AMERICAN AIRLINES' "SABRE" ELECTRONIC RESERVATIONS SYSTEM

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Summary

The American Airlines Sabre System, a joint development of American Airlines and IBM, is a major step into the field of total data processing. This system is designed to solve the problems confronting the airlines in passenger sales, seat inventory control, and maintenance and retrieval of passenger records.

After six years of joint effort, a complex of programs and hardware has been developed which will be the largest commercial data processing system in existence. At the heart of this duplexed system are two IBM 7090's. At the extremities are agent consoles built to American Airlines specifications. This system will automate all of the daily reservations processes with the exception of the vital agent-customer contact.

The Sabre System will give, in addition to the obvious customer advantages, the availability of current, detailed and summarized data for the use of American Airlines' management in their constant endeavor to improve passenger service.

Purpose Of The Sabre System

Progress in the air since 1930 from the DC-2 to the DC-7 was matched with similar, but less dramatic advances in our Reservations offices. The dynamic and revolutionary burst into the Jet Age with the Boeing 707, DC-8 and now the Convair 880 and 990 has presented the airline industry with new problems in the Reservations function because of the jet aircraft size and speed. These airplanes which can carry up to 150 passengers can depart an airport and in some instances arrive at the next down-line city before our present day reservations systems has adjusted the passenger inventory.

In the year 1960, American Airlines carried 8,615,000 passengers. In terms of reservations' phone transactions, this figure must be multiplied by a factor of 3 or a total of 26,000,000. The Sabre System being installed for American Airlines in 1962 will assist us in processing 85,000 daily telephone calls -- 30,000 daily requests for fare quotations -- 40,000 daily passenger reservations -- 30,000 daily queries to and from other airlines and 20,000 daily ticket sales. All of this processing for most individual interrogations will be handled in less than three seconds.

Sabre's main purpose is to carry out on a nation-wide basis, the functions associated with the sale and control of air transportation from the customer's first call for information to his arrival at his final destination. To achieve this purpose, Sabre will perform a large number of different functions which can be grouped into three main areas; Passenger Sales, Reservations Record Service and Management Reporting.

Passenger Sales

The primary role of reservations sales agents and ticket sales agents is to sell American Airlines' space and provide the quality of customer service which will encourage passengers always to turn to American for their air travel needs. The Sabre System was designed to help the agent provide this kind of customer service with increased speed and accuracy.

Reservations Record Service

The electronic processing center will perform a number of record service functions, which also support the sales efforts of agents in the Field and promote efficient flight loading. These functions can be grouped into three main areas; information maintenance, distribution of schedules and operating changes, and teletype message handling.

Management Reporting

In addition to Sabre's Passenger Sales and Reservations Record Service, the system will provide as
an important by-product, management control information. The electronic processing center automatically can and will prepare several management reports at given intervals.

Over six years of joint American Airlines - IBM development effort has been devoted to this system, which has now emerged as a comprehensive reservations and control device, designed both to serve the air traveler more swiftly and effectively and to offer American Airlines increased sales effectiveness and better utilization of passenger space. The Sabre System will contain two duplexed IBM 7090 computers, disk and drum storage devices of advanced design and much greater capacity than any now in use, and a specially designed on-line data communications network with remote input - output devices -- all on a scale never before seen in a commercial application.

The system will maintain a complete and up-to-date inventory of passengers booked and seats available. It will enable reservations agents to confirm, cancel or alter reservations and determine seat availability in a matter of seconds. And it will enable reservations agents to obtain the passengers name, record and all pertinent data from the storage devices in a matter of seconds. One of the most important and unique aspects of the Sabre System is that it will operate on current information and will be involved in the control and execution of current transactions. The accumulation of historical data will be a secondary function. The Sabre System is not a record keeping device, but it is an operating real time system in operation 24 hours a day, 365 days a year.

Why We Need Electronic Computers For Reservations Control

The airline industry, including American Airlines, cannot afford to operate 65 million dollar airplanes without reservations. The balancing of equipment, government regulations to adhere to scheduled operations, food services, and last but not least, our competition dictates that to run a profitable airline, you have to have reservations.

