TITLE: Empirical Assessment of the End-Around Taxiway’s Operational Benefits at Dallas/Fort Worth International Airport Using ASDE-X Data

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ABSTRACT
At the present time, only a few airfields in the world have an End-Around Taxiway (EAT). Since December 2008, an EAT serves Dallas/Fort Worth International Airport’s (DFW) runways 17L, 17C, and 17R, with the purpose of reducing the number of runway crossings and therefore improving safety and capacity.

This paper describes the results of the research project (funded by the FAA and performed by the authors) to assess the safety impacts of DFW’s EAT in terms of reduction in number of runway crossings. In addition, this paper empirically defines the enhancement in departure and arrival throughput achieved after the construction of the EAT. These assessments are based on data from DFW’s Surface Detection Equipment – Model X (ASDE-X) database.

This study has found that the EAT has improved runway safety, increased capacity and reduced departure delay at DFW, although for several reasons its usage is essentially limited to runway 17L arrivals. The EAT has eliminated on average 51% crossings on runway 17C daily and over 83% percent of runway 17L arrivals use the EAT or cross runway 17C using low-risk taxiways. In fact, the EAT has nearly eliminated all mid-runway 17C crossings due to 17L arrivals.

The EAT has exceeded the expected enhancements of departure and arrival capacity. Compared to pre-EAT operations, the ASDE-X data reveals that both departure and arrival
demand have increased at DFW. However, EAT operation has allowed the daily mean arrival and departure maximum throughput rates to increase by 40% and 25%, respectively, while the mean daily maximum departure delay has decreased by 38%.

1 INTRODUCTION

The End-Around Taxiway (EAT) is an innovative runway safety infrastructure concept that the Federal Aviation Administration (FAA) has introduced in recent years at some of the busiest airports in the United States. The primary EAT goal is to reduce the number of runway crossings, thereby reducing the opportunities for runway incursions; as a result, on these runways, which experience fewer crossings, additional expected operational benefits from an EAT include (1) an increase in departure rate and therefore a reduction in departure queue delay.

At the present time, Hartsfield-Jackson Atlanta International Airport (ATL) and Dallas/Fort Worth International Airport (DFW) have one EAT each; San Francisco International Airport (SFO), Houston George Bush Intercontinental Airport (IAH), and Los Angeles International Airport (LAX) have considered implementing EATs. In Europe, only Amsterdam Schiphol (EHAM) and Frankfurt Main (EDDF) have an EAT (2).

The original plan for DFW’s EAT system included a total of four EATs, each located in one of the airport quadrants (1). FAA performed an early study of this EAT system in 1998 (1); five years later, in cooperation with DFW’s management and air traffic control (ATC), the FAA conducted a human-in-the-loop simulation at the NASA Ames Research Center (ARC), which included a control tower simulator and a full flight simulator (1). In this simulation, actual DFW air traffic controllers and pilots interacted in a simulation of DFW operations without and with the proposed EAT system (1). The results of this simulation were used as an operational baseline for the subsequent EAT planning process.

The FAA Airport Obstruction Standards Committee (AOSC), in 2005, per DFW request evaluated the compatibility of an EAT located on the Southeast quadrant with departure operations. The U.S. Standard for Terminal Instrument Approach Procedures (TERPS), which required protection of the 40:1 Obstacle Clearance Surface (OCS) from penetrations by the tails of taxiing aircraft (3), provided the technical reference for this assessment. Given the slope of the OCS and a distance of about 0.5 miles from the runways’ 17C and 17R thresholds to the EAT (Figure 1), the AOSC observed that aircraft with tails up to 65 feet (Group V) would not penetrate the departure surface (3).

![Obstacle Clearance Requirements](image)

FIGURE 1 Sketch of EAT compatibility with OCS. (17)
As a result, the AOSC approved unrestricted operations on the Southeast EAT, but limited to South flow airport configuration (3).

