Evaluation of a Bar-Code System to Detect Unaccompanied Baggage

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EXECUTIVE SUMMARY

The objective of the Unaccompanied Baggage Detection System (UBDS) Project has been to gain field experience with a system designed to identify passengers who check baggage for a flight and subsequently fail to board that flight. In the first phase of the project, various identification techniques including bar-code, magnetic stripe, optical character readers, and micro-wave transponders, were reviewed. Bar-code was selected because of its low cost and because of the off-the-shelf availability of all of the necessary components for a system.

During a March, 1986 meeting of airline security officials, the representative of United Airlines volunteered his carrier to host a UBDS demonstration. UAL's station at Green Airport near Providence, R.I. was selected because of its proximity to TSC and its scale of operations which allows collection of a substantial volume of data while incurring costs for only a single gate.

Although it was recognized at the start that integration of the UBDS with UAL's Apollo reservations system would provide the most realistic operating environment, the lead-time for such integration was estimated at more than one year, which excluded it from further consideration. Instead a stand-alone system was designed consisting of miniature terminals placed at each ticket counter position linked to bar-code label printers through a micro-computer and concentrator. As each passenger with bags to check appeared at the counter, the agent was supposed to enter the passenger's last name and initial along with the number of bags. This action created a computer record of the passenger together with a sequence number. The latter plus a code for the flight number was automatically printed on bar-code labels, one to be scanned as the passenger boarded the aircraft and the other(s) for the baggage tags in case it was desired to identify and remove a bag.

At the gate, a scanner terminal was installed for use by the flight attendant while the ticket coupons were being collected from boarding passengers. At any point in the boarding process, pressing a single function key of the gate terminal would cause a list of passengers who had checked baggage but who had not yet boarded to appear on the display.

Additionally the system generated a data base listing for each passenger providing:

name,
which was terminal used,
the number of bags, and
whether the passenger actually boarded.

Exception reports showing which passengers were unaccounted at various points in time were also collected. Shortly after the demonstration phase began, another check-in station was installed at curbside, intended for use by the skycaps.

The system was placed in operation in December of 1986 and demonstrations were conducted for a number of visiting officials. Initial testing showed that 15 to 25 seconds of additional time were required to process each passenger at the ticket counter. Because using the system might cause a few minutes departure delay on full flights, the station manager refused to order routine use. Furthermore there was seldom anyone available among UAL's small staff there to explain to flight attendants how to operate the scanner at the gate.

Routine use of the UBDS as configured at Providence would have required having at least one extra staff member on duty, the funds for which were never allocated by UAL despite UAL's having signed a Memorandum of Understanding committing it to provide operating labor for the test. At curbside, the skycaps found that the extra time for checking in through the UBDS reduced their tip income and also declined to use it. Since they were employed by an independent contractor to the airport authority, there was no direct way to compel their participation.

Various means were explored, over several months, to overcome the objections raised by the UAL station manager and the skycaps. Ultimately, government funds were used to hire temporary workers to operate the UBDS, beginning in July, 1987, and concluding in December.

From an analysis of the data gathered in the course of several months of routine operation and discussions with the personnel involved, a number of conclusions about the baggage reconciliation systems have been reached:

1. Of the 21 scheduled UAL departures per week from Providence, usually one or two had missing passengers indicated during the later weeks of the testing.

More than 80% of these apparently missing passengers were caused by operator errors such as putting the bar-code sticker on the wrong ticket or checking in a passenger under the wrong flight number.

Machine-readable tickets are needed to eliminate the high incidence of human error in the check-in process. A number of carriers have plans to phase in such tickets and scanners over the next few years, but the hardware is still in the developmental stage.

Full automation and integration with the reservations system are required to avoid a significant increase in staffing requirements. There does not appear to be labor-savings advantage to stand-alone automatic identification systems over simpler manual systems.

During periods when the bar-code system was inoperative due to printer failures a back-up pen-and-paper system was substituted. **The manual system proved as effective as the bar-code system and was preferred by the operators for its ease of use.** Its only disadvantage was that machine readable records were not generated automatically. However, the use of a purely manual system would be considerably more cumbersome if larger aircraft were being loaded through two gates.

2. **Passengers can not be relied upon to serve as active participants in the process.** When the bar-code stickers were placed on the ticket envelopes or on other documents separate from the ticket itself, about ten percent of them were unavailable for scanning at the gate despite signs and oral reminders. **The system must be designed so that it is transparent to the passenger.**

On about one flight in forty, passenger actions generated missing passenger incidents. These included simply missing the plane even after checking baggage in plenty of time, losing the ticket that had the bar-code, and changing itinerary (causing the ticket to be re-issued).

3. To minimize the impact of apparently missing passengers on departure delays, it is **necessary to have all passengers boarded by 15 minutes prior to the scheduled departure time.**

This much time is generally required to locate or otherwise account for the apparently missing person. While this would compel passengers to arrive at the airport earlier than they usually do for domestic flights such as those observed in the UBDS test, it should not have much effect on international passengers because they are already required to check in an hour before flight time.

In retrospect it seems obvious that the short domestic flights used for the UBDS test were not representative of flights to overseas destinations. Passengers at Green Airport tended to arrive at the gate much closer to scheduled departure time and to change their plans at the last minute more often than is characteristic of international flights because of the ready availability of alternative flights.

4. **There have been no confirmed instances of passengers who checked baggage, but then disappeared.**

1. Introduction

1.1 Project History

In March of 1986, the chief security officers of several of the nation's larger carriers met in Washington at FAA Headquarters. Among the agenda items was a discussion of ways to conduct passenger-baggage reconciliation as effectively and efficiently as possible. It was agreed that further research was needed and that the FAA would fund a demonstration project. The United Airlines Director of Security, Robert Bauter, volunteered his airline as host for such a demonstration.

On April 17, 1986, the author met with Robert Bauter, Ray Mrazek, Archie Lind, and Linda Oros, all representing various UAL headquarters staff functions, to discuss the project. A broad range of options of options was considered, but in the interest of minimizing implementation time and cost, it was soon agreed that the demonstration should be conducted at a small station on a stand-alone basis. Although a link to United's Apollo reservations system could have minimized the burden on ticket agents, it was estimated that the lead time for the necessary approvals and preparing the software would be about one year.

T. F. Green Airport, near Providence, Rhode Island was chosen as the site because it offered: (1) a single UAL gate, (2) three UAL departures per day with a substantial number of checked bags, and (3) fairly close proximity to TSC.

Following visits to Providence and meetings with the UAL Station Manager at the time, James Helton, it was agreed that there were no obstacles to conducting the demonstration there. Equipment and furniture appropriate to that site were designed and ordered during May and June.

In July, a second meeting with UAL Headquarters staff was held to discuss the project. A Memorandum of Understanding setting forth the responsibilities of United Airlines and of the government was drafted. After some revisions this memorandum was signed on October 09, 1986, and appears as Appendix One to this report.

Installation of the ticket-counter and boarding-lounge hardware for the UBDS was completed at the end of October, 1986, at United Airline's T. F.Green terminal. This work was delayed 10 weeks by the late delivery of bar-code printers by their manufacturer, Intermec. Although the system was capable of being used at that time, a number of software bugs remained, which were not cleared until mid-November.

Because of the expected crush of Thanksgiving travel, the new Providence station manager, Dody Grier, requested a delay in startup until the first of December.

Ordinarily, the UAL Providence terminal is staffed by three ticket agents, a gate agent, a ramp agent and the station manager during the day. The total complement of ticket agents is about eight including part-timers. Thus the incapacity of even one agent can significantly decrease the availability of labor, forcing someone, usually the station manager to work two jobs.

In November one of the senior ticket agents sustained a back injury which left him unable to work for six weeks.

During December, the system was demonstrated to several visitors but there was no routine use because of this labor shortage. Dody Grier requested another delay until January, when it was expected her staff would be up to full strength.

