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ENDING THE BLUES FOR AIRLINE TRAVELERS

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ABSTRACT

The fast growth in airline passenger traffic combined with the slow growth in airport capacity worldwide is putting a severe strain on the capability of airlines to adapt their processes to maintain satisfactory levels of customer service. The urgent need to better utilize assets, handle more flights in shorter periods of time, increase the number of waves at hubs, coordinate schedules with alliance partners, and quickly respond to irregularities, such as weather and malfunctioning equipment delays, is confronting airlines worldwide. IBM Research and IBM's Travel and Transportation Industry Solution Unit are helping airlines and airports to use advanced information technology to get passengers through check-in, security, and boarding faster, and to improve baggage handling systems, thus improving the passenger experience. Simulation models are useful in helping airlines understand what impact new technologies, such as self-service kiosks, voice recognition check-in, smart cards, electronic ticketing, and radio frequency devices, will have on bottlenecks, personnel needs, and customer service levels.

1 THE EVOLUTION OF JOURNEY MANAGEMENT

Remember the old days when we had to queue up at the teller line inside the bank's lobby to withdraw or deposit cash? Those were the unpleasant days before Automated Teller Machine (ATM) technology made it possible to redefine the process. No more queues. Fast service, anytime, anywhere.

Remember the old days when we had to queue up at the counter inside a car rental location to check out or check in our rental car? Those were the unpleasant days before mobile and self-service technologies made it possible to redefine the processes. No more queues. Fast service, high customer satisfaction.

Remember the old days when we had to queue up at the airline check-in line inside the airport terminal lobby and wait, and wait? That was just this morning.

Have you noticed that airports seem a little more crowded lately and lines at the ticket, check-in, and security locations are longer? That's because the number of flights, especially into and out of hub-and-spoke airports is increasing, disgorging dramatically more passengers into an airport system that has expanded little in recent years.

Are the airlines and airport authorities exploiting modern technology to improve the passengers' flow through the airport? Is the journey of the passenger effectively managed to high levels of satisfaction? The answer to these critical questions is not always what it should be. While airlines recognize that the adoption of new technologies can achieve higher levels of service, they have a difficult time quantifying the service level and the economic impact of interactions between new technologies and process changes.

In the fall of 1996, IBM Research and IBM's Worldwide Travel and Transportation Industry Solution Unit began exploring the application of simulation modeling techniques, used for decades to streamline manufacturing lines, to the airport terminal congestion problem. A project, under the name of "Journey Management," was formed to address the need to allow airlines and airport authorities to deliver a positive experience to airline passengers as they proceed through airport processes. The project's main objective was to develop tools and techniques that extend to the airlines the ability to achieve higher customer satisfaction and the capability to cost-effectively process larger numbers of passengers through existing airport facilities.

With that in mind, we established, as a primary accomplishment to be developed by the project, a library of building blocks and templates, called the "IBM Journey Management Library®" (IBM JML®), for use with a simulation tool to describe airline processes (e.g. check-in) and related new technologies. We also wanted to be able to efficiently reuse the JML both to model multiple airport environments under variable local conditions and to serve as the core engine for the expansion of simulation models into other related airport activities, such as baggage handling and ramp services.

With these objectives in mind, we assembled a team of IBM experts in simulation technology and the travel industry business to form the nucleus of the project, with the opportunity to extend the reach into other IBM areas of expertise and capabilities as deemed necessary during the course of the development. We then selected a simulation tool to be used as the technology base for the project. The selection criteria were originally based on range of functionality, ease of use, and flexibility, and are described in more detail in the next section.

Having secured necessary knowledge and technology, we took a further step to engage an airline partner who would fully participate in the project. We wanted a partner who would provide in-depth insight into the business and operational aspects of passenger processes at the airports, and who would be able to supply the rather extensive set of statistical and operational data required for construction of the model. We approached several airlines worldwide and presented our Journey Management Library idea and the business objectives we intended to achieve.