The Sabre System represents a major step in what has been an evolutionary process in our reservations function. Twenty years ago, we installed availability boards in our larger offices. As volume increased, we soon found the availability boards crowded, more and more flights were added and our employees had to sit further and further away from the board. It became obvious that some system of providing information directly to the agent position was necessary. We began exploring means of replacing the manual effort for determining seat availability with faster, more accurate mechanical methods. In 1944 we developed the idea or concept of a mechanical system which would keep our sales agents informed of seat availability on various flights. We found an equipment manufacturer - Teleregister - to develop the system. By 1946, such a system called the Reservisor was installed in our Boston Reservations Office. The original Reservisor was a combination of input and output units which interrogated a central source and reflected the availability status on a given flight - "OPEN" for sale, or "CLOSED." It did not allow for the automatic register of "SELL" and "CANCEL" transaction, but it was a milestone in reservations' history, because it was the first time any airline had adapted current electronic discoveries to reservations handling.

Further research and development led to a larger and more complex Reservisor called the Magnetronic Reservisor which was installed at LaGuardia in 1952 to handle our mounting tide of passengers. The significant advancement found in the Electronic Reservisor was the introduction of an arithmetic ability and a memory drum to the system, which allowed sales agents in the New York area not only to determine seat availability, but also to automatically "SELL" or "CANCEL" seats recorded on the drum.

While the Reservisor's devices brought significant improvements to the reservations handling function, we saw the need for further improvements in the overall reservations area. Several problems were arising because with a growing volume of passengers, we faced increasing difficulty in keeping seat inventories in conformity with the reservations records. There was no direct or automatic link between the Reservisor seat inventory system and the passenger and reservations record, which were handled by manual methods. Serious
error problems were arising in the handling of reconfirmations and wait lists, which were further aggravated by delays in finding the errors. As a result of these problems, customer service and efficient aircraft loading were suffering. For example, we often found the inventory count of passengers booked would not agree with the reservations records and this resulted in either oversales or undersales, i.e., either more seats were sold than were available under the original flight schedule or seats were not sold to requesting customers even though in actuality they were available. Undersales also arose because cancellations did not result in a timely reopening of the affected flight. In addition, in order to allow for sales already in the communications "pipeline" but not reflected on the records, a certain number of seats were held open as a "cushion." This "cushion" often was not fully absorbed by sales in the "pipeline" and was not reopened in time to make the seats available to customers on the waiting list.

We also were reaching a point of diminishing returns in terms of reservations manpower. As the passenger volume grew, more and more reservations manpower per passenger boarded was required for communications and record keeping. This resulted in a cost ratio trend that was beginning to take alarming unfavorable proportions.

Foreseeing the affect of further increases in passenger volume upon the efficiency and accuracy of the present reservations handling system, we began exploring with IBM the possibility of further improving the reservations operations. In 1953 American Airlines and IBM formed a joint engineering -- Product Planning Project. Staffed by both American Airlines and IBM working in close cooperation, this joint team performed a thorough detailed overall system analysis in the sales and reservations area, to determine the characteristics and volumes of the existing operation and to develop a program to solve the overall problem. The approach was not one of what equipment was available on the shelf to do the job, but rather what equipment was needed with the thought being that whatever was needed would be developed from the ground up.

Benefits Of The Sabre System

In all three of the major groups of functions performed -- Passenger Sales, Reservations Record Service and Management Reporting -- substantial improvements will be realized.

The customer himself will be a major beneficiary of the system. His request will be processed more speedily and accurately with timely information that reflects the actual status of seats available. This superior service, we hope will attract more customers and therefore more revenue to American Airlines. This system will also increase agent productivity, which should result in improved sales.

