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Los Angeles International Airport Runway Incursion Studies: Phase III—Center-Taxiway Simulation

Michael D. Madson

August 2004

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GLOSSARY

ASDE	airport surface detection equipment
ATIS	automated terminal information service
DBRITE	digital bright radar indicator tower equipment
FAA	Federal Aviation Administration
FFC	FutureFlight Central
IFR	instrument flight rules
LAX	Los Angeles International Airport
NATCA	National Air Traffic Controllers Association
TBIT	Tom Bradley International Terminal
TMC	traffic management controller
VFR	visual flight rules

SUMMARY

Phase III of the Los Angeles International Airport (LAX) Runway Incursion Studies was conducted, under an agreement with HNTB Corporation, at the NASA Ames FutureFlight Central (FFC) facility in June 2003. The objective of the study was to evaluate a new center taxiway on the south airfield between runways 25L and 25R at LAX. This study is an extension of the Phase I and II studies conducted at FFC in February and April 2001.

Phase III data were compared objectively against Baseline data collected during Phases I and II. Subjective evaluations by participating LAX controllers were obtained with regard to workload, efficiency, and safety criteria. To facilitate the comparison of Baseline and Phase III data, the same scenarios were used for Phase III that were used during Phases I and II.

Modifications to the taxiways between runways 25L and 25R required development of a new taxiway naming convention. The following operational rules were defined for the Phase III simulations:

- Aircraft arriving on runway 25L exit to the north (except for cargo and general aviation that park south of runway 25L), similar to current LAX operations. The controller will direct aircraft onto taxiway AC (center taxiway).
- Crossing restrictions—No aircraft will cross runway 25R east of taxiway M.
- Aircraft are held short of crossing taxiways on taxiway AC (center taxiway), rather than holding short of runway 25R, keeping aircraft parallel to runways until ready to cross.

A total of twelve 45-minute runs were conducted over the 3-day test period. Quantitative data from these runs were compared with the Baseline data from the 2001 studies. Confidential controller surveys were administered after each run.

In addition to runway and taxiway changes related to the addition of the center taxiway, several other factors may affect the accuracy of the quantitative data, the validity of the survey data, and the comparison of the Phase III results with the Baseline data. The contribution of these factors must be considered in the evaluation of the center taxiway.

Ratings for survey questions were relative to LAX operations in early 2001 (“pre-9/11”). The south Local controller position rated operations with the center taxiway as somewhat more efficient, safe, and manageable compared to pre-9/11 operations. The south Ground position rated efficiency, safety, and manageability as somewhat less than pre-9/11 operations. Debriefings indicated that, although workload is an issue, the concept of a center taxiway would be effective in reducing runway incursions at LAX.

Voice-communication data for the pilots and controllers showed that the south Local and south Ground controllers executed the same number of transmissions, on average, as they did for the baseline runs.

Departure rates for the center-taxiway configuration compared very closely with the Baseline data for the two visual-flight-rules (VFR) scenarios. There was an 8% reduction in airport departure rate for the instrument-flight-rules (IFR) scenario, amounting to 3 flights per hour on both the north and south airfields.

Taxi-in times for arrivals landing on the south runways ranged from 3% less to 16% higher with the center-taxiway concept as compared to the Baseline data. The exception was Skywest arrivals taxiing to the “Box,” whose taxi distance increased significantly with the closure of taxiways J and K for crossing. Taxi-out times for departures ranged from a reduction of 12% compared to Baseline, to an increase of 27%.

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CAVEATS

Because of inherent limitations of virtual reality, decisions should not be based solely on results obtained in FutureFlight Central. This study addresses neither engineering feasibility nor adherence to regulatory requirements. NASA shall not be liable for direct, indirect, or consequential damage or injury arising from decisions made based on this data.

This study focuses on airfield and procedural changes at LAX that may reduce the potential for runway incursions. For this reason, NASA has omitted non-movement-area operation, such as ground-vehicle traffic and ramp control. Although NASA has included overall capacity data in this report, it is not a precise quantitative assessment of the capacity impact of any airport or airfield changes.

1. INTRODUCTION

Phase III of the Los Angeles International Airport Runway Incursion Studies was conducted, under an agreement with HNTB Corporation, at the NASA Ames FutureFlight Central (FFC) facility in June 2003. The objective of the study was the evaluation of a new center-taxiway concept at LAX. This study is an extension of the Phase I and Phase II studies previously conducted at FFC.

Phase I of the studies was conducted at FFC in February 2001. Objective and subjective data were collected, and a validation analysis performed, which determined that FFC was able to simulate LAX operations sufficiently well that the Phase II study could be conducted. The collection of objective data from Phase I is referred to as "Baseline" data, against which data collected during Phases II and III is compared.

Phase II was conducted during April 2001 at FFC. Five alternatives to current LAX operations were simulated and evaluated. These alternatives were subjectively evaluated relative to actual LAX operations, and objectively compared to the Baseline data. Additional Baseline runs were conducted during Phase II to add to the Baseline database, because only two runs of each scenario were included in the database from Phase I. The complete Phase I and Phase II reports can be downloaded in PDF format from http://ffc.arc.nasa.gov/our_projects/lax.

This report presents results from Phase III of the study, in which a center-taxiway concept between runways 25L and 25R was simulated and evaluated. Phase III data were compared objectively against the Baseline data. Subjective evaluations by participating LAX controllers were obtained with regard to workload, efficiency, and safety criteria. To facilitate a valid comparison between Baseline and Phase III data, the same scenarios were used for Phase III that were tested during Phases I and II. This required briefing participating controllers on differences in airport and airline operations between 2001 and today.

2. DESCRIPTION OF CENTER TAXIWAY

The most common runway incursions at LAX occur when an aircraft arriving on runway 25L exits at one of the high-speed exits, and then fails to stop the aircraft before overshooting the hold-short bars for runway 25R. The intent of the center-taxiway concept is to force aircraft to turn onto a parallel center-taxiway, thus eliminating the "straight shot" to runway 25R that exists on the current high-speed exits. The existing LAX configuration is shown in figure 1. The proposed center taxiway and associated changes are shown in figure 2.

Federal Aviation Administration (FAA) requirements for centerline separation between a runway and a parallel taxiway dictated that runway 25L be moved to achieve a separation of 800 feet between the two runways. This provided the necessary separation between runway 25L and the center taxiway, and between runway 25R and the center taxiway.

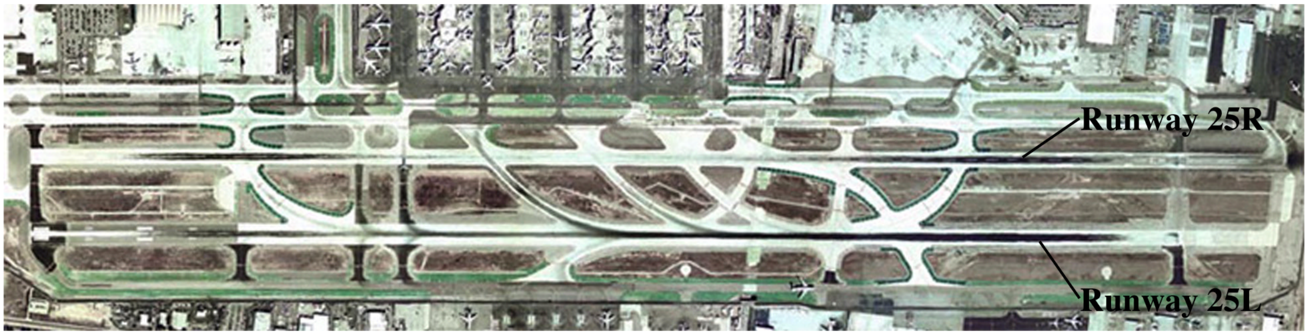


Figure 1. Existing layout, south airfield at LAX.

Figure 2. Center-taxiway concept, south airfield at LAX.

2.1 Taxiway Naming Convention

Modifications to the taxiways between runways 25L and 25R required development of a new taxiway naming convention. To minimize potential confusion for pilots and controllers, all existing taxiways north of runway 25R retained their existing designations for Phase III. Figure 3 shows the taxiway naming convention adopted for the Phase III study.

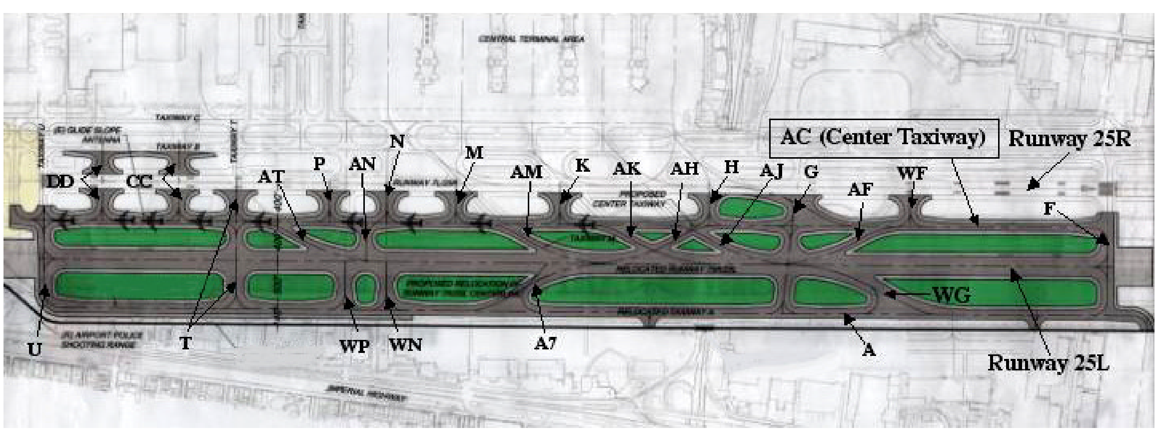


Figure 3. Taxiway naming convention for center-taxiway configuration.

High-speed exit designations were changed to accommodate the goal of keeping taxiway names north of runway 25R unchanged. Because the high-speed exits were effectively “split up” by the center taxiway, the taxiways connecting taxiway AC (center taxiway) and runway 25R retained their original naming convention. Between taxiway AC and runway 25L, exits J, K, M, and T became AJ, AK, AM, and AT, respectively. Dual 90-degree exits N and P were combined into one exit between 25L and taxiway AC. This exit was designated AN. Taxiway P between runway 25R and taxiway AC was shifted west to allow an aircraft to hold on AC, between taxiways N and P. Taxiway J does not exist between taxiway AC and runway 25R. Two additional taxiways were added between runway 25R and taxiway C, west of existing taxiway T. These two taxiways are designated CC and DD. Other changes to lesser-used taxiways from the existing LAX configuration are shown in figure 3 as well.

2.2 Operational Rules for Center Taxiway

The center-taxiway configuration is conceptual, and criteria for operating the center taxiway at LAX do not exist. Therefore, with HNTB, National Air Traffic Controllers Association (NATCA), FAA, and FFC personnel working together, the following operational rules were defined for the Phase III simulations:

- Aircraft arriving on runway 25L exit to the north, similar to current LAX operations. The Local controller will instruct the aircraft to turn onto taxiway AC (center taxiway).
- Crossing restrictions—Aircraft are restricted from crossing runway 25R at taxiways K, H, G, and WF.
- Aircraft remain on taxiway AC until cleared to cross runway 25R. By keeping aircraft parallel to the runways until ready to cross runway 25R, the possibility of a runway incursion is greatly reduced.

3. SIMULATION DESCRIPTION

This section discusses the design of the simulation, the mock-up of the FFC tower to simulate LAX operations, and the schedule of runs during the simulation.

3.1 Simulation Design

The customer required that the Phase III simulation be conducted using the same scenarios as those used during Phases I and II. The current simulation is considered an extension of the Phase II work, and as such, as few changes as possible were to be made to the simulation design and operation from Phase II. The Phase I and II simulations, as well as the Phase III simulation, did not model the following airport operations, under the agreement of all parties:

- Ramp control operations
- Traffic-management coordinator in tower

- Ground vehicle traffic
- Tows to and from the remote gates on the far west side of the airport
- Maintenance tows
- Helicopter operations

Several changes to LAX airport operations have taken place since the completion of Phases I and II in early 2001. The Phase III simulation maintained operations as they existed during Phases I and II. Table 1 identifies the major changes since 2001 that were not reflected during the Phase III simulation. Participating LAX air traffic controllers were briefed on the items in table 1 prior to conducting the simulations.

Table 1. Changes to airport operations since April 2001.

April 2001 Operations	Current Operations
TWA is in operation	TWA taken over by American Airlines
United Shuttle operates B737 fleet out of Terminal 8	United operates Regional Jet fleet and B737s out of Terminal 8
Skywest parks some flights on the west side of Terminal 6, in addition to the "Box" (east of Terminal 8)	Skywest parks all flights in the "Box"
Taxiway C between C-5 and C-6 does not allow taxiing of B757 aircraft or larger	Taxiway C between C-5 and C-6 is open to all aircraft types for taxi

Similar to the Phase I and Phase II simulations, the approach for Phase III was to present a realistic environment for the controllers, such that they could operate in the FFC tower as they would in the LAX tower. Both the north and south sides of LAX were simulated, with a complement of 22 airlines and an aircraft mix representative of LAX in the summer of 2000.

