Time-Stamping: A New Way to Survey Pedestrian Traffic in Airport Terminals

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The author has developed a new method for collecting pedestrian traffic flow data in airport terminals. The method was developed for the Airport Facilities Branch of the Canada Ministry of Transport. The problem was to find a better way of conducting terminals surveys. Traditional interview surveys and time and motion studies yield only fragmented bits of information. A total systems approach was required. The method consists of handing a card to each person as he or she enters the terminal either at the gate or at the door. The person is asked to carry the card during his or her stay in the terminal. At various check points the card is time-stamped. When the person leaves the terminal, the card is collected. The result is a complete trace of his or her movements in the terminal. A pilot study to test this technique was conducted at the Winnipeg International Airport on August 1 and 2, 1975. The survey was successful: 10 055 cards were carried successfully through the terminal for 2 days, 96 cards were discarded and recovered, and about 150 cards were unaccounted for, which is a 98 percent return. The result is a complete travel pattern for each person. The data are so comprehensive that they will yield volumes, flow rates, occupancies, queuing length, service times, delays, levels of service, velocities, densities, flow patterns, conflicts, processing line balance, space use, and total travel effort.

In the summer of 1974, the Airport Facilities Branch of the Canada Ministry of Transport initiated a program to conduct effectiveness evaluation studies of major airport terminal buildings in Canada. I was retained by the Canada Ministry of Transport to develop the overall methodology. Part of this methodology was directed at the pedestrian traffic flow subsystem of the terminal. The terms of reference for the pedestrian flow system specified that the methodology

identify, assess and quantify:

1. Problem areas in major terminal buildings;
2. The operational capacity, level of service, and traffic pattern of major terminal buildings;
3. Relationship between traffic volumes, capacities, and net costs;
4. Data for a comparative analysis of terminal concepts leading to policies and standards;
5. A data base for the calibration of simulation models.

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Furthermore, 1 constraint was imposed. The new methodology was not to use questionnaires of any kind to collect data. Traditional surveying techniques, such as questionnaires and time and motion studies, yield only fragmented pieces of information. A total systems approach was required.

The purpose of this paper is to report on a new type of terminal survey—time-stamping—that was developed to meet the objectives and constraints set out in the terms of reference. Essentially the technique involves "tagging" each pedestrian and tracing his or her movements through the terminal. The method was successfully tested in a pilot study at the Winnipeg International Airport on August 1 and 2, 1975.

PEDESTRIAN FLOW SYSTEM

The pedestrian flow system can be viewed at 3 levels of detail: small, intermediate, and large.

Components (Small Level)

At the small level, there are 3 basic components: reservoirs, processors, and links. Reservoirs are terminal elements where people are collected and detained for a period of time. A reservoir is a static component of the terminal, generally a waiting area with either ordered or bulk queuing. Examples of reservoirs are public waiting areas, washrooms, coffee shops, restaurants, bars, bookstores, and newsstands.

Processors are special types of reservoirs that house mandatory activities related to processing passengers for their flights. A processor consists of a service facility plus queuing space. Examples of processors are curbsides, ticket counters, check-in counters, holding rooms, aircraft, customs inspection, and baggage-claim areas. Examples of service facilities are desks, carousels, and magnetometers.

A link is a terminal component that connects reservoirs and processors to other reservoirs and processors. It is a transportation facility where people move or are moved. It is a dynamic component of the terminal system. Examples of links are corridors, aisles, moving sidewalks,

loading bridges, mobile lounges, stairs, escalators, and elevators.

Processing Lines (Intermediate Level)

A processing line is a linear sequence of reservoirs, processors, and links associated with the enplaning or deplaning function of each flight. Processing lines can be classified by flight sector (e.g., domestic, transborder, and international).

Flow System (Large Level)

The pedestrian flow system is made up of a set of interconnected processing lines. Grouping the processing lines into 2 major subsystems—enplaning and deplaning—is convenient. The enplaning subsystem handles originating and outbound connecting flows. Enplaning activities normally take place on the departure floor of the terminal building. The deplaning subsystem handles terminating and inbound connecting flows. Deplaning activities normally take place on the arrivals floor of the terminal.