Our aircraft will be more efficiently and fully loaded, since cancellations, "no-shows," and waiting lists will be processed immediately and accurately. Also, with more timely and accurate information it will not be necessary to maintain a "cushion" of unsold seats to handle sales in the communications "pipeline," or to cover clerical errors. American Airlines' reservation agents throughout the United States will have an agent set which is connected to the computer via the Sabre communications network. With this, they will be able to request and obtain a reply on seat availability instantaneously on any flight on the American Airlines System. Management direction, both of an operating and planning nature, will be based on more accurate and timely data. This should allow for a more effective and better informed control and evaluation of our airline operations.

Sabre's benefits assume a great importance when viewed against the background of the airline industry during the present decade. The costs of both flight crews and equipment in the Jet Age have increased and, therefore, placed a high premium on the efficient utilization or loading of equipment. An empty seat is much more expensive than it used to be from many standpoints. Also, the growth in passenger volumes and the increased speed of aircraft have produced a need for processing a greater volume of data, faster and more accurately. The growth of competitive conditions in the industry accentuate these needs for more timely and accurate information and control.
Operating Characteristics of The Sabre System

The Sabre System will consist of three main elements: the Electronic Reservations Processing Center in the New York area, the Agents Sets in the field offices, and the Communications Network. The processing center is completely duplexed. The reliability requirements are such that, if necessary, the entire system might be duplexed.

The Electronic Reservations Processing Center will contain all of the system's electronic storage facilities, and will perform logical, computational, and decision-making functions for the system. An important aspect of the center is that all of the memory is randomly accessible. This is one of the features which allow the simultaneous processing of many requests.

At the heart of the electronic processing center are two IBM 7090's, each having a 32,000 word memory. The memory of the computer actually performing the reservations processing will contain the "control program," the messages actually being processed, and operational programs to perform those functions which have been requested. The "control program" has the capabilities of a conventional execution program; but, in addition, will perform all allocation of core temporaries on request, and will allocate space for programs when needed. Due to the magnitude of programs required (well over 100,000 words), only those programs actually in use can be retained in core. Using a hardware relocation device, programs will be shuttled into core each time they are used. The "control program" also facilitates multiprogramming which will be carried on to a degree never before attempted. As many as 30 programs will be in progress at any given time during the peak load period of the day. Each program will proceed until it is required to "wait" for an external reference, at which time, another program will be initiated or allowed to proceed. By this device, each request will be processed in a minimum of elapsed time, making this system truly "Real Time."

In addition to the computer's internal core memory, the electronic processing center will contain magnetic drums and large-capacity magnetic disk files which will act as the system's principal storage media.

The magnetic drums will have capacity for 7.2 million characters and will contain:

1. The inventory of the number of seats sold and remaining for sale on each American Airlines flight.
2. Current flight and schedule information.
3. An area for each of the 1100 agent sets using the Sabre System where requests and messages will be assembled.
4. The more than 100,000 words of programs.

The magnetic disk files will have capacity for over half a billion characters and will contain:

2. The indices to facilitate retrieval of passenger records.
3. Duplicate copies of all information stored on the magnetic drums.

There will be several buffer units which will enable the computer and the many input/output devices to communicate with each other. These buffer units have the logical ability to schedule, control, and assemble input and output data between the computer and the magnetic drums, the magnetic disk files, the communications lines to the Agent Sets, and other input/output equipment located in the processing center.

In addition to the random access storage devices mentioned above, there will be a large library of magnetic tapes which contain historical information.

Agent Sets will be located at more than 50 cities throughout the United States and are used by American Airlines' Reservations agents to communicate with the processing center in the New York area. To facilitate the use of these sets, each agent will have a file of Air Information Cards, which are pre-coded, machinesensitive cards showing information relating to all American Airlines flights and certain flights of other airlines.

Each agent set will consist of three principal elements: an Air
Information Device, a Director Console of rapid action pushbuttons, and an input/output typewriter. Air Information Cards are inserted in the Air Information Device, which automatically senses the code punched in the card for transmission to the computer. Row and column pushbuttons on the Air Information Device are depressed to designate a service preprinted on the Air Information Card, and buttons on the Director Console are depressed to indicate the date on which the service is requested, the number of passengers involved, and the type of action required.