The reaction was always extremely positive confirming our belief that simulation modeling, enhanced by the availability of a JML, was essential to the integration, coordination, and optimization of information technology into journey management processes. In addition, the ability to test and evaluate alternative solutions before venturing into "real life" prototyping of and investment in new technologies was seen by us and the airlines as a major, fundamental benefit providing the very important bridge between proposed ideas for operational improvement and their implementation.

Air Canada was the airline that responded with the greatest interest and enthusiasm. The leadership, knowledge, and skills provided by their Operations Research and Business Innovation Solutions (ORBIS) organization was most impressive. We all agreed that we would form a close partnership in this venture. After evaluating potential alternative environments, Toronto's Lester B. Pearson domestic terminal was selected as the best candidate for modeling. The terminal operations for domestic passengers processing at that facility provided the greatest variations of interactions between passengers and Air Canada's processes where process capabilities were both integrated and segregated in the form of check-in, ticketing, and baggage handling. Domestic departures operations were also determined to be the best source of significant amounts of reliable information in the form of collected statistical data, quality assurance, and contemporary databases. Starting in early 1997 the Journey Management Library project was on its way to success.

2 TEMPLATE DEVELOPMENT APPROACH

The initial step in the development of the Journey Management Library was to select a simulation tool. In addition to seemingly meeting the project requirements at the onset, and because of the vast experience in both simulation technology and simulation tool development within IBM Research, the initial simulation tool selected was one that had been jointly developed by IBM Research and a vendor partner. This simulation tool was then subsequently commercialized and supported by the vendor partner. At the conclusion of the study to model Toronto's Lester B. Pearson domestic terminal, and based on experience gained through model development, both Air Canada and IBM identified the need for additional functionality that was not currently available in the existing simulation tool. Our set of comprehensive requirements is listed below. The four most important requirements in priority order are: ease of use (open architecture, user-friendly to multiple types of users), graphics and animation, speed, and portability.

- Graphics: State-of-the-art animation for visualization; ability to import CAD drawings
- Portability: Implement on a personal computer running Windows 95®
- Ease of Use: User-friendly to business process analysts, planners, and operations research experts throughout the organization. Must have an open architecture so that spreadsheet data can be easily imported and exported.
- Flexibility: Easily extensible
- Data Manipulation: Automatically fit distributions to historical data
- Simulation Depth: Powerful functionality
- Analysis of Information: Perform automated analysis so that each alternative is running in parallel in multiple split screens simultaneously
- Scenarios: Perform "what if" scenarios easily
- Reporting: Comprehensive, easy-to-interpret reports with excellent graphing capability
- Speed: Very good performance running on a personal computer
- Performance of Runs: High degree of automation for conducting multiple runs
- Presentation: Easy-to-understand results
- Hardware Needs: Personal computer, not a mid-range workstation
- Full Service Support: High quality and responsive technical support
- Perception of Use: Easy, portable, yet sophisticated with a short learning curve

As a result of the need to comply with the requirements above, we assessed the suitability of other simulation tools for development of the Journey Management Library. The following five-step approach was used for the tool evaluation. First, a literature search was conducted to identify possible candidates. Second, Dunn and Bradstreet reports on the simulation companies were obtained to ascertain their financial viability. In some instances where the company was privately held, the information available was incomplete.

Third, a two-day visit with each candidate simulation company was arranged. The first day was devoted to understanding the business aspects of the company such as company history, number and role of employees, product offerings, marketing channels, business partners, major customers, and future development strategies and directions. The second day was devoted to understanding the technical aspects of the simulation tool. On the second day, a tutorial session was conducted and then a problem scenario was posed to the vendor, who was then asked to model the scenario on the fly. The purpose of this exercise was to assess the ease or difficulty in creating and debugging models and to evaluate the flexibility of the tool in handling a problem specific to a non-manufacturing domain. Many of the simulation tools on the market have origins in the manufacturing domain and thus the terminology and slant of some tools are more tailored for manufacturing problems.