REQUIRED DATA

The minimum data required for analysis of the reservoirs, processors, links, processing lines, and flow system are given in the following outline:

1. Reservoirs
   a. Geometry (shape and area)
   b. Loads (number of people)
   c. Waiting time (min)
   d. Population mix (passengers, visitors, greeters, well-wishers)
2. Processors
   a. Geometry (shape)
   b. Mode of operation (first in, first out)
   c. Processing time (min)
   d. Volumes (persons/min)
   e. Loads (number of people)
3. Links
   a. Geometry (shape and area)
   b. Volumes (persons/min/m)
   c. Speeds (feet/min)
   d. Densities (persons/m^2)
4. Processing Lines
   a. Sequence of reservoirs, processors, and links (geometric configuration)
   b. Processing times (min)
   c. Volumes (passengers/h)
   d. Flights (flight numbers)
5. Flow System
   a. Layout of terminal building (walking distance matrix)
   b. Origin-destination trip table (flow matrix)
   c. Desired line pattern

TERMINAL SURVEY TECHNIQUES

It was clear from the nature of the data required that some kind of survey had to be conducted in the terminal building. In the past few years, numerous surveys of various types have been conducted in air terminals around the world. The purpose of these surveys has been as diverse as their techniques. This section offers a brief overview of various pedestrian survey techniques that have been used in airport terminals.

Manual Observation Techniques

Manual observation relies on survey personnel to make head counts and time readings either manually or with mechanical devices. The method is best suited for analysis of components. It has been widely used in airport planning. Recent examples are the surveys at the Ottawa International Airport (1), at the Toronto International Airport (2), and at Washington National and Dulles International Airports (3).

Photographic Techniques

The photographic technique is essentially a deferred observation technique. The activity at a component is either filmed by movie camera or taped by television camera for analysis later at the office. A method using videotape analysis has been used by the Ground Transportation Section of the Airports Facilities Branch of the Canada Ministry of Transport to evaluate the road access at Dorval, Toronto, and Vancouver Airports. I have done experimental work using time-lapse photography and videotaping for the Vancouver and Ottawa terminals. It appears to be a valuable technique as a supplement to or a check on other techniques.

Mail-Back Questionnaires

The third type of data collection technique is the self-administered mail-back questionnaire. Respondents are given a questionnaire to be filled out and mailed back to the survey office. This technique is suitable when respondents have little time or will not be able to answer certain questions until they have left the airport. The success of this technique is highly dependent on the use of a simple, readily understandable questionnaire (4). This technique has been used by the Toronto Area Airports Project Team at Toronto International Airport (Malton) (5).

Collected Questionnaires

In the fourth technique, self-administered questionnaires are handed to the respondents to be completed by themselves. The questionnaires are collected after some reasonable time period by survey personnel. For this technique to be applied successfully, the respondents must be captive and not be pressed for time. The questionnaire should be simple, in the sense that questions can be easily understood by respondents. It is also important that the respondent know the answers to questions rather than have to guess or estimate in responding. For example, inbound air passengers may not know which of the available ground services they will use, how many persons are going to meet them at the airport, or how long it will take to reach their ultimate destinations (4).

Interviewing Technique

In the personal interviewing technique, surveyors ask questions directly of respondents and record the answers on prepared forms. The use of this technique requires that the respondent not be pressed for time or that only a few questions be asked. Personal interviewing is most suitable when certain aspects of the questionnaire might not be fully understood by respondents or when the line of questioning is dependent on the response to specific questions. This survey technique is often used to determine characteristics of the terminal population. Personal interviewing is generally employed only when activities to be surveyed are concentrated at a small number of points, activity levels are low, and the desired sample size is

small (4). This technique has been widely used by the Canada Ministry of Transport. For example, it was used by the Toronto Area Airports Project team (5) and by the New Montreal International Airport Project Office at Dorval (6).

Tailing Technique

The tailing technique involves following a small sample of people as they travel through the terminal. The sample can be selected by using a random number table. The surveyor fills in a questionnaire as he or she follows the traveler around. Thus, in addition to recording the traveler's travel pattern, the surveyor is also able to note certain other characteristics such as sex of the traveler, party size, number of bags carried, flight number, physical handicaps, and queuing behavior. This technique was recently used in Britain in a survey of Heathrow Airport (7).