In 2007, one of the authors estimated that the probability to penetrate the OCS for an aircraft taxiing on the EAT was nearly zero, based on transponder height data analysis (4).

DFW and FAA started the construction of the Southeast EAT in 2006, and it opened in December 2008; as shown in Figure 2, this EAT is essentially formed by extensions of the north-south taxiways “P”, “M”, “JS”, and by taxiway “ES” that links these extensions along their south ends. This EAT serves the three parallel runways on the East side of the airport 35L/17R, 35C/17C, and 35R/17L.

![FIGURE 2 DFW EAT, runways 35L/17R, 35C/17C, and 35R/17L. (5)](image)

The current operating procedure for this EAT, issued by FAA DFW ATC in April 2011(6), states that during VFR conditions the EAT should be preferred for the arrivals leaving runway 17L via taxiway “ER” (unless ATC approves an exception), and for runway 17C arrivals only when the wait time to cross runway 17R is expected to be more than five minutes.

In recent years, the FAA installed Airport Surface Detection Equipment – Model X (ASDE-X) at many of the nation’s busiest airports, including DFW (7). The primary purpose of ASDE-X is to prevent runway incursions by enhancing the situational awareness of tower controllers through the visualization of real time localization and identification of aircraft and vehicles on an electronic map of the airport, which also includes airborne aircraft flying the final approach segment. The ASDE-X data can be stored in a database for further processing and analysis, and it can be enriched by merging data acquired by different sources, such as automatic dependent surveillance broadcast (ADS-B), and radar regarding airborne operations beyond ASDE-X’s radius of reception. As a result, this combined data provides valuable information pertaining to aircraft operations; for example, the database integrates several characteristics of individual flights, such as call sign, tail number, gates, specific surface movements (e.g. runways, taxiways, and taxi times), and navigation fixes used. This study uses the DFW ASDE-X database created and maintained by NASA/FAA North Texas Research Station (NTX). The specific ASDE-X data used are presented in the data analysis section.

The importance of research using ASDE-X data continues to increase; however, at this time, there is limited runway and surface safety research based on this data. Typical research using ASDE-X data address impacts associated with surface movement characteristics, new approach and departure procedures, and surface management systems at a single airport. Engelland (2) uses the DFW ASDE-X database to quantify EAT usage volume and to compare the taxi times for arrivals using the EAT with those crossing the runways. Simaiakis et al. (8) develop a pushback rate control strategy to reduce delay and maximize throughput for departures
based on an analysis of the Boston Logan International Airport ASDE-PX database. Balakrishnan et al. (9) develop a taxi route plan that optimizes surface operations using Integer Programming. ASDE-PX data is proving to be critically desirable for assessing the impacts of airport infrastructure and operational policy changes.

Given the increasing congestion of the National Airspace System and at major airports, the problems of airfield capacity and throughput have received significant attention from several researchers and the FAA. Several approaches for estimating or calculating airfield capacity and throughput have been proposed. In one such study, Hansen et al. (10), proposes a method for empirically analyzing the runway throughput. This study uses this methodology for analyzing the impacts of the EAT on arrival and departure throughput (more details are provided in section 3). While all previous studies on EAT impacts have been based on simulation results, this research seeks to evaluate the actual EAT impacts on surface operations using DFW’s ASDE-X data.

Section two describes the approach used for conducting a before and after evaluation of surface operations at DFW. In section three, the ASDE-X data is used to analyze the EAT’s impacts on runway crossings, departure and arrival throughput, and departure delay. The final section summarizes the overall impacts of the EAT on safety and operations, and proposes additional research involving the EAT and ASDE-X data.

2 Research Approach

This research used the ASDE-X database to compare observed runway crossings before/after the EAT construction. In addition, the study assesses the impacts on demand, delay, and throughput for runway 17R departures, and on arrival throughput for runways 17C and 17L. The study uses the Surface Operations Data Analysis and Adaptation (SODAA) tool, developed by Mosaic ATM, Inc. to access the database and export the information to custom spreadsheets developed by the research team. The authors develop SODAA queries to retrieve taxi routes for runway 17L arrivals during South flow operating conditions.