January 6, 1987 was the first day of routine use. For the first departing flight that day, the baggage conveyor broke down. Since the ticket agents had to carry bags themselves, they stopped using the UBDS to save time. On the second flight, things ran smoothly. One passenger was identified as missing, apparently because two tickets had been placed inside one envelope so that only one was scanned at the gate. On the evening of January 6 a UAL agent had his thumb severed in an accident and was incapacitated for four weeks, bringing about another suspension of data collection.

At the beginning of February, the Providence station manager brought up the problem of the new FAA regulation requiring one flight attendant to remain on the aircraft for each group of exits during boarding. Since Providence was being served by older 727's carrying only three flight attendants, ticket collection had to be moved on board, leaving no one to operate the scanner in the lounge.

Discussions were held with Bob Bauter and other United officials about the prospects for hiring additional staff but the lead-times for budgetary approvals seemed quite discouraging. The problem was raised with Bill Wall and also discussed at a meeting on March 17 in Ray Salazar's office. A waiver was requested by Roy Mason so that United could have one flight attendant in the boarding lounge at Providence. About April 1, however the request was rejected by the FAA. By that time, United had scheduled the phase-in of stretched-727 service for Providence beginning in May and covering all but one flight per day by June 5. With the larger planes, the fourth flight attendant would be available to operate the UBDS.

On April 21, Dody Grier reported that she had recently hired five new employees, bringing her staff up to its full authorized complement. She anticipated no problems in operating the system in May as the stretched aircraft began arriving.

Routine operation of the UBDS began again on May 11. Examination of data from that first week showed a high incidence of ticket agent errors and skipped passengers. By the end of that week, three of the new employees had quit to take other jobs. (Providence has enjoyed an unemployment rate below four percent for some time now.) Neither the station manager nor any other UAL ground staff were available to instruct flight attendants in the operation of the UBDS. Hence no data were collected.

United's failure to deliver the required labor to fulfill its role under the Memorandum of Understanding was again brought to Bob Bauter's attention. He was quite apologetic. He felt that he could eventually win a budgetary allotment for additional personnel at Providence dedicated to the UBDS, but that the process was likely to take two or three months.

In the interest of time, an additional $24,192 was allocated to pay for a temporary services contractor to staff the gate and curbside baggage check-in for several months. A Purchase Order in that amount was awarded to Additional Support Incorporated of Warwick, R.I., which has supplied staff for the system from July 7,

1987 to the conclusion of operations.

1.2 Objectives

The principal objective of the field trial of the UBDS system was simply to gain operating experince with such a system under realistic conditions. In particular, an assessment was needed of how UBDS operations would affect passenger processing time and the associated costs for the labor of ticket and gate agents.

A second major objective was to describe the attitudes of various airline and airport personnel as well as passengers toward such a system.

The third objective was to acquire data regarding the incidence of passengers who deliberately fail to board after having checked baggage (true missing passengers) and of passengers who are recorded by the system as missing, but who have actually boarded or sought to board (apparently missing passengers). Data on the rates of occurence of each category of missing passenger incident were to be recorded over time.

Finally, tests were planned to determine how much time would be required to locate and remove the bags of passengers identified as missing. Because the actual conduct of such tests would have required delaying departures, they were deleted from the plan.

2.0 Hardware and Operating Procedures

Given the need to have a system operational as soon as possible and the modest level of funds available, the choice of technologies and equipment for the UBDS project was quickly limited to off-the-shelf bar-code systems. The offerings of various manufacturers were reviewed at the SCAN-2 trade show. Only Intermec demonstrated a complete system with the particular capabilities required for this project.

2.1 Hardware Description

In the initial hardware configuration designed for use by UAL ticket agents, Intermec Model 9512 terminals and Model 8635 thermal bar-code printers were installed in the ticket counter. Figure 2.1-1 shows the rear of a section of the counter. A close-up of the terminal unit appears in Figure 2.1-2. Each of the three ticket-agent positions was fitted with a terminal. Adjacent positions shared a bar-code printer so that only two of the latter were required.

For curbside check-in, a special console was built to house the terminal and printer. This cabinet was fitted with a cooling fan and thermostatically controlled heaters to maintain equipment operating temperatures well within limits. A light was included for possible night use. Figure 2.1-3 shows the curbside unit in place. Since the curbside station is unattended at night in Providence, the cabinet was equipped with casters so that it could easily be rolled inside the terminal building for storage.

At the entrance to United's single gate, another small, custom-built console was installed to hold a Model 9512 terminal and keyboard along with a Model 1620 bar-code scanner. In the original configuration, the scanner was mounted inside the podium with automatic actuation by photocell whenever a ticket or other document was inserted in the slot in the top. Figure 2.1-4 illustrates this unit in use.

All of the hardware described above was linked to an IBM XT microcomputer through an Intermec Model 9116 port concentrator operating in polling mode D and using RS-422 communications. This equipment was installed in a terminal room behind the UAL ticket counter adjacent to the multiplexer for the UAL Apollo Reservations System and shared its cable raceways.

Figure 2.1-1: Rear view of ticket counter with UBDS terminal installed adjacent to Apollo terminal.

Figure 2.1-2: Close-up of UBDS terminal. Display shows that passenger "NIDAL" has checked one bag aboard flight #111 and has been assigned sequence number "006."

Figure 2.1-3: Curbside unit in use.

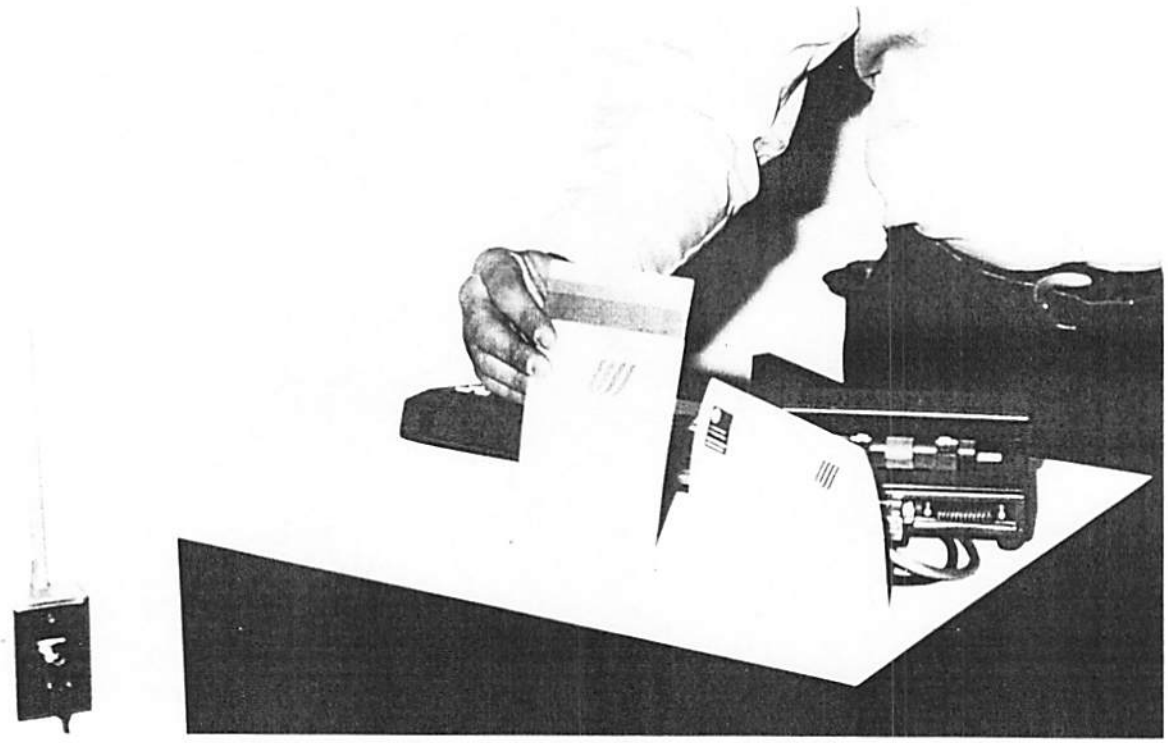

Figure 2.1-4: Close-up of gate console set up for automatic scanning of ticket envelopes inserted in slot.