Tag Technique

The tag technique involves "tagging" the traveler and tracing his or her movements through the terminal. The tagging can be accomplished by having the pedestrian carry a card and having the time entered at various checkpoints in the terminal building. The card is collected when the pedestrian leaves the terminal either by gate or by door. A limited survey of this kind was conducted in West Germany by Baron and Henning (8).

NEW TIME-STAMPING SURVEY TECHNIQUE

An analysis of the advantages and disadvantages of the various survey techniques in light of the required data showed the tag technique to be the most suitable method. In the time-stamping survey technique each pedestrian—passenger and visitor alike—is handed a card when he or she enters the terminal either at the gate or at the doors at the curb. The pedestrian is asked to have the card time-stamped at various checkpoints in the terminal. The time stamps are coded by checkpoint. The card is collected from the pedestrian when he or she leaves the terminal either by gate or by door. When aggregated over a day, the result is a complete travel pattern of pedestrians.

Advantages

The technique yields a maximum of quantitative data. A complete travel pattern (complete origin-destination table) of all pedestrians can be obtained. The method permits analysis at 3 levels of detail: (a) component level, (b) subsystem level, and (c) total system level. The resulting data are versatile, and useful for evaluation, simulation, and standards. The technique minimizes passenger contacts; no questions are asked. A 100 percent sample/day is theoretically possible, and excellent results at a low cost per sample are yielded. The method is flexible; it can be used in terminals of any size. The survey can be done quickly (within 2 or 3 days). Some pedestrian characteristics (e.g., what the sex of the person is, whether the person is a visitor or a passenger, and whether the person has baggage) can be determined.

Disadvantages

The survey can be expensive in terms of total cost because of the large number of surveyors and equipment required in a major terminal building. The placement of a large number of surveyors in a terminal may be a hindrance to normal traffic flow. The method produces a minimum of qualitative data.

Checkpoints

A checkpoint is an entrance and exit at a reservoir, processor, or link. Here the cards are time-stamped, thereby recording the time in and the time out for each person. Checkpoints are identified, coded, and recorded on the floor plans of the terminal building. The following is a list of typical facilities where checkpoints should be located: doors; stairs, escalators, and elevators; general waiting areas; special waiting areas; ticket counters; check-in counters; baggage claim areas; U.S. preclearance areas; security clearance areas; holding rooms; gate positions; immigration check areas; customs check areas; and amenity areas such as restaurants, coffee shops, bars, rent-a-car counters, gift shops, duty-free shops, flight insurance counters, post offices, banks, barbershops, and VIP lounges.

Equipment

The success of the time-stamp technique depends on 2 pieces of equipment, a time stamp and a card.

Time Stamp

Each surveyor must have a time stamp. These stamps should be lightweight, portable, and compact. The stamps should show the time of day to the nearest minute, a.m. and p.m., and the code for the checkpoint. An ink pad should be available and fastened to a clip board. Figure 1 shows a typical time stamp.

Card

Each person entering the terminal either at the door or at the gate is handed a card and instructed to carry the card wherever he or she travels in the terminal. The card is time-stamped by a surveyor at each checkpoint. It is collected when the pedestrian leaves the terminal building. The card should be of attractive design, look "official," and be of convenient size (e.g., the size of an airline ticket). Figure 1 also shows a typical card. (The message on the card is printed in French on the reverse side.)

WINNIPEG TERMINAL PILOT STUDY

Need for Pilot Study

The proposed time-stamping survey was new and untried. To my knowledge, no such survey had ever been done before in Canada or the United States; therefore, a pilot study was required to test the technique. The objectives of the pilot study were

1. To test public acceptance of the new technique (Would people carry the cards through the terminal? What would their reaction be?),
2. To test the surveyor's acceptance of the technique (Would survey personnel be able to cope with large volumes of traffic? Would they be comfortable?),
3. To test the equipment of the survey (Would the time stamps work? Were the cards designed correctly?),
4. To test the logistics of implementing the survey (Can the survey be started and stopped with ease? Is the work schedule adequate?),
5. To test the impact of the new survey technique on the terminal's operation (Will it alter flow patterns? Will it delay passengers? Will it impede airline operations?), and