Data sets are randomly selected from both the before and after periods based on required minimum sample size estimates (see 11 for more information). The research team defines the Before EAT time period from April 2008 to November 2008, which corresponds to the entire pre-EAT operations portion of the ASDE-X database. To control for seasonal effects, the After EAT period begins in April 2011 at the same time as the current EAT usage policy (1) and extends for the same length of time as the before period, until November 2011. The researchers have verified (using online historical aviation meteorological information, see 11) that during every randomly selected day only regular South flow operations were conducted and that the weather conditions were compatible with visual flight rules (VFR) (1).

A preliminary analysis of Before EAT data shows that the volume of runway 17C arrivals that use the EAT appear negligible. This confirms the findings of the aforementioned Engelland’s study (2). Therefore, the research team compares the distribution of runway 17C crossings observed before and after the EAT. However, the effects of runway 17R crossings are considered during the departure delay and throughput analyses.

3 Data Analysis

This section uses observed operations retrieved from the DFW ASDE-X database to assess the impact of the EAT. The changes in the runway crossing distribution relate to both the
operational and safety benefits associated with the EAT while the throughput and delay analysis characterize both the capacity and operational improvements.

3.1 Runway Crossing and EAT Operation Distributions

During south flow configuration at DFW, the locations of taxiways “Y”, “Z”, and “EJ” increase the potential severity of a runway incident due to runway incursion; in fact, aircraft landing on runway 17C reach those points at considerable speed, leaving less time for avoiding a collision, and increasing the potential severity. Taxiway “EL” poses similar concerns for both arrival operations on runway 17C and departure operations on runway 17R. Taxiways B and ER are located south of the designated land and hold short point for runway 17C; therefore, those taxiways are often used while conducting land and hold short operations (LAHSO). Figure 3, a detail from the airport diagram, shows those runways, taxiways, and the EAT.

![Figure 3](image-url)

**Figure 3** Runways 17R, 17C, intersecting taxiways, and the EAT. (5)

3.1.1 Methodology

The taxiway intersections with runway 17C are aggregated into three groups based on the similarity of their safety impacts: North, Middle, and South. For the After EAT case only, the EAT, represented by taxiway “ES”, is added as a fourth group. The taxiway groups are shown in Table 1.

<table>
<thead>
<tr>
<th>Taxiway Groups</th>
<th>Before EAT</th>
<th>After EAT</th>
<th>Taxiways</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Z</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EJ</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EK</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>K8</td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td></td>
<td>EL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EM</td>
</tr>
<tr>
<td>South</td>
<td></td>
<td></td>
<td>B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EQ</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ER</td>
</tr>
<tr>
<td>N/A</td>
<td>EAT</td>
<td>ES</td>
<td></td>
</tr>
</tbody>
</table>
The Before EAT runway crossing distribution is obtained by combining runway crossings from twelve randomly selected data sets (days) with a total number of 772 operations (only runway crossings), and the After EAT frequency distribution is obtained by combining runway crossings from fifteen randomly selected data sets (days), with a total number of 807 operations (runway crossings and EAT operations). The study confirms the suitability of these sample sizes by using the methodology proposed by Nisen et al. (13); for the minimum sample size determination, \( \alpha \) and \( \beta \) are set at 0.05 and a meaningful change is set at ten percent. With these values, the minimum required sample size is 477 operations, which both the Before EAT and After EAT cases surpass. The researchers conduct validation tests (see 10 for more information) to provide additional verification that the randomly selected samples adequately represent their respective sampling frames.