2.2 Operating Procedures

To begin checking passengers for a particular flight the UBDS software requires that an operator first enter the flight number. The flight number need not be re-entered until some passenger wants to check in for a different flight. As each passenger appears at the checking point, his/her name and number of bags are entered on the keyboard. This results in the creation of a computer file entry for that person and the printing of bar-code stickers for that passenger bearing a letter-code corresponding to the flight number and a three-digit sequence number. One of these stickers is placed on some document the passenger is expected to show and/or turn in at boarding. At various times in the experiment, the stickers were attached to the ticket envelope, a special separate card, or the ticket coupon itself. The other stickers could be attached to the bag tag(s). Figure 2.2-1 shows examples of stickers on the backs of tickets and ticket envelopes. Appendix 2 contains detailed operating instructions for check-in.

When a flight is ready to begin boarding, the operator of the gate terminal must first enter the flight number and then press a second function key to initiate the process. Then each passenger's sticker-bearing document must be scanned. Transmission of the sequence number to the computer is automatic. During the period of the experiment when the sticker were attached to the ticket envelope or a separate card, the scanner was concealed within the console and triggered by a photocell whenever a document was inserted in the slot. Later, when the stickers were placed on the ticket backs, a hand-held scanner pistol was used because many tickets have additional documents stapled to them such that they cannot be read without holding the extra documents out of the scanner beam. Detailed instructions for gate operations are found in Appendix 3.

The photograph in Figure 2.2-2 shows the last passenger boarding a flight with two UBDS operators and a UAL flight attendant behind her.

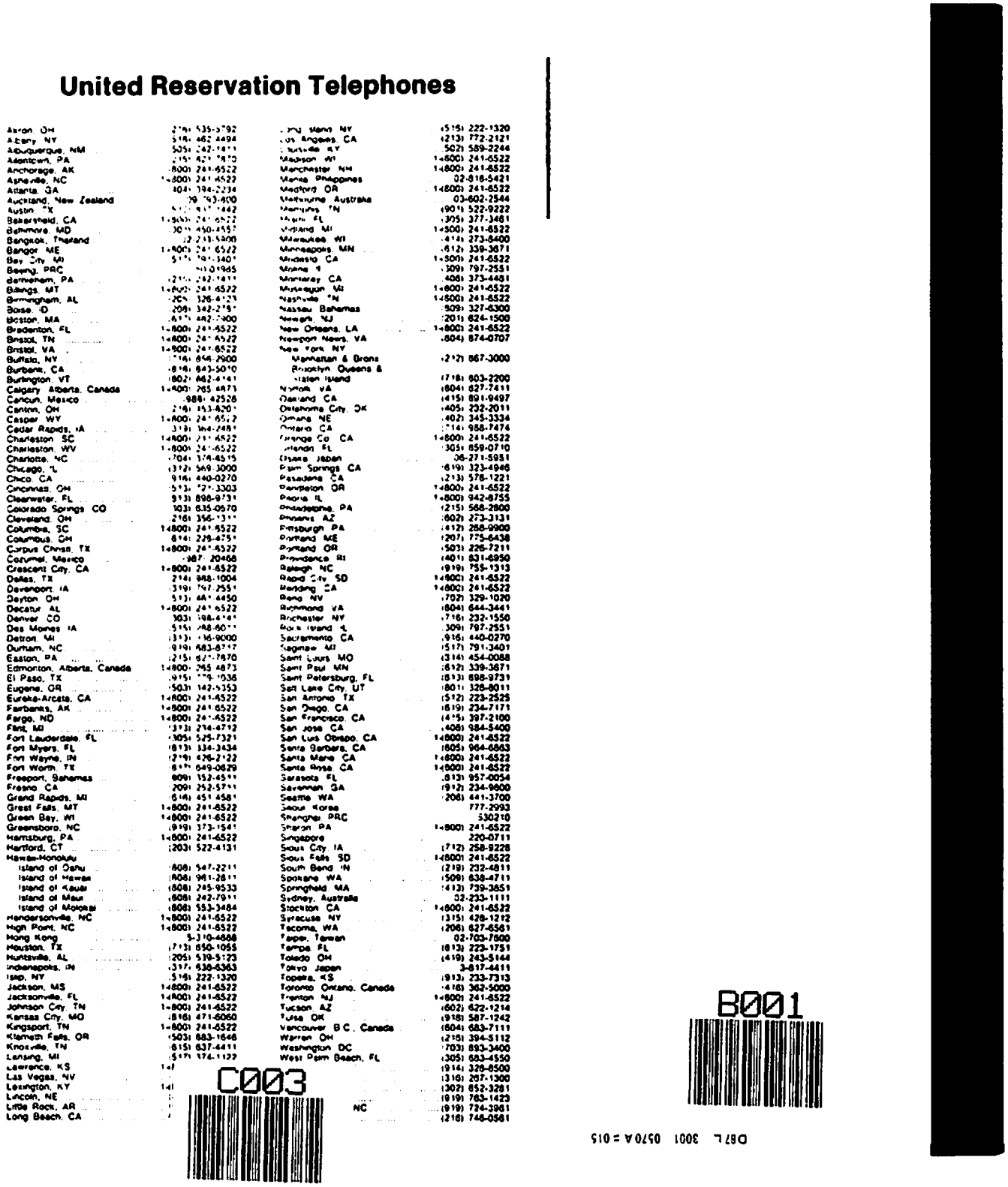

Figure 2.2-1: Examples of the placement of UBDS bar-code stickers on the backs of ticket envelopes (left) and ATB tickets (right).

Figure 2.2-2: UAL flight attendant handing a ticket to UBDS operators for scanning using a hand-held laser pistol.

2.3 Data Collection

As the operations described above were carried out, a computer record of each passenger was automatically generated. These records showed the passenger's name, number of bags checked flight number and final status. The codes for final status were as follows:

0 - checked in but never boarded
1 - checked in and boarded normally
2 - (not used)
3 - checked in but cancelled
4 - flight cancelled

Figure 2.3-1 shows an example of the passenger records for one day of operations.

If a missing passenger was indicated, the operators were instructed to investigate and complete a "MISSING PASSENGER REPORT." An example of this report appears in Figure 2.3-2.

In the event of malfunctions in the bar-code system (see Section 4.1) operators reverted to a pen-and-paper system in which they assigned sequence numbers to passengers from a pre-printed form and wrote down the same information that was captured by the bar-code system. Figure 2.3-3 shows an example.

Print-Out of LDDMSTR.DAT File Run Date: 11-07-1987 Run Time: 15:48:59

DAY	FLIGHT#	ID	SEQ.#	NAME	#BAGS	STATUS	TERM.IN	TERM.OUT
07	887	A	001	gino	8	1	A	
07	887	A	002	morin	2	1	A	
07	887	A	003	LEFTOWITZ	2	1	A	
07	887	A	004	MAHAN	3	1	A	
07	887	A	005	CULLIN	2	1	A	
07	887	A	006	OVALTIN	2	1	A	
07	887	A	007	DUNN	3	1	A	
07	887	A	008	NANNI	3	1	A	
07	887	A	009	GANDRIAN	2	1	A	
07	887	A	010	MILLER	2	1	A	
07	887	A	011	MCKOWN	2	1	A	
07	887	A	012	CANTY	1	1	A	
07	887	A	013	LYONS	3	1	A	
07	887	A	014	FITZPATRICK	5	1	A	
07	887	A	015	WALLS	1	1	A	
07	887	A	016	SULLIVAN	4	1	A	
07	887	A	017	JUBIN	4	1	A	
07	547	B	001	LANDOWSKI	1	1	A	
07	547	B	002	CIGRESS	3	1	A	
07	547	B	003	FEDERICO	2	1	A	
07	547	B	004	shearicci	3	1	E	
07	547	B	005	gauvin	1	1	E	
07	547	B	006	RIPLEY	1	1	A	
07	547	B	007	DUCHARM	2	1	A	
07	547	B	008	MARCHANT	3	1	A	
07	547	B	009	PAINE	3	1	A	
07	547	B	010	MCDONELL	1	1	A	
07	547	B	011	DEWOLF	1	1	A	
07	547	B	012	MCKENNA	2	1	A	
07	477	C	001	HINDLE	5	1	A	
07	477	C	002	WOJCIK	4	1	A	
07	477	C	003	DANGELIS	2	1	A	
07	477	C	004	SULLIVAN	2	1	A	
07	477	C	005	MEDEIROS	7	1	A	
07	477	C	006	CAPPICI	1	1	A	

Figure 2.3-1: Example of passenger records for one day of operation.

