AMC draws not only on its organic assets but also on commercial augmentation to meet the peacetime airlift requirements both of the military services and of the U.S. government. A high level of peacetime demand relative to overall capacity could stress U.S. airlift assets, both organic and commercial, to the point at which they are not adequately maintained to be ready for war. On the other hand, a low level of peacetime demand relative to capacity might lead to insufficient flying hours for both (1) meeting military pilots’ aging and proficiency requirements, which are necessary to ensure readiness, and (2) providing enough business to commercial carriers to induce them to be CRAF participants. At any level of demand, AMC’s objective is to acquire and manage its organic assets efficiently and to purchase the right amount and types of commercial augmentation.

In this chapter, we examine the deviation of actual flying hours from those planned. The larger the deviation, the more difficult and expensive it is for AMC to adjust its flight schedules and to meet its pilots’ flying requirements. Adjustments include flying organic assets with lighter payloads and canceling buys that are incentives for commercial air carriers to participate in CRAF. We will introduce two categories of deviation. First, we assess annual programmed versus actual flying hours. We then assess three metrics of planned versus actual flying hours on a monthly basis.

**PROGRAMMED VERSUS ACTUAL ANNUAL FLYING HOURS**

Each year, AMC prepares a Flying-Hour Program for organic assets using as its basis its pilots’ aging and proficiency requirements. Then, when AMC plans the commercial augmentation that will be used, it subtracts Flying-Hour Program hours from the projected flying demand of AMC customers. The resulting excess demand is then met by commercial air carriers. The timeline in establishing the Flying-Hour Program follows that of the federal government’s budget cycle. AMC submits its Flying-Hour Program to Congress for funding. After
congressional appropriation, these flying hours, now in the “Congress Program,” remain unchanged throughout the fiscal year. Thus, by comparing flying hours in the Congress Program with actual flying hours, we can see the deviation from programmed flying hours. In Figure 5.1, we plot programmed and actual flying hours reported in the annual Command Data Books. We include additional data points from selected AMC flying-hour execution reports that were provided to us by AMC.

From 1986 to 1997, the actual annual flying hours of the C-5 exceeded the corresponding programmed hours, implying that C-5 pilots had flown more than enough to meet their aging and proficiency requirements. During FY 2000, however, the situation was reversed, with actual flying hours falling below programmed hours. Consequently, as indicated earlier in Table 2.3, C-5 CPs did not have enough flying hours to meet the aging requirements reflected in the Flying-Hour Program. For C-141s, the same phenomenon of insufficient flying hours began to appear by 1992. C-17s have been flying below programmed hours ever since their introduction into the force. The actual flying hours of

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1The data are reported in AMC’s Flying-Hour Execution Reports.
2 In the Command Data Books, the Congress Program is simply listed as “the Program.”
3 See Figures A.31 to A.35 in the appendix for the C-141, C-17, C-130, KC-135, and KC-10.
4 Unfortunately, such numbers were not reported in the Command Data Books for the years 1981–1985 and 1994–1998.
C-130s dropped below planned flying hours in 1999 and 2000. Therefore, all four airlifters faced insufficient flying hours at various times. In contrast, the KC-135 and KC-10 tankers have largely flown more than programmed since 1993.

These results are consistent with the flying-hour shortage found in Chapter Two but shed more light on the situation. First, when the total actual flying hours were below those programmed, there was a shortage of flying hours for CPs. This implies that the flying hours of ACs were adjusted sufficiently downward to spare enough flying hours for CPs to meet their aging requirement. Second, the programmed flying hours were estimated with little safety margin. Thus, whenever actual hours fell below programmed hours, a shortage occurred. Third, even when actual flying hours somewhat exceeded programmed hours during FY 2000, the CPs of the KC-135 and KC-10 tankers still flew fewer hours than their aging requirements called for. Thus, either the CP flying hours had been programmed too low in the first place or some of the programmed CP flying hours were flown by ACs instead.

**PLANNED VERSUS ACTUAL ANNUAL FLYING HOURS**

In the section above, we discussed programmed annual flying hours that were generally approved by Congress before or shortly after the beginning of the fiscal year in October. As the fiscal year proceeds, AMC adjusts its flying-hour plan. The adjusted hours for organic flying appear under the heading “current program” in AMC’s monthly and quarterly flying-hour execution reports. While adjustments can be made as frequently as necessary, they typically follow the schedule below.