The center taxiway alternative was tested under three west-flow traffic conditions:

> Visual flight rules 1 (VFR1): Peak Arrivals —The scenario included 92 programmed arrivals and a total of 78 departures originating in the departure queue, at the gate, in an alleyway, or in transit.
>
> VFR2: Peak Departures—The scenario included 62 programmed arrivals and a total of 107 departures originating in the departure queue, at the gate, in an alleyway, or in transit.
>
> Instrument flight rules (IFR): Peak Operations—The scenario included 88 programmed arrivals, and a total of 107 departures originating in the departure queue, at the gate, in an alleyway, or in transit.

As in Phases I and II, the departure traffic was run “correct” for the simulation. That is, departure runway assignments were based on the departure fix for the flight, and not with regard to its departing gate location.

A group of 4 LAX controllers each worked twelve 45-minute scenarios over a 3-day period. Appendix A gives the run schedule for the Phase III study. The following positions were staffed by the controllers during the simulation:

LC-1: Local controller, south side (south Local)
LC-2: Local controller, north side (north Local)
GC-1: Ground controller, south side (south Ground)
GC-2: Ground controller, north side (north Ground)

Controllers were rotated by tower position to ensure that there was no response bias produced by over-familiarity with the scenario, fatigue, boredom, or particular expertise in a position by any individual. No controller worked the same position for the same scenario more than once. Controllers were instructed to direct air and ground traffic as they would at LAX, given the operational rules for the center taxiway as identified in Section 2.2, and the changes to current operations at LAX identified in table 1. The controller rotation schedule is provided in Appendix A.

Automated terminal information service (ATIS) “Hotel” information was used in all scenarios: “Los Angeles Airport Information Hotel, 1050Z; wind 24007; visibility 10; few clouds at 2300, ceiling 6000 broken; temperature 14; dew point 9; altimeter 2998. ILS approaches in progress to runways 24R and 25L, or vector for a visual approach will be provided. Simultaneous visual approaches to all runways are in progress. Simultaneous instrument departures in progress runways 24 and 25. Readback of all runway holding instructions is required. Advise on initial contact you have information Hotel.”

Pilots were given the following departure heading information. “Runway 24L/R - Props: 270 degrees, Jets: 250 degrees; Runway 25L/R - Props: 200 degrees, Jets: (LOOP) 235 degrees, (LAXX) 220 degrees; Both Props and Jets turn at the SHORELINE or SMO 160R. Go-around or Missed Approach: Runway 24 L/R - 250 heading/climb to 2000, Runway 25 L/R - 235 heading/climb to 2000.”

3.2 FFC Model of LAX Tower

FFC duplicated the LAX tower layout, controller positions, and view out the window as closely as possible. Figures 4 and 5, schematics of the FFC and LAX tower cabs, respectively, show the relative size and the position of the controller stations.

FFC has 12 windows of equal size around the 360 degrees of azimuth. The LAX tower cab is essentially a square with small corner windows at the 90-degree intersections.

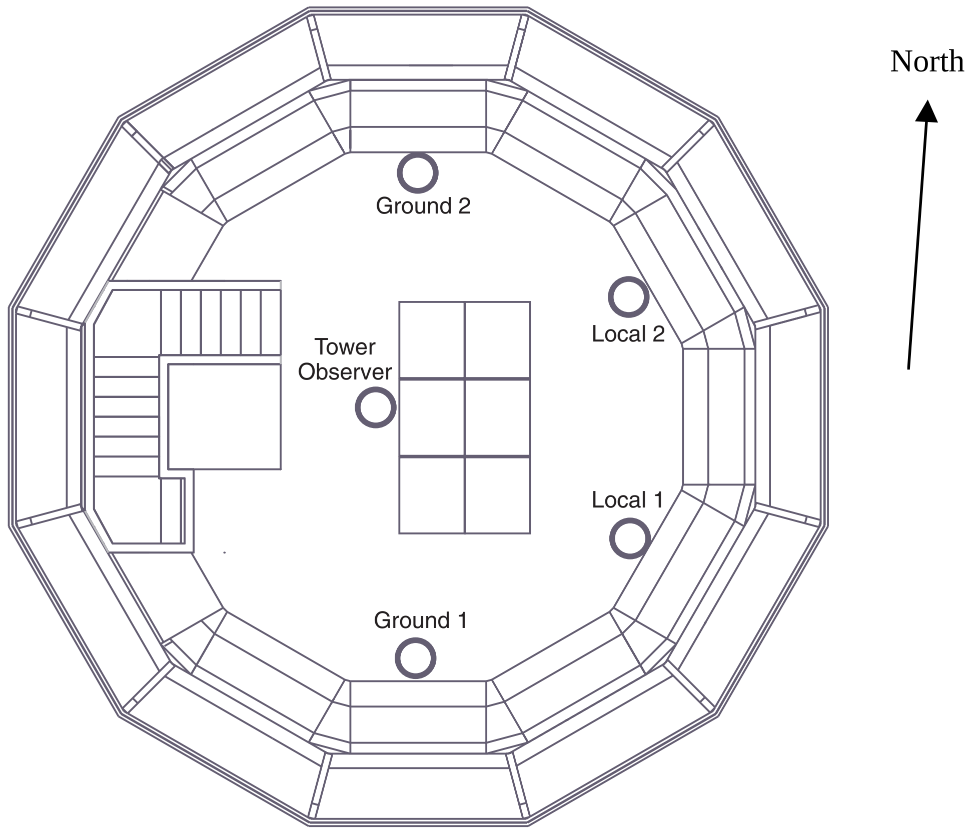


Figure 4. FFC controller-position diagram.

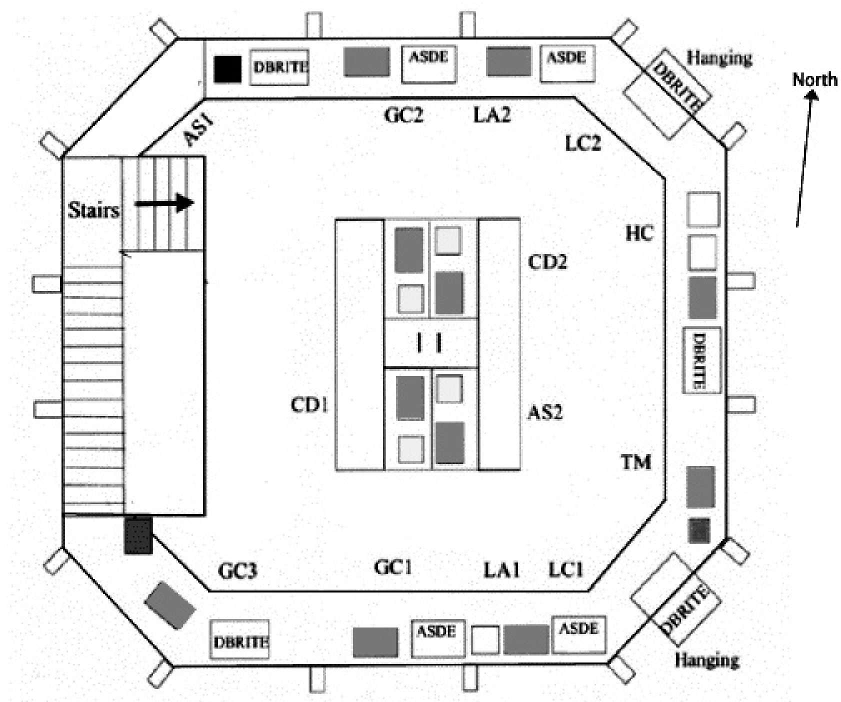


Figure 5. LAX tower controller-position diagram.

Information displays in the FFC tower cab were configured as closely as possible to their counterpart displays in the LAX tower. Hanging digital bright radar indicator tower equipment (DBRITE) displays were positioned for use by the north and south Local controllers. Each controller station had an active airport surface detection equipment (ASDE) display, and a communications panel with headsets for pilot/controller and controller/controller communications.

Thirty-two people participated in each simulation run. They included:

24	Pseudo-pilots
1	Test engineer
4	LAX controllers
2	Pseudo-pilot room coordinators
1	Tower-cab coordinator

One of the biggest challenges in presenting an accurate representation of the real world to the controllers is realistic movement of the airplanes that they are controlling. Pseudo-pilots direct the airplane movements at computer workstations in a room downstairs from the tower cab. To generate realistic traffic, a group of 24 pseudo-pilots at 13 workstations directed the aircraft during the simulations. They were given comprehensive training that included familiarization with LAX runway and taxiway layouts, traffic flows, nomenclature, special procedures, airlines and callsigns, radio-communication phraseology, and hands-on training using the FFC pseudo-pilot interface.

The pseudo-pilot crew had 72 hours of training on the three Phase III scenarios. Retired air traffic controllers staffed the FFC tower during training, closely mimicking the air traffic controller functions at LAX, and critiquing the pseudo-pilots' performance during training runs.

3.3 Simulation Run Schedule

The objectives of Phase III were to evaluate the center-taxiway concept subjectively, and to collect objective data for comparison with Baseline data. The original schedule called for 12 data-collection runs over the 3-day simulation period. However, at the end of the second day of simulation, after 9 successful runs had been completed (3 runs of each scenario), the customer decided that enough data had been collected to make meaningful comparisons with the Baseline data. The final 3 runs of the simulation were instead conducted with the intent of increasing controller workload on the south side of the airport to look at the center-taxiway concept in a "worst-case" environment.

3.3.1 Data-collection runs

Each of the 3 basic scenarios (Section 3.1) was run 3 times for 45 minutes each. No controller worked the same position for the same scenario more than once. The data from these 9 runs were used in the comparison with Baseline data.

3.3.2 Special runs

The final 3 runs of the test were operated with special rules in the tower designed to increase controller workload on the south side, to evaluate the center-taxiway concept in a "worst-case" environment. For all 3 of the special runs, taxiway M was added to the list of taxiways restricted from crossing 25R. The impact on operational aspects by closing taxiway M to crossing traffic was investigated during the 3 special runs.

The same data were collected for the special runs as for the first 9 runs of the study. Because some of the operational rules for the airport were changed for these runs, they were not included in the Baseline comparisons. However, the results of each special run are presented in the Appendices for completeness.

Conditions for Run 10 (Special Run 1)
For this run, the IFR traffic scenario was used, but the weather was lifted to create VFR conditions. This scenario was considered the most demanding in terms of the number of aircraft taxiing between runways 25L and 25R. Departing traffic was run “easy” (runway assignment a function of the departing aircraft gate, rather than the departure fix for the flight). The workload for the Local controllers was increased because of departure crossover coordination requirements, which was accomplished through the digital voice-communication system at FFC.

Conditions for Run 11 (Special Run 2)
The VFR1 scenario was used for this run. An additional level of operational realism was added by having a traffic management coordinator (TMC) in the tower make the call on departure runway assignments. A fifth LAX controller, who participated in the simulation as an advisor to FFC, served as the TMC for this run.

Conditions for Run 12 (Special Run 3)
This run again used the IFR scenario, but this time retained the low-visibility weather conditions for the out-the-tower view. As in run 11, departure runways were assigned by the TMC.

4. TEST DATA COLLECTED

Data from several sources were collected for each run during the simulation. Subjective data in the form of controller surveys, as well as quantitative voice-communication and airport-surface data, were gathered for analysis and comparison with Baseline data.

Simulation runs during Phase I lasted for approximately 1 hour. For Phase II, run times were reduced to 45 minutes to allow for completion of the number of desired runs within the test period. For Phase III, run times were again limited to 45 minutes in order to complete the desired number of runs during the 3-day test period. In computing the average quantities for the baseline runs conducted during Phases I and II, only the first 45 minutes of the Phase I data is considered. This yields a more direct comparison with the Phase III data.

The absence of the raw audio data from Phase I precluded the possibility of recomputing the Phase I audio data over the first 45 minutes. Instead, the full hour of data from the Phase I runs are included in the computation of the average baseline audio data for Phases I and II combined.

4.1 Controller Surveys

At the end of each simulation run, the participating controllers were asked to complete a confidential survey, rating factors such as coordination, communication, safety, complexity, and manageability. Controllers were asked to rate the survey questions relative to early-2001 ("pre-9/11") operations at LAX because that corresponded with the operations on which the Phase I and Phase II controllers based their survey responses. For completeness, the controllers were also asked to rate the factors based on the current (June 2003) traffic operations at LAX. In addition, controllers could select up to three "critical issues" that affected their ability to control the traffic safely and efficiently. A sample of the survey is provided in Appendix B, along with a compilation of the controller survey responses. This report analyzes only the ratings relative to pre-9/11 operations at LAX.

4.2 Controller Debriefs

In addition to the surveys, controllers were debriefed after each run to discuss operational issues with the center taxiway. Appendix C shows a transcript of the controller debriefs.

