clear difference in meaning between the two. The RDTM purpose statement and AFI 11-412 both make it clear that absorption concerns should *constrain* production. Indeed, RDTM provided the first formal recognition of this fact by the Air Force. Historically, fighter pilot production had to be dramatically increased during wartime to meet combat needs, and newly trained pilots were rushed into combat from replacement training units with little concern for their initial training adequacy or for their future development as fighter pilots. The following description captures the essence of that approach:

\(^6\)The definition quoted is given in Department of the Air Force, AFI 11-412, paragraph 4.5.1, August 1, 1997. We will deal primarily with fighters, so we will use the term *B-Course* for the initial formal training course required for any weapon system.
No one who attended a replacement training unit (RTU) during the Vietnam War would deny that the mission of those squadrons was to mass-produce fighter pilots to fill wartime cock-pits. . . . Everything they needed to know to survive combat and become an efficient killing machine had to be learned in the RTU. These schoolhouses for fighter crews were the only chance for learning before the crucible of combat. Nonetheless, most who attended them remember the schoolhouse as a poor learning experience that did not adequately prepare them for the rigors of war.\textsuperscript{7}

Clearly, absorption was not a concern at that time. The training revolution that would follow, however, was designed to correct the aircrew and aircraft losses experienced by units flying combat in Southeast Asia—an effort that was prompted by Air Force leaders’ recognition that more of these losses were caused by lack of experience than by enemy fire.\textsuperscript{8} It had become clear that the collective experience of a unit’s pilots provides a useful indicator of that unit’s readiness and combat capability.

We will see that pipeline capacity and absorption should impose upper, or maximum, constraints on production, while Eq. (3.1) establishes a desired lower, or minimum, limit (for given requirements and retention rates). We will use the term \textit{production rate} to indicate the annual B-Course output of pilots in a specific aircraft weapon system type (or MDS). We can then obtain the production rate for an MWS category by aggregating production rates for the appropriate MDSs.\textsuperscript{9}

It will remain essential to separately track who enter their B-Course directly from UFT and those (such as FAIPs) who enter from a non-MWS aircraft because pilots who are late arrivals into their MWS inventory are expected to benefit from the additional flying experience they gain during their intervening tour. The system assumes that such pilots will be able to acquire essential experience—i.e., will

\textsuperscript{7}Anderegg, 2001, p. 17.

\textsuperscript{8}Anderegg, 2001. The primary focus of the book is the training revolution that the Air Force achieved in the decade following the Vietnam War. This revolution took place in association with RED FLAG, the aggressor program, and other innovations that occurred during that period.

\textsuperscript{9}One can make a strong case that the absorption constraint should be included in the pipeline capacity because of the limit it imposes on new pilot production rates.
complete the absorption process—more rapidly once they begin their operational flying, and many are indeed qualified to function as flight leads and aircraft commanders sooner than their B-Course contemporaries who came directly from UFT.

It is important to distinguish between programmed and actual production rates because every pilot who completes B-Course FTU training each year must be assigned to an appropriate operational unit, irrespective of whether absorption constraints are met or violated. This can create some definitional confusion because the Air Force typically identifies these pilots as having been absorbed with no explicit reference to the fact that their absorption process must continue until they become experienced. Absorption constraints have previously been interpreted to limit the number of new pilots who can be assigned each year rather than the total number who are still participating in the absorption process. The latter number, of course, would correspond to the total number of inexperienced pilots. These distinctions may become clearer once the formulas that govern the relationships have been developed.10

**Absorption Capacity**

Specific objectives are set for operational units to maintain readiness and combat capability. These objectives include acceptable experience and manning criteria for the units. Lengthy lists of absorption constraints to support these objectives are given both in the RDTM purpose statement and in AFI 11-412 in the form of upper, or maximum, limits imposed on the numbers of new pilots who can enter a weapon system (or MWS category) while still allowing the system to meet the criteria essential to maintaining unit readiness and combat capability objectives. In aggregate, these constraints define the absorption capacity of the system under review in the sense that the absorption capacity represents the maximum number of new pilots who can be absorbed without violating any of the specified objec-

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10Our terminology throughout this section incorporates the Air Force’s traditional policy of absorbing entire active FTU production cohorts only in active units. A total force alternative that could absorb some number of active pilots in operational guard or reserve units will be examined independently.
tives or aspiration levels. We will soon interpret several absorption-capacity excursions, but this will first require a thorough understanding of associated parameters and their interrelationships.

**Preliminary Discussion**

Before we proceed, it may be useful to examine some of the factors that influence the issues associated with absorption capacity. These factors are depicted schematically in Figure 4.1.

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11We will use the term *system* as a generic reference that includes the API-1 pilots assigned to a unit, a weapon system (or MDS), an MWS category, or any other useful aggregation.
Production and absorption are clearly related by how long it takes new pilots to become experienced (the *time to experience*, or TTE) and by how many of these pilots can complete their absorption process by becoming experienced each year (or *experience rate*).

Beginning at the top of Figure 4.1, aircraft utilization, or UTE (in sorties per PAA), and PAA numbers determine the monthly sortie pool that is available to a unit for operational training. This pool defines the *training capacity* that is available to a unit (or an aggregation of units). Since API-6 pilots should already be experienced, these sorties must be distributed between API-1 and API-6 pilots, and the API-6 sorties are omitted from further calculations. We next divide the API-1 sortie total by the number of assigned API-1 pilots to determine the average sorties per crew per month (SCM) for these pilots. When units have a greater number of assigned pilots than they are authorized, this average will obviously decrease.\(^\text{12}\) This is important because operational units historically become overmanned when the flow of incoming new pilots exceeds their training capacity for any period of time, as the Pope Air Force Base example illustrates. The API-1 sorties must also be distributed between experienced and inexperienced pilots because, as documented in our previous work, lower experience levels mean that new pilots fly fewer sorties on average per month than the overall average.\(^\text{13}\)

The *aging rate* is the number of hours inexperienced pilots are able to average each month. This factor can be calculated by multiplying the average number of monthly sorties inexperienced pilots are able to fly by the average number of hours per sortie (i.e., the ASD). Aging rate thus depends on a unit’s ASD as well as on its experience level. When experienced pilots are defined in terms of flying hours (as is currently the case), the TTE can easily be calculated from the flying-hour requirement and the aging rate. The TTE can then be used to determine the number of pilots who become experienced each year.