6. To provide useful data to a planning team.

Winnipeg—An Ideal Site

An appropriate terminal had to be found in which to conduct the pilot study. The terminal had to be relatively small to keep the cost down and to keep the survey under control. It also had to have a representative sample of air traffic (domestic, transborder, and international). The terminal at the Winnipeg International Airport fitted these selection criteria well. Furthermore, it offered an additional benefit. Traditional surveys were planned for the terminal for 2 weeks beginning July 21, 1975. These surveys were to be conducted by the Winnipeg Area Airports System Study team (WAASS) as the first phase of a 2-year study to formulate a plan of long-range development for airports in the Winnipeg area. Here was a unique opportunity to conduct the pilot study. An agreement was reached with the WAASS team by which they would add 2 days to their normal survey schedule to accommodate the pilot study. The WAASS team also agreed to provide the necessary personnel, include the pilot study in their extensive public relations program, and secure cooperation from the various airlines concerned. In return, the Airport Facilities Branch in Ottawa agreed to purchase the time stamps and provide the WAASS team with the results of the survey.

Figure 1. Time stamp.

Terminal Layout

To keep the pilot study within manageable proportions, only the north end of the terminal was surveyed. The Winnipeg terminal is of symmetrical design; the north end is a mirror image of the south end. The south end of the terminal is exclusively for Air Canada, and the north end accommodates all other airlines. This division in effect creates a self-contained miniterminal.

Forty checkpoints were identified and coded in the north end of the terminal. Table 1 gives the codes of the checkpoints, and Figures 2 and 3 show the layout of the north end of the terminal. Openings in the rope barricades dividing the terminal were treated as entrances to and exits from the miniterminal. Thus, if a passenger walked from the CP Air counter to the Air Canada counter, he or she effectively exited the miniterminal and surrendered the time card. If the passenger returned, he or she would be given a new card and would be treated as a new person. Therefore, the cards really represent person trips, rather than persons. Because some of the 40 checkpoints required 2 surveyors, 50 time stamps were required to conduct the pilot study.

Personnel and Equipment

Fifty people were needed to conduct the survey because, as was just mentioned, some of the 40 checkpoints required 2 surveyors. Only 1 shift would be operated per day (11:00 a.m. to 8:00 p.m.) to keep costs down. The surveyors were supplied by a private company in the temporary help and project staffing industry. This company also provided 3 supervisors. Each surveyor was equipped with a time stamp, an ink pad, and a clipboard that was rigged with a harness. The harness was necessary to free the surveyor's hands to accept the card, ink the stamp, and stamp the card. The strange looking outfit had an added advantage in that it made the surveyors clearly identifiable. An examination of the airline schedules for the north end of the terminal suggested that 15 000 cards would be required for the 2 days.

Table 1. Codes of checkpoints in north end of terminal.

Code	Checkpoint	Code	Checkpoint
1	In and out door 1	21	Out Northwest check-in desk
2	In and out door 2	22	In U.S. preclearance facility
3	In and out door 3	23	Out U.S. preclearance facility
4	In and out barrier at south stairs	24	In immigration queue (PIL)
5	Up and down north stairs	25	Out immigration desks (PIL)
6	In and out gate 1A	26	Out baggage claim (customs)
7	In and out barrier at information counter	27	In customs queue (secondary)
8	In and out barrier at cafeteria	28	Out customs hall
9	In and out gate 1	29	In and out waiting area
10	In and out gate 2	30	In and out duty-free store
11	In and out gate 5	31	In security check
12	In baggage claim area	32	Out security check
13	Out baggage claim area	33	In hold room 1 queue
14	In CP Air queue at check-in counter	34	Out hold room 1 desk
15	Out CP Air check-in desk	35	In hold room 2 queue
16	In Transair queue at check-in counter	36	Out hold room 2 desk
17	Out Transair check-in desk	37	In hold room 5 queue
18	In Frontier queue at check-in counter	38	Out hold room 5 desk
19	Out Frontier check-in desk	39	In and out greeter and well-wisher area
20	In Northwest queue at check-in counter	40	Out corridor

Figure 2. Checkpoints in north end of terminal, first floor and basement.