4.3 Voice Communications

Digital audio transmissions between the pseudo-pilots and the controllers were recorded for each run. Controller and pilot transmissions for each tower frequency were recorded on separate channels to simplify the postprocessing of the data. The recorded data were analyzed for transmissions per hour, transmission length, and percent of time transmitting. Appendix D gives a compilation of the audio data for each run.

4.4 Airport Operations

For each run, operational data for each aircraft in the simulation were recorded to enable the calculation of airport arrival and departure rates, and inbound and outbound taxi times. These data are compared with similar data collected for the Baseline. A compilation of the operational results for Phase III is provided in Appendix E.

5. SIMULATION RESULTS

A summary of the Phase III data is presented in the following sections. Comparisons with the Baseline data, although insightful, must be viewed with some caution, as discussed in the following section.

5.1 Limitations of Comparisons

The objectives of this simulation were to subjectively evaluate a center-taxiway concept at LAX, and to compare objective data from Phase III with Baseline data. Several factors must be considered when comparing Phase III data and Baseline data, and when evaluating the survey data. A summary of the factors to consider, and their potential effects on the Phase III data and comparison with the Baseline data, is provided in table 2.

Table 2. Factors potentially influencing Phase III data and Baseline comparisons.

Factor	Potential Issues
Different pseudo-pilot personnel for Phase III than for Phases I and II	—Differences in aircraft handling may affect taxi times —Differences in ramp management may effect taxi times
Level of pseudo-pilot staffing increased 50% for Phase III over Phase I and II staffing	—Better aircraft oversight (fewer pilot errors such as stops, wrong taxi routes, and aircraft run-throughs) may affect taxi times —Fewer missed calls by pilots and fewer repeat calls by controllers may affect audio data for all frequencies
Software/system stability greatly enhanced since Phase I and II studies	—Some Phase I and II runs were less than 45 minutes and data from those runs were extrapolated, reducing accuracy —Fewer aircraft terminations during Phase III means more aircraft in problem longer, possibly affecting taxi times and communication data —Software caused far fewer inappropriate aircraft stops, possibly affecting taxi times and communication data
Controller participants for Phase III different than for Phases I and II	—Different set of controllers from those who participated in Phases I and II may affect all quantitative data
Controllers for Phase III unfamiliar with center-taxiway configuration and related taxiway changes	—Inefficiencies related to not being familiar with center-taxiway operations may affect taxi times, departure rates, and audio transmissions for LC-1 and GC-1 —Unfamiliarity with modified taxiway names between 25L and 25R may affect LC-1 traffic and communication data —Coordination issues between LC-1 and GC-1 may affect taxi times and audio transmissions for both frequencies
Comparison to pre-9/11 (2001) for Phase III survey ratings	—Survey ratings relative to recollection of LAX operations in 2001 makes assessments less reliable

5.2 Controller Surveys

The survey results presented here represent the averages for the 9 data-collection runs conducted during the simulation. Controllers were asked to rate each of the questions relative to LAX traffic as it existed pre-9/11.

Question 1: The amount of coordination required with the controllers on my side of the airport was: (1 represents ‘Much Greater,’ 5 - ‘Much less’)

	South		North	
Same-Side Coordination	**LC-1**	**GC-1**	**LC-2**	**GC-2**
Mean Rating	3.22	3.00	3.11	3.33
Standard Deviation	1.40	1.33	1.10	0.94

The presence of the center taxiway apparently does not significantly impact coordination efforts between the same-side controllers overall. However, the relatively large standard deviation for the south-side controllers implies that the controllers had wide-ranging perceptions over the course of the 9 data-collection runs.

Question 2: The amount of coordination required with the controllers on other side of the airport was: (1 represents ‘Much Greater,’ 5 - ‘Much less’)

	South		North	
Cross-Cab Coordination	**LC-1**	**GC-1**	**LC-2**	**GC-2**
Mean Rating	3.33	3.33	3.11	3.44
Standard Deviation	1.25	0.94	1.10	0.96

Running the departure traffic “correct” (runway assignments based on departure route) eliminated much of the cross-cab coordination between the local controllers with regard to crossover traffic for departures. The ground controllers also experienced less coordination relative to pre-9/11 operations.

Question 3: The amount of communication with the pilots was: (1 represents ‘Much Greater,’ 5 - ‘Much less’)

	South		North	
Communication	**LC-1**	**GC-1**	**LC-2**	**GC-2**
Mean Rating	3.00	2.33	2.56	2.33
Standard Deviation	1.05	0.82	1.07	0.82

These results indicate that the south Local position did not experience a significant change in communication with the pilots with the addition of the center taxiway. The south Ground position perceived an increase in the amount of communication with the pilots relative to pre-9/11 conditions. With the addition of the center taxiway, and with the crossing restrictions imposed (no traffic crosses runway 25R east of taxiway M), the ground controller’s “hot area” moved from the area between taxiways J and S to the area between taxiways M and T.

Question 4: The overall efficiency of this operation was: (1 represents 'Greatly Decreased,' 5 - 'Greatly Increased')

	South		North	
Efficiency	**LC-1**	**GC-1**	**LC-2**	**GC-2**
Mean Rating	3.11	2.88	3.00	2.67
Standard Deviation	0.57	0.60	0.47	0.82

The results for this question indicate the controllers thought that the overall efficiency of the airport operation was just about the same as for pre-9/11 operations. The south Local position was rated as slightly more efficient, and the south Ground position rated it as slightly less efficient. These results are roughly consistent with those from Question 3 regarding the level of communication with the pilots.

Question 5: In my estimation, relative to pre-9/11 LAX operations, the potential for a runway incursion on this run was: (1 represents 'Much Greater,' 5 - 'Much less')

	South		North	
Safety	**LC-1**	**GC-1**	**LC-2**	**GC-2**
Mean Rating	3.11	2.89	3.11	3.22
Standard Deviation	0.74	0.99	0.87	0.63

Despite the rule that aircraft on the center taxiway remain parallel to runway 25R until cleared to cross, the south Local position rated the potential for a runway incursion as only slightly less than under pre-9/11 operations. The south Ground position actually rated the incursion potential as somewhat higher than under pre-9/11 conditions.

Question 6: The level of traffic complexity in my control area was: (1 - 'Much Greater,' 5 - 'Much Less)

	South		North	
Complexity	**LC-1**	**GC-1**	**LC-2**	**GC-2**
Mean Rating	3.44	2.22	3.11	2.78
Standard Deviation	1.07	0.79	1.10	0.63

The south Local position seemed to think that the traffic complexity was reduced by the presence of the center taxiway. Conversely, the south Ground position rated the traffic as more complex relative to pre-9/11 traffic. These results are consistent with their respective ratings from question 5 with regard to the potential for runway incursions.

Question 7: I would rate my ability to manage the traffic flow under this scenario - from 1 (impossible to manage) to 5 (easier than under pre-9/11 operations)

	South		North	
Manageability	**LC-1**	**GC-1**	**LC-2**	**GC-2**
Mean Rating	3.56	2.89	3.89	3.56
Standard Deviation	0.68	0.74	0.87	1.07

The results from this question indicate that the south Local position, with the addition of the center taxiway, tended to be easier to manage than under pre-9/11 operations. The south Ground position rated traffic somewhat less manageable. These results are consistent with those from questions 4, 5, and 6 with respect to the south Local and south Ground positions.

Question 8: The most critical problem(s) in this scenario was/were: (circle up to three choices)

	South		North	
	LC-1	**GC-1**	**LC-2**	**GC-2**
Communication	0.22	**0.33**	0.11	**0.33**
Coordination	0.22	0.11	0	0
Traffic Complexity	**0.33**	0.22	**0.33**	0.22
Workload	**0.55**	**0.44**	**0.55**	**0.33**
Safety	0.11	0	0.11	0
Manageability of Traffic Flow	**0.33**	**0.33**	0.22	0.22

Question 8 presented the 6 operational criteria shown in the table. Controllers could select up to 3 of the criteria as the most challenging aspects of each run. Each time a controller selected a criterion, it was counted as an "occurrence." The total number of occurrences divided by the number of surveys filled out for each position results in a "Frequency of Occurrence" value. A value of 0.0 indicates that a particular controller position never selected the item as critical, whereas a value of 1.0 indicates that the item was selected by a particular controller position for every run. Since, in many cases, a Frequency of Occurrence less than 0.3 can be inconclusive, only those criteria with a Frequency of Occurrence of greater than 0.3 are highlighted in the table.

Each of the controller positions identified workload as one of the critical problems. In addition, both LC-1 and GC-1 identified manageability of traffic flow as a critical problem. LC-1 also identified traffic complexity, and GC-1 identified communication as critical problems. Safety was not considered a significant problem by any of the controllers.

5.3 Voice Communications

Pilot-controller communications were recorded on a digital audio system, and postprocessed to measure average transmissions per hour, average length of transmissions, and the average airtime distributions. These averages were computed from the 9 data-collection runs. Three components could affect the contents of the audio data, and the significance of the comparisons with Baseline data. The first component is the addition of the center taxiway, which should primarily affect the LC-1 and GC-1 positions. The second component, which affects all controller positions, is the quantity and quality of the pseudo-pilot staff. Fewer missed calls affect communication data for pilots and controllers. Pilots were better able to keep aircraft moving during Phase III, avoiding extraneous controller calls to stopped aircraft. The third component is the improved reliability of the software. There were far fewer aircraft terminations than in Phases I and II, meaning more planes stayed in the problem, affecting the number of transmissions for a given frequency. The latter two factors warrant some caution when viewing comparisons between Baseline and Phase III audio data.

5.3.1 Transmissions per hour

The average number of transmissions (converted to hourly rates) for the 9 data-collection runs is presented in figure 6. The Phase III data for LC-1 is very consistent in comparison with Phase I. Pilot transmissions are down about 7% compared to Phase I, and controller transmissions are essentially identical to Phase I. An analysis of the audio recordings revealed that the pseudo-pilot responsible for contacting the tower for arrival landing clearance to runways 25L and 25R tended to let the controller reach out to the aircraft rather than initiating contact with the tower when the frequency became congested. Factoring in the one extra pilot call for each arrival that did not initiate contact with the tower raises the pilot transmissions to a value comparable to the Baseline data. For the GC-1 frequency, the number of controller transmissions was again nearly identical to the Baseline data. Pilot transmissions increased by about 10%. Several factors may contribute to this increase, including changes to the flow of ground traffic caused by the center taxiway, and improved operational capabilities within FFC (fewer missed calls and aircraft terminations).

5.3.2 Airtime distribution and transmission duration

The percent of the total run time spent transmitting for the pilots and controllers is shown in figure 7. The figure shows that for all frequencies, the pilots spent about the same amount of time transmitting as they did for Phase I. Controllers on the GC-1 and LC-1 frequencies reduced their percent airtime by 25% and 19%, respectively, in comparison with the Baseline data. However, as was shown in figure 6, the transmission rates for the two positions were essentially identical to the Baseline data.

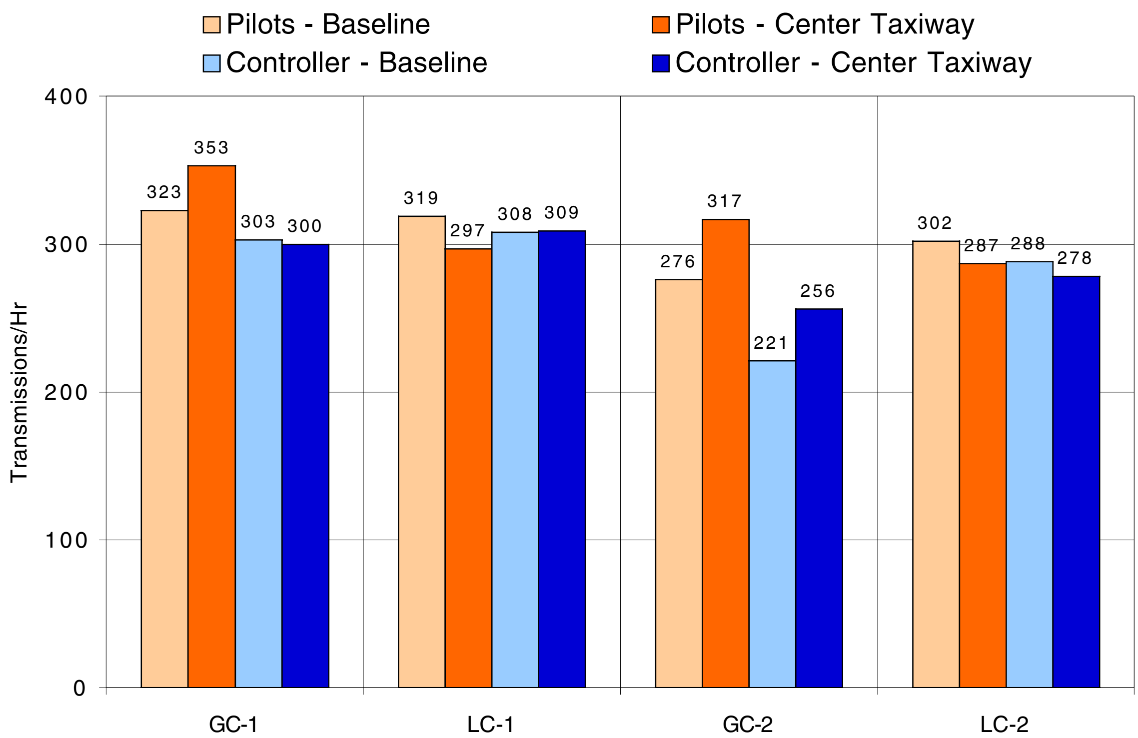


Figure 6. Average transmissions per hour.