The primary factors are illustrated here for convenience. We will now turn to a more detailed examination of all the parameters that influence these factors.

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\(^{12}\)Moreover, if fewer pilots are assigned than authorized, the unit may have serious problems accomplishing its specified mission.

\(^{13}\)See Taylor et al., 2000.
PARAMETERS THAT INFLUENCE ABSORPTION CAPACITY

Now that we have agreed that absorption capacity is the maximum number of pilots that can be absorbed by a weapon system (or MWS category) while still allowing the system under review to meet prescribed objective, or aspiration, levels, it will be useful to examine in more detail the factors that determine these levels. These objectives are important because many of them play a critical role in determining readiness issues or combat capabilities for units and MWS categories. The RDTM paradigm incorporates the fundamental assumption that these objectives are compatible (or simultaneously achievable) in the sense that the system can be tuned to achieve a steady-state condition with absorption capacity that meets them all. We will confirm that such steady-state conditions occur only when the number of new pilots who enter the system each year does not exceed the number that the system turns into experienced pilots. When the absorption constraints become inconsistent for a system of interest so that they cannot be met simultaneously, we will discover that the parameter values start to vary over time, necessitating more advanced analytic methods to track these changes.

Absorbable Billets

The billets to which new pilots can actually be assigned are called absorbable billets, and their number clearly imposes related constraints on possible production goals. The demand-side requisites ensure that these billets must all be line pilot (i.e., API-1) billets in operational units. Unfortunately, not all of these API-1 billets are absorbable. Certain aircraft have mission demands and crew compositions that prevent new pilots from being assigned to these aircraft until they have become experienced in a related aircraft type. Current aircraft with such constraints include the F-117 in fighters, the U-2 in bombers, and the E-4 in tankers. Additionally, as new aircraft types replace older ones in the force-structure inventory, restrictions are often placed on assigning new pilots to these aircraft.

14 The B-2 was previously limited to experienced pilots only, but the Air Force recently initiated a controlled program to absorb small numbers of new pilots (two UFT graduates and five FAIPs per year) into the B-2. These numbers are perhaps more significant than they seem owing to the small size of the B-2 community.
Such restrictions are required to ensure safety and supervision during the initial phase of the transition period, so they apply for only limited periods of time. Nonetheless, they limit the available absorbable billets during the period of transition, and these limits are exacerbated when delays occur and cause initial operational capability (IOC) dates for the new aircraft to slip. Aircraft replacements scheduled to start during the current planning horizon (i.e., the FYDP) include the F-22 (replacing F-15s) and the CV-22 (replacing HH-60s).

Even when the number of absorbable billets remains stable, these billets cannot all be filled with brand-new pilots. Sufficient numbers of experienced pilots are required in these billets to ensure that the operational units have adequate numbers of flight leads or aircraft commanders to allow for safe and effective flying operations. Operational unit experience levels clearly depend on the proportion of the API-1 billets that are filled by experienced pilots. Indeed, we will soon use this concept to define unit experience levels. Thus, it remains important to recognize the distinction between the number of billets that are absorbable and the number of new pilots who can actually be incumbent in these billets at a given point in time.

Finally, because all pilots must initially mature in absorbable-billet assignments before they become eligible to fill nonabsorbable-billet requirements in any MWS category, the rates at which pilots gain experience as well as pilots’ retention rates are also important factors in building steady-state inventories that adequately fill requirements. Increases in either of these rates can require extensive resource expenditures so that MWS categories with larger ratios of nonabsorbable to absorbable billets (the nonabsorbable-to-absorbable ratio) will have greater problems developing adequate inventories than will those with smaller ratios. This is because pilots may need to mature more rapidly or exhibit higher retention rates to be able to flow through the relatively smaller numbers of absorbable billets and become eligible to fill relatively larger numbers of nonabsorbable (or advanced) ones.

Figures 4.2 and 4.3 show historical changes (for total billets and fighter billets, respectively) in nonabsorbable and absorbable billets since the military drawdown began. The total pilot nonabsorbable-
Figure 4.2—The Nonabsorbable-to-Absorbable Billet Ratio Has Improved from 2.18:1 to 1.77:1 for Total Pilot Requirements Since FY 1990

to-absorbable billet ratio decreased from 2.18:1 (2.18 advanced billets needing to be filled for each billet capable of accepting entering pilots) in FY 1990 to only 1.77:1 in FY 2001, implying an improved ability to meet requirements through adequate inventory growth. During the same period, however, the nonabsorbable-to-absorbable billet ratio for fighters increased from 1.82 to 2.73 advanced billets for each absorbable billet, implying a degraded opportunity to absorb pilots in sufficient numbers to meet requirements for this MWS. These numbers are not unrelated to the production-retention excursions that we conducted in the preceding chapter. It is interesting to note that bomber requirements also became more difficult during the same period, with the ratio increasing from 1.21:1 to 3.22:1. Since bombers and fighters represent the primary combat weapon systems (the others are basically combat support), this implies an increasing need for combat expertise among the advanced billets. This is the result of steady requirement numbers for joint billets (which are
Figure 4.3—The Nonabsorbable-to-Absorbable Billet Ratio for Fighters has Worsened from 1:82:1 to 2:73:1 Since FY 1990

The number of absorbable billets depends directly on active force structure decisions because all of the absorbable billets are determined by CR calculations. A key component of the data depicted in Figure 4.3 is that force structure reductions have decreased the number of absorbable fighter billets by a full 50 percent since 1990, while the nonabsorbable billets have decreased by only 25 percent in the same period. The reason for this disparity is that the staff and other advanced requirements that constitute the nonabsorbable billets do not respond directly to force structure changes. Throughout the

15All data in this paragraph, including the method used to distinguish between absorbable and nonabsorbable billets, are from AF/XOOT. It is also clear that one may infer that other MWS categories have improved (at least in aggregate) during the drawdown period.
drawdown, the Air Force could not gain congressional support to close enough bases to achieve the organizational changes that would bring nonabsorbable billets down in proportion to the force structure reductions achieved among the operational active fighter units.\textsuperscript{16}

This means that there are three distinct aspects of absorbable-billet reductions that will continue to cause absorption concerns. The first is the number of \textit{absolute} reductions that occurred in conjunction with force structure changes in active forces throughout the drawdown period. The second is the \textit{relative} decrease in absorbable billets that occurred in fighters and bombers during the same period (in relation to the nonabsorbable billets). The third concern deals with the consequences of the \textit{effective} reductions in force structure that will be caused by long-delayed aircraft replacement and modernization programs currently scheduled for the future.\textsuperscript{17} All of these factors have serious absorption implications.