The Before EAT distribution is compared with the After EAT distribution using the Pearson Chi Square test (also known as “goodness of fit”). This test evaluates if a change in runway crossing distribution has occurred. The tested null and alternative hypotheses for this goodness of fit test are:

- \( H_0 = \) the After EAT distribution is not significantly different than the Before EAT distribution (\( F_{A\ text{ North}} = F_{B\ text{ North}}, F_{A\ text{ Middle}} = F_{B\ text{ Middle}}, F_{A\ text{ South}} = F_{B\ text{ South}} \))
- \( H_1 = \) the After EAT distribution is significantly different than the Before EAT distribution (\( F_{A\ text{ North}} \neq F_{B\ text{ North}} \) or \( F_{A\ text{ Middle}} \neq F_{B\ text{ Middle}}, \) or \( F_{A\ text{ South}} \neq F_{B\ text{ South}} \))

Where:
- \( F_{A\ text{ North/Middle/South}} \) = After case frequency for the category
- \( F_{B\ text{ North/Middle/South}} \) = Before case frequency for the category

The Chi Square values are calculated with the following:

\[
\chi^2 = \sum_{i=1}^{j} \frac{(After_i - Before_i)^2}{Before_i}
\]

Where:
- \( \chi^2 \) = Pearson's cumulative test statistic
- \( After_i \) = After value of category “\( i \)”
- \( Before_i \) = Before value of category “\( i \)”
- \( j \) = Number of categories

### 3.1.2 Results
Table 2 compares the frequencies of taxiway group usage between the Before EAT and the After EAT case.
Table 2: Comparative Assessment Runway 17C Crossing Before and After the EAT

<table>
<thead>
<tr>
<th>Taxiway Groups</th>
<th>Frequency Before EAT</th>
<th>Frequency After EAT</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>0.18</td>
<td>0.15</td>
<td>-17%</td>
</tr>
<tr>
<td>Middle</td>
<td>0.44</td>
<td>0.02</td>
<td>-95%</td>
</tr>
<tr>
<td>South</td>
<td>0.38</td>
<td>0.32</td>
<td>-16%</td>
</tr>
<tr>
<td>EAT</td>
<td>N/A</td>
<td>0.51</td>
<td>N/A</td>
</tr>
</tbody>
</table>

When comparing only the North, Middle and South distributions, the Chi Square test statistic is equal to 446, which is an extremely high value; this statistic corresponds to a p-value that is essentially zero.

The safety benefits from DFW’s EAT are very clear. This demonstrates that a significant difference exists between the Before and the After case runway crossing frequency distributions, and that the EAT has a positive safety impact on runway crossings. After the EAT, the number of runway crossings reduced on all taxiway groups; on average, the EAT removes fifty-six crossings per day. Most importantly, the “Middle” group’s crossings, which had the highest severity risk in case of a runway incursion, have been significantly reduced and virtually eliminated. In a hypothetical safety assessment process, part of the FAA Safety Management System, the EAT functioned as a risk mitigation strategy to reduce the risk associated with those crossings, based on the FAA risk matrix (14).

Within the South group, taxiway “B” accounted for about three quarters of the group’s crossings during the Before EAT case, but after the EAT construction, its frequency decreased to only four percent. This reduces the risk of collisions when land and hold short operations (LAHSO) are conducted on runway 17C. In fact, while “B” is located just 235 ft beyond the LAHSO stop bar, taxiway “ER” crosses that runway’s South threshold, is located more than 2,700 ft beyond.

After the EAT, 83% of runway 17L arrivals either used the EAT or crossed runway 17C at the low risk “South” intersection. Overall, the risk associated with surface operations appears to have decreased significantly because of the EAT.