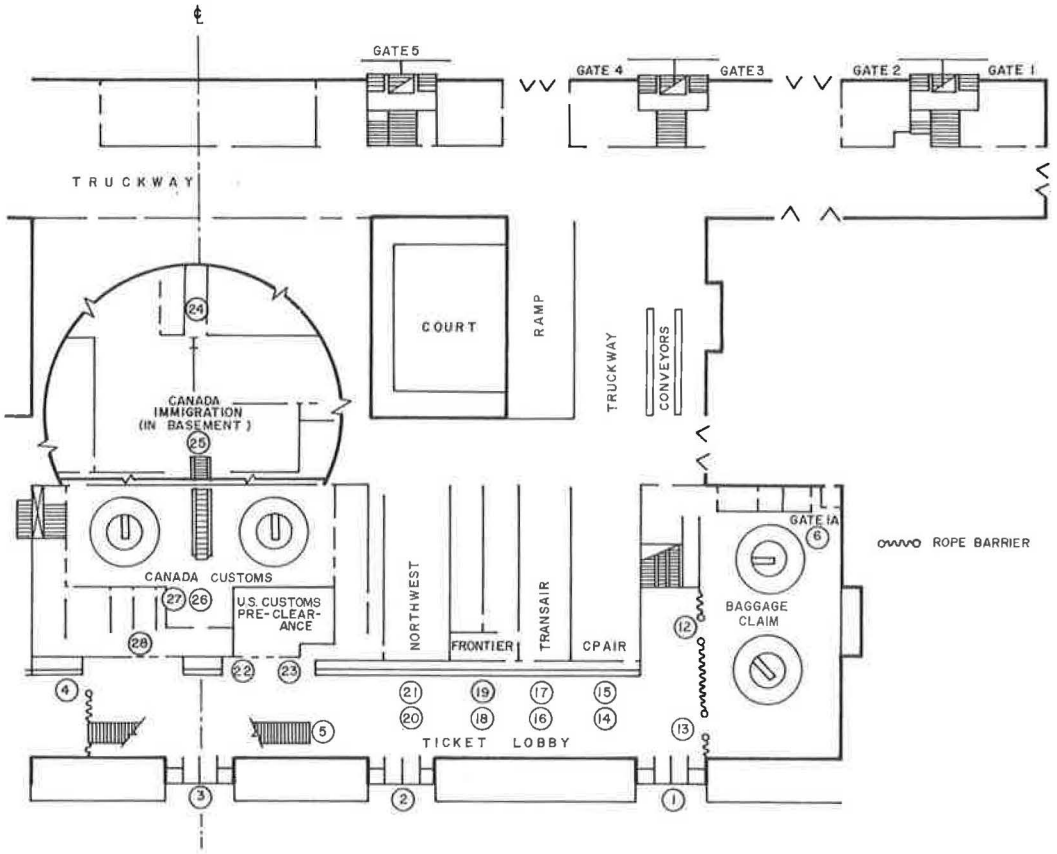

Figure 3. Checkpoints in north end of terminal, second floor.