Some sample numbers might help illustrate these issues. Current programming documents identify 1223 absorbable fighter billets and 3158 nonabsorbable billets in the steady-state requirement for 4381 fighter pilots. The current Air Force experience objective is to fill at least 50 percent of the absorbable billets with experienced pilots, leaving 611 absorbable billets that can be filled with inexperienced pilots. If the production rate is 330 new fighter pilots per year (the current Air Force objective), these pilots would have to become experienced in roughly 22.2 months (on average) in order to avoid having more than 611 inexperienced pilots assigned to absorbable billets.

Unfortunately, current programmed UTE rates will not provide an adequate training capacity to enable new fighter pilots to become experienced that quickly, and we have already confirmed that this

\textsuperscript{16}An additional factor is the “fixed” manpower cost required to maintain the joint global command-and-control structure that was discussed previously. These manpower requirements have been relatively insensitive to force structure reductions.

\textsuperscript{17}Fighter modernization programs are required to extend the service life of F-16 and A/OA-10 aircraft until they can be replaced by the Joint Strike Fighter (JSF), whose IOC date is currently scheduled for 2014. Slips in this IOC would complicate matters even further. It is interesting to observe that the IOC date for the F-22 at the corresponding stage of its development was 1994.
production rate will require a 53 percent bonus take rate to generate a steady-state inventory of 4381 pilots. Alternatively, if none of the new fighter pilots were FAIPs, current training capacity would limit new fighter pilot production to only 266 pilots per year and would require a BTR of 82 percent in order for the inventory to match requirements. If we include the 75 FAIPs who are currently programmed for fighters, then new pilots can become experienced in just over two years (on average), and the production level drops to about 300 pilots per year to ensure that no more than 611 inexperienced pilots are in absorbable billets.18 As we discussed in Chapter Three, this production rate requires a 70 percent BTR to match inventory to requirements.

**Experienced Pilot Criteria**

The term *experienced pilot* defines a pilot who has completed the absorption process and can be assigned to more advanced billets. The need for a precise and objective standard that measures experience led to the use of a RDTM-implemented flying hour–based criterion in place of previously used subjective descriptions such as “fundamental understanding of the operational mission” and “operational knowledge and mission experience.” The requirement for fighter pilots to become experienced, for example, is 500 flying hours in the primary mission aircraft for pilots who proceed directly to fighters from UFT. For pilots (such as FAIPs) with an intervening non-MWS flying assignment, the requirement is 1000 hours of total flying time and 300 hours in the primary mission aircraft.19 Other MWS categories have similar requirements, although the number and nature of the required hours will change in accordance with mission and training differences among the categories.

The essential component involved in setting the standards is a general understanding that meeting the objective criterion ensures the

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18 This value is calculated as a weighted average of 75 FAIPs who become experienced in about 14.5 months and 225 non-FAIPs who become experienced in about 27.6 months.

19 The total hours must be logged as first pilot or IP time; copilot time is not allowed. To allow for changes from one aircraft to another, the provision is 100 hours in the primary mission aircraft for pilots who were previously experienced in another fighter.
fulfillment of the subjective description as well. Historically, this criteria has been satisfied, but recently there have been questions about whether it remains the case in today’s environment. Inexperienced pilots have been flying at very low rates—rates so low in some operational units that, as discussed in Chapter Two, IPs have expressed concern that inexperienced pilots are merely maintaining their basic flying skills and do not have the opportunity to learn more advanced skills. Moreover, much of the flying that has been accomplished during contingency deployments may have less training value per flying hour than traditional home-station training.

The pre-RDTM definition of an experienced pilot was based on active rated service and imposed no conditions either on total flying hours or on the type of aircraft flown. The sole requirement was five years of active rated service, which happened to coincide with the ADSC in effect at that time. A pilot was thus deemed experienced in the pre-RDTM period if he (there were no female pilots at the time) was serving on active duty voluntarily irrespective of any actual flying background, previous assignments, or relevant operational knowledge. Again, changing attitudes and policies during the hostilities in Southeast Asia may account for this apparent anomaly. At the outset of these hostilities, fighter pilots entering combat averaged more than 1000 hours each, whereas their average had dropped below 250 hours by the end of the war.

Prior to the implementation of the Aviation Career Incentive Pay (ACIP) program in 1974, there were no nonflying assignments per se. All pilots were required to fly for pay and proficiency regardless of the nature of their assignments, and proficiency-flying options were provided as necessary. Pilots thus continued to accumulate flying hours (and related experience) wherever their assignments took them.

The five-year requirement was probably adequate to ensure that every pilot had at least one assignment that stressed operational mission demands rather than proficiency issues only. Also, the distinction between the two types of flying was less clear in many MWS
Experience Level

The experience level establishes the proportion of experienced pilots in a particular pilot population. Experience levels were recognized under RDTM as an important indicator of unit readiness and combat capability. Moreover, we have just confirmed that such levels are also an important component governing the dynamic behavior of the flow of new pilots into a weapon system. In a sense, experience level measures the proportion of absorbable billets in a given population that are not (or cannot be) filled by inexperienced pilots.

Experience level is an extremely important parameter in operational units because it governs how the available training sorties can be distributed among pilots. It has long been recognized that inexperienced pilots, who typically require supervision, need more training than do experienced pilots, who typically provide supervision. This distribution of sorties is not attainable at any experience level in actual units because of in-flight supervisory demands, but for units with experience levels of 60 percent or above, sorties can be distributed uniformly among the pilots in the unit. If experienced pilots represent a lower proportion of the total, however, they must individually fly a disproportionately greater share of the available sorties in order to ensure that adequate supervision is provided. These effects are primary findings in our earlier work, which documents the increase in sorties required to offset decreasing unit experience levels. The document also includes charts depicting sortie and aging rate degradations as functions of unit experience level. These are important considerations as units endeavor to meet ongoing upgrade demands and to accomplish their respective mission taskings.