The computer's response to a request using an Air Information Card will be displayed to the agent by lights on the Air Information Device or on the input/output typewriter. The input/output typewriter is also used by the agent to enter information of a variable nature, such as passenger name, phone number, etc.

The Communications Network, which is similar in operation to an AT&T automatic switching teletype circuit, will consist of over 10,000 miles of telephone lines and switching devices which are required at each of the more than 110 physical locations at which Agent Sets are installed. These switching devices called Mulcoms (Multiplexor-Communications) accomplish the sharing of each of the 9 or 10 separate long telephone lines radiating from the processing center in the New York area. All outgoing messages transmitted from the processing center are monitored by each Mulcom on the line and sent only to the appropriate Agent Set.

In the other direction, when an agent using an Agent Set initiates transmission, it is buffered in a logic gate until it is time for its associated Mulcom to use the telephone line. Under this structure, rate of input can be controlled by the computer in the processing center. Periodically (at least every half second), the computer instructs the farthest Mulcom to begin sending. After this Mulcom has transmitted all waiting messages, it instructs the next farthest Mulcom to "go ahead." This process continues until all Mulcoms on the line have transmitted all waiting messages.

Following is a typical example of the use of the equipment which has been described. Let us suppose that a customer telephones the American Airlines' reservations desk in Washington and wishes to reserve a "seat on a flight to Chicago, leaving Washington sometime tomorrow." The agent will select an Air Information Card marked "Chicago" from the file before him. For agents in Washington, this card lists all relevant information for American Airlines' flights between Washington and Chicago. The agent inserts this card into the Air Information Device on his Agent Set, where it will remain in sight throughout the remainder of the transaction. By pushing buttons on the Director Console, the agent records the number of seats required and the date for the trip. After discussing the desired flight with the customer, the agent depresses the row and column pushbuttons on the Air Information Device to designate the flight most convenient for the customer. He then presses the "Sell" button which sends all of the information which he has entered through a Mulcom and thence to the computer in the processing center. If, in scanning the inventory records, the computer determines that the desired seats are available, a message is sent to the agent (printed on his typewriter) giving him information concerning the flight and advising him that the seat has been reserved. If, on the other hand, the seat had not been available for sale, a display of lights on the Air Information Device would inform the agent on which flights he could reserve seats. Assuming that the seats were available, the agent would ask for the customer's name, home and business phone numbers, the name of the person making the reservation if not the customer, and any special requirements the customer might have, such as car rental, wheelchair, special diet, etc. The agent enters all of this information, properly identified, via the input/output typewriter, into the computer. At the end of the transaction, the agent depresses the "end transaction" button. If all of the necessary information has been entered, the computer will send a confirming message to the agent and will construct, file, and index a passenger record for future reference. If, at some future time, whether 1 second or 1 year later, the customer wishes to revise his reservation, this record can be retrieved and used as the point of departure for his revised reservation.
The foregoing example showed the most normal use of the Sabre System. Some of its other vital, if less-used, capabilities are briefly outlined below.

**Teletype Communications**

Requests for continuing space on other airlines, car rentals, tours and hotels, and taxi service, may be entered directly into the agent's set. If a request is to be executed by American Airlines, it will be transmitted by Sabre to an office in the appropriate city. If it must be executed by another airline, a teletype message will be transmitted to the proper point on that airline. Airlines which are permitted to sell space on American Airlines will notify American of each sale by sending a teletype message. When a designated inventory level is reached, Sabre must generate and transmit stop sales messages via teletypes. Naturally, Sabre must be prepared to accept and interpret each type of message that it generates. An interesting and unusual example of worldwide industry cooperation is provided in the development by the Air Transport Association of America and the International Air Transport Association of a machineable interline message format which specifies rigidly the form and control of each such message.

**Waitlists**

Waitlists are created and processed for all flights. If a cancellation occurs, the first passenger on the waitlist is "confirmed" and a confirmation message sent to him via an American Airlines agent.