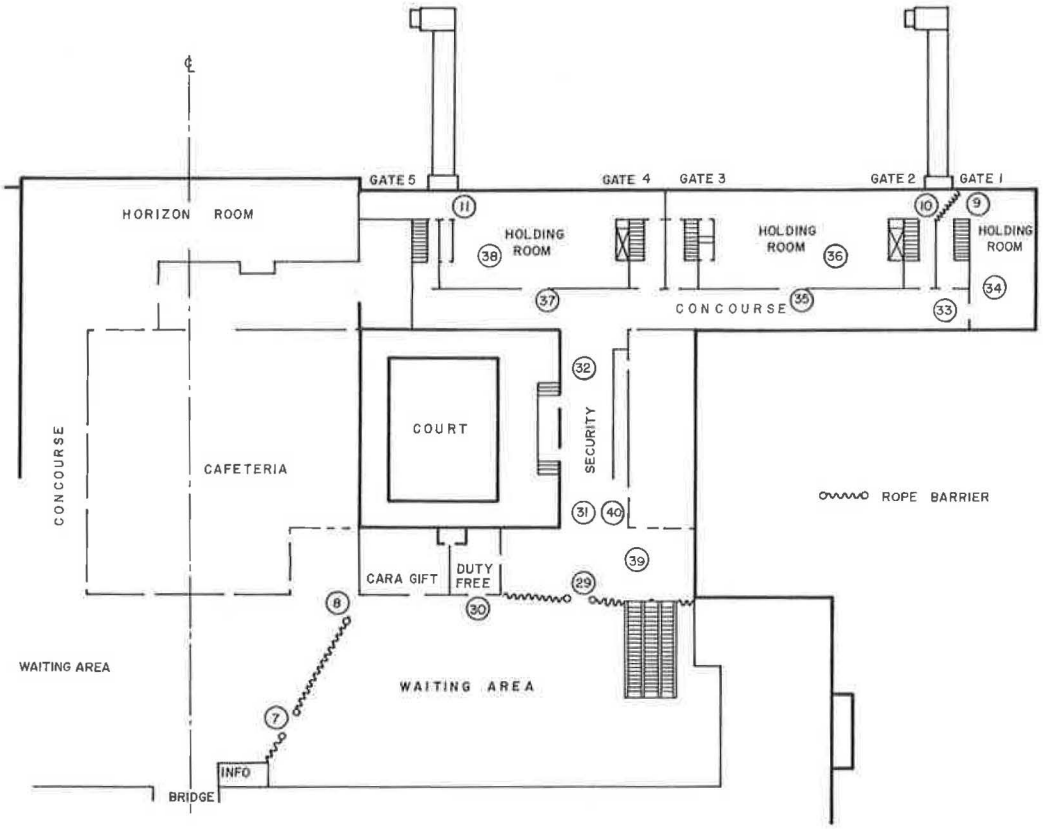

Table 2. Airline schedule during time-stamp survey.

Airline	Arrival		Departure	
	Flight Number	Time	Flight Number	Time
Northwest	505	12:20 p.m.	736	1:10 p.m.
	735	1:17 p.m.	382	2:15 p.m.
	215	3:24 p.m.	474	5:00 p.m.
North Central	571	12:40 p.m.	574	1:15 p.m.
Frontier	94	3:30 p.m.	99	4:10 p.m.
Trans Air	710[a]	12 noon	332[b]	1:05 p.m.
	106	12:10 p.m.	753[a]	1:05 p.m.
	743	12:15 p.m.	738[b]	1:30 p.m.
	726	12:35 p.m.	740[a]	1:30 p.m.
	754[a]	3:45 p.m.	703[b]	2:05 p.m.
	331[b]	4:45 p.m.	731[a]	2:05 p.m.
	704[b]	5:05 p.m.	744[b]	4:40 p.m.
			757[b]	5:45 p.m.
CP Air	72	12:15 p.m.	72	12:35 p.m.
	86	1:25 p.m.	86	1:45 p.m.
	73	3:50 p.m.	73	4:10 p.m.
	385[a]	4:20 p.m.	385[a]	5:30 p.m.
	70	6:05 p.m.	70	6:25 p.m.
	386[b]	6:30 p.m.	386[b]	7:30 p.m.
	87	7:35 p.m.	87	7:55 p.m.

[a]Saturday. [b]Friday.

Sample Size

On Friday, August 1, 1975, the survey ran from 11:30 a.m. to 8:30 p.m. This time span covered 34 scheduled flights and 3 charter flights. On Saturday, August 2, 1975, the survey ran from 11:00 a.m. to 6:30 p.m. During this time span, 30 scheduled flights and 2 charter flights were surveyed. A total of 69 flights of 7 airlines were surveyed. Table 2 gives the airline schedule during the time-stamp survey.

Training

On July 21, 1975, the surveyors were introduced to the new survey technique along with the traditional surveying methods. A review session was held for an hour on the morning of August 1, 1975. Equipment was issued at that time and the surveyors practiced stamping. At 11:30 a.m., the survey personnel moved into their positions in the terminal.

Performing the Survey

The surveyors were sent out in 2 groups. Those who manned the internal checkpoints of the terminal were sent out first so that they would be in position when the public started coming through with cards. Those assigned to cover the entrances and exits were sent in about 10 min after the first group. During the first 2 h, there were some difficulties as the surveyors learned their task. After that, the survey ran very smoothly. Five supervisors equipped with walkie-talkies coordinated the survey. A half hour before closing the survey, the surveyors at the entrances and exits were instructed to collect cards and not hand out any more. This step permitted most pedestrians with cards to leave the terminal and have their cards collected. Lunch breaks were scheduled between 2:00 p.m. and 3:00 p.m., the period that was the least busy. Coffee breaks were taken when feasible.

