

To meet the increased demand for air travel and to properly accommodate the new requirements of modern aircraft, airport facilities designed in the early part of the 20th century have been undergoing major expansion programs. With limited functional space and fixed capital budgets, these projects have provided many challenges to airport designers.

Looking south from Calgary International Airport to the city centre (photo: EBA).

Calgary's juggling act

As part of this development trend, Canada's Calgary International Airport recently underwent a major expansion to its airside facilities. The new "Taxi Juliett Development", budgeted at \$12.5 million, features 67,400 m² of new taxiway and a 24,600 m² of new cargo apron.

Calgary International Airport was originally built in 1939. As one of Canada's top airports, the facility has undergone numerous upgrades to meet growing demand. Since 1994 alone, passenger traffic at the airport has grown by over 60%.

When EBA Engineering (see box story) was retained to design the new Taxi Juliett development, the company was given the considerable task of balancing a number of somewhat competing objectives - that of developing a design that maximised functionality (optimised space and layout), minimised capital costs, and ensured safety and quality.

By undergoing a planned approach and evaluating alternative designs, EBA was able to identify several design alternatives, and ultimately determine and execute the best approach to successfully meet the challenge.

The new cargo apron features four aircraft parking positions accommodating a broad range of aircraft.

"Developing a layout that maximised parking while ensuring the safe movement of incoming and outgoing aircraft was critical to the design," notes Richard Kohler, Project Manager of EBA

Kelly Foley from Transoft Solutions explains how Calgary International Airport used a ground movement simulation software to help make crucial decisions during its recent Airside Expansion Programme.

Engineering. Accommodating ground service vehicles and allowing for future expansion all had to be accomplished within a fixed budget. To achieve maximum efficiency, EBA utilised an aircraft simulation software known as AutoTURN to evaluate parking layout options.

The AutoTURN software, developed by Transoft Solutions based in Vancouver, provides specialised computer simulation of the ground movements of both aircraft and airport vehicles.

"For airport planners, the challenge begins and ends with the aircraft on the ground", explains Milton Carrasco, President of Transoft Solutions. "In this dynamic and congested environment, the ground movement of aircraft between the takeoff runways and the gates of terminal buildings, and the servicing by a wide variety of specialist and conventional traffic is a significant design focus".

With the AutoTURN software, the simulation of aircraft and airport vehicles can be accomplished directly within the computer aided design (CAD) environment used by engineers. It enables designers not only to test their designs against the normally expected activity but also allows them the opportunity to evaluate potential future changes and to review unusual or emergency situations.

By using AutoTURN, EBA was able to determine and evaluate the swept path and wing-tip clearances of a diverse range of aircraft. Jet blast contours of aircraft were also evaluated using the program. Based on this analysis, EBA was able to identify minimum clearance requirements and then develop layout options that would accommodate a variety of aircraft and service vehicles.

Before detailed design commenced, these options were presented to the Airport Authority for their consideration. Once the final layout was determined, EBA produced a design program that allowed the cargo apron to be developed in four stages. This gave the Airport Authority the opportunity to decide the size and configuration of

the apron that best suited its current and future requirements while remaining within the allocated budget.

Minimising capital cost

The development of new taxiways represents a significant cost to airports, mainly due to high-priced material costs such as concrete and asphalt.

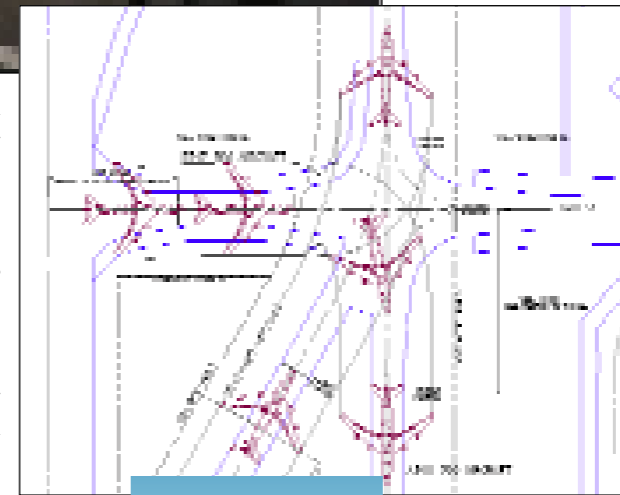
"To reduce these costs while still meeting operational requirements, we endeavoured to minimise the fillets that connect the taxiways to the runways," says Kohler. "As these fillets need to accommodate a diverse range of aircraft types, the turning angle had to be large enough to meet all clearance requirements".

