



TECHNICAL PAPER

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THE VIRTUAL AIRPORT

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All airports are unique in terms of markets served, services offered, physical layouts and appearance, business and community relations, and profitability. So why would airport planning and design be based on generic formulas derived from average performance between many airports? The traditional “one solution fits all” planning approach is giving way to ever improving computerized programming methods that better consider each airport’s unique setting and pattern of traffic fluctuation.

In the early 1990s, Bechtel began to assemble and build a suite of computer software programs aimed at providing tailored master planning and design solutions through automated simulation of airfield, terminals, roads, and other airport systems. Bechtel calls this collection of industry and proprietary simulation modules “the Virtual Airport”.

Over time, the Virtual Airport modules have been upgraded to provide tailored solutions to airport business plans, not just master plans. This enables Bechtel and its clients to analyze different alternatives under specific traffic scenarios, quantify the expected level of service, visualize performance and appearance, understand financial implications of various development options, prioritize capital investment projects, and mitigate environmental impacts.

Why the Virtual Airport?

Simulation techniques are common today as a supplement to FAA, ICAO, and IATA guidelines. So, what is unique about the Virtual Airport application?

Bechtel's Virtual Airport is designed in interrelated modules and combines four key elements: 1) flight schedule generator, 2) simulators of airside, terminal, and landside operations, 3) visualization and animation, and 4) economic implications of various alternatives. Here are key advantages:



- Airline- and airport-approved design day flight schedules form the basis of peak-period projections for passengers, cargo, aircraft, and cars. Thus, estimates of peak-hour traffic are calculated consistent with airline growth projections and airport-specific peaking patterns.
- Airfield, terminal, and ground access simulation modules are interlinked to allow testing of alternative development options in a realistic matter. The introduction of an A380 to a flight schedule will immediately depict implications on performance standards for the airfield, aprons, terminal, roadway, and parking systems.
- Visualization techniques allow clients to view various esthetic alternatives to determine desired spatial configuration, materials, finishes, light conditions, etc. Animation depicts how conditions develop during a specific traffic peak or during an abnormal event.
- Operational simulations are interlinked to economic modules so that capital costs, operating expenses, and revenue implications of proposed alternatives are projected based on the same set of client- and operator-approved assumptions.

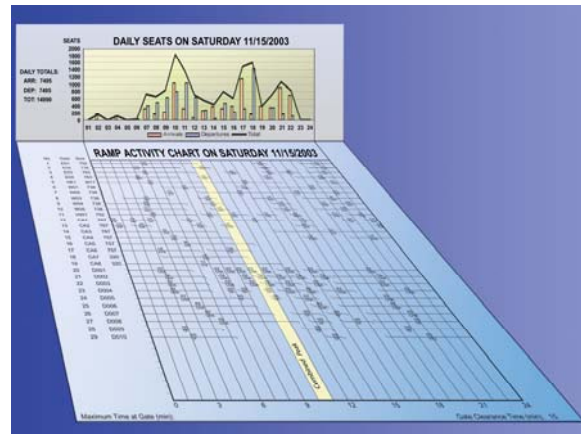
Each Bechtel-proprietary module has been tested on dozens of airport projects and calibrated based on actual performance results. Continuous improvement is in Bechtel's

culture to service our clients, especially if the client is sometimes ourselves. The Virtual Airport modules are constantly utilized by Alterra Partners, a 50-50 joint venture of Bechtel Enterprises Holdings and Singapore Changi Airport Enterprise, as part of concession agreements at London Luton, Costa Rica, Lima, and Curacao airports.

Flight Schedule Generator

The flight schedule generator is a key element to the Virtual Airport suite of software because it emulates the demand on an airport system relative to time of day.

The flight schedule software package is organized into interfacing modules. The first module includes the worldwide Official Airline Guide (OAG) database. This database covers all route segments of some 900 scheduled carriers between 4,500 airports around the globe. Using this database and Bechtel proprietary software, flight schedules can be analyzed to determine key patterns at the airport under study or at competing airports.