Videotaping

Nineteen and a half hours of videotape were produced before, during, and after the time-stamping survey for 3 reasons:

1. To have a check on the validity of the data,
2. To record the survey technique, and
3. To permit an analysis of the impact of the survey on terminal operations.

The taping was done by 2 television cameras that were mounted at the same place each day. All major activities were taped including activities at entrance doors, check-in counters, stairways, security checks, hold rooms, and baggage claim areas.

PILOT STUDY RESULTS

Public Acceptance

The survey technique was a tremendous success. In 2 days, 10 055 cards were carried by the public through the terminal. During and after the survey, the terminal was searched for discarded cards; 52 cards were found in the north end of the terminal, and another 44 cards that somehow escaped the surveyors at the barricades were found in the south end of the terminal. About 150 cards were unaccounted for, which means a 98 percent return. From surveyors' notes and recollections and videotape analysis, an estimated 150 people refused to carry cards. Another 300 people were estimated to have been inadvertently missed in the survey. Thus the sample size was 94.4 percent.

Surveyors' Acceptance

In general, the surveyors accepted the technique well. There were some poor starts initially, but these were quickly corrected. A more thorough training program would have eliminated a lot of start-up problems. Some of the surveyors complained of standing, and chairs were provided where feasible. No difficulties were encountered in keeping up with the volumes of traffic. Heavily loaded areas, such as doors and gates, had more than 1 surveyor. In future surveys, survey personnel should be issues airline schedules so that they can prepare themselves for peak periods.

Equipment

The time stamps caused some difficulties. Occasionally, a clock would stop ticking. When that happened the surveyor would record the time by hand until the clock could be started or repaired by a supervisor. Another problem with the clocks was synchronization. Most of the clocks lost 2 to 3 min over a day. This problem was minimized by the supervisors who checked each clock every hour. Another synchronization problem occurred between clockface and stamp imprint. Play in the gears and hands caused some time stamps to be out 2 min. The resulting data are not as precise as was anticipated. A problem with the clarity of the imprint on some cards was also detected, but, as the surveyors gained experience, this difficulty righted itself. Some surveyors found that the size of the grid on the card was too small for the stamp and that the stamping process was messy. The cards themselves appeared to function well. They were the correct size and weight. Not one card was mutilated in any way.

Logistics

No great difficulties were encountered in actually running the survey. The start-up and shut-down procedure worked well. The biggest problem was in scheduling lunch and coffee breaks for 50 surveyors. In future surveys, extra personnel should be available to act as

relief when required. The nurse provided by the temporary services company looked after the welfare of the surveyors and appeared to be good for morale.

Impact on Terminal

Except for a couple of isolated incidences, the time-stamping survey appeared to have had little impact on terminal operation. One incident occurred at checkpoint 39 near the top of the escalator (Figure 3). Some 200 passengers of a charter flight came up the escalator en masse. The 2 surveyors at the checkpoint attempted to handle the volume but, because queuing space was very small at the top of the escalator, a dangerous situation developed. The time-stamping was suspended for a few minutes at the checkpoint until the backlog cleared. On Saturday, that checkpoint was eliminated.

During the peak period, a second bottleneck occurred at checkpoint 8 on the second floor (Figure 3). This checkpoint was on the main corridor between the 2 halves of the terminal. The problem was quickly corrected by adding a second surveyor to the checkpoint. No comments were made about the rope barricades that divided the terminal. These barriers did not appear to influence traffic flow patterns very much. An in-depth analysis is planned of the videotapes to see whether pedestrian traffic flow patterns changed. After the survey, I interviewed several agencies to learn whether they had been inconvenienced in any way. Canadian immigration and customs personnel said that the survey had had no impact on their operation. Similarly, agents for Northwest, Transair, and CP Air stated that the survey had not bothered them at all. And the agents at the security check position declared that the survey had had no effect on their operation.

Before the implementation of the pilot study, many people had expressed concern over the impact of so many surveyors in the terminal building. This concern was unfounded. From a vantage point above the first floor, I had difficulty in spotting the surveyors among the hundreds of passengers and friends. They were well dispersed throughout the terminal. Most passengers encountered only 6 to 8 surveyors in their path of travel.