The first adjustment is made in January, after review of the actual flying data for the first quarter of the fiscal year. At this time, AMC examines whether pilots of each aircraft type are flying enough hours to meet their aging and proficiency requirements. This generally correlates closely with which aircraft are flying more or less than programmed. If pilots of a certain type are flying less than the amount programmed during the first quarter, AMC allocates more flying hours to those pilots and their aircraft for the remainder of the fiscal year. If the overall airlift demand suddenly declines, however, the shortage can be across the board for pilots of all aircraft types—at which point AMC reduces commercial expansion buys to keep up organic flying hours. On the other hand, if it becomes apparent that the demand for certain missions will be higher than initially projected and if commercial air carriers are unsuitable for these missions,

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5As shown in Table 2.3, KC-135 and KC-10 CPs flew below their aging requirements during FY 2000 and FY 2001.
AMC makes upward modifications for organic flying in the current program. In order to avoid overstressing the aircraft and pilots flying those extra missions, AMC is likely to increase commercial augmentation in the mission areas to which organic assets are diverted. The second adjustment is generally made three months later, in April and onward. In this manner, the current program is typically revised once every few months.

In the results that follow, we compare actual monthly flying hours with those in the most recent revision of the current program (which we refer to as “planned hours”). It can thus be seen that these planned numbers are not the programmed numbers at the beginning of the fiscal year; rather, they are the numbers revised throughout the year in an attempt to better match actual flying hours for the remaining months of the fiscal year. The extent to which these numbers still do not match is the discrepancy between actual and planned flying hours for a “few-month” horizon. If we compare planned and actual flying hours, we are thus measuring short-term deviations. Large deviations represent difficulties that have been encountered in predicting actual flying hours throughout the fiscal year, for which AMC might have incurred extra expenses in assembling the aircrew and aircraft at the last minute. A key cause of large deviations stems from unexpected and sudden changes in demand over a few-month horizon. For the rest of this chapter, we will examine how the deviation evolved in the 1980s and 1990s.

Figure 5.2 shows the actual and planned annual flying hours for the C-5. Other than the Gulf War years (FY 1990 and FY 1991) and the exceptional year of FY 1994,6 AMC generally managed to match planned and actual flying hours rather well, with actual hours on average slightly above those planned. These annual numbers do not, however, reveal monthly overshoots (actual exceeding planned) or undershoots throughout a given fiscal year. Such monthly deviations can cancel each other out to yield a deceptive picture of little annual deviation or adjustment difficulty.

The monthly deviation for a given aircraft type is defined as actual monthly flying hours minus planned monthly flying hours.7 We introduce three means of measuring the deviation of actual flying from that planned. The first measure is the absolute deviation-from-planned flying, which is the annual sum of absolute monthly deviations. The larger this measure, the larger the monthly differ-

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6 See Chapter Two for an explanation of why FY 1994 is excluded in the determination of the trend line for all aircraft types.
7 The planned hours are those with a planning horizon ranging from zero to a few months depending on when and how many times the plan is adjusted throughout the fiscal year.
How Does Actual Flying Deviate from That Planned?

Deviation-from-Planned Flying

Before we show the three measures outlined above, we present in Figure 5.3 a histogram of the monthly deviation (actual flying hours minus planned flying hours for a particular month) of the C-5. The difficulty one encounters in de-
Figure 5.3—C-5 Monthly Deviation (actual minus planned flying hours)

Detecting the characteristics and trend of these deviations illustrates why we need better measures. The right panel in this figure, as well as in Figures 5.4, A.36, and A.38 to A.42, is an enlargement of the left panel.