**Flight Forecasts**

Flight forecasts are maintained for all flights which have not departed. If the forecast is "not normal," this forecast information is furnished automatically each time a reservation is made on this flight. Flight progress is maintained on each flight after it departs. This information is furnished to the agent on request to facilitate answering inquiries concerning details of the flight. Flight forecast and progress information is entered into Sabre via agent sets.

**Ticketing Arrangements**

Ticketing arrangements are entered as part of each passenger record. Ticket pick-up time limits are tabulated and periodically, the list is scanned to determine if any of the limits have been expired. If a time limit has expired, the reservation is automatically cancelled in most instances. In a few cases of especially complicated itineraries, the passenger must be contacted. Information is furnished by Sabre to facilitate this contact.

**Flight Manifests and Passenger Name Lists**

Flight manifests and passenger name lists are furnished for each flight and upon request. These name lists are used to check against boarding passengers. It greatly facilitates detecting "no shows."

**Processing of Schedule Changes and Extra Sections**

Processing of schedule changes and extra sections will result in automatic generation of lists of affected passengers and how they may be contacted.

**Historical Records**

Historical records are retained (on magnetic tape) to allow investigation of transactions for some months past as prescribed by law.

**Various Operating Statistics**

Various operating statistics will be gathered to allow improvement of the System, to predict saturation of the present equipment, and provide data for management control.

**Other On-Line Applications Being Considered**

At the outset, the Sabre System will perform the reservations functions as described in this paper. In the final analysis, however, many other on-line applications will be put on the Sabre System.

There are several ways that a company can approach the task of developing an integrated real time
inventory control and information retrieval system.

One approach is to do a total system study and establish broad company objectives which then are translated into system requirements. From these requirements a system is designed and implemented in one step on a company-wide basis.

Another approach is to select electronic equipment which has expansion capability as the basic components of the system, to implement an important company function and to concurrently study other applications for later application. This is the approach being followed by American Airlines in Sabre. The Sabre System uses standard IBM 7090's as the heart of the system. The reservations function is large and important enough to justify the installation of the minimum data processing and nation-wide high speed communications network.

Our immediate objectives are to get the system paying for itself as soon as possible, to develop our own experienced computer applications staff and at the same time learn more about the problems and capabilities of real time data processing.

Concurrently, we have embarked upon a study and planning effort to meet the following objectives:

1. Determine the expansion capabilities of the Sabre System.
2. Study potential applications.
3. Rank an application in order of its operational need or return on investment.

The results of this study will be a three to five year plan for orderly Sabre growth.

Some of the areas which may benefit in the future from real time data processing are Customer Services, Flight Operations and Maintenance. I shall discuss a few of these briefly.

Customer Services

Ticketing. Such functions as seat confirmation and automatic fare computation and printing could be accomplished.

Air Cargo. Freight inventory control and informational retrieval, optimum space allocation, tariff calculation and billing and freight forwarding messages are feasible.

Lost and Found Baggage. An up-to-date inventory of misguided baggage coupled with a means of rapidly locating it and forwarding it to its owner could be accomplished.

Flight Operations

Flight Dispatch. By providing current aircraft status, it would be possible for Sabre to assist in aircraft rescheduling and re-routing, fuel load calculation, flight plans and clearance requests. In an area such as this, the planning would be done off-line by operational personnel. The Sabre System would provide "how goes it" information and it is conceivable that sometime in the future it would be possible to simulate the effect of a given operational decision so operational personnel could select optimum solution to a multi-factor problem. An example of this is the problem of getting an airline back on a normal schedule after operations have been curtailed over a large portion of the country by a three day snow storm.

At the present time, American Airlines is conducting Ticketing and Air Cargo Feasibility Studies. In the very near future, we will be investigating crew scheduling and communications.