Data Collected

The ultimate test of the success of any survey is the quantity and quality of data collected. The data were processed by computer, and the results were verified by comparing the computer printout with videotape head counts. The results were excellent. From the data, accumulations (loads), average occupancy times, and population mix for reservoirs were extracted; processing times, rates of flow, average waiting times, and queue sizes for processors were obtained; and volumes, speeds, and densities in the links were derived. Processing times and volumes by flight numbers also were produced, and a complete flow matrix and a desire line pattern for the north half of the terminal were generated. This vast amount of data can now be used to analyze the terminal for capacities, levels of service, bottlenecks, and adequacy of layout. A complete description of the results is available elsewhere (9).

Survey Cost

In terms of total cost, the pilot study was fairly expensive primarily because of the initial capital cost of the time stamps and personnel costs. The following tabulation gives an itemization of the costs in dollars:

Item	Cost
50 time stamps	3750
50 surveyors	5000
15 000 cards	300
Total	9050

If we look at the survey in terms of cost per sample, then the time-stamping technique is much cheaper than other surveys. For example, the cost per sample for the time-stamp survey was 90 cents ($9050 ÷ 10 055). The cost per sample for the traditional surveys at Winnipeg International Airport was $1.12 ($45 000 ÷ 40 000). Furthermore, if other time-stamp surveys were to be done, the capital cost of the time stamps would decrease. Also a great deal more quantitative information can be extracted from the time-stamp survey than from other types of surveys.

CONCLUSIONS AND RECOMMENDATIONS

The time-stamp survey technique was a success. We derived 6 conclusions and recommendations.

1. Public acceptance of the time-stamp survey technique was excellent. People cooperated to the fullest in carrying their cards and presenting them for stamping. Therefore, other terminals should be surveyed by using the new technique. Also the survey should be well advertised before the date of the survey.
2. The pilot study demonstrated that ordinary people with little training can do a good job with this type of survey. However, for better and quicker results, a more detailed training program should be instituted. One day should be set aside for training, and practice on the floor should be closely supervised.
3. The equipment worked satisfactorily. But there is room for improvement in the time stamps. The time stamps were not designed for this study. Therefore, a research and development program should be instituted to design a better time stamp. Ideally, the stamp should leave a digital imprint and be self-inking, accurate, nonwinding, and lightweight.
4. No great problems were encountered in the logistics of the survey. Some difficulty was experienced in scheduling lunch, coffee, and rest breaks. Therefore, adequate spare personnel should be available for future surveys.
5. The impact of the survey on the terminal operations appeared negligible. No significant delays were experienced by passengers; no complaints were received; and no detrimental effects were observed.
6. In the light of the magnitude of the data and the large number of ways of manipulating them, a computer should be used to process the data.

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REFERENCES

1. Summary of Airport Survey at Ottawa International Airport, Aug. 23-Sept. 1, 1972. National Airports Plan Project, Ottawa Ministry of Transport.
2. Toronto International Airport (Malton) Systems Analysis. Civil Aviation Branch, Ottawa Ministry of Transport, Nov. 1965.
3. R. D. Worral and J. M. Bruggeman. Analysis of the Locations and Functions of the Terminal Interface System. Northeast Corridor Transportation Project, Dec. 1969; NTIS, Springfield, Va., PB 191 393.
4. Airport Travel Survey Manual. Barton-Aschman Associates, July 1973; NTIS, Springfield, Va., PB 224 049.
5. 1972 Toronto International Airport Survey. Toronto Area Airports Project, Toronto Ministry of Transport, April 1, 1974.
6. Air Passenger Survey, Dorval, 1972. New Montreal International Airport Project Office, Montreal Ministry of Transport, Sept. 1973.
7. Heathrow Passenger and Baggage Survey. Metra Consulting Group, London, Vols. 1, 2, and 3, Feb. 1973.
8. P. Baron and D. Henning. The Passenger Terminal—A Systems Analysis Approach. Airport Forum, No. 2, 1974, pp. 69-82.
9. J. P. Braaksma. Pilot Study of the New Time Stamping Survey Technique at the Winnipeg Airport. Airport Facilities Branch, Ottawa Ministry of Transport, Jan. 1976.