Fourth, past and current users were contacted to obtain insight on their experiences with using the candidate tools. Fifth, and finally, we recreated the domestic passenger process model at Toronto airport to gain first-hand experience using the tools.

We concluded that Arena® from Systems Modeling Corporation most closely met our requirements for a simulation tool. Arena is well established in Operations Research groups of major airlines and small package delivery companies for modeling operations. Arena is a proven tool for manufacturing simulation and has been used extensively in IBM. Together Air Canada and IBM agreed to proceed forward in developing the Journey Management Library using Arena.

The development approach for the JML has five phases. Phase 1 involves the selection of the simulation tool. Phase 2 involves creating, validating, and testing a simulation model for a specific problem domain, in particular passenger-oriented processes for a specific airline at a specific airport. Once the model is validated, the simulation results are analyzed. Phase 3 involves defining functional specifications and a high-level design for the template based on the experience gained in Phase 2 and generalizing it for any airline or any airport. Phase 4 involves low-level design, development, and component, functional verification and systems integration testing of the template. Phases 3 and 4 are iterative phases because design decisions and their associated development implications influence implementation. Phase 5 involves transferring the template and skills to the IBM Travel Industry Consulting organization worldwide for use in helping their customers implement advanced solutions. Phases 2 through 5 are described in more detail in the next section.

3 EXPERIENCE

3.1 Simulation Model Description and Study Results

The scope of the baseline simulation model of Air Canada's domestic passenger processing functions consists of these processes: ticketing, economy passenger check-in, premium passenger (e.g., first class, elite frequent flyers) check-in, special assistance (e.g., unaccompanied minors, people requiring wheelchairs), special services (e.g., oversized baggage, pets), and gate control (e.g., gate check-in, coupon lift, close-out / reconciliation). The intent of this journey management model is for use in analyzing the impact of introducing advanced information technology capabilities and evaluating their improvement on customer service.

In the simulation model, the key entities are passengers that move through a set of processes and activities that consume resources. Constructing a suitable model of this airport passenger service process presents a number of challenges in the application of simulation technology.

In many simulation models, specifying a parameterized distribution such as the Poisson process with a given rate easily captures the entity arrival process. However the dependence of passenger appearance on the flight schedule prohibits using this approach. In our model a set of flight pre-departure events was generated at a fixed time interval before the departure time of each flight in the schedule. During the simulation, each of these flight pre-departure events in turn simultaneously kicks off the generation of each passenger on the flight. Each passenger entity is then assigned a terminal appearance event time based on the appropriate distribution of time ahead of flight. The pre-departure event is also used to key the timing of process activities.

Another challenge in this simulation effort was to accurately capture the complexity of the passenger mix and its impact on the requirements for airport services. For example, a different distribution of number of bags needed to be applied to business and leisure passengers. Such distinctions were further broken down by type of travel (domestic versus regional) and even time of day. Immediately upon generation and prior to terminal appearance, each passenger type, as determined by the flight-boarding forecast, is assigned some key attributes. Based on statistical information about the percentage of each category, a passenger is assigned an attribute of either originating or connecting. These attributes work with the processing logic to model the flow of the passenger through the process.

A different challenge involved incorporating the resource schedules to model the assignment of agents to counters. Both full-time and part-time agent schedules are phased in and out over the course of the day to maximize productivity by approximating the peaks and valleys in passenger activity. The result is a resource profile that can vary significantly in each fifteen-minute interval throughout the workday. The model dealt with this complexity in two ways. The first was to take advantage of the modeling tool's ability to group individual resources into workgroups. Secondly, in the course of the study, a method of transforming agent schedules from manpower planning worksheets into simulation resource downtime schedules was devised. This allowed the modification of resource schedules to be accomplished outside of the simulation interface using either a text editor or spreadsheet application.

Another resource-related modeling challenge was making adjustments in the allocation of resources to activities based on observations of the system. For example, one step of the processing logic is to serve regular customers "unless you see a line forming" at the priority counter. Human behavior of this kind is difficult to model as a rule or procedure. In the model, this procedure was handled by giving priority passengers priority access to a "swing" counter. The definition of the resources for the swing counter then needed to be modeled in more detail and separately from the other counters. Such balance decisions will likely continue to be difficult to capture in process modeling regardless of the type of simulation technology.