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20 See Anderegg, 2001, p. 40, and the references cited therein for flying hour data. The book chronicles events in the training revolution. One could probably conclude that pilots flew many more hours per month before the training revolution began, but they definitely received less training per hour and probably less training per month than was subsequently the case. Proficiency flying ended formally when Congress passed the Aviation Career Incentive Pay Act of 1974, although it was effectively terminated by executive order in the spring of 1971.
Experience level also has a significant effect on the quality of training per available sortie that the unit is able to accomplish.\textsuperscript{21}

These factors mean that the experience level parameter also provides an important management tool for entire MWS categories. This was yet another major contribution of the RDTM paradigm. For the first time, the Air Force began to use overall experience level objectives within an MWS category to manage the distribution of newly produced pilots to specific operational units. The issue that has yet to be resolved, however, is exactly how experience levels should be calculated for specific pilot populations.

**Calculating Experience Levels**

The meaningful experience level value for operational units measures the proportion of primary mission (i.e., API-1) pilots who are experienced. The API-6 staff and supervisory billets that are assigned or attached to a squadron should be filled with experienced pilots, so they should not figure into experience level calculations unless these positions are not filled and the unit is undermanned.\textsuperscript{22} The API-1 proportion is the meaningful value for our model calculations as well as for the squadron schedulers who need to build flying schedules that ensure the availability of adequate in-flight supervision.

Unfortunately, the assignment system sends pilots to wings, not squadrons, so it has no control over which pilots will be assigned to API-1 billets and which to API-6. Wing and group commanders quite correctly maintain control over these assignments. The system does remain fully aware of the total number of experienced pilots that it sends to a wing, but the extended lead times associated with the training pipeline require that it make forecasts concerning future experience levels. These forecasts in turn require assumptions on how the API assignments will eventually break down. To ensure that the

\textsuperscript{21}See Taylor et al., 2000, pp. 19 and 21, for the referenced charts. The work also confirms the fact that inexperienced pilots can never actually fly more sorties on average than experienced ones while also confirming the 60 percent experience level cutoff below which a unit cannot distribute its sorties uniformly.

\textsuperscript{22}Operational flying is scheduled, managed, and conducted within squadrons. Therefore, overhead pilots assigned at the group or wing level must be attached to a squadron for flying purposes.
Absorbing Air Force Fighter Pilots

experienced pilots assigned will fill all of the API-6 authorizations, these billets are subtracted from the number of experienced pilots projected in the unit to yield the experienced portion of the assigned pilot population. The “official” experience level is then calculated by dividing by the number of API-1 authorizations because the future API-1 assignments are not available to the assignment community. AFI 11-412 provides two experience formulas, both of which suffer from the problem of mixing spaces with faces:

\[
\text{Wing experience level} = \frac{\text{Experienced pilots assigned} - \text{API-6 authorizations}}{\text{API-1 authorizations}} \quad (4.1)
\]

\[
\text{Squadron experience level} = \frac{\text{API-1 experienced pilots assigned}}{\text{API-1 authorizations}} \quad (4.2)
\]

Both of these equations make the assumption that manning will stay at 100 percent (i.e., that the number of assigned pilots is exactly the same as the number of authorizations). Equation (4.1) reflects the actual experience level for a wing only when it is manned at exactly 100 percent for both API-1 and API-6 pilots. The primary problem is that the denominator, which should express the actual number of API-1 pilots assigned, is in error when actual manning deviates from authorizations. If the wing is undermanned in API-1 pilots, Eq. (4.1) underestimates its actual experience level, whereas the equation overestimates the experience level of a wing that is overmanned. Similarly, Eq. (4.2) provides an accurate squadron measure only when that squadron is manned at exactly 100 percent.23 We need to stress that neither of these formulas accurately exhibits the experience issues that were developed in our earlier work, especially when units are overmanned.24 The key ratio in useful experience level

23The behavior of the errors in the estimate is reversed if the denominator in the equation uses the expression (total pilots assigned – API-6 authorizations) to estimate the number of API-1 pilots actually assigned. This option was rejected in favor of the formula shown. This may reflect a natural bias in assignment system evaluation methods against a failure to fill all of the authorized billets. The API-6 billets can also fail to be properly manned, but if the sum of the two types of authorizations is manned accurately, this reflects a local problem in distributing the available pilots.

calculations is the number of experienced API-1 pilots assigned divided by the total number of API-1 pilots assigned—for squadron as well as aggregated calculations for weapon systems or MWS categories. We must use:

\[
\text{ExpLevel} = \frac{\text{Experienced API-1 assigned}}{\text{API-1 assigned}}
\]  

(4.3)

to avoid errors as manning levels vary.

The aircrew management successes that followed the implementation of RDTM kept units manned at levels very near 100 percent for more than two decades (FY 1978 through FY 1998), and it became commonplace for Eq. (4.1) to be used to report actual conditions as well as to make forecasts. Unfortunately, provisions were never made to aggregate the data required to calculate actual API-1 experience levels for MDS communities and MWS categories. This is what caused inaccurate experience levels to be reported in FY 2000 at Pope Air Force Base, for example, and the magnitude and effects of these errors were not fully recognized by appropriate staff members until the resulting problems had become quite severe. The Air Force is currently addressing these issues, but it is not clear that accurate experience information consistently reaches decisionmakers in all cases.\(^{25}\)

Finally, pilot shortfalls coupled with low experience levels can lead to circumstances in which pilots who are technically experienced but cannot immediately become flight leads or aircraft commanders are more likely to be assigned to operational units. Typically, these pilots were previously qualified in an obsolescent airframe from the same MWS category (such as the F-4 or F-111 in fighters) and have served several intervening staff or other nonoperational assignments. Such pilots improve experience levels only on paper because they do not improve the unit’s ability to cope with problems resulting from low experience.

\(^{25}\)There are other examples in which the system has confused programming values with actual values for key parameters, thereby providing decisionmakers with erroneous information. We will see in the next section that flying hours historically have provided multiple opportunities for misinterpretation.
This discussion exhibits another key factor that can limit the quantity of training available to individual pilots. It should be clear that the manning level of an operational unit can have a significant effect on its experience level.