3.2 Departure and Arrival Throughput

In addition to providing safety benefits, the FAA and DFW expected the EAT to improve operations and increase capacity. At the time of the EAT’s initial conception, DFW experienced severely constrained operations due to high demand. Throughput represents a commonly used measure of effectiveness for assessing capacity constrained operations. While throughput lacks a standard calculation methodology, its ability to measure the rate of operations makes it extremely useful for assessing the impacts of infrastructure and policy changes. This study uses the methodology discussed in the next section for determining departure and arrival throughput. Figure 4 presents an example of the observed pattern of EAT usage and departure and arrival operations for one day. One of the expected, but clear patterns is that the departure rate and
arrival rate do not peak at the same time, since arrivals generate runway crossings for 17R that periodically interrupt departure operations.

FIGURE 4 Departure, arrival, and EAT operations.

The EAT usage pattern shows that the ATC uses it to allow uninterrupted operations on the departure and arrival runways, during high demand. The impacts of this usage strategy on the departure and arrival throughput are assessed in section 3.2.2.

3.2.1 Methodology
The reduction in runway crossings and the change in their distribution achieved by the EAT’s construction shows that the EAT likely has a positive impact on both arrival and departure operations by reducing their interruption due to crossing aircraft. As mentioned in the introduction, the researchers use the methodology proposed by Hansen et al. to calculate hourly departure and arrival throughput \((10)\) for runways 17R and 17C, respectively. This study replaces the data from the Airline Service Quality Program (ASQP), used by that study, with DFW’s ASDE-X data. Since the ASQP data refers to only the ten largest airlines in the U.S. at the time, which accounted for sixty percent of the flights at DFW \((10)\), the throughput rates calculated by the older study slightly underestimated the total rates \((10)\). Since the ASDE-X database includes all flights at that airport compared to older databases, its data may be used to develop more accurate assessments of airport operational performance. While ASDE-X data gaps may affect accuracy, however, the authors have developed strategies to close the few observed gaps (report).

Although the aforementioned study estimated DFW’s arrival throughput for all runways in an aggregate form, the same methodology may be used to determine arrival and departure throughput for an individual runway. To calculate a maximum rate, Hansen’s study found the shortest time in which \(N\) flights arrived at their gates. That number had to be “large enough to yield a stable average, but small enough to avoid lulls in demand” \((10)\); as a result, these researchers set \(N\) equal to thirty flights. The “hourly arrival rate based on the shortest time interval for thirty arrivals at the airport is defined as the Daily Maximum Throughput Rate...
(DMTR).” This study replicates this methodology using the DFW ASDE-X data, which provides the departure and arrival times, runway entry, exit, and time in queue. For more detailed information on how this data is processed and interpreted by the SODAA tool, the reader can refer to the user manual. Using the same method for calculating the DMTR, this study calculated the Daily Maximum Departure Demand (DMDD) and the Daily Maximum Average Departure Delay (DMAD).

A sample size of five for the before and after cases is adequate for assessing the impact of the EAT on throughput. Five days are selected using Simple Random Sampling from the before and after cases; once again, the researchers verify that VFR conditions exist for the selected days. When VFR conditions do not exist the day is discarded and another day is randomly selected to replace it. Each randomly selected day represents a single data point in the analysis because the maximum daily throughput values are used. The mean daily maximums (DMTR, DMDD and DMAD) for the before case are compared with the same values after the EAT’s construction. A t-test is used to evaluate if EAT has a significant impact on the throughput and delay.

### 3.2.2 Results

#### Departure Throughput

For the departure throughput, this study focuses on runway 17R, the primary departure runway on the East side during South flow, to determine if the EAT increases departure capacity as measured by departure DMTR. The reduction in runway crossings that result from use of the EAT should have a positive impact on capacity; however, this effect is somewhat muted because the EAT is not used by the vast majority of the arriving aircraft (93%). The study also determines Runway 17R’s DMDD and DMAD. The departure demand differs from the departure throughput because the first is the rate at which aircraft reach the departure queue, which is determined by the software’s logic based on aircraft position, while the second is the rate at which the runway serves the departing aircraft. Table 3 shows the results of the departure throughput analysis for runway 17R and provides the significance level observed for the change in mean values between the before and after cases.