Air Canada's industrial engineering and quality control organizations provided input data to the model from both current observations and historical patterns. After validating the model with actual data collected for the day of May 2, 1997, we conducted multiple simulation runs for each day of the week of July 7-13, 1997. The runs used forecasted data as input and collected performance measures for all major processes. The measures included peak and average wait times, peak and average number of passengers waiting in line, resource utilization, etc.

The primary objective of these runs was to assess whether predefined standards for passenger service levels were attained. Ticketing standards stipulate that 80% of passengers should wait in queue less than five minutes. Similar standards that 90% of economy check-in passengers wait less than five minutes and 90% of premium check-in passengers wait less than two minutes also hold.

As such, each run took a snapshot of system conditions at each instance when a passenger experienced a service level that did not meet Air Canada's standards. These conditions include time of day, type of passenger, number of passengers in queue, wait time, resources availability and resources utilization.

After analyzing all collected statistics, we focused on investigating conditions where wait time exceeded Air Canada's targets. Those areas for which the target service levels appeared to be inconsistent were the ticketing process and the economy check-in process. Output from the model indicated that a minimum of 87% and a maximum of 93% of all passengers waiting in the ticketing queue and a minimum of 81% and a maximum of 93% of all passengers waiting in the economy check-in queue waited less than the target 5 minutes.

However, a detailed analysis of the ticketing counter process showed that those passengers whose wait time exceeded the service standard experience a consistent and significant clustering of excessive waiting time during a period of about one hour in the morning. A closer scrutiny of the clustering revealed that almost 60% of those passengers whose wait time exceeds 5 minutes waited more than twice the desired standard with about 20% of passengers waiting between 25 and 30 minutes. Hence, the ticketing process represents an opportunity to investigate the integration of self-service kiosks to improve the throughput.

In contrast, a more detailed data analysis at the economy check-in process portrayed a different picture. In this case, passengers whose wait time exceeds 5 minutes seldom do so by more than 7 minutes. This type of observation provides a base for further simulations that seek to integrate new technology enablers into streamlined processes.

3.2 Journey Management Library Template Description

A functional specification for the Journey Management Library template was developed based on the knowledge gained from the simulation study described in Section 3.1. The template provides a simple user-friendly interface, an interface to outside data sources, a visual representation of the activities taking place within the model, an easy to understand representation of results, and on-line help and user documentation. A tutorial and training course are also being developed to accompany the template, thereby facilitating the technology transfer to the IBM Travel Industry and its customers. The Journey Management Library template consists of custom designed simulation modules that represent portions of the airline passenger processes. Template modules are classified into three main groups: data modules, logic modules and process modules.

1. Data modules define system information that is critical to either the passengers or the processes in the model. Data modules are placed in the model once and define and control the basic parameters of the model. Each of these data modules is linked to an interface to allow the information to be imported and/or entered easily. Microsoft® Visual Basic® for Applications was used to build the interface to the data modules. Microsoft® Excel 97 is the standard data repository.

2. Logic modules allow the user to define passenger flow through the model. Most of the logic modules in the template describe the actions in one type of area in the actual system, such as physical locations like security. In addition to these high level modules, other lower level logic modules are included to allow the modeling of more advanced logic. Logic modules may be used in a model multiple times and are connected to each other in such a way as to describe the logical flow of passengers throughout the system.

3. Process modules define tasks to be performed in the model. A process is defined once, but may be referenced in multiple locations in the model. Passenger Process modules define specific passenger activities, for example, Issue Ticket, Issue Boarding Pass, Accept Baggage, Clear Security, Clear Immigration, Clear Customs, Gate Check-In, and Boarding Control.