**Manning Level**

*Manning level* is another important parameter that influences a unit’s ability to manage the training opportunities that are available to its pilots. This parameter measures the ratio of assigned pilots to authorized pilots. At the squadron level, the most meaningful ratio involves primary mission pilots (i.e., API-1 pilots assigned divided by API-1 authorizations) because the two API-6 authorizations are extremely likely to be filled exactly. At the wing level, primary mission pilots still represent the most important manning-level concern, but it may prove useful to examine the API-6 ratio as well because wing and group commanders have the flexibility to make adjustments in both categories when manning levels deviate from 100 percent.

Adverse effects on unit training and readiness occur when deviations in either direction (i.e., manning levels above or below 100 percent) become excessive.\(^\text{26}\) It is clear that when inadequate numbers of pilots are assigned, units could have difficulty meeting combat tasking levels. Undermanning could also prevent units from developing adequate numbers of new pilots who are qualified to maintain a pilot mix sufficient to the conduct of mission-essential training.

Deviations that take manning levels above 100 percent, however, can also cause serious training problems. A unit with an excessive number of assigned pilots must distribute its limited training resources among these pilots, ensuring that each pilot receives less training than would have been available at a lower manning level. We will later establish conditions in which high manning and low experience levels are likely to occur simultaneously and seriously impair training options. At this point, however, we will simply provide historical evidence confirming that this combination can generate serious con-

\(^{26}\)At the squadron level, any deviation exceeding three pilots in either direction can become problematic. Three pilots represent about 10 percent of a typical squadron’s API-1 authorization. Deviations that exceed 15 percent in either direction for any aggregation of units would definitely generate concerns.
cerns with regard to readiness and combat capability. In documents that characterize the post-Vietnam aircrew management problems that generated the paradigm shift to the RDTM system, for example, both high manning levels and low experience levels are identified as primary causes. Indeed, the Tactical Air Command’s (TAC’s) Director of Personnel sent a message in October 1974 containing the following statement: “[The] combat capability of F-4 units is of continuing concern to TAC/DO/DP. All operational F-4 units are currently experiencing high manning/low experience levels.”

The message goes on to make it clear with data that the second sentence states the fundamental reasons for the concern expressed in the first. Also included in the data is the information that the wing with the greatest problem at that time had a manning level near 120 percent and an experience level (using the 5-year active rated service criterion) below 30 percent. It may also be worthwhile to observe that very similar manning and experience conditions contributed to the adverse training circumstances that we documented at Pope Air Force Base in July 2000.27

**CALCULATING THE RATE AT WHICH PILOTS BECOME EXPERIENCED**

We will next turn to the calculations required to determine how many pilots can become experienced each year. This experience rate factor was introduced earlier and depends in a crucial way on the aging rate for new pilots, which is the monthly rate at which new pilots gain experience. The aging rate, in turn, is a fairly complex function of several other parameters. Although many of these parameters may be somewhat familiar, we will show that opportunities still exist for them to be misinterpreted. We begin the discussion with a unit’s training capacity.

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27The message quoted is HQ TAC/DP, TAC/DP 211820Z, October 1974. TAC was the Cold War predecessor of ACC. Almost all fighter units were equipped with F-4 aircraft in 1974. “TAC/DO” in the message text refers to the TAC Director of Operations and TAC/DP to the TAC Director of Personnel. The manning and experience levels cited refer to primary mission (API-1) pilots only. Actual experience levels increased significantly (to above 40 percent) when the new definition was applied. The ACC staff (ACC/DOT) provided the actual historical documents.
Training Capacity

An operational unit’s training capacity (TngCapacity) is the total number of sorties available each month that the unit is able to fly. This sortie total is a function of a unit’s PAA and UTE-rate parameters.

The PAA parameter, which identifies the number of primary aircraft that a unit is authorized to possess, was previously encountered in our discussions of pilot requirements and absorbable billets because the number of API-1 pilot authorizations for any unit is determined by multiplying the appropriate CR by the PAA. The PAA is closely related to another parameter, called the primary mission aircraft inventory (PMAI), that is also associated with operational units. Careful management of backup aircraft inventory (BAI) and attrition reserve (AR) aircraft is required for the Air Force to maintain an acceptable balance between unit aircraft authorizations and inventories. All units lose aircraft from their inventories and must balance these losses using BAI and AR adjustments. These losses can be permanent or long term, depending on whether they are caused by attrition or by off-station maintenance and modification needs.28

The UTE rate is defined (for fighters) as the number of sorties per authorized airframe per month that the unit can fly. Thus, the training capacity, or the sortie total available to any operational unit, is given by

\[ TngCapacity = UTE \times PAA \]

It will be important to distinguish between the programmed UTE rate (a planning figure) and the actual UTE rate. In the late 1990s, actual UTE rates for fighters dropped well below programmed UTE rates, resulting in lowered training capacities. This drop was caused by a combination of factors that included funding issues, depot maintenance problems, maintenance manning difficulties, parts supply problems, and aging aircraft.

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28 See Department of the Air Force, AFI 11-401, Flight Management, October 1, 2001, for more information on these relationships.
Sorties Available to API-1 Pilots

Each squadron’s available sorties must be shared between its assigned API-1 pilots and its assigned and attached API-6 pilots. Again, because API-6 pilots should always be experienced, only the API-1 portion of the unit’s training capacity contributes to the process of turning inexperienced pilots into experienced ones. Every squadron has exactly two internal API-6 authorizations, but the number of attached API-6, or overhead, pilots varies among squadrons depending on the characteristics of the parent wing or group to which the squadrons belong. Parent units containing fewer squadrons, for example, generally require more overhead pilots per squadron, and parent units with mixed-aircraft MDS configurations impose larger overhead flying burdens on its squadrons than do more traditional single-MDS units. Clearly, when training resources remain fixed, increasing the overhead burden on any squadron reduces the sorties available to API-1 pilots.

It should also be clear that lower-PAA squadrons will have fewer API-1 pilots than higher-PAA squadrons because the API-1 pilot authorization of the former is given by their CR multiplied by their PAA. Thus, for a fixed overhead pilot burden, lower-PAA squadrons must devote smaller proportions of their sortie training capacity to API-1 pilots than higher-PAA squadrons because training capacity also varies directly with PAA. In particular, the move from 24-PAA to 18-PAA squadrons that accompanied the 1990s drawdown led to marked decreases in the proportion of training sorties available to API-1 pilots throughout the active fighter force.

