Laboratory advances

Not many of the 100,000 people at the public unveiling of the 777 on 9 April will realise that the aircraft has already "flown" for thousands of hours.

The flights have been happening for months, not through the airspace over Seattle, but by the murky Duwamish Waterway in the southern district of the city. Here lies Boeing's newest, most powerful development tool, the Integrated Aircraft Systems Laboratory (IASL).

Inside this centre of excellence are grouped several integration laboratories devoted to meeting the "service-ready" goal of the 777 — the first aircraft to pass through the new system. "The 777 represents a change in the way we're doing things at Boeing and this represents that change," says IASL implementation manager, Arthur Fanning.

"The biggest challenge is keeping up with the dynamic environment. Building an aircraft is a huge human endeavour and keeping up with that dynamic is the largest challenge," he says.

One of the main dynamics of the 777 programme is the drive to have the aircraft ready to enter service from day one. "We have a service-ready initiative....but how do we know the 777's service-ready? We don't know that until we see it work. We used to see it work on the flight line. Now we see it in the lab before it ever gets built."

The IASL "....consolidates tasks that were done around Seattle and brings together technical development under one roof. We used to develop technology in one location, build it in another and test it somewhere else. Now we're trying to locate all those functions here, apart from the design," says Fanning.

The $110 million centre opened for business in October 1992 and is still expanding, as new activities begin filling its 48,000m² area with over $250 million worth of test equipment. More than 50 functional laboratories are housed, four of which are integration labs which bring together groups of aircraft systems.

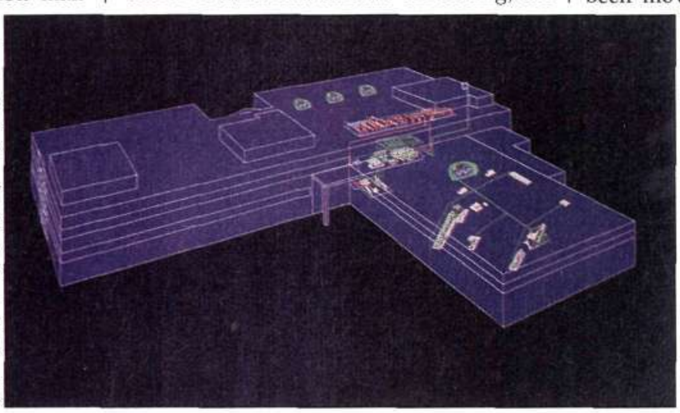
The Systems Integration Laboratory (SIL) is one of the major units of this group. The SIL has 43 Harris Night Hawk computers to verify the correct performance of the systems interfaces and checks their behaviour in simulated flight and ground operations.

"Aircraft Zero", or the "777 without the skin", is divided up between the laboratories. "Aircraft-Zero avionics are in the SIL, Aircraft-Zero engineering is in the 'Iron Bird' [the flight-controls test rig] and Aircraft-Zero flightdeck systems are in the cab 2 interactive flightdeck simulator," says Fanning.

Aircraft Zero represents the entire philosophy of the IASL. "We must think of it as the first aircraft — not the one that will roll out. We encourage people to think of it like that because it focuses them. When I say 'them', I mean people here as well as those involved in production," he adds.

EARLY EMPHASIS

Early test emphasis was on the flight-control test rig (FCTR) which is used to validate the 777's fly-by-wire flight-controls system and its electrical and hydraulic support systems. Unlike previous rigs, which required the correct orientation of an actual aircraft for testing, the flight controls for the 777's three control axes are mechanically independent of each other and connected by wire.



Integrated Aircraft Systems Laboratory: dedicated to "service-ready" 777

Signals are sent electronically from a simulated cockpit, where engineers move the control columns and rudder pedals to actuate the rig's control surfaces. In the case of the Iron Bird, it has one of each of the main "flight feathers" — an aileron, rudder and elevator — as well as a set of spoiler panels.

Once electronic "boxes" have been tested in the FCTR, they join others already being run in the SIL. "We've built up the SIL layer by layer by layer and we've gradually assembled the backbone of the structure with a digital bus and got it communicating," says Fanning.

Software needed for the first aircraft was infiltrated into the system in January and later shipped as "Red Label" items to Everett for installation in the real 777.

The impact of the IASL was felt by the programme as early as late 1993. "We've changed the later parts of the programme already," says Fanning. "We've been able to reduce the number of demonstrations required in flight test by doing them here. This will keep the flight-test programme to a manageable size."

The ability to test and re-test systems will also help Boeing in its efforts to achieve "instant ETOPS", or "ETOPS out of the box" as it is sometimes called. "We're extremely useful to ETOPS because we're taking development work and pulling that forward. We've always had the desire to do that, but never had the tool to do it before," Fanning says.

The IASL is not intended just for the 777 and, as part of the recognition of the increasing complexity of new air-transport aircraft, it will be used for all new Boeing aircraft and derivatives. "We're looking at what we'll have to do for the 737-X family as well as the B-market 777 and the stretch version," says Fanning.

Some other activities, such as the engineering-development flightdeck cabs of the 737, 747-400, 757 and 767 have also been moved into the IASL. The group of seven engineering simulation cabs is recognised as a third integration lab in its own right. "Cab 2 [777] is among those IASL systems that are really pushing the technology edge," says Fanning. "It does a full simulation of the aircraft by using real aircraft systems. Without those systems in place it would be really difficult to de-bug them."

The fourth integration laboratory is for the electrical-power system, in which new designs for electrical-power generation and distribution are evaluated. The site is used as a test rig for the 777's systems, largely produced by Sundstrand Electric Power Systems. The aircraft's variable-speed, constant-frequency electrical-power generation system is among the first commercial applications of this technology.

Boeing's experience of the IASL and new technology to date indicates that this will continue to be the right way to go.

"We were concerned that growing complexity will outpace our ability to make aircraft in this way. In some cases, such as using CAD/CAM [computer-aided design/manufacturing], we put in extra time for building up and fitting together the first parts, using what we thought was already an aggressive time improvement compared to the past.

"What actually happened was that less time was required than we expected. Parts fitted together much better and more consistently.

"So, the next time we know we will continue to be cautious, but we shall shorten our development time. Already, the team's doing great and every day they find new ways to amaze us," concludes Fanning.