The template includes two separate modules with flight specific data. The Flight Schedule module contains standard information for each flight like airline code, flight number, scheduled departure time, aircraft type, and flight type. The Carrier Specific Data module contains other flight specific data like assigned gate number, estimated departure time, number of first class passengers, number of business class passengers, and number of economy class passengers.

The Arrival Pattern modules define the percentage of passengers who arrive during defined time intervals prior to the flight departure. There can be different arrival patterns based on passenger type, time of day, and flight type.

The Passenger Definition module assigns values to passenger attributes. The attributes include passenger status, value to the airline, ticket status, ticket type, and payment type.

The Aircraft Parameters module contains aircraft type specific information that is needed in the template. This information includes the gate open and close time, the aircraft boarding time, the gate close-out time, and the number of gate agents assigned for check-in and boarding.

Service Location modules represent physical areas in the system where passengers are serviced. A terminal check-in counter or security checkpoint are examples of service locations.

Decision Location modules represent points in the system where passengers choose among various routing options. These decisions may be based on passenger attributes, system status, or random chance.

Gate Area modules represent areas in the system where passengers go through gate processes. Gate check-in and boarding are examples of gate areas.

The Resource Schedule module defines a staffing schedule for service locations, gate check-in counters, or boarding areas. The staffing schedule controls the availability of the resources required to support the processes at these locations.

3.3 Experiences in Template Development

We describe both positive and negative experiences we have encountered during the development of the Journey Management Library template. The template provides a much easier method to import data directly from a spread-sheet and to export data for reporting and analysis. The need to convert alphabetic and alphanumeric information to a corresponding number or nickname, for use by Arena, is avoided. The logic for generating passenger arrivals and other computationally intensive functions is built into the template and invisible to the end-user. The animation is flexible and realistic. By starting with a previous model, the process of defining the functional specifications and developing the template was facilitated. However, the specifications still needed to be refined as our understanding of the system improved and the development progressed. Systems Modeling Corporation’s expertise in developing templates and providing options and advice on implementation issues was invaluable.

The major steps in template development are high-level design (HLD), low-level design (LLD), develop, and test. It is good development practice to complete both high-level and low-level designs prior to beginning actual coding. Based on Systems Modeling Corporation's experience and recommendation, we decided to complete HLD and then do LLD and development in parallel. This decision proved to have both positive and negative ramifications. On the negative side, we experienced multiple refinement iterations because decisions made at one point in time had repercussions in other places. On the positive side, it provided us with more flexibility in making decisions as we reviewed and refined the template prototypes throughout the development phase.

4 NEXT STEPS

The JML is a decision support application that provides relevant and timely information. As an interactive and flexible management tool, the JML enables resource planners, business process experts, and operations research analysts to solve complex planning tasks in order to provide the highest level of service to its customers and enhance productivity at airports. Specifically, the JML can be used to benchmark the use of several customer service technologies, such as voice recognition, smart cards, or self-service kiosks against internal and industry performance measurements to identify which solutions perform the best under various scenarios, on a desktop workbench, before making actual investments in staffing or equipment.

Because the template can operate as a stand-alone module representing a single process or integrated with other templates to examine multiple processes across functional areas, the JML template can be used in the future by both airlines and airport authorities to, amongst other things:

1. Examine baggage handling operations from terminal check-in to the air field;
2. Examine the impact of security and customs regulations on passenger movements and terminal resource allocation;
3. Examine the management of air cargo warehousing and handling operations; and
4. Examine the travel patterns of passengers to and from retail and food & beverage concessions within the terminal building.

The JML, given its ease of use, allows airlines and airport authorities the ability to easily represent multiple service configurations and quantifiably (e.g. either by economic or statistical measures) choose between alternatives. The value to the organization is that the template can be quickly assimilated, re-used, and repeated with minor parametric changes by other field locations and used to improve customer service and enhance productivity.

The JML also has applicability to other travel-related service providers. In the competitive travel and transportation environment, rail, lodging, rental car, and cruise line companies are planning and preparing for ways to handle the increased volumes of passengers as the millenium approaches.

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