Throughout this report, we have used ACC programming values for both assigned and overhead API-6 sorties. These values are calculated unit by unit to accommodate the variations we have just described, but the allocation assumes that these pilots fly at essentially the minimum rates required to maintain their mission qualifications. The available API-1 sorties are then calculated by subtracting the API-6 sorties from the total training capacity.29 We will see that this value probably underestimates the sorties flown by these pilots and

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29These programmed values provide an overall average for active fighter units of about seven sorties per authorized overhead pilot per month (to maintain BMC status) and roughly nine sorties per month per assigned API-6 pilot (to maintain CMR status).
provides a highly optimistic estimate of the sorties available to API-1 pilots—especially as experience levels drop—because of the in-flight supervision that inexperienced pilots require.

**Average Sortie Duration**

To convert numbers of sorties into numbers of flying hours, we use a factor called average sortie duration (ASD). This parameter applies only to fighter aircraft, as all other major weapon systems measure their activity directly in hours.

Once again, it is important to distinguish between programmed and actual values. If a unit deploys to Operation Northern or Southern Watch, for example, the flights in the area of responsibility (AOR) may involve several air refuelings and will thus be many times longer than the programmed ASD. Aircraft may be stationed relatively far from the AOR, so patrol flights can be quite long. The key issue is whether increases in ASD correspond to proportionate increases in training. Typically they do not. Recent Operation Noble Eagle combat air patrol (CAP) flights supporting homeland security provide additional examples of flights in which the training received per hour is definitely degraded in comparison to normal home-station training standards.

Still, for a fixed set of circumstances, it is convenient to be able to move back and forth between sorties and hours using average ASD values as appropriate.

**Sorties and Hours per Crew per Month**

We can use the API-1 portion of the training capacity (API-1 sorties) and the number of API-1 pilots assigned to calculate the average number of sorties per crew per month (SCM) that are available for API-1 pilots to fly. We can then use the appropriate ASD value to calculate the average number of hours these pilots can fly each month. Even though new pilots may gain flying hours at significantly disparate rates, we want to develop the factors that govern the average or typical behavior of the pilots in a unit, weapon system, MWS category, or other aggregation so that we can develop models that replicate this behavior. Our immediate objective is to calculate how long
it takes to turn new pilots into experienced ones. This, in turn, helps us estimate the total number of inexperienced pilots as well as the rate at which these pilots will on average become experienced. This average flying hour accumulation is typically measured by a parameter that the Air Force calls *hours per crew per month*, or HCM. This term can be applied in several contexts, however, and it will be useful to understand these distinctions. First, we will restrict our attention primarily to API-1 averages because of our interest in inexperienced pilots. The values that primarily interest us are given by

$$SCM = \frac{\text{API-1 sorties}}{\text{API-1 assigned}}$$  \hspace{1cm} (4.5)

and

$$HCM = SCM \times ASD$$  \hspace{1cm} (4.6)

We must continue to distinguish between *programmed* and *actual* HCM values. Historically, the HCM measure was developed as a programmatic indicator to examine the effects of actions taken within the planning, programming, and budgeting system (PPBS) process. This was motivated by events in the 1970s, when rising fuel costs and domestic pressure on the defense budget initially made flying time a serious budgetary issue. Previously, available flying hours had rarely imposed a training constraint on Air Force units. Programmed HCM is based only on aircrew authorizations and is never adjusted for manning or experience level concerns. Actual HCM, on the other hand, should measure the actual hours flown each month by the assigned pilots and definitely depends on manning levels.

The historical methods that have been used to calculate this measure, however, have typically been flawed. Prior to 1990, for example, pilot authorizations, not assigned pilots, were divided into monthly flying hour values to calculate the “actual” HCM average. Prior to 1993, the flying hour values were taken from maintenance records that tallied aircraft hours, not aircrew hours, and the breakdown by aircrew position indicator was estimated rather than calculated. Even though the Air Force Operations Resource Management System (AFORMS) database has been used since 1994 to provide flying hours by API designation and average numbers of assigned
pilots, much useful information can still be lost in the averaging process. It is interesting to note that TAC began tracking actual HCM values in the late 1970s as part of an initiative by General Wilbur Creech, then the TAC commander, to improve operational training for line pilots. This initiative generated an annual increase of approximately 5 percent in actual HCM each year from FY 1981 through FY 1985, and it may have marked the first instance in which programmers and decisionmakers fully recognized the distinction between programmed and actual HCM values.

We will discover that glaring errors result when either programmed or actual HCM values are used to estimate the rate at which new pilots are flying. The latter value fails to incorporate the reduced training available to inexperienced pilots because of their need for in-flight supervision, and the former value makes the additional assumptions that the flying hour program can be flown out unit by unit and that units are never overmanned. This brings us to the next parameter.

**Aging Rate**

The *aging rate* is given by the hours that are actually flown on average per month by inexperienced pilots. It must be obtained by separating the actual HCM values into the respective portions flown by inexperienced and experienced pilots. This process must account for the reduced flying opportunity available to new pilots who do not have the knowledge and experience required to fly as flight leads or aircraft commanders. An approach toward achieving this was a primary topic in our earlier work, where we confirmed that aging rates for pilots in notional fighter units depend on the units’ experience.

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30. The actual availability of assigned pilots to fly, for example, is always lost in the averaging process.
31. The information in this paragraph is taken primarily from Air Staff documents prepared to support Corona Top 2000. See HQ USAF/XOOT, bullet background paper, April 2000, *Actual Hours per Crew per Month*, and its attachments, plus HQ USAF/XO, *Corona Top, Active Duty Actual Hours/Crew/Month (HCM)*, briefing, June 2000. The historical perspective on training constraints imposed by flying hours and the actions taken to improve training in the late 1970s are also documented in Anderegg, 2001.
levels as well as on their actual HCM flown on average. Graphical
depictions of these relationships are given in that document.32

ACC implemented a new initiative in FY 2000 to collect data captur-
ing the actual HCM by MWS category for inexperienced pilots. While
it is true that aging rate and inexperienced HCM are different names
for the same parameter value, recording inexperienced HCM data is
only an important first step in documenting actual aging rate data in
order to test the validity of our model estimates. This is because the
corresponding unit experience levels that produce the actual inex-
perienced HCM data are not being recorded. It is also likely that any
experience levels that might be available in other data banks have
been calculated using pilot authorizations instead of pilots assigned,
as exhibited in Eq. (4.1). It will be essential to have experience level
data as well as the aging rate (or inexperienced pilot HCM data) in
order to test our model results and obtain the accurate historical ag-
ing rate information that is essential for estimating future aging rates,
which have an important programmatic function in setting produc-
tion rate quotas.