### Table 3 Comparison of Departure Performance for Runway 17R Before and After the EAT

<table>
<thead>
<tr>
<th></th>
<th>Runway 17R Daily Maximum Throughput Rate DMTR (departures/hr)</th>
<th>Runway 17R Daily Maximum Departure Demand DMDD (aircraft/hr)</th>
<th>Runway 17R Daily Maximum Average Departure Delay DMAD (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
</tr>
<tr>
<td>Before EAT</td>
<td>39.14</td>
<td>3.51</td>
<td>37.88</td>
</tr>
<tr>
<td>After EAT</td>
<td>48.83</td>
<td>3.74</td>
<td>47.34</td>
</tr>
<tr>
<td>Significance Level</td>
<td>0.002</td>
<td></td>
<td>0.001</td>
</tr>
</tbody>
</table>
When comparing the mean values for the DMTR and DMDD observed before and after the EAT for runway 17R departures, the extremely low p-values demonstrate that a significant increase has occurred after the implementation of the EAT; the reduction in crossings appears to provide a direct operational benefit and permits runway 17R to accommodate higher demand. The simulation conducted during EAT development estimated an average increase of the total departure rate by 18 aircraft per hour when considering all departure runways. Given that DFW ATC, essentially, uses two runways for departures during South flow, the results of that simulation can be divided by two to consider only one departure runway, by assuming that departures may be equally distributed between East and West side runways. This study observes an average increase in DMTR of 9.69 aircraft per hour, which appears to validate the simulation study results. The high variability in the DMAD makes its assessment more difficult. While a thirty-eight percent reduction is observed, a much larger sample size is required to verify this result statistically. Departure delays should be investigated in more depth in future research.

Arrival Throughput
This analysis measures the increase in average Daily Maximum Arrival Throughput Rate (DMATR) for runway 17C as a result of the fewer crossings observed after the EAT; in addition, the combined arrival throughput for runways 17C and 17L is calculated (see Table 4).

Table 4 Comparison of the Arrival Throughput Rate Before and After the EAT for Runway 17C Alone and Combined with 17L

<table>
<thead>
<tr>
<th>Daily Maximum Arrival Throughput Rate (DMATR) (departures/hr)</th>
<th>Runway 17C</th>
<th>Runways 17C and 17L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>Before EAT</td>
<td>31.87</td>
<td>0.88</td>
</tr>
<tr>
<td>After EAT</td>
<td>34.05</td>
<td>0.97</td>
</tr>
<tr>
<td>Significance Level</td>
<td>0.004</td>
<td></td>
</tr>
</tbody>
</table>

Although the increase of the average DMATR observed after the EAT for runway 17C is statistically significant, its magnitude is limited. In average, only about two more arrivals per hour are observed. However, when considering runways 17C and 17L combined, their average DMATR increased dramatically after the EAT; these runways are now serving over sixteen more arrivals. To exclude that these results are due to a lull in departure demand during the DMATR time interval, the researchers compared the observed demand and throughput rates for runway 17R and found that they had increased after the EAT. Before the EAT, the mean departure demand during runway 17C DMATR was 26 aircraft per hour, while after the EAT the mean demand increased to 30.2; when considering runways 17C and 17L combined, the mean departure demand increased from 25 to 26.6.
4 CONCLUSIONS AND FUTURE RESEARCH

This research compares ASDE-X data for operations at DFW before and after the implementation of the EAT, which represents the current ATC operating procedures. The findings clearly indicate that the EAT at DFW achieves its goals of improving runway safety and airfield capacity. Firstly, it improves the safety of East side surface operations by reducing the number of crossings on runway 17C, used for arrivals, and by relocating other crossings away from more dangerous locations. Secondly, the East side runways’ capacity increases because the arrival and departure operations can be better sequenced and coordinated with the conflicting surface operations.