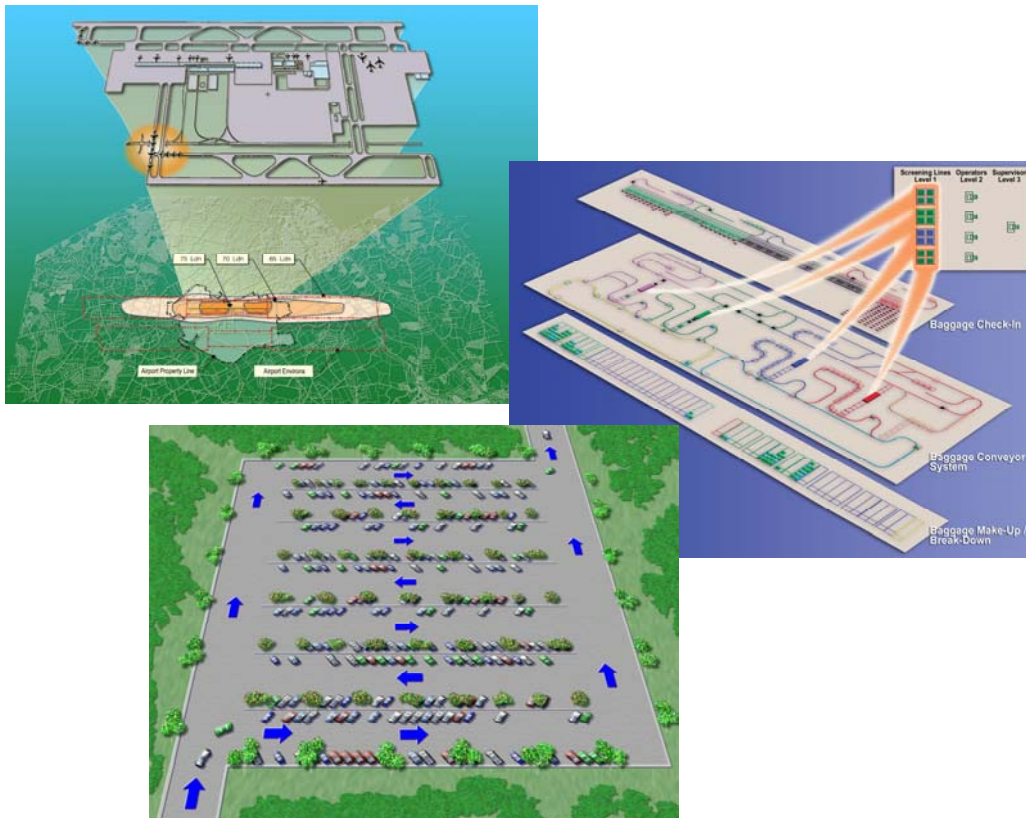
Using passenger and cargo traffic forecasts, a design day flight schedule for each planning horizon is developed. This flight schedule embodies all the assumptions about fleet mix, load factor, and seasonal and hourly flight patterns. Various peaking conditions for different airport users can be derived from this flight schedule.

Operations Simulations

Simulation of airspace, airfield, terminal, and ground access operations are key to optimizing operational efficiency relative to client-approved levels of service. The Virtual Airport toolkit includes third-party software as well as Bechtel proprietary applications that have been developed and tested on Bechtel jobs. All of these modules are driven by the same design day flight schedule to promote consistency.

Aircraft Simulations: These modules deal with aircraft movements and ground support. FAA-developed SIMMOD models the movement of aircraft between the gate and the runway and into the airspace that is subject to air traffic control rules and airfield limitations. Bechtel used this program recently to model air traffic conditions for the three primary San Francisco Bay Area airports to determine if new runways will be needed by 2010 and 2020. INM software, the standard FAA noise impact program, is used for planning and determining zoning restrictions around an airport. INM was recently used to complete noise analyses and airfield movement simulations for the Greenville-Spartanburg airport in South Carolina. PathFinder is a plug-in module of advanced CAD software. It enables planners to simulate the movement of an aircraft's

nose wheel along specified taxiway striping and computes the resulting the wingtip and tail paths. PathFinder is very helpful in ensuring that clearances to other aircraft and fixed objects are met, and if there are clearance problems, can compute where the nose wheel stripe should be. Bechtel proprietary modules estimate ground service equipment requirements based on ramp charts derived from the design day flight schedules. Future fuel demands were recently estimated for sizing the hydrant system capacity and the fuel truck fleet for Miami International Airport.



Terminal Simulations: Bechtel’s proprietary modules track the movement of people and baggage inside a passenger terminal, driven by the flight schedule and earliness of arrival patterns. With this tool, the different facilities of the terminal can be sized to meet closely the desired level-of-service criterion. This simulation recently resulted in substantial savings of expenditure for the Juan Santamaria airport in Costa Rica.

The current security environment at airports, mandated by TSA and other international agencies, has increased security-processing threefold. Several recent terminal simulations have quantified the extent of queues and the resulting blockage of critical functions during peak hours. Simulations also indicate that a multistep baggage screening approach aimed at funneling unresolved bags to more sophisticated detection equipment would increase throughput and minimize outlay for expensive equipment and terminal space.

Ground Access Simulations: The design flight schedule and travel patterns drives vehicular and train movements at airports. TRANSCAD is a commercial urban transportation-planning tool that models vehicular traffic on a network of streets, ramps, and freeways. TRANSCAD software applies traffic generated by the airport to surrounding highways and streets to determine peak-hour impacts. TPC is a proprietary train performance program that has been used with success in modeling the new rail line that will serve the Athens airport for the 2004 Olympics Games. PARKSIM is also a proprietary program that is used for determining the short-term and long-term parking needs of airport patrons.