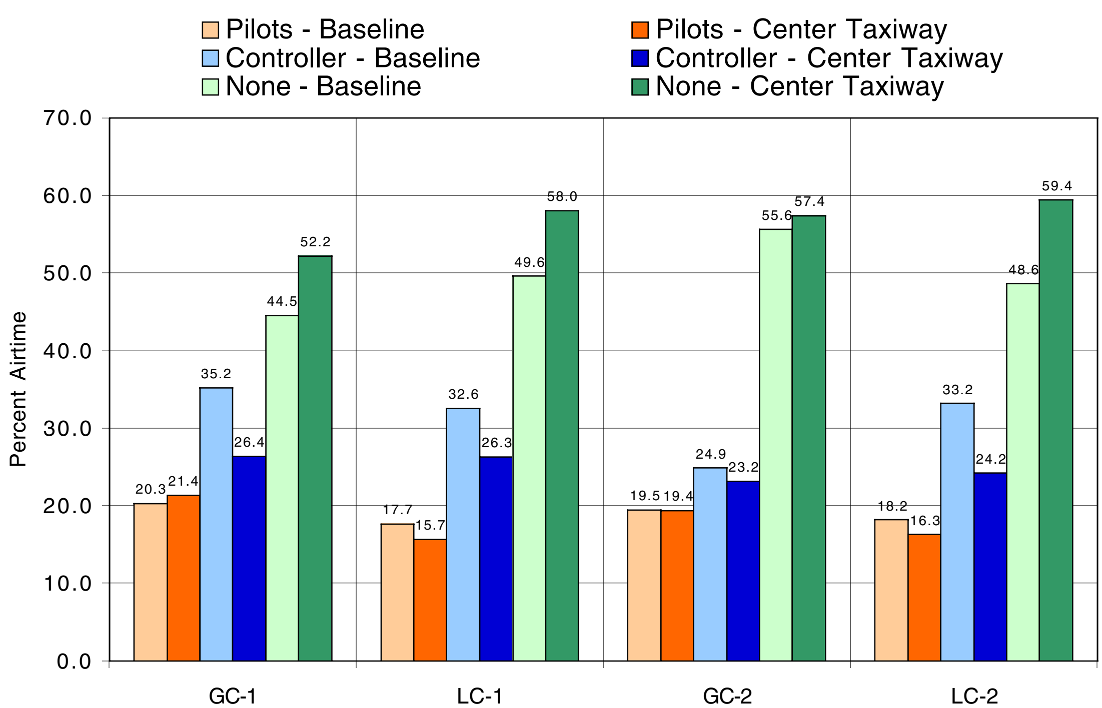


Figure 7. Airtime distribution (percent of total run time).

A further look at the data shows that the reduction in total airtime for the controllers is mostly due to shorter average transmission lengths, as shown in figure 8. The reductions for the GC-1 and LC-1 controllers, 22% and 18% respectively, accounts for nearly all the reduction in airtime for those positions. This is most likely attributable to the increase in the pseudo-pilot staff, which allowed the controllers to communicate more realistically than during Phases I and II. The average transmission length data for the pilots was in very good agreement with the Baseline data.

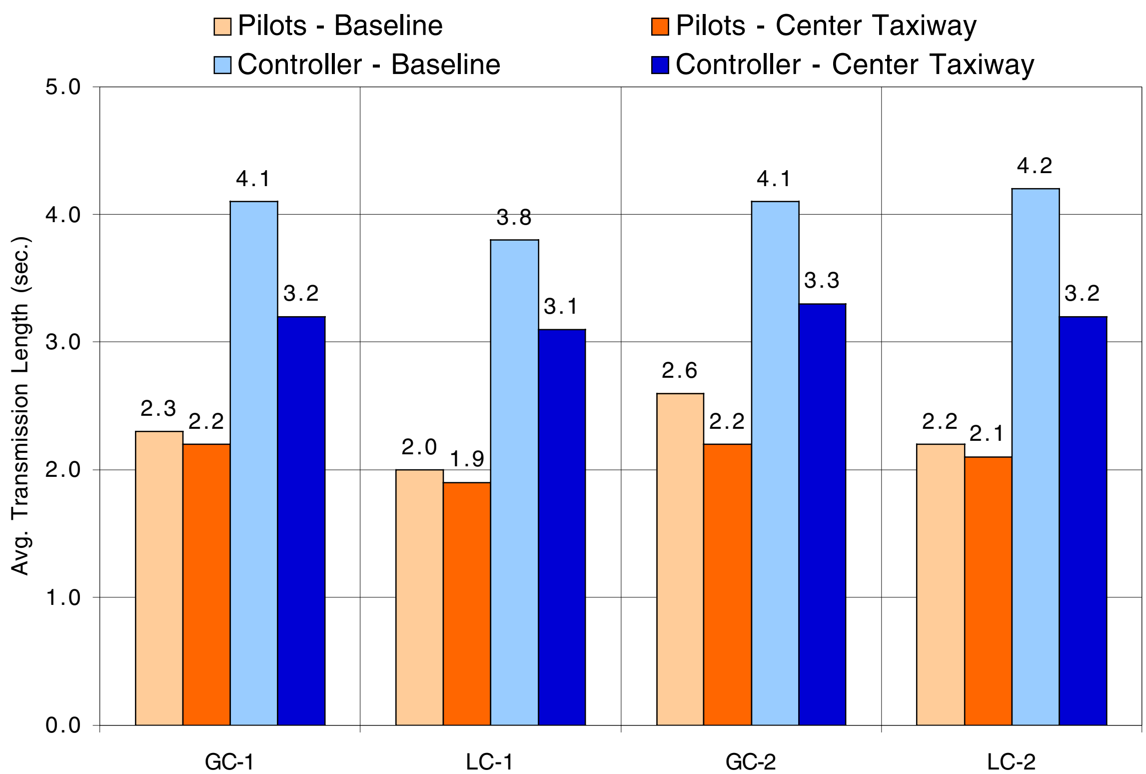


Figure 8. Average transmission length (seconds).

5.4 Airport Operations

This section provides some of the airport data collected during Phase III, and compares it to Baseline data. In particular, the average arrival and departure taxi times and the airport arrival and departure rates are presented.

5.4.1 Airport arrival and departure rate

Arrivals for a given scenario are preprogrammed to activate at specific times during the run, and enter the problem on final approach, about 12 miles from the arrival runway. As such, each scenario has a repeatable arrival sequence. Table 3 shows the programmed arrival rates for the scenarios.

Table 3. Average arrival rate (per hour).

Scenario	Arrival Rate (per hr)
VFR1	92
VFR2	61
IFR	87

Unlike arrival rates for the simulations, departure-rate data reflect factors such as traffic demand, weather, and controller efficiency. Table 4 shows the average departure rates achieved for Baseline and Phase III.

Table 4. Average departure rate (per hour).

Scenario	Baseline	Center Taxiway
VFR1	66	68
VFR2	83	83
IFR	75	69

These results show that for visual conditions, departures rates for Phase III were virtually identical to those from the Baseline. For IFR, the Phase III departure rate was about 8% below the Baseline data. Looking at the departure rates for the north airfield (runways 24L and 24R) and the south airfield (runways 25L and 25R) separately for the IFR scenario, the data show that there were 3 fewer departures per hour, on average, for each airfield. The controllers' handling of IFR separation requirements is a possible contributor to the reduction on both sides of the airport.

5.4.2 Average arrival and departure taxi times

The arrival taxi time for a flight begins when it touches down on the runway, and ends at the gate. Departure taxi time begins when an aircraft taxis off of an alleyway "spot" onto the movement area, and ends when it begins its take-off roll on the runway. For aircraft that push from the gate directly onto the movement area (taxiway C on the south side and taxiway D on the north side), the departure taxi time begins at the start of the forward taxi roll.

Average arrival taxi-time data are presented in table 5, and departure taxi-time data are shown in table 6. For these tables, "North" refers to gates at terminals 1, 2, and 3, and gates 119–123 at the Tom Bradley International Terminal (TBIT). "South" refers to gates at terminals 4–8, and gates 101–106 at the TBIT. "C-Nest" refers to taxiway C-11 access to the Nest (Eagle parking area west of taxiway S and north of taxiway C), and "Q-Nest" refers to taxiway Q-1 access to the Nest. The "Box" is the Skywest parking area east of Terminal 8. The "24s" and "25s" refer to the north runways (24L or 24R) and south runways (25L or 25R), respectively. Appendix F contains a map of LAX with the runways and parking areas identified.

Table 5. Average arrival taxi time (minutes).

		Arrival Taxi Time (Minutes)	
From	To	Baseline	Center Taxiway
25s	South	7.5	8.7
	North	11.2	12.5
	Box	6.3	10.2
	C-Nest	6.5	6.3
24s	South	14.2	15.2
	North	9.2	11.0
	Box	11.8	12.5
	Q-Nest	3.1	6.4

Data from table 5 indicate that, on average, the taxi times for Phase III are slightly greater than those for the Baseline data. Again, several factors contribute to the computed simulation results. The center taxiway does not appear to cause significant increases in average arrival taxi time, with the exception of Skywest flights landing on the south side and taxiing to the Box. Normally, Skywest flights cross runway 25R at taxiway J or K, and thus have a short taxi distance to the Box after they cross runway 25R. For the center-taxiway configuration, aircraft could not cross runway 25R until taxiway M or west. Taxi distances for other airlines were less impacted by the presence of the center taxiway.

Table 6. Average departure taxi time (minutes).

		Departure Taxi Time (Minutes)	
From	To	Baseline	Center Taxiway
South	25s	12.9	13.5
	24s	12.3	15.5
North	25s	19.5	20.0
	24s	7.5	10.1
Box	25s	15.0	13.2
	24s	15.0	18.6
Q-Nest	24s	11.9	13.8

Departure taxi times show a trend similar to the arrival taxi times. As an indication of the variation of data that can exist because of causes unrelated to changes in airport geometry, the largest difference in taxi time between Baseline and Phase III, in terms of percent increase, was for north departures to runways 24L and 24R. This segment of departures should be essentially unaffected by the presence of the center taxiway, yet it shows the largest percent increase in departure taxi time.

APPENDIX A: RUN SCHEDULE AND CONTROLLER ROTATION

Phase III Run Schedule

Time	Day 1-Tues	Day 2-Wed	Day 3-Thurs
08:30-08:45			
08:45-09:00	Controller Briefing	Run 5 VFR1	Run 10 IFR, no Wx
09:00-09:15			
09:15-09:30			
09:30-09:45		Surveys	Surveys
09:45-10:00	Run 1 VFR2	Break	Break
10:00-10:15			
10:15-10:30		Run 6 IFR	Run 11 VFR1
10:30-10:45	Surveys		
10:45-11:00	Break		
11:00-11:15		Surveys	Surveys
11:15-11:30	Run 2 VFR1		
11:30-11:45		Lunch	Lunch
11:45-12:00			
12:00-12:15	Surveys		
12:15-12:30			
12:30-12:45	Lunch		
12:45-13:00		Run 7 VFR1	Run 12 IFR
13:00-13:15			
13:15-13:30			
13:30-13:45		Surveys	Surveys
13:45-14:00	Run 3 IFR	Break	
14:00-14:15			
14:15-14:30		Run 8 VFR2	Discussion & Test Wrap-Up
14:30-14:45	Surveys		
14:45-15:00	Break		
15:00-15:15		Surveys	
15:15-15:30	Run 4 VFR2	Break	
15:30-15:45			
15:45-16:00		Run 9 IFR	
16:00-16:15	Surveys		
16:15-16:30			
16:30-16:45		Surveys	

Controller Rotation Schedule

In order to assure the anonymity of the participating controllers, they were randomly assigned letters A, B, C, and D as identifiers at the beginning of Day 1, and retained those identifiers over the course of the simulations.