ACCOUNTING FOR MISSING PASSENGERS

DATE: NOV 29 FLIGHT NUMBER: 547 INITIALS: ~~ES~~

CHECK HERE IF TICKETS COLLECTED ON BOARD: _____

SEQUENCE NUMBER	PASSENGER NAME	CODE	COMMENTS
~~B026~~ B003	Gellers R.	7	
~~B003~~ B026	Damien	1	

DEFINITION OF CODES:

0. Ticket found with sticker and successfully scanned.
1. Correct ticket found but sticker missing.
2. Correct ticket found but sticker has wrong number.
3. Correct ticket found with sticker, but sticker will not scan correctly. Peel this sticker off the ticket and attach to this sheet.
4. Correct ticket found with sticker missing, but sticker found at the end of the day with turned-in tickets. Change the "1" to a "4".
5. Ticket found for missing passenger, but not for Providence-Chicago, i.e., flight attendant removed the wrong ticket.
6. Sticker found, but not attached to the ticket.
7. Passenger missed flight.
8. No trace of passenger, ticket or sticker.
9. Passenger was checked for wrong flight (usually United Express).

Figure 2.3-2: Example of missing passenger report.

TICKET-COUNTER MANUAL CHECK-IN (RED FELT-TIP)

DATE: 10/29 FLIGHT NUMBER: 547 NAME: CC

SEQUENCE NUMBER	PASSENGER NAME	BAG COUNT	TIME-IN (HH:MM)	TIME-OUT (HH:MM)	MISSING CODE
01	Ruddy S	1	9:45	10:27	
02	Valva J	2	10:01	10:30	
03	Embree M	2	10:09	10:25	
04	Quondam L	2	10:10	10:27	
05	Andrews H	1	10:11	10:25	
06	Patterson J	2	10:11	10:30	
07	Howland M	1	10:13	10:28	
08	Colleto J	1	10:15	10:35	
09	Boyd J	2	10:17	10:33	
10	Hanna N	1	10:17	10:37	
11	Brunk L	2	10:19	10:33	
12	Richards J	1	10:20	10:28	
13	Felts D	1	10:22	10:33	
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					

TOTAL PASSENGERS BOARDED: 55

Figure 2.3-3: Example of manual passenger reconciliation for one flight.

3.0 Human-Factors Problems

Introduction of the experimental UBDS equipment and attempts to get the various airline and airport support personnel to use it exposed a variety of human-factors problems. In the following sections, the attitudes, comments and operating experiences of various affected personnel are discussed.

3.1 Check-in Process

Under the original experimental design, the UBDS was to have been operated exclusively by UAL personnel, i.e., ticket agents and flight attendants. The scope of the experiment was soon expanded to include curbside checking which was planned to have been performed by skycaps. When these arrangements proved unworkable for reasons detailed in Section 1.1, all UBDS operations were assumed by contractor personnel.

3.1.1 Ticket Agents

The UBDS check-in terminals were installed at each of the three UAL ticket counter positions in October of 1986. In the initial system trials, the ticket agents experienced no difficulty in operating the system as intended. However, they found that the UBDS check-in added significantly to the amount of time required to process each passenger. Depending upon the number of bags being checked and the number of characters in the passenger's name, this time ranged from about 12 seconds to about 25. Total processing time for a passengers with checked bags is about two minutes. Hence the UBDS procedure increased the total processing time by 10 to 20 per cent.

Given the tendency of many travellers using T.F. Green Airport to arrive less than half an hour before scheduled departure, the UAL ticket agents frequently have to struggle to get them all checked in fast enough to avoid departure delay when the flight is fully loaded. Therefore the extra time required by using the UBDS at the ticket counter amounted to a substantial barrier to its use. It was clear from the start that the ticket agents did not like the experiment because of the extra work it required of them and because the delays it caused would likely make passengers angry and tense about getting to the gate before the plane left.

In their comments on the UBDS, the ticket agents first wondered why the UBDS experiment had not been linked to the Apollo reservations system so that it could be fully automatic and avoid any increase in check-in processing time. When it was explained that the lead-times for hardware and software development for a fully automatic system were too long to provide timely data, they were somewhat more sympathetic. They still felt however that an unreasonable burden was being imposed upon them. Inasmuch as the station manager was unwilling to order them to use the UBDS procedure, the check-in task was removed from the ticket counter to a special console in front of the counter staffed by contractor personnel.

3.1.2 Skycaps

A curbside check-in station was installed in January, 1987, which was intended to be used by the skycaps. During preliminary trials, some of the skycaps proved as facile as the ticket counter agents. However others were completely unfamiliar with

keyboards and took more than 30 seconds to handle a transaction. Their disinclination to use the system was much stronger than that of the ticket agents because their compensation is linked to the number of passengers they can process. Any activity such as UBDS which slows down their handling results in passengers deciding to walk the extra 75 feet to the ticket counter. Thus the skycaps could lose tip income.

Several discussions were held with the manager of support services to consider ways of compensating the skycaps for their potential loss of income. It was suggested that project funds could be provided for an incentive fee of fifty cents per passenger checked into the UBDS by each skycap. Although such an arrangement would probably have been well received by the skycaps, the manager rejected the idea because it would set a precedent for a higher wage level and would likely lead to dissatisfaction when the project ended. The manager retired about the time the decision was made to employ contractor operators.

3.1.3 Temporary Personnel

Because airline employees were unavailable to operate the UBDS for the reasons discussed above, it was eventually decided to hire temporary workers at government expense. After discussions with operators of such services, a wage of six dollars per hour was agreed upon as adequate to attract applicants of sufficient ability to do the job. Other security personnel at T.F. Green, such as those who conduct passenger screening, are paid about five dollars per hour. A purchase order providing for up to 3000 hours of such labor was awarded to Additional Support Inc. of Warwick, R.I. under competitive bidding.

All of the workers hired were young, ranging from high-school students to those in their mid-twenties. About half had some previous office work experience, but none had much familiarity with personal computers nor with airline operations. Thus while it took only a few minutes to instruct a UAL ticket agent in the use of the UBDS, the temporary workers could not work without supervision until they had a few days experience. A great deal more training time was spent on ancillary tasks, such as cleaning and loading printers, data saving operations, and procedures for investigating missing passengers, than on the basic tasks of checking passengers.

During their first few days on the job, most of the temporary workers made several errors which resulted in passengers being incorrectly listed as missing. The most common errors were putting the bar-code sticker on the wrong ticket coupon and checking in passengers under the wrong flight number. Both of these mistakes could easily be avoided by checking the destination block on the coupon, but some employees made these errors repeatedly. Less common errors included entering the wrong flight number at the initiation of the check-in process and failure to press the sticker on firmly so that it subsequently fell off.

Except for a couple of employees who were terminated after only a few work sessions, all the rest learned to avoid these mistakes so that their individual error rates dropped to about one in a few hundred. However, because new employees were being introduced into the work force every few weeks as replacements, the overall error rate remained in the range of one for every two or three hundred passengers processed. A stable complement of experienced employees is clearly preferable to a high-turnover group of temporaries.

The second major problem with the temporaries was lack of motivation. Because they were not employees of the airline or any of the airport services contractors, they were unsupervised about 95% of the time. Hence their arrival for work on time, their care and thoroughness in checking passengers and investigating the missing and their initiative in dealing with problems such as equipment breakdowns depended upon self-motivation. Fortunately, the two employees who worked the greatest number of hours, covering the morning flights on weekdays, had sufficient motivation. For the rest of the week, however, the level of motivation left much to be desired.