This study finds that the EAT is used by between 47% and 55% of runway 17L arrivals; however, only between 6% and 8% of all the East side runways 17C and 17L arrivals use the EAT. These EAT usage levels correspond to an average daily reduction of 56 runway crossings. In addition, the EAT has been a catalyst for implementing operational procedures that mitigate runway crossing risk due to their locations, considering the FAA risk assessment matrix (14). The EAT operating procedure adopted by DFW ATC allows using the low risk taxiway “ER” to cross runways 17C and 17R on in lieu of using the EAT. Therefore, virtually all of the average 48 runway crossings per day observed before the EAT runway crossings at the midfield taxiway EL, which posed the most safety concerns among all crossing due to its location and the potential conflict with departure and arrival operations at high speed, have been eliminated. Also, when conducting LAHSO on runway 17C, this observed increase in use of taxiway “ER” has mitigated the risk by increasing the minimum potential distance between a landing aircraft and a crossing aircraft from about 235 feet to about 2,700 feet.

This study demonstrates the improvement in runway capacity due to EAT operations by quantifying their daily maximum throughput. The observed mean DMTR after the EAT, is significantly larger than the mean DMTR observed before the EAT. The departure capacity finding is consistent with the simulation performed in 2003 by FAA and DFW in cooperation with NASA (1); however, the simulation failed to identify the improvement in arrival capacity identified in this study. The ASDE-X data reveals its flexibility for use in empirically validating simulated or modeled results. Although this study uses an earlier study’s methodology for determining the daily maximum throughput, the results of these two studies are not comparable because in the meantime the Area Navigation (RNAV) departure and arrival procedures, which have improved DFW’s terminal airspace efficiency (15), have been implemented.

Although the observed mean DMAD is not statistically significant, the improvement in departure delay appears to be tangible. In fact, despite the increase in observed departure demand after the EAT, the mean DMAD has reduced from eleven minutes to about seven minutes. For all these reasons, this retrospective empirical study demonstrates the improvement in operational efficiency that result from the reduction in runway crossings.

These safety and capacity benefits by themselves show promise for justifying the EAT’s construction, and if the number of runway 17C arrivals using the EAT would increase, the observed effectiveness in improving surface operation safety and in increasing arrival and departure capacity would likely increase further.

Finally, study provides opportunities for future research based on ASDE-X data; these projects may include comparisons between actual airfield performance with the estimated results of the models typically used by the FAA (16), and other models under development. This study can be extended to evaluate the entire airfield performance, and the factors impacting the
throughput, such as the fleet mix (8) can be examined more closely to determine their importance and magnitude.

In an effort to seek future research on EAT performance, the authors compared the taxi times for aircraft landing on runway 17L and using different routes to reach terminal C, as shown in Figure 5.

![Figure 5 Examples of taxi routes.](image)

Taxi time for the aircraft routed via taxiway “EL” was 8 minutes and 33 seconds, while the aircraft using the EAT took 9 minutes and 50 seconds, eight seconds less than the taxi time for the aircraft using taxiway “ER”. Although these are only three examples of taxi times and do not prove any assumption, they show that this EAT route can have similar taxi times to runway crossing taxi routes. Most importantly, these examples confirm that EAT operations deserve further investigation to assess its impacts on the arrival delay, which is a critical performance measure for all air carriers.

Based on a detailed analysis of taxi times, the operational costs for air carriers and the environmental impacts associated with EAT use can be estimated to complete the assessment of this innovative infrastructure. The results of all of these studies, which integrate the safety and operational benefits together, may also be used by the FAA and the airports to evaluate or to validate the cost-effectiveness of the EATs.

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Mosaic ATM, Inc., Leesburg, VA
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6) N DFW ATCT 7110.518 – Southeast End-Around Taxiway Operations and RY 17R/17C Departures


14) Federal Aviation Administration, Order 5200.11. Effective 08/30/2010.


16) Federal Aviation Administration, Advisory Circular (AC) 150/5060-5 (Change 2), Airport Capacity and Delay.