The absolute deviation-from-planned flying for the C-5 is shown in Figure 5.4. The enlarged right panel allows the trend excluding the Gulf War and the 1994 data points to be viewed more clearly. The deviation increased by 5.9 percent a year, or from around 50 flying hours per year per C-5 in the early 1980s to more than 100 hours by the late 1990s. The number of annual flying hours per C-5 in the late 1990s stood at around 750,8 and a deviation of 100 hours translates into 13 percent of actual flying hours. The deviation was less in the 1980s because during the Cold War era, peacetime demand was governed to a greater extent by routine missions and thus remained stable. In the 1990s, by contrast, engagements unpredictably ebbed and flowed. Airlift planning thus became more difficult, and correspondingly large and frequent deviations were demonstrated. More frequent upward and downward monthly adjustments can be more costly, as flights have to be added or canceled at the last minute. Moreover, the fluctuations around the trend line in 1993 and 1998 (even when the Gulf War and the 1994 data points were excluded) were much larger than those during the 1980s.

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8See Figure 2.6.
The absolute deviation-from-planned flying for the C-141 showed much larger fluctuations in the 1990s than in the 1980s, and the average trend shows a deviation increasing by 4.4 percent per year.\(^9\)

Although only a few data points are available since 1995 for the newly introduced C-17 airlifter, the deviation for this aircraft can still be seen to have rapidly declined to about 200 hours by the late 1990s. Because the number of annual flying hours per C-17 is around 1200 hours,\(^10\) the deviation amounted to 17 percent—a level not much different from that of the C-5. By the late 1990s, the demand for the C-17 was as predictable as that for the C-5.

C-130 deviations show a positive trend, as do those for the C-5 and C-141. The increase in deviation, however, amounted to 8.1 percent, which was greater than comparable increases for the C-5 and C-141. We have no similar data for the KC-135 and KC-10 tankers.

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\(^9\)See Figures A.36 to A.38 in the appendix for the C-141, C-17, and C-130.

\(^10\)See Figure A.7 in the appendix.
In sum, the deviations of actual from planned flying hours increased for the C-5, C-141, and C-130 over the past two decades. The deviation for the C-17 was significant when the aircraft was first introduced, but by 1997 that deviation had declined to a level similar to that of the C-5.

Peak Greater-than-Planned Flying

Among the positive monthly deviations of actual flying hours from those planned in a given year, how large is the largest deviation? The peak monthly deviation shows the largest monthly positive miss in AMC’s flying-hour plan during a given year. Table 5.1 shows the peak GTP flying levels for the C-5, C-141, C-17, and C-130.\(^{11}\) The peak GTP for the C-5 trended upward at a rate of 4.3 percent per year. In the early 1980s, the peak GTP was about 10 hours per month per C-5, or roughly 17 percent of the actual 60 hours of flying.\(^{12}\) The trend line indicates that the peak GTP doubled from the 1980s on to reach a level of about 20 hours per month per C-5 by the late 1990s. The greater the peak GTP, the more difficult and costly it is likely to be to reschedule flights quickly, and the more likely it is that the quality of life of the pilots who must staff these short-notice flights will be negatively affected. There were larger fluctuations in the 1990s than in the 1980s.\(^{13}\)

Table 5.1 also shows the peak GTP flying levels for the C-141. The rate of change was 4.3 percent per year, and was similar to that for the C-5. Also, as with the C-5, there were more fluctuations in the 1990s than in the 1980s.\(^{14}\) The newly deployed C-17 airlifter has too few data points to indicate whether the peak GTP will level off at 45 hours per month.\(^{15}\) As with the C-5 and C-141, the peak GTP flying level of the C-130 showed an upward trend, but its 9.3 percent rate of increase per year was roughly twice that of the C-5 and C-141 (see Table 5.1).\(^{16}\)

In sum, the peak GTP showed an upward trend for the C-5, C-141, C-17, and C-130. In other words, the largest positive monthly adjustment in flying hours

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\(^{11}\)See also Figures A.39 to A.42 in the appendix.

\(^{12}\)The figure of 60 hours was calculated by dividing the annual number of about 700 hours during the early 1980s, as shown in Figure 2.6, by 12 months.

\(^{13}\)See Figure A.39 in the appendix.

\(^{14}\)See Figure A.40 in the appendix.

\(^{15}\)See Figure A.41 in the appendix.

\(^{16}\)See also Figure A.42 in the appendix.
How Does Actual Flying Deviate from That Planned?