Finally, some data were lost due to computer illiteracy on the part of the temporaries. Although operation was almost entirely automatic, there were a few elementary tasks, such as loading paper into printers or clearing jams, that had to be mastered. Although these tasks were explained to the temporaries during their initial training, they had often forgotten what they were supposed to do by the time the need arose. The motivated called for help; the unmotivated took the opportunity to leave early.

3.1.4 Passengers

Passengers contributed to errors in the check-in process in several ways. On many occasions they questioned or otherwise conversed with the UBDS operators about matters unrelated to the UBDS thereby distracting the operators and leading to errors.

When asked, "Are you checking baggage on United flight _____?" they sometimes responded negatively but incorrectly. Such wrong responses sometimes led the UBDS operators skip over a passenger who should have been checked. On other occasions, passengers for flights which were not included in the experiment gave a false affirmative. If the operator then failed to read the ticket carefully, this passenger might be logged in, and would subsequently be recorded as a missing passenger.

A few passengers checked baggage aboard one flight, even though they had in mind some change of plans, such as leaving on a latter flight or a change of itinerary, which would require that the ticket be reissued.

3.2 Boarding Process

3.2.1 Gate Agents

Like the ticket agents, the gate agents were able to master their UBDS operating procedures with only a few minutes' training. Their role was not to conduct the boarding procedure, but to explain to whichever flight attendant happened to be collecting tickets how to use the scanner. Although this explanation required only a few minutes, it would have to have been performed at the same point in time when there is generally a long line of passengers waiting to check in at the boarding lounge podium. Unless there happened to be three or more agents on duty in the boarding lounge, a rare circumstance at T.F. Green, no one was free to brief the flight attendant.

Because of the various delays described in Section 1.1, the gate agents briefed only a

handful of flight attendants before their role was eliminated by contractor personnel.

3.2.2 Flight Attendants

In the course of a year, scores of different flight attendants may be assigned to United's Providence-Chicago Service. Usually no one of them remains on that route for more than a month at a time. It was quite impractical to teach the attendants how to use the UBDS at their regular training sessions in Chicago because so few of them would be using it and because the duration of their use would be so short. Instead, the plan was to give on-the-spot instruction to whatever attendants happened to show up. During several demonstrations early in the testing, this process worked reasonably well. That is, the flight attendants were able to grasp what needed to be done with less than two minute's explanation.

While it was easy for the attendants to understand what had to be done, finding the time to do it was another matter. Although the scanning procedure required only a few seconds, passengers would sometimes try to crowd past the attendant faster than she could process them. The procedure worked much better with two persons assigned so that the attendant performed only the usual duties while the second person did the scanning. Alternatively, one attendant could handle the task fairly smoothly if the flow of passengers was channeled into single file by appropriate barriers. Boarding a full flight would probably take at least five minutes longer however. Unfortunately, very little experience was gained with scanning by flight attendants since there was seldom a member of the UAL Providence staff available to provide the necessary instruction.

The flight attendants' direct role was eventually eliminated by temporary workers hired with government funds. During the period of data collection, the flight attendants' only function was to collect the tickets as usual. The temporary workers performed all of the scanning. However, if the attendant happened to pull the wrong coupon out of the passengers ticket packet, then a false missing passenger report could be generated.

The Providence station manager estimated that as many as one out of every few hundred tickets pulled was an error. Apparently this mistake occurs frequently enough that it is expected by airline employees. If they find a passenger who is lacking the proper ticket coupon for a given stage of his itinerary, but who still has a coupon which should have been collected for an earlier stage, they allow the passenger to board.

It is the author's opinion that the poor readability of some of the older style tickets contributes to the incidence of this problem, especially on a multi-stop itinerary with many carbons. The new ATB tickets were clearly superior in readability and should lower this error rate considerably.

3.2.3 Temporary Workers

At the gate the only significant problem with the temporary workforce, as contrasted with the UAL employees, was their lack of knowledge of airline ticketing procedures and their lack of direct access to the reservations computer. Explanation of what became of apparently missing passengers usually required rescanning the tickets and checking Apollo to see if the passenger was supposed to be on the flight in question,

had changed flights or itinerary, etc. UAL agents were willing to conduct these investigations only after they had completed their other tasks and had no passengers waiting. The poorly motivated temporaries often declined to wait around until the UAL staff were free and thus many missing passenger reports were not filed or not filed correctly.

3.2.4 Passengers

In the original planning for the UBDS demonstration, it had been assumed that no changes in passenger behavior would be required because the tag (bar-code sticker or whatever) would be attached to some document that the passenger had to surrender at the gate, either the ticket or the boarding pass. It was further assumed that the attachment would be performed by a UAL ticket agent so that no changes could take place subsequently. Unfortunately, at the site selected for the demonstration, United has no boarding-pass printers installed. Ticket-counter agents write seat assignments on the face of the ticket coupon with a felt-tip pen. Initially there was great reluctance on United's part to attach anything to the ticket itself for fear the attachment might jam in the automatic sorters used by the airline's revenue accounting department. As a result, when the demonstration began, the bar-code stickers were attached to the passengers' ticket envelopes.

During the first week of data collection, about a third of the passengers checked into the UBDS were not scanned at the gate. This very high rate of apparently missing passengers was due in part to the failure of the flight attendants to check each ticket envelope carefully for the presence of a bar-code sticker. However the principal reason was that a substantial fraction of the passengers did not have the ticket envelope, at least not readily available. Some had received new ticket envelopes at the counter, some had packed everything but the coupon for the flight in question away in a bag, and some had simply discarded the envelope.

Signs were posted stating, "IF YOUR TICKET ENVELOPE HAS A BAR-CODE SECURITY STICKER, PLEASE HAVE IT READY FOR THE FLIGHT ATTENDANT WHEN YOU BOARD." Passengers were also reminded orally to keep the envelope readily at hand. These measures helped considerably, but an unacceptably high percentage of passengers continued to arrive at the gate without the bar-coded envelope.

The next approach tried was placement of the bar-code sticker on a yellow IBM card which was inserted in the ticket envelope. This card bore a reminder "Please hand this card to the flight attendant with your ticket." These cards were more easily spotted at the gate and a reduction in the number of apparently missing passengers to about 15% was achieved. However a significant fraction of passengers continued to lose or misplace these cards.

As soon as permission form UAL was received to begin placing the stickers directly on the tickets, that practice was adopted. This brought a sharp reduction in the number of apparently missing passengers. The remaining errors were mostly caused by operator mistakes, but a few were caused by passengers. These included:

1. Passengers who changed their plans after checking into the UBDS because of something they learned from the ticket agent, for example, that a connecting flight had been cancelled.

2. Passengers who had their tickets reissued to reflect some change of itinerary on some future leg of their journeys.

3. Passengers who lost their tickets in the airport.

4. Passengers who missed the plane even after having checked in 30 minutes or more prior to scheduled departure. These included a priest who was apparently deeply engrossed in conversation with a fellow priest and a salesman who lingered too long on the phone.

To conclude, the Providence experiment repeatedly demonstrated that a passenger-baggage reconciliation system should be designed to be completely transparent to the passenger. Re-educating passengers to comply with new security procedures should be avoided as much as possible.

4.0 Hardware Problems

4.1 Malfunctions

During the test period, only two equipment failures requiring replacement parts occurred. Both of these were minor -- a label sensor in one printer and a fatigue break in the ribbon cable connecting one of the readers to its flexible display assembly. Neither of these malfunctions resulted in the system being out of service for very long because spares for these units were on hand.

Far more frequent and frustrating than the hard failures of the bar-code equipment were the instances in which operator errors or omissions led to malfunctions which appeared to be the result of component failure. For example, there were five instances in which the communications protocols (stored in non-volatile memory in the readers) were lost. Since the operators were not trained to reprogram the readers, the system was out of service until a technician could be dispatched. These memory losses were probably the result of surges of current from the air-conditioner motors in the boarding lounge, since they occurred only in terminals at that location and during hot weather. This problem was eventually eliminated by changing to a different grounding scheme from the one suggested in the manufacturer's installation manual.