EBA was able to identify the minimum required outside limit of taxiway fillets without extensive design calculations. The concrete panel locations and configurations were then determined from this outside limit, which minimised construction requirements and ultimately the cost to the Airport Authority.

The requirement of a new taxiway to improve aircraft movement ultimately involved the development of a five-way intersection - the busiest taxiway at the airport. Although optimising safety was a fundamental criterion for all elements of the project, the design of the five-way intersection was particularly crucial.

With multiple aircraft being positioned on the intersection, the location of the hold line positions was a key consideration. In order to optimise functionality and safety, these hold line positions needed to provide the minimum setbacks between taxiways, runways and associated wing tip clearances. Again, EBA used AutoTURN to plot various aircraft approaching the intersection and evaluate possible configurations.

As Transport Canada and NAV Canada were concerned with the operational considerations of this intersection, the ability to present design options was



Taxiway fillet design: The use of AutoTURN allowed EBA to identify the minimum outside limit of taxiway fillets without extensive design calculations (graphic: Transoft).

particularly important. EBA provided representatives drawings of taxiways and aircraft movements for the airport's review. All parties subsequently approved the design configurations and hold line positions.

Canadian taxiway first

The entrance of Taxi Juliett to the threshold of Runway 10 was an issue with the airlines throughout the entire design process. Taxiways have traditionally been designed to enter the runway at the threshold location from the side in a variety of configurations. However, the airlines requested that Taxi Juliett enter the runway through the end of the threshold in order to eliminate the lost 'line-up distance' of approximately 60 metres.

This lost line-up distance on Runway 10 can, at times, equate to a reduction in payload on takeoff,

depending on the time of year. EBA provided several design configurations that provided the required taxiway alignment and widths for acceleration/deceleration and off-tracking of aircraft. These options were reviewed for functionality and cost in order to determine the most efficient and cost effective design.

In the end, Transport Canada, NAV Canada, the Calgary Airport Authority, and the airlines agreed on the ultimate design that would

provide the Calgary International Airport with the first curved taxiway in Canada designed to enter a runway through the threshold.

There is little doubt that, to meet the changing need of the coming millennium, airport facilities around the world are undergoing dramatic upgrades that are presenting unique challenges to airport designers. The Calgary International Airport Airside Expansion Program, an inherent juggling act of balancing cost, functionality, and safety, typifies this trend.

By effectively performing the "juggling act" for Calgary International Airport, EBA was able to not only develop an innovative yet cost-effective design that reduced the taxiway and apron areas, but also meet code and safety standards and the unique requirements of the airport.

What is AutoTURN?

AutoTURN is a software programme for simulating turning vehicles and aircraft. With its comprehensive evaluation capabilities, AutoTURN promotes the development of innovative solutions to complex design challenges.

Alternative designs can be assessed against a wide set of variables, including multi-aircraft alignment considerations, service point locations, jet blast contours, curb and pavement locations, future expansions, and overall cost-effectiveness.

About EBA

EBA's team of airport consultants offers a broad range of consulting services relating to planning, design construction management, environmental, airside operations, maintenance and pavement management systems, with the level and type of service provided dependant on the size and requirements of the airport. The organisation has completed more than 300 projects on 100 airports and navigational facilities in Western and Arctic Canada, Alaska and Norway.