			Controller Position			
Day	**Run #**	**Exercise**	**LC-1**	**GC-1**	**LC-2**	**GC-2**
1	1	VFR2	A	B	C	D
	2	VFR1	B	D	A	C
	3	IFR	D	A	C	B
	4	VFR2	C	D	B	A
2	5	VFR1	A	C	D	B
	6	IFR	C	B	A	D
	7	VFR1	D	B	C	A
	8	VFR2	B	A	D	C
	9	IFR	A	D	B	C
3	10*	IFR	D	C	A	B
	11*	VFR1	C	A	B	D
	12*	IFR	B	C	D	A

* “Special” run not part of data collected for comparison with Baseline data

APPENDIX B: CONTROLLER SURVEY AND RESULTS

Controller Survey

Confidential Controller Survey

Controler ID: ______________________ Run no.: _______________ Date: _________________

Position (circle one): LC-1 GC-1 LC-2 GC-2 Condition: VFR1 VFR2 IFR

Please complete the following survey and then give it to the FFC Cab Coordinator. Circle the most appropriate answer for each question and also tell why (comments on back of survey). **All questions are relative to your experience under Baseline Operations at LAX. Ratings should be given in comparison with current LAX operations, and with pre-9/11 operations.** Add any other comments/observations on the opposite side if necessary.

1. The amount of coordination required with the controllers on my side of the airport was: (circle one)

	Much Greater				Much less
Current:	1	2	3	4	5
Pre-9/11:	1	2	3	4	5

2. The amount of coordination required with the controllers on other side of the airport was: (circle one)

	Much Greater				Much less
Current:	1	2	3	4	5
Pre-9/11:	1	2	3	4	5

3. The amount of communication with the pilots was:

	Much Greater				Much less
Current:	1	2	3	4	5
Pre-9/11:	1	2	3	4	5

4. The overall efficiency of this operation was:

	Much Greater				Much less
Current:	1	2	3	4	5
Pre-9/11:	1	2	3	4	5

5. In my estimation, relative to current and pre-9/11 LAX operations, the potential for a runway incursion on this run was:

	Much Greater				Much less
Current:	1	2	3	4	5
Pre-9/11:	1	2	3	4	5

6. Level of traffic complexity in my control area was:

	Much Greater				Much less
Current:	1	2	3	4	5
Pre-9/11:	1	2	3	4	5

7. I would rate my ability to manage the traffic flow under this scenario - from 1 (impossible to manage) to 5 (easier than under current / pre-9/11 operations)

	Much Greater				Much less
Current:	1	2	3	4	5
Pre-9/11:	1	2	3	4	5

8. The most critical problem(s) in this scenario was/were: (circle up to three choices)

Communi-cation	Coordination	Traffic complexity	Workload	Safety	Manageability of the traffic flow
1	2	3	4	5	6

Survey Results – Comparison with Pre-9/11 Operations

				Question Ratings						
Run	**Scenario**	**ID**	**Position**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
1	VFR2	A	LC-1	5	5	5	2	4	5	3
		B	GC-1	2	3	3	3	4	2	3
		C	LC-2	3	3	2	4	4	2	4
		D	GC-2	3	3	2	4	4	2	4
2	VFR1	B	LC-1	3	3	2	3	4	5	3
		D	GC-1	2	3	1	4	1	1	2
		A	LC-2	5	5	2	3	3	3	4
		C	GC-2	2	2	2	3	2	2	2
3	IFR	D	LC-1	1	2	2	3	2	2	4
		A	GC-1	5	5	3	3	4	3	4
		C	LC-2	2	2	2	3	2	2	3
		B	GC-2	3	3	3	3	3	3	3
4	VFR2	C	LC-1	2	2	2	3	3	2	3
		D	GC-1	4	3	3	3	3	3	3
		B	LC-2	3	3	3	3	3	3	3
		A	GC-2	5	5	1	1	4	3	2
5	VFR1	A	LC-1	5	5	4	3	3	4	4
		C	GC-1	2	3	2	3	2	2	4
		D	LC-2	2	2	1	3	2	2	3
		B	GC-2	3	3	3	3	3	3	3
6	IFR	C	LC-1	3	3	3	3	3	3	3
		B	GC-1	3	3	2	-	3	2	2
		A	LC-2	5	5	5	3	3	5	5
		D	GC-2	3	4	3	3	4	2	5
7	VFR1	D	LC-1	2	2	2	4	3	3	4
		B	GC-1	3	3	3	3	4	3	3
		C	LC-2	3	3	3	3	3	3	5
		A	GC-2	5	5	1	2	3	4	4
8	VFR2	B	LC-1	3	3	3	3	2	3	3
		A	GC-1	5	5	3	2	3	3	3
		D	LC-2	2	2	2	2	5	5	5
		C	GC-2	3	3	3	3	3	3	5
9	IFR	A	LC-1	5	5	4	4	4	4	5
		D	GC-1	1	2	1	2	2	1	2
		B	LC-2	3	3	3	3	3	3	3
		C	GC-2	3	3	3	2	3	3	4

Survey Results – Comparison with Current Operations

Run	Condition	ID	Position	Question Ratings Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	VFR2	A	LC-1	5	5	5	3	3	3	3
		B	GC-1	2	3	3	3	4	2	3
		C	LC-2	3	5	3	4	3	4	5
		D	GC-2	3	4	4	3	4	4	5
2	VFR1	B	LC-1	3	3	2	3	4	3	3
		D	GC-1	5	5	5	2	5	4	4
		A	LC-2	5	5	2	3	3	2	4
		C	GC-2	3	3	3	4	3	4	5
3	IFR	D	LC-1	4	3	3	3	2	2	4
		A	GC-1	5	5	3	3	3	1	2
		C	LC-2	3	3	3	4	3	3	4
		B	GC-2	3	3	3	3	3	3	3
4	VFR2	C	LC-1	3	3	3	4	4	4	4
		D	GC-1	2	3	3	3	3	3	3
		B	LC-2	3	3	3	3	3	3	3
		A	GC-2	5	5	1	1	3	3	2
5	VFR1	A	LC-1	5	5	4	2	3	2	3
		C	GC-1	3	4	3	3	4	3	5
		D	LC-2	4	4	3	4	2	3	4
		B	GC-2	3	3	3	3	3	3	3
6	IFR	C	LC-1	3	4	3	3	2	3	3
		B	GC-1	3	3	2	-	3	2	2
		A	LC-2	5	5	3	3	3	3	3
		D	GC-2	4	4	3	3	4	4	5
7	VFR1	D	LC-1	3	4	4	2	4	4	4
		B	GC-1	3	3	3	3	4	3	3
		C	LC-2	3	3	3	3	3	3	5
		A	GC-2	5	5	1	3	3	3	2
8	VFR2	B	LC-1	3	3	3	3	2	3	3
		A	GC-1	5	5	3	1	3	1	2
		D	LC-2	5	5	3	4	5	5	5
		C	GC-2	3	3	3	3	3	3	5
9	IFR	A	LC-1	5	5	3	3	3	2	3
		D	GC-1	2	3	1	1	1	1	2
		B	LC-2	3	3	3	3	3	3	3
		C	GC-2	3	3	3	2	3	3	4

Survey Results – Comparison of "Special" Runs with Pre-9/11 Operations

				Question Ratings						
Run	**Condition**	**ID**	**Position**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
10	IFR	D	LC-1	3	1	2	3	3	2	3
		C	GC-1	3	4	3	3	4	3	4
		A	LC-2	5	4	3	3	3	4	4
		B	GC-2	3	2	3	2	3	4	3
11	VFR1	C	LC-1	3	3	3	2	2	3	4
		A	GC-1	4	5	4	5	4	4	5
		B	LC-2	3	3	3	-	-	-	-
		D	GC-2	3	4	2	2	2	2	4
12	IFR	B	LC-1	3	3	2	3	4	3	4
		C	GC-1	3	3	3	3	3	3	4
		D	LC-2	2	2	2	4	3	1	4
		A	GC-2	5	5	4	3	3	5	4

Survey Results – Comparison of "Special" Runs with Current Operations

				Question Ratings						
Run	**Condition**	**ID**	**Position**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
10	IFR	D	LC-1	3	2	3	2	3	3	4
		C	GC-1	3	4	3	4	3	3	4
		A	LC-2	5	3	3	3	2	2	2
		B	GC-2	3	2	3	2	3	4	3
11	VFR1	C	LC-1	3	2	3	3	3	2	4
		A	GC-1	3	5	3	3	3	2	2
		B	LC-2	3	3	3	-	-	-	-
		D	GC-2	5	5	4	3	2	3	5
12	IFR	B	LC-1	3	3	2	3	4	2	4
		C	GC-1	3	3	2	3	2	2	3
		D	LC-2	3	3	3	3	5	2	5
		A	GC-2	5	5	3	3	3	3	2

Survey Results – Question 8: Critical Problems

For Question 8 on the survey, controllers evaluated six operational criteria. They could select up to three of the criteria to indicate the most challenging aspects of each run. The list of operational criteria was:

1 - Communication
2 - Coordination
3 - Traffic Complexity
4 - Workload
5 - Safety
6 - Manageability of Traffic Flow

For data-collection runs:

		LC-1						GC-1						LC-2						GC-2					
Scenario	**Run**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
VFR2	1	x					x	x									x			x					
	4		x	x	x															x					
	8				x								x				x						x		
VFR1	2	x									x		x	x								x	x		
	5						x		x	x	x					x	x		x						
	7				x			x								x	x	x		x					
IFR	3			x	x	x					x					x	x								x
	6		x	x	x					x									x						x
	9						x	x			x		x									x	x		

For “special” runs:

		LC-1						GC-1						LC-2						GC-2					
Scenario	**Run**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
IFR	10			x	x	x				x	x		x	x	x						x				
VFR1	11			x	x	x			x																
IFR	12			x						x	x		x	x		x			x	x					

Survey Results - Controller Comments

Run	Position	Question	Comments
1	GC-1	Other	All exiting west of Mike actually makes the most congested intersection of P/N Bravo even more difficult
3	GC-2	Q6	Not enough taxiway space for # of airplanes
5	GC-2	Other	Only comment toward simulation-Real life would be more real-time (quicker) for movement of aircraft
6	GC-1	Other	1) Without D-BRITE (usable at ground control) complexity increases 2) ASDE Difficult 3) As far taxiway configuration - crossings
6	LC-1	Q5, Q7	Local working center taxiway takes away from collapsing finals and not being familiar
7	GC-1	Other	Runway incursion prevention seems greater than contribution to efficiency
7	LC-2	Q1	Worked LC-2 no factor!
8	LC-1	Other	A little more attention is spent with dealing with traffic holding between the runways
10	GC-2	Other	Coordination between locals may have slowed down departures a little bit." "How about all correct, except Loops easy or just correct?
11	LC-1	Q6	Not being able to use Mike hurt the operation
12	LC-1	Other	It becomes more complex for local controlling the taxiway
12	GC-1	Q1	Traffic at CC - DD harder to work and takes more transmissions, miss traffic at T, N, P, M

APPENDIX C: TRANSCRIPT OF CONTROLLER DEBRIEFS

Run 1 – VFR 2

GC-2: "I found it easier to take them around then opposed to staggering them somewhere to fit them in with the normal crossover traffic. I found it easier for me, probably put more pressure on them because I'm taking the extra five around that have to go over to GC-1 and work them all the way down to..."

FFC: "Now is that a particular issue to that exercise or having to do with what was going on the south side of the center taxiway?"

GC-2: "It's just about anytime, normally we try to stagger them on the north side and run them on the inside of the smaller aircraft."

GC-1: "That intersection by Papa and Bravo, you're adding numerous aircraft to that intersection which is one of the busiest intersections already on the airport, with everybody exiting there, that tripled the amount of aircraft at that intersection. So it constitutes too many aircraft that have to come through this one spot in this exercise, where in real life they would be more staggered and everybody coming around the corner. Where they exit in this exercise made it difficult.

FFC: "Where the planes exited off of 25L or crossed 25R?"

GC-1: "Well for ground control, all I care about is the ones crossing 25R."

FFC: "So for local it would be a matter of staging them down several more exits."

LC-1: "I was so into my traffic that I didn't have time to look at what she had. It was easier to take everybody to November or Papa because they all came off at Alpha-Mike.

FFC: "Would that Papa Bravo issue would still have existed if those aircraft would have been taken down to Alpha-Charlie to Tango or Charlie-Charlie? You would still get them coming back through Papa Bravo, would that have been any different?"

GC-1: "It probably would be a little less, but...Where I think just staggering them better, a lot of times they exit Kilo in real life, that staggering you would get a few out at once then bring everybody around at Bravo. If you stop every time someone is exiting they still can't use 25R at Papa or November, so you still have to protect for that."

LC-2: "That scenario was basically a Loop rush as well, so we had tons of airplanes over here (North airfield)."

GC-1: "So with the Loops going around, added more aircraft."

FFC: “Did you find with Kilo not being available affecting your ability to cross or would that affect local or ground? Did that restrict you or effect or help you at all?”

GC-1: “Normally all Skywest would exit at Kilo, and that’s a large percentage and they would be there and out of the way. Instead they had to go with everybody else. And they are just as bad with any other aircraft with communication or any other problem. So the less you have to do the more efficient it will be.

FFC: “So ground would have preferred having some Kilo crossings particularly with Skywest, but local wasn’t really affected.”

LC-1: “Because Skywest mostly gets off at Kilo.”