Another frequent malfunction was the jamming of printer heads with labels that had come off the carrier strip prematurely. Some of these instances arose when operators inadvertently pressed the "batch mode" button on the front panel of the printer. In retrospect, this switch should have been permanently disabled to prevent such occurrences. However, many other jams occurred for no obvious reason. Clearing the jam and cleaning the print head usually took less than five minutes for anyone with much experience with office machines. However, most of the operators from the temporary services contractor lacked such experience and preferred to use the manual back-up system rather than attempting to clear the jam. Finally the setting of the user-adjustable "strip point" control was extremely critical. Drift in this circuitry caused three instances of apparent printer failure. The procedure for re-setting this control was too complex to be mastered by the temporary workers.

4.2 Vandalism

Only one instance of vandalism against UBDS equipment occurred during the 14 months it was left at Green Airport. It happened late at night when about 150 tourists from the Azores were left stranded at the airport by a charter operator experiencing mechanical problems. A group of these travellers discovered the unattended, but powered check-in station in the nearly deserted ticket lobby. They read the instructions sheet and began printing bar-code stickers to amuse themselves. Hundreds of labels were printed and plastered all over the ticket lobby. At some point, one of them engaged the "batch mode" feature of the printer without disengaging the pressure roller. This action resulted in a large number of labels being jammed in the head. The system was out of service for a day until the printer could be given a thorough cleaning, but there was no significant damage. After that incident, all terminals were shut off at night by power switches inside the locked consoles.

The lesson from this occurrence is that vandalism must be considered in the design

of airport security hardware. It would be quite easy for a potential terrorist to disable many kinds of electronic devices by some seemingly innocent act, such as spilling a soft drink into them.

5.0 Results of Data Analysis

During the 19 weeks of data collection at both inside and outside terminals, about 38,000 revenue passengers boarded United's Providence to Chicago flights. 5617 of these were checked in through the UBDS, of which all but 426 were recorded as boarded. The UBDS software package automatically generated a record for each flight containing the date, flight number, number of passengers checked into the system, and status of each passenger. Total passenger counts for each flight were recorded manually from the data supplied by United's Apollo System. Explanations for apparently missing passengers were supposed to be recorded manually, but the temporary workers sometimes failed to do so properly.

Tabulation and plotting of the data described above over time were quite straightforward. The following table shows the percentages of passengers counted as missing and the percentages of flights listed as having one or more missing passengers by week from August 2, through December 12.

WEEK	PERCENTAGE OF UBDS PASSENGERS LISTED AS MISSING	PERCENTAGE OF FLIGHTS WITH ONE OR MORE PASSENGERS LISTED AS MISSING
1	11.6	65
2	15.1	100
3	19.4	100
4	15.6	94
5	14.2	89
6	10.1	83
7	9.0	53
8	2.6	35
9	2.1	25
10	4.3	23
11	0.9	8
12	2.9	21
13	2.3	13
14	0.8	13
15	1.9	25
16	0.8	6
17	0.5	6
18	2.0	16
19	0.0	0

The substantial decline over time is caused by several factors. The most important was the reduction in operator errors. During the first month, each of the operators tended to make several mistakes a week that resulted in an apparently missing passenger. Most operators cut their error rates by more than an order of magnitude after a few weeks on the job. However, because of turnover in the workforce of temporary employees, inexperienced operators were introduced from time to time, which kept the overall average from falling as low as for certain individual operators. In September about half of the workforce was new because of the return

to school of the students who had been working in the summer. Thus it was not until October that nearly all of the workers had sufficient experience to avoid the most common errors.

A second factor in the decline was the falloff in passenger load factor. The data collection began during the height of the tourist season for the Providence area, with very high average loads. By mid-September, these had fallen significantly. Furthermore, the business travellers who replaced the vacationers tended to carry less baggage and were therefore less likely to check it. Thus the number of passengers checking baggage fell more than proportionately to the decline in total passengers boarded. As a result the UBDS operators had only about half as much work to do as they had in August and could spend more time with each passenger to double check their work.

During the first several weeks of data collection, operator errors were so frequent that there was little point in investigating the causes of apparently missing passengers. 371 out of a total of 426 missing passengers were recorded during the first seven weeks. On september 21, operators were instructed to begin using the reporting form shown in Figure 2.3-2 to account for missing passengers. In the remaining twelve weeks of data collection, 2957 passengers were checked into the system, 55 of whom were listed as missing. Reports were completed for 40 of these. The following table shows the distribution of explanations provided for these passengers whose tickets were not scanned at the gate:

CODE & EXPLANATION	NUMBER OF PASSENGERS	PERCENTAGE
0. CORRECT TICKET FOUND & SCANNED SUCCESSFULLY	2	3.6
1. TICKET FOUND, STICKER MISSING	15	32.7
2. TICKET FOUND, STICKER NUMBER WRONG	0	0.0
3. UNREADABLE STICKER	7	12.7
4. PASSENGER EXCHANGED TICKET	3	5.5
5. FLIGHT ATTENDANT PULLED WRONG TICKET	1	1.8
6. STICKER CAME OFF TICKET	0	0.0
7. PASSENGER MISSED FLIGHT	2	3.6
8. NO TRACE OF PASSENGER OR TICKET	1	1.8
9. OPERATOR CHECKED PAX FOR WRONG FLIGHT	8	14.5
10.PASSENGER LOST TICKET	1	1.8
11.NO REPORT	15	32.7
	55	100.0

Most of these causes represent various forms of operator errors. For example, a "0" code means that a stickered ticket was overlooked during boarding. Operators were instructed to scan such tickets and clear these passengers but on two occasions, they neglected to do so. One of the most common errors was placing a sticker on the wrong coupon in the pack, which generally resulted in code 1 error. Operators alleged that seven stickers would not scan, but on retest, only one of these was found to have been caused by a problem with the bar-code printer. The other six were the result of operator errors which kept the system from accepting readings. Checking passengers for the wrong flight, code 9, was another common error. Finally, there were 15 instances in which no investigation was conducted (code 11), and one in which nothing was found (code 8).

After excluding the incidents caused by operator errors, only eight could be attributed to other factors. There were three in which the passenger exchanged a ticket after checking baggage and one in which the passenger lost or misplaced the ticket. Two passengers missed their flights. A flight attendant pulled the wrong coupon once. Only one bar-code label was unreadable.

There were no confirmed instances in which a passenger deliberately missed the flight after having checked bags.

6.0 Conclusions and Recommendations

From the experience gained during the Providence test of the UBDS, a substantial understanding of the operational problems of passenger-baggage reconciliation has been gained. The following conclusions and recommendations are the result of that experience.

1. Operator errors, even in a partially automated system, can cause a significant fraction of passengers to be falsely identified as missing. Such errors caused about 15% of the passengers checked to be listed as missing during the first several weeks of operation. After all of the operators had at least two months' experience, the incidence of such errors dropped to about one percent.

2. Although airline ticket agents are likely to have much lower error rates than the temporary workers used at Providence, there may still be an unacceptably high rate so long as passenger name entry and application of the sticker to the ticket continue to be performed manually. Only a fully automated system drawing its inputs from the reservations system and printing its identification directly on the passenger's ticket or boarding pass can completely eliminate these errors.

3. Full automation is also required to avoid a significant increase in check-in time, about 15-20 seconds. The stand-alone bar-code system offered no time savings over a simple pencil-and-paper list system.

4. Baggage reconciliation systems should be designed with minimum reliance on changing passenger behavior. Upwards of 10% of passengers tended to forget simple instructions like retaining their ticket envelopes until they boarded the aircraft. Non-English-speaking passengers never understood these instructions in the first place.

5. During the last month of data collection at Providence, when operator errors had apparently dropped as low as they ever would, more than 5% of flights had one or more passengers listed as missing due to such errors. An additional 2% of flights had missing passengers due to passengers exchanging tickets or missing the flight. Thus a significant fraction of departures would have been delayed had it been necessary to account for these incidents or remove the baggage in question before the plane left the gate.

6. If it were mandated that baggage reconciliation be performed and that the baggage of unaccounted passengers be removed, it would be necessary to begin boarding about 15 minutes earlier to avoid departure delays. This would allow sufficient time to locate or account for missing passengers in most cases. Alternatively it would provid enough time to locate and remove the bags of the missing passengers in most, though not all, incidents involving narrow-body aircraft. However the time required to locate and remove bags from a wide-body could be substantially greater.