**Time to Experience and the Number of Inexperienced Pilots**

Future aging rates are vital to the programmatic process because
they determine the time period required for inexperienced pilots to
become experienced. This parameter is called the time to experience
(TTE) and is given by

\[
TTE = \frac{\text{HoursExp}}{\text{AgingRate}}
\]

(4.7)

where \(\text{HoursExp}\) denotes the remaining PMAI hours required to be-
come experienced.33 A related parameter is the average time on sta-
tion (TOS) that pilots spend at their initial operational assignment.
The TOS parameter can depend on the nature of the assignment.
Overseas assignments, for example, are typically of a fixed length,

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33Hours flown during FTU B-Course training (normally about 80 hours in fighters) will
count toward the PMAI hours required to become experienced.
whereas CONUS assignments vary depending on other assignment demands. For our purposes, we interpret TOS as the point at which pilots leave operational flying to perform other duties. It is important that TOS exceed TTE values on average for CONUS units if one is to avoid sending inexperienced pilots to fill billets that require experienced ones, so steady-state analyses typically regard TTE as a lower bound for an acceptable TOS level.\textsuperscript{34}

We can use the TTE value to estimate the total number of inexperienced pilots in a specific pilot population for a steady-state situation as long as we account for the dynamic element that this parameter introduces. If the TTE is not excessive, the number of inexperienced pilots in the population will be given by

\[
\text{InExp} = \text{ProdRate} \times \text{TTE} \text{ if } \text{TTE} \leq \text{TOS}
\] (4.8)

If TTE does exceed the available time that pilots can remain in the population, the assignment system cannot flow in an acceptable manner because inexperienced pilots who exit operational flying billets before they become experienced are not qualified to fill alternative fighter requirements.

**Experience Rate**

The number of pilots who become experienced, or the *experience rate*, can now be calculated as follows:

\[
\text{ExpRate} = \frac{\text{InExp}}{\text{TTE}} \text{ if } \text{TTE} \leq \text{TOS}
\] (4.9)

where the TTE constraint is necessary to ensure that the pilots actually do become experienced.

\textsuperscript{34}Although TOS is the standard terminology, it can sometimes be misleading. We will see that when we aggregate the operational API-1 billets for a weapon system or MWS category, a more critical measure may be the time available on average for inexperienced pilots to remain in operational units. The key issue is that no system can reach an acceptable steady state if TTE values become excessive.
The expected value of future experience levels can then be estimated if the remaining population billets can be exactly filled with experienced pilots. This estimate is given by

\[
\text{ExpLevel} = \frac{\text{API-1 assigned} - \text{InExp}}{\text{API-1 assigned}}
\]

Before we use these relationships to express the precise definitions associated with absorption capacity, we need to examine the problems associated with historical efforts to forecast the required parameter values.

**FORECAST AND ACTUAL VALUES**

Production rate quotas can require long lead times to achieve,35 and there is a definite need to estimate future aging rate and experience level values that will result from production changes. Currently, however, no accepted method is available for calculating programmed aging-rate values. Indeed, we know of no effort to quantify the differences between aging rate and HCM until our earlier work in this area became available.36 Until 1999, the programmed HCM value was typically used in the programmatic process to estimate TTE and expected experience levels. This is the wrong value to use for this purpose because programmed HCM overestimates the hours inexperienced pilots can average each month and leads to optimistic TTE and experience level values.

**Programmed HCM Is an Optimistic Aging Rate Estimate**

First, even if the programmed hours are actually flown in aggregate, the programmed HCM will not accurately represent the aging rate because of manning and experience issues. Indeed, our previous

35The production-rate quotas set by the 1996 Four-Star Rated Summit were never achieved. Those set at the 1999 summit were programmed to occur in FY 2002, but it now appears that they will not be fully implemented until FY 2003. Constraints on pipeline capacity in both UFT and FTU training programs are the primary causes for the delays.

discussions confirm that programmed HCM accurately represents aging rates only for units that meet three highly restrictive criteria. For new pilots to age at programmed HCM rates, units must

1. Fully fly their programmed flying hours;
2. Be manned at exactly 100 percent of their authorized pilot strength; and
3. Have experience levels that exceed 60 percent.

Very few units have met all three of these conditions simultaneously over the past decade. Moreover, historical evidence indicates that programmed flying hours are never fully flown in aggregate. This is true in virtually every weapon system category, but the effects are more evident in fighters than in other MWS categories that may have access to alternative flying hour options.37

The budget process has evolved to the point at which programmed hours represent an absolute upper bound for the number of hours that can be flown each year in fighters. Units cannot exceed programmed hours in aggregate because funds for additional hours have been capped. Indeed, the funds are often exhausted before the hours can be flown out because the actual cost of fuel and other consumable items exceeds the original programmed per-hour charges. Even when funds and flying hours are available, however, fighter units have in recent years had difficulty generating requisite numbers of training sorties. These difficulties are the result of aircraft

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37 Alternative flying hour sources include contingency hours that are normally funded after the fact by separate congressional authority and hours that are funded by the Transportation Working Capital Fund (TWCF), which supports the movement of significant quantities of government personnel and equipment. The tanker and airlift categories regularly benefit from TWCF hours, and the additional hours flown in this mode continue to provide training and experience for the pilots. Although fighters are typically tasked when national contingency operations are required and the pilots continue to gain experience in these operations, previous congressional funding delays have caused the Air Force to require that units fly programmed hours in support of these contingencies until the hours are exhausted. This means that for the most part, these hours are flown in place of normal programmed training hours and thus do not appreciably increase aging rates. Indeed, the regular contingency support that has occurred over the last decade to enforce no-fly zones over Iraq often impedes upgrade opportunities for new pilots and slows their development into experienced pilots. Also, these contingencies must often be supported by split flying operations that degrade home-station training opportunities.
utilization problems that have been exacerbated by aging aircraft, parts shortages, reduced funding, maintenance problems, split operations, and other issues. These factors have combined to ensure that actual HCM remains well below the programmed HCM value for primary mission (API-1) pilots in operational fighter units. As shown in Figure 4.3, these results have not been encouraging for the fighter MWS category over the past decade.