Run 2 – VFR1

GC-1: “I had to try and coordinate with my local controller, to tell me where to cross and coordinated to push things further down the taxiway. If you have it built up though, you can’t do the same of letting four or five go at any one particular time. Need to try and keep the flow moving of having multiple crossings. I found having aircraft going to the North side go down further is easier to take them on Charlie and the North-Route.

LC-1: “Traffic takes a lot longer to cross, so you have to allow the time for the crossing. Part of it is the simulation where a Skywest could cross in a blink of an eye in real life but here it could cross like a 747 or cross quickly. Something that’s hard to get use to.

FFC: “Something to look at is the increase in workload for LC-1 with moving aircraft down Alpha-Charlie.”

LC-1: “Especially if you have to move them all the way down to Uniform. I was trying to get them down there but with the time it takes to get them to move and the time it takes for them to move, you may have a crossing hole before they get down there and you may miss a crossing hole because the aircraft is in-between a taxiway.”

Run 3 – IFR

GC-1: “Much easier having the local controller taking all my northbound airplanes to Uniform and he alerted me to that because I was holding everybody short at Tango that was coming on Alpha-Alpha. But when he told me he was crossing at Uniform then I started holding at Uniform. I think not using Juliet-Kilo helped me out because I was able to taxi everybody to the runway from there and taxi straight to the gate because I didn’t have to protect those high-speeds.”

LC-1: “Having to pre-plan a little bit to get the people to go down to the further high speeds and then having them, due to traffic, go down to Uniform. It’s a longer taxi route, but it clears out any runway incursion at Papa or November and at Mike.

FFC: “So all crossings were at Uniform?”

LC-1: “No, for the north-siders, I first started at Tango but I found it difficult with the guys coming on Alpha-Alpha. There was too much confliction for me to cross my runway. Getting them in and out and taking them down to Uniform and crossing them, it made it easier. So there was no confliction of ground using the intersection of Papa-November and Sierra-Quebec with the backup on Quebec.”

FFC: “If coming the Bridge route, if they were going to use Charlie instead of Bravo does that cause more problems?”

LC-1: “In a perfect scenario what you would have is no tugs, so you would have to leave Charlie open.”

GC-1: “But with airplanes going to Terminal 6 and 7, Bravo would be easier because you’re having people going on the North Route turning on Quebec, so you have to constantly watch for that and they have to turn on Bravo anyway, so it’s better to keep them on Bravo rather than Charlie.”

FFC: “For the next IFR would you use the same strategy or try and cross them sooner?”

LC-1: “I probably would cross them a little sooner. I think I delayed a departure about six minutes (for runway crossing), but I only had three guys in line for departure so I figured it was more important to clear my taxiway up than keep clearing airplanes for takeoff. It got backed up for guys on the North Route were backed up and around.”

GC-2: “If they would balance the departures, if he only had three, and I was lined up all the way down Quebec the whole time, it would have been better to send some of the Loop’s down there.”

GC-1: “I think the center taxiway increases the workload almost too much, because right now it’s not so hard, but if we’re going to have to do all the crossovers or input in the ARTS, it’s a lot of work for that one controller.”

FFC: “So far we’ve had three different people work LC-1. How much of that is the lack of familiarity with running this configuration versus real issues that might run on for months?”

GC-1: “I think it’s both. We’re still not familiar but we’re trying to be efficient. You’re losing focus trying to make it work for ground and yourself. Because Mike, November and Papa are so close together, you can only hold one airplane at each one. So you’re inclined to take everybody down to Tango or Uniform and you’re watching that and you’re not watching what else is going on.”

Run 4 – VFR2

LC-1: “This if my first time on the south side, so getting used to the taxiways was the most difficult part. The arrivals weren’t too bad so I was able to hold and pre-plan. In the perfect scenario you tell them where to exit and they exit there. In that scenario with the pre-planning it worked out pretty good and look at the ground traffic and see what he has and cross a couple at a time. It wasn’t as bad as I thought it would be. We didn't have over-takes or "squeeze plays" on the arrivals like we normally do at LAX.

FFC: "When you had that crossing five or six all at once, how was that on your end (to GC-1)?"

GC-1: "It was easy."

LC-1: "Well I gave him three Skywest back to back to back at Mike which were all automatic to the gate and two North-bounders."

FFC: "I saw you use Kilo one time, did you feel that made things smoother?"

LC-1: "Yeah. The Brasilias at Kilo made it a lot easier. You can really improve the efficiency of the Brasilias by getting them out of the mix, by exiting at Kilo or have them go opposite direction (east bound) on Alpha-Charlie and hold short of Hotel because it's a straight shot to their gate."

Run 5 – VFR1

FFC: "Did anybody run a position for the second time for this scenario, and was it easier or harder?"

LC-1: "I've worked LC-1 twice. The first time was a little harder, but this time I tried to pay a little more attention to where they turned off and where I was going to cross - more than I did last time."

GC-1: " Right now their gates are open, so we're just taxiing them to the gates, where as before (pre 9/11) we would be holding people on Bravo short of Charlie-8, hold on Charlie short of Charlie 6-7, and people would call back for push and we have people waiting to get into the alley.

GC-1: "You can see on the south side, the local was able to load up more airplanes on the centerline taxiway without the airport restriction of having them cross, and that's the key for us because we have so many restrictions between the runways of what we can and can't hold. And when we get a huge departure push and rush that's when safety gets compromised because so much is going on. So for a safety standpoint, with the centerline taxiway we can keep loading it up on the centerline and wait for the inboard and then flush. Without a doubt we can load more airplanes on the centerline."

FFC: "Everyone that has worked local, yesterday you ran them down to Uniform with a lot of them, do we see that happening in IFR again?"

GC-1: "As a local controller you need options. If there's nothing going on at ground, you have a guy that got off at Mike or Kilo, you might take them down to Uniform. But then you have a perfect opportunity to take him out of your hair as being opposed being lost in-between the runways. IFR, last thing you want is an aircraft in-between runways lost - especially at LAX. When the fog comes in, it gets nasty to the west of the airport, where you get conditions of zero visibility. The further west you put them, the better chance they're going to be stopped and can't see anything, so we need options of taxiways further down. They were talking earlier about taking away Mike. That would not be an option - might as well make it a one-runway operation. You don't want to limit what we can do."

Run 6 – IFR

LC-1: “Most of my attention was towards where I’m going to stage these aircraft and I’m looking at ground control swamped with arrivals and departures on the taxiway and try to help ground control where I could stage the arrivals, but sometimes you just have to give up and just cross and pound ground control. Even taking them downstream, there’s still a ton of traffic that came from the Bridge Route on Bravo. There’s always a factor no matter where I cross. I realized a couple of times after I did it, we weren’t suppose to cross at Kilo, but that saved me and ground control because the Brasilias were able to stage there and taxi straight into the Box instead of them bringing them downstream and swamping ground control with traffic. With collapsing finals, especially in IFR, that the planes can’t see each other with one landing on the runway the other guy can’t see if he’s off the runway or not, and that’s a major factor for us paying more attention to separating those airplanes as opposed to staging these aircraft down the taxiways trying to find a crossing hole for them to cross.”

FFC: “If you have gotten a lot of experience working with the centerline taxiway, would that level of distraction go down at some point?”

LC-1: “I think you’re going to get accustomed to it. Everything changes for us but we notoriously hate change, but you always adapt. Just have to get use to it. It helps having an assist to help you out. Just getting acclimated to the equipment is a factor for us not being comfortable with it. It’s a lot better now than with no centerline taxiway. It may come with practice. It’s definitely an advantage with the centerline taxiway, safety-wise. Getting airplanes clear of 25L is a lot better than what we have now.”

GC-1: “Having traffic on the taxiways for a longer period of time adds to the complexity. Longer they are on the taxiway the more calls you’re going to have to make. For someone coming down at Uniform that’s going to be potentially four more calls than if he came off of Mike.”

FFC: “The centerline taxiway seems to be a good tool if you’re not too constrained on how exactly you’re going to use it.”

GC-1: “The centerline taxiway does help prevent runway incursion, because it prevents the standard someone exiting 25L and accidentally crossing 25R and that’s the non-controllable runway incursion. So on that level, complex or not, that type of runway incursion it helps.”

LC-1: “Even with the same scenario, and we take away the center taxiway, we’re still going to pound ground the same. No matter where we come off - Tango, Papa, November, Mike, Kilo, Juliet - ground is going to pounded. Now I know they concentrate a lot of traffic at the Charlie-10 alleyway. No matter how you design the airport, unless you extend the runway to the 405 freeway, that traffic has to exit. And if you push that traffic to the west, the traffic has to comeback down to Papa, so you’re going to get grounded with the traffic at Papa. What that centerline taxiway does, it gives you more time and more of an out to shoot one across and stage a little bit better, where now there’s airport restrictions and we don’t have a choice - here it comes.”

FFC: “What are your thoughts when six or seven aircraft cross at one time? Is it something you’re used to doing or is it a big deal or could have been a big deal?”

GC-1: “Personally, it’s not a big deal. My concern is if local crosses six and they need their runway, then there might be a problem. It doesn’t really matter that much except for frequency congestion and things like that.”

Run 7 – VFR1

LC-1: “I found if I pre-planned with the heavies roll down to Alpha-Tango, with some of the Brasilias running them down to at least Mike or November, doesn’t seem to be a problem grouping them together three at a time. I found a couple times on the inboards, that if you notice when it’s at the top of the scope then you can pre-plan how many departures you’re going to run, we found that pretty smooth to run the full traffic all the way through. I did have my first go-around a couple minutes into the problem - I noticed the aircraft took an extra 30 seconds to depart after I told him to go. I didn’t seem to bunch them up too much on my ground controller and kept running them all the way down and waiting for the appropriate sequence of aircraft departing to cross them.”

FFC: “Now that you’ve worked it a few times, you mentioned that you’re moving the aircraft to your advantage. Is it getting easier for you?”

LC-1: “I found that Alpha-Charlie (center taxiway) is moving pretty nice. It gives the pilot more ease to not to jam somebody on taxiway Mike. If it was just the diagonal that somebody was sitting already on Mike, you could actually turn them on Alpha-Mike and then turn them on Alpha-Charlie, if they say they’re not going to make it.

GC-1: “I used Charlie more down on the west side and I found that to cut down the complexity of the arrivals exiting and it wasn’t too bad because there’s not too much of opposite direction traffic. By using Charlie not too many had to stop, unless it got full I could turn them onto Bravo. The only time it got backed up was when a couple turned onto Charlie when they were supposed to turn on Bravo.”

FFC: “And you were using Charlie for traffic coming from 25R or the Bridge? “

GC-1: “Both. From Alpha-Alpha and if I could from 25R to bring them in, but if there was no hole on Charlie they could go on Bravo. It was just another place to put them. Keeping them lined up on Charlie worked the best for everybody.”

FFC: “Now how much control do you have over arrivals to plan Alpha-Tango or Alpha-Mike, can you get away with specifying that?”

LC-1: “Depends on the sequence and who is behind them like heavies.”

GC-1: “The big thing with that is the time and spacing behind them. You don’t know how long they are going to take to land long.”

FFC: “Is the loss of Kilo still hampering airport efficiency?”

LC-1: “On this sequence of VFR it wasn’t that much. I didn’t really care to run them down to Mike and then back around, but I could have.”

Run 8 – VFR2

FFC: “We saw a little different traffic setup that time, any comments from LC-1 or GC-1 about what happened and what led to it? Is this something that would have happened normally? Is this something that the center taxiway induced?”

GC-1: “It would have happened normally, but it wouldn’t happened if we had an assist. I was pushing in front of every terminal so I couldn’t use Charlie for anything. I had five or six airplanes on the North Route on Bravo and she crossed three airplanes that had to go the other way.”

FFC: “Did the center taxiway help that problem snowball, since now we could a bunch of crossing airplanes until we get that cleaned up?”

GC-1: “Could have been, but probably not because the three airplanes all could have held there whether the centerline was there or not, just a bad timing thing.”

LC-1: “The reason I crossed them was because I held them for quite awhile and I was running out of room. They had to cross since they weren’t on the inboards. Maybe because I was paying so much attention to manage them in-between the runways, I didn’t see you were going upstream with that many.”

FFC: “It seems like when you get into a situation when ground is tied up, you have an option with the centerline taxiway to maybe hold more airplanes longer, giving ground more time to clean it up. is that a true statement?”

GC-1: “Yes it is, but the timing was bad when she decided to send the airplanes across. If it was a little before or after it would have been great. Also when it was busy like that, a traffic manager would have said to her, ‘take it easy’.”

Run 9 – IFR

LC-1: “I found my job was extremely easy. I did not hold a lot of airplanes on the centerline taxiway because I had a lot of crossing holes to get rid of them instead of just backing them up. I guess GC-1 had problems crossing at Tango. He said he could not see traffic crossing at Tango because of the weather. I wasn’t too sure what was going on.”

FFC: “You worked GC-1 during IFR. In that case, local was holding several at a time and crossing bunches.”