Management Reports And Control By Exception

The Sabre System while basically devoted to the processing of reservations will be extremely useful in supplying Management with an abundant amount of information on day-to-day operations. In addition, Sabre will be able to pin-point critical values from the vast amount of data and "flag" such information to Management. This latter concept known as "control by exception," is especially effective with Sabre because of the tremendous processing capabilities inherent. Management Reports are divided into 3 basic areas:

1. Information that must be
supplied to Sabre Management.

2. Information which is required within the framework of American Airlines, i.e., to divisions of the company outside of Sabre.

3. Information which must be given to agencies outside of the structure of American Airlines.

Information for Sabre Management

In order to evaluate whether the Sabre System is meeting the response time of interrogations entered by the sales agents, several measurements of critical variables will be obtained from Sabre.

One critical variable that Sabre Management is concerned with is saturation of the system. For increased passenger boardings per period of time, additional passenger name records will be composed and stored in the disk files. Consequently, a point in time could occur where the disk files are full. Such a situation will be made known to Sabre Management via an unsolicited computer response. If such a contingency continually arises, Sabre Management may decide to add additional disk files to the system to alleviate the saturation condition.

A second critical variable is the "line loading." An analysis of communication loading in the Sabre System may reveal that the elapsed time from sales agent to computer and return is continually increasing. The computer will be able to measure the response time and print the values per period of time. If the response times are too high, Management may add facilities or re-route interrogations to the computer. If too low, economies can be achieved through consolidating facilities.

Several other critical variables which can be obtained from Sabre for Management decision include:

1. Measure of extent to which Sabre uses teletype equipment, i.e., volume of teletype messages entering and leaving the computer.
2. Measure of the extent of usage of programming routines.
3. Measure of the extent of reference to disk and drum files.

It is intended, therefore, to utilize Sabre to its fullest capabilities in rendering information which heretofore was either unobtainable or laboriously calculated.

Information for other Departments of American Airlines

Sabre will be able to retrieve on command, past-date records from the historical files to satisfy the needs of Management outside of Sabre. The basic purpose of such reports is to illustrate past performances and to predict future goals.

1. These reports may be regularly recurring reports, with specific information occurring at stated intervals, or
2. Reports which may be useful over designated lengths of time, or
3. "One-time" analyses of special interest.

For (1), Sabre will be able to compute daily load factors (ratio of passengers boarded to total seats authorized) per flight for each airport. Under present procedures, such information is not immediately available in total for all airports. Sabre will be able to pin-point those flight legs whose load factors are outside of a certain range. For a low load factor, a sales program would be instituted. A high load factor may be an indication that extra sections should be brought into service for frequently travelled flight legs.

For (2), Management will be interested in such information as:

a. A report of production for the past month which comprises a breakdown of sales by station, activity, sales account and sales agent.
b. A report on reservation-making habits of customers for a particular period of time, as an aid to the sales program.
c. A report on source of business; for example, percentage of business derived from other airlines, commuters, conventions, etc.
d. A report on passengers preference for certain types of meals.

For (3), Management will be interested in such information as:

a. Effect on bookings due to specific advertising campaigns.
b. Measure of extent to which American Airlines is requested to make reservations for passengers on other airlines.

It will be Sabre's purpose to supply a variety of reports to Management instantaneously. (See attachment for examples of Management Reports.)

Information for Agencies Outside of American Airlines

In general, information that is required by organizations outside of the company will not differ in any major respect from that required by the company itself. Such information will be limited to the following outside agencies.

1. The Air Transport Association (ATA)
2. The International Air Transport Association (IATA)
3. The Air Traffic Conference (ATC)
4. The Civil Aeronautics Board (CAB)
5. The Federal Aviation Agency (FAA)

Civil Air regulation requires that airlines retain certain information for a period of 90 days.

a. All Passenger Name Records made for a day including a cancelled reservation or waitlisted passenger.
b. The corrected Inventory Record (record of seats sold for each flight) for the day's flights.
c. Flight information (data governing whether a flight will take off or not) and flight progress information for all flights.

This information will be made available for examination on request. It will be conveniently and efficiently supplied by Sabre from the historical records which are purged from the master files of passenger name records at the end of each day.