Actual HCM values have been trending downward throughout most of the decade, and programmed HCM values also exhibit downward trends during the years for which data are available. It is important to recognize that pilots have been unable to fly the programmed HCM despite a significant effort within the Combat Air Forces (CAF) to increase aircraft UTE rates for fighters that began in FY 2000. Decisionmakers now recognize that it is critical to fully fund and fly the flying hour program, but this may not help the aging rates for new pilots unless the effects of other parameters are also accounted for. Fighter aircraft UTE rates, for example, increased from 16.3 sor-
ties per airframe per month in FY 1999 to 17.7 (in the aggregate) in FY 2000, yet Figure 4.4 clearly shows that there was no accompanying increase in the actual HCM average for primary mission pilots. This disparity was caused by overmanning problems that operational fighter units experienced in FY 2000 as well as by sortie distribution issues that caused more of the available sorties to be flown by overhead (API-6) pilots in order to meet supervisory needs. The situation is even more discouraging when we examine the HCM data for inexperienced pilots that units started reporting in FY 2000. During the 18-month period that includes FY 2000 and the first half of FY 2001, for example, inexperienced A-10 API-1 pilots averaged about 13 hours each month compared to a programmed HCM value of about 19. When we compare this result to the hours flown by inexperienced pilots at Pope Air Force Base, first discussed in Chapter Two, we can also appreciate the amount of information that can be lost in the averaging and aggregation process. It is important to note that lost information of this type may never reach decisionmakers.38

Aging rates represent the key parameter developed in this section, but there is a high potential for the precise interrelationships among the associated parameters to be confused. It may help avoid confusion if we review some of the issues and relationships that will pertain in our subsequent discussion.

**Summary of Aging Rate Issues and Related Parameters**

As depicted in Figure 4.1, the pool of aircraft sorties available to a given operational squadron is determined by its PAA together with its actual (monthly) aircraft UTE rate.39 This pool represents the unit’s total monthly training resources and is simply the product of these

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38A-10 units had the most significant overmanning problem from FY 2000 to FY 2001, but other MDSs were also affected, with the next-largest effect in F-15s. Data in this paragraph (including Figure 4.3) are from the Air Staff (AF/XOOT) and the ACC Staff (ACC/DOTB).

39The need to track both sorties and hours applies only to fighter units. Other MDSs measure both training needs and aircraft utilization in terms of aircraft hours, rather than aircraft sorties. Sorties, however, definitely represent the appropriate incremental training unit for fighters, but hours remain essential to determining when pilots become experienced. Other weapon systems are similarly affected, but all of the issues seem to resonate most noticeably in fighter units.
two parameters. The sortie pool itself is constrained in the current environment by a number of factors. These include aging aircraft, parts shortages and other exigencies that were caused by a number of years of inadequate funding, low experience levels in maintenance organizations, and heavy deployment tasking that leads to split operations and reduced home-station training options. As mentioned previously, Air Force leadership has recognized the need for units to increase aircraft UTE rates so that in aggregate they can fly the flying hour program. For most of the analysis that we are documenting here, we are willing to make the assumption that these planned UTE rate increases will occur exactly as programmed. We will point out some of the consequences of not meeting this assumption, however, and will conduct excursions that use current data instead of programmed results or that more clearly exhibit the problems that could result if programmed values are not attained.

The distribution of available training sorties is another important factor in determining the aging rates for new pilots in a given unit. The first sortie distribution issue is how sorties break out between primary mission (API-1) pilots and overhead (API-6) pilots. Except for qualitative discussions, our analysis will use current ACC methodology to shred the sorties between these two groups. The pool of available sorties rarely changes as the unit’s pilot manning level increases, however, so that actual HCM values for overmanned units can fall short of programmed HCM values even when aircraft UTE rates meet programmed levels. This effect has never been recognized in existing Air Force steady-state RDTM models, but manning levels are an essential component in any analysis that seeks to determine appropriate production rates. Actual HCM data, however, still do not yield actual aging rates. The final sortie distribution factor required to determine aging rates is how the sorties are split between experienced and inexperienced pilots in a unit. This factor has also been omitted from most Air Force steady-state analyses. The initiative to begin tracking actual HCM values for inexperienced pilots that was implemented in FY 2000 could help analysts estimate

\[40\] Requirements also exist to support above-wing staff (API-8) pilots, but their sortie needs are small and will be ignored. A potentially more significant problem is represented by the sorties required to support the flying needs of O-6s and above because they often require IP assistance, but this requirement is also ignored in our analysis.
aging rates on the basis of historical information, but the problem with information lost in aggregation will remain unresolved.

STEADY-STATE CONDITIONS AND MAXIMUM ABSORPTION

The equations in the preceding section provide the information necessary to define exactly what is meant when we discuss steady-state analyses. If TTE is not excessive and the pertinent parameter values remain constant over time, we can substitute Eq. (4.8) into Eq. (4.9) to obtain

\[
\text{ExpRate} = \frac{\text{ProdRate} \times \text{TTE}}{\text{TTE}} = \text{ProdRate}
\]

for a steady-state situation. Indeed, we will use the equilibrium condition determined when the annual production rate is equal to the experience rate as the definition of a viable steady state. When Eq. (4.11) fails to hold, the system is not operating in a steady-state environment because the parameter values are changing with time. If ExpRate exceeds ProdRate, for example, then the number of inexperienced pilots in the population is decreasing, resulting in higher experience levels, increased aging rates (until ExpLevel = 60 percent), and shorter TTEs. As long as the production rate is large enough to maintain the population inventory at required levels, these are all conditions aircrew managers can deal with because they do not stress the absorption capacity of the system.

It is when the production rate exceeds the experience rate that absorption issues become a problem, and maximum absorption for a weapon system population meeting specified parameters is the production rate that enables the system to operate at its maximum absorption capacity. We have just demonstrated that this occurs when a system is operating in a viable steady state, so maximum absorption capacity is the production-rate value that is equal to the experience rate achievable for the population. Absorption issues occur when a system is stressed beyond its absorption capacity. This causes changes in the key parameter values that cannot be tracked using steady-state methods. This behavior is the subject of the next chapter, in which we will also examine specific numerical excursions.