Visualization

Technology has greatly advanced in the field of visualization and Bechtel has taken advantage of applying such technology to daily engineering activities. Our airport design utilizes commercial 2D/3D CAD modeling and Flythrough software as well as virtual reality applications.

Visualizations, animations, and simulations can be tied together into a dynamic simulation virtual reality model so that facility space requirements and level of service during peak conditions can be verified.



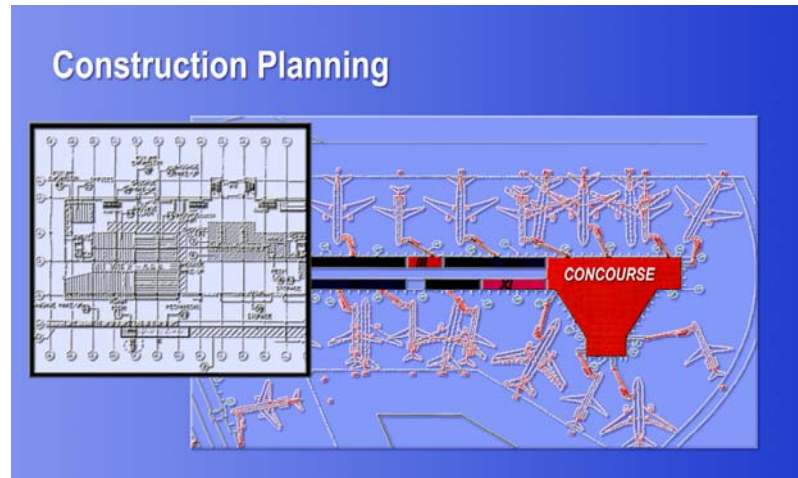
Visualization techniques were heavily utilized on recent projects in Curacao and Jeddah to demonstrate specific design solutions and proposed architectural treatment. Realism was key in the creation of the final product; 3D models were created in CAD. Material texture was applied to each surface of the model so that a glass panel wall was distinguishable from a stucco wall. Lighting and reflectivity studies were applied to the model to analyze light distribution. Walk-through models were created to enable clients to visit the site in a virtual reality tour.

Economics – Commercial Applications

As a result of the post-September 11 environment of rapidly increasing costs and declining revenues, airports want to know how growth plans impact the flow of money, where the money comes from, and where it is spent. The Virtual Airport offers numerous

modules to determine investment levels, quantify financial impacts of various alternatives, and optimize expenditures through effective construction sequencing.

Proper phasing of planned development is key to both airport costs and revenues. The Virtual Airport incorporates modules that integrate CAD graphics with intelligent database and scheduling software. Construction progress information flows via the Bechtel network from the jobsite to the engineering offices for conversion



into precise staging diagrams and management controls information. The information is then sent back to the job site, often within 24 hours, to guide the next construction increment. Not only is the Virtual Airport able to save clients millions of dollars, but it also minimizes disruptions to existing operations that impact level of service and revenue generation.

The Virtual Airport also features a financial module that groups the various functions performed at an airport into revenue and cost centers. Annual cash flows driven by client-approved flight schedules are generated. A financial model then tests numerous scenarios and sensitivities using statistics such as net present value, return on equity, return on investment, and debt-service coverage ratio. The demand of this service to date has mostly been from privatized airports or airports considering privatization. Bechtel completed a strategic business plan study for Aeroporto G. Marconi di Bologna S.p.A. and provided specific recommendations to alleviate infrastructure, environmental, organizational, and commercial/financial constraints. The financial model showed that successful implementation of the recommended strategies could increase the net present value of the airport by nearly 300 percent and increase employment and economic benefits by 50 percent beyond current plans.

The cost of implementing different alternatives of airport expansion is greatly facilitated by the database of airport cost information maintained by Bechtel's cost estimating department. These costs are further adjusted to local conditions anywhere in the world, by means of indices on labor and material trends. Bechtel Estimating Toolkit (BETK) is a suite of software programs sharing a common database and COM-based software architecture (Component Object Model). The BETK database is hosted on Windows 2000 Servers running Oracle 8.1 or later, and several COM layers tie everything together. Depending on the degree of design detail of each alternative, experienced cost estimators can develop cost figures with corresponding precision, from order of magnitude costs to definitive and engineers' costs estimates.

MOVING FORWARD

The Virtual Airport offers Bechtel's clients:

- Faster planning cycle – schedule and cost reduction
- More informed decision-making capability
- Verification of proposed service levels
- Testing before construction
- Optimization of capital expenditures
- Better means to inform the public

As different modules of the Virtual Airport are utilized by Bechtel's projects, new features are added, older manual calculations are automated, and more data interfaces between modules are developed and upgraded. Clients can keep asking "what if?". . . be it efficiency, security, appearance, economics, sustainable development, or any other critical issue of the day.

About the authors:

Both are employed by Bechtel Aviation Services. Omran Assa is vice president and manager of aviation planning. Michel Thomet is manager of modeling and simulation.