LC-1: “Yea, and that is much more work. To me, I want to get one and get them out of the way instead of having everybody come at once.”

FFC: “So crossing over and holding fewer, did that have an effect on the departure rate?”

LC-1: “No, you only crossed when he asked to cross. I never held anybody up.”

GC-1: “During IFR weather in the beginning it was fairly smooth to maneuver around. I found it difficult to cross taxiway Tango with a multitude of aircraft. I was unable to reach out and get to them in a timely matter to move them to taxiway Charlie. I didn’t have a problem taking aircraft on the north side on the Bridge Route. I used Bravo and held them short of Tango and them based on there held them a couple minutes, and one ended up staying there about five minutes due to traffic crossing at Tango. Also, crossing a multitude of aircraft at Mike and November, reaching out and getting them in a timely manner to get them to their gates. Overall it wouldn’t be bad if they didn’t cross a multitude of aircraft at one single time. I noticed it got backed up taking the Loops, Venturas back up to Charlie-10 for a couple of minutes trying to re-sequence aircraft from taxiway Tango on Charlie on the North Route. I was unable to move a couple of aircraft on the south side on Sierra over to taxiway Bravo.

FFC: “So taxiway Tango got backed up mainly because a heavy line came from Tango and a heavy line coming from the Bridge. If this taxiway were built, and local had a procedure, could look and go and tell the guy coming across on Tango to cross Bravo short of Charlie.”

GC-1: “I’ve used that before, and already now using taxiway Tango crossing straight into Charlie, just look and go and yell over to ground controller, ‘can I taxi onto Charlie?’, and that would have been no problem.”

“Special Runs”:

Run 10 – IFR (Visuals set to VMC), Mike Closed for Crossing, “Easy” Departures

GC-1: “Traffic was realistic and really didn’t have any problems.”

FFC: “No issues with number of crossings?”

GC-1: “There was a point where I had a two heavies coming out of Charlie-10 and I asked him (LC-1) if he was going to cross here, I have these two guys coming out. He would tell me if he was going to cross four or five into Charlie.”

LC-1: “I had to pre-plan a lot before, and where to exit on Alpha-Charlie. I didn’t have a problem holding in-between, just where to cross them and not to run into Ground’s traffic. Coordination wasn’t too bad, just had to get used to. There were a couple times I could have crossed at Mike where it could have been easier. By putting them all the way down to taxiway November, you eliminate taxiway Alpha-Mike exiting onto Alpha-Charlie. So you had to be cautious of how many you were holding there to cross. Where if you had them further down at Kilo then you could cross there and you wouldn’t have to worry where you had to cross your next final. Still a little bit too much attention where to exit the airplanes, feels like I’m doing more ground controlling. There’s an advantage but disadvantage when closing Mike.”

Run 11 – VFR1, Mike Closed for Crossing, "TM Call" for Departures

LC-1: "Closure of Mike or anything east of Mike was brutal, for the inboards and for getting the departures out especially moving everybody that far down. With one scenario left and we can cross anywhere on Alpha-Charlie and take all your Brasilias and Uniteds down this way and stage and they are clear where these people are going to be exiting, where you can hold them short of Charlie-6 and when the alley way opens up it's a straight shot in, instead of bringing them down Mike where all the traffic is. There's lots of potential bringing these guys east bound and staging them."

FFC: "We have the safety people versus the people who have to work the airport versus the airlines." (Regarding taxiway restrictions i.e. closing Mike)

GC-1: "They are just assuming that it would be safer if we didn't cross at Mike. They have not seen what's going on and if we are able to do what we want to do and how we want to do it. Because everything is so static and we change our minds all the time. They may think it's safer because they haven't seen anything else. They have only seen without the centerline taxiway what's happened, but now since we do have that, let us do what we do and see how it works."

FFC: "You're creating an extra workload on the LC-1 position with this restriction, which is a safety issue."

LC-1: "With this restriction, I was working ground control. My focus was taken away from the approach end where it should be.

FFC: "Were you less distracted if you could use it (Mike)?"

LC-1: "Yea, it's an automatic. Because when they exit the runway you tell them turn left on Alpha-Charlie and hold short of Kilo, they are there. Where if they missed it, continue down to Papa, hold short of Papa, continue down to Tango."

FFC: "Instead of stepping them have you tried, if there was three or four in front of the guy you want to take down to Tango, like someone going to the north side, have you said 'when able hold short of Tango', even if there's three aircraft stopped in front of him? Does that reduce the workload?"

LC-1: "No, Nope."

FFC: "The developers or designers tell you that you have Charlie-Charlie, Delta-Delta and Uniform, why don't you use them?"

GC-1: "Charlie-Charlie and Delta-Delta are very inconvenient for the ground controller, also our automatic stop point is usually Tango, then it would be Charlie-Charlie, Delta-Delta and they are just going to keep stopping and stopping."

LC-1: "Which would put airplanes on the runway. If they cross at those odd marks, if I just randomly cross at Uniform, Charlie-Charlie, Delta-Delta, Tango, Mike and every single taxiway to the west, we have lots of traffic coming from the Bridge Route from airplanes landing long on the north side and parking on the south side, where you have to stop a United at every other intersection trying to get him to his gate and people are going to come across the runway and stop because here comes United. Now I have inboards and traffic at Delta-Delta, Charlie-Charlie, and Uniform stopped on my runway with an inboard - we are going to have a problem."

FFC: "If they extend that design down to Charlie."

LC-1: "They can take that out to Persia. Now my attention is at the very end of the runway. When I have traffic on short final, my attention needs to be on final to the east not to the west. If all my attention is down at Uniform, 'so what the heck is happening over here', if there's a guy in position and a guy on short final that I miss because all this stuff that is going on down here, that's not going to be good.

FFC: "Kilo and Mike are the hot spots for incursions right?"

GC-1: "Right, and if we're on inboards and I'm working ground and I don't see them, but landing on the inboard and I'm looking down there, it's more of a distraction than anything."

LC-1: "It was definitely a workload issue for me with those closures."

GC-1: "And with Charlie-Charlie, Delta-Delta so close together, there's only room for one or half an airplane to hold."

LC-1: "With a centerline taxiway, with Kilo and Mike available for crossing, everywhere available for crossing, just with the centerline taxiway alone you can see where it's going to eliminate the runway incursions, period. There might be a workload issue for the local controller, but it's going to be a safer operation. The only problem is efficiency-wise; you're not going to have that with the departures, period, because it takes the aircraft so long to make that hard right turn to cross the runway. You're not going to be as efficient, but from a safety standpoint a centerline taxiway is going to be a safer operation than what we have right now. With the centerline, we have four loaded intersections that we can stack more airplanes at - Alpha-Kilo, Alpha-Mike, November, Papa, and Tango. We can take more airplanes and cross them in a safe fashion."

FFC: "With all these aircraft coming down Alpha-Charlie and passing up Mike and coming at you from November and beyond, did that make it easier or was that congestion near Quebec..."

GC-1: "I would have to say it was easier, but with the inboards I still had to protect for that, it was easier to not have all that traffic there because I could taxi onto Bravo without looking."

Run 12 – IFR, Mike Closed for Crossing, "TM Call" for Departures

GC-1: "I found that when LC-1 would take the arrivals down Alpha-Charlie to Charlie-Charlie, Delta-Delta, that was more verbiage. I had to control Alpha-Alpha a lot harder, where as before it was more automatic than you can count on these guys to taxi on Bravo, hold short of Sierra, Tango. But with Charlie-Charlie, Delta-Delta, and Uniform, it's a lot of work for ground.

FFC: “With Kilo and Mike not available, you spent more head down time because all of your arrivals are....”

GC-1: “Once you expand the taxiway like that, the assist is going to help out a lot since they are going to know where the crossings are.”

FFC: “Things got pretty busy out here on Bravo. If you had that level of traffic, and guys were shooting across Mike and Kilo, how would that work?”

GC-1: “We protect for that, we’re geared up for what we do now. So we’re staging them and protecting those intersections. I wouldn’t give instructions that I would normally give, because I didn’t want to give instructions to the guys downstairs and tube them and have the airplanes to stop. So basically I just staged everybody on Bravo and waiting for the alleys to clear and bring them in. Normally you would stage the aircraft off of Bravo onto Charlie facing east or west short of the alleyway, you would know what strip to have or what the aircraft is that pushed back so you know what to expect and know where he’s going. So you have better planning in the real world, because here and the limitations, we kept it simple. It would have been faster and cleaner on Bravo. I found that working Charlie-Charlie, Delta-Delta, you have to pay attention to what the local is doing and that’s half the battle when you know when they are going to cross.”

LC-1: “The local workload does take some attention away, where I found myself getting back to checking the separation on the arrivals knowing I had it a couple miles out, I would check to make sure when he was on a mile-final. I would say it got me behind insuring my arrival traffic. Running departures it slowed it down, but that’s more of the simulation than anything else. The crossings take longer because they turn right and they cross at a 90.”

General Comments on Centerline Taxiway

Unknown: “I say it would be completely useful and cut down on runway incursion.”

GC-1: “If you put the center taxiway in there and there’s restrictions, then it doesn’t make any sense to have it. If we build it right the first time, we don’t have to change it if air carriers start to complain. If it’s the same distance from Bravo centerline to 25R centerline, then we should be fine. If it’s 50 feet and it’s not going to meet those restrictions, it’s going to be worthless if we can’t hold the 747 or the future Airbus. If the designers build it and we’re not restricted to holding aircraft holding in-between the runways, and we can land and depart with the largest aircraft in the world holding in-between the runways, it’s going to be fantastic. You can see how it’s going to eliminate runway incursions.”

APPENDIX D: VOICE-COMMUNICATION DATA

South Airfield		GC-1 Pilots			GC-1 Controller			LC-1 Pilots			LC-1 Controller		
Scenario	Run	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)
VFR2	1	355	2.1	12.7	275	3.4	15.5	283	2.0	9.2	284	2.5	12.0
	4	304	2.1	10.5	246	3.4	14.1	300	2.0	9.9	278	3.1	14.2
	8	394	2.1	13.8	342	2.9	16.6	304	1.8	9.3	321	3.3	17.4
VFR1	2	335	2.1	11.5	307	2.8	14.2	308	2.1	10.5	313	3.2	16.4
	5	343	2.1	11.7	283	3.3	15.7	276	2.1	9.5	Corrupted Data		
	7	308	2.6	13.3	261	3.7	15.9	310	1.9	9.8	333	3.6	19.8
IFR	3	412	2.1	14.7	342	2.8	16.0	337	1.6	9.0	368	3.0	18.0
	6	359	2.3	13.8	311	3.3	17.2	272	1.9	8.7	279	3.2	14.6
	9	372	2.2	13.9	332	3.2	17.4	288	1.9	9.0	299	2.8	13.9
VFR2 Average		351	2.1	12.3	288	3.2	15.4	295	1.9	9.5	295	3.0	14.5
VFR2 Stan. Dev.		46	0.0	1.7	49	0.3	1.3	11	0.1	0.4	23	0.4	2.7
VFR1 Average		328	2.3	12.2	283	3.3	15.3	298	2.0	9.9	323	3.4	18.1
VFR1 Stan. Dev.		18	0.3	1.0	23	0.5	0.9	19	0.1	0.5	14	0.3	2.4
IFR Average		381	2.2	14.1	328	3.1	16.9	299	1.8	8.9	315	3.0	15.5
IFR Stan. Dev.		28	0.1	0.5	16	0.3	0.7	34	0.2	0.2	47	0.2	2.2
Overall Average		353	2.2	12.9	300	3.2	15.8	297	1.9	9.4	309	3.1	15.8
Overall Stan. Dev.		36	0.2	1.4	36	0.3	1.2	20	0.2	0.6	31	0.3	2.6

North Airfield		GC-2 Pilots			GC-2 Controller			LC-2 Pilots			LC-2 Controller		
Scenario	Run	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)
VFR2	1	306	2.3	11.9	251	3.4	14.2	256	2.3	9.8	235	3.3	13.1
	4	345	2.1	12.0	304	2.5	12.7	252	2.0	8.3	232	3.1	12.1
	8	290	2.2	10.6	188	3.3	10.3	246	1.9	8.0	237	3.7	14.7
VFR1	2	315	2.4	12.3	229	3.6	13.7	316	2.1	11.1	336	3.1	17.3
	5	307	2.4	12.1	260	3.8	16.4	304	2.2	10.9	303	3.4	17.1
	7	328	2.2	11.8	264	2.9	12.5	289	2.0	9.7	276	2.9	13.1
IFR	3	321	2.3	12.1	285	3.5	16.5	Corrupted Data			229	3.2	12.3
	6	317	2.1	10.8	244	3.1	12.5	332	1.9	10.4	332	2.9	16.2
	9	325	2.1	11.2	280	3.6	16.6	300	2.1	10.2	319	2.8	15.0
VFR2 Average		314	2.2	11.5	247	3.1	12.4	251	2.1	8.7	235	3.4	13.3
VFR2 Stan. Dev.		28	0.1	0.8	58	0.5	2.0	5	0.2	1.0	3	0.3	1.3
VFR1 Average		316	2.3	12.1	251	3.4	14.2	303	2.1	10.5	305	3.1	15.8
VFR1 Stan. Dev.		11	0.1	0.2	19	0.5	2.0	14	0.1	0.8	30	0.3	2.4
IFR Average		321	2.2	11.4	270	3.4	15.2	316	2.0	10.3	293	3.0	14.5
IFR Stan. Dev.		4	0.1	0.7	22	0.3	2.3	23	0.1	0.1	56	0.2	2.0
Overall Average		317	2.2	11.7	256	3.3	13.9	287	2.1	9.8	278	3.2	14.5
Overall Stan. Dev.		15	0.1	0.6	34	0.4	2.2	32	0.1	1.1	45	0.3	2.0