Appendix 1: Memorandum of Understanding and Loan Agreement

MEMORANDUM OF UNDERSTANDING CONCERNING AN AUTOMATIC UNACCOMPANIED-BAGGAGE-DETECTION SYSTEM TO BE DEMONSTRATED JOINTLY BY UNITED AIRLINES AND THE U.S. DEPARTMENT OF TRANSPORTATION

1. Background:

Current airport security systems in the U.S. focus on avoiding hijacking by individuals who actually board the aircraft. They concentrate on passengers and their carry-on baggage unless there is a specific threat. There is recent evidence that some terrorist groups have adopted alternative tactics, e.g. the 1985 Air India crash and the apparently related explosion in the Tokyo baggage area. The purpose of this project is to demonstrate one method for detecting baggage which has been checked by individuals who subsequently fail to board the aircraft.

While many methods are conceivable, the challenge is to identify and develop method(s) to detect the presence of unaccompanied baggage without adversely affecting airline schedules, passenger convenience, or operating costs to any significant degree.

In any detection system, performance is measured in terms of how many events are truly detected (the hit rate) and how many non-critical events are falsely detected (the false alarm rate). Because the "thing" to be detected is a "non-event", i.e., the presence of baggage without matching passengers, and because any false alarms will occur just before take off (the most disruptive time) the critical element of this project will be to design a detection system with a very low false alarm rate. The false alarm rate will depend primarily upon the reading accuracy of the sensors employed. For this reason it is desirable to begin with a proven technology capable of 100% error-free readings, e.g.,bar-code scanners, even though more advanced technologies may ultimately supplant it.

Informal polling of airline security personnel has indicated that "gate no-shows" are a fairly common problem with an incidence as high as one passenger per 30 flights. The vast majority of these are persons who have neglected to set their watches to the correct time zone and who can generally be located in the terminal by paging. A much smaller group consists of persons who suddenly become ill or who are in the midst of some emotional crisis which leads to abrupt behavioral changes. Finally there are a few individuals out to steal air-freight service or record unearned frequent-flyer credits. Since all of these types of "gate no-shows" who are not terrorists will nonetheless generate alarms and delays it is very important to establish data regarding their incidence early in the project. In later stages of the project it may be desirable to test the effectiveness of various types of reminders, warnings and penalties designed to minimize this behavior.

Initially the project will be concerned with evaluating bar-code scanners for determining when bags are unaccompanied by checking passengers. Assuming that a significant number of such incidents occur, methods for quickly finding and removing these bags from the aircraft's hold will also be tested.

2. Objectives:

This demonstration is expected to achieve several objectives: (1) acquisition of field experience with bar-code scanners in an airline-terminal environment; (2) generation of a data base of about 100,000 passengers showing the incidence of "gate no-shows" at a terminal without a significant number of transfers; (3) testing of bar-code-scanner pistols to determine how quickly an unaccompanied bag can be located and removed from the hold of a Boeing 727.

3. DOT/TSC Responsibilities:

TSC is responsible for the overall design, equipment acquisition, data analysis, evaluation and documentation of this project. The government will provide all hardware, software and installation labor required to conduct this demonstration. For the proposed Providence, Rhode Island site this will include three Intermec #9512 keyboard/display units and two #8635 bar-code-sticker printers to be located at the ticket counter. An IBM XT personal computer system together with an Intermec #9161 concentrator will be placed in the computer terminal room. For the gate area a small podium containing the bar-code scanner and display will be custom-built in a style and finish matching the existing furniture. Installation will be scheduled to occur only during those hours when the gate is not in use.

Once the system becomes operational, the government will provide an initial training session for the station manager, ticket agents and gate agents. Sufficient bar-code label stock will also be supplied.

Additional hardware for a curbside check-in station will be designed and installed during the Fall of 1986.

Two Intermec #1620 scanner pistols with holsters, rechargers and #9420 readers will be provided for the unaccompanied bag recovery tests.

System software will be provided which will automatically create on a hard disk a record for each departing flight containing the number of passengers boarded, number of passengers with checked bags, and total number of bags checked. For each incident of "gate no-shows", TSC will investigate the behavior of the missing passenger by telephone interview.

A final report describing the experiment and evaluating the results will be prepared for circulation within the FAA and among airline security personnel on a "need to know" basis.

4. UAL Responsibilities:

United Airlines will serve as host for this project at its Providence, Rhode Island terminal and provide all operating labor. The incremental tasks for the ticket agents include: (1) prompting the system to issue a set of bar-code stickers each time a passenger with baggage to check appears at the counter, (2) keying in the passenger's last name, and (3) affixing these stickers to the bag tags and ticket. Flight attendants will be required to insert each ticket into a slot in the top of a small podium near the gate. This action should take only about 2 seconds and should speed the boarding process since it will no longer be necessary for the attendant to verify that the ticket is valid (so long as it has bar code). In the event that an unaccompanied-bag incident occurs, baggage handlers and the station manager will take appropriate action to locate the missing passenger or remove the bag. Details of each of these tasks are given in the attached instruction sheets.

5. Schedule:

Purchase requisitions for all of the required hardware and software were initiated in May, 1986. Hardware deliveries should be completed during August. The software vendor, Lowell Systems, estimates that programming will be completed in the third week of August and that an additional week will be needed for system integration and final testing. Thus in the absence of unforseen delays, it should be possible to make the installation in the last week of August.

In order to gather a sample of about 100,000 passenger boardings, it is expected that the demonstration will run for about one year.

CONCURRENCES:

FOR: United Airlines

BY: _____

DATE:_____

FOR: U.S. Dept. of Transportation

BY:_____
Stewart B. Hobbs
Associate Director
Office of Administration
U.S. Dept. of Transportation
Transportation Systems Center

DATE:_____

PROPERTY LOAN AGREEMENT

This day of August, 1986, the U.S. Department of Transportation's Transportation Systems Center (hereinafter TSC), lender, agrees to lend to United Airlines (hereinafter UAL) certain bar-code identification equipment (hereinafter equipment), more particularly described and identified in Attachment A, which Attachment A is specifically incorporated herein. The term of this Agreement shall be for a period of one year from the date of actual installation contained in paragraph 3 of this Agreement. The equipment is loaned at no charge to UAL.

1. The purpose of this Agreement is to provide UAL with the equipment set forth in Attachment A in order that a demonstration of the use of the equipment may be carried out by UAL to detect incidents in which a passenger fails to board an aircraft after having checked baggage aboard that aircraft. Rapid location and recovery of such baggage from the hold of an aircraft may also be demonstrated.

2. This Agreement may be extended for such additional equipment and/or for such additional period of time as the parties may mutually agree to in writing.

3. TSC agrees to deliver and install the equipment at UAL's ticket counter and gate at the T. F. Green Airport near Providence, Rhode Island. Installation is planned for August, 1986.

4. UAL agrees to assume responsibility for loss or damage to the equipment while it is in the custody of UAL. The equipment shall at all times relevant to this agreement be kept on the property of UAL. The designated custodian of this equipment for UAL shall be James Helton, Station Manager.

5. At the expiration of this agreement, or any written extension thereof pursuant to Paragraph 2 of this Agreement, UAL agrees to return the equipment to TSC. The equipment shall be returned in the same condition as tendered, subject to any modifications approved by TSC in accordance with paragraph 8, reasonable wear and tear excepted. TSC shall be responsible for the removal.

6. Legal title to the equipment provided pursuant to this Agreement shall remain in the Government. UAL agrees to keep said title to the equipment free and clear of all claims, encumbrances and liens.

7. UAL further agrees that the equipment furnished by TSC will remain in the possession or under the control of UAL during the full period of this Agreement, as extended, and may be inspected by TSC at reasonable times on advance notice by TSC. Operation of the equipment shall be by UAL employees.