Table 5.1
Peak GTP Flying Hours

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Data Period (fiscal years)</th>
<th>Rate of Change (%/year)</th>
<th>t-Test Statistic</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-5</td>
<td>1981–1999</td>
<td>+4.3</td>
<td>1.8</td>
<td>0.10</td>
</tr>
<tr>
<td>C-141</td>
<td>1981–1999</td>
<td>+4.3</td>
<td>0.9</td>
<td>0.41</td>
</tr>
<tr>
<td>C-17</td>
<td>1994–1999</td>
<td>+25.0</td>
<td>1.5</td>
<td>0.22</td>
</tr>
<tr>
<td>C-130</td>
<td>1981–1999</td>
<td>+9.3</td>
<td>4.4</td>
<td>0.00</td>
</tr>
</tbody>
</table>

NOTE: Data points for 1990, 1991, and 1994 were excluded from the determination of the numbers in the third to fifth columns. Bold entries indicate that the probability of a nonzero trend (rate of change) is 95 percent or higher.

during a year increased between the 1980s and the 1990s. We have no data on the peak GTP for the KC-135 and KC-10 tankers.

Length of Greater-than-Planned Flying

In the previous two subsections, we determined the yearly sum of the absolute monthly deviations from planned flying hours and the largest of the monthly GTP flying hours in a given fiscal year. This subsection looks at the length of uninterrupted monthly GTP flying hours or simply the length of GTP flying hours. In it, we measure how long a span of monthly GTP flying hours lasts. If there are four months in a row in which monthly actual flying hours exceed those planned, the length is considered to be four months. A longer length of time places an increasing burden on the air mobility system, which must sustain the effort of quickly gathering extra aircraft and personnel.

Table 5.2 shows the length of uninterrupted monthly GTP flying hours for the C-5, C-141, C-17, and C-130. The C-5 shows a flat trend line, with the average GTP flying-hour period lasting about three months. In other words, the duration of GTP flying was as long in the 1990s as in the 1980s. The fluctuation in duration was wide in the 1990s, just as it was in the 1980s. Thus, one cannot say that the situation was worse in the 1990s.

The length of GTP flying for the C-141, shown in Table 5.2, had characteristics similar to those for the C-5—a flat trend line with wide fluctuation both in the 1980s and in the 1990s. The duration was two months as opposed to three months for the C-5. Even the C-17, for which few data points were available,

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17See also Figures A.43 to A.46 in the appendix.
18See Figure A.43 in the appendix.
19See also Figure A.44 in the appendix.
20See Figure A.45 in the appendix.
mimicked the patterns of the C-5 and C-141: The GTP duration was two months, similar to that of the C-141. Finally, the pattern for the C-130, shown in Table 5.2, showed a flat trend similar to that seen with the C-5, C-141, and C-17 and a two-month duration akin to that for the C-141 and C-17. For the C-130, there was more fluctuation in duration in the 1980s than in the 1990s.

In sum, the average duration of GTP flying hours was for two to three months—a duration that did not change substantially from the 1980s to the 1990s. The fluctuation in duration was also relatively similar in the 1980s and 1990s except in the case of the C-130, which showed a decrease in fluctuation. Overall, the air mobility system was not burdened more by the duration of GTP flying hours in the 1990s. We have no data on the length of GTP flying hours for the KC-135 and KC-10 tankers.

Table 5.2

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Data Period (fiscal years)</th>
<th>Rate of Change (%/year)</th>
<th>t-Test Statistic</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-5</td>
<td>1981–1999</td>
<td>–0.3</td>
<td>0.1</td>
<td>0.90</td>
</tr>
<tr>
<td>C-141</td>
<td>1981–1999</td>
<td>–0.1</td>
<td>0.0</td>
<td>0.98</td>
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<tr>
<td>C-17</td>
<td>1994–1999</td>
<td>+3.3</td>
<td>0.5</td>
<td>0.63</td>
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<td>C-130</td>
<td>1981–1999</td>
<td>–1.1</td>
<td>0.6</td>
<td>0.56</td>
</tr>
</tbody>
</table>

NOTE: Data points for 1990, 1991, and 1994 were excluded from the determination of the numbers in the third to fifth columns.