Voice Communication Data for "Special" Runs

South Airfield		GC-1 Pilots			GC-1 Controller			LC-1 Pilots			LC-1 Controller		
Run	Scenario	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)
10	IFR (VMC)	362	2.1	12.8	290	3.6	17.5	301	1.8	9.1	325	3.3	17.7
11	VFR1	341	2.2	12.7	234	2.9	11.3	333	1.9	10.4	321	3.0	16.3
12	IFR	386	2.0	12.9	312	2.8	14.5	302	1.9	9.4	296	3.4	16.5

North Airfield		GC-2 Pilots			GC-2 Controller			LC-2 Pilots			LC-2 Controller		
Run	Scenario	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)	Trans per hour	Average Trans Length (secs)	total trans time per hour (minutes)
10	IFR (VMC)	314	2.1	11.2	257	3.4	14.5	Corrupted Data			405	2.8	19.1
11	VFR1	285	2.2	10.6	207	3.3	11.3	Corrupted Data			304	3.2	16.2
12	IFR	328	2.3	12.5	258	2.8	12.1	312	1.7	8.9	273	3.6	16.6

APPENDIX E: AIRPORT-SURFACE DATA

Arrival Taxi Statistics

Arrival Runway	Destination	Scenario*	No. Aircraft	Ave. taxi-in (minutes)	Stan. Dev. (minutes)
24L	Box	VFR1	8	10.8	1.8
	North		9	9.3	4.0
	Q-Nest		3	6.4	3.2
	South		3	11.8	2.2
24R	Box	IFR	6	15.2	2.4
		VFR1	3	13.1	3.0
		VFR2	7	11.9	2.1
	North	IFR	32	11.7	3.2
		VFR1	27	12.3	3.3
		VFR2	24	9.5	2.7
	South	IFR	26	17.1	3.6
		VFR1	21	14.8	2.4
		VFR2	16	13.5	2.4
25L	Box	IFR	10	10.5	1.8
		VFR1	9	10.8	2.0
		VFR2	5	8.7	2.3
	C-Nest	IFR	6	6.8	2.0
		VFR1	3	7.9	1.9
		VFR2	3	6.1	0.6
	North	IFR	18	14.1	3.7
		VFR1	18	12.0	3.7
		VFR2	16	11.5	3.7
	South	IFR	31	9.0	3.2
		VFR1	37	8.8	2.8
		VFR2	20	10.4	4.1
25R	C-Nest	VFR1	3	3.8	1.0
	North		3	11.2	3.6
	South		8	3.6	1.3

*Averages for the three data-collection runs for each scenario are presented

Average Arrival Taxi Time for Nine Data-Collection Runs, by Airfield

Arrival Runway	Destination	No. Aircraft	Ave. taxi-in (minutes)	Stan. Dev. (minutes)
24s	Box	24	12.5	2.4
	Q-Nest	3	6.4	3.2
	North	92	11.0	3.4
	South	66	15.2	3.2
25s	Box	24	10.2	2.1
	C-Nest	15	6.3	1.7
	North	55	12.5	3.8
	South	96	8.7	3.3

Departure Taxi Statistics

Depart From	To Runway	Scenario*	Total Aircraft	Ave. Taxi-In (min)	Std. Dev. (min)
North	24L	IFR	26	12.0	3.9
		VFR1	22	10.0	3.1
		VFR2	29	8.5	3.9
	24R	VFR1	2	12.2	5.4
		VFR2	1	7.7	0.0
	25R	IFR	10	21.3	3.8
		VFR1	6	14.8	3.9
		VFR2	10	21.9	3.4
South	24L	IFR	16	18.4	3.8
		VFR1	16	14.9	3.1
		VFR2	22	14.1	2.4
	24R	VFR1	1	17.4	0.0
		VFR2	1	9.9	0.0
	25L	VFR2	1	15.2	0.0
	25R	IFR	24	14.7	4.6
		VFR1	24	10.9	3.5
		VFR2	34	14.5	2.8
Box	24L	IFR	6	23.6	4.7
		VFR1	1	15.2	0.0
		VFR2	6	15.6	2.9
	24R	VFR1	2	18.0	2.3
		VFR2	3	16.3	3.3
	25L	VFR1	2	6.3	2.3
	25R	IFR	3	13.9	1.9
		VFR1	4	11.7	1.0
		VFR2	6	16.0	1.7
Q-Nest	24L	IFR	6	15.5	3.4
		VFR1	2	13.7	2.0
		VFR2	5	11.4	1.7
	24R	VFR1	1	18.5	0.0
		VFR2	1	10.9	0.0

*Averages for the three data-collection runs for each scenario are presented

Average Departure Taxi Time for Nine Data-Collection Runs, by Area

Depart From	To Runway	Total Aircraft	Ave. Taxi-In (min)	Std. Dev. (min)
North	24s	80	10.1	3.9
	25s	26	20.0	4.6
South	24s	56	15.5	3.6
	25s	83	13.5	3.9
Box	24s	18	18.6	4.9
	25s	15	13.2	3.6
Q-Nest	24s	15	13.8	3.3

Data for "Special" Runs

Arrival and Departure Rates (per hour)

Run	Scenario	Arrival Rate	Departure Rate
10	IFR (VMC)	85	78
11	VFR1	87	64
12	IFR	86	66

Average Arrival Taxi Time

Run 10

Arrival Runway	Destination	No. Aircraft	Ave. taxi-in (minutes)	Stan. Dev. (minutes)
24s	Box	2	13.5	3.0
	North	12	10.3	2.8
	South	12	13.1	3.3
25s	Box	3	8.2	0.7
	C-Nest	2	6.3	1.1
	North	9	11.5	2.9
	South	9	7.2	1.9

Run 11

Arrival Runway	Destination	No. Aircraft	Ave. taxi-in (minutes)	Stan. Dev. (minutes)
24s	Box	5	10.6	2.6
	Q-Nest	1	3.7	0.0
	North	11	9.5	2.1
	South	8	12.8	1.8
25s	Box	3	8.6	0.3
	C-Nest	2	10.3	1.0
	North	7	13.1	3.1
	South	17	8.2	2.8

Run 12

Arrival Runway	Destination	No. Aircraft	Ave. taxi-in (minutes)	Stan. Dev. (minutes)
24s	Box	2	15.9	5.0
	North	10	10.3	3.7
	South	10	15.9	3.4
25s	Box	3	16.7	3.7
	C-Nest	2	8.8	0.7
	North	7	14.2	2.8
	South	11	10.7	3.9

Average Departure Taxi Time

Run 10

Depart From	To Runway	Total Aircraft	Ave. Taxi-In (min)	Std. Dev. (min)
Box	24s	3	12.6	2.3
	25s	1	16.7	0.0
North	24s	17	7.2	2.8
	25s	0		
Q-Nest	24s	2	11.7	1.7
South	24s	3	12.1	3.6
	25s	12	17.7	2.2

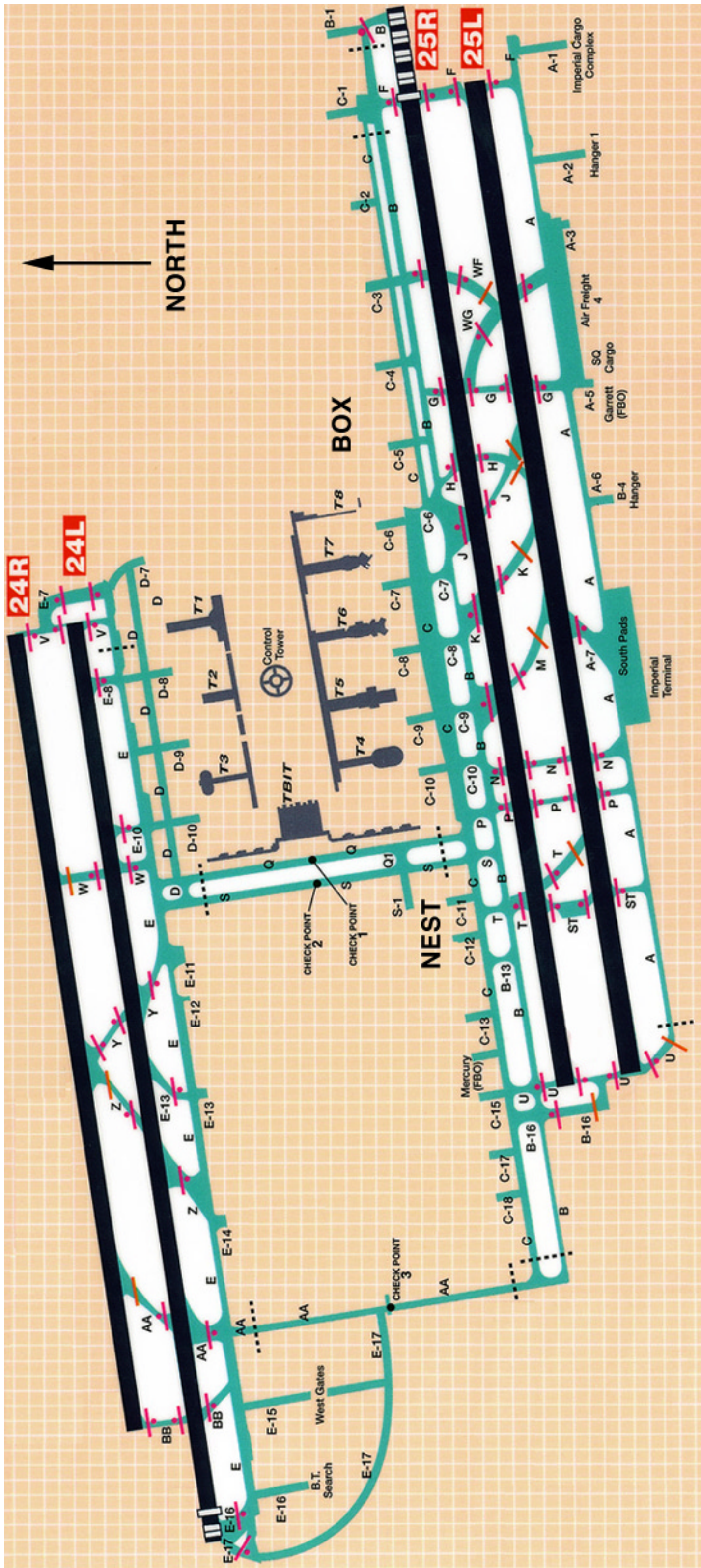
Run 11

Depart From	To Runway	Total Aircraft	Ave. Taxi-In (min)	Std. Dev. (min)
Box	24s	0	0.0	0.0
	25s	2	11.6	2.0
North	24s	9	16.1	2.8
	25s	0		
Q-Nest	24s	1	19.2	0.0
South	24s	3	21.2	2.3
	25s	12	11.5	2.7

Run 12

Depart From	To Runway	Total Aircraft	Ave. Taxi-In (min)	Std. Dev. (min)
Box	24s	2	22.3	3.1
	25s	1	20.7	0.0
North	24s	12	11.9	3.4
	25s	2	28.2	1.7
Q-Nest	24s	2	14.1	1.3
South	24s	2	20.2	2.2
	25s	8	22.3	2.3

APPENDIX F: MAP OF LAX AIRPORT



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14. ABSTRACT
Phase III of the Los Angeles International Airport Runway Incursion Studies was conducted, under an agreement with HNTB Corporation, at the NASA Ames FutureFlight Central (FFC) facility in June 2003. The objective of the study was the evaluation of a new center-taxiway concept at LAX. This study is an extension of the Phase I and Phase II studies previously conducted at FFC. This report presents results from Phase III of the study, in which a center-taxiway concept between runways 25L and 25R was simulated and evaluated. Phase III data were compared objectively against the Baseline data. Subjective evaluations by participating LAX controllers were obtained with regard to workload, efficiency, and safety criteria. To facilitate a valid comparison between Baseline and Phase III data, the same scenarios were used for Phase III that were tested during Phases I and II. This required briefing participating controllers on differences in airport and airline operations between 2001 and today.

15. SUBJECT TERMS
Simulation, Air traffic control, Real-time, Runway incursion, LAX (Los Angeles International Airport), FutureFlight Central

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