8. TSC will provide initial training in the use of this equipment to UAL's

station manager, ticket and gate agents, and baggage handlers at the time of installation. UAL agrees to train additional employees as necessary following the instruction sheets supplied by TSC. UAL also agrees that its employees will not use the equipment in any manner which may jeopardize its performance nor make any modifications without written approval from the TSC Technical Monitor.

9. The TSC Technical Monitor for this project will be John K. Pollard, DTS-45.

10. In consideration for the use of this equipment, UAL agrees to provide to the TSC Technical Monitor brief reports regarding all incidents of "gate-no-shows" as may be detected by the equipment. These reports shall contain the data from the missing passengers' name records in the UAL reservations computer together with any additional observations noted by UAL employees. UAL further agrees that the Government may publish, translate, duplicate, deliver, perform, use, and dispose in any form or manner or for any purpose whatever, and have others to so do, any and all such information, with the exception of data protected by the Privacy Act of 1974, 5 U.S.C. §552a.

11. UAL shall indemnify and hold the Government harmless from and against any and all loss, damage, expense or liability incurred, suffered, or claimed on account of any injury, including death of any person or damage to property occurring or alleged to have occurred as a consequence of any negligence of UAL related to or arising out of the use of the equipment from and after the date of this Agreement, or extension thereof. This obligation shall survive the expiration or termination of this Agreement.

12. Notwithstanding any other provision herein, it is mutually agreed that either party may cancel this Agreement or extension hereof upon thirty (30) days written notice.

In witness whereof, the parties have hereto executed this Agreement.

FOR: **United Airlines**

BY: _____

DATE:_____

FOR: **U.S. Dept. of Transportation**

BY:_____
Stewart B. Hobbs
Associate Director
Office of Administration
U.S. Dept. of Transportation
Transportation Systems Center

DATE:_____

Appendix 2: Check-in Instructions

UNACCOMPANIED BAGGAGE DETECTION SYSTEM

CHECK-IN INSTRUCTIONS
12/01/86

1. Leave power switches on at all times. If power to a printer is lost accidentally, simultaneously press the <CTRL>,<ALT> and <DEL> keys on the IBM computer keyboard to reboot the system. If the computer looses power at the same time, this will happen automatically.

2. Don't worry about mistakes. If you press the wrong function key, just press the right one. Each command supercedes the previous one. If you make a mistake while typing in a name or number, erase it with the back-space key, < >, and retype. If you notice a mistake after you have pressed the <ENTER> key, just repeat the whole command.

3. Press <F0> to open a flight. This must be done once for each flight for each terminal. Example:

(you type)	<F0>
(response)	OPEN FLIGHT#
(you type)	575<ENTER>
(response)	* READY * 575

4.Press <F1> to check in a passenger or a group whose tickets will go into the same wallet. Enter the last name, followed by a space, followed by the number of bags to be checked. Suppose the first passenger you check in for flight #575 is named Robertson and has one bag:

(you type)	<F1>
(response)	ENTER PASSENGER
(you type)	ROBERTSON 1<ENTER>
(response)	A001 READY 575

One bar-code sticker will be printed for the ticket wallet and one for each bag. Place the wallet sticker on the back of the wallet anywhere along the bottom edge. Put the other sticker(s) on the strap tags where they will not cover any important information (usually over the UAL logo).

5. If a passenger appears with some business for a flight other than the last one you worked on and if that flight has already been opened at your terminal, just press <F2> followed by the flight number. For example, if you have opened 839 and 380 and have just checked a passenger for 380, but the next passenger wants 839:

(you type)	<F2>
(response)	CHANGE FLIGHT
(you type)	839<ENTER>
(response)	* READY * 839

6. If a passenger changes his mind after having checked in, press <F3> to cancel him. Assume you are working on passengers for 839 when a 380 passenger with sticker number D056 wants to cancel:

(you type)	<F3>
(response)	CANCEL PASSNGR
(you type)	380 056<ENTER>
(response)	* READY * 839

Note that the alpha character on the sticker is NOT part of the sequence number.

7. To cancel a flight use <F4>. Example:

(you type)	<F4>
(response)	CANCEL FLIGHT
(you type)	380<ENTER>
(response)	* READY *

8. If a passenger decides to check an extra bag (or you press the wrong key for number of bags) use <ALT><F5> to get additional sticker labels with the same sequence number. For example, if a passenger with a sticker that says "B037" wants to check another bag and "B" corresponds to flight #349 on which you are working.)

(you type)	<ALT><F5>
(response)	REPRINT LABELS
(you type)	037 1<ENTER>
(response)	*READY *

Note: If you had been working on a different flight number when this passenger appeared, you would have had to change the flight number using <F2> before you could process this request.

9. If you would like to see a count of passengers boarded on the default flight, press <ALT><F6> followed by <ENTER>.

GENERAL INSTRUCTIONS

If you key in an incorrect flight number, you will get a error message, "INVALID FLIGHT #." Just repeat the command using the correct number or open the flight if you omitted that step.

Appendix 3: Boarding Instructions

UNACCOMPANIED BAGGAGE DETECTION SYSTEM

BOARDING INSTRUCTION SHEET
12/01/86

1. Power to the boarding console should be left on at all times. The orange button on the display controls all power. Should power be lost accidentally, no damage will result and no corrective action is necessary.

2. Don't worry about mistakes. If you press the wrong function key, just press the right one. Each command supercedes the previous one. If you make a mistake while typing in a number use the backspace key, < >, to erase it and retype. If you notice the mistake after you have pressed the <ENTER> key, just repeat the whole command.

3. To begin the boarding process use the <F2> key. To start flight #375, for example:

(you type)	<F2>
(response)	CHANGE FLIGHT
(you type)	375<ENTER>
(response)	* READY * 375

4. When the first passenger appears, press <F0>:

(you type)	<F0>
(response)	BOARD 375

5. Then insert the ticket wallet of each passenger in the slot with the bar-code sticker at the bottom and facing you. As each sticker is read, the display will beep. If you hear no beep, make sure the sticker is there and try again. If there is no sticker, press <SPACE><ENTER> to count the passenger. Likewise, for each passenger with no ticket wallet (usually members of a family travelling together), press <SPACE><ENTER> to maintain the head count.

Ordinarily the display will contain a two-line response to each passenger with the top line showing the sticker number and the bottom line showing the passenger count and flight number. For example, if the fifty-seventh passenger to board flight #839 happened to have a sticker reading "D023",the display would show:

D023
57 839

If you insert wallets in rapid succession, say one a second, the counts will come back in a bunch but that's O.K.

6. If a passenger tries to board the wrong flight, the display will say:

WRONG FLIGHT

If you insert the same passenger's ticket wallet twice, the display will read:

ALREADY BOARDED

In both these cases the count will not increase.

7. If a passenger with a sticker on his wallet decides to cancel in the boarding lounge, press <F4>. For example if a passenger for flight 839 with "D016" on his sticker wants to cancel, type:

(you type)	<F4>
(response)	CANCEL PASSNGR
(you type)	839 016
(response)	* READY * 839

Note that the alpha character on the sticker is NOT part of the sequence number and must not be included here.

8. If the flight should be cancelled use <F3>. Suppose you must cancel flight 380:

(you type)	<F3>
(response)	CANCEL FLIGHT
(you type)	380
(response)	READY

9. To close the flight, simply press <F1>. If all passengers with stickers have boarded on flight #839, after about 15 seconds the display will respond:

CLOSED OK 839

If any passengers are missing , a list will appear on the display. For example, if a passenger named Robertson with two bags who had sequence number "093" and checked in at ticket counter terminal "C" failed to board, the display will show:

```
* MISSING LIST *
0932ROBERTSON     C
W-A-R-N-I-N-G
```

This information about all missing passengers will be sent to the display, but since it can show only two lines at a time, you will have to use the up and down arrow keys to scroll the display to whatever lines you want to see.

10. Check Apollo for passengers whose last names match those shown on the missing list. Page them and alert the flight crew and station manager about the

situation. If the missing passenger(s) appear in response to the page, press <F0> again and insert the ticket wallet(s) into the slot, then reclose the flight with the <F1> key.

11. If you would like to see the count of passengers boarded after closeout, press <ALT